INDIAN JOURNAL OF ORTHOPAEDICS
April 2004
Volume 38 : Number 2 : P. 73-79

Current Concepts Article

Digital X-ray radiogrammetry : a new technique for bone mineral density estimation in osteoporosis

Ketan C Pande

Department of Orthopaedics, Indira Gandhi Medical College and Mayo General Hospital, Nagpur

Osteoporosis is a major health care problem around the world and its importance lies in the fractures that result. The aetiology of fractures in osteoporosis is multi-factorial. Reduced bone mineral density (BMD) is an important component of fracture risk and its measurement forms the basis for the working definition of osteoporosis. A variety of devices are available in India for BMD assessment, but their clinical utility is limited because of non-availability of Indian database.

Osteoporosis is defined as 'a systemic skeletal disease characterised by low bone mass and micro-architectural deterioration of bone tissue, with a consequent increase in bone fragility and susceptibility to fractures'.[1]

Fractures are the hallmark of osteoporosis. These commonly affect the distal radius, vertebral bodies and the hips. The risk of fracture in osteoporosis is determined by the risk of fall, the force of impact and the strength of bone.[2] The increase in hip fracture incidence with aging is partly due to an age-related reduction in bone strength. Many of the factors that contribute to bone strength (microarchitecture and presence or absence of microfractures) are correlated with bone mass,[3] which can be assessed by non-invasive measures. Thus bone mineral density (BMD) is an important determinant of fracture risk in patients with osteoporosis and forms the basis of the World Health Organisation (WHO) classification.[4]

Various techniques for the non-invasive assessment of skeletal status are now available. These include conventional radiography, radiogrammetry, radiographic absorptiometry, single- (SXA) and dual X-ray absorptiometry (DXA), spinal and peripheral quantitative computed tomography (QCT/pQCT), quantitative ultrasound (QUS) and magnetic resonance imaging. The role of these modalities in the management of osteoporosis has been a subject of recent reviews.[5-7] The techniques mentioned above differ in their precision, accuracy and discriminatory ability as well as their fundamental methodology, availability and utility in clinical practice and research.

Increasing awareness of osteoporosis worldwide and the development of effective treatments will increase the demand for management of patients with osteoporosis. This will include facilities for the diagnosis and assessment of osteoporosis. There is evidence in literature that bone mass is lower in Indians and osteoporosis may be more common than in the west.[8] A variety of devices like DXA, QCT and QUS are now available in India, but their clinical usefulness is limited by lack of Indian normative databases.

Historical Perspective

It is well recognised that as much as 20-40% of bone mass must be lost before a decrease in bone density can be detected on a conventional radiograph.[9]

Radiogrammetry is a technique that uses a conventional radiograph for the assessment of bone status. The use of cortical width as a measure of bone strength was originally proposed by Barnett and Nordin and Virtama and Mahonen in 1960.[10,11] The earlier technique had a large precision error owing to the subjective human measurements of cortical width. There has been a renewed interest in the technique with the availability of modern computer technology and high-resolution digital scanners.[12,13]

In 1999, the US Food and Drug Administration approved Digital X-ray Radiogrammetry (DXR) (Pronosco X-posure System V.1) as a clinical method for estimating BMD substantially equivalent to BMD assessed by Dual X-ray Absorptiometry (DXA-BMD). In 2000, the Pronosco X-posure System V.2 was approved.

Technique

With Pronosco X-posure V.2 based on DXR, a BMD estimate is obtained through a combined computerised

Ketan C Pande, MS (Orth), DNB (Orth), MCh (Orth), Consultant Orthopaedic and Spinal Surgeon, Centre for Osteoporosis Management & Research, Sushrut Hospital, Research Centre and PostGraduate Institute of Orthopaedics, Nagpur and Hon. Astt. Prof. of Orthopaedic Surgery, Indira Gandhi Medical College and Mayo General Hospital, Nagpur. Email: ketanpande@yahoo.com
Received : 2.1.2003; Revised : 5.2.2004; Accepted : Mar. 2004

radiogrammetric analysis and textural analysis of a digitised radiograph of the hand. Information from the middle three metacarpals is used by the system to generate a BMD estimate. This is referred to as digital X-ray radiogrammetry BMD (DXR-BMD). The DXR-BMD is corrected for porosity, which is assumed to reflect properties of the cortical bone micro-architecture.

In the Pronosco X-posure System V.1, the BMD estimate was obtained through the same technique as V.2 except that information from distal radius and ulna was also used.

A plain radiograph of the non-dominant hand (preferably) is taken under standardised conditions. After checking the quality of the radiograph, it is placed in a scanner, which digitises the image. The initial computer processing identifies anatomical landmarks and automatically defines the 'Regions of Interest' (ROIs). The digitised image is displayed on the screen with the ROIs superimposed. There is no operator activity involved in placing the regions.

The system computes the DXR-BMD based on the cortical thickness of the ROIs. The cortical thickness is measured 118 times per vertical centimetre of the ROI in each cortex, giving a total of 236 measurements per centimetre when averaging over the two cortices. The DXR-BMD estimate is presented as i) an absolute bone mineral density estimate in g/cm^2, ii) graphically, in a DXR-BMD versus age plot, together with a reference curve, iii) a T score and iv) a Z score.

A number of studies with the use of DXR have been initially done using the Pronosco X-posure System V.1. Recent studies have been with the Version 2. Several studies have confirmed that there is equivalence between the two versions of the Pronosco X-posure System. The regression analyses of DXR-BMD V.1 versus DXR-BMD V.2 measurements indicated that the slope of regression line was close to one (with a 95% confidence interval) and the intercept was close to zero (with a 95% confidence interval). These two observations indicate high degree of correspondence between DXR-BMD V.1 and DXR-BMD V.2 measurements.[14]

Fundamentals of DXR-BMD

In order to establish the equation for DXR-BMD, the Bone Volume per Area (VPA) is determined by radiogrammetry.[15,16] The DXR method applies to bones that are mainly cortical. For a cylindrical bone, the following exact formula can be derived: $VPA = \pi * t * (1 - t/W)$

W is the outer diameter of the bone and t is the cortical thickness. The volume V and the mass m of a homogenous body is in general related by the specific density ρ through the relation $m = \rho * V$. In the context of BMD, it is the specific mineral density rather than the specific density that is required. This has been studied by Laval-Jeantet [17], who found that this specific mineral density after correction for porosity is $\rho = 1.2$ g Ca/cm^3 for both men and women with no age dependence.

Thus there is a constant relation between BMD and VPA, and the DXR method determines VPA, which by multiplication by a constant becomes a BMD estimate. Hence the simplest DXR-BMD expression derived from the first principle is

$$DXR\text{-}BMD = \rho * VPA$$

The DXR-BMD equation includes a number of refinements to the fundamental considerations described above. These refinements address non-cylindrical bone shape, magnification factor, trabecular bone fraction, and porosity. The first three properties are adapted to through a proportional constant, whereas the porosity is estimated through a separate algorithm.

The importance of reference database

According to the literature, BMD varies with ethnic origin [18] and therefore interpretation of BMD measurements requires a reference range for the local population. Using data from Indian and other reference databases established using the Pronosco X-posure system, it has been shown that Indians have BMD lower than the Americans, Caucasians and Germans while it is greater that that in Hispanics, Koreans, Chinese and Japanese.[19] It is obvious that the use of a reference database where the BMD is known to be higher will lead to overdiagnosis and conversely the use of database with lower BMD values will lead to underdiagnosis of osteoporosis.[8]

As of today reference values for DXR-BMD obtained by Pronosco X-posure System™ are established for more than 11 different ethnic populations. Of all the techniques now in use in India, till date Pronosco X-posure system is the only device for which normative reference ranges are available for Indian men as well as women.[20]

Performance of the DXR-BMD

A number of clinical studies have been completed evaluating the equivalence of the DXR-BMD to DXA-BMD, in-vivo precision of the DXR-BMD measurements, and the diagnostic value of the system. The effect of a number of different capture conditions on the sensitivity of the DXR-BMD measuring algorithm has also been studied.

There are four different ways in which a BMD assessment technology can be used. It should i) help in the diagnosis of osteoporosis, ii) be able to detect changes in BMD with time or after any therapeutic intervention, iii) be able to predict occurrence of fragility fractures in a patient, and iv) be able to discriminate between patients with and without previous fragility fractures.

Diagnosis of Osteoporosis

Bone mineral density assessed by dual energy X-ray absorptiometry (DXA-BMD) is referred to as gold standard in the assessment of BMD and prediction of fractures.[21] To study the utility of any newer device, equivalence of the new technology with DXA-BMD can be studied.

In a cohort of 416 Danish women, DXR-BMD was found to be closely related with BMD at the distal radius measured by DXA ($r=0.86$, $p<0.0001$) and also with BMD at the spine, total hip and femoral neck ($r=0.62$, 0.69 and 0.73 respectively, $p<0.0001$ for all).[16] In another study of 822 patients, the equivalence between DXR-BMD and distal forearm DXA-BMD was found to be 0.9 (p value 0.0001) and that with hip BMD was found to be 0.6 (p value 0.0001).[22] Bouxsein et al [23] in a study of about 100 patients reported a correlation of 0.75 between DXR-BMD and distal radial DXA-BMD and a correlation of 0.50 between hip DXA-BMD and DXR-BMD.

In a study of 340 healthy women and 49 women with osteoporosis, after calculation of T score for all measurements, the study group was divided according to the WHO criteria for osteoporosis. If the T-score of the femoral neck and spine was above –2.5, the subject was categorised as normal and if it was below –2.5, the subject was categorised as osteoporotic. Close agreement was found between the assessment by DXA and DXR. Both measures agreed on categorisation of sample as normal as well as osteoporotic. The agreement for the normal individuals (specificity) was 0.93 and the corresponding agreement for the osteoporotic individuals (sensitivity) was 0.89. Furthermore, only very few osteoporotic individuals were diagnosed as normal based on DXR-BMD, reflected by a negative predictive value of 0.98.[24]

The above studies suggest that DXR-BMD has high correlation with site specific DXA-BMD as well as significant correlation with hip DXA-BMD. There is also close agreement between the categorisation of patients using DXR and DXA. Therefore DXR-BMD can be used in the diagnosis of osteoporosis.

Measurement of longitudinal change

Hyldstrup et al [25] reported a study to assess changes in BMD following treatment with bisphosphonates using DXR and DXA at the spine, hip and distal radius. After a mean observation period of more than 2 years, DXR-BMD and trochanteric DXA-BMD showed a significant difference, when comparing annual changes in the test group (10 women treated with etidronate or alendronate) and controls (21 women).

The ability of DXR to evaluate the longitudinal changes in different bone parameters was studied in comparison with DXA-BMD in an open comparative, non-randomised observational study. In the sample of 113 postmenopausal women, 69 were untreated, 28 were using HRT and 11 were being treated with bisphosphonates.[26] An expected annual postmenopausal reduction in BMD of 1 to 1.5% per year was detected in the untreated group by both DXA and DXR. The HRT treated group had a lower annual decrease in BMD compared to the untreated group whereas the bisphosphonate treated group demonstrated an increase in BMD measured at all sites except for the forearm DXA. In conclusion, the DXR technology in comparison to DXA was found to be more sensitive to changes in the bones caused by anti-resorptive treatment.

In a more recent study it was demonstrated that treatment with clodronate was associated with highly significant differences in changes of DXR-BMD over three years compared to placebo. The changes detected by DXR-BMD were of similar magnitude to those observed with DXA-BMD at the spine and hip.[27]

Precision

When evaluating individual changes in BMD over time, knowledge about the reproducibility (precision error) of the measurement device is important in order to determine if a given change in BMD can be regarded as significant.[28]

The smallest statistically significant change that can be determined by a given densitometric technique is directly dependent on the reproducibility of the technique. This minimum change is often referred to as the least significant difference (LSD). With a confidence of 95%, a change in BMD of approximately 2.8 times the precision error is required in order to be statistically significant, while a change of approximately 1.8 times the precision implies a confidence of 80% that the change is real. The minimum monitoring interval (MMI) is the interval over which a given change rate results in a significant observed change.[28]

Table 1: Summary of precision studies

Reference	N	Repetitions	Mean (g/cm^2)	SD (mg/cm^2)	CV %	LSD (0.95%)	MMI (months)
Helboe et al 2001[30]	40	3	0.549	1.95	0.36	1.01	8.0
Friis et al 2001[31]	30	3	0.556	2.00	0.36	1.01	8.0
Sorensen et al 2001[32]	31	3	0.536	1.99	0.37	1.04	8.3
Johnell et al 2001[33]	34	3	0.495	2.78	0.56	1.57	12.5
All Pooled	135	3	0.533	2.22	0.42	1.18	9.4

LSD: Least Significant Difference

MMI: Minimum Monitoring Interval

One of the main advantages of the device with a good precision is that high rate of bone loss can be detected sooner than with a device with a relatively poorer precision. The required monitoring interval is directly proportional to the precision. For an individual with an annual bone mass decrease of 1.5%, a device with a precision of 0.5% will already detect a significant change after approximately 1 year, whereas the same decrease rate first will result in a significant absolute change after 2 years when using a device with a precision of 1%. For the most prevalent BMD assessment technique, DXA, the in vivo precision at different sites like spine, hip and distal radius has been reported to be between 1 and 3%.[28,29]

The precision of DXR technology has been thoroughly investigated in a number of independent studies. The results of these studies are summarised in Table 1.

Pooling of observed variations from the above four studies reveals an overall CV% of 0.42%. This is superior to other precision data documented in the literature on e.g. forearm DXA-BMD.[24]

So far no data on the long-term precision of the DXR method are available, but it is expected that the CV% will not be much different due to insensitivity of the method with respect to variations in the x-ray source. This is in contrast to DXA, where the calibration tends to drift over time. The DXA method is also known to be sensitive to the amount of the soft tissue, replacement of the X-ray tubes, staff changes and physical movement of the equipment.[34-36]

Fracture risk and fracture prediction with the DXR technology

A number of studies have given indication of the fracture risk prediction ability of DXR-BMD.[22-24, 37-41]

The ability of DXR-BMD to predict wrist, hip and vertebral fracture was studied in a case-cohort study within a prospective study of 9704 elderly women. The DXR-BMD was compared with BMD of the radius, calcaneus, femoral neck and lumber spine in women who subsequently sustained a wrist (n=192), hip (n=195), or vertebral fracture (n=193). All BMD measurements were similar for prediction of wrist (RH = 1.5 – 2.1) and vertebral fracture (OR = 1.8 – 2.5). Femoral neck BMD best predicted hip fracture (RH = 3.0), while the relative hazards for all other BMD measurements were similar (RH = 1.5 – 1.9).[23]

The odds ratio of all types of fragility fractures was reported to be 1.35 (n=264)[39], 1.50 (n=124)[40] and 1.81 (n=822)[22] by various authors.

Ashford et al [38] conducted a case-control study with 44 hip-fractures individuals and 173 normal cases. For DXR-BMD, the authors reported an age- and weight adjusted odds-ratio of OR=1.76. This is lower than OR=2.99 found for the DXA-BMD at the hip in the same study.

Andersen et al [37] compared DXA-BMD of the spine with DXR-BMD with respect to prediction of vertebral fractures on a study group of 619 subjects. The fracture definition was based on the sum of individual morphological grading from 0 to 3 for L1-L4. When a threshold of 1 was used to define osteoporosis, DXR-BMD showed an OR=1.5 compared to an OR=1.2 for spine DXA-BMD. When only the most pronounced fracture subjects were defined to be osteoporotic via a threshold of 4, the OR for DXR-BMD increased to 2.9 compared to 2.6 for spine DXA-BMD.

Table 2: Summary of diagnostic performance of DXR-BMD as represented by odds-ratio for various fracture types. Measurements marked with an asterix * refer to relative risks instead of adds-ratio.

Reference	N	Odds-ratio for fractures			
		Hip	Vertebral	Wrist	Others/All
Bouxsein et al 2002[23]	9704	1.80*	1.90*	1.90*	
Vasireddy et al 2002[41]	583		1.60		
Black et al 2001[22]	822				1.81
Shepherd 2001[40]	124				1.50
Ashford et al 2001[38]	217	1.76			
Bach-Mortensen et al 2001[39]	264				1.35
Andersen et al 2001[37]	619		1.5-2.9		

In a study of 538 women with osteoporosis with at least one prevalent vertebral fracture, 90 were found to have one or more incident fracture over a follow up period of 3 years. The gradient of risk per 1SD decrease (Odds Ratio, 95%CI) for incident vertebral fractures were similar for DXR-BMD, total hip BMD and spine BMD (1.6, 1.2-2.0; 1.5, 1.2-1.9 and 1.8, 1.4-2.4 for 1SD decrease in either respectively).[41]

Discriminatory ability of DXR-BMD for previous fractures

The ability of DXR-BMD to discriminate between patients with and without fragility fracture has been evaluated in a few studies.[42,43]

In a study of 313 women reported by Black et al [42], 60 (19%) reported a history of fracture. The age-adjusted association with fracture history expressed as odds ratio (OR) per SD decrease in BMD was found to be similar with DXR-BMD (1.81 [95% CI 1.2,2.7]) and DXA-BMD at the distal radius (1.98 [1.4,2.9]).

The discriminatory ability of DXR-BMD was compared with DXA-BMD at the spine, hip and distal radius in the study reported by Bach-Mortensen et al [43]. In a sample of 227 postmenopausal women with various fragility fractures, the DXR-BMD showed significantly lower T-scores ($p<0.001$) than DXA at any of the measured sites.

Reproducibility and sensitivity to changes in capture conditions

The reproducibility of the DXR-BMD estimation with respect to variation between sites, operators and repetitions using conventional radiographic equipment was studied by using 5 different anatomical hand phantoms with various BMD. The reproducibility of the Pronosco X-posure System V.2 as observed when performing two repeated measurements on two arbitrary different X-ray installations was found to be 0.5% of the mean value of young adult women. The precision error caused solely by repetition of measurements within a single X-ray installation and operator was found to be 0,3% of the mean BMD value of young adult women. The variation in X-ray equipment was not significant.[44,45]

Chen et al [46] reported no difference in the important DXR parameters except porosity, when the radiographs were obtained using two different techniques. DXR-BMD changed less than 0.3% from a combined setting of 50kV, 400mA, and 0.8s to a rather different setting of 60kV, 300mA, and 0.5s.

To test whether standard radiographs provide sufficient image quality for accurate DXR-BMD analysis, radiographs were obtained under different settings and conditions of the X-ray equipment. The following capture condition parameters were identified as causing less than 1% change in the DXR-BMD: Tube voltage, Exposure, size of focal spot, film-object distance, film-focus distance, displacement of the phantom, additional soft-tissue and different film screen systems.[47]

Hussain et al [48] conducted another study with different capture conditions for computed radiography (CR) derived BMD measurements. Variations across image plates and acquisition sites were added as well as filtering and rotation of the image plate. The maximal deviation of the BMD estimated from the standard protocol BMD was less than 1%. The above findings suggest that DXR-BMD is remarkably insensitive to all practical capture conditions.

An ideal screening tool or assessment method should be inexpensive, readily available, portable and should expose the patient to minimal or low risk or discomfort. It should provide information, which will help in the decision making process in the management of osteoporosis. In addition, it should have an acceptable accuracy and precision error.

Use of DXR in India

The DXA is regarded as the Gold Standard in the assessment BMD in Osteoorosis. Evidence of good correlation between DXA and DXR found in studies conducted in the west has been presented.[16,22-24]

In India, study is ongoing to assess the correlation of DXA and DXR. It is expected that the findings of this study will be similar to those from the studies mentioned above. Unpublished data suggests satisfactory correlation between DXR and distal radial BMD assessed by DXA. It is however important to note that no normative Indian data is available for DXA.

In addition to studies mentioned earlier for establishment of normative reference database,[20] assess prevalence of low bone mass in healthy Indian population[8] and demonstration of ethnic differences in BMD[19], DXR has been used to study BMD in Indian patients with fragility fractures.[49] Unpublished data is also available for BMD in Indian women with relation to menopausal status.

In terms of cost of installation and maintenance as well as cost to the patient, DXR has distinct advantages over DXA. Though the exact figures may vary, DXR is available at 1/4 to 1/5 the cost of DXA. Estimate of BMD can be made available to the patient at 1/3 to 1/4 the cost of DXA.

Summary

DXR-BMD seems to fulfil most of the requirements of an ideal screening tool, particularly in India where affordability and availability are two main issues for the use of any investigation. It has been extensively studied with respect to various uses of a BMD assessment technique. There is evidence of its high correlation with DXA-BMD, its ability to predict fractures as well as discriminate patients with and with out fractures. DXR-BMD can also detect longitudinal change in bone density with time and anti-resorptive therapy. It is operator independent and its robustness has been confirmed in two detailed technical studies. With respect to use in clinical practice, it is the only device for which an Indian normative database for man and women is available.

In conclusion, DXR-BMD is a promising simple and cost-effective alternative to conventional bone densitometry measurements by DXA.

References

1. **Consensus Development Conference V.** Diagnosis, prophylaxis, and treatment of osteoporosis. *Am J Med.* 1993;94: 646-650.
2. **Kanis JA, McCloskey EV.** Evaluation of the risk of hip fracture. *Bone.* 1996; 18: 127S-132S.
3. **Hayes WC, Piazza SJ, Zysset PK.** Biomechanics of fracture risk prediction of the hip and spine by quantitative computed tomography. *Radiol Clin North Am.* 1991; 29:1-18.
4. **WHO Study Group.** Assessment of fracture risk and its application to screening for Postmenopausal osteoporosis. *WHO Technical Report Series*, World Health Organisation, 1994, Geneva.
5. **Genant HK, Engelke K, Fuerst T, Gluer CC, Grampp S, Harris ST, Jergas M, Lang T, Lu Y, Majumdar S, Mathur A, Takada M.** Noninvasive assessment of bone mineral and structure: State of the art. *J Bone Miner Res.* 1996;11:707-730.
6. **Mirsky EC, Einhorn T.** Bone densitometry in orthopaedic practice: *J Bone Joint Surg (Am).* 1998; 80:1687-1698.
7. **Kanis JA, McCloskey EV, D de Takats, Pande K.** Clinical assessment of Bone Mass, Quality and Architecture. *Osteoporos Int.* 1999;Suppl.2:S24-S28.
8. **Pande KC.** Prevalence of low bone mass in healthy Indian population. *J Ind Med Assoc.* 2002;1000:598-600.
9. **Genant HK.** Radiology of Osteoporosis and other Metabolic Bone Diseases. In Favus MJ, editor. *Osteoporosis and Metabolic Bone Diseases*. Philadelphia: Lippincot-Raven, Publishers, 1996:152-163.
10. **Barnett E, Nordin BEC.** The radiological diagnosis of osteoporosis: a new approach. *Clin Radiol.* 1960;11:166-174.
11. **Virtama P, Mahonen H.** Thickness of the cortical layer as n estimate of mineral content of human finger bones. *Br J Radiol.* 1960;6:60-62.
12. **Rico H, Revilla M, Villa LF, Martin-Santos JF, Cardenas JL, Fraile E.** Comparison between Metacarpal Bone Measurements by Computerised Radiogrammetry and Total Body DEXA in Normal and Osteoporotic women. *Clin Rheumatol.* 1994;13:593-597.
13. **Aguado F, Revilla M, Villa LF, Rico H.** Cortical bone resorption in Osteoporosis. *Calcif Tissue Int.* 1997;60:323-326.
14. **Exposing Osteoporosis.** Pronosco X-posure System™. *Product Monograph*. Sectra Pronosco, Denmark, 2000.
15. **Jorgensen JT, Andersen PB, Rosholm A, Bjarnason NH.** Digital X-ray Radiogrammetry: a new appendicular bone densitometric method with high precision. *Clin Physiol.* 2000;20:330-335.
16. **Rosholm A, Hyldstrup L, Backsgaard L, Grunkin M, Thodberg HH.** Estimation of bone density by digital X-ray radiogrammetry: theoretical background and clinical testing. *Osteoporos Int.* 2001;12:961-969.
17. **Laval-Jeantet AM, Bergot C, Carroll R, Garcia-Schaefer F.** Cortical bone senescence and mineral bone density of the humerus. *Calcif Tissue Int.* 1983;35:268-272.
18. **Genant HK, Guglielmi G, Jergas M. *Bone Densitometry and osteoporosis*.** Berlin:Springer-Verlag, 1998.
19. **Pande KC.** Demonstration of Ethnic differences in Bone Mineral Density using Digital X-ray Radiogrammetry. *Presentation at 20th Annual Meeting of the Japanese Society for Bone and Mineral Research,* Okayama, July 2002.
20. **Pande KC, Johansen KB, Helboe AB.** Digital X-ray Radiogrammetry: Establishment and comparison of Indian Female and Male Normative Reference Data. *J Bone Miner Res.* 2001;16:S456.
21. **Kanis JA, Gluer CC.** An update on the diagnosis and assessment of Osteoporosis with densitometry. *Osteoporos Int.* 2000;11:192-202.
22. **Black DM, Palermo L, Sorensen T, Jorgensen JT, Lewis C, Tylavsky F, Wallace R, Harris E, Cummings SR.** A Normative reference database study for Pronosco X-posure Radiogrammetry System. *J Clin Densit.* 2001;4:5-12.
23. **Bouxsein ML, Palermo L, Yeung C, Black DM.** Digital X-ray Radiogrammetry predicts hip, wrist and vertebral fracture risk in elderly women: a prospective analysis from the study of osteoporotic fractures. *Osteoporos Int.* 2002;13:358-365.
24. **Hyldstrup L, Timm W, Gluer C.** Fracture discrimination by Digital X-ray Radiogrammetry. *J Bone Min Res.* 2000;15:SU280.
25. **Hyldstrup L, Jorgensen JT, Sorensen TK, Baeksgaard L.** Bisphosphonate treatment evaluated by new qualitative measures of cortical bone. *J Bone Min Res.* 1999;14:F337.
26. **Hyldstrup L, Jorgensen JT, Sorensen TK, Baeksgaard L.** Response of cortical bone to antiresorptive treatment. *Calcif Tissue Int.* 2001;68:135-139.
27. **Haigh C, Reaney L, Adams I, Davies M, Selby PL, Robinson I, Francis R, Dey A, Kanis JA, Bostock J, Horvath C, Kenrali J, Jalava T, McCloskey E.** Digital X-ray Radiogrammetry indices are sensitive to Clodronate treatment in women with Osteoporosis. *J Bone Min Res.* 2002, SA092.
28. **Kanis JA.** Assessment of bone mass. In *Textbook of Osteoporosis*. Blackwell Science Ltd., Oxford, 1996;71-105.
29. **Heilmann P, Wuster C, Prolingheuer M, Gotz M, Zeigler R.** Measurement of forearm bone mineral density: comparison of precision of five different instruments. *Calcif Tissue Int.* 1998;62:383-387.

30. **Helboe AB, Juul K, Rosholm A, Andersen PB, Bjarnason NH.** High short term invivo precision of the Pronosco X-posure System ™ on hand x-rays. *J Int Bone Min Soc.* 2001;28:P335.

31. **Friis M, Skovgaard N, Juul K, Nissen DS.** Digital X-ray Radiogrammetry on hand x-rays obtained on Mammographic x-ray equipment. *J Int Bone Min Soc.* 2001;28:P336.

32. **Sorensen JK:** A clinical study to evaluate the repeatability of Pronosco X-posure System Version CR and demonstrate equivalence with Pronosco X-posure Version 2 RAD. Internal Clinical Report 2001, Sectra Pronosco, Denmark.

33. **Johnell O, Onnby K, Redlund-Johnell I.** Short-term in vivo repeatability of Digital X-ray Radiogrammetry and Dual energy X-ray absorptiometry. *J Bone Min Res.* 2001;16:SU099.

34. **Sievanen H, Pekka O, Vuori I.** Scanner-induced variability and quality assurance in longitudinal dual energy X-ray absorptiometry measurements. *Med Phys.* 1994;21:1795-1805.

35. **Garland SW, Lees B, Stevenson JC.** DXA longitudinal quality control: a comparison of inbuilt quality assurance, visual inspection, multi-rule Shewhart charts and Cusum analysis. *Osteoporos Int.* 1997;7:231-237.

36. **Bolotin HH.** A new perspective on the causal influence of soft tissue composition on DXA-measured in vivo bone mineral density. *J Bone Miner Res.* 1998;13:1739-1746.

37. **Andersen H, Jorgensen JT, Helboe A, Bjarnason NH.** DXR-BMD has a superior discriminatory ability of patients with and without vertebral fractures when compared to DXA-BMD. Presentation at World Congress on Osteoporosis, Chicago, 2000.

38. **Ashford RU, Dey A, Kayan K, Delaney H, Nissen DS, Arnbjerg D, Reaney L, McGurk C, McCloskey E.** Digital X-ray Radiogrammetry predicts hip fracture in elderly women. *J Bone Min Res.* 2001;16:F082.

39. **Bach-Mortensen P, Hindso K, Jensen K, Jensen T, Hyldstrup L.:** Prediction of osteoporotic fracture by Digital X-ray Radiogrammetry and DXA. A case-control study of three different fracture types. *J Bone Min Res.* 2001;16:S458.

40. **Shepherd JA, Fan B, Chen Y, Njeh CF, Genant HK.** Digital X-ray Radiogrammetry in assessing age-related loss, fracture discrimination, and diagnostic classification. *J Bone Min Res.* 2001;16:M103.

41. **Vasireddy S, Haigh C, Reaney L, Adams J, Selby PL, Bal SK, Ashford R, Charlesworth D, Kanis JA, Jalava T, Beneton M, McCloskey EV.** Digital X-ray Radiogrammetry Indices, particularly MCI, can predict Vertebral Fracture risk in Osteoporotic Women. *J Bone Min Res.* 2002, SA092.

42. **Black DM, Palermo L, Sorensen TK, Quandt SA, Tylavsky F, Cummings SR.** Association of bone mass at the radius, ulna and metacarpals with history of fracture. *J Bone Min Res.* 1999;14:252.

43. **Bach-Mortensen P, Hyldstrup L, Hindso K, Bouxsein M.** Discrimination of patients with fractures of the distal forearm, proximal humerus or proximal hip: Comparison of DXA and digital X-ray radiogrammetry of the hand and forearm (DXR): *J Bone Min Res.* 1999;14:S368.

44. **XPO/TECH-014.** Sensitivity study for X-posure 2.0: Conventional image capture. *Internal Technical Report 2000*, Pronosco, Denmark.

