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Editorial

JOURNEY TILL NOW AND FUTURE AHEAD

The Orthopaedic Journal of M P Chapter started in the early 1980's with Dr. P.K. Rai as the first editor. He was very much enthusiastic about it and the journal was being published twice a year at times. Dr. P.K. Rai as Editor published the journal till volume 7 and this was the era when I was doing my MBBS and then MS Orthopaedics. I joined Govt. Medical College Jabalpur in the late 1997 when Dr. H.K.T. Raza was the editor of the journal. Dr. Raza is a man of principle. He wanted that the journal should have quality articles and they should be submitted by enthusiasm and not repeated requests. In his tenure he published volume 8 and volune 9 as single journals in 1998 and 1999. He had taken special permission from the executive body of IOA MP Chapter to co-opt me as a member of the editorial board in 1999 and that was my first entry to this journal. The computer man, printer, basic structure of the journal then has been preserved all over the years till now. These were days when the journal had to generate its own income for getting printed.

I was elected as editor in the year 1999-2000 for 3 years when I published the journal volume 10 and 11 and then during the the journal got a special permission that if the journal can be printed by the efforts of the editor at least once then the association will pay for the second issue of the year. This continued till volume 12 when I was re-elected for the second term of 3 years and published volume 13, 14, 15 with 2 issue each year. This was heavy work and my whole time, energy and sponcerships were going in publishing the journal and writing letters to all members and HOD of various medical colleges to send quality articles for publication. Most of my own quality work and researches used to go to this journal in an effort to get it printed and the support I received in these times used to come from Hon. Secretary of the association DrUmeshBatra and Dr. Sanjeev Gaur. I wanted to come out to a bigger journal now and in 2006-2007 was nominated as Editor for Volume 16 No 1 and 2 for the 7th consecutive year and during all these years I did justice to my job. After me for the years 2007, 8 and 9, Dr. Sunil Rajan was elected as editor from medical college Indore. He used to be very busy in patient care and research and in his duration tried to take out 2 journals as volume 17 and 18 whereas the succeeding editor Dr. A Mukherjee for the years 2010,11 and 12 due to personal reasons could not print any journal. Meanwhile I was elected as Honorary secretary of IOA MP Chapter for 3 years and these were the years when the journal was tring to sustain itself.

Finally I was re-nominated as Editor in the year 2012 for 3 years when I was given the task to start some indexing activities. The journal got its ISSN no.for print edition in 2013 when I submitted all the journals with me from vol 8 no 1 to vol 18 including my personal copies to ISSN no Centre National Library New Delhi. This is the time when I registered the journal for Index Copernicus also. Late Prof. Dr. Neeraj Sharma the official website master used to put the PDF of the journal on its website. We tried to get an e-ISSN but the requisite was to have a website with hyperlink to all articles which could not materialize. I have taken out Volume 19, 20 and 21 no 1 and 2 all with print ISSN and finally the Journal is indexed with Index Copernicus master list 2014 with an Index Copernicus value of 37.91. Meanwhile the Medical council of India has made it mandatory to have publications in print journals with indexing in any of the following Pubmed, Index Medicus, Medline, Scopus and Index Copernicus etc .and now the task becomes more difficult and technical.

The time has come when the journal should have its own website , peer review system, online article submission system and facility for hyperlinks to all published articles with e-issn also. It has to be indexed with the recommended indexing agencies and I know future efforts in these directions will keep all legally safe and increase the level of academics in the state. I wish you all success in this 10th year of my editorship and know you will adopt this path of dedication for future generations.

Yours truly

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CONTENTS

FRACTURES OF THE MALLEOLUS WITH SYNDESMOTIC INJURY : A CHALLENGE TO DIAGNOSIS AND TREATMENT

Agrawal A.C.* **Sahoo B.****

Fractures of the malleolus associated with syndesmotic injuries are common. Diagnosis of the syndesmotic injury often is missed and requires stress testing. An initial stable syndesmosis on x-ray may get displaced in later x-ray and a high suspicion Index can prevent one from missing this injury. Figure 1 and 2. Accurate reduction and stable fixation of the syndesmosis are critical to outcomes. Unstable syndesmosis is particularly prone to malreduction including translation, rotation, and overcompression. Knowledge of the technical details regarding intraoperative reduction methods and reduction assessment can minimize the risk of syndesmotic malreduction and improve patient outcomes. Figure 3.

Syndesmosis is a complex of ligaments that joins the distal fibula to the distal tibia at the level of the ankle joint. Four main ligaments contribute to the syndesmotic complex: the anterior-inferior tibiofibular ligament (AITFL), the posterior-inferior tibiofibular ligament (PITFL), the transverse ligament, and the interosseous ligament. The AITFL is situated obliquely between the anterolateral tibial (Chaput) tubercle and the anteromedial distal fibula. The PITFL connects the posterolateral tibial (Volkmann) tubercle to the posteromedial distal fibula. The transverse ligament represents a deep, thickened zone of the distal-most portion of the PITFL and functions like a labrum, deepening and stabilizing the tibiotalar joint. The PITFL and associated transverse ligament provide nearly half of the overall syndesmotic strength.[1] The interosseous ligament is the distal aspect of the tibiofibular interosseous membrane and joins the tibia to the fibula several centimeters above the articular surface.[2] A concavity of variable depth and shape known as the incisura fibularis is located at the posterolateral aspect of the distal tibia.[3] The distal fibula fits into this structure, which provides a small amount of bony support to this articulation. However, without the ligamentous stability provided by the syndesmosis, the articulation is rendered unstable to physiologic stresses. In the normal ankle, the stabilizing ligaments of the syndesmosis provide a small amount of elasticity, allowing physiologic motion at the distal tibiofibular joint. With ankle dorsiflexion, the wider anterior talar body rotates into the mortise, requiring posterolateral and proximal translation of the fibula, as well as external rotation.[4] Overall fibular displacement is normally approximately 1 to 2 mm through the entire ankle range of motion. The position of the fibula within the incisura and its relative stability are critical for maintenance of ankle mortise congruity and normal distributionof tibiotalar cartilage forces, minimizing the risk of posttraumatic arthrosis. Because multiple individual structures contribute to distal tibiofibular joint stability, pathological instability presents along a spectrum, depending on the number and severity of structures injured. An untreated syndesmotic

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Figure 1 Fractures of the Malleolus showing a stable syndesmotic injury.