45. **XPO/TECH-016.** Reproducibility study for X-posure V.2 conventional image capture. *Internal Technical Report 2000*, Pronosco, Denmark.

46. **Chen Y, Shepherd JA, Fan B, Cheng XG, Genant HK.** Do different X-ray techniques affect the measurement parameters of Digital X-ray radiogrammetry on scanned radiographs of the hands? *J Bone Min Res.* 2001;16:S459.

47. **Thodberg HH, Jensen JK, Rosholm A.** BMD from digital X-ray radiogrammetry: sensitivity to details of the image capture. *J Bone Min Res.* 1999;14:S369.

48. **Hussain A, Baadegaard N, Wendt O, Rosholm A.** Digital X-ray radiogrammetry (DXR) on hand X-ray image using Computed Radiography (CR). *J Bone Min Res.* 2001;16:M093.

49. **Pande KC, Veeraji E, Apte A.** Bone mineral density in Indian patients with osteoporotic fragility fractures. *Bone.* 2003; 32(Suppl.5): S173.

INDIAN JOURNAL OF ORTHOPAEDICS
April 2004
Volume 38 : Number 2 : P. 80-83

Comparison of PCL sparing and PCL substituting implants for total knee replacement

ON Nagi, Mandeep S Dhillon, Vinod Kumar

Department of Orthopaedics, PGIMER, Chandigarh

Background: Saving the PCL or resecting it to facilitate deformity correction and improve component fixation has been a controversial issue in total knee replacement.

Methods: A retrospective study was done to compare the results of PCL sparing with PCL retaining designs of TKR in patients with similar types of deformities, with special reference to ease of surgery, post operative motion range and functional outcome. Group 1 consisted of 10 PCL substituting knees, with a mean follow up of 5.76 years, and group 2 consisted of 10 PCL retaining knees with a mean follow up of 6.31 years. We only included those cases which could be matched preoperatively with regard to age, sex, diagnosis, deformity, knee score and functional status.

Results: Postoperative evaluation was done by using the Knee Society's clinical and functional scoring system, and follow up radiographs were obtained and analysed. The knee score had improved from average of 43.3 points to 90.10 points in group 1 and from 46.10 points to an average of 84.6 points in group 2. The function scores improved from 17 to 66.5 in group 1 and from 17 to 72 points in group 2. There was no difference in the post operative radiological grades. Our results showed no difference in the change in parameters in these two groups, with all cases having similar improvement vis- a- vis function and motion range.

Conclusion: We noted that in cases with similar deformities, no significant improvement was achieved by sacrificing the PCL. However, specific indications do exists for excising the PCL; even if the implant is more expensive, it may be better for some cases with severe deformity, which may be difficult to correct intra-operatively without excising the PCL.

Key-word: Total knee replacement; Posterior cruciate ligament

Introduction

Total knee arthroplasty (TKA) has now become accepted universally as the treatment for a severely arthritic knee with end stage disease. It provides good pain relief satisfactory restoration of the function in patients with advanced degenerative changes.

The role of the posterior cruciate ligament (PCL) in primary total knee arthroplasty has been under study for several years.[1] Proponents of saving the PCL argue that in addition to enhancing stability, allowing femoral roll back and increased flexion, it also absorbs shearing forces that would otherwise be imparted to the implant bone interface. Additionally the PCL may have a role in improved post operative proprioception[2]. On the other hand, the policy at some centers is to routinely resect the PCL to facilitate deformity correction and improve component fixation; this allows the use of a prosthesis with more congruent articulations that imparts less stress to their polyethylene inserts[3].

A variety of prostheses have been designed, with most of the implants either substituting a resected PCL or allow for its preservation[4]. Clinical success and satisfactory survivorship have been reported with both these procedures. There are several advantages in implanting a PCL substituting prosthesis; the surgical technique is easier to perform, the surgeon can get away with minimal tibial resection allowing placement of tibial component in stronger host bone, and polyethylene wear is decreased when a conforming articular surface is implanted. Additionally the deformity can be corrected more easily[5].

Advocates of PCL retention in TKA cite an increase range of flexion extension motion[4,5] however other published studies cite the problem of a tight PCL as one which restricts flexion[6]. Additionally, the normal mechanism of femoral roll back is facilitated by the PCL, which increases the moment arm of the quadriceps. This can be compensated with a post or cam tibial design[7]. The PCL also acts as a secondary stabilizer to varus/valgus knee stability[8] and controls external rotation in flexion; on the other hand a tight PCL can make collateral ligament balancing difficult in cases of significant knee deformity.

Keeping the fact in mind that the PCL may have

Onkar N Nagi, Professor and Head
Mandeep S Dhillon, Additional Professor
Vinod Kumar, Senior Resident
Deptt of Orthopaedics, P.G.I.M.E.R., Chandigarh,
Dr O N Nagi, 1027, Sector 24-B, Chandigarh INDIA, E mail: drnagi@yahoo.com
Received : 16.2.2002; Revised : 10.11.2003; Accepted : Mar. 2004

Fig. 1. *X-ray showing posterior cruciate ligament retaining knee joint implant.*

Fig. 3. *X-ray showing total knee replacement with posterior substituting design.*

significant advantages if retained, and a tight PCL may also create surgical and post surgical problems on the other hand, it was proposed to evaluate the functional and radiological results of these two types of TKA in two similar subsets of patients. In one group a PCL substituting design was used for TKA and in the second group PCL retaining design was employed.

Materials and Methods

Over a 6 month period, a retrospective review was done of 20 cases that had undergone TKA a minimum of 4 year prior to evaluation; the chosen cases were called for examination and radiological assessment. These patients were selected from the data base of the PGIMER; ten cases with PCL retaining TKA and ten cases with a PCL substituting design TKA were invited for follow up. The records were carefully examined to try and include similar preoperative knees (age, sex matched, with somewhat similar indications for surgery and similar pre-operative deformities), so that comparative data would be relevant. All the TKAs were performed by the principal author, and all follow up cases were examined by at least 2 of the three authors of this study.

The clinical examination was done on the basis of the Knee Society clinical rating system[9] and the radiological examination was done according to the Knee Society radiological evaluation[10] form respectively. Group 1 (PCL substituting) TKA was done using IB two implants (Zimmer), and Group 2 (PCL retaining) employed IB one (Zimmer) implants.

Both groups were compared for preoperative and post operative parameters. Detailed functional and radiological data was compiled using the above mentioned scores, and these were compared to see for any differences in the post operative function.

Table I : Demographic details, 20 cases

	Group 1	Group 2
Age	Av 55.9	Av 60.3
Sex	All 10 Female	8 Female, 2 male
Indication for Surgery	6- Rheumatoid	Rheumatoid – 4
	4-OA	OA - 6
Follow Up	Mean 5.7 yrs	Mean 6.3 yrs
	Range, 4-7.6 yrs	Range, 5.8-7.6 yrs
Deformity	Varus in all 10	Varus in 8, Valgus in 2
	Mean 9.4 (5-30°)	Varus mean 10°, (5-20°)

Results

The demographic data is given in Table 1. The mean ages of both the groups of patients were comparable. There were no statistically significant difference in the age, sex, diagnosis, duration of follow up and pre-operative deformity.

The detailed clinical assessment scores of both groups are given in Tables II, III. Clinical scores taking into account pain (mean score increased by 32.50 points and by 34.00 points in groups 1 and 2 respectively), range of movement (mean score changed from 18.30 points to 19.10 points and from 17.70 points to 16.90 points) were not statistically different

Table II-a : Preoperative parameters

	Group I		Group II	
	Mean + SD (Points)	Range (Point)	Mean + SD (Points)	Range (Point)
Pain	14 + 10.74	0-30	13 + 9.48	0-30
ROM	18 + 3.30	16-25	17 + 1.82	16-21
Stability				
A – P	5 + 0.00	5	4.50 + 2.83	0-10
M – L	11 + 2.10	10-15	11.50 + 2.85	0-10
Alignment	4 + 8.43	0-20	4 + 8.43	0.20
Walking Ability	9 + 5.67	0-20	11 + 7.37	0-20
Stair Climbing Ability	11 + 16.46	0-40	9 + 7.74	0 – 15
Walking Aids	-3 + 2.50	-5-0	-3 + 2.50	-5-0

Table II-B : Preoperative comparison of knee score and functional scores

	Knee Score (Pts.)		Functional Score (Pts.)	
	Mean + SD (Points)	Range (Point)	Mean + SD (Points)	Range (Point)
Group – I	43.30 + 13.19	25.61	17 + 16.02	0-40
Group – II	40.10 + 13.07	16.56	17 + 12.29	0-30

Table III-a : Comparison of post operative parameters

	Group I		Group II	
	Mean + SD (Points)	Range (Point)	Mean + SD (Points)	Range (Point)
Pain	46.50 + 6.68	30-50	47 + 2.58	45-50
ROM	19.10 + 2.51	16-24	16.90 + 5.30	8-22
Stability				
A – P	9 + 2.10	5-10	6.50 + 3.37	0-10
M – L	15 + 0.00	15	13.00 + 4.83	0-15
Alignment	**0.0**	**0.0**	**0.0**	**0.0**
Walking Ability	36 + 8.43	20-40	38 + 6.32	30-40
Stair Climbing Ability	32 + 16.86	0-40	40 + 0.00	40
Walking Aids	-4.50 + 1.58	-5 - 0	- 4 + 2.10	-5 – 0

Table III-b : Post operative comparison of knee score and functional score

	Knee score (Pts.)		Functional score (Pts.)	
	Mean + SD (Points)	Range (Point)	Mean + SD (Points)	Range (Point)
Group – I	46.50 ± 5.62	83-99	66.50 ± 15.64	35-80
Group – II	84.60 ± 9.70	67-97	72 ± 6.32	65-80

in both groups of patients. In Group I stability in A-P and medio-lateral direction, increased by 4 points (mean) each, and in Group II, by 2.00 points (mean) and 1.50 points (mean) respectively. The difference in stability change in both groups was not statistically significant.

In Group I ability to use stairs increased by 21.00 points (mean), in Group II by 31.00 points (mean) and walking ability increase in both groups was the same (27.00 points mean).

In Group-I Knee score increased by 47.28 points (mean) and in Group-II by 44.60 points (mean) and functional score in Group-I increased by 49.50 points (mean) and in Group-II by 55 points (mean), as shown in table-2b and 3b.

Radiological evaluation using the femur flexion angle, tibia angle and tibia valgus angle in A-P X-ray and femur flexion angle and tibia angle in lateral X-ray and patellar position were not significant between both the group and there were no radiolucencies in any of the TKAs (Table IV).

Analysis of the above data showed that there was no significant difference in knee score, functional score and radiological data between the TKA using either PCL substituting or PCL retaining designs.

Table IV : Radiological data AP (Degree)

	FFA (L)		TA (B)		TVA (?)	
	Mean	Range	Mean	Range	Mean	Range
Group – I	99.20	92-110	88.40	80-96	9.6	8-18
Group – II	100	90-112	88.40	80-96	10.50	8-11

LAT (DEGREE)

	- FFA (L)		TA (B)		Radiolucency		
	Mean	Range	Mean	Range	Femur	Tibia	Patella
Group – I	-4.40	-20-10	86.40	80-90	Nil	Nil	Nil
Group – II	-0.20	-10-10	84.00	70-90	Nil	Nil	Nil

Discussion

The role of the PCL in primary TKA has been debated for several years[11,12]. The PCL is the strongest ligament in the knee and can be responsible for absorbing a significant amount of force. As in the normal knee, the prosthetic knee can achieve greater flexion if the implanted prosthesis allows the femur to glide posteriorly on the tibia, cleaning the posterior structures. Moreover, this posterior roll back enhances the efficiency of the quadriceps muscles by lengthening the lever arm from the point of joint contact to the quadriceps tendon.

Freeman et al[13] have shown that the knee represents a crossed four-bar linkage, the upper and lower elements of which are represented by the femur and tibia and the crossed linkage is represented by the ACL and the PCL. If the ACL is excised (as is done in routine TKA), then the crossed linkage effect of the PCL in isolation becomes ineffective. Additionally surgical difficulties encountered due to contracted PCLs and the restricted flexion postoperatively with PCL retention lead many surgeons to change routinely to PCL substituting designs. This was refuted by many who found that preplanned PCL resection and PCL retention did not show significant alterations in function[11]. Backer et al conducted a study of

bilateral TKAs where they used patients as their own control by carrying out a PCL substituting TKA in one knee and a PCL retaining TKA in the contralateral knee. The results were identical as judged by patient satisfaction.

Pereira et al[5] revealed no difference in clinical or early radiological outcome between PCL sacrificing and PCL substituting and retaining TKA; they however supported the argument that PCL sacrifice should be considered in cases in which extensive releases and complex ligamentous balancing are required, and this would not alter the functional and result.

The controversy in the literature regarding choosing to save or sacrifice the PCL at time of TKA is made more confusing by reports that advocate the advantages of both procedures. In an attempt to clarify the surgical indications, Laskin et al[14] found that in 15° or more of varus contracture the PCL was partly responsible for the deformity, and unless excised, the deformity could not be corrected by medial release alone. Hirbch et al[12] have observed that preserving the PCL does not consistently lead to improved functional range of movement. The PCL substituting implant, when implanted with the correct indications, has demonstrated excellent survivor ship in some hands, and appears to offer greater range of movement[14]. On the other hand the prosthesis is more expensive and needs more specialized equipment, adding significantly to the cost.

As a counter argument, Vinchiguerra et al[15] found that functional outcome seems to be the same whenever a PCL substituting or a PCL retaining total knee prosthesis was used, regardless of the indications.

In the Indian scenario these are important arguments. Cost and prosthesis availability may influences decisions to some extent, but this should not be at the expense of post operative results. With this in mind, we analyzed similarly deformed knees in age and sex matched cases to see if the end results were different at the early follow up periods. Increases in all parameters in both groups were almost similar and there was no statistically significant difference between both the groups.

It is difficult to explain why the results have not been improved by the use of more recent type of prosthesis (PCL substituting design) which have been designed or modified to overcome recognized causes of failure in earlier designs, or by their implantation with the aid of more advanced instrumentation. The present study seems to find no short term benefit. However, it is wise to understand that perhaps the two types of prostheses have different indications, and may not be applicable in similar situations. We believe that if the contractures are significant, and the PCL is adding to the deformity, it should be excised and a PCL substituting implant should be used. On the other hand, if the PCL seems adequate and does not hinder the surgical procedure, and seems to be adding to the stability, it should preferably be retained, as it has significant stabilizing function. The biggest disadvantages in this protocol would be the added cost of having both types of implants as well as relevant instrumentation available in the OT.

References

1. **Dorr LD, Ochsner JL, Gronley J, Perry J:** Functional comparison of posterior cruciate – retaining versus cruciate – sacrificed total knee arthroplasty. *Clin Orthop.* 1988; 236: 36-43.
2. **Insall JN :** Presidential address to the knee society : choices and compromises in total knee arthroplasty. *Clin Orthop.* 1989; 248: 13-14.
3. **Freeman MAR, Insall JN, Besser W, Walker PS, Hallel T :** Excision of the cruciate ligament in total knee replacement. *Clin Orthop.* 1977; 126: 209-212.
4. **Bourne MH, Rand JA, Listrup DM:** Posterior cruciate condylar total knee arthroplasty : five years results. *Clin Orthop.* 1988; 234 : 129-133.
5. **Pereira DS, Jaffe FF, Ortiguera C:** Posterior cruciate ligament sparing versus posterior cruciate ligament – sacrificing arthroplasty : Functional result using the same prosthesis. *J Arthroplasty.* 1998; 13(2): 138-144.
6. **Insall JN, Hood RW, Flawn LB, Sullivan DS :** Total condylar knee prosthesis in gonarthrosis. *J Bone Joing Surg (Am).* 1983; 65: 619-623.
7. **Ewald EC, Jacabs MA, Miegel RE:** Kinematic Total Knee replacement. *J Bone Joint Surg (Am).* 1984; 66 : 1032-38.
8. **Whiteside LA, Amardor DD :** The effect of posterior tibial slope on the knee ability after Ortholoc total knee arthroplasty. *J Arthroplasty.* 1988; 53: 192-196.
9. **Insall JN, Dorr LD, Scott RD, Scott WN :** Rationale of the knee socity clinical rating system. *Clin Orthop.* 1989; 248 : 13-14.
10. **Frederick C, Ewald EC:** The knee society total knee arthroplasty Roentogeno-graphic Evaluation and Scoring System. *Clin Orthop.* 1989; 248 : 9-12.
11. **Backer M, Micheal W, Insall JN, Fair PM :** Bilateral total knee arthroplasty (one cruciate retaining and one cruciate substituting). *Clin Orthop.* 1991; 271 : 124-129.
12. **Hirch HS, Lotke PA, Morrison LD :** The posterior cruciate ligament in the total knee surgery – save, sacrifice or substitute? *Clin Orthop.* 1994; 309: 64-68.
13. **Freeman MAR, Samuelson KM, Bertin KC:** Freeman – Samuelson total arthroplasty of the knee. *Clin Orthop.* 1985; 192: 46-58.
14. **Laskin MD :** Total knee replacement with posterior cruciate retention in patient with a fixed varus deformity. *Clin Orthop.* 1996; 331 : 29-34.
15. **Vincigurerra B, Pascarel X, Hontal JL :** Result of total knee arthroplasty with or without preservation of posterior cruciate ligament. *Rev Chir Orthop Reparatrice Appar Mot (France).* 1994; 80: 620-625.

INDIAN JOURNAL OF ORTHOPAEDICS
April 2004
Volume 38 : Number 2 : P. 84-87

Resurfacing versus non-resurfacing of patella in total knee arthroplasty

Vishal Kumar, J Rai, N Khandelwal

Department of Orthopaedics and Radiology, Postgraduate Institute of Medical Education and Research, Chandigarh

Background: The patello-femoral problems are most common cause of morbidity and reoperation after total knee arthroplasty.

Methods: Twenty-seven knees in 17 patients who underwent total knee arthroplasty were studied. Eleven knees underwent patellar resurfacing and in 16 knees patella was not resurfaced. These patients were assessed preoperatively and post operatively using knee society scoring system, patellar scoring system and patellar thickness noted.

Results: At a mean follow up of 29 months in resurfaced and 17 months in non resurfaced group, statistically significant difference was found, with better patellar scores, stair climbing capacity and lower incidence of anterior knee pain in nonresurfaced group. But the overall knee scores were better in resurfaced group. There was no correlation of anterior knee pain with age, sex, obesity, patellar thickness and range of flexion achieved post arthroplasty.

Conclusion: Not resurfacing the patella in mild to moderate osteoarthritic knee especially in obese patients with thin patella gives satisfactory results in total knee arthroplasty.

Keywords: Patella; Total knee arthroplasty; Resurfacing.

Introduction

The hesitancy to resurface the patella routinely in total knee arthroplasty stems from the history of higher than acceptable complications with patellar component. A lack of patellofemoral symptoms preoperatively creates further doubt as to whether all patients need patellar resurfacing.

The results comparing knee pain in resurfaced and non resurfaced patella are mixed. There are authors recommending routine resurfacing[1-4], routine retention[5,6] and selective resurfacing of the patella[7-11]. Wisdom of adding a patellar component routinely has been tempered by concerns about implant loosening, patellar fractures, avascular necrosis, patellar subluxation and dislocation, and extensor mechanism rupture[12-14]. The issue of whether or not the patella should be resurfaced routinely during total knee arthroplasty is still controversial. The issue concerns whether long term patient satisfaction is improved by patellar resurfacing and whether patellar symptoms and complications can be avoided by not resurfacing the patella.

Vishal Kumar, Resident, MS (Orth), Department of Orthopaedics
Jaswant Rai, MS (Orth), Professor, Department of Orthopaedics
N Khandelwal, MD, Additional Professor, Department of Radiology
Postgraduate Institute of Medical Education and Research, Chandigarh
Received : 16.2.2003; Revised : 23.12.2003; Accepted : Jan. 2004

Materials and Methods

Primary total knee replacements done by the senior author from 1999 to 2002 were reviewed. Study included 27 knees in 17 patients with osteoarthosis, out of which 11 knees (6 patients) underwent patellar resurfacing and in 16 knees (11 patients) patella was not resurfaced. Ten patients had bilateral knee replacement; five in each group among which six patients, three in each group had simultaneous bilateral knee arthroplasty and remaining four patients, two in each group had staged bilateral knee arthroplasty. There were 3 females and 3 males in the resurfaced patellar group where as among non-resurfaced patella there were 8 females and 3 males. The average age of resurfaced group was 59.91 years (45 – 70) while it was 64.38 years (50-78) in the non-resurfaced group. The mean height in the resurfaced group was 163.27 cms (155-174) and 162.25 cms (152-178) in the non-resurfaced group. The mean weight of the resurfaced group was 73.36 kgs (62-84) and that of non-resurfaced group was 72 kgs (53-92). Two patients (bilateral cases) in resurfaced group and three patients (2 bilateral and 1 unilateral cases) in non-resurfaced group were obese and all of these five patients were females. The average follow up in the resurfaced group was 29 months (26-35) where as in the non resurfaced group it was 17 months (2-24).

The indications for the operation were degenerative osteoarthrosis that was severe enough to warrant total knee arthroplasty after an adequate trial of non-operative therapy. Exclusion criteria included inflammatory arthropathy and severe deformity (Varus angulation more than 15^0, valgus

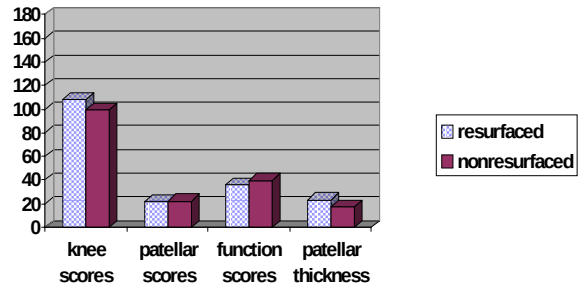


Fig. 1. *Pre operative scores and patellar thickness*

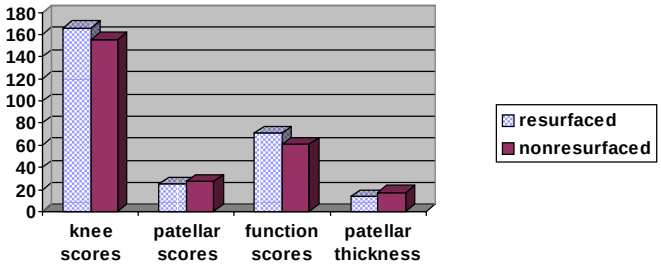


Fig. 2. *Post operative scores and patellar thickness*

angulation more than 15 ^{0} or flexion contracture of more than 15 ^{0}). Patients that previously had a patellar realignment operation or other major knee surgery such as high tibial osteotomy were excluded. The following total condylar knee designs were used– INOR, Freeman – Samuelson Knee System (Protek) and Sulzer-Natural knee II. Operative techniques and characteristics were not different in two groups.

These patients were assessed preoperatively and postoperatively using knee society scoring system and patellar scoring system. Standard anteroposterior, lateral and skyline views were taken and specifically patellar parameters i.e. patellar tilt, patellar sclerosis, patellar subluxation or dislocation and patellar thickness were noted. Patellar subluxation is present when there is an overhang of the bone and / or the component over the rim of the lateral femoral condyle[15].

Statistical analysis was done by two tailed student's t test and Chi square test with two degrees of freedom

Results

The mean knee society score, on a scale ranging from 0 to 200 points, in resurfaced group improved from 107.91 (85-130) preoperatively to 165.91(155-175) post arthroplasty and in non resurfaced group the mean scores preoperatively improved from 99.41 (59-120) to 155.44(108-167) post-arthroplasty. The mean patellar scores in resurfaced group improved from 21.73 (19-24) preoperatively to 25.18(22-29) and in non resurfaced group from 22 (18-26) to 27.38 (21-38).

The mean scores for function in resurfaced group improved from 35.91 (15-50) to 70.91 (60-80) whereas in the non- resurfaced group there was improvement from 39.38 (10-60) to 60.63(20-70). The preoperative patellar thickness in the non resurfaced group was 17.19mm (14-24) and post operative thickness of 17.31 (14-24) was measured whereas in the resurfaced group preoperative mean patellar thickness of 23.27 (22-26) was reduced to 13.45(13-14) (Fig.1,2).

The reduced patellar thickness of native patella shows significant statistical difference in the two groups, possibly owing to thinner patella of non resurfaced group, majority of them being female i.e. 8 females in non resurfaced group and 3 in resurfaced group.

In resurfaced group, 9 patients had total condylar knee (FS-Protek) and 2 had condylar knees of INOR. In three cases lateral release was done in the resurfaced group and in five knees PCL was cut to correct deformity or to avoid anterior push of the tibial tray during trial of components. In non resurfaced group 12 patients had total condylar knee (FS Protek) and 4 had condylar knee of Sulzer-NKII. Ten patients' required lateral release and PCL was retained only in three knees out of sixteen though, no complication of lateral release was observed in either group.

Two patients in non-resurfaced group had anterior knee pain at 23 and 24 months follow up out of which one patient did not have anterior knee pain preoperatively. He developed postoperative anterior knee pain in non-resurfaced group and had patellar flattening at 24 months follow up (fig.1), which was not seen preoperatively and did not develop in other cases, though these changes of patella are more often seen in rheumatoid patients over prolonged period of time[16]. The other patient in non-resurfaced group had myocardial infarction in immediate postoperative period. His physiotherapy protocol was delayed but he managed to achieve an overall good knee score but had anterior knee pain at 23 months follow up.

In resurfaced group three patients (five knees) had anterior knee pain out of which two patients (three knees) had anterior knee pain preoperatively and one patient (2 knees) developed anterior knee pain at 28 months follow up which was not there preoperatively. All these patients had mild anterior knee pain and were treated non-operatively. In our study the incidence of anterior knee pain in the resurfaced

group was 12.5% (2/16 knees) and in the un-resurfaced group 45.45%(5/11 knees). There was no statistically significant relation between anterior knee pain and patellar thickness, patellar sclerosis, obesity or age.

There were no re-surgeries in either group for any complication. Major patello-femoral complication i.e. loosening of patellar component, subluxation of patellar component, patellar fractures, and patellar ligament rupture was not seen in either group, possibly due to shorter follow up, overall less gain in knee flexion was achieved postoperatively. Long term results and follow up are yet to be seen. There was no statistically significant difference found in the two groups in terms of quadriceps strength, chair raising ability, patellar tilt or patellar sclerosis.

Discussion

Though we studied a relatively small number of patients, the groups had similar patient characteristics and we minimized the number of potential variables. Our study provided no evidence to support the routine resurfacing of patella at total knee arthroplasty for osteoarthritis in terms of patello-femoral function. Indeed there was a trend towards poorer results in patellar scores in the resurfacing group and poor stair climbing ability, but the overall knee scores were better in the resurfaced group. Our findings confirm reports of other studies, in which patients who had bilateral knee arthroplasties with resurfacing of patella in only one side were studied[7,8]. All these authors found no clear benefit in routine resurfacing. However many studies on this issue are limited because they include the use of various prosthesis, some of which possesses a non anatomic trochlea, not in use today due to various disadvantages and complications. The results were also limited as the surgeries were done by several surgeons and the groups lacked sufficient similarities in patients' characteristics, extent of deformities and diagnosis.

It has also been proved that posterior stabilized designs, which allow greater mean flexion and increased extensor forces during stair climbing than unconstrained condylar models, have been reported to be associated with a higher incidence of patellar fractures[17-19]. Since the study group had patients with minimum deformities and good preoperative range of movements there was overall reduction in range of movement in both of the groups, though not statistically significant.

Levitsky et al[7] reported 19 % incidence of mild anterior knee pain in the absence of resurfacing of patella. Soudry et al[11] had noted impaired stair climbing abilities when the patella had not been resurfaced but in our study we found that stair climbing ability was significantly better in those patients in whom patella had not been resurfaced. In a study of 100 total knee arthroplasties, with 10-15 years follow up better results were found in resurfaced group[20]. However, the cohort in this study was skewed by the inclusion of high percentage of patients with rheumatoid arthritis. The retrospective design for our resurfaced group was appropriate because we routinely resurfaced the patella prior to 2000 and majority of total knee arthroplasties done henceforth invariably had their patella unresurfaced but the operative techniques and the characteristics of the patient were not different between the resurfaced and non-resurfaced group, implantation done with similar knee designs by the same surgeon.

In our entire unresurfaced patellar group, patelloplasty (i.e. shaping the contour of the patella, by removal of osteophytes, into facets to improve tracking and to provide a fulcrum for the extensor mechanism) was performed. It has been shown that increased patellar thickness increases the patellar forces at the higher flexion angles[20]. So a balance must be stuck between excessive patellar bone thinning and increased patello-femoral forces with increased patellar thickness during acute knee flexion. In our study there was decrease in range of movement in both resurfaced and non resurfaced groups though, this was not statistically significant. With stiffer knees gaining range of motion and knees with good range of movement losing flexion range both in resurfaced and non-resurfaced group.

The most important factor influencing patellofemoral performance includes the shape of the trochlear flange, mechanical factors and balance of the extensor mechanism.[9] Most authors agree that to avoid patellofemoral complications the arthroplasty should be close to ideal [21-26]. The incidence and severity of the fractures of resurfaced patella after total knee arthroplasty has been shown to be proportionately related to the degree of mal-alignment and mal-tracking[26]. Studies have yet to show long term effect of patellar cartilage articulation over metallic femoral component, though some thinning of patella was observed in non resurfaced group in our study In considering patellar resurfacing there are several areas which require review. These include knee function after replacement, mechanical consideration with respect to the patellofemoral joint and complications.

In modern designs of total knee prosthesis the trochlea of the femoral component has been shaped to accept the natural patella. In older design of knee prosthesis where the femoral trochlea was not patellar friendly, there was

advantage to replace the patella using the specific prosthesis designed to track in the femoral trochlea.

It is necessary to consider patellar tracking and congruence as well as patello femoral pressure. Patellar tracking is not a function of patellar arthroplasty but rather a function of restoration of alignment of the knee and appropriate rotation of both the tibial and femoral components to allow for central patellar tracking. Congruence of the natural patella in the femoral trochlea has been significantly enhanced through modern prosthesis designed and congruence no longer relies on the matching a patellar component to the specific trochlear design.

It is in the area of the pressures in the patellofemoral joint where the strongest arguments against patellar resurfacing arise. The important concept is of compressive yield strength, which is the compressive pressure above which material failure occurs. Studies of the pressures produced in the patellofemoral joint in the day to day living have demonstrated that at flexion of greater than 60 degrees resisted knee extension produces contact pressures far exceeding the yield strength of UHMWPE.

Statistically significant better patellar scores and better stair climbing abilities in non resurfaced patella and concern of increased complication rates with resurfaced patella had led us to believe that not resurfacing the patella in mild to moderate osteoarthritic knee especially in obese patients with thin patella gives satisfactory results in total knee arthroplasty.

References

1. **Rae PJ, Noble J, Hodgkinson JP.** Patella resurfacing in total condylar knee arthroplasty. Technique and results. *J Arthroplasty*. 1990; 160-167.
2. **Webster DA, Murray DG.** Complications of variable axis total knee arthroplasty. *Clin Orthop.* 1985; 193: 160-167.
3. **Levai JP, Mcleod HC, Freeman MAR.** Why not resurface patella*? J Bone Joint Surg (Br).* 1978; 65: 448-451.
4. **Ranawat CS.** The Patellofemoral Joint in total Condylar knee arthroplasty. Pros and Cons based on five to ten years followup observations. *Clin Orthop.* 1986; 205: 93-99.
5. **Abraham W, Bachanan JR, Daubert 4, Gree RH, Kneefer J.** Should the patella be resurfaced into total knee arthroplasty? Efficacy of patella resurfacing. *Clin Orthop.* 1988; 236:128-134.
6. **Brick GW, Scott RJ.** The patellofemoral component of total knee arthroplasty. *Clin Orthop.* 1988; 231: 163-178.
7. **Keblish PA, Varma AK, Greenwald AS.** Patella resurfacing or retention in total knee arthroplasty. A prospective study of patients with bilateral repalcement. *J Bone Joint Surg (Br).* 1994; 76: 930-937.
8. **Leivlsky KA, Harris WJ, Mc Manus I, Scott RD.** Total knee arthroplasty without patellar resurfacing. Clinical outcomes and long term follow of evaluation. *Clin Orthop.* 1993; 286: 116-121.
9. **Picetti IV GB, McGann WA, Welch RB.** The patellofemoral joint after total knee arthroplasty without patellar resurfacing. *J Bone Joint Surg (Am).* 1990; 72: 1379-1382.
10. **Scott RD, Reily DJ.** Pros and cons of patella resurfacing in total knee replacement. *Orthop Trans.* 1980; 4: 328-329.
11. **Soudry M, Mestriner CA, Binazzi R, Insall JN.** Total knee arthroplasty without patella resurfacing. *Clin orthop.* 1986; 205: 166-170.
12. **Bayley JC, Scott RD, Ewald FC.** Failure of the metal backed patellar component after total knee replacement. *J Bone Joint Surg (Am).* 1988; 70: 668.
13. **Insall JN, Ranawat CS, Aglietti P, et al.** comparison of four models of total knee replacement prostheses. *J Bone Joint Surg (Am).* 1976; 58: 754.
14. **Lynch AF, Rorabeck CH, Bourne RB.** Extensor mechanism complications following total knee arthroplasty. *J Arthroplasty.* 1987; 2: 135
15. **Merchant AC, Mercer RL, Jacobsen RH, Cool CR.** Roentogenographic analysis of patellofemoral congruence. *J Bone Joint Surg (Am).* 1974; 56: 1391-1396.
16. **Kawakubo M et al.** Radiographic changes in the patella after total knee arthroplasty without resurfacing the patella. *Bulletin Hospital for joint disease*.1997;56:237-244.
17. **Scott RD, Turoff, Newald FS.** Stress fracture of the patella following duopatellar total knee arthroplasty with patellar resurfacing. *Clin Orthop.* 1982;170:147-151.
18. **.Insall J, Lachieviecz P, Burstein.** The posterior stabilized condylar prosthesis: a modification of the total condylar design. J Bone Joint Surg 1982; 60A: 1317-1324.
19. **Nielson S, Hvis I, Sneppen O.** Total condylar kne arthroplasty . Arch Ortho Trauma Surg 1985; 104:227-232.
20. **Ranawat CS.** The patellofemoral joint in total condylar knee arhtroplasty pros and cons based on five to ten years follow up and observations. *Clin Orthop.* 1982; 170: 141-151.
21. **MJ Star, Cliford WC Jr et al.** The effects of patellar thickness on patellofemoral forces after resurfacing. *Clin Orthop.* 1996; 322: 279-285
22. **Dorr LD, Boiardo RA.** Technical considerations in total knee arthroplasty. *Clin Orthop.* 1986; 205:5-11
23. **Kaufer H, Matthews LS.** Spherocentric arthroplasty of the knee. Clinical experience with four years follow up. *J Bone Joint Surg* 1981;63(4):545-549.
24. **Briard JL, Hungerford DS.** Patellofemoral instability in total knee arthroplasty. *J Arthroplasty.* 1989; 4:88-97.
25. **Merkow RL, Soudry M, Insall JN.** Patellar dislocation following total knee arthroplasty. *J Bone Joint Surg* 1985; 67(9): 1321-1327.
26. **Figgie HEIII, Goldberg VM, Figgie MP et al.** The effect of alignment of the implant on the fracture of the patella after condylar total knee arthroplasty. *J Bone Joint Surg* 1989; 71(7): 1031-1039.

INDIAN JOURNAL OF ORTHOPAEDICS
April 2004
Volume 38 : Number 2 : P. 88-91

Valgus osteotomy for nonunion fracture neck femur

Manish Sharma, LK Sood, RK Kanojia, Alok Sud

Department of Orthopaedics, Lady Hardinge Medical College and Associated Hospitals, New Delhi.

Background: Non union of femoral neck fracture in young patients is still a problem as they are too young to have hip replacement and other salvage procedures are usually unsatisfactory. Pauwels described valgus osteotomy for nonunion of femoral neck which was used by later surgeons also.

Methods: We report a series of 22 patients of nonunion of femoral neck fracture which were taken up for valgus osteotomy and fixed with 120^0 double angled dynamic hip screw. Average age of patients was 36.5 yrs. Injury operation interval ranged from 4wks- 32wks. Average follow up was 18 months (12 mths-38 mths).

Results: Femoral neck fractures united in 18 patients (82%). Excellent to good results were seen in 70% patients.

Conclusion: 120^0 double angled dynamic screw plate assembly provides rigid internal fixation after valgus osteotomy and being a more familiar fixation device simplifies the procedure and gives good results.

Key-words: Nonunion neck of femur; Valgus osteotomy; 120^0 double angled dynamic hip screw plate

Introduction

In young patients with femoral neck non-union it is desirable to preserve the femoral head. Various treatment modalities have been described to preserve the head e.g. vascularised bone grafts[1,2], muscle pedicle grafts[3,4], fibular grafts with or without osteotomy[5,6] but still the best form of treatment remains inconclusive as these procedures are technically demanding and have not given consistently reproducible results. Pauwels[7] postulated that in non-union of femoral neck the problem is both biological and mechanical. He suggested that by changing the fracture inclination the fracture site can be brought under compression, thereby resulting in union of fracture. These principles still hold true, most authors have used blade plate for fixation after osteotomy[8-10]. As dynamic hip screw is a more familiar fixation device in use today and has replaced condylar blade plate for most indications, we used a 120^0 double angled dynamic hip screw barrel plate assembly for fixation which we believe will further simplify the procedure and decrease the complication rate.

Manish Sharma, MS (Orth), Senior Resident
LK Sood, MS (Orth), Director Professor and Head
RK Kanojia, MS (Orth), Associate Professor
Alok Sud, MS (Orth), Assistant Professor
Department of Orthopaedics, Lady Hardinge Medical College and Associated Hospitals, New Delhi.
Dr Manish Sharma, B2/ 65 Safdarjung Enclave, New Delhi -110029. E-mail : drmanishsharma@hotmail.com
Received : 25.2.2003; Accepted : Jan. 2004

Materials and Methods

From November 1999 to Dec 2001, 22 cases of non-union of femoral neck fractures in young patients were taken up for valgus osteotomy and fixed using 120^0 double angled dynamic hip screw and barrel plate assembly. Patients were divided into two categories -neglected cases where no previous surgery was done and those with previous failed internal fixation device.

There were 17 patients in first group with average injury operation interval of 12 wks (4wks—24 wks) The second group had 5 patients with an average injury operation interval of 24 wks (20 wks— 32 wks). Anteroposterior radiographs of both hips in internal rotation were taken to assess for neck length and classify fracture according to Pauwels criteria and to detect avascular necrosis of femoral head. No special studies were done to detect precollapse avascular necrosis of femoral head as this was not considered to be a contraindication for valgus osteotomy[8-10].

Preoperative tracing of proximal femur and both hips were taken. The goal of osteotomy was to achieve a Pauwels angle of 30^0 or less and hence to bring fracture site under compression. The inclination of fracture line to horizontal was measured. We planned a wedge of 30^0 in all cases as it is difficult to precisely measure the size of wedge[9] (Fig 1) and in 2 cases with fracture inclination $>70^0$ we planned a Y-osteotomy with removal of 50^0 wedge(Fig 2).

The osteotomy was planned at the level of lesser trochanter as described by Pauwel[7] and later modified by Muller[11]. The entry point of dynamic hip screw was 2 cm above the osteotomy site. The procedure was performed with

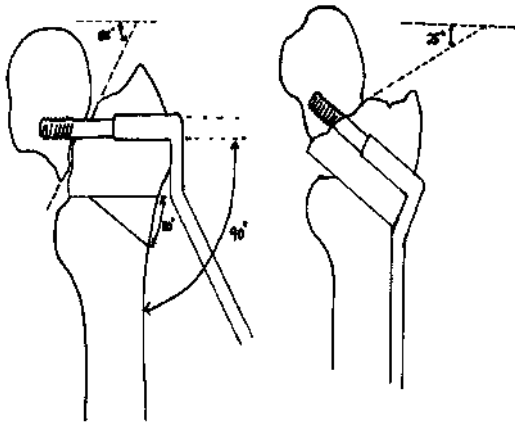


Fig. 1 *Diagram showing method of 30⁰ wedge*

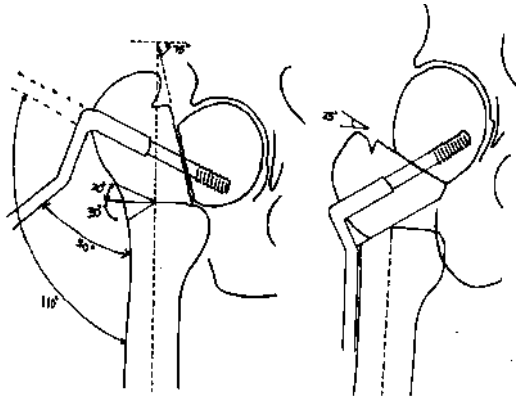


Fig. 2 *Diagram showing method of 50⁰ wedge with Y-osteotomy.*

patient on fracture table under general or spinal anaesthesia and under C-arm image intensifier. The skin incision was directly lateral and straight over greater trochanter and proximal femur. Vastus lateralis was cut in L-shaped manner and elevated subperiosteally. All previous internal fixation devices were removed. The fracture site was not exposed in any patient. After identifying the level of osteotomy a guide wire was inserted above it to make entry point for lag screw. Appropriate sized lag screw was inserted after drilling and tapping. At the level of osteotomy proximal transverse cut and distal angled cut were made and predetermined sized wedge (usually 30^0) was removed. The lower limb was swung into abduction to align the femur to plate and reduction clamps were applied. The barrel plate was fixed to femur using 4.5 mm cortical screws. The removed bone wedge was used as bone graft at osteotomy site.

Postoperatively active exercises of hip and knee were started and non-weight bearing crutch walking began after 2-3 days. Weight bearing was delayed till healing was seen at osteotomy site on radiographs and then progressed gradually to full weight bearing.

Results

Average age of patients was 36.5 yrs (range 17 yrs to 52 yrs). Right side was involved in 9 cases and left side in 13 cases. There were 14 males and eight females. Although precollapse avascular necrosis was not considered to be a contraindication for osteotomy, none of our patients had signs of precollapse avascular necrosis on plain radiograph. There were 14 Pauwel type 2 and 8 Pauwel type 3 fractures in our series.

Assessment of union was done by both clinical and radiological criteria. Clinically healing was defined as pain free full weight bearing without assistance. Radiographically healing was determined by presence of bridging trabeculae of bone crossing the non-union site on plain radiographs (Fig 3,4). Average follow up was 18 mths (12 mths—38 mths). All osteotomy sites healed in an average of 14 weeks (8 wks—20 wks). Non union healed in 18 patients (82%). Fifteen of the seventeen non-union in patients where no previous surgery was done united while three of the five patients with previous failed internal fixation united. Average time to healing of non-union was 20 weeks (12 wks - 40wks). Average change in radiographic fracture inclination after osteotomy was 25^0. In all patients there was improvement in leg length discrepancy (average 1.5 cm) after osteotomy. Two patients developed avascular necrosis with collapse of femoral head after union of fracture 12 months and 16 months postoperatively. Two patients with pre-existing osteoarthritis of knee with mild pain had no change in pain or deformity at knee after osteotomy. There was no infection, thromboembolic complications or implant failure in our series.

Functional outcome was judged according to Askin-Bryan[12] criteria

Excellent - Full range of movements and strength, little or no pain and essentially normal appearing radiographs.

Good - Some limitation of motion, mild discomfort and mild joint space narrowing.

Fair - Some limitation of motion and moderate pain with degenerative changes or aseptic necrosis.

Poor - Severe restriction of function and pain requiring salvage procedure.

Excellent results were seen in four patients, good in 10 patients and fair results in two patients. Poor outcome was

Fig. 3 *Preoperative radiograph of three months old ununited femoral neck fracture*

Fig. 4 *Postoperative radiograph of same patient after osteotomy.*

seen in six patients. Four patients had non-union at fracture site and two patients had avascular necrosis with collapse of head after union of fracture. In one case the position of lag screw was not central, this led to cut through of screw once patient started weight bearing. Two patients had non-union as threads of lag screw were at the fracture site which prevented collapse of fracture. In one patient due to small size of wedge removed the fracture site did not come under compression. Of six patients with poor results, four patients were taken up for bipolar arthroplasty. The remaining two patients refused further surgical treatment and were lost to follow up.

Discussion

Femoral neck fractures in young active adult patients should be treated by early closed reduction and stable internal fixation. Despite improvement in results of internal fixation due to better understanding of reduction of fracture and positioning of implants and improvement in radiography, non-union results in 4%-30% cases[13-16]. In our country late and neglected presentation of femoral neck fractures is common as initial treatment is usually done by local bone setters. Reports in literature suggest that if neck fracture is more than 2-3 weeks old then primary osteosynthesis with cancellous screw alone does not give good results[17, 18]. Meyers[4] also classified acute fractures of neck of femur as those treated upto 30 days after injury and those beyond 30 days as delayed or non-union.

It is well accepted that aim of treatment in young adult patients with non-union of femoral neck without avascular necrosis is preservation of femoral head. Pauwel[7] showed that placing the non-union of fracture neck under compression by resecting a laterally based wedge resulted in union of fracture. Pauwels carried out a simple lateral closing valgus osteotomy for non-union and if head had slipped down he did a Y-osteotomy[7]. For post operative immobilisation patients were placed in hip spica. This type of osteotomy resulted in shortening and marked medialisation of femoral shaft which usually led to genu valgum. To overcome these problems Muller suggested condylar blade plate for fixation after valgus osteotomy.

The largest series in literature is that of Marti et al[7]. They presented results of valgus osteotomy in 41 patients of non-union of femoral neck, with union rate of 86%. They experienced technical difficulties in six patients requiring a second surgery for refixation. Seven other patients required replacement due to persistent non-union, late segmental collapse or implant failure at the shaft. Angelen[8] reported 13 patients with failed internal fixation of femoral neck treated with valgus osteotomy achieving a union rate of 100%.

Studies comparing blade plate with compression screw for fixation have reported a higher rate of suboptimal position of implant, cut through and implant failure with blade plate[19]. In using blade plate hammer impact can displace the fragments. In dynamic hip screw the implant is not hammered. This assembly also gives compression at fracture site by application of compression screw. It also allows some play for fixation as the assembly can be rotated so that plate rests on outer surface of femur while doing the same in blade plate results in anterior or posterior angulation at osteotomy site. Wu et al [20] used a sliding hip screw to compress the non-union and to realign the proximal femur.

The mechanics of hip joint shows that in one leg stance phase a load of at least three times body weight will transfer

21^0 inferolaterally[21]. We routinely planned a wedge of 30^0 as it is difficult to precisely calculate the size of wedge[8]. Pauwels recommended placing the final fracture inclination to 25^0. This can be explained on the basis of biological as well as mechanical reasons for effectiveness of osteotomy in promoting union[8].

Avascular necrosis without head collapse has not been considered to be a contraindication for valgus osteotomy. Calandruccio and Anderson [22] considered that vascular damage at the time of fracture decides whether or not necrosis will develop. However Stromquist and Harrison [23] used tetracycline and isotope studies to show that vascular damage may be increased during the fixation of fracture. In fresh femoral neck fractures overcorrection to more than 20^0 to 30^0 valgus or malrotation will affect the remaining vessels and increase the chance of developing necrosis but whether this holds true in old cases with resorption of neck is debatable. It is also well documented that revascularisation of head is possible both by artery of ligamentum teres and by vessels crossing the uniting fracture[24]. Precollapse avascular necrosis is not a contraindication for valgus osteotomy in ununited fracture neck of femur. We believe further studies by non-invasive means are required to evaluate effect of osteotomy on vascularity of femoral head.

References

1. **Huang CH.** Treatment of neglected femoral neck fracture in young adults. *Clin Orthop.* 1986; 206: 117-126
2. **Lueng PC, Shen WY.** Fractures of femoral neck in young adults : a new method of treatment for delayed and non-union. *Clin Orthop.* 1993: 295: 156-160.
3. **Baksi DP.** Internal fixation of ununited femoral neck fracture combined with muscle – pedicle bone grafting . *J Bone Joint Surg (Br).* 1986; 68:239-245.
4. **Meyers MH, Harvy JP Jr, Moore TM.** Treatment of displaced subcapital and transcervical fracture of femoral neck by muscle pedicle bone graft and internal fixation. *J Bone Joint Surg (Am).* 1933:55:257-274.
5. **Dooley BJ, Hooper J.** Fibular bone grafting for non-union fracture neck of femur. *Aust NZ J Surg*. 1982: 52: 134 -140
6. **Nagi ON, Dhillon MS, Goni VG.** Open reduction, internal fixation and fibular auto grafting for neglected fracture of femoral neck. *J Bone Joint Surg (Br).* 1998:80:798-804
7. **Pauwels F.** Der Schenkelhalsbruch ein mechanisches Problem : Grundlagen des Heilungsvorganges, Prognose and kausale Therapie. Stuttgart; Ferdinand Enke Verlag 1935.
8. **Marti RK, Schuller HM, Raymakers ELFB.** Intertrochantric osteotomy for non-union of femoral neck. *J Bone Joint Surg (Br).* 1989: 71:782-787
9. **Angelen JO.** Intertrochantric osteotomy for failed internal fixation of femoral neck fractures.*Clin Orthop.* 341:1997 :175-182
10. **Ballmer FT et al.** Pauwel osteotomy for nonunion of femoral neck. *Orthop Clin North Am.* 1990; 21:759-767.
11. **Muller ME, Allgower M, Schneider R, Willeneger H.** Manual of internal fixation: 2nd ed Berlin etc:Springer – Verlag.1979.
12. **Askin SR, Bryan RS.** Femoral neck fractures in young adults. *Clin Orthop. 1976*.114:259-264.
13. **Garden RS.** Low angle fixation in fractures of femoral neck. *J Bone Joint Surg (Br).* 1961; 43: 647-663.
14. **Kofoed H, Alberts A.** Femoral neck fractures. *Acta Orthop Scand.* 1980; 51:, 127-136.
15. **Asnis SE et al.** Intracapsular fractures of femoral neck: Results of cannulated cancellous screw fixation. *J Bone Joint Surg (Am).* 1994; 76: 1793-1803.
16. **Garden RS.** Reduction and fixation of subcapital fracture of femoral neck. *Orthop Clin North Am.* 1974, 5, 683-712.
17. **CA Bout et al.** Percutaneous cannulated cancellous scre fixation of femoral neck fractures: Three point principle. *Injury.* 1997; 28:135-139
18. **Sud A et al.** Closed reduction and percutaneous cannulated cancellous screw fixation of femoral neck fractures. *Ind J Orthop.* 2000; 34:151-152.
19. **Doppelt SH.** The sliding compression screw : Todays best answer for stabilisation of intertrochantric hip fractures. *Orthop Clin North Am.* 1980:11: 507-523.
20. **Wu et al.** Treatment of femoral neck nonunion with a sliding compression screw: Comparison with and without subtrochantric valgus osteotomy. Injury. 1999; 46:312-317.
21. **Pring D.** Biomechanics of hip. In: Barrett D. *Essential basic sciences for orthopaedics* Oxford: Butterworth – Heinemann. 1994:62-93
22. **Calandruccio RA, Anderson WE.** Post fracture AVN of femoral head: Correlation of experience and clinical studies. *Clin Orthop.* 1980; 152: 49-84.
23. **Stromquist B, Harrison LJ.** Femoral head vitality after femoral neck fractures- Comparison between pre and perioperative tetracycline labelling. *Arch Orthop Trauma Surg.* 1983; 101: 251.
24. **Catto M.** A histological study of femoral head AVN after transcervical fractures. *J Bone Joint Surg [Br].* 1965; 47: 749-776.

INDIAN JOURNAL OF ORTHOPAEDICS
April 2004
Volume 38 : Number 2 : P. 92-95

Repositioning osteotomy with dynamic hip screw with 120° double angled barrel plate fixation in fracture neck femur

KK Pruthi, H Chandra, RK Goyal, VP Singh

Department Of Orthopaedics, SN Medical College, Agra

Background: Nonunion of femoral neck fracture has remained a major complication in spite of advances in treatment.

Methods: Twenty eight patients of femoral neck fracture with viable femoral head were treated with repositioning osteotomy with dynamic hip screw and 120º double angled barrel plate fixation. Patients were followed for an average of 26.5 months.

Results: Radiological signs of union in 26 cases were observed in an average period of 5.2 months; On the basis of functional assessment by Larson's method 26 patients were graded as good results with Larson's score>90 and one patient with a score of 88 as fair result and one patients with a score of 63 as poor result.

Conclusion: Repositioning osteotomy with dynamic hip screw and 120ºdouble angled barrel plate fixation is a useful method in treatment of fracture neck femur with viable femoral head.

Key-words: Repositioning osteotomy; Dynamic hip screw and 120º double angled barrel plate fixation; Fracture neck femur.

Introduction

The fracture of femoral neck has been called the "unsolved fracture"[1]. Extensive studies of the biomechanics[2] of the femur and pelvis and development of new methods of fixation[3,4] have led to well defined primary treatment directives[5]. Factors known to pose problems in the management of fracture neck femur are intracapsular location, precarious blood supply of head of femur, difficulty in reduction, strong muscle forces, flow of synovial fluid and osteoporosis. Nonunion and avascular necrosis of femoral head have nevertheless remained major complications. The non-union rate of all femoral neck fracture is still in the range of 10% to 20%[6,7] despite modern treatment modalities. In old people the fracture neck can be treated by prosthetic replacement arthroplasty but in young people below the age of 60 years it is desirable that the patient's own hip joint should be preserved.

Pauwels[8] exclusively followed biomechanical principles changing the shear and tension forces of a nonunion into compression forces. In internal fixation of repositioning osteotomy by double angled blade plate, at times blade may displace the fracture fragments and minimal change in the direction of blade may change the direction of plate anterior or posterior to the shaft of femur.

KK Pruthi, MS (Orth), Associate Professor
Harish Chandra, MS (Orth), Professor and Head
RK Goyal, MS (Orth), Assistant Professor
VP Singh, MS (Orth), Senior Resident
Department of Orthopaedics, SN Medical College, Agra
Received : 10.9.2003; Revised : 15.3.2004; Accepted : Mar. 2004

Materials and methods

Twenty eight patients of fracture neck femur were treated with repositioning osteotomy with dynamic hip screw 120º double angled barrel plate fixation from March 2001 to March 2004. Their average age was 42 years (18-58 years). According to anatomical type, six patients were sub capital, 14 patients were trans cervical and eight patients were basal fractures. Viability of femoral head was decided on the basis of radiological examination.

Indications for the surgery were

1. Non union of fracture neck femur with viable head of femur
2. Late cases of fracture neck femur with viable head of femur.
3. Fresh Pauwels' type III fracture neck femur.

According to Pauwels' classification of fracture neck femur, six were type II and 22 fractures were types III fracture neck femur. Two patients were operated within 3 weeks of injury, 19 patients between 3 to 12 weeks and 7 patients operated more than 12 weeks after fracture, 15 patients exhibited absorption of femoral neck.

Pre – Operative Planning

Quality skiagrams of pelvis with both hip–anteroposterior view in full internal rotation and lateral view of affected hip were taken. Pre- operative planning was done by measurement

of repositioning angle by subtracting 25º from Pauwel's angle. We have taken 30º wedge from below the lesser trochanter and rest amount of wedge (>30º) was resected from above the lesser trochanter. Grading of osteoporosis was done as per Singh's index[9] from the sound hip.

Operative Technique

Under spinal anaesthesia patient was laid supine on orthopaedic table and image intensifier positioned for AP and lateral views. Closed reduction of fracture was done by Whitman's method and in difficult cases by Leadbetter or Flynn methods. After preparation of skin and surgical draping of extremity proximal femur was exposed by lateral incision .Ante version of femoral neck was determined by placing the guide wire along the front of femoral neck. DHS guide wire was inserted from the lateral cortex through 120º DHS angle guide to the posteroinferior quadrant of femoral head up to subchondral bone parallel to the previously inserted anteversion wire and triple reaming was done up to 5-10 mm less than inserted guide wire. Dynamic hip screw of selected size was inserted after tapping, 120º double angled barrel plate placed over DHS and the site of osteotomy decided. The linear osteotomy was done just above the lesser trochanter leaving some medial cortex then calculated laterally based wedge was resected. A wedge of 30º was cut distal to the osteotomy and rest amount of wedge was resected proximal to the osteotomy, then osteotomy was completed medially and guide wire was removed. Gap after osteotomy was reduced by abduction of lower limb; 120º double angled barrel plate was fixed with cortical screws and wound was closed in layers after leaving suction drain. The tube of suction drain was taken out 48 hours after the operation and skin stitches were taken out at 12th day after operation.

Quadriceps drill was encouraged as soon as patients were in a position to tolerate it. Patients were allowed to sit next day. Partial weight bearing was allowed at 5-7 weeks after operation and full weight bearing was permitted according to the progress of union at osteotomy as well as the fracture sites. Follow up was done on the basis of clinical and radiological assessment, post operatively at monthly interval for three months and then after at the interval of two months.

Results

The patients were followed for an average period of 26.5 months. Functional results were assessed clinically by Larson's method of clinical assessment. Quality of reduction of fracture neck femur was assessed by the Garden's alignment index.

Reduction was good in 25 patients and fair in three cases (good reduction + 10º). The duration of surgery (from skin incision to skin closure) was 60-90 minutes in 25 cases. In one patient dynamic hip screw did cut through the head of femur. In our series average post operative hospital stay of the patients was approximately 16 days. Post operatively we achieved 25º Pauwel's angle in 14 cases in other 14 cases it was 26º-30º. Partial weight bearing with the help of walker was allowed at an average period of 6 weeks after the operation and full weight bearing was allowed at an average period of 10 weeks after operation. There was pre-operative shortening in all cases. At final outcome in 19 cases there was no limb length discrepancy of lower limb, in 4 cases the shortening was under corrected and in other 2 cases there was gain in length of 0.5-1 cm due to over correction. In all cases union at osteotomy site occurred with an average of 2.6 months (Fig. 1).

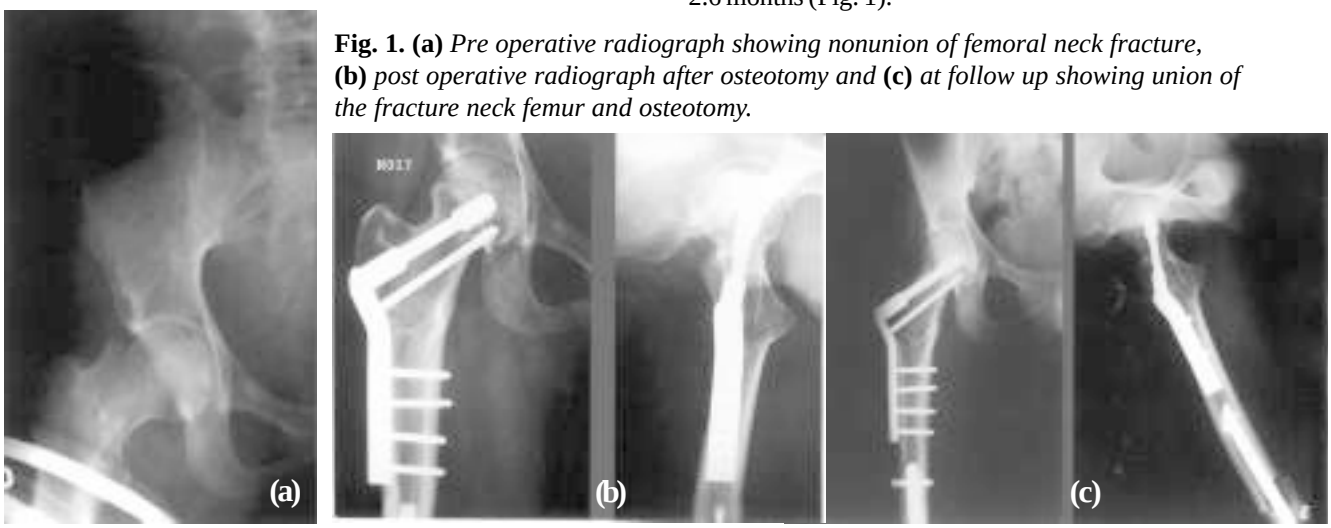


Fig. 1. (a) *Pre operative radiograph showing nonunion of femoral neck fracture,* **(b)** *post operative radiograph after osteotomy and* **(c)** *at follow up showing union of the fracture neck femur and osteotomy.*

Table I. Results based on Larson's method of functional Assessment

Grade (result)	No. of cases
Good (91-100)	26
Fair (71-90)	1
Poor < 70	1
Total	28

Radiological union was determined by the presence of continuation of trabeculi across the osteotomy and fracture sites. In 26 cases union at fracture site occurred with an average of 5.2 months and two cases had non-union of which one showed fair and the other case showed poor results. Average Larson's score was 91.8 (Table I). All the 14 cases of transcervical fracture showed good results. Out of six cases of sub capital fracture, five cases showed good results while one case showed poor result, out of eight cases of basalcervical fracture seven cases showed good results and one case showed fair result. Six patients of Pauwel's Type II fracture showed good results and 20 out of 22 patients of Pauwel's type III fracture showed good results and one case showed fair and another one case had poor result. All 14 cases in which post operatively we achieved Pauwel's angle of 25º showed good results and in other 14 cases in whom we achieved Pauwel's angle between 26º-30º,12 cases showed good results while one case each showed fair and poor result. Two cases operated within three weeks after injury and 19 cases operated between 3-12 weeks after injury, results of all these cases were graded as good results, five out of seven cases operated after 12 weeks of injury showed good results and result of one patient graded as fair and of another one graded as poor result. Complications are given in table III.