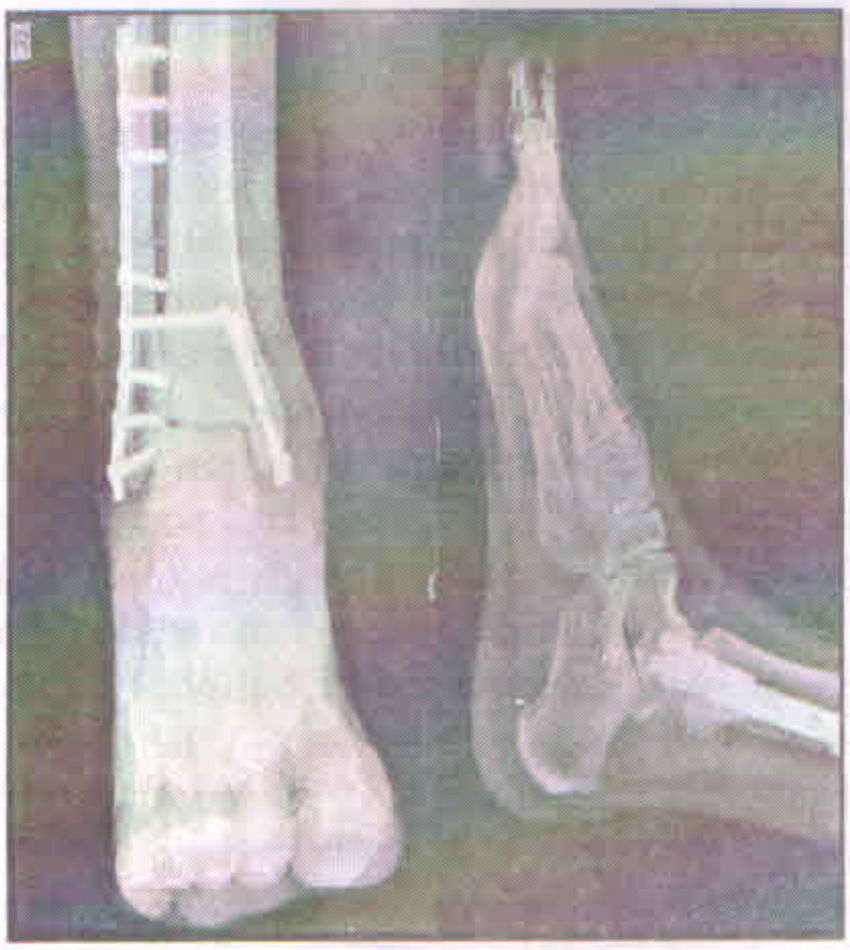

Figure 3 : Anatomic reconstruction with restoration of the syndesmosis

injury can adversely affect functional outcomes. Additionally, applying unstable fixation to a reduced syndesmosis or stable fixation to a malreduced syndesmosis can lead to poor function.

Plain radiographs of the ankle and tibia should be evaluated for the presence of an ankle

Figure 2 : Xray of the same patient showing displaced fragments with fracture of the posterior malleolus and syndesmotic disruption and displacement.

fracture, a proximal fibula fracture, and disruption of the normal relationship between the distal tibia and distal fibula. Three radiographic findings have been identified as indicators of syndesmotic injury: increased tibiofibular clear space, decreased tibiofibular overlap, and increased medial clear space.[5]

Tibiofibular clear space is the distance between the medial border of the fibula and the lateral border of the posterior tibia at the incisura. At 1 cm above the joint, the tibiofibular clear space should be 0.6 mm on both the AP and mortise radiographic views. Tibiofibular overlap is the radiographic projection of overlap of the lateral malleolus and the anterior tibial tubercle at 1 cm above the joint. On the AP view, the overlap should be 0.6 mm and, on a true mortise view, it should be 0.1 mm. On the mortise view, the medial clear space is the distance between the lateral border of the medial malleolus and the medial border of the talus, with the ankle at 90 of flexion. The medial clear space should be less than or equalto the superior clear space between the talar dome and the tibial plafond.[5]

CT is commonly employed to diagnose this injury and pre-operatively decide the

osteosynthesis plan (Figure 4-5) but it gives information only on bony structures and configurations. Although CT cannot demonstrate instability (Figure 6) at times and may lead to underdiagnosis of clinically significant injuries, MRI demonstrates even the slightest evidence of soft-tissue injury, some of which may not correlate with clinical instability. Therefore, the clinical significance of these diagnostic tools in the management of syndesmotic injury remains unclear. Although there are injury patterns that should heighten concern for instability, few patterns have no risk. According to the Lauge-Hansen classification system, pronation external rotation, supination external rotation, and pronation abduction fractures hold the highest risk of syndesmotic injury. The supination adduction pattern is the only type with minimal risk of instability. Based on the DanisWeber classification system, type B and C fibular fractures have the highest risk of syndesmotic instability, and type A fibular fractures pose minimal risk (note the correlation between the two systems, with the type A fibular fracture pattern seen in the supination adduction fracture pattern). However, many ankle fracture patterns do not conform perfectly to the Lauge-Hansen system. Similarly, severe capsular and ligamentous injuries, which destabilize the syndesmosis, can be present even in Danis-Weber type A fibular fractures. Because missed syndesmotic injuries are associated with inferior results and the current classification systems are imperfect in predicting syndesmotic instability, it is logical to conclude that the syndesmosis should be evaluated intraoperatively in every patient with an ankle fracture.

Although intraoperative manual stress testing provides the advantages of simplicity and efficiency, arthroscopic evaluation of the syndesmosis provides other advantages, including direct visualization of ligaments. First, direct visualization of the AITFL and PITFL ligaments provides clearer evidence of injury to these ligaments than an indirect evaluation of their stability through stress testing.[6] Second, associated injuries, such as loose bodies and osteochondral

Figure 4 : CT scan of the same patient showing communited fracture of posterior malleolus.