Table II. Result according to Singh's Index

	Total cases	Results	
		Good	Fair
gr III	4	3	1
gr IV	11	10	1
gr V	7	7	0
gr VI	6	6	0

Table III. Complications

Complication	No.of cases
Superficial infection	2
Hip stiffness	1
Lower limb length discrepancy	6
Cut through of Richard's Screw through femoral head	1
Non Union	2

Discussion

The femoral neck fracture is probably the fracture for which there exists the larger number of methods of osteosynthesis. Internal fixation of femoral neck fracture is followed by certain incidence of fixation failure. Nonunion may occur in one third of patients with higher rate in vertical or displaced fractures[10]. Number of methods of internal fixation when used alone have failed to achieve the desired end result. Osteoporosis directly influences the degree of displacement and quality of internal fixation. The deficient bone stock and posterior communiation plays a significant role in its biological failure to unite the fracture. The age and sex of patient, ostreoporosis, degree of displacement and quality of fracture reduction are the factors that have found to affect the end result[11,12].

Since the first report of internal fixation of femoral neck fracture by von Langen Beck[13] in 1850, multitude of devices for internal fixation of femoral neck fractures have been designed and popularized. Surgical treatment of femoral neck fractures include arthroplasty, non vascularised bone grafting, arthrodesis and osteotomy. Arthroplasty is an acceptable treatment in older patient, in younger patients alternative methods aimed to preserve the patients own femoral head should be favored, cortical bone grafts have been associated with disimpaction or angulations of the head leading to failure[14]. The initially reported success of Meyer's procedure has not been reproduced in a large series and the procedure has been considered unreliable[15]. Arthrodesis has a high failure rate but when successful it leads to a functional hip.

Pauwels recognized that a non- union of femoral neck fracture would consolidate with in few months if shearing force acting on non union fracture site were transformed into compression forces[8]. Repositioning osteotomy with dynamic hip screw and 120º double angled barrel plate fixation plays two folds role. It converts the shearing forces into the compression forces by placing the fracture site perpendicular to the resultant of body weight forces. It buttresses the head of femur from below to improve the stability provided by the internal fixation. Good results had been reported in femoral neck fracture treated with primary osteosynthesis and valgus intertrochantric osteotomy[16, 17]. Avascular necrosis may develop following surgery. Marti et al while making observations on avascular necrosis mention that partial or complete collapse of head of the femur can occur up to 3 or 4 years later[18]. Soto–Hall et al observed that incidence of aseptic necrosis was not raised when treatment for fracture neck

femur was neglected because patients inevitably assumed the positions of the greatest joint capacity (flexion, abduction and external rotation)[19]. This posture would relieve the intra articular temponade and lessen the possibility of avascular necrosis. This probably explains why avascular necrosis was not seen in our patients.

In conclusion repositioning osteotomy with dynamic hip screw and 120º double angled barrel plate fixation is a useful method in treatment of fracture neck femur with viable femoral head.

References

1. **Dickson JA.** The "Unsolved" fracture: A protest against defeatism: *J Bone Joint Surg (Am).* 35:805, 1953.
2. **Linton P.** On the different types of intracapsular fractures of the femoral neck: A surgical investigation of the origin, treatment, prognosis, and complications in 365 cases. *Acta Chir Scand.* 1990 (suppl 86) : 1 , 1944.
3. **Blount WP.** Blade Plate internal fixation for high femoral osteotomies. *J Bone Joint Surg.* 25: 319, 1943.
4. **Muller ME, Allgower M, Willenegger H.** ***Manual Der Osteosynthese.*** Berlin; Springer. 1977:360.
5. **DeLee JC.** Fractures and dislocations of the hip. In Rockwood CA, Green DP (eds): *Fractures in adults*, ed 2. Philadelphia; JB Lippincott. 1984: 1211.
6. **Holmberg S, Kalen R, Thorngren KG.** Treatment and outcome of femoral neck farctures . An analysis of 2418 patients admitted from their own homes. *Clin Orthop.* 218: 42, 1987.
7. **Garden RS.** Low- angle fixation in fractures of the femoral neck. *J Bone Joint Surg (Br).* 1961; 43:647.
8. **Pauwels F.** Der Schenkelhalsbruch ein mechanisches Problem : Grundlagen des Heilungsvorganges, Prognose and kausale Therapie. Stuttgart; Ferdinand Enke Verlag 1935.
9. **Singh M, Nagrath AR, Maini PS.** Changes in the trabecular pattern of the upper end of the femur as an index of osteoporosis. *J Bone Joint Surg (Am).* 1970;52: 457- 467.
10. **Lu-Yoa GL, Keller RB , Littenberg B, Wenliberg JE.** Outcomes after displaced fractures of the femoral neck . A meta – analysis of one hundred and six published reports. *J Bone Joint Surg (Am).* 1994; 76: 15-23
11. **Garden RS.** Stability and union in subcapital fractures of the femur. *J Bone Joint Surg (Br).* 1964; 46: 630-47
12. **Dalen N.** Jacobson B. Rarefied femoral neck trebecular patterns,fractures displacement and femoral head vitality in femoral neck fractures. *Clin Orthop.* 1986; 207: 97-8.
13. **Von Langen Beck B.** Gvar Deen . Ges Chri 7:40: *J Trauma.* 27:291, 1987
14. **Baksi DP.** Internal fixation of ununited femoral neck fracture combined with muscle – pedicle bone grafting . *J Bone Joint Surg (Br).* 1986;68:239-245.
15. **Zukerman JD, Koval KJ.** Hip trauma. In Frimoyer JW {ed} *Orthopaedic knowledge update 4*. Rosemont; American Academy of Orthopaedic surgeons. 1993:525-538.
16. **Rinaldi E, Marengh P, Negri V.** Osteosynthesis with vulgus osteotomy in the primary treatment of subcapital fractures of the neck of the femur. *Ital J Orthop Traumatol*. 1984, 10{3}: 313 –320.
17. **Lifeso R, Younge D.** The neglected hip fractures . *J Orthop Trauma.* 1990 ; 4: 287 –292.
18. **Marti RK, Schuller HM, Raaymakers ELFB.** Intertrochanteric osteotomy for nonunion of the femoral neck. *J Bone Joint Surg (Br).* 1989; 71: 782-787}.
19. **Soto-Hall R , Johnson LH, Johnson RA.** Variations in intraaticular pressure of the hip joint in injury and disease . A probable factor in avascular necrosis. J *Bone Joint Surg (Am).* 1964; 46;509.

INDIAN JOURNAL OF ORTHOPAEDICS
April 2004
Volume 38 : Number 2 : P. 96-99

Thoracolumbar spine injuries-*comparison of 4 different posterior spinal instrumentation systems*

BN Pati, L Krishna, RK Chopra, VA Senthil Kumar, M Bansal

Central Institute of Orthopaedics, Safdarjang Hospital, New Delhi

Background : Unstable spinal injuries require fixation to provide stability. Various modalities of fixation have been used.

Methods : One hundred and forty seven patients of thoracolumbar spine fractures with neurological deficit were surgically treated using posterior approach. Four different types of posterior instrumentation were used to reduce the fractures and dislocation of thoracolumbar spine and achieve cord decompression – Harrington rod fixation in 55, Hartshill in 19, Steffee in 51 and newer pedicle screw rod systems in 22 patients.

Results : The patients were followed up for minimum period of 2 years. Neurological improvement did not vary with type of instrumentation.

Conclusion : Pedicle screw rod-systems are more versatile and technically superior than Harrington and Hartshill systems, in lieu of their ability to gain purchase in all the 3 columns and better reduction of thoraculumbar spine fractures and ability to maintain reduction at the end of 2 years.

Key-words: Thoracolumbar spine; fractures dislocation; posterior spine instrumentation; Harrington; Steffee; Hartshill; Pedicle screw rod systems.

Introduction

Considerable controversy exists regarding the clinical performance of different instrumentation systems for the surgical treatment of unstable fractures of the thoracolumbar spine. Although the biomechamical performance of different spinal fixation devices has been studied extensively in the laboratory, comparative clinical outcome data are few. This paper compares the versatility/ clinical outcome of different posterior internal fixation devices for thoracolumbar spinal trauma.

The more classic systems of posterior instrumentation, i.e., Harrington, Hartshill and Luque are based on hooks or sublaminar wiring to gain purchase on posterior column structures alone, whereas in pedicle screw fixation all three spinal columns may be controlled directly the pedicle screw rod systems, by virtue of direct fixation through middle and anterior columns, are able to reduce fractures of these columns by ligamentotaxis[1-5].

Some authors have shown that early operation within 4 days of trauma results in significant reduction in spinal canal encroachment irrespective of instrumentation systems used Harrington or Pedicle screw systems[1,6]. Not many studies have compared pedicle screw systems with Harrington or Hartshill systems in the management of fractures of thoracic and lumber spine[1,6]. The aim of this study is to compare the efficacy of the classic Harrington, Hartshill and Steffe system and newer pedicle screw rod systems in attainment and maintenance of reduction (i.e., vertebral body height and percentage reduction of horizontal translation) of thoracolumbar spine fractures and also to assess the complication rates and safety of the above systems in the treatment of thoracolumbar spine fractures.

Materials and Methods

One hundred and forty seven patients of thoracolumbar [T_{12}/L_1] spine fractures with partial or complete neurological deficit were included in this study. After routine plain X-ray studies, the extent of cord compression and the presence of cord contusion or cord edema or cord transaction was evaluated by MRI. The neurological status was classified according to Frankel's grades. These patients were operated using posterior approach. Harrington rod fixation was performed in 55, Hartshill in 19 patients, Steffee (pedicle screw and plate) in 51 patients and newer pedicle screw rod systems [Moss Miami System and Universal Spine Stabilisation System – AO] in 22 patients. Standard midline posterior approach was used in all patients. In the earlier period of our study we were using Harrington and Steffee instrumentation predominantly. Later Moss-Miami/USS systems was used predominantly. Initially we used fluoroscopy to guide the placement of pedicle screws[5], but later with greater experience pedicle screw placement without fluoroscopy could be performed.

BN Pati, MBBS, MS (Orth), Senior Orthopaedic Surgeon
Loveneesh Krishna, MBBS, MS (Orth), DNB (Orth), Associate Professor
RK Chopra, MBBS, MS (Orth), Associate Professor
VA Senthil Kumar, MBBS, MS (Orth), Senior Resident
Manish Bansal, MBBS, MS (Orth), Junior Resident
Central Institute of Orthopaedics, Safdarjang Hospital, New Delhi
Dr BN Pati, 303, Sector – III, RK Puram, New Delhi
Received : 11.2.2002; Revised : 26.11.2003; Accepted : Mar. 2004

Of the 147 patients, 98 were males and 49 were females. Average age was 24 years (range – 16 years to 53 years). The time interval between injury and operative procedure averaged 11 days (range – 3 days to 35 days). We classified the fracture pattern in our patients according to McCormack's load sharing method[14] for the purpose of evaluating the results (Table I).

Irrespective of the type of instrumentation used for the fixation of the fracture, the patients with a McCormack's point score of 4 or 5 were mobilized to sitting posture with a thoracolumbar spinal brace after 3rd week postoperatively. Patients with a point score [McCormack] of 8 or 9 week mobilized to sitting posture with a thoracolumbar brace only after 8 to 12 weeks [though the patients were turned on bed for proper back care, surgical stabilization makes nursing easier in these patients], thus making the follow up results comparable irrespective of the type of instrumentation used. Depending on the neurological status of the patients mobilization was done on a wheel chair [Frankel's Grade A or B or C] or with a walker frame of crutches [in Frankel's Grade D or E]. Vigorous preoperative and postoperative chest and lower limb physiotherapy was performed. Thoracolumbar orthosis was continued for 2 years or till radiological evidence of fracture consolidation was seen.

The patients were reviewed at 1 month, 3 months, 6 months, 1 year and 2 years from the date of surgery and the following radiological and clinical parameters were noted in the immediate postoperative period and in the successive visit: reduction achieved, loss of reduction, complication and neurological status.

Table I: Load sharing classification of dorso lumbar spine fractures

Total points score	Harrington	Stefee	Hartshill	Moss & USS.
9	2	3	1	1
8	7	7	2	3
7	11	10	4	5
6	23	21	8	9
5	11	10	4	4
4	1	1	0	0
3	0	0	0	0

The preoperative anterior and posterior vertebral heights were measured as a percentage of the mean anterior and posterior body heights of the non-fractured vertebrae immediately above and below. Also, anterior translation of dislocated vertebra was calculated as percentage of antero-posterior diameter of immediately intact vertebra. The above values were compared with the immediate postoperative and values and the measurements in the follow-up x-rays, at the end of one year and 2 years. The neurological status was assessed periodically.

Table II:

Hook & Rod System	Pre-op	Post-op	1 year	2 years
Anterior vertebral height	39%	76%	73%	68%
Posterior vertebral Height	92%	99%	96%	93%
Anterior translation	71%	29%	33%	34%
Pedicle Screw Plate System				
Anterior vertebral height	36%	79%	76%	74%
Post verebral Height	91%	93%	92%	92%
Anterior translation	67%	33%	34%	34%
Laminar Wire System				
Anterior vertebral height	37%	63%	58%	53%
Post verebral Height	85%	90%	89%	88%
Anterior translation	70%	31%	33%	34%
Pedicle Screw & Rod System				
Anterior vertebral height	42%	84%	83%	82%
Post verebral Height	87%	95%	93%	93%
Anterior translation	66%	30%	32%	33%

Results

Initial restoration of anterior vertebral height of fractured vertebrae is much better with pedicle screw systems when compare to Harrington or Hartshill systems (Table II). Among these, Harrington shows better reduction than Hartshill System. Similarly maintenance of the achieved reduction is superior and consistent at 1 and 2 years follow- up in pedicle screw and rod systems. The loss of reduction was much higher with Hartshill system. Harrington also showed loss of reduction comparable to Steffeee system, but still they fared better than Hartshill but reduction of translation is comparable with all the four types of posterior instrumentation.

In this study, cases operated upon within 2 weeks of injury showed better reduction compared to those operated upon later than 2 weeks. Complication of implant failure like screw breakage was higher with Steffee system (11.8%) than with Pedicle screw rods system(Table III). Wire breakage/ cutout were a high 21% with Hartshill system and hook cut through (10.9%) ws a common comlication with Harrington. Deep infection necessitating implant removal was commoner with Harrington system.

Neurologically, majority or our patients were in Frankel's A and B grades. None of our patients were in Frankel's E Grade (Table IV). Almost all the patients in Frankel's Grade A did not show improvement. There was improvement by one

Table III. Complications

	Harrington	Steffee (51 cases)	Hartshill (19 cases)	Pedicle screw rod (22 cases)
Loss of reduction of vertebral height	6 cases (10.9%)	3 cases (5.9%)	2 cases (10.5%)	1 case (4.5%)
Loss of reduction of translation	-	-	-	-
Pedicle / lamina fracture	2 (3.6%)	3 (5.9%)	1 (5.3%)	1 (4.5%)
Screw breakage	-	4 (7.8%)	-	-
Screw cutout	-	2 (10.5%)	-	1 (4.5%)
Wire breakage	-	-	2 (10.5%)	-
Wire cutout	-	-	2 (10.5%)	-
Hook cut through	6 (10.9%)	-	-	-
Nerve root injury	-	2 (3.9%)	-	1 (4.5%)
CSF leakage	3 (5.4%)	1(1.96%)	1 (5.3%)	1 (4.5%)
Pain on mobilization	4 (7.3%)	7 (13.7%)	3 (15.8%)	2 (9%)

or two grades in many of the patients with Frankel's Grade B and Grade C, irrespective of the instrumentation system used. Only an occasional patient showed neurological worsening by one grade (Table V).

Table IV:

Preoperative Neuro Status	Harrington 55	Hartshill 19	Steffee 51	Pedicle Screw 22
Frankel A (Complete injuries)	22 (40%)	8 (42 %)	23 (45%)	9 (41%)
Frankel B	25 (45.5%)	19 (58%)	21 (41%)	11 (50%)
Frankel C	5 (9%)	0	6 (12%)	2 (9%)
Frankel D	3 (5.5%)	0	1 (2%)	0
Frankel E	0	0	0	0

Table V:

Post-operative Neuro recovery	Harrington	Hartshill	Steffee	Pedicle Screw Rod
Neurologically improved	28 (51%)	9 (47%)	23 (45%)	13 (59%)
Neurologically unchanged	26 (47%)	10 (53%)	27 (53%)	9 (41%)
Neurologically worsened	1 (2%)	0	1 (2%)	0

Discussion

Pedicle screw devices have shown better reduction than Harrington rods and Hartshill system[1,7,9-13]. The advantage of pedicle screws is its capability of holding all the 3 colums of spine where as Harrington and Hartshill systems get a purchase over the posterior column structures alone. Therefore the efficacy of reduction of anterior column fractures is better with pedicle screw systems and maintenance of reduction in one and 2 years follow-up is superior with pedicle screw compared to Harrington and Hartshill systems[1,7,11-13]. Whether combining an anterior procedure is necessary, is beyond the scope of this study.

Vornanen et al have shown better reduction with Harrington rods when compared to pedicle screw systems[6]. It is important to take into consideration the results of Shono et al[7] who have shown in their experimental study that posterior distractive reduction maneuver generates anterior and middle spinal column defects, leading to significant mechanical instabilities particularly in axial compressive loading. This had prompted us to use thoracolumbar spinal brace for 2 years or till radiological evidence of fracture consolidation is evident.

Pedicle screw fracture occurred in 7.8% of our patients which is comparable to published literature[2]. Wire breakage with Hartshill instrumentation was 10.5% in our study in compared to 8.3% in reports4. Pedicle or lamina fracture varied between 3.65 to 5.9% with the different instrumentation's, when compared to the reports in literature of 1.4% to 2.6% 2,4

In our study, cases operated within 2 weeks of injury showed better reduction when compared to cases operated after 2 weeks, though Vornanen et al observed that early operation with 4 days after injury is essential to achieve significant reduction7. Neurological outcome analysis showed that cases who fell in Frankel's Grade A did not show improvement, similar to Dickman's observation4. Neurological improvement was not affected by the type of instrumentation used.

We conclude that in our country where resources are limited, using the easier and the less demanding posterior approach, and indirect reduction techniques are the best surgical options for injuries of T_{12} and L_1. The newer pedicle screw rod system are more versatile and technically superior to classic Harrington, Hartshill systems, in fixation of thoraco-lumbar spine injuries because pedicle screw rod systems achieve 3 column fixation causing efficient distraction and

translation and because of their ability to maintain the reduction at 2 years, follow up.

Fewer complications (like screw breakage), compared to the Steffee system make the pedicle screw rod systems, the posterior instrumentation of choice. At the same time the authors emphasize the fact that insertion of pedicle screws needs technical expertise and experience of high order to minimize complications of nerve root injury and pedicle fracture. The time at which postoperative mobilization to erect posture is started, should strictly take note of the fracture pattern.

References

1. **Timothy R, Cresswell TR, Marshall PD, Smith RB.** Mechanical stability of the AO internal spinal fixation system compared with that of the Hartshill rectangle and sublaminar wiring in the management of the unstable burst fractures of the thoracic and lumbar spine. *Spine*. 1988; 23:111-115.
2. **Yuan HA, Garfin SR, Dickman CA, Mardjetko SM.** A historical cohort study of pedicle screw fixation in thoracic, lumbar and sacral spinal fusions. *Spine.* 1994; 19: 2279S-2296S.
3. **Gestzbeni SD, Macmichael D, Tile M.** Harrington instrumentation as a method of fixation of fractures of the spine: A critical analysis of deficiencies. *J Bone Joint Surg (Br).* 1982; 64:526-9.
4. **Dickman CA, Yahirs MA, Lu HTC, Melkerson MN.** Surgical treatment alternatives for fixation of unstable fractures of the thoracic and lumbar spine – A meta analysis. *Spine.* 1994; 19; 20S:2279S-2296S.
5. **Temple HT, Kruse RW, van Dam BE.** Lumbar and lumbosacral fusion using Steffee instrumentation. *Spine.* 1994; 19:537-541.
6. **Vornanen MJ, Bostman OM, Myllynen PJ.** Reduction of bone retropulsed into the spiral canal in thoracolumbar vertebral body compression burst fractures – A prospective randomized comparative study between Harrington rods and two transpedicular devices. *Spine.* 1995; 20: 1699-1703.
7. **Shono Y, McAfee PC, Cunningham BW.** Experimental study of thoracolumbar burst fractures – A radiographic and bio-mechanical analysis of anterior and posterior instrumentation systems. *Spine.* 1994; 19:1711-1722.
8. **Dick W, Kluger P Magesl F, Warslorfer 0, Zach G.** A new device for internal fixation of thoracolumbar and lumbar spine fractures 'the fixateur interne'. *Paraplegia*. 1988;23:225-32.
9. **Aebi M, Etter C, Kehl T, Thalgott J.** The internal skeletal fixation system; a new treatment of thoracolumbar fractures and other spinal disorders. *Clin Orthop.* 1986; 227: 30-43.
10. **Olerud S, Karhstrom G, Sjostrom L.** Transpedicular Fixation of thoracolumbar vertebrae fractures. *Clin Orthop.* 1988;
11. **Denis F.** The three column spine and its significance in the classification of acute thoracolumbar spine injuries. *Spine.* 1983; 8:817-831
12. **Fredrickson E, Mannie, Yuan H., Lubicky J.** Reduction of the intra-canal fragment in experimental burst fractures. *Spine.* 1988; 13:267-271.
13. **Harrington RM, Budorick HJ, Anderson PA, Tencer AF.** Bio-mechanics of indirect reduction of bone retropulsed into the spinal canal in vertebral fracture. *Spine.* 1993; 18: 692-699.
14. **McCormack T, Karaikovic E, Gaines RW.** The load sharing classification of spine fractures. *Spine.* 1994; 19:1741-1744.

INDIAN JOURNAL OF ORTHOPAEDICS
April 2004
Volume 38 : Number 2 : P. 100-103

Role of modified Kuntscher's nail in management of subtrochanteric fractures of femur

SS Sangwan, ZS Kundu, RC Siwach, KM Marya, Vikas Yadav, Ashish Devgan

Department of Orthopaedics, Paraplegia & Rehabilitation, Pt. BDS, Postgraduate Institute of Medical Sciences, Rohtak

Background : Subtrochanteric fractures of femur are a problem in management due to displacement of the fragments. Various extramedullary or intramedullary implants have been described .

Methods: Eighty-five patients who had sustained 87 subtrochanteric fractures (two bilateral) that had been fixed by a modified Kuntscher's nail (K-nail) during 1992 to 2000, and were available for follow-up in 2001, were reviewed. The average age of the patients was 37.6 years (range 20 to 51 years). The standard K-nail was flattened proximally to provide rotational stability and angled laterally to prevent varus angulation. Fourty seven nails were locked proximally through the broadened eye, the rest were left unlocked.

Results : After an average follow-up duration of 6.8 years (range 1.2 to 8.5 years), the results in terms of prevention of varus and rotational alignment were found to be encouraging.

Conclusion : Low implant cost and the advantage of an intramedullary device make this modification even more attractive for the poor Asian patients. Locking does not influence the results significantly.

Key-words : Subtrochanteric fracture; internal fixation; intramedullary implant; Kuntscher's nail.

Introduction

Subtrochanteric fractures of femur are best managed by operative procedures using either extramedullary or intramedullary implants. Extramedullary implants include plates, dynamic condylar or hip screws (DCS or DHS) and angled blade plates. The intramedullary implants commonly used are simple Kuntscher's nails, interlocking nails, K-Y nail, Ender's nail, Zickel, Gamma nail, Recon and the Proximal femoral nail (PFN). The intramedullary implants have the advantage of being load-sharing and being closer to the weight bearing axis. Whereas straight nails are unable to prevent varus angulation (due to abduction of the proximal fragment and wide medullary canal), the modern locked nails often prove to be too expensive for the poor patient in this subcontinent. The standard K-nail was modified with an aim to improve its rotational stability and enable it to prevent varus mal-alignment so as to provide a cost effective alternative to the more established but expensive implants.

Sukhbir Singh Sangwan, MS (Orth), Professor and Head
Zile Singh Kundu, MS (Orth), Lecturer
Ram Chander Siwach, MS (Orth), Proessor
Kirti Mohan Marya, MS (Orth), Lecturer
Vikas Yadav, MS (Orth), Lecturer
Ashish Devgan, MS (Orth), Lecturer
Department of Orthopaedics, Paraplegia & Rehabilitation,
Pt. BDS, Postgraduate Institute of Medical Sciences, Rohtak, Haryana
Dr. Zile Singh Kundu, 11J/ 7 (UH) Medical Campus, PGIMS, Rohtak 124 001 Haryana
Received : 16.2.2003; Accepted : Mar. 2004

Material and Methods

A) *Implant* (*Rohtak nail*): The Kuntscher's nail was flattened at one end using a mechanical press and its eye was broadened with a drill (Fig.1). An angle of 12^0 to 15^0 was introduced at certain distance (individualized to the fracture

Fig. 1. Lateral and front profile of the modified Kuntscher's nail (Rohtak nail).

Fig. 2. *Pre-operative and post-operative radiographs of a patient. Note that the nail has been locked proximally.*

distance from tip of trochanter) below the flattened tip so as to provide a lateral angulation that lies at the level of the fracture after insertion. Whereas flattening increases the rotational stability of the implant in the cancellous proximal fragment, the bend does not allow the fracture to drift into varus.

B) *Patients:* Eighty five patients with 87 subtrochanteric fractures were managed using this modified device in this institute during 1992 to 2000. All the patients were put on skeletal traction in abduction preoperatively. The X-rays of the affected hip with thigh were taken in antero-posterior and lateral planes and the displacement, personality of the fracture, comminution and distance of fracture from lesser trochanter was carefully noted.

The surgery was performed under general or spinal anaesthesia. The patient was put in lateral position and through the standard lateral surgical approach the modified K-nail was inserted in an ante grade fashion over a guide wire. Hammering was done very gently particularly when the broadened part of the nail was entering through the tip of greater trochanter to avoid splintering. The slot was kept laterally as usual and the angle kept as near to the fracture as possible.

Proximal locking was done in 44 nails. A hole was made through the outer cortex just below the tip of greater trochanter and then a drill bit was passed through the enlarged eye. Locking was done with the help of a screw of appropriate length directed medially and inferiorly (Fig.2). A washer was used with the screw to avoid sinking of screw in the cancellous trochanteric area. In 43 cases, no locking was done (Fig 3, 4). X-rays were taken to check the placement of nail and screw and to check neck-shaft angle. Wound was closed in layers over a negative suction drain and aseptic dressing was done.

Skeletal traction was removed postoperatively when a stable and secure fixation could be achieved per-operatively. However in six cases with comminuted fractures and unstable fixation, skeletal traction was continued for three weeks with 3kg weight to avoid shortening till the fracture "gluing" took place. Active quadriceps exercises and ankle and toe movements were started immediately postoperatively. Straight leg raising and knee mobilizing exercises were started after third postoperative day. Stitches were removed after 12 days. Non-weight bearing ambulation with bilateral axillary crutches was begun at 4 weeks and partial weight bearing was started at 6 weeks post-operatively. Full weight bearing was commenced once radiological evidence of consolidation was seen. At each follow-up, the patients were clinically assessed for infection; nail migration and movements of hip, knee and ankle. Radiographs were taken to assess the progress of fracture healing, neck-shaft angle and implant failure.

Results

Eighty seven fractures in 85 patients (53 males and 32 females), in age group ranging from 20 to 51 years constituted the material for this retrospective study. There were 64 high-energy motor vehicle accidents, 15 moderate energy fall accidents and 6 low energy pathological fractures. Associated fractures and medical conditions were evaluated. Fractures were classified as per Fielding and Seinschiemer system (Table I). Two patients had bilateral subtrochanteric fractures. Majority of the patients were operated within first two weeks of injury apart from four patients who had reported two months after the trauma. Operative time ranged from 45 to 60

Table 1. Fracture classification (n=87)

Fielding	classification	Seinsheimer	classification
Type I	0	Type I	5
Type II	63	Type II a	16
Type III	24	Type II b	23
		Type II c	22
		Type III a	8
		Type III b	7
		Type IV	6
		Type V	0

Fig. 3. *Pre-operative radiograph of a patient who sustained bilateral fracture in the subtrochanteric region of femur.*

Fig. 4. *Post-operative radiograph of the same patient.*

minutes in unilateral and 90 to 110 minutes in bilateral cases. In majority of the patients, one unit of blood was transfused.

Clinical and radiological union was achieved within 3 months in 67 fractures, within 3.5 months in 13, within 4 months in three fractures and by 5 months in two fractures. Two patients went into non-union. There was no difference in the union rate between the locked and the non-locked groups. Implant failure in form of nail breakage at fracture site was present in one case who started early full weight bearing. Seventy patients regained full range of hip and knee movements. Thirteen patients had limitation of knee flexion beyond 120^0 and two had hip (0-90^0) and knee (0-70^0) stiffness. Complications of this procedure included splintering of greater trochanter in one case which was managed by tension band wiring and healed eventlessly. Varus angulation and shortening were seen in three patients who had pathological fractures. The shortening was less than 2.5 cm in all cases. Proximal migration of nail was found in two cases, where the proximal locking was not done. In two patients, over-bent nail caused a valgus mal-alignment of 5 degrees leading to slight lengthening of the limb but the patients had no limp and / or disability. No antero-posterior angulation or rotation was observed in any patient. Superficial infection was seen in five patients and was managed by oral antibiotics uneventfully.

Discussion

Many internal fixation devices have been recommended for use in subtrochanteric fractures including extramedullary and intramedullary implant. Intramedullary implants are preferred in comparison to extramedullary ones due to their placement close to the weight bearing axis and hence less stress on the implant and mechanical failure. Verettas et al[1] in a recently reported series in young adults, found that the rate of complications was 22.5% for the trochanteric and subtrochanteric fractures (mal-union and displacement into varus) and was attributed to early collapse of the fracture and the inability of the implant to withstand the strain before osseous union. Furthermore, they also suggested that intramedullary fixation of subtrochanteric fractures should be preferred to the sliding screw and side plate. Various intramedullary implants have been used for fixation of these fractures at different points of time and include Kuntscher's nail, Ender's nail, Zickel nail, K-Y nail, Interlocking Grosse-Kempf nail, Gamma nail and recently introduced Proximal Femoral Nail.

Ender's condylocephalic nail has been used in intertrochanteric and subtrochanteric fractures and has advantage like reduced surgical trauma required for insertion, less blood loss, uniform distribution of stress and better healing potential.[2] However disadvantages like proximal or distal nail migration, loss of fixation and irritation of the knee have virtually kept back many a surgeon from using this implant.[3] Simple Kuntscher's nail is associated with varus angulation and rotational mal-alignment.[4] Kuntscher's Y nail has been used for improved proximal fixation in subtrochanteric fractures but it is difficult to use and its complication includes coxavara in 10%, external rotation in 13%, implant failure in 7%, migration of nail, and a 24.2% mortality rate within 3 months.[5] Zickel nail had been designed with the provision of supplementary internal fixation by means of a nail into the head and neck fragments but it has shown problems of intra-operative trochanteric comminution,

rotational mal-alignment of the femoral shaft and perforation of the head and neck of the femur.[6-9] Brien et al reported 10 mal-unions and one non union out of 21 fractures treated by Zickel nail.[10] The Grosse-Kempf nail, which allows the insertion of proximal and distal transfixing or locking screw, has extended the indication for closed intramedullary nailing to subtrochanteric fractures. But this implant cannot be applied in the fractures above the level of lesser trochanter where varus angulation has been reported in 19% of cases in which it was used. It has also been mentioned that choosing a point of entry of the nail in the greater trochanter too far lateral in subtrochanteric fractures, may lead to fixation of fracture in varus alignment.[11] So it is very demanding procedure and needs experience.

Gamma nails have recently been used for intertrochanteric and subtrochanteric fractures. They, however, have their own drawbacks like intra-operative fracture of greater trochanter, cutout of screw through the femoral head, femoral fracture at the lower end (tip) of the implant, penetration of the femoral cortex during placement and the need of image intensifier during closed technique of insertion. The reported mortality is 12.2% within one month and 30.1% within one year.[12] A mismatch of the nail design and femoral canal has been shown to exist in Asian patients where bone morphology is quite different from western patients. This led to the development of modified Gamma nail.[13]

The implants like Grosse Kempf nail, Gamma nail, Zickel nail and the PFN are quite costly and many of the patients in Indian subcontinent are not able to afford the implant. Further these implants and their gadgetry are not available in the peripheral hospital and small cities. Kuntscher's nail is the cheapest implant with wide availability and its modification is feasible even in smaller peripheral hospitals. In the patients with short oblique fractures without comminution, where the nail fits snuggly in the medullary canal at the level of isthmus, no locking is needed through the hole. In the cases with comminution or osteoporosis and where the nail is slightly loose in distal fragment, proximal locking should be done and also skeletal traction continued for 4 weeks to avoid proximal migration of nail and shortening of limb and rotation. The procedure is quite easy and simple and can be well utilized in peripheral hospitals without modern instrumentation and gadgetry. Image intensifier is not required and thus the surgeon and patient can avoid unnecessary radiation hazards. The only drawback is that modifying the original shape of nail slightly weakens it and weight bearing cannot be allowed for 4 to 6 weeks until callus and healing of fracture becomes evident though the patient can be mobilized in bed. This, however, can easily be taken care of by manufacturing the nail in this modified fashion.

References

1. **Verettas DA, Galanis B, Kazakos K, Hatziyiannakis A, Kotsios E.** Fractures of the proximal part of the femur in patients under 50 years of age. *Injury.* 2002; 33:41-5.
2. **Russin LA, Sonni A.** Treatment of intertrochanteric and Subtrochanteric fractures with Ender's intramedullary rod. *Clin Orthop.* 1980; 148:203-212.
3. **Pankovich AM, Tarabishy IE.** Ender nailing of intertrochanteric and subtrochanteric fractures of the femur. *J Bone Joint Surg [Am].* 1980; 62:635-645.
4. **Mahaisvariya B, Kesprayura S, Laupattarakasem W, Suthiyuth T.** Subtrochanteric fracture: fixation using AO tibial nail. *Injury.* 1992; 23:231-233.
5. **Cuthbart H, Howat TW.** The use of Kuntscher Y nail in the treatment of intertrochanteric and subtrochanteric fractures of the femur. *Injury*. 1976; 8:135-142.
6. **Zickel RE.** A new fixation device for subtrochanteric fractures of the femur. *Clin Orthop.* 1967; 54: 115-123.
7. **Zickel RE.** Subtrochanteric femoral fractures. *Orthop Clin North [Am].* 1980; 11:555-568.
8. **Zickel RE, Mouradian WH.** Intramedullary fixation of pathological fractures and lesions of the subtrochanteric region of the femur. *J Bone Joint Surg [Am].* 1976; 58:1061-1066.
9. **Mickelson MR, Bonfiglio M.** Pathological fractures in the proximal part of the femur treated by Zickel nail fixation. *J Bone Joint Surg [Am].* 1976; 58:1067-1070.
10. **Brien WW, Wiss DA, Becker V Jr, Lehman T.** Subtrochanteric femur fractures: a comparison of the Zickel nail, 95 degrees blade plate, and interlocking nail. *J Orthop Trauma.* 1991; 5:458-464.
11. **Kempf I, Grosse A, Beck G.** Locked intramedullary nailing. *J Bone Joint Surg [Am].* 1985; 67:709-720.
12. **Halder SC.** The Gamma nail for peritrochanteric fractures. *J Bone Joint Surg [Br].* 1992; 74: 340-344.
13. **Leung K, Proctor P, Robineck B, Behrens K.** Geometric mismatch of Gamma nail to the Chinese femur. *Clin Orthop.* 1996; 303:42-48.

INDIAN JOURNAL OF ORTHOPAEDICS
April 2004
Volume 38 : Number 2 : P. 104-106

Evaluation of results of surgical treatment of closed fractures of the patella

K Srinivas, V Surya Prakash Rao, L Narendranath, VBN Prasad Rao

Department of Orthopaedics, Nizam's Institute of Medical Sciences, Punjagutta, Hyderabad

Background : Management of patellar fractures is controversial.

Methods : Outcome of treatment in thirty two patients of fracture patella was studied. Osteosynthesis with modified TBW of patella was done (10 cases) for non-comminuted fractures of the patella, partial patellectomy (12 cases) for fractures with lower fragment comminution and total patellectomy (10 cases) for severely comminuted fractures of the patella.

Results : Eight out of ten patients who underwent TBW of the patella had minimal or no quadriceps wasting, knee pain or quadriceps power loss and extension lag. In partial patellectomy group eight of 12 patients had minimal or no quadriceps wasting and knee pain with knee range of movement greater than 110 degrees.

Conclusion : It was found that osteosynthesis with modified TBW of patella gives the best results as the normal anatomy is being restored.

Key-words : Comminuted patellar fracture; Patellectomy.

Introduction

Fractures of the patella account for 1% of all skeletal injuries. Although patellar fractures appears to be simple injury they do have an important bearing on subsequent knee function. There is no universally accepted treatment for patellar fractures. Treatment options included reconstruction of the entire patella, partial patellectomy & tendon repair or total patellectomy with extensor mechanism repair. Despite advances in surgical techniques, the basic treatment options have not changed significantly and are similar to those available in the early years of patellar fracture surgery. However, the preference is being shifted from patellectomy to reconstruction and preservation of patella and restoration of the extensor mechanism.

K Srinivas, MS (Orth), Post Graduate
V Surya Prakash Rao, MS (Orth), DNB (Orth), Assistant Professor,
L Narendranath, MS (Orth), Additional Professor,
VBN Prasad Rao, MS (Orth), Professor and Head of the Department.
Department of Orthopaedics, Nizam's Institute of Medical Sciences, Punjagutta, Hyderabad, A.P.
Dr V.Suryaprakash Rao, 1-1-419/e/5/1,'Sivapriya', Gandhinagar, HYDERABAD 500080. Email : vsprao@hd1.vsnl.net.in
Received : 15.1.2002; Revised : 23.12.2003; Accepted : Jan. 2004

Materials and Methods

This study consists of a prospective and retrospective analysis of the results of various methods of surgical treatment of 32 cases of closed fractures of patella, osteosynthesis vs. partial patellectomy vs. total patellectomy. Ten cases were treated by modified tension band wiring, 12 by partial patellectomy and 10 cases by total patellectomy.

The indication for surgery included displacement between the fracture fragments > 2mm and articular surface in congruency of > 2mm. Transverse fractures of the patella in which there was no comminution of the fragment were treated by osteosynthesis using the modified tension band wiring technique[1].

Transverse fracture of the patella with lower fragment comminution, which was not reconstructable, was treated by lower fragment excision (partial patellectomy) and repair of the patellar tendon to the proximal fragment of the patella by modified Thomson technique. Extremely comminuted fracture of the patella, in which no portion of the patella was reconstructable, was treated by total patellectomy and repair of extensor mechanism.

The results of surgery were evaluated using the Gaur criteria for knee function evaluation[2] based on quadriceps wasting, quadriceps power loss, extension lag, knee range of motion, knee pain and functional status and the results were graded as excellent, good, fair, poor (Table I).

Table I. Gaur criteria for knee function evaluation

Parameters	Result			
	Excellent	Good	Fair	Poor
Quadriceps Wasting	Nil	< 1.5 cm	Up to2.5 cm	> 2.5 cm
Quadriceps Power Loss	Nil	< 10%	Up to 25%	> 25%
Extension Lag	No	No	< 10°	> 10°
Knee Rom	Full	0-110°	Upto 90°	< 90°
Knee Pain	No	Min	Mod	Severe
Function	Normal	Normal	Restricted	Incapacitated

Fig 1. *Spring dynamometer*

Quadriceps wasting was measured by measuring the circumference of thigh 15 cm above the knee joint level on both sides and the amount of wasting was noted in centimeters. Quadriceps power was tested by using a spring dynamometer (a strap around the ankle led to a spring balance attached to a lever) with the knee in 90^0 of flexion and measuring the power of quadriceps by extending the knee against the spring dynamometer (Fig 1). Quadriceps power of both knees was calculated and the amount of power loss was calculated as the percentage of the quadriceps power loss. Making the patient to actively extend the knee and noting the amount of loss of active extension calculated extension lag. Knee pain and function were evaluated based on subjective symptoms.

Results

The youngest patient was 12 years and oldest 65 years with a mean age of 39.9 years. Male: female ratio was 9:1 and vehicular trauma resulted in 59.7% of patellar fractures. Complications included two cases of irritation from implant with modified TBW patella and one case of DVT in partial patellectomy.

Eight out of ten patients who underwent TBW of the patella had minimal or no quadriceps wasting, knee pain or quadriceps power loss and extension lag. Knee range of motion was greater than 110 deg in nine patients. In Partial patellectomy group eight of 12 patients had minimal or no quadriceps wasting and knee pain with knee range of movement greater than 110 degrees. Good to excellent results are seen in only six out of ten cases with total patellectomy and more than 80 % results with preservation of patella.

The detailed results are shown in table II and final out come in table III.

Table 2. Results of the Study

Parameters	TBW patella		Partial patellectomy		Total patellectomy	
	No. of Cases	%	No. of Cases	%	No. of Cases	%
Quadriceps wasting						
> 2.5	1	10	1	8.3	1	10
Up to 2.5	1	10	2	16.7	3	30
< 1.5	2	20	7	58.3	4	40
Nil	6	60	2	16.7	2	20
Quadriceps power loss						
> 25%	2	20	1	8.3	1	10
Up to 25%	0	0	1	8.3	2	20
< 10%	4	40	8	66.7	6	60
Nil	4	40	2	16.7	1	10
Knee ROM						
< 90	0	0	1	8.3	2	20
Up to 90	1	10	2	16.7	2	20
0-110	6	60	6	50	4	40
Full	3	30	3	25	2	20
Knee pain						
Min	2	20	3	25	7	70
Mod	2	20	1	8.3	0	0
No	6	60	8	66.7	3	30
Extension lag						
No	8	80	11	91.7	7	70
< 10	0	0	0	0	1	10
> 10	2	20	1	8.3	2	20
Function						
Restricted	2	20	2	16.7	4	40
Normal	8	80	10	83.3	6	60

Table 3. Final outcome

	TBW patella	Partial patellectomy	Total patellectomy
Poor	2 (20%)	1 (8.3%)	2 (20%)
Fair	0	2 (16.7%)	2 (20%)
Good	4 (40%)	7 (58.3%)	4 (40%)
Excellent	4 (40%)	2 (16.7%)	2 (20%)

Discussion

Fractures of the patella occur very frequently. They often require surgical treatment involving one of several methods. Osteosynthesis, partial patellectomy and total patellectomy. The consequences of a patellar fracture as they affect joint function, mobility, muscle power, and development of

osteoarthritis can be significant, as the functional role of the patella is needed to obtain a successful result.

There was not much difference in the power of quadriceps muscle in the osteosynthesis and partial patellectomy groups but there is a significant decrease in the power of quadriceps muscle in case of total patellectomy. This emphasizes the fact that patella transmits tensile forces generated by the quadriceps to the patellar ligament and increases the effective lever arm of the knee extensor mechanism from the axis of knee flexion and extension[3]. Partial patellectomy does not significantly compromise the mechanical advantage afforded by the patella and is due to preservation of the near normal patella biomechanics due to preservation of a large fragment.

The decreased range of knee flexion in case of total patellectomy is probably due to change in mechanics of knee motion. Before fracture or in cases of osteosynthesis or partial patellectomy it was smooth cartilage on cartilage articulation between patella and femoral condyle with an added advantage of long extensor moment arm. After total excision of patella these are lost and quadriceps tendon now has to glide over the femoral trochlea with a different coefficient of friction and without the mechanical advantage[4].

The best results after surgical treatment of patella fracture are obtained by osteosynthesis of the fracture by using modified TBW technique[5,6]. The results with partial patellectomy are also nearly those of osteosynthesis and where the entire patella could not be salvaged partial patellectomy offers a better alternative[5,6,7]. The results of total patellectomy were significantly lower than those of osteosynthesis with TBW of patella (P value < 0.05) and partial patellectomy.

References

1. **Muller ME, Allgower M, Schneider R, Willenegger H:** Manual *of Internal Fixation.* Techniques recommended by the AO-ASIF Group. 3rd ed. New York; Springer-Verlag.1991.
2. **Gaur SC, Verma AN, Kulshreshtha, AK Katiyar, RK Sinha.** Late outcome of patellectomy. *Ind J Orthop.* 1997;33(2):109.
3. **Kaufer H.** Mechanical function of the patella. *J Bone Joint Surg (Am).* 1971 ; 53:1551-1560.
4. **Das R et al.** A comparative study of partial & total patellectomy for comminuted fractures. *Ind J Orthop.* 2000; 34: .
5. **Aglietti P, Chambat P.** Fractures of the patella. In Insall J, ed: *Surgery of the Knee.* 1st ed. New York; Churchill Livingstone. 1984.
6. **Bostman O, Kiviluoto O, Santavirta S, et al.** Fractures of the patella treated by operation. *Arch Orthop Trauma Surg.* 1983; 102: 778-81.
7. **Saltzman G, Goulet J, McClellan R, et al.** Results of treatment of displaced patella fractures by partial patellectomy. *J Bone Joint Surg (Am).* 1990; 72:1279.

INDIAN JOURNAL OF ORTHOPAEDICS
April 2004
Volume 38 : Number 2 : P. 107-109

Humeral nonunion after failure of plate fixation, managed by Ilizarov fixator

H P Singh

Rallis Ortho Hospital, Surat

Background: Various modalities of treating humeral nonunion like interlock nail or plate and screw fixation have been tried but humeral nonunion, particularly those associated with bone loss are difficult to treat.

Methods: Fourteen cases of nonunion of humerus in adults were treated by Ilizarov fixator. These cases were primarily treated by open reduction and DCP fixation. Six cases were complicated with infection at the time of primary surgery and two still had active infection. The nonunion site was explored through the previous incision, implants were removed, margins of the bone ends were freshened and an Ilizarov fixator was applied. Adequate compression was achieved by the fixator.

Results: Healing of the nonunion was achieved in 13 of 14 cases after a single application of the frame. One patient required an additional surgery for achieving union, which was eventually achieved by the second intervention (Ilizarov fixation & bone grafting).

Conclusion: Ilizarov technique helps in union of these fractures through the process of distraction osteogenesis and provides sufficient axial compression and rotational stability for the nonunion to heal.

Key-words: Humerus, Nonunion, Ilizarov fixator

Introduction

Prior to the introduction of Ilizarov technique, humeral nonunion, particularly those associated with bone loss were thought to be difficult to treat. Various modalities of treating humeral nonunion which have been tried are interlock nail or plate and screw fixation. There are inherent problems associated with these techniques[1-5]. Difficulty in achieving union in presence of active infection, depleted bone stock and inability to utilize a particular method for specific sites are the limiting factors with these techniques. A humeral nonunion resulting after operative intervention of plate fixation presents a different set of problems like broken or loosened implants, scarred tissues, avascular bone ends and sometimes deep seated infection. Loosened screws cause osteolysis at the hole sites and loss of local bone substance. The cortex underneath the plate becomes sclerotic and avascular. In such a complicated condition replating becomes even more difficult and enough stability may not be achieved. In addition, dissection and periosteal damage further decreases the viability of the bone ends and puts radial nerve at a high risk of injury. Ilizarov technique allows the surgeon to replace the missing bone through the process of distraction osteogenesis. The need to use bone grafts can also be obviated due to the advantages of this technique. Intramedullary nailing, simple or locked are site specific and may not provide sufficient axial compression and rotational stability for the nonunion to heal. These problems are overcome through Ilizarov fixator by achieving stable fixation with minimum dissection required to remove the implants and freshening of the bone ends.

This study analyses the use of Ilizarov technique for patients of humeral nonunion arising after surgical intervention (plating) as the first modality of treatment. The nonunions were categorized into nonunions with infection, hypertrophy and atrophy. Additionally bony osteolysis resulting from excessive movement of the fixing screws giving rise to large bony defects was also handled.

Materials and Methods

This study was conducted between January 1997 and December 2001 on 14 patients (10 males and four females). The median age was 42 years (range 22 to 58 years). All patients had a nonunion of shaft humerus. The primary treatment in all the patients was open reduction and internal plate fixation. (Anterior: 10, posterior: 4). Six of these were primarily infected. The site of nonunion was upper third in one patient, middle third in 12 patients and lower third in one patient. The average duration of nonunion was 40 months (range 6 months to 240 months). One patient was treated 20 years after the nonunion. All the patients had markedly restricted movements of the shoulder (range $30^0 - 80^0$,average 40^0).

Dr. HP Singh, Rallis Ortho Hospital, 1/1037, Chowki Street, Nanpura, Surat 395001. E-Mail: Singhherjeet@Hotmail.Com

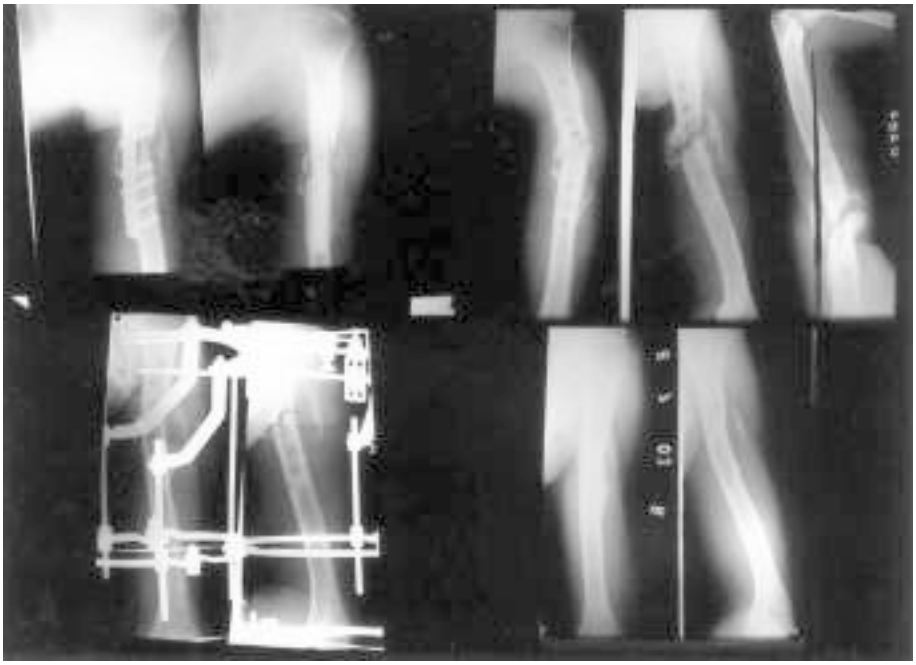


Fig 1: *Combined photograph of a patient (AIM) showing radiographic appearance of a humeral nonunion with DCP fixation and bone grafting* (A), *following infection after removal of implants* (B) , *with Ilizarov fixator* (C) *and after healing of nonunion and removal of fixator* (D)

The patients were categorized into 3 groups, atrophic nonunion (8), hypertrophic nonunion (4) and infected nonunion (2). Eight patients had an additional bone loss due to enlargement of the screw holes from previous surgery. (Ranging in size from 6 to 12 mm) which would be a hindrance for further surgical internal fixation.

The patients were operated under general anesthesia or interscalene regional block. Surgery included removal of the implants, freshening of the edges and Ilizarov frame fixation. The Ilizarov frame was applied using the principle of progressive construct, initiating from the lower end of the humerus. The lower end of the humerus was fixed by application of five eighth ring; using 2-3 wires for better stability and allowing free movement at the elbow joint. At the proximal end, the fixation was achieved by threaded half pins fixed to an Italian arch located anterolateral to the shoulder to allow free mobility at the shoulder joint with avoidance of discomfort in the lying down position. Bone grafts were placed in two patients because they had unicortical bone defect owing to which there was inability to achieve circumferential bone contact without shortening the limb.

Antibiotics (2nd generation cephalosporins) were administered in the perioperative period. Movements at the elbow and shoulder could be allowed by third postoperative day. Simple cleaning of the wire skin junction with antiseptic lotion was advised on domiciliary basis every week. Compression of 4-6 mm was achieved within one month postoperatively with progressive tightening of the nuts. The mean hospital stay was approximately one week. The radiographs were taken at 4-6 week interval till the appearance of bridging bony trabeculae was noted as the evidence of healing of the nonunion. The frame was then removed under anesthesia and a protective POP cast was applied for further 4 weeks. Average duration of frame was 5 months in monofocal method and 12 months in bifocal method.

Results

Healing of nonunion was achieved in 13 cases (Fig. 1, 2). In one case which failed, repeat application of frame augmented with bone grafts yielded healing in 6 months. This case had active infection at the time of first application, the infection subsided within six weeks of first surgery but atrophic avascular ends failed to unite. The screw holes and holes of Schanz pins ossified between 6-12 months after removal of frame. At one year follow up three patients had restricted range of movements of overhead abduction, others had regained full movements. All the patients went to their previous occupation and were happy with the results. No permanent pin site problems were encountered in any patient. There was no neural damage encountered in any patient.

Discussion

Primary treatment of humeral shaft fractures is non operative[1, 2]. Internal fixation with compression plate is commonest intervention done in humeral shaft fractures[3, 4].

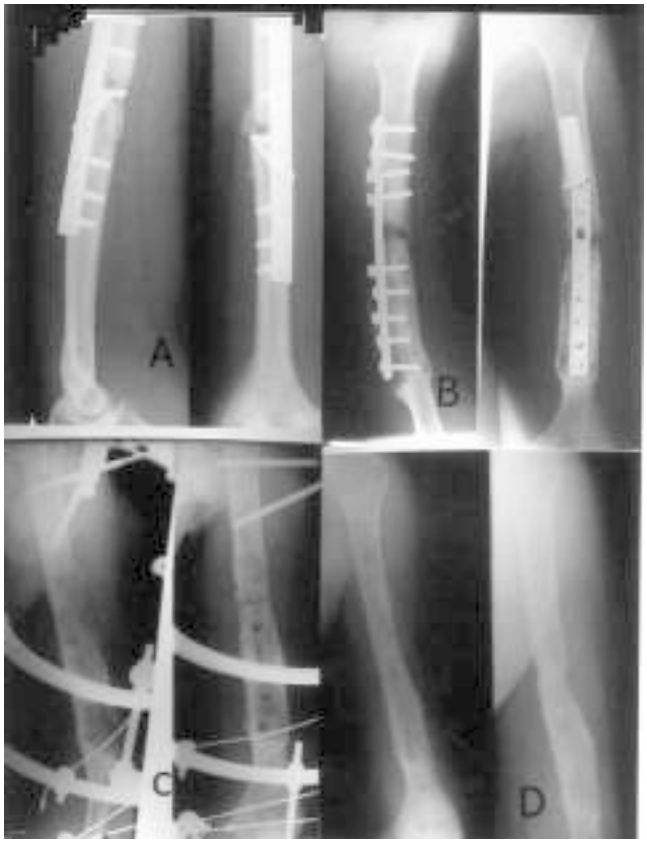


Fig 2: *Combined photograph of a patient (JSS) showing radiographic appearance ozf a humeral nonunion following DCP fixation (A), refixation by DCP and bone grafting and implant failure (B) , with Ilizarov fixator(C) and healed nonunion and fixator removed (D).*

Rate of nonunion ranges from 0-8 % with nonoperative treatment and 0-13 % with operative treatment[5]. Nonunion after operative intervention may be dealt with by intramedullary nailing or plate fixation. Reported rates of union with these methods ranges between 53 -95 %[5]. However they are not an effective modality to treat nonunion associated with depleted local bone stock or infection. Moreover bone grafting is an integral part of these procedures[5]. Nonunion after plate fixation may be associated with extensive fibrosis, enlarged screw holes, sclerotic avascular bone ends. Further dissection for a bigger plate carries risk of radial nerve injury and deep infection. The option of intramedullary nailing simple or locked is limited, because of the anatomy of the medullary canal, lack of axial compression force, rotational instability and subacromial impingement syndrome.

The use of the Ilizarov method has many advantages as compared to the above mentioned routine options available. Here the fixation is secured by an external device, axial compression can be applied as per the need and rotational as well angulatory stability is marked. Moreover even if nonunion is actively draining, the fixator can be applied and stability achieved. The main disadvantage is the bulky frame, which causes some discomfort and need of regular care of skin-wire junctions. However a carefully applied frame allows immediate partial movements of shoulder and elbow and thus use of the extremity in day to day work.

By the use of Ilizarov method 86- 93% healing rate in cases of nonunion has been reported[6,7]. In these series significant number of cases had had previous surgical treatment. Their incidence of infected cases is also high (10.4-25%). All cases in the present series were previously operated and 46% were infected. Healing of the nonunion was achieved in all 14 cases irrespective of type and duration of the nonunion, and the presence of active or dormant infection.

References

1. **Wu CC.** Humeral shaft nonunion treated by a Seidel interlocking nail with a supplementary staple. *Clin Orthop.* 1996; 326: 203-208.
2. **Watanabe RS.** Intramedullary fixation of complicated fractures of the humeral shaft. *Clin Orthop.* 1993; 292: 255-263.
3. **Dabezies EJ, Banta CJ, Murphy CP, D' Ambrosia RD.** Plate fixation of the humeral shaft for acute fractures, with or without radial nerve injuries. *J Orthop Trauma*. 1992; 6: 10-13.
4. **Foster RJ, Dixon GL, Bach AW, Appleyard RW, Green TM.** Internal fixation of fractures and nonunions of the humeral shaft. *J Bone Joint Surg (Am).* 1985; 67: 857-864.
5. **Healy W, White GM, Mick CA, Brooker AF Weiland AJ.** Nonunion of the humeral shaft. *Clin Orthop.* 1987; 219: 206-212.
6. **Lammens J, Bauduin G, Driesen R, Moens P, et al.**Treatment of nonunion of the humerus using the Ilizarov external fixator. *Clin Orthop.* 1998; 353: 223-230.
7. **Cattaneo R, Catagni MA, Guerrreschi F.** Application of the Ilizarov method in the humerus lengthening and nonunions. *Hand Clinics.* 1993; 9: 729-739.

INDIAN JOURNAL OF ORTHOPAEDICS
April 2004
Volume 38 : Number 2 : P. 110-112

Internal fixation of type C fracture of distal humerus

I Ibomcha Singh, Sanjib Waikhom

Department of Orthopaedics, Regional Institute of Medical Sciences, Imphal, Manipur

Background: Type C fracture of distal humerus is a relatively uncommon fracture. Internal fixation is difficult but anatomical reduction is needed to prevent poor functional outcome and degenerative changes.

Methods: Twenty two cases with type C fracture of distal humerus including 6 having grade I compound fracture were treated with open reduction and internal fixation. Dual 3.5mm reconstruction plates in two planes were used in 17 patients and single plate was used in 5 patients. Patients were followed up for a mean period of 45 months (24 to 60 months).

Results: All the fractures united at a mean duration of 13 weeks (8 to 20 weeks). Mean loss of extension (flexion deformity) was 28^0 (5^0 to 60^0). Mean range of movement achieved was 106^0. Complications were few, except restriction of movement. **Conclusion:** Internal fixation is a good method of treatment for this type of fracture to get restoration of the articular surface anatomy, stable fixation and early mobilization.

Key words: Internal fixation; Distal humerus fracture.

Introduction

Intra-articular bicondylar fractures of distal humerus (Type C, AO classification) are difficult to manage. Malunion, stiffness and osteoarthrosis are common. Many methods like close reduction, hanging arm cast, traction, limited internal fixation, open reduction with rigid fixation and elbow replacement have been described. In the last few decades, the popularity of internal fixation of this fracture is growing fast.[1-3] Being intra-articular fracture the importance of anatomical reduction is vital. Surgical treatment gives a chance for accurate anatomical reduction of the joint surface. Most of the recent reports emphasize that accurate restoration of the articular surface anatomy, stable fixation and early mobilization gives the best result.[4-6] We are reporting the result of internal fixation of this fracture in young adults.