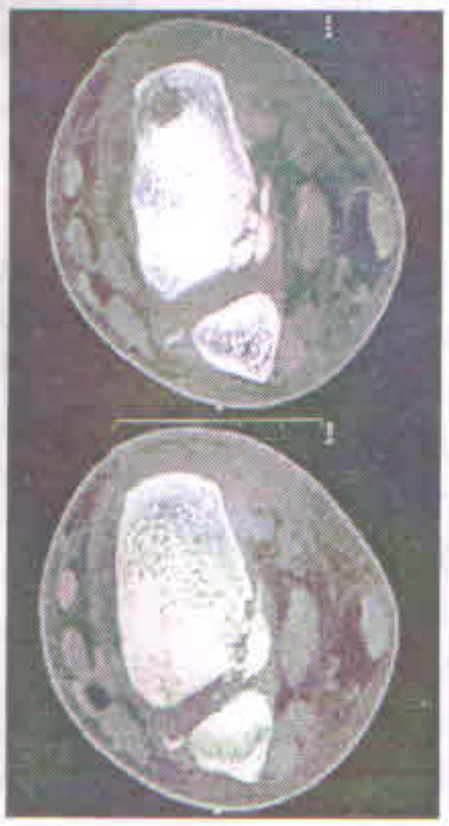

Figure 5 : Transverse view in CT of the same case showing communited fracture of posterior malleolus with syndesmosis avulsion from anterior lip of tibia. AITFL injury. This guides us that instead of specific fixation for posterior malleolus or AITFL an anatomic reduction and holding it in position till healing will give good results.

Figure 6 : CT coronal view of the same patient. A CT scan may at times not give any indication of instability.

defects, may be more completely diagnosed arthroscopically. Third, arthroscopy aids the clinician in defining the different patterns of syndesmotic displacement and assessment of reduction.[7] Disadvantages include the potential for cutaneous nerve injury,[8] overtreatment based on anatomic findings that do not correlate with pathologic instability, andthe increased setup time and logistical complexity of intraoperative fluoroscopy and arthroscopy equipment in the same surgical field. Syndesmotic Reduction and Assessment Following the intraoperative determination or confirmation of a syndesmotic disruption, reduction must be achieved.

Interestingly, a recent study by Song et al[9] demonstrated that 8 of 9 syndesmotic malreductions (89%) spontaneously reduced following screw removal at 3 months postoperatively.

DISCUSSION

The use of a clamp to reduce the syndesmosis frequently leads to inaccurate reduction. Avoiding malrotation, overcompression, and sagittal plane translation can be difficult. The anatomic reconstruction of the fibula (in length and rotation) and reconstruction of the incisura (if either the anterolateral distal tibia or posterior malleolus is fractured) should be prioritized. Following restoration of lateral malleolar length and articulation with a stable syndesmotic incisura, ankle mortise relationships can be restored with the application of a clamp. Syndesmotic reduction is highly sensitive to clamp and screw positioning. A clamp angle of zero leads to the least amount of fibular rotation, but substantial posterior translation and all clamp vectors can lead to overcompression. Intraoperatively, assessment of direct reduction or meticulous fluoroscopic comparison of the injured and contralateral ankles can be helpful to determine the accuracy of the reduction. Restoring the fibula to an anatomic position within the incisura has repeatedly correlated with functional outcomes.

There is a high need to be aware of this injury complex and treat it properly. The injury should be diagnosed pre-operatively so that one plans proper treatment. Intraoperative stability and motion should be evaluated and malreduction should be avoided. A pre-operative MRI can help in diagnosing this injury in time.

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PLATELET RICH PLASMA IN TENDINOPATHIES

Agrawal A.C.* **Kalia R.B.****

Tendinopathy is a broad term encompassing painful conditions occurring in and around tendons in response to overuse. There is currently no consensus on its optimal treatment. Conservative management is the first line treatment in most patients by activity restriction, non-steroid anti-inflammatory drugs, physiotherapy and judicious use of orthoses. However, these traditional treatments fail in some patients. These subsets of patients are treated with steroid injections or surgical interventions but there is no assurance of relief. In such cases a novel emerging technique involving injection of platelet rich plasma isolated from the patient's own blood, at the site of injury, is proving to be more effective. Although there is still insufficient evidence to support the use of PRP for treating musculoskeletal injuries, due to the ease of its preparation and minimal side effects on application, PRP has received much attention as a promising treatment option and the clinical use of PRP is increasing. Platelet-rich plasma (PRP), also known as platelet-enriched plasma (PeRP), platelet-rich concentrate (PRC), autogenous platelet gel, or platelet releasate, may be defined as the volume of the plasma fraction of autologous blood having a platelet concentration above baseline.[1] Normal platelet counts in blood range between 150,000/µl and 350,000/µl and average about 200,000/µl.[2]

Platelets are cytoplasmic fragments of megakaryocytes, a type of white blood cell, which are formed in the bone marrow. They are the smallest of the blood cells, round or oval in shape and approximately 2µm in diameter. They lack nuclei but contain organelles such as mitochondria, microtubules, and secretory granules (α, δ, λ). Among the three types of platelet secretory granules, α-granule is the most abundant and essential to normal platelet activity. These granules are formed during maturation of the megakaryocytes. They are about 200 nm to 500 nm in diameter, and approximately 50 to 80 granules are formed in each platelet.[3] α-granules contain more than 30 bioactive proteins, many of which have a fundamental role in hemostasis or tissue healing. Hemostasis can be considered to be the first stage of healing of injured tissue.[4]

The properties of PRP are based on the production and release of multiple growth and differentiation factors when the platelets are activated. Platelets begin actively secreting these proteins within ten minutes of clotting,[5] with more than 95% of the pre-synthesized growth factors secreted within one hour.[6] After the initial burst of growth factors, the platelets synthesize and secrete additional such factors for the remaining several days of their life span. These growth factors secreted mainly by alpha granules are known to cause tissue healing by promoting cellular chemotaxis, proliferation and differentiation of cells, removal of cellular debris , vascular invasion by angiogenesis and formation of extracellular matrix.[7] Since PRP is derived autologously from the patient's own blood there are no concerns about immunological reactions and disease

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transmission associated with other allergenic biological treatments like fibrin glue. Recombinant tissue growth factors developed by bioengineering have been used previously to obtain similar results but they have short shelf lives and are expensive which has precluded their wide spread use in routine clinical practise. Also, unlike recombinant growth factors, PRP delivery has the advantage of releasing multiple growth factors and differentiation factors upon platelet activation.[8]

The objective of this article is to review the current literature on the role of PRP in the treatment of tendinopathies and identify possible difficulties and complications associated with its use.

METHODS

A MEDLINE search was done with the key words Platelet Rich plasma and tendon and original research articles with free full-text were analyzed.

PREPARATION OF PRP

PRP can be prepared within minutes in a laboratory, an operating theatre or a clinic from blood collected in the immediate period before treatment. Usually, citrate or Anticoagulant Citrate Dextrose Solution, Solution A, USP (2.13% free citrate ion) (ACD-A) anticoagulation is highly recommended because it better preserves blood and ex vivo platelet reactivity. In contrast, EDTA and heparin should be avoided due to decreased platelet reactivity leading to reduced release of growth factors.[9,10]

For collection of PRP, automated blood cell separators use microprocessors to draw and anticoagulate blood, separate components either by centrifugation or by filtration, collect the desired component and recombine the remaining components for return to the donor. Centrifugal separation involves either a discontinuous or a continuous flow of blood into the devices. There are at least three techniques for preparation : the gravitational platelet sequestration (GPS) technique, standard cell separators, and autologous selective filtration technology (plateletpheresis).[11]

The GPS is a table-top centrifuge system using a flat-bottomed, 60-ml plastic centrifuge tube containing a buoy. PRP is collected following a 12-minute spin at 3200 rpm. When anticoagulated blood is centrifuged, three layers become evident. The bottom layer is comprised of red blood cells (specific gravity = 1.09), the middle of platelets and white blood cells (buffy coat, specific gravity = 1.06), and the top of plasma (specific gravity = 1.03). The buoy is lowered to remove the platelet-poor plasma, thereafter, PRP (about 5ml) volume is collected. PRP yield is approximately 10% of the volume of whole blood drawn. With this device, the red blood cells cannot be collected separately and are therefore discarded.

Standard cell separators and salvage devices generally operate on a full unit of blood. In general, they use a continuous-flow centrifuge bowl or a continuous-flow disk separation technique. It uses both hard spin (5,400-rpm) and soft spin (2,400-rpm) to collect the PRP. PRP is collected using a syringe. Weibrich and Kleis[18] describe a discontinuous technique with a cell separator that also produces a fivefold increase in platelet count. In both cases, the red blood cells and some, or all, of the platelet-poor plasma (PPP) can be retransfused to the patient to maintain circulating volume. Small compact office systems have been developed that produce approximately 6 ml of PRP from 45 ml to 60 ml of blood, obviating the need for reinfusion.[18,20] These systems differ widely in their ability to collect and concentrate platelets, collecting from 30% to 85% of the available platelets and increasing the platelet concentration between two and eight fold.[19] Some of the units permit the processing of two sets of disposables at once, or performing multiple sequential processes using the same disposable set, so that multiples of the 6 ml standard volume of PRP can be produced.

While preparing PRP by either of the above techniques, it is important that centrifugation be sterile and precisely suited to separating platelets from red blood cells with adequate concentrations of platelets.[12] Not all currently available

commercial devices are same, and some probably do not concentrate active platelets in sufficient numbers to enhance healing. This might explain the variability of the clinical efficacy of PRP. Studies suggesting that there is no benefit from PRP might be based on a product of poor quality produced by inadequate devices. Several studies suggest different centrifugation cycles in terms of time and force (4). The centrifugation force may be a critical step in preparation of PRP as applied mechanical forces may damage platelets, thereby losing the granular load of the growth factors. One study evaluated the effect of different centrifugal forces and showed that spins > 800 g may reduce the amount of TGF-β released by the PRP.[13] In another study it was shown that centrifugation speed of higher than 900 rpm (100g), can lead to platelet activation and resulting decrease of platelet reactivity.

Selective filtration technology or platelet apheresis depends on a single-use disposable proprietary filter designed to concentrate platelets from whole blood. The platelets are captured on the filter and are then harvested to provide a platelet-rich concentrate (PRC) without the need for centrifugation. Compared to a commercial centrifuge-based method, the filtration device produces a blood fraction similarly enriched in platelets and growth factors.[14] Currently, only platelet collection using an apheresis machine enables these objectives to be easily achieved.[15,16]

Despite these variations, all protocols follow a generic sequence that consists of blood collection, an initial centrifugation to separate red blood cells, subsequent centrifugations to concentrate platelets, and other components and an activation of the sample by adding a platelet agonist (Figure 1). In addition to the platelets, it is important to analyze red and white blood cells in the preparation.

Platelet activation is reduced postprandially (5). However, a gentle mastication is able to induce the release of pro-inflammatory components into the bloodstream, especially when patients have severe periodontal disease (6). Thus, it is preferable that patient be fasting before preparing the PRP to reduce pro-inflammatory factors in platelet concentrate. In addition, aspirin, corticosteroids and NSAIDs affect platelet functions and should be avoided at least during 10 days before blood collection.

After blood collection, it is mandatory to prepare the PRP as soon as possible (ideally within 1 hour) to avoid undesired non-specific platelet activation. The PRP is stable for about 3 to 4 hours at room temperature, but platelets can become refractory to agonist stimulation.[17,18,19]

HANDLING AND APPLICATION OF PRP

Once the PRP is prepared, it is stable in the anti-coagulated state for eight hours or longer, permitting the blood to be drawn before operation and used as needed during lengthy procedures.[20] It must be activated for the platelets to release the contents of their α-granules, with the clot that forms providing a vehicle to contain the secreted proteins and maintain their presence at the site of application. This is most commonly accomplished by adding a solution of 1000 units of topical bovine thrombin per millilitre in 10% calcium chloride to the PRP.[36] Marx[37] described a technique in which 6 ml of PRP, 1 ml of the calcium chloride/ thrombin mix and 1 ml of air are introduced into a 10 ml syringe, with the air acting as a mixing bubble. The syringe is agitated for six to ten seconds to initiate clotting, and the clot is then delivered. Man, Plosker and Winland-Brown[38] described an alternative technique for delivering the activated PRP. The PRP and calcium chloride/ thrombin solution are mixed in a 10:1 ratio using a dual syringe system. The PRP is drawn into a 10 ml syringe and the activating solution is drawn into a 1 ml syringe. Both syringe plungers are connected to move in concert with both output ports connected to a dual spray applicator tip which allows both solutions to be mixed as they are applied to the surgical bed. Because α-granules immediately release their contents on activation, the clotted PRP should be used within ten minutes of clot initiation. This issue is circumvented in the dual syringe delivery system because PRP is

delivered to the wound site immediately after activation. In the case of other mixing techniques, it is important to transfer the clot to the surgical site before retraction, otherwise the clot that is transferred may be deficient in secretory proteins.