Irom Ibomcha Singh, Associate Professor *
Sanjib Waikhom, Senior Resident
Department of Orthopaedics, Regional Institute of Medical Sciences, Imphal, Manipur
Received : 12.3.2003; Revised : 24.1.2004; Accepted : Feb. 2004

Materials and Methods

Twenty two cases (15 males and 7 females) of type C (AO classification) fracture of distal humerus were treated from 1996 to 2000 in the age group of 20 to 45 years. Six fractures were Grade I compound fracture. The patients, in whom surgery was delayed were excluded. Patient was kept in lateral position, arm resting on a bolster which was kept in front of the chest. Tourniquet was used, but released as soon as the exposure was completed. Transolecranon approach was used in all the cases. A transverse osteotomy was used but the subchondral bone was fractured by levering the osteotome instead of cutting it. The ragged edge created in this manner helped in accurate reduction at the time of olecranon fixation. Fracture haematoma was cleaned. Assessment of the fracture anatomy was done. It may be different from what was seen on X-ray. No fragment was discarded except the very small one. Reduction was done and fixed temporarily with 1.5mm K-wires. Reduction forceps with points was useful to hold the condyles. Anatomical reduction was the aim. Reconstruction of the trochlea is the most important part. Stenosis of the olecranon fossa was avoided at all cost. Valgus and varus position were checked. Normal anterior tilt of the condyle or humero -capitulum angle was checked. Defect in the inter condylar area, if any, was filled with cancellous bone graft. Inter condylar fracture was fixed with a 4 mm cancellous screw as lag screw. But compression was avoided in presence of comminution. If medial or lateral column was broken as a butterfly fragment or a wedge, it was fixed to the proximal fragment with lag screw to make the fracture anatomy simpler before applying plate. Two 3.5 reconstruction plates in two perpendicular planes were used in 17 cases. One 3.5 mm reconstruction plate was kept on the posterior surface of the lateral column and one on the medial side of the medial column. Main problem was to achieve a good purchase of the distal screw in low fractures. In such cases, the lag screw which was fixing the intercondylar component of the fracture was passed through the distal most hole of the plate (Fig. 2). This increased the fixation to the distal fragment. Single plate was used in 5 patients. If the plate was encroaching the ulnar groove, the nerve was transposed anteriorly and noted

Fig1. *Pre-operative X-ray of a 30 years old male with type C fracture.*

Fig2. *Post-operative X-ray . Two 3.5 reconstruction plates were used.The lag screw fixing the intercondylar fracture was through the last hole of the lateral plate.*

carefully for future reference. Olecranon was fixed with tension band wiring. A below elbow slab was applied at 70º to 80º flexion. Exercise was started as soon as pain subsided, usually in one week. Only active exercise was given. No passive mobilization was done. Muscle strengthening exercises was given after the union of the fracture. Result was assessed with criteria of Riseborough and Radin (1969) and criteria of Jupiter et al and Mayo elbow performance score (Table I, II).

Table I. Criteria of Riseborough and Radin. (1969)

	Flexion contracture	Flexion (degree)	Subjective Symptom
Good.	$<30^0$	$>115^0$	Minor
Fair	$30 - 60^0$	$>115^0$	Minor
Poor	$>60^0$	$<115^0$	Major

Table II. Criteria of Jupiter etal (1985)

	Range of movement (degrees)			
Loss of extension	flexion	Pain	Disability	
Excellent	<15	>130	None	None
Good	<30	>120	Slight	Minimal
Fair	<40	>90	With activity	Moderate
Poor	<40	>90	Variable	Severe

Result

Mean age of the patient was 34 years (20 to 45 years). Patients were followed up for a mean duration of 45 month (24 to 60 months). All the fracture united in a mean duration of 13 weeks (8 to 20 weeks). Mean loss of extension (flexion deformity) was 28^0 (5^0 to 60^0), mean range of movement obtained was 106^0 (45 to 130^0). Functional result with three systems of assessment is shown in table III. Mean Mayo elbow performance score was 84. None had clinically obvious varus or valgus deformity. Two patients had collapse of fixation, two patients had superficial infection, none had myositis ossificans, nerve injury or olecranon nonunion. Three cases underwent arthrolysis at the time of implant removal, with some improvement in function. Two cases with collapse of fixation were immobilised in cast and united with a relatively poor function.

Table III. Functional results with three assessment criteria (expressed in number of patients and its percentage in bracket.)

	Riseborough and Radin criteria	Jupiter etal criteria	Mayo elbow performance score
Excellent	-	0	6(27.2)
Good	15(68.2)	15(68.2)	12(54.5)
Fair	5(22.7)	3(13.6)	4(18.2)
Poor	2(9.1)	4(18.2)	0

Discussion

Type C fractures of distal humerus are difficult to manage inspite of the advancement in fixation technique. Though the range of movement is better in surgically treated patients, stiffness is the most important complication. It is due to intra-articular adhesion, periarticular fibrosis, myositis ossificans and malunion. Accurate restoration of articular surface prevents osteoarthrosis. Reported[8] mean range of movement in conservatively treated patients is 47^0. Mean range of movement obtained in this series (106^0), is less than 115^0 and

Fig 3. *Pre-operative X-ray with a wedge fragment from the medial column.*

Fig 4. *X-ray after the union of the fracture. Medial wedge fragment was fixed with interfragmentary screw from lateral side and single plate for lateral column was used. Perfect bony anatomy was restored.*

108^{0} reported[4,9]. Result appears better with Mayo elbow performance score as 18 patients (81.8%) were rated as excellent or good. The reason is that this score provide only 20 points to motion and 80 points to pain, instability and function. These patients rarely complained of pain and instability.

Transolecranon approach is must for these fractures. We did not find any difficulty in reduction and fixation of olecranon and none of the cases developed nonunion of olecranon. Anatomical reduction of articular surface was achieved in all cases without comminution at articular surface, but in cases with comminution some amount of step at the articular surface was common. Fixation of the distal fragment in low fracture is a problem as there is hardly any space to accommodate two screws for each plate. Preoperatively placement of the screws should be meticulously planned. Passing the lag screw which fixes the intercondylar fracture through the plate is one way to increase the fixation (fig.2). If the purchase of the screw is poor, double tension band wiring is one option[9]. If there is wedge fragment from the medial or lateral column it should be fixed to the shaft of humerus with lag screw first to make the fracture anatomy simple.

This fracture in young patients should be treated with internal fixation through a transolecranon approach. Single method of fixation could not be applied to every case. Meticulous planning should be done for every case. Functional results are better than radiological results.

References

1. **Gabel GT, Hanson G, Bennett JB, Noble PC, Tullos HS.** Intra-articular fracture of the distal humerus in the adult. *Clin Orthop.* 1987;216:99-108.
2. **Holdsworth BJ, Mossad MM.** Fractures of the adult distal humerus: elbow function after internal fixation. *J Bone Joint Surg (Br).* 1990;72:362-365
3. **Jupiter JB, Noff U, Hoizach P, Allgower M.** Intercondylar fractures of the humerus: an operative approach. *J Bone Joint Surg (Am).* 1985; 67: 226-39.
4. **McKee MD, Wilson TL, Winston L, Schenitsch EH, Richard RR.** Functional outcome following surgical treatment of intra-articular distal humeral fractures through a posterior approach. *J Bone Joint Surg (Am).* 2000;82:1701-7.
5. **Pojorinon J, Bjorlanheim JM.** Operative treatment of type C intercondylar fracture of the distal humerus: results after a mean follow up of 2 years in a series of 18 patients. *J Shoulder Elbow Surg.* 2002;11(1):48-52.
6. **Riseborough EJ, Radin EL.** Intercondylar T fractures of the humerus in the adults (a comparison of operative and non-operative treatment in twenty nine cases *J Bone Joint Surg (Am).* 1969;51:130.
7. **Wallace E, Miller MD.** Comminuted fracture of the distal end of the humerus in adult. *J Bone Joint Surg (Am).* 1964;46:644-57.
8. **Zhao J, Wang X, Zhang Q.** Surgical treatment of comminuted intra-articular fractures of the distal humerus with double tension band Osteosynthesis. *Orthopaedics.* 2000; 23(5): 449 -52.

INDIAN JOURNAL OF ORTHOPAEDICS
April 2004
Volume 38 : Number 1 : P. 113-117

Closed reduction and plaster cast immobilization Vs. external fixation in comminuted intra-articular fractures of distal radius

Jayant Arora, Harmesh Kapoor, Avinash Malik, Manish Bansal

Central Institute of Orthopaedics, Safdarjang Hospital, New Delhi, India

Background: Comminuted intra-articular fractures of distal radius often result in a painful, stiff, dysfunctional wrist. They may be treated by external fixators or by closed reduction and plaster.

Methods: Fifty-five patients of comminuted, intra-articular fractures of distal radius were treated randomly either by closed reduction and plaster immobilisation or by external fixation. The radiological results, functional results and complications in both the groups were analyzed.

Results: The outcome of external fixation was significantly better as compared to cast immobilization ($p < .05$). Incidence of loss of reduction was significantly improved by external fixation as compared to cast immobilization ($p < .001$). There was a strong positive correlation between restoration of normal anatomy (radiological results) and functional outcome ($r = .811$). Complications were seen in 43% of patients in POP group and 33% of patients in external fixator group.

Conclusion: We conclude from this study that external fixator is a better modality of treatment as compared to plaster cast immobilization for intra-articular distal radial fractures. It is also reliable in maintaining the reduction of unstable fractures however it is inadequate in attaining anatomical reduction in many cases when used exclusively. Complications of external fixation, although less frequent than cast immobilization, are potentially serious in nature.

Key-words: Intra-articular fractures; Distal radius; External fixation.

Introduction

It is now well recognized that describing every fracture of the distal radius by the eponym of Colles' fracture is no longer relevant[1,2]. Comminuted intra-articular fractures of distal radius are common injuries that will not do well, unless certain treatment criteria are met and result will be a painful, stiff, dysfunctional wrist[1-4]. The goal of the treatment is to achieve and maintain certain extraarticular and intra-articular criteria during healing[1]. Numerous techniques have been described and developed to treat these complex fractures in an effort to improve the outcome[1,2,5]. This prospective randomized study was designed to compare the results and complications of conventional POP immobilisition after closed reduction and external fixation in intra-articular fractures of the distal radius.

Jayant Arora, MS(Orth), DNB(Orth), MRCS Ed, Resident
Harmesh Kapoor, MS(Orth), DNB(Orth), Senior Resident
Avinash Malik, MS(Orth), Consultant and Head of Unit
Manish Bansal, MS(Orth), Junior Resident
Central Institute of Orthopaedics, Safdarjang Hospital, New Delhi, India
Dr. Jayant Arora, MS(Orth), DNB(Orth), MRCS Ed, Block 8, Flat 5, Yorkhill Court, Yorkhill hospital, Dalnair Street, Glasgow G3 8SJ UK, E-mail: arorajayant@yahoo.com

Received : 14.10.2003; Revised : 18.3.2004; Accepted : Apr. 2004

Material and Methods

This study was conducted on 55 patients of intra-articular fractures of distal radius. Extraarticular fractures and minimally displaced intra-articular fractures (step off<1mm, dorsal angulation <10 degree) were excluded from the study. Forty nine patients sustained high velocity injury as a result of RTA or fall from height. Twelve patients had associated injuries: skull fracture in four patients, femoral fracture in three, stable thoracic spine fractures in two, cervical spine fracture without neurological deficit, mandible fracture and ipsilateral scaphoid fracture in one patient each. There were two patients with open grade I and one with grade II fractures. Postero-anterior and lateral radiographs of the wrist were taken and fractures were classified according to Frykman's classification. Patients were randomly treated either by external fixator or by closed reduction and POP cast.

A below elbow plaster of Paris cast was applied after closed reduction under regional anesthesia and patient was called for inspection after 24 hours to assess distal circulation, swelling and tight plaster. External fixator (Orthosys/Inor) was applied under general or regional anesthesia. This fixator consists of a ball and socket joint attachment with the Schanz pins. After cleaning and draping, a three cm incision was given over bare area of radius, just proximal to the crossing of the musculotendinous junction of abductor pollicis longus. Dissection was carefully carried out to protect the superficial branch of radial nerve and the plane between brachioradialis and extensor carpi radialis longus was developed to expose

Fig. 1 *Preoperative radiograph of* **(a)** *comminuted destal radial fracture,* **(b)** *after reduction and immobilisation in external fixator, and* **(c)** *after six months follow up.*

the radial shaft. Two 3.5 mm Schanz pins were inserted in the proximal radius. Stab incisions were given at the base and the shaft of 2nd Metacarpal and two 2.5 mm Schanz pins were inserted after flexing the metacarpophalangeal joint to avoid tethering of extensor hood. All the four pins were inserted in a plane that was at 45^0 to the vertical and true lateral. Closed reduction was done under X-ray control and assembly was fixed using spanners with distraction forces maintained across the wrist joint. Ball and socket joints allowed the wrist to be placed in slight extension or neutral position without compromising fracture reduction in most cases.

Active movements of fingers and thumb were encouraged as soon as tolerated by the patient. Most of the patients could hold pens, cups within one week of surgery and felt comfortable with frames. Patients were instructed to clean pin tracts daily with saline and to do shoulder and elbow mobilization exercises.

On demonstration of the radiological union, the external fixator/POP was removed and physiotherapy of the wrist was commenced. In both groups, check X-rays were taken at 1st and 2nd weeks during immobilization to detect any loss of position. The study protocol stipulated that if reduction of the fracture had been lost to an unacceptable position by first follow up visit, it would be remanipulated. An unacceptable position was defined as a dorsal angulation of more than 10, articular step off >2mm and radial shortening of more than 3mm. Displacements in position occurring after 10 days of the initial treatment were not considered for remanipulation.

All patients were observed for any possible complications. Grip strength was measured using a dynamometer and range of motion was measured using goniometer. Anatomical assessment providing radiological scoring included radial length, radial angle and volar tilt. Assessment of any incongruity of the radio carpal and radio ulnar joint was noted. The data obtained were tabulated, analyzed and subjected to standard statistical methods. Standard error of difference between two means was used to compare the anatomical parameters, standard error of difference between proportions was used to compare the incidence of loss of reduction and overall results were compared using Chi squared test. Correlation between anatomical and functional score was calculated using coefficient of correlation-r.

Results

Twenty seven fractures were immobilised by external fixation and 28 by plaster. The average duration of follow up was 24.4 months (range 14-35 months). The average duration of treatment in external fixation group was 44 days and in

close reduction and POP cast group was 41.5 days. Forty five fractures were Frykman grade VII or VIII. The mean age of the patients was 37.8 years (17-79 years) and 41 were males. Both groups were comparable with respect to age, sex and Frykman's grading of the fractures (Table 1).

Table I. Demographic parameters of the two groups

	External Fixator group	Closed reduction and POP group	Stastical # significance
Mean Age	37.5±12.1	38.1±11.88	
M : F ratio	3.6 : 1	2.85 : 1	p > .5
Fr (VII/VIII)*	85.7%	77.7%	p > .5
Mean Rx**	44.4	41.5	

* Frykman grade VII or VIII

** Mean duration of treatment in days

Chi squared test

Seventeen patients treated by cast immobilization lost position on subsequent check X-rays at follow up visits. Of these, seven patients had re-manipulation under regional anesthesia as per criteria mentioned previously. Two patients treated by external fixation also lost fracture reduction in the third week of treatment; however re-manipulation was not attempted in these patients.

Table II : Anatomical and functional parameters in two groups

Parameters	External Fixator	Closed reduction & POP	Statistical Significance
ANATOMICAL			
· Mean articular step off	0.51±.64mm	0.96±.83mm	p≤ .05
· Mean radial length	10.07±1.93mm	8.21±1.66mm	p≤ .001
· Mean radial angle	19.4^0±3.50^0	15.96^0±3.15^0	p≤ .001
· Mean palmar tilt	$+3.37^0$±6.16^0	-2.57±8.22^0	p≤ .002
FUNCTIONAL *			
· Grip Strength	82.88%	72.89%	
· Palmarflexion	64.5^0	52.3^0	
· Dorsiflexion	65.4^0	53.6^0	
· Pronation	75.9^0	67.8^0	
· Supination	63.29^0	58.1^0	

* Mean values

Both the groups were evaluated radiologically and functionally (Table II) using the criteria of Jakim et al[6]. Overall the results were graded as acceptable (sum of excellent, good and fair) or poor. Twenty two of 27 patients treated by external fixation and 15 of 28 patients treated by cast had acceptable results (Table III). This difference is statistically significant as calculated by Chi square test ($p < .05$). The grip strength was calculated as the percentage of the contralateral side. The average grip strength in external fixation was 82.8% while in POP group it was 72.89%.

Table III. Overall Results

Final result	External Fixator group	Closed reduction and POP group
Excellent	7 (26%)	2 (7.1%)
Good	9 (33.3%)	5 (17.8%)
Fair	6 (22.2%)	8 (28.5%)
Poor	5 (19%)	13 (46.5%)

Anatomical results were calculated from the various radiological parameters on X-rays (Fig 1-3) taken at the last follow up visit (table II). Radiological parameters were significantly better in external fixation as compared to POP group as determined by student t test ($p< .001$ for radial length and radial angle, $p< .002$ for palmar tilt and $p< .05$ for articular step). There was a strongly positive co-relation between functional and radiological result as seen in the scatter diagram (Fig 4) and as determined by co-efficient of correlation ($r=0.81$).

Complications were seen in 12 out of 28 patients in POP group (43%): seven patients required re-manipulation due to significant loss of position, three patients had obvious wrist deformity that required osteotomy and two patients developed transient median nerve compression. Nine patients in external fixation group (33%) developed complications. The commonest complication was pin tract infection, which was seen in six patients, two patients lost position leading to malunion and of these, one patient also developed reflex sympathetic dystrophy. A sixty-year-old female developed iatrogenic fracture of the 2nd metacarpal during the fourth week necessitating fixator removal. Pin tract infections in five patients were superficial and responded to oral antibiotics. In all the five patients proximal radial pin was the site of infection. One patient presented with a grade 2 compound fracture 72 hours after the injury, with an abscess (infected hematoma) over the fracture site. He developed pin tract infection leading to osteomyelitis and nonunion of the fracture. We did not encounter any iatrogenic damage to superficial branch of radial nerve or tendon injuries. Fracture was anatomically reduced in fifteen patients and ten patients had a residual step of 1mm at the time of healing in external fixator group. Two patients treated by external fixation had a residual step of 2 mm and both these patients developed grade I arthritis on subsequent follow up. In POP group five patients developed grade I and two patients had grade II arthritis. In this group twenty patients had a residual articular step off of 1-3 mm. Grading of arthritis was based on the

scoring system of Knirk and Jupiter[1]. Six patients treated by POP complained of regular wrist pain requiring analgesics on heavy work. Two of them had to change their jobs as a result. Two patients managed by external fixation had wrist pain limiting heavy work. Of these one had developed osteomyelitis resulting in nonunion and other had lost the fracture reduction leading to malunion.

Discussion

Intra-articular fractures of the distal radius are commonly encountered complex fractures. These fractures usually occur as a result of high-energy trauma and are often unstable. Current treatment goals are centered on restitution of bony anatomy of the distal radius (radial angle, radial length and volar tilt), with specific attention to restoration of articular surfaces of radiocarpal and radioulnar joints[3,4,7]. Past decade has witnessed various modalities of treatment in an effort to improve the outcome of these fractures[5]. The external fixator is a versatile tool that is now well established in the treatment of these fractures. It has several distinct advantages over conventional POP cast and plate fixation[8,9].

External fixator is very useful in maintaining restored axes and length. The principles of external fixation involve longitudinal traction (ligamentotaxis) and, most importantly, palmar translation[10]. Longitudinal traction alone cannot restore palmar tilt[11]. In our study the ball and socket attachment facilitated not only palmar translation (thereby achieving significantly improved palmar tilt at union), but also allowed wrist to be placed in a neutral or extended position without compromising the reduction. Wrist extension helps in flexing the metacarpo-phalangeal joints and allows active hand function while the fracture unites. Conventional POP cast places the wrist in flexed position that tends to extend MP joints causing MP joint stiffness and also predisposes the wrist to median nerve compression.

It has been well documented that external fixation maintains the reduced position significantly better as compared to cast immobilization[8]. In our study only two (7.4%) patients treated by external fixation lost reduction where as loss of position was seen in seventeen (60.7%) patients treated by POP immobilization ($p < .001$). However, twelve patients treated by external fixation did not achieve anatomical reduction: ten patients had a residual step of 1mm which couldn't be improved by closed manipulation under fluoroscopy and two fractures slipped later leading to an articular step of 2mm at healing. This can be explained because external fixation alone does not expand crushed cancellous bone, and it cannot work without soft tissue hinges. Therefore satisfactory reduction may not be achieved in fractures with depressed articular fragments and in highly comminuted fractures. In these circumstances external fixation has to be augmented by mini open procedure to elevate articular depressions and supplement fixation with K-wires or bone grafting. Klein et al have reported on a series of 103 distal radial fractures that were treated by external fixator[12]. In 61% of the cases, adjuvant procedures were required to obtain and maintain satisfactory reduction. Similarly, Rikli et al achieved satisfactory reduction in 74% of cases treated exclusively by external fixator however 26% required additional intervention in the form of K-wires, bone grafting, screw fixation or volar plate[13]. Functional score and final outcome also depends upon the initial severity of injury and compounding[14]. Three fractures were compound of which, two had poor results while one had fair functional outcome.

This study shows that functional results and restoration of anatomical parameters were significantly better in the group treated by external fixator as compared to POP immobilization. However results of external fixation in our series were not comparable to those reported in literature. Klien et al and Rikli et al reported that more than 80% of patients treated by external fixator achieved excellent or good results[12,13], but in our study 60% patients achieved the same and 22 % patients had fair results. The difference in the results can be explained by the fact that, unlike above studies we used external fixator exclusively without augmenting it with any form of adjuvant treatments.

Although, the complications were less frequent in external fixator group but they were more serious in nature. Most complications have been previously reported and were related to pin tracts[15]. They included superficial pin tract infection, chronic osteomyelitis, iatrogenic fracture and reflex sympathetic dystrophy. Since radial pins were inserted through a 2-3 cm incision after identifying structures, we did not encounter any damage to superficial branch of radial nerve or adjacent tendons. One patient with AO type-B fracture with a volar fragment (reversed Barton) did not achieve anatomical reduction and subsequently lost position leading to an intrarticular step of 2mm. External fixation for this fracture pattern has been found to be inadequate in achieving and maintaining reduction, and it is best treated by a volar buttress plate[2,13].

We conclude from this study that external fixator is a better modality of treatment as compared to POP immobilization for intra-articular distal radial fractures. It is

reliable in maintaining the reduction of unstable fractures, however it is inadequate in attaining anatomical reduction in many cases when used exclusively. When required, this shortcoming can be overcome by supplementing external fixation with additional procedures that can attain the articular congruity, like limited open reduction with or without bone grafting. Complications of external fixation, although less frequent than cast immobilization, are potentially serious in nature.

References

1. **Lipton HA, Wollstien R.** Operative treatment of intraarticular distal radius fractures. *Clin Orthop.* 1996; 327: 110-124.
2. **Trumble T, Culp R, Hanu D, et al.** Intraarticular fractures of distal aspect of radius. *Instruct Course Lect.* 1999; 48: 465-480.
3. **Aro HT, Koivunero T.** Minor axial shortening of the radius affects the outcome of Colles' fracture treatment. *J Hand Surg (Am).* 1991; 16: 392-8.
4. **Knirk JL, Jupiter JB.** Intraarticular fractures of distal end of radius in young adults. *J Bone Joint Surg (Am).* 1986; 68: 647-659.
5. **Rodriguez M, Carlos E.** Management of comminuted fractures of distal radius in adults: conservative or surgical. *Clin Orthop.*1998; 353: 53-62.
6. **Jakim I, Pieterse HS, Sweet MBE**. External fixation for intraarticular fracture of distal radius. *J Bone Joint Surg (Br).* 1991; 73: 302-306.
7. **Altissimi M, Antenucci R et al.** Long term results of conservative treatment of fractures of the distal radius. *Clin Orthop.* 1986; 206: 202-210.
8. **Kapoor H, Agarwal A, Dhaon B.** Displaced intraarticular fractures of distal radius: A comparative evaluation of results following closed reduction, external fixation and open reduction with internal fixation. *Injury*. 2000; 31: 75-79.
9. **Weiland AJ.** External fixation, not ORIF as the treatment of choice for fractures of the distal radius. *J Orthop Trauma.*1999; 13(8): 570-572.
10. **Agee JM.** Distal radius fractures: Multiplanar ligamentotaxis. *Hand Clin.* 1995; 4: 577-585.
11. **Bartosh RA, Saldana MJ.** Intraarticular fractures of the distal radius: A cadaveric study to determine if ligamentotaxis restores radiopalmar tilt. *J Hand Surg (Am).* 1990; 15: 18-21.
12. **Klien W, Dee W, Rieger H et al.** Results of transarticular fixator application in distal radius fractures. *Injury.* 2000; 31(suppl 1): 71-77.
13. **Rikli DA, Kupfer K, Bodoky A.** Long term results of external fixation of distal radius fractures. *J Trauma.*1998; 44: 970-976.
14. **Hugh SD, Alan IR, Frank BD.** Factors affecting outcome of Colles' fracture: an anatomical and functional study. *Injury.* 1985;16:289-295.
15. **Reynolds PR, Beredjklian PK.** External fixation of distal radius: Do benefits outweigh complications? *Current Opinion Orthop*. 2001; 12(4): 286-289

INDIAN JOURNAL OF ORTHOPAEDICS
April 2004
Volume 38 : Number 2 : P. 118-120

Stress fractures-management using a new classification

PK Agarwal

Department of Orthopedics, Command Hospital, Air Force, Bangalore

Background: Stress fractures during military training are common occurrence.

Methods: Over a period of five years 12,700 recruits from a single military training centre had 1452 cases (11.4%) of stress fracture. They were classified and managed according to new classification system.

Results: The commonest site was tibia (93.5%) and overall rate of return to active training was 91% at 12 weeks and 99% at 24 weeks.

Conclusion: We conclude that this new classification is a useful, simple and user-friendly system for categorizing and treating stress fractures. It is useful for documentation, prognostication and comparison of data in future studies.

Key-words: Stress Fracture; Classification of stress fractures; Military Recruits

Introduction

The stress fracture (fatigue fracture) is a common occurrence in military medicine when dealing with a large number of recruits. Stress fracture is a tiny crack in the bone as a result of repeated overstress to which the body is not accustomed. It presents in variety of grades thus the management and outcome differs accordingly. Since there is no known acceptable classification, we have devised a classification system to help categorize our patients to help choose a treatment protocol.

Material and Methods

During last five years (Jan 1999 to Dec 2003) total of 12,700 male recruits from a single military training centre were included in the study having similar pattern of training program. All of them belonged to the same training batch and therefore were in the same stage of training. These were in the age group of 17 to 20 years. Out of these 1452 individuals presented with diagnosis of stress fracture. On arrival, all the cases of stress fracture were classified according to the new classification system devised by us (table I).

The diagnosis was clinical because the population under study was that of recruits undergoing strenuous physical training and the stress fracture is a common problem amongst them.

Radiography was done in following situations.

a) All cases who presented with severe pain, unable to walk without support.

b) Cases with groin pain and tenderness where stress fracture of neck of femur is suspected.

c) Ambulant cases of mild pain who did not respond to rest in three weeks time. In these cases initial radiography was avoided because the clinical diagnosis was obvious and radiation was considered unnecessary.

d) All cases of recurrence.

Bone scanning (Tc ^{99m}) was done only to confirm the diagnosis in absence of radiographic finding at three weeks (grade '0') and also to help exclude feigning recruits. The individuals with groin pain but normal radiographs were also investigated by bone scanning to confirm the diagnosis of stress fracture of femoral neck. All those who were negative on bone scan were excluded from the study.

Table 1: Classification of stress fracture

Grade	Clinical Picture	Radiography
Grade-0	Mild Pain, limp & tenderness, comes walking without support	Normal even after 3 wks of onset of symptoms (Bone scan positive)
Grade-1	Same as above	Periosteal reaction
Grade-2	Severe pain & may walk with support	Unicortical break
Grade-3	Severe pain, Inability to stand/walk	Complete undisplaced fracture
Grade-4	same as above	Complete, displaced fracture

Note: Garden's classification was used for stress fracture neck of femur. Cases with groin pain, normal radiograph but positive bone scan were also included in Garden type-1

PK Agarwal, MS (Orth), MS (Surg), AO Fellow (Germany), Spine Fellow (Edinburgh), Ranawat Fellow (New York), Professor of Orthopedics, Department of Orthopedics, Command Hospital, Air Force, Bangalore-560007. E mail: drpka@hotmail.com

The treatment was instituted as per the grade (Table II). The table describes the method mainly adopted in cases of stress fracture tibia, being the commonest.

Table 2: Treatment Regime

Grade	Management
Grade-0	Rest for 6 weeks, Analgesics, Ice packs, Crepe bandage, weekly review,
	Gradual re-induction to training program
Grade-1	Same as above, but for a longer period (12 Weeks)
Grade-2	Admission to hospital, plaster cast and weight bearing ambulation within tolerance of pain (in case of femur it was immobilization in Thomas or Foam splint)
Grade-3	Admission to hospital, Plaster cast and partial weight bearing (internal fixation in case of femur)
Grade-4	Internal fixation
All the above were excused from physical training until union	
Stress fracture neck of femur	
Garden 1 -	(a) If medial cortex break- complete bed rest on de-rotation foam splint for minimum 6 weeks.
	(b) If lateral cortical break- internal fixation with screws
Garden 2,3 & 4 -	Internal fixation with screws

Union was considered once there was radiological union and complete absence of pain and tenderness. The final outcome was assessed in the form of return to full activity at 6, 12 or 24 weeks and non union was considered if the union was not satisfactory at 24 weeks.

Results

The total number of recruits who underwent training over past five years was 12,700 out of whom only 1452 were diagnosed as cases of stress fracture (11.4%). The commonest site of involvement was tibia (93.5%). The commonest grade was grade 1 in all and the stress fracture neck femur was mostly of Garden grade 1 (Table III).