In contradiction to the above method of activation in some studies un-activated PRP is used with the belief that collagen is a natural activator of PRP, thus when PRP is used in soft tissue, it does not need to be exogenously activated.[39]

CELLULAR COMPOSITION AND BIOLOGICAL EFFECTS OF PRP

In spite of efforts to inject similar amounts of PRP to patients, there is a high variability in PRP obtained. There is limited information available regarding the optimal platelet and WBC content necessary to achieve a desired biologic effect and it may be that specific products are better for certain applications. Platelets increase anabolic signalling and, in contrast, leukocytes increase catabolic signalling molecules. Depending on how they are obtained and prepared, PRPs present highly variable concentrations of platelets, erythrocytes and leukocytes.[20,21,22] Previously, investigators have defined platelet-rich plasma according to platelet concentration. Marx defined platelet numbers of $1000x10^3/\mu l$ as therapeutic PRP[23] whereas Mazzucco et al., in 2009, has defined platelet numbers of $>200x10^3$ platelet/μL as sufficient for a therapeutic effect.[24] But Jungbluth et al, described a platelet concentration three to five times higher than in peripheral blood to be advantageous to stimulate bone regeneration. Below this concentration, they found the effect of PRP to be suboptimal, and paradoxically, a higher concentration was shown to inhibit bone regeneration.[25] Similarly, Giusti et al. showed that PRP preparation with $0.5\text{-}1x10^6$ platelet/μL induced proliferation, migration, collagen, and MMPs production when compared to untreated tenocytes in culture. Higher concentrations were found to have inhibitory effects on the proliferation, migration of tenocytes and overall production of collagen. In contrast, matrix metalloprotease production increased with increasing concentration of platelet, which could be counterproductive as excessive proteolysis, can impair tendon mechanical stability.[26] In general it has been suggested that for maximum efficacy, platelet concentration in PRP should be three to four times that of whole blood, i.e. between 600,000 and 900,000 platelets per microliter.[27,28,29]

But there is still no agreement on the concentration of leucocytes that should be present in therapeutic PRP. Proponents of PRP containing high white blood cell concentrations believe that the presence of WBC provides natural protection against infections and allergic responses. Other authors do not recommend the presence of high white blood cells concentration in PRP as they destroy surrounding tissue.[30] PRP containing concentrated leukocytes release more catabolic cytokines compared to PRP with low leukocytes.[31] Presence of high white blood cells concentration prevented proliferation of osteocytes and myocytes whereas it did not seem to have any effect on tenocyte proliferation.[32] Furthermore, platelets and white blood cells contribute to the formation of microaggregates in the red blood cells, which are thought to be deleterious for the recipient.[33] However, clinical positive effects of pure-PRP have not been demonstrated in controlled studies yet, and, in many clinical controlled studies, only a slight reduction of pain was obtained after a leukocyte rich-PRP injection. Moreover, it has been demonstrated that the anti-bacterial effect of PRP against Staphylococcus aureus, Staphylococcus epidermidis, Propionibacterium acnes and meticillin-resistant Staphylococcus aureus was not linked to the presence of leukocytes.[34]

Healing of injured tendinous tissue is mediated by a complex array of intra- and extra-cellular events that are regulated by signaling proteins. This entire process is incompletely understood. Disruption of the vascular structure as a result of injury leads to the formation of fibrin and platelet aggregation.[35,36] A stable blood clot is then formed by coagulation of the blood. Subsequently, several growth factors are released

into the injured tissue from the platelets and other cells that induce and support healing and tissue formation.[37] PRP is also activated by the addition of thrombin and calcium, resulting in the release of a cascade of growth factors from the α-granules.[38] These granules contain numerous proteins which are members of the families of growth factors, cytokines and chemokines that provide a powerful influence on tissue healing. They include platelet-derived growth factor (PDGF), transforming growth factor (TGF), platelet-derived angiogenesis factor (PDAF), Vascular endothelial growth factor (VEGF), epidermal growth factor (EGF), fibroblast growth factor (FGF), Connective tissue growth factor(CTGF) insulin-like growth factor (IGF), osteocalcin, osteonectin, fibrinogen, vitronectin, fibronectin, and thrombospondin-1 (Table 1). The interaction between these growth factors and surface receptors on the target cells activates the intracellular signaling pathways that induce the production of proteins needed for the regenerative processes such as cellular proliferation, matrix formation, osteoid production and collagen synthesis. Release of these growth factor and catabolic cytokine concentrations are influenced by the cellular composition of PRP.

Tendon tissue is known to heal slower than connective tissues because of a poor intrinsic vascularization. However, in a study done on 24 patients affected by jumper's knee who underwent US-guided PRP injection, intratendinous vascularity needed to improve tendon regeneration was significantly increased.[39]

IN VITRO AND ANIMAL STUDIES OF PRP ON TENDINOPATHIES

Unlike the variations seen on application of PRP to patients, *in vitro* using cell cultures and in animals have shown more consistent results which have helped elucidate the biological mechanism of healing promoted by PRP.

PRP prepared by different methods results in a preparation that secretes different amounts of growth factors which in turn could either inhibit or speed up the healing process. Different growth factors significantly increased type I and III collagen production in tendon fibroblasts. Tendons cultured in 100% PRP showed enhanced gene expression of the matrix molecules, with no concomitant increase in the catabolic molecules. Moreover, releases from both PRP and PPP clots stimulate tendon cell proliferation, in contrast to unclotted PPP. In studies of human tenocyte culture both PRP, and PPP, stimulate cell proliferation and total collagen production. However, only PRP but not PPP slightly increases the expression of matrix-degrading enzymes and endogenous growth factors.[40]

In an *in vitro* study, Aspenberg and Virchenko injected PRP percutaneously into transected tendo Achillis in the rat.[41] This increased the strength and stiffness of tendon callus by about 30% after one week. Mechanical testing indicated an improvement in maturation of the callus. Kajikawa et al[42] showed that PRP injected locally in the rat patellar tendon increased the activation of circulation-derived cells and the immuno-reactivity for types I and III collagen at an early phase of tendon healing. The osteo-inductive effect of PRP on tendon-to-bone healing was evaluated on repair of the infraspinatus in a sheep model using MRI and histological study.[43] The results showed increased formation of new bone and fibrocartilage at the healing site.

CLINICAL STUDIES OF PRP

Although the majority of clinical studies have yielded excellent outcomes, most are only limited to case reports or small series. The evidence of enhancement of tissue healing by PRP remains largely anecdotal. Very few clinical studies with prospective or retrospective controls have demonstrated a significant enhancement of healing of hard and soft tissue with the use of PRP.

One of the first clinical applications of PRP was the addition of autologous fibrin adhesive to cancellous bone during mandibular reconstruction. This study, published in 1994, described radiographic consolidation of bone after four weeks, as opposed to eight in controls which was

attributed to enhanced osteo-conduction given to the osteo-competent cells in the graft by the fibrin network developed by the concentrated platelets.[44]

Buffered PRP has been used as an alternative to surgery in patients with lateral epicondylitis who had not responded to conservative treatment. In Mishra's series, 15 patients showed significant improvement with a single injection, and this was sustained over time with no reported complications.[45]

In another study, Sánchez et al investigated the effect of PRP in ruptures of the tendo- Achillis in athletes who underwent open repair. The procedure was undertaken in conjunction with a preparation rich in growth factors (PRGF) in six athletes and compared retrospectively with a matched group who had the conventional surgical procedure. Those receiving PRGF recovered their range of movement, showed no wound complications and took less time to resume training.[46]

The potential of using PRP in repair of the rotator cuff was evaluated in a pilot study by Randelli et al.[47] After repair of the tear, 14 patients received intra-operative autologous PRP combined with an autologous thrombin component. They were followed up for 24 months and demonstrated a significant reduction in their pain score and significant increases in functional scoring. In another study of 33 patients, there was some evidence for small short-term symptomatic improvements with the addition of autologous blood injection to standard treatment for Achilles tendinopathy.[48]

Other authors have shown that in patients with chronic patellar tendinopathy (jumper's knee), PRP-treated group demonstrated significantly greater improvements compared with focused extracorporeal shock-wave therapy (ESWT).[49,50]

Question about how many PRP injections are needed remains unanswered. To date, no consensus on the minimal number of PRP injections that optimizes tendon healing has been published. Most growth factors contained in platelets are short-lived and thus, repeated administration is advised. Patellar tendinopathy is a common disorder that can affect athletes in different sports at all levels of activity. Dragoo et al. in a randomized controlled study have proved that a single injection of PRP was enough to accelerate the recovery from patellar tendinopathy relative to exercise and ultrasound-guided dry needling alone, but they remarked that the benefit of PRP dissipates over time.[51] Zayni et al treated 40 athletes with proximal patellar tendinopathy over a period of three years and showed that two consecutive PRP injections in chronic patellar tendinopathy showed better improvement in outcomes when compared to single injection.[52] Charousset et al. studied a series of 28 athletes and demonstrated that the application of 3 consecutive US-guided PRP injections significantly improved the symptoms and function in athletes with chronic PT and allowed a more rapid recovery to their pre-symptom level of sporting participation. In addition, they found a return to a normal architecture of the patellar tendon after this treatment on MRI assessment.[53] Other clinical studies suggest that a weekly repeated injection of PRP permitted better clinical outcomes. Filardo et al. treated 15 patients with multiple PRP injections and observed a statistically significant improvement in knee function and quality of life, and most patients had a good recovery and returned to their previous sporting activity level.[54]

However, de Vos et al did not find any greater improvement in pain and activity in 54 patients with chronic Achilles tendinopathy who were treated with eccentric exercises, a PRP injection or with a saline injection. No enhanced tendon structure and neovascularisation was observed in the PRP treated athletes compared to the placebo.[55,56,57] Similarly, PRP injection was found to be no more effective in improving quality of life, pain, disability, and shoulder range of motion than placebo in patients with chronic rotator cuff tendinopathy who were treated with an exercise program.[58] MRI appearance of diseased Achilles tendons also remained largely unchanged following

PRP injection.[59] Similarly, Bell et al showed that the administration of two unguided peritendinous autologous blood injections one month apart, in addition to a standardized eccentric training program, provided no additional benefit in the treatment of mid-portion Achilles tendinopathy.[60]

POTENTIAL RISKS OF PRP USE

Because PRP is prepared from autologous blood it is inherently safe, and any concerns regarding transmission of diseases such as HIV, hepatitis, or of immunogenic reactions that exist with preparations of allograft or xenograft, are eliminated. However, the activation of PRP involves using calcium chloride and bovine thrombin preparations, which contain bovine factor V. The systemic use of bovine thrombin in cardiovascular surgery to promote clotting has been reported to be associated with coagulopathies resulting from cross-reactivity of anti-bovine factor V antibodies with human factor V.[61] The bovine thrombin preparations used in these cases were of high dose (> 10,000 units) and were applied directly to open wounds, where absorption into the systemic circulation is certain. There have been no similar reports since 1997 owing to the use of highly purified bovine thrombin. The very small dose of bovine thrombin (< 200 units) used to activate PRP before application will be consumed during clot formation and digested by macrophages. Hence, bovine thrombin-activated PRP does not produce anti-factor V antibodies.

CONCLUSION

In spite of the growing clinical use of PRP, there is still no standardized method of producing PRP for clinical use which is universally acceptable. This creates difficulties in comparing the results of PRP and precludes establishment of standards for basic and clinical studies. The clinical use of PRP for a wide variety of applications has been described, particularly in periodontal, craniofacial and orthopedic spinal surgery. However mostly the evidence is anecdotal and inconclusive as most studies do not include controls. The available scientific evidence does not warrant the use of PRP for the first-line treatment of tendinopathies. PRP therapy may, however, deserve consideration in specific tendinopathies subtypes, after failure of ultrasound-guided corticosteroid injections. Nevertheless, further studies are needed to define these potential indications and the optimal treatment protocols. It is important to note that the complexity of the tendon healing process cannot be replicated simply by injecting a subset of growth factors, whose effects may occur in opposite directions over time.[3] Additionally, there is also significant variation in platelets and white blood cells with repetitive blood draws from the same individual at different times for all methods of platelet-rich plasma separation. Considering platelet-rich plasma application methods tend toward a repetitive treatment, the lack of consistency at the level of the individual is important, as reliable platelet-rich plasma dosages may be needed to produce consistent results.[62] Improving the techniques for obtaining PRP is crucial, as the injection protocol. Finally, post-infiltration rehabilitation remains absolutely necessary.