Table 3: Incidence and distribution of 1452 cases of stress fractures

Site	Tibia	Femur (shaft)	Neck of Femur	Fibula	Metatarsals	Total
Grade 0	372	02	—	10	00	384
Grade 1	713	13	—	19	03	748
Grade 2	173	03	—	12	01	189
Grade 3	86	00	—	04	00	90
Grade 4	14	05	—	00	00	19
Garden 1	—	—	11			
Garden 2	—	—	06			
Garden 3	—	—	05			
Garden 4	—	—	00			
Total	1358	23	22	45	04	1452
	(93.5%)	(1.6%)	(1.5%)	(3.1%)	(0.3%)	

Out of all the cases 45% returned to active training in six weeks and further 46% at 12 weeks. There were overall good results with union in 99% cases at 24 weeks (Table IV). The incidence of delayed and non-union was more in grades 3 & 4 and also stress fracture neck of femur when it was Garden grade 2 or 3. There were no cases of avascular necrosis in case of stress fracture neck of femur assessed by radiography and bone scanning at 24 weeks. The results are summarized in.

Table 4: Results of treatment

	Union at 06 weeks	Union at 12 weeks	Union at 24 weeks	Non union at 24 wks	Total
Grade 0	384	00	00	00	384
Grade 1	269	479	00	00	748
Grade 2	00	156	33	00	189
Grade 3	00	11	71	08 (8.8%)	90
Grade 4	00	09	08	02 (10.5%)	19
Garden 1	00	11	—	—	11
Garden 2	00	02	03	01 (16.6%)	06
Garden 3	00	00	03	02 (40%)	05
Total	653 (45%)	668 (46%)	118 (8.1%)	13 (0.9%)	1452

Discussion

The incidence of stress fracture is affected by many factors including training schedule, cushioning quality of shoes, the training ground, previous physical habits and nutritional status of the individual etc. The incidence of stress fractures has been reported as 1% in males and 10% in women undergoing military training[1]. Givon et al reported 24 to 31% incidence of stress fractures among Israeli recruits primarily during their basic training[2].

The commonest site involved in our cases was tibia (93.5%), which is due to training with maximum stress on running, jumping, parade on hard ground, and gymnastics. These activities result in impact transmission up the bone, which is unsupported by the fatigued muscles at that point of time. The German Army, in a study of 600 cases, recorded highest incidence in metatarsals (81.3%) followed by tibia (11.6%), fibula (2%), femoral shaft (1.2%), neck of femur (1%) and others[1].

The usual cause of higher grade of stress fractures in long bones and also neck femur was either the individual did not report his pain and continued strenuous exercise for fear

of loosing his term or back phasing in training or due to these people pushed to physical training despite symptoms. The bone can repair itself if the pathological strain is removed by giving rest otherwise it leads to progression till it becomes a complete fracture (grade-3 or 4), a situation which should not arise.[3]

Return to full activity is possible at 6 to 8 weeks[3]. This high union rate is due to less number of stress fractures in higher grades 3 and 4 where incidence of delayed union was higher. Early reporting to hospital and treatment results in early return to full activity[4].

If the high risk patients (viz. military recruits, athletes etc) are seen at early stage when they are mildly symptomatic, the radiographs are likely to be normal, therefore there is no need to subject these individuals to unnecessary radiation in the beginning. These individuals usually show symptomatic improvement in next one or two weeks of taking rest. If the symptoms continue then they should be investigated by radiography to confirm the diagnosis and also to grade them. However, it is important to recognize that when stress fracture of neck femur is suspected, radiography is not delayed. If the radiography is normal bone scan should be done to confirm the diagnosis as it is more sensitive and positive two or more weeks before the radiographs show any findings[5]. This is done to pick up stress fracture of neck of femur before it becomes complete. The indications for radiography and bone scan are described under material and methods.

There is no classification described for stress fractures in English literature to our knowledge hence this classification was used successfully in categorizing stress fractures, planning management and also prognostication. We conclude that this classification system is simple, useful and can be recommended for routine application and future compilation of database.

References

1. **Wilson JN.** *Watson Jones Fractures and Joint Injuries*. 6th ed. Edinburgh: Churchill Livingstone. 1982; 1273-1278.
2. **Givon U, et al.** Stress Fractures in the Israeli Defense Forces From 1995 to 1996. *Clin Orthop*. 2000; 373: 227-232.
3. **Springfield D, Jennings LC.** Pathological Fractures. In: *Rockwood and Green's Fractures in Adults*. Philadelphia: Lippincott-Raven. 1996; 532-534.
4. **Ohta FM, Mutoh Y, Takasugi S, Itawa H, Ishii S.** Characteristics of stress fractures in young athletes under 20 years. *J Sports Med Phys Fitness*. 2002; 42(2):198-206.
5. **Fullerton LR Jr.** Femoral neck stress fractures. *Sports Med*. 1990; 9(3):192-7.

INDIAN JOURNAL OF ORTHOPAEDICS
April 2004
Volume 38 : Number 2 : P. 121-123

Conservative treatment of plantar fasciitis

RS Kulkarni

Civil Hospital Sindhudurg, Maharashtra

Background : Plantar fasciitis is a common condition causing misery to lot of patients.

Methods : Natural history of plantar fasciitis was studied in 804 patients with 828 painful heels and effects of various modalities of treatment were evaluated. All patients were divided in three main groups depending on the presence or absence of spur. In 270 patients where the spur was not seen on X-rays, NSAIDs and physiotherapy was given with an insole having a transverse bar. In 296 patients having rudimentary spur on X-rays up to five local injection of hydro cortisone acetate of 25 mg. mixed in 1 ml. of 2% xylocaine were given and transverse platform combined with sponge heel cushion was advised for foot wear. In 262 patients having painful heel with large spur NSAIDs along with injection of hydro cortisone acetate were given. Heel moulds are advised for these patients.

Results : On short term results of 6 months, there is no much of significant difference between three groups of patients being treated by three different conservative treatment schedules. Relapse more than 8 times were mainly seen in patients with obesity, flat feet and in patients who are standing and walking for long time.

Conclusion : The condition is self limiting and only conservative measures should be used to either hasten recovery or allow enough time for the natural history to run its course.

Key-words: Plantar fasciitis

Introduction

Plantar fasciitis or painful heel syndrome is not an uncommon condition and is found significantly in middle aged, overweight patients, whose work involves prolonged standing. As the pain in the heel is aggravated on weight bearing, it affects adversely daily activities and is often responsible for loss of many man-hours of work. The aetiology and treatment of plantar fasciitis are poorly understood.

Dr RS Kulkarni, MBBS, D (Orth), MS(Orth), FCPS(Orth) Civil Surgeon, Civil Hospital, Sindhudurg, Sindhudurgnagari-Oras, Maharashtra State.
Received : 1.11.2001; Revised : 22.3.2003; Accepted : Jan. 2004

Material & Methods

A prospective study was done in 804 patients with 828 painful heels from February 1992 to March 1997 to study the natural history of plantar fasciitis and evaluate various modalities of treatment. Patients of plantar fasciitis in presence of other systemic disease like diabetes mellitus, rheumatoid arthritis, gout etc. were excluded from study. This entity constitutes to 12% of total Orthopaedic OPD at Govt. Rural Hospital, Kudal over a span of five years. Tenderness in the heel on weight bearing and firm pressure with thumb by palpation especially at the medial side of heel were two main criteria for the diagnosis. A lateral X-ray of calcaneum of both heels was taken to demonstrate the presence or absence of a spur in normal and painful heel for all cases.

The treatment schedule was conservative consisting of oral drug, advice on foot wears, physiotherapy, orthosis and steroid injections. All patients were divided in three main groups depending on the presence or absence of spur.

Group I: In 270 patients where the spur was not seen on X-rays - Tab. Ibuprofen 400 mg + Paracetamol 325 mg. One tablet 3 times a day along with antacid and physiotherapy for 10 day followed by 1 tablet twice a day for another 10 days. These patients were advised an insole having a transverse bar.

Group II: In 296 patients having rudimentary spur on X-rays were given local injection of hydro cortisone acetate of 25 mg. mixed in 1 ml. of 2% xylocaine was given on the medial side of heel at maximum tender spot. The injection was repeated at 2 weeks interval and not more than 5 injections were given. A transverse platform combined with sponge heel cushion was advised for foot wear.

Group III: In 262 patients having painful heel with large spur were given Tab (Ibuprofen 400 mg + Paracetamol 325 mg) one tablet thrice a day for 3 weeks along with injection of hydro cortisone acetate, once in 15 days interval, not more than 5 injections. Heel moulds are advised for these patients.

Heal mould consisted of carefully made heel seat which extends forward under the long arch to the base of meta-tarsals and then closely fit to the meta-tarso phalangeal joints; to be braced so as to control from both sides. This was

prepared from poly propylene to an accurate plaster model of the foot in the corrected weight bearing position. The heel must be flat at its point of contact with the floor, the os calcis must be maintained vertical an attempt must be made to create a reasonably long arch and the mould should also demonstrate slight lateral bulge of soft tissue on each side of heel, which undergoes a dynamic volume change in motion. This was achieved in very thin section and is applied so closely to the foot that it can go into a regular shoe or sandal of the usual size. Poly propylene has a high strength/weight ratio, is easily formed to the required shape and once formed will maintain it.

The longest follow up was 4 years and 2 months. Reporting of patients for follow up was quite regular to the tune of 84%. Patients were advised for follow up every week in the first month, later once in two weeks for next month, subsequently once in a month for four months. Then the patients were asked to come for follow up thrice in a year, by requesting them through letters.

Following criteria were used to evaluate results....

* Good: No pain in day to day activities including bare foot walking.
* Fair: No pain with use of cushion heel and appliances in foot wear, but slight pain on bare foot walking.
* Poor: Definite pain in spite of use of cushion heel with appliance requiring analgesics.

Results

The youngest patient was a boy of 14 years and the oldest was a 68 years woman. Five hundred and forty (67%) patients were in age group of 31-50 years. The occupational incidence varied (Table I). Duration of pain was more than eight months on an average, the maximum being 4 years and the minimum four months. Four hundred and ten (49.5%) patients were males and 418 (50.4%) were females. Three hundred forty two (41.3%) patients were found to be obese (above 70 kg. wt.). Bilateral plantar fasciitis was found in 24 patients.

Spur was associated with flat foot in 86(10.4%) patients. Twenty four patients were found to have a high arched foot with narrow weight bearing heel surface. Forty two patients were also found to have tennis elbow and 26 patients had De Quervan's Disease.

***Short term results*:** Patients were evaluated at the end of 6 months of treatment regimen (Table II). There was no significant difference between three groups of patients, being treated by three different regimens. Twelve patients belonging to three different groups who had poor results were specifically followed up once in every 15 days and they showed improvement with continuation of same previous treatment. Time duration which took for recovery is as follows (Table III).

Table I. Occupational incidence

Category	No. of patients
Police Constables	62
Farmers	182
Building Construction Workers	110
House Wives	294
Teachers	62
Hotel Waiters	54
Others	64

Table II. Groupwise evaluation of six month of treatment regimen

Results	No. of cases		
	Group-I	Group-II	Group-III
Good	201	198	196
Fair	18	46	23
Poor	3	4	5
TOTAL	222	248	224

Table III. Groupwise time duration for recovery

Time duration in months	Group of patients		
	Group-I	Group-II	Group-III
2-4	2	0	3
4-6	1	2	1
6-8	0	2	1
TOTAL	3	4	5

Long term results: Once 6 months follow up period is over for each patient, then they were called for subsequent visits once in four months by sending printed postcards. At this review, mainly fluctuations in severity (exacerbations and remissions) are taken into account along with other criteria which are narrated above (Table IV).

The relapses were seen in highest number in Group III patients who had large calcaneal spur radiologically as compared to Group II patients who had rudimentary spur. Whereas the exacerbations are seen minimal in Group I where the spur was not seen on X-rays. All above patients by repeating the previous line of treatment of their group

improved well in course of time. Relapses more than 8 times were mainly seen in patients associated with obesity (weight more than 70 kg.), flat feet and patients who have to stand and walk for long time. In such resistant cases heel moulds were advised, which gave tremendous relief from pain.

Table IV. Exacerbation and remissions during period of follow up

No. of exacerbation and remissions in whole of follow up period	Groups of Patients		
	Group-I	Group-II	Group-III
0-4 times	20	32	46
5-8 times	8	11	18
8 & above	4	6	14
TOTAL	32	49	78

Discussion

The aetiology and treatment of plantar fasciitis, the most common cause of plantar heel pain are poorly understood. The patient usually in middle years develops pain beneath the heel for no apparent reason on following minor injury to foot. For some time, there is no pain but after a few weeks a painful heel develops. Trauma alone cannot become the whole cause of the lesion, not only because the injury is trivial but it may affect both heels.

It is significant that most patients are middle aged, an age when other inflammatory condition affecting collagen fibres, where they attach to bone are common, like tennis elbow, supraspinatus tendinitis etc. Obesity is also a potent initiating factor in plantar fasciitis and tends to make the lesion refractory to treatment. The presence of spur does not always mean that the patient is suffering from a painful heel. Many middle aged people have spurs without suffering or ever having suffered. The relation between pain and presence of spur is by no means a direct one. The calcaneal spur is not the cause of pain. It is the result of an inflammation that may induce pain. Conservative treatment controls most of these patients. Some times just a sponge heel and restricted weight bearing are enough for recovery. The value of hydrocortisone is controversial. Some patients do get relief, but recurrence is common[6,8]. Fearnley and Vadaaz have studied the action of hydro cortisone acetate on various inflammatory processes, but their response was variable[2]. Quinn has shown that local hydrocortisone injection is given for anti-inflammatory effect, but the exact mode of action is unknown. Some times it produces an initial, often severe and some times prolonged painful reaction with subsequent relief. Blockey used hydro cortisone injection in a controlled trial of relatively small number of cases; there was no statistical proof of its efficiency[1].

Application of skillfully fitted heel support that supports the pressure from the medial longitudinal arch is the most effective measure. Rose advocated in insole extending well back to the heel in the form a convex wedge to tilt the heel into varus and to relax the plantar fascia[7]. Frieberg suggested a transverse pad of felt should be strapped to the heel immediately in front of the tender area and combined with a valgus in sole[4]. Fowler suggested a total contact in sole[3]. The heel mould is not made simply to elevate the posteromedial aspect of the heel, but also to relieve tension from the longitudinal arch. Thus holding the foot in inversion and adduction allows some decrease in long arch soft tissue stretch. In persistent cases, heel mould is required.

Although several operations have been devised for this condition, there is no evidence that the results are superior to non operative treatment and they are best avoided[5]. In many cases the process of natural resolution may give relief from pain. However it appears from the study of the patients suffering from plantar fasciitis by and large the conservative treatment gives short term relief and that too not in all cases. We think that the condition is self limiting and only conservative measures should be used to either hasten recovery or allow enough time for the natural history to run its course.

References

1. **Reynold FC, Ramsey RG.** The use of hydrocortisone in orthopaedic surgery. *Southern Med J.* 1954 ; 47 : 209
2. **Young HH, Ward LE, Handerson ED.** The use of hydrocortisone. *J Bone Joint Surg (Am).* 1954 ; 36 : 602.
3. **Blockey NJ.** The painful heel. 1956; 1: 1277-1278.
4. **Rose GK.** Orthotics, principles & principle. London; Heinemann. 137.
5. **Freiberg J.** The diagnosis and treatment of common painful conditions of the foot. *Am Acad Orthop Surg* 1957 ; 14 : 238.
6. **Furey JG.** Plantar fascitis - The painful heel syndrome. *J Bone Joint Surg (Am).* 1975; 57: 672.

INDIAN JOURNAL OF ORTHOPAEDICS
April 2004
Volume 38 : Number 2 : P. 124-127

Recurrent aneurysmal bone cyst of cervical spine with contiguous pharyngo-oesophageal spread - *A case report with 30 years follow up.*

V Marwah

Orthopaedic Surgeon, Nagpur

Introduction

Aneurysmal bone cyst is a benign bone lesion. Total excision and bone grafting is an accepted procedure. However, total excision in cervical spine is not a facile option as the body of cervical spine is small, spinal cord is adjacent and the two vertebral arteries run close by. Long-term results in irradiated cases need life time follow up, for the rare complication of malignancy developing. Pain and stiffness, persisting after simple treatment is more suspicious of tuberculosis of spine, in these parts and erosion of edges of vertebra seen in radiograph is in fact is its late manifestation. M.R.I. or C.T. can help, but an irrevocable diagnosis is best made on a biopsy. A simple biopsy or an even simple aspiration and incomplete curettage can lead to spontaneous healing[1]. Healing of the lesions is nearly constantly achieved despite the type of treatment. Total excision is demanding in cervical spine, particularly if the lesion involves the body. Intralesional excision with bone grafting is an acceptable procedure, adding radiation, where so indicated. Involvement of Pharynx, esophagus, larynx by extension in contiguity, as also pressure on the spinal cord is expected from a lesion in the body. Pressure on the cord expectedly could be diagnosed early. The spine and the cervical spine in particular, present special difficultly in providing stability. Recurrence presents a greater difficultly in terms of feasibility of total excision.

Case Report

A 20 year old girl complained of pain of the neck in February 1972 after a sporting outing. This subsided for a while, with routine rest and analgesics but recurred by first week of March. A small erosion in the disc space between C_2-C_3 cervical vertebra, spasm of neck muscles (and which is the more common clinical presentation in these parts), led to a diagnosis of tuberculosis of spine, and the patient was treated such. By 1st May 1972 the patient was shifted to the Nagpur Medical College, where cervical traction and anti tubercular treatment was continued. By August, the patient developed weakness in the limbs. There was obvious pressure on the cord. Since the author has to leave for a visit abroad, the case was handed over to a colleague a trained Neurosurgeon, in a sister medical college. By now C_3 vertebra appeared to be affected considerably. In early September, by an anterior cervical incision, upper cervical spine was exposed to reveal a bluish pre-vertebral mass. Aspiration presented a vascular structure. Incision revealed a vascular 'malignant' looking mass. There was no evidence of caseation or necrosis. The histopathology revealed that the tumor was an aneurysmal bone cyst. This was confirmed by more than one pathologist. The slide was seen at a histology conference. More deliberate exploration was done on 19th September, 1972 and the whole tumor was curetted out. There was less bleeding this time. The tumor was grayish and soft. Cortical graft from the iliac crest was inserted between the space thus created. The decompression and cervical traction controlled the cord compression almost completely and patient was discharged with a Minerva jacket.

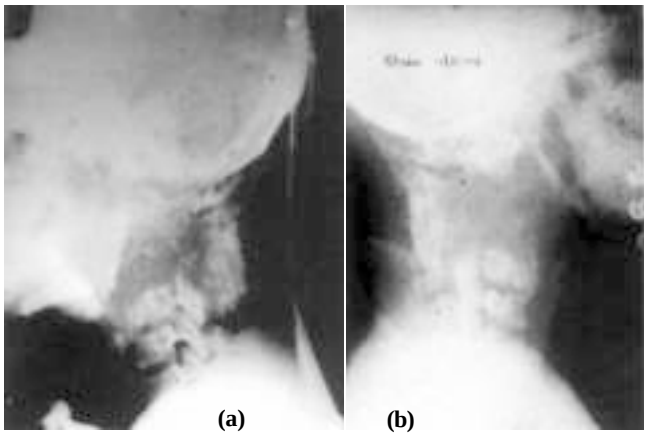
However, within a month, cord compression re-appeared and the X-ray showed that bone graft has not been taken up. The neck was unstable. It was decided then to fix the spine by plate and screws posteriorly, from occipital protuberance to spinous process of C_6. The cervical traction was maintained. The neck did not heal even after 3 weeks. The general condition of the patient was deteriorating. Suspecting adverse body reaction and infection plate and screws were removed.

On 13th January, 1973, the surgeon re-explored the lesion by anterior route. Tumor like material was scooped out from the under surface of body of C_2 and upper part of body of the third cervical vertebra. Some bone formation could be noticed across the defect. A strut rib graft and chips were placed between the bodies. Six weeks later, the strut graft has

Dr V Marwah, Orthopaedic Surgeon, 'Anchal', Tagore Road, Civil Lines, Nagpur-440010, Maharashtra

Received : 15.1.2002; Revised : 23.3.2004; Accepted : Apr. 2004

Fig 1. *Shows the halo pelvic fixation in position. The scar and granulation tissue at the site of removed plate and screws.*



(a) **(b)**

Fig 2. (a) *At 18 months, part of body of C2, whole of C3 and part of C4 body has been absorbed. Some new bone formation can be seen at lower edge* **(b)** *at 21 months after first exposure to radiotherapy, a hazy mass can be seen replacing bodies of 2nd, 3rd and 4th bodies of cervical spine*

slipped, through the chips were in place. Traction by crutch field gongs has also slipped. This was replaced by simple Halter's traction.

Radiographs taken in June 1973 showed very minimal attempt of fusion and clinically the neck was far from stable. Weakness of the limbs had progressed and there was spasticity. By the end of July 1973, the neurosurgeon and the author operated again. The bodies were re-explored, and graft from both the iliac crests was used. An improvised Halo-pelvic fixation, using the exposed iliac crest as base, passing 'K' wires across the pelvis posterior-anteriorly under vision, fitted to a skull Halo, using tapered blunt ended bone screws, in a nine hour procedure (Fig 1). The decompression, grafting and fixation were satisfactory. The pressure over cord also appeared to be relieved.

The patient was brought back to the Medical College on 24th September 1973. Although the paraparesis has improved and the neck was stable in the Halo, the patient has difficulty in swallowing and in breathing (Fig 2-a). The neck had foreshortened and appeared a little bulky for a thin person who had lost weight in all these weeks. Since it was relatively less difficult to shift the patient in the Halo, radiotherapy was decided upon and the girl was exposed to 2500 rads in to portals in 3 week stretch. Clinically this seemed to help, as the neck felt firm (Fig 2-b). By mid January 1974, the patient was encouraged to sit up. However, three of the skull screws and points of emergence of the K wires appeared infected and the Halo did not hold properly. This had to be removed. While removing the fixation, the neck, which was being held by the surgeon, appeared to sag. The patient went back to bed in cervical traction.

In 3rd week of February 1974, throat examination showed flakes of cobweb like grayish masses appearing in oropharynx. Tracheostomy and intragastric tube controlled the respiration and nutrition respectively. Chest X-ray showed patchy areas in lungs and there was paravertebral abscess like shadow in mid thoracic region – suggesting that the flakes of tumor were trekking down the prevertebral space (Fig 3).

Fig. 3.

Fig 4. *Radiograph of cervical spine- one year after discharge. There is ground glass appearance over bodies of part of bodies of C2, C3, C4 extending to posterior elements. Definition of the bodies not clearly seen. There is loss of lovdosis and loss of height. Translency persists.*

Fig 5. *30 years later ; bodies of C2 C3 and C4 can be seen. There is loss of normal contour inclined to be mildly kyphotic. The spinal canal can be seen clearly.*

Radiotherapy had improved the patient earlier. A further exposure to deep X-rays was planned in which a higher dose was given and all the portals were used. The next 3 weeks were full of morbidity-swelling, erythema and bouts of cough. Full supportive therapy, somehow gradually overcame the morbidity. Traction was there all the time. By May 1974, the neck skin improved and the neck felt firm. One day the patient wanted to eat ice cream. With the anesthetist in tow with a laryngoscope to look at the oropharynx a difficult procedure under the circumstances, it was found that the throat was clear and cobwebs had gone.

By July 1974, patient could sit up with a firm neck, though shortened a bit and she could swallow semisolids. The radiograph still showed translucency at part of body of C_2, C_3 and part of body of C_4 (Fig 4). Tracheotomy tube was removed by September 1974 and patient was discharged and she resumed her post graduate studies.

She had residual problem of hoarseness and trouble breathing when she had URI. For many years thereafter the patient was lost to proper follow up. Proper contact was made in September 2003. She continued to be well and was working as a scientist in Geological Survey of India. The radiograph showed consolidation of bodies though a little deformed and the neck foreshortened (Fig 5).

Discussion

Aneurysmal bone cyst is a lytic pseudotumoral condition. It has a thin capsule and appears like a 'blood soaked' sponge'. On aspiration, blood is easily drawn in and at operation it bleeds profusely. Incidence in spine is reported as 10-30% mostly occurring in ages below 20 yrs[1,2]. Posterior elements, pedicles are reported more commonly. Body alone has been reported twice[2]. Simple biopsy or a incomplete curettage, can sometimes lead to a spontaneous healing. While the capsule can be seen in surface, it can not be defined clearly on the bulk of the body, this and the fact that spinal cord and the vertebral arteries, are in close proximity in cervical spine, enblock excision can be demanding and some what impractical. Therefore intralesional excision as in the present case, was the practical alternative. In spine, particularly cervical spine and in younger patient, providing stability is a important factor.

Capanna et al[2] reported a case of second cervical vertebra which had only a biopsy and the lesion progressed post operatively. Patient complained of pain and was subjected to posterior fusion of first, second and third cervical vertebra after which the pain was relieved. She refused further treatment. The lesion located in body the pedicle of second cervical vertebra progressively involved lamina and spinous process and part of the autogenous graft. Three years later, the lesion stabilized spontaneously and she had no complaints 21 years after treatment. In the present case, lesion had extended from inferior part of body of second to the body of third and part of body of fourth cervical vertebra. After second recurrence, posteriorly placed plate fixation and grafting had failed to consolidate. The lesion extended beyond the anterior longitudinal ligament to prevertebral space and extending in continuity and contiguity to oropharynx and laryngo pharynx needing tube feeding and tracheotomy since normal swallowing and breathing became very difficult. Capanna[2] reports only radiation in six patients, three of whom were followed up 2 years. In one patient, he reports radiation first with 3000 rads and repeated with 4000

rads resulting in healing of the cyst and neurological recovery in a lesion in lumbar spine. Seven years later this patient had pathological fracture, resulting in deformity and was treated by anterior arthodesis. The patient remained well after 11 years and 7 months of follow up. He reports another case of lumbar spine who had 3 recurrence after curettage and bone grafting and at fourth recurrence was treated with radiotherapy (4000 rads). The patient died 4 years and 10 months after treatment due to complications of cystitis. Septicaemia, endocarditis and a abdominal mass displacing the ureter causing diplegia (Complication of radiotherapy as mentioned in the paper). He further reports a case of 46 years old man, who had lesion in fifth cervical vertebra which extended to fourth and sixth cervical spine, had neurological complications, had radiation '3500 rads' and improved clinically. Additional treatment was refused. Fifteen years after original treatment becoming paraplegic was decompressed in another hospital, but died in the post operative period. No material was obtained for history. Therefore, if it was a post radiation, related sarcoma could not be determined.

In the present case radiation 2500 rads was employed after 3 attempts of intra lesional excison of the lesion. There was cord pressure but the cord was not infiltrated. The paresis improved on cervical traction with patient lying down. During the period of Halo pelvic fixation there was no cord compression. The radiation given earlier did bring forth clinical improvement which lasted only few weeks. With the combined morbidity of infection, at most points of emergence of metal in the base rods and skull openings of the Halo and the neck appearing to collapse, second attempt at radiation was undertaken a larger dose was administered. After 4 weeks of constitutional and local problems, the local lesion improved the extension, to orophorynx disappeared and normal feeding could be started in 2 ½ months. The tracheotomy tube had to be in position for months. Though the neck felt firm it appeared fore shortened. Radiograph of what was left of bodies of part C_2, C_3, C_4 cervical spine showed translucency.

Translucency, persistent after surgery and radiotherapy, according to Capanna[2] should not be a cause for worry. It should be followed up and if there is no increase in lucency, no treatment is necessary. In the present case lucency remained for 2 ½ years after completion of treatment. There after the case was lost to proper follow up for over 29 years. Radiographs, almost 30 years after discharge, when contact was re-established, showed normal density of the bodies. Boriani[2] recommends monitoring for at least 5 years, the patients who have received radiation should be followed up for life time. 30 years follow up in the present case has not shown any post radiation problems.

Some aspects of spontaneous healing in this case can be explained, with respect to its extension, by continuity and contiguity to oropharynx, to aspirated flakes in lungs, to the prevertebral extension, which formed a small para vertebral bulge and to some flakes that were swallowed. These could not be explained by healing by radiation. A small dose exposure at 20 months did show improvement for about six weeks, but the resultant firmness was not sustained. Subsequent larger dose did clinically resolve the lesion completely, though the local and constitutional problems of radiation were considerable.

References

1. **Boriani S, Campanacci L, Gasbarrini A, Bandiera S, Biagini R, Bertoni F, Picci P.** Aneurysmal bone cyst of the mobile spine – report of 41 cases. *Spine.* 2001; 26: 27-35.

2. **Capanna R, Albisinni U, Picci P, Calderoni P, Campanacci M, Springfield DS.** Aneurysmal bone cyst of the spine. *J Bone Joint Surg (Am).* 1985; 67.

INDIAN JOURNAL OF ORTHOPAEDICS
April 2004
Volume 38 : Number 2 : P. 128-129

Bilateral idiopathic chondrolysis of hip – *A case report*

AM Patel, PK Raj, AK Kapoor, NM Modi, VR Agarwal, PP Golwala

Department of Orthopaedics, Medical College and SSG Hospital, Baroda

Introduction

Chondrolysis of the hip has been described as a complication of slipped capital femoral epiphysis[1,2]. Chondrolysis has also been reported as a complication of immobilization and of trauma[3,4]. It was only since 1971 has so called idiopathic chondrolysis of hip, not associated with slipped capital femoral epiphysis or other known factors, been reported as mainly occurring in black adolescents, uncommon in white adolescents and rare in male adolescents[1]. We present here a case of bilateral idiopathic chondrolysis of hip, which is rare and less frequently bilateral.

Case Report

A 12 year old girl, studying in school presented with history of insidious onset of pain in the anterior part of the left hip. The pain was gradually increasing, was aggravated by movements, relieved by rest. She had associated limp and noticed stiffness of the hip in form of difficulty in sitting crossed legged and squatting. There was no pain in right hip. There was no history of trauma, systemic illness and she was otherwise healthy.

On examination she had fullness and tenderness in left Scarpa's region. Local temperature was normal and there were no scar or sinus. There was exaggerated lumbar lordosis. There was no tenderness on palpation in right hip. Local temperature was normal and there were no scar or sinuses. Movements of the left hip were restricted with absence of adduction and internal rotation. There was rubbery noise felt throughout the available range of movements in left hip. The other joints were normal to examination.