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SURGICAL MANAGEMENT OF INTRA-ARTICULAR FRACTURES OF DISTAL HUMERUS IN ADULTS USING TRICEPS REFLECTING ANCONEUS PEDICLE APPROACH (TRAP)

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ABSTRACT

Introduction: Intra-articular fractures of distal humerus constitute 0.5% - 0.7% of all the fractures and 30% of elbow fractures. Exposure of distal humerus via posterior approach is dependent on the triceps mobilization and there are many other modifications e.g. olecranon osteotomy, triceps splitting, triceps reflecting, paratricipital.

Aim: To evaluate functional outcome of fixation of displaced intra-articular distal humeral fractures with use of triceps-reflecting anconeus pedicle approach.

Materials and Methods: 28 patients (16 males and 12 females) of closed intra-articular fractures of distal humerus were treated by open reduction and internal fixation with plate and screws using TRAP approach. Fractures were classified using A.O. classification. Mean age of the patients was 37 yrs(18-62 yrs). All open fractures, injuries older than 3 weeks, associated bony injuries of ipsilateral limb were excluded from the study. Passive and active Elbow mobilization exercises were started after stitch removal. Patients were advised to keep the extremity supported in a splint in between exercises which was discarded after 6-8 weeks. Average period of follow up was 9 months. Patients were evaluated using Mayo Elbow performance index.

Results: As per Mayo index results were excellent in 9 patients, good in 13 patients and fair in 4 patients and poor in 2 patients. Average arc of motion at elbow was 101.300. None of the patients had weakness of triceps. Most common complication was discomfort because of hardware prominence.

Conclusion: TRAP approach allows adequate fracture visualization of distal humerus for stable fixation of intra-articular fractures without creating an iatrogenic fracture of olecranon and its associated complications.

Keywords: Humerus, intercondylar fracture, Triceps-reflecting anconeus pedicle approach

INTRODUCTION

Intra-articular fractures of the distal humerus constitute 0.5%-7% of all fractures and 30% of elbow fractures.[1] The distal humerus fracture is commonly multifragmented have complex anatomy.[2,3] Hence, Distal humerus fractures demand technically difficult operative treatment, often with relatively high morbidity.[4]

The preferred treatment for displaced, intra-articular, intercondylar fractures of the distal part of the humerus is open reduction and internal fixation.[5] Adequate exposure of the articular

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surface of the distal humerus and elbow joint is required for operative stabilization of bicolumnar distal humerus fractures. Generally intrarticular fracture of the distal humerus are accessed by the posterior approach which gives excellent exposure of the articular fragments of the distal humerus.[6,7,8] Distally intrarticular exposure is dependent on the triceps mobilization and there are many modifications in posterior elbow surgical approaches eg. Olecranon osteotomy, triceps splitting, triceps reflecting, triceps reflecting anconeus pedicle, paratriciptial approaches.[6,7] The transolecranon approach, which provides complete posterior visualization and access to the distal humerus, is the most commonly used surgical approach.[9] An olecranon osteotomy has risks and possible complications such as prominence/ migration of hardware, displacement/nonunion of osteotomy and triceps weakness.

Triceps reflecting Anconeus pedicle approach (TRAP) described by O' Driscoll et al in 2000 and involves completely detaching the triceps from proximal ulna with the anconeus muscle.[10] This approach provides good exposure to the posterior elbow joint while protecting the neurovascular supply to the anconeus muscle. The TRAP approach also avoid the complication of an olecranon osteotomy & allow the use of trochlear sulcus as a template to assist with articular reduction of distal humerus.[10]

The purpose of our study was to determine the functional outcome of fixation of displaced intra-articular distal humeral fractures with use of triceps-reflecting anconeus pedicle approach.

MATERIALS AND METHODS

28 patients (16 males and 12 females) of age 18-62 yrs of intra-articular distal humerus fractures were managed using TRAP approach from January 2012 to July 2014. Standard antero-posterior and lateral views were obtained of the injured elbow. CT scans were obtained to evaluate comminuted fractures.

All fractures were classified using A.O. classification suggested by Muller.

- Type A : Extra-articular
- Type-B : Partial articular
- Type-C : Complete articular (Figure 1)

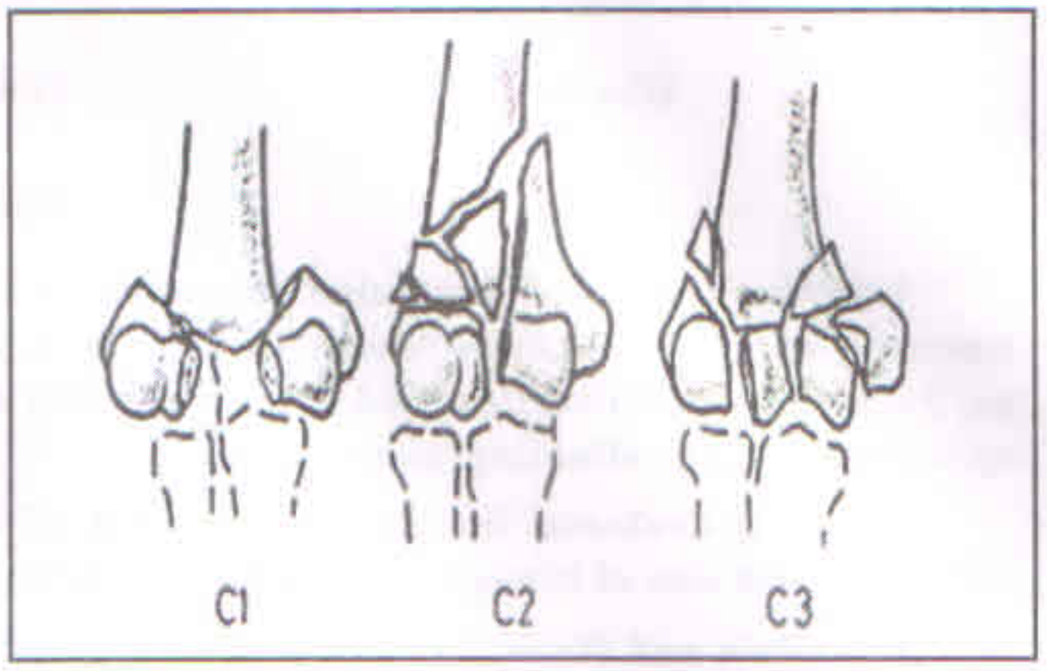

Figure 1 : Type C distal humerus fractures

Patients of age 18 yrs or greater with duration of injury less than 3 weeks were only included in the study. All closed, displaced fractures which were A.O. type C were included in the study.