Alpesh M Patel, Senior Resident. ✉
Prgnesh Raj, Resident
Amit Kapoor, Resident
Nirav Modi, Resident
Vivek Agarwal, Assistant Professor
Paresh Golwala, Professor and Head of Unit
Department of Orthopaedics, Medical College and SSG Hospital, Baroda
Dr. Alpesh M Patel, C/o. MR Patel, F-2, C-Block, Sun Terrace Flats, Opp. Gurukul, B/h. Gala Towers, Memnagar, Ahmedabad-380052. Gujarat E-mail: alpesh_21in@yahoo.co.uk
Received : 18.8.2002; Accepted : Jan. 2004

Fig 1. *Radiograph of pelvis showing pelvic obliquity and reduced hip joint space on left side*

Haemogram and blood counts were within normal limits. RA factor, sickling test and mantoux test were negative. Serum IgG was 95.0 sero unit which was well within normal limits. Anteroposterior radiograph (Fig.1) showed pelvic obliquity due to abduction deformity on left side and markedly reduced hip joint space. The femoral capital physis showed premature fusion on both sides taking into consideration the age. The triradiate cartilage showed premature fusion on left side. Width of femoral head was equal to opposite side while joint space was reduced to 2 mm compared to 5 mm on right side. CT scan of pelvis with both hip shows reduced joint space on left side with areas of diffuse osteonecrotic foci within both the femoral heads. The femoral head on left appeared to be grasped by the border of the acetabulum.

The patient was given bilateral skeletal traction with about 2.5 kg on right side and 4 kg on left side. Patient was administered oral analgesics. Regular assessment was done. After continuing traction for two weeks the deformities were corrected and pain subsided. Intermittent assisted mobilization of both hips with continued traction was done. The patient was pain free and had reasonable good range of movements after 4 weeks. Mobilization exercises of hip were continued and she was advised cycling. Protected weight bearing was allowed after 2 months, once adequate clinical and radiological improvement was evident. She was advised to continue exercises and cycling.

Fig 2. *(a, b) CT scan of pelvis showing reduced joint space in left hip with osteonecrotic foci in both femoral heads.*

Discussion

Idiopathic chondrolysis of hip was first described by Jones in 1971[1]. The etiology of idiopathic chondrolysis is still unknown[1,3]. It was speculated that it was an ill defined immunological disease. Their series reported elevated serum immunoglobulins and C_3 component of complement in few patients[1]. In our patient the serum immunoglobulin was well within normal limits.

Bleck performed diagnostic biopsy of hip to establish diagnosis[1]. He concluded that the diagnosis of idiopathic chondrolysis was based on clinical signs, characteristic radiographic changes, coupled with lack of evidence of infection (normal leucocyte count). If the ESR is elevated, the diagnosis is most likely juvenile rheumatoid arthritis where it would be followed up by other joints involvement and could be infection[1,4].

The line of management discussed in literature is conservative. Non-steroidal anti-inflammatory drugs are very useful in relieving discomfort. The weight bearing should be limited with crutches and should be continued till the pain is relieved and range of motion improved. Weight bearing is allowed after 8-12 weeks. Non-weight bearing repetitive exercises, regular swimming in heated pool is recommended. Skin and skeletal traction are applied as necessary and surgery is tailored to individual cases for release of joint contractures[1]. There is high degree of chance of development of early osteoarthritis, so the patient is cautioned against overuse and overloading hip joint with excessive pressure (for example running, lifting weight, standing up from floor).

It is the degree of suspicion aided with X-rays and CT-scan findings which confirms the diagnosis. Diagnostic arthroscopic confirmation is also not necessary[1].

References

1. **Bleck EE.** Idiopathic chondrolysis of the hip. *J Bone Joint Surg (Am).* 1983 ; 65: 1266-1275.
2. **Durbin FC.** Treatment of slipped upper femoral epiphysis. *J Bone Joint Surg (Br).* 1960; 42: 289-302.
3. **Sherlock DA.** Acute idiopathic chondrolysis and primary acetabular protrusio may be the same disease. *J Bone Joint Surg (Br).* 1995; 77: 392-395.
4. **Moule NJ, Golding.** Idiopathic chondrolysis of hip. *Clin Radiol.* 1974; 25: 247-251.

INDIAN JOURNAL OF ORTHOPAEDICS
April 2004
Volume 38 : Number 2 : P. 130-131

Intraoperative fracture of patella during harvest of graft for ACL Reconstruction- *A case report*

Deepak Chaudhary, Puneet Monga, Deepak Joshi, Harmesh Kapoor, Naval Bhatia, AK Singh

Arthroscopy & Sports Injury Clinic, Central Institute of Orthopaedics, Safdarjung Hospital, New Delhi

Introduction

The central third of the patellar tendon with attached bone from the patella and tibial tuberosity is the most commonly used autograft for arthroscopically assisted anterior cruciate ligament (ACL) reconstruction. It is the strongest graft biomechanically and has the advantage of bone-to-bone healing within the osseous femoral and tibial tunnels[1]. Intra-operative complications related to graft harvesting and post-operative morbidity especially anterior knee pain and patellar fractures are potential disadvantages of this method. A case of displaced longitudinal fracture of the patella occurring during graft harvest is presented.

Case Report

A 17-year old male sustained an injury to the knee in a motor vehicle accident two months before presenting to Arthroscopy & Sports Injury Clinic. Clinical examination revealed positive Lachman, anterior drawer and pivot shift tests. Medial joint line tenderness was present although McMurray's and Apley's grinding test were negative. An Arthroscopically assisted reconstruction of the ACL using middle third patellar tendon with patellar and tibial bone plugs was planned. Diagnostic arthroscopy at the time of the procedure confirmed the ACL tear and revealed a medial meniscal tear for which partial menisectomy was performed.

A double-edged knife with 10mm gap between the blades was used to harvest the tendon. Anterior surface of the patella and the tibial tuberosity were marked to delineate the site of bone cuts. A one centimeter wide oscillating saw was used to cut the anterior cortices aiming towards an 8mm deep cut. Tibial side of the graft was harvested first and detached using an osteotome. After making appropriate cuts on the patellar surface, an osteotome was used to detach this patellar bone plug. During this step a displaced longitudinal fracture of the patella occurred. The fracture line ran along the medial longitudinal cut. The fracture was displaced about 5mm. Fixation of the fracture was performed immediately using two K wires perpendicular to the fracture which were protected by a figure of eight loop. The articular congruity was confirmed using arthroscopic examination of the patellar articular surface. Full range of motion of the knee was done repeatedly to confirm the fracture stability. This was followed by reconstruction of the ACL using the standard single incision technique. Graft fixation was performed by interference screws stabilizing the bone plugs.

Post operatively the knee was immobilized in a rigid knee brace for two weeks. Static quadriceps exercises were started immediately in the post operative period. Gentle range of motion exercises were started at 2 weeks and rehabilitation was executed in similar way as in other ACL reconstructed knees. Partial weight bearing was allowed post operatively with gradually increasing weight bearing and till full weight bearing at six weeks. Resistive quadriceps exercises and forceful knee bending exercises were started at six weeks. At about six months when evidence of sound bony healing had occurred (Fig 1), running was allowed. The patient has full range of motion and no quadriceps lag.

Discussion

With the advancement in arthroscopically assisted therapeutic procedures, reconstruction of the torn ACL using Bone-Patellar Tendon-Bone autograft has gained wide popularity. Donor site morbidity has been a major cause for many surgeons to move over to sourcing their grafts from the harmstrings[2].

Patellar fractures occurring post operatively in ACL reconstruction have been reported in the literature[3-5]. Most of them are a result of direct or indirect trauma to the knee.

Deepak Chaudhary, Orthopaedic Surgeon
Puneet Monga, Senior Resident
Deepak Joshi, Senior Resident
Harmesh Kapoor, Senior Resident
Naval Bhatia, Orthopaedic Surgeon
AK Singh, Director
Arthroscopy & Sports Injury Clinic, Central Institute of Orthopaedics, Safdarjung Hospital, New Delhi
Dr. Deepak Chaudhary, 241, Laxmi Bai Nagar, New Delhi – 110023 Email: deepakchaudhary@hotmail.com
Received : 16.8.2003; Accepted : Jan. 2004

Fig 1. *Patellar fracture during graft harvest in ACL reconstruction*

The average incidence ranges from 0.23% to 1.3%[4]. These were associated with minimal residual sequelae and the functional results were not compromised.

Removal of bone block from the anterior inferior surface of the patella induces a significant redistribution of the surface strain. This leads to greater local strain adjacent to the upper border of the bone block hence increasing the risk of patellar fracture[6]. The shape of the bone defect has no significant bearing on this predisposition[7].

Intraoperative fracture of the patella occurring during graft harvest could be related to various reasons. Small size of the patella due to racial factors and related to the age of the patient are beyond the control of the surgeon. Indian patients have shorter stature and built as compared to their western counterparts, in whom most of the original procedures have been described. Being seventeen years old our patients had achieved skeletal maturity, however, an adult size of patella may not have been reached. A preoperative fracture of the patella should always be sought and an alternate source of the ACL graft should be selected in its presence.

An oscillating saw should always be used to make precise and sharp bone cuts. An osteotome being used alone would frequently create bone cuts beyond the control of the surgeon. However, depth of the bone cut while using an oscillating saw should be carefully tampered. A mark using a black sterile marker on the desired depth (8mm) of the oscillating saw serves excellent purpose. Final detachment of the graft from its bed is made using an osteotome. Use of a sharp osteotome and an assistant stabilizing the patella against the femoral condyle are very important measures in preventing the use of excessive force during this step.

If at all such a complication does occur, the ACL reconstruction should not be abandoned. Simultaneous stabilization of the patellar fracture using conventional technique followed immediately by rapid and intensive post operative rehabilitation, gives excellent functional results for newly reconstructed ACL ligament.

We attribute the patellar fracture occurring in our case to two factors: small size of the patella and deep bone cuts. Most of the factors leading to intra-operative patellar fracture may be prevented if adequate pre-operative planning and intra-operative adherence to operating technique is followed. The rehabilitation program for such knee should be executed in a similar fashion as done in other ACL reconstructed knees without patellar fracture.

References

1. **Philips BB.** Arthroscopy of Lower Extremity. *In* : Canale S.T. ed. *Campbell's Operative Orthopaedics.* Mosby 1998; 1470-1561.
2. **Shrock KB, Douglas WJ.** Arthroscopic management of the anterior cruciate ligament deficient knee. In : Mc Ginty JB ed. *Operative Arthroscopy*. Philadelphia : Lippencott Raven. 1996; 511-531.
3. **Papageorgiou CD, Kostopoulos VK, Moebius UG et al.** Patellar fractures associated with medial-third bone-patellar-bone autograft ACL reconstruction. *Knee Surg Sports Tramatol Arthrosc.* 2001; 9(3) : 151-4.
4. **Stein DA, Hunt SA, Rosen JE, Sherman OH.** The incidence and outcome of patella fractures after anterior cruciate ligament reconstruction. *Arthroscopy.* 2002; 18(6): 578-83.
5. **Viola R, Vianello R.** Three cases of patella fracture in 1,320 anterior cruciate ligament reconstructions with bone-patellar tendon-bone autograft. *Arthroscopy.* 1999; 15(1); 93-7.
6. **Steen H, Tseng KF, Goldstein SA, Carpenter JE.** Harvest of patellar tendon (bone-tendon-bone) autograft for ACL reconstruction significantly alters surface strain in the human patella. *J Biomech Eng.* 1999; 121 (2): 229-33.
7. **Du Monteir TA, Metcalf MH, Simonian PT, Larson RV.** Patellar fracture after anterior cruciate ligament reconstruction with the patellar tendon: a comparison between different shaped bone block excisions. *Am J Knee Surg.* 2001; 14(1): 9-15.

INDIAN JOURNAL OF ORTHOPAEDICS
April 2004
Volume 38 : Number 2 : P. 132-133

Hydatid cyst of spine- a case report

GN Maity, RK Biswas, AK Pal, K Banerjee, B Acharyya

Department of Orthopaedics, NRS Medical College, Kolkata

Introduction

Hydatid cyst of spine is a rare entity, but produce severe morbidity, therefore careful vigilance is mandatory for its early diagnosis and proper management. Previous reports revealed that hydatid disease presents as cystic compressive lesion of spinal cord with paraplegia, usually affecting middorsal region rarely the lumber vertebrae.[1-5] Most of the reported cases were located extradurally[4,6-8], rarely subdural[8,9]. Their unsatisfactory neurological recovery even after decompression of the cord with or without laminectomy are mostly due to incomplete eradication or recurrence of the lesion.[1,2] The case to be presented here had a peculiar presentation and had several treatment and consequences of special interest.

Case report

A 30 years old male reported to a neurosurgeon in Sept. 1987 with the complaints of low back pain followed by paraparesis with hypoaesthesia of both legs and feet with bladder involvement. In Feb 1988 he was treated by laminectomy at L_3- L_4 level, and excision of peroperatively detected extradural granulamatous mass along with the intervertebral disc between L_4 and L_5, found to be involved by the mass. Histopathological report suggested that the excised mass was an epidermal cyst of spinal cord. Patient had almost complete neurological recovery and was ambulatory up to 8 years following this operation.

In July 1996, patient came to an orthopaedic surgeon with recurrence of low back pain, paraparesis with another swelling over lumber region with subsequent development of a discharging sinus with liver abscess. Radiologically there was a cystic lesion of L_3 vertebral body with reduction of intervertebral disc space between L_3 and L_4 (Fig.1). He was treated with anti tuberculous drugs followed by drainage of abscess and excision of sinus tract. The tissues from the back and wall of the sinus were sent for histopathological examination which showed only nonspecific inflammation. Patient was on conservative treatment of caries spine including antitubercular drug for two years with no improvement of neurological status.

In January, 1999 patient attended the Orthopaedic Department of NRS Medical College and Hospital with recurrence of discharge over lumber region with low back pain and persistent paraparesis. Radiologically, there was a persistent cystic lesion of L_3 vertebral body with minimal reduction of height and persistent reduction of disc space between L_3 and L_4 (Fig.2). Sinogram showed extension of sinus tract up to L_3 vertebral body (Fig.3). The MRI showed extensive infective changes of lumbosacral spine, a soft tissue mass or epidural mass extending from L_2 to L_4 level. CT guided biopsy suggested tubercular granuloma but no acid fast bacilli were found. He was operated through anterior retroperitoneal approach. On opening the spine, huge amount of thick pus, plenty of membranous flakes extending up to spinal cord were removed in the level of 2nd to 4th lumber vertebrae, which were sent for histopathology and showed the report of hydatid cyst. Post-operatively, the patient was treated by Albendazole 400 mg daily for 3 months, bed rest with spinal orthosis for 6 months followed by gradual mobilization with the help of lumbosacral corset.

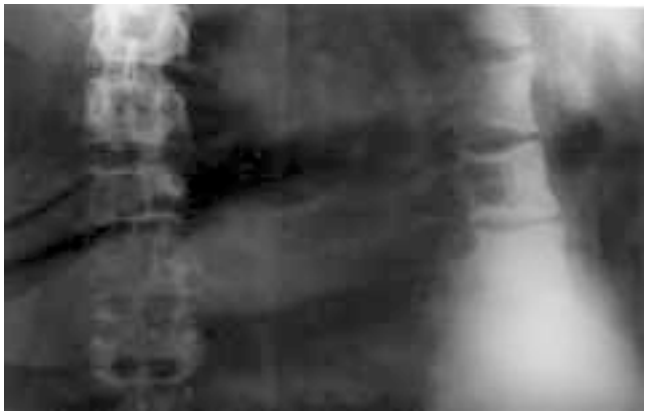


Fig.1. *A.P. and Lateral radiograph suggests a cystic lesion of L_3 vertebral body with reduction of intervertebral disc space between L_3 and L_4.*

GN Maity, Assistant Professor
RK Biswas, RMO Cum Clinical Tutor
AK Pal, Assistant Professor
K Banerjee, RMO Cum Clinical Tutor
B Acharyya, Professor & Head
Department Of Orthopaedics, NRS Medical College, Kolkata
AK Pal, 1/1a Yogi Para Bye Lane, Kolkata - 700 006, Tel : 033- 351-2532
Received : 26.8.2002; Accepted : Jan. 2004

Fig.2. *A.P. and Lateral radiograph suggests a persistent cystic lesion of L_3 vertebral body with minimal reduction of it's height and persistent reduction of disc space between L_3 and L_4.*

Fig.3. *Sinogram showing extension of sinus tract upto L_3 vertebral body.*

Fig.4. *A.P. and Lateral radiograph showing reduced size of the cystic lesion of L_3 vertebral body with it's clear margin of demarcation and reactive sclerosis.*

At 25 months follow up patient had significant neurological recovery up to Frankel's classification Grade E from pre-operative grade Frankel-C with slight weakness of dorsiflexion of right foot and ankle. Patient is now ambulatory but developed a discharging sinus which again healed with Albendazole 400 mg daily for 6 weeks. Radiologically cystic lesion of L_3 vertebral body is reduced in size with clear margin of demarcation and reactive sclerosis (Fig. 4).

Discussion

Primary vertebral involvement of hydatid disease can be diagnosed by clinical suspicion specially when there is close association with the dogs or the patients comes from sheep farmer's community, because the dogs are the primary host and the sheep or men are the secondary host of ecchinococcus. [11]

In orthopaedic practice, spine is the common site of infection[1-5,8], though affection of other bones like rib[1], femur[2,12], sacrum[11], ileum[12], tibia[12], humerus[12] are also reported. In the spine the common presentation is low back pain followed by gradual onset compressive myelopathy and paraparesis[3,4,7,8] with or without bladder and bowel involvement. Radiograph suggests cystic destruction of adjacent vertebrae with paravertebral shadow[1,3], often unilateral[1] resembling caries spine, However, non response to conservative treatment including antitubercular drug should raise the suspicion and Casoni's test may be performed for supportive test[3], whereas MRI or CT guided FNAC may be misleading like the presented case. Only histopathological examination of the excised tissue from spine during decompression can clinch the diagnosis. Thorough decompression of the cord including excision of the lesion preventing its spillage into the adjacent soft tissue and post operative prolong use of Albendazole is the mainstay for neurological recovery but total eradication of the disease is very difficult as seen in the present case.

References

1. **Tuli SM.** *Tuberculosis of the skeletal system.* Second Edition. 2000; 215-216.
2. **Srivastava TP, Tuli SM.** Hydatidosis of spine and femur: A report of two cases. *Ind J Orthop.* 1974; 5-7: 86-89.
3. **Sami A, Elazhari A, Ouboukhlik A, Elkamar A, Jiddane M, Boucetta M.** Hydatidose vertebro-medullaire. *Neuro-Chirurgie.* 1996; 42 (6): 281-7.
4. **Parvaresh M, Moin H, Miles JB.** Dumbbell hydatid cyst of the Spine. *Br J Neurosurg.* 1996; 10(2); 211-3.
5. **Gelabert-Gonzalez M.** Compression medular por quiste hidatidico vertebral, *Revista de neurologia.* 2000; 30: 654-5.
6. **Pamir MN, Akalan N, Ozgen T, Erbengi A.** Spinal hydatid cyst. *Surg Neurol.* 1984; 21 (1) :53-7.
7. **Wani MA, Taheri SA, Babu ML, Ahangar GA, Wani H.** Primary spinal extradural hydatid cyst. *Neurosurg.* 1989; 24(4): 631-2.
8. **Baysefer A, Gonul E, Canakci Z, Erdogan E, Aydogan N, Kayali H.** Hydatid disease of the spine. *Spinal Cord.* 1996; 34 (5): 297-300.
9. **Medjek L, Zenini S, Hammoum S, Hartani M.** Hydatidose intra-durale rachidienne dorsale. A propos d'un cas. *Ann Radiol.* 1991, 34 (4) p251-5.
10. **Ruelle A, Boccardo M, Lasio G, Severi P.** Idatidosi vertebrale primitiva. Daso clinico e breve revisione della letteratura ; *Riv Neurol (Italy).* 1985; 55(5):332-7.
11. **Solomon L, Warwick D, Nayagam S, Mankin HJ.** Graham Apley's Textbook of *"System of Orthopaedics and fractures".*: 8th Edition. 2001; 48-49.
12. **Sapkas GS, Stathakopoulos DP, Babis GC, Tsarouehas JK.** Hydatid disease of bones and joints. 8 cases followed for 4-16 years. *Acta Orthop Scand.* 1998: 69(1) 89-94.

INDIAN JOURNAL OF ORTHOPAEDICS
April 2004
Volume 38 : Number 2 : P. 134-136

Fracture neck of femur with avascular necrosis of head in fibrous dysplasia

Rajkumar S Amaravati, Thomas KT, Phaneesha MS, R Jadhav, Mallikarjunswami B, Thomas Isaac

Department of Orthopaedics and Traumatology, St. Johns Medical College Hospital, Bangalore

Introduction

Fibrous dysplasia of bone probably represents fibrous metaplasia of the primitive mesenchymal cells in the skeleton. The disease in some begins right from the childhood and is usually self-limiting, but may also progress beyond puberty compromising the structural integrity of the affected bones, leading to progressive deformities and pathological fractures[1]. Deformities are a result of micro fractures in the metaplastic weak bone during normal weight bearing[2]. Bone heals readily after fracture but with a deformity like Shepherd's crook deformity of the femur, Harrisons groove following the rib fractures and protrusio acetabuli[3]. Fibrous dysplasia of bone is an enigma with no known cure. In case of fibrous dysplasia of the neck of femur with fracture the usual from of treatment described in the literature are closed reduction and cast application, curettage and bone grafting, internal fixation, multiple osteotomies, radical resection and amputation. However, because of poor bone quality incidence of refractures and failure of the implant are high[4,5]. The purpose of this paper is to evaluate the outcome of primary arthroplasty of the hip following avascular necrosis of the head due to pathological fracture of the neck in fibrous dysplasia.

Case report

A 20-year-old male had a five month history of left hip pain and inability to walk. A review of the patient's medical history revealed that he had sustained injury from a fall after being thrown away on coming into contact with high-tension electric wire. He was apparently fine till he sustained the injury. Physical examination revealed one inch shortening of left leg, which was abducted and externally related with limited range of motion of hip joint. The left hip joint was tender with cafe-eu-lait spots on the chest and back.

Radiographically there was thinning and expansion of cortex of the left femur with radiolucent and partly sclerotic lesions of various sizes with a typical ground glass appearance in the left femur, left tibia and left fibula. There was intracapsular fracture neck of left femur with a sclerosed head (Fig 1a,b). Further evaluation was carried out to assess the vascular status of head of femur. Bone scan revealed no uptake in the head of femur but increased uptake in the left femur and tibia. Computerised axial tomography aided biopsy from the head and neck of the left femur confirmed the histological findings consistent with fibrous dysplasia (Fig 1c). All haematological parameters were normal except for high alkaline phosphatase levels. The patient was not compliant for salvaging the head of femur by osteosynthesis with fibular graft or to do total joint replacement. A primary bipolar hemireplacement arthroplasty of the left hip was performed (Fig 2a). After 6 weeks of non-weight bearing,

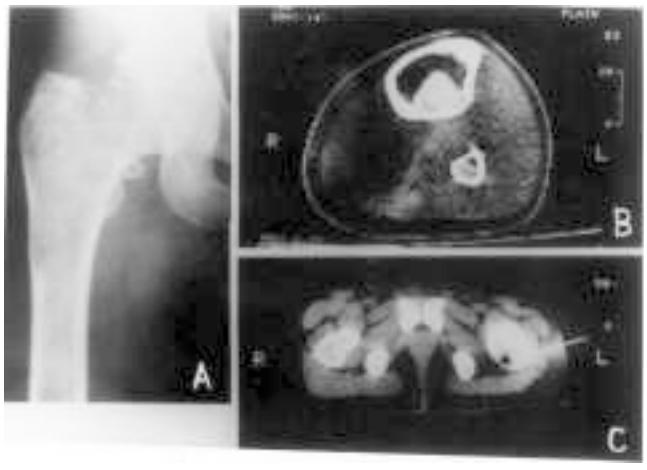


Fig 1 (a) *Fracture neck of femur with rarefaction of proximal femur (Left),* **(b)** *CT scan showing lesions in left tibia and fibula and* **(c)** *CT guided biopsy of the neck of femur.*

Rajkumar S Amaravati,
Thomas KT,
Phaneesha MS,
Ramesh Jadhav,
Mallikarjunswami B,
Thomas Isaac
Department of Orthopaedics and Traumatology, St. Johns Medical College Hospital, Bangalore
Dr Rajkumar S Amaravati, Lecturer, Department of Orthopaedics and Traumatology, St. Johns Medical College Hospital, Bangalore – 560 034
Received : 10.12.2001; Accepted : Jan. 2004

Fig 2 (a) *Bipolar hemireplacement arthroplasty of the left hip,* **(b)** *Follow up X-ray at 28 months showing mild sclerosis of trochanter with sinking of prosthesis at the calcar.*

patient stated partial weight bearing and crutch walking. The patient was allowed to walk independently four months after surgery. At the latest follow up 28 months after surgery the patient was free of pain and functionally independent. The X-rays showed mild sclerosis of the trochanter with sinking of the prosthesis at the calcar (Fig 2b).

Discussion

Lichtenstein is credited with having coined the term fibrous dysplasia in 1938 and in 1942, he and Jaffe reviewed all known cases of this entity[6,7]. Fibrous dysplasia is divided in to three clinical forms, monostotic, polyostotic and endocrinopathic (McCune-Albright Syndrome). Polystotic lesions are large, difficult to treat with unpredictable results[1].

Fractures in the bones affected by fibrous dysplasia do not need surgery and generally heal without difficulty, but the callus that forms is dysplastic and is prone to repeated microfractures and deformity[8,9]. The indications for surgical intervention are persistence of pain, progression of lesion and failure of union[10]. In some instances vascular status of the head of femur in a pathological fracture neck of femur cannot be assessed as the tumorous tissue and the fracture tissue obscure the findings[11]. Prediction of vascular status of head of femur can be done by using electrochemically generated hydrogen clearance method or by the hydrogen wash out technique[12,13]. Surgical treatment of fibrous dysplasia is challenging. Curettage and bone grafting used to replace the dysplastic bone is associated with high failure rates[14]. Internal splintage with metal implants has been used to prevent deformity but they are prone to fatigue failure.

Osteosynthesis using cortical autografts and allografts has been employed with varied success[15, 16, 17]. Unlike conventional grafts vascularized grafts are unaffected by the dysplasia of humerus and radius[18]. No evidence is available as to the use of vascularized fibular graft in osteosynthesis of fracture neck of femur with avascular necrosis of the head in fibrous dysplasia. Total hip arthroplasty was done in a case of polyostotic fibrous dysplasia with degenerative disease of hip joint due to multiple osteotomies and bone grafting[19]. Bipolar hemireplacement arthoplasty can be considered as an alternative to total hip replacement surgery in younger individuals especially in third world countries.

References

1. **Funk FJ Jr, Wells RE.** Hip problems in Fibrous Dysplasia, *Clin Orthop*. 1973; 90: 77-82.
2. **Connolly JF.** Shepard's Crook Deformities of Polyostotic fibrous Dysplasia treated by Osteotomy and Zickel Nail Fixation. *Clin Orthop*. 1977; 123: 22-24
3. **Stewart MJ, Climer WS, Edmonson AS.** Fibrous dysplasia of bone. *J Bone Joint Surg (Br).* 1962 ; 44-2: 302-308
4. **Breck LW.** Treatment of fibrous dysplasia of bone by total femoral plating and hip nailing. A case report. *Clin Orthop.* 1972; 82: 82-83
5. **Freeman BH, Bray EW, Meyer IC.** Multiple Osteotomies with Zickel nail fixation for polystotic fibrous dysplasia involving proximal part of femur. *J Bone Joint Surg (Am)*. 1987; 69: 691.
6. **Lichtenstein L.** Polyostotic Fibrous Dysplasia. *Arch Surg.* 1938; 36: 874-898.
7. **Lichtenstein L, Jaffe HL.** Fibrous dysplasia of bone. A condition affecting one, several or many bones. The graver cases of which may present abnormal pigmentation of skin, premature sexual development, hyperthyroidism of still other Extra-skeletal Abnormalities. *Arch Pathol*. 1942; 33: 777-816.
8. **Grabias SC, Campbell CJ.** Fibrous dysplasia. *Orthop Clin North Am.* 1977; 8: 771-783.
9. **Enneking WF.** Clinical musculoskeletal pathology Third Revised ed. Gainesville: University of Florida Press. 1990:266-7.
10. **Harries WH, Dudley HR Jr, Barary RJ.** The natural history of fibrous dysplasia. An orthopaedic, pathological and roentgenographic study. *J Bone Joint Sur (Am)..* 1962; 44: 207-233.
11. **Hiroyuki T, Katsuro T, Matsumoto J, et al.** Shepherds crook deformity with intracapsular femoral neck fracture in fibrous dysplasia. *Clin Orthop*. 1995, 310: 160-164.
12. **Matsumoto J, Tsuji S, Miyamori K, et al.** Precition of avascular necrosis in the femoral head following fracture dislocation using the electro chemically generated Hydrogen clearance method. *J Jpn Orthop Assoc*. 1988; 62: 747.

13. **Whiteside LA, Lange TR, Capello FR, et al.** The effects of surgical procedures on the blood supply to the femoral head. *J Bone Joint Surg (Am).* 1983; 65: 1127.
14. **Guille JT, Kumar SJ, MacEwen GD.** Fibrous Dysplasia of the proximal part of femur. Long term results of curettage and hone grafting and mechanical realignment. *J Bone Joint Surg (Am).* 1998; 80: 648-658.
15. **Bryant DD IIIrd RF, Tang D.** Fibular Strut grafting for Fibrous dysplasis of femoral neck. *J Nat Med Assoc.* 1992; 84: 893-7.
16. **Enneking WF, Gearen PF.** Fibrous dysplasia of femoral neck treatment by cortical bone grafting. *J Bone Joint Surg (Am).* 1986; 68:1415-22.
17. **Shin HN, Chen YJ, Huang TJ, et al.** Treatment of Fibrous dysplasia involving the proximal femur. *Orthopaedics*. 1998; 21:1263-6.
18. **Kumta SM, Leung PC, Griffith JF, et al.** Vascularized bone grafting for Fibrous dysplasia of upper limb. *J Bone Joint Surg (Br).* 2000; 82: 409-412.
19. **Matlen JA, Hupfer TA, Caste ME, et al.** Total hip arthoplasty and polyostotic Fibrous dysplasia: a case report. *Bull Hosp Jt Dis Orthop Inst*. 1987; 47: 58-66.