Patients with associated skeletal injury of same limb, or with active infection or any preexisting disease like Rheumatoid arthritis were excluded from the study.

Implants used to fix the fracture were 3.5 mm Reconstruction plate, 3.5 mm One third tubular plate, 3.5 mm cortical screws, 4.0 mm cancellous screws (partially / fully threaded), K-Wire 1.6 mm. paltes were applied in orthogonal fashion in all the cases.

All patients were operated under regional or general anesthesia in lateral decubitus position with the injured limb hanging by the side of the table on a padded armrest with elbow flexed at 900. High tourniquet was applied in all the cases.

The TRAP approach incorporates a modified Kocher approach on the lateral side and a triceps-reflecting approach on the medial side, with the two approaches converging distally at the tip of the anconeus.

SURGICAL TECHNIQUE

After painting and draping a superficial

curvilinear posterior skin incision was made. The incision was approximately 15 cm long and was placed just lateral to the tip of the olecranon. Medial and lateral skin flaps were raised to expose the supracondylar ridges on either side of the distal humerus. The ulnar nerve was first identified and was carefully preserved.

The modified Kocher approach on the lateral side, commencing distally in the interval between the extensor carpi ulnaris (ECU) and the anconeus was used to elevate the anconeus muscle and develop the distal lateral portion of the flap. The muscle fibers and tendon of the anconeus was dissected off the annular ligament, lateral collateral ligament complex and capsule. The posterior capsule was incised and the dissection was carried proximally between the triceps and posterior humerus. The deep fibers of the triceps were dissected off the posterior humerus by bluntdissection.

On medial side triceps-reflecting approach performed by reflecting the triceps laterally off the posterior distal humerus in continuity with the periosteal sleeve over the olecranon and proximal ulna. Starting at the distal tip of the anconeus, an incision was made in the periosteum along the edge of the ulnar origin of the flexor carpi ulnaris (FCU) muscle to the medial tip of the olecranon and then it was continued proximally along the medial border of the triceps. The proximal ulna was exposed subperiosteally, then the Sharpey's fibers at the insertion of the triceps on the tip of the olecranon was released carefully by sharp dissection. This critical portion of the exposure was performed carefully to maintain continuity of the triceps and periosteal sleeve. After dissecting slightly more than halfway across the tip of the olecranon, a marking suture was placed in the Sharpey's fibers precisely where this part of the tendon was reattached to the olecranon at the completion of the procedure. The marking suture was essential for anatomic reattachment of the triceps tendon and prevention of shortening, lengthening, or medial and lateral displacement. The dissection was continued laterally beneath the triceps and anconeus until it joins the previous plane of dissection in the modified Kocher approach from the lateral side.

Once the modified Kocher and triceps-reflecting approaches was performed medially and laterally, respectively, a continuous plane of elevation exists beneath the sleeve of triceps, anconeus, and periosteum (indicated by fingers beneath the tissues). The final step was detachment of the periosteum from the subcutaneous border of the ulna at the distal end of the anconeus and the reflection of the triceps proximally.

The exposure (Figure 2) was almost equivalent to that provided by olecranon osteotomy, with the exception of a portion of the anterior trochlea, which could be visualized by looking in the lateral ulno-humeral articulation while retracting the ulna gently with a blunt retractor.

Figure 2 : Exposure of the fracture

Adequate fixation of intercondylar components and both the columns done with plate and screws (Figure 3). The triceps was reattached with interrupted number-2 braided polyester sutures, with use of drill-holes through bone in the region of the olecranon. A vacuum suction drain was placed on the triceps fascia and subcutaneous

Figure 3 : Both column fixation done reduction with TRAP approach with plate and screws

tissue and skin was closed in layers. Sterile dressing and above elbow POP slab was applied in 900 flexion.

Post-operatively gentle active and active-assisted range-of-motion exercises were started after stitch removal i.e. 10-12 days with the advice to keep the extremity in removable splint in between exercises. Active extension was prohibited until 6 weeks postoperatively to avoid undue stress on the extensor mechanism repair. At 6 weeks splints were discarded and patient advised to keep limb in triangular sling in between exercise during day time.

Patients were followed up at regular intervals. After stitch removal next follow-ups were done at 3 week and 6 week postoperatively while all subsequent follow-ups were done at an interval of 6 week up to minimum of 6 months. Average period of follow up was 9 months(6-12 months).

The final results of 28 patients were assessed as per criteria laid down by Mayo elbow performance Score (MEPS) (Table 1).

Table 1
Mayo elbow performance score

Function	Points	Definition	Points
Pain	45	None	45
		Mild	30
		Moderate	15
		Severe	0
Motion	20	Arc > 100°	20
		Arc 50-100°	15
		Arc < 50°	5
Stability	10	Stable	10
		Moderate instability	5
		Gross instability	0
Function	25	Comb hair	5
		Feed	5
		Hygiene	5
		Wear shirt	5
		Wear shoes	5

Total score = 100, Excellent Result = >90,
Good Result= 75-89, Fair Result = 60-74,
Poor Result = <60

ILLUSTRATIVE CASE REPORTS

Case 1: 48 yr old female of type C1 distal humerus fracture treated by ORIF with plate and screws using Trap approach. (Figure 4 and Figure 5). Final range of motion was 100-135°. Final result- excellent (Figure 6).

Figure 4 : Pre-operative radiographs

Figure 5 : At final follow up showing good union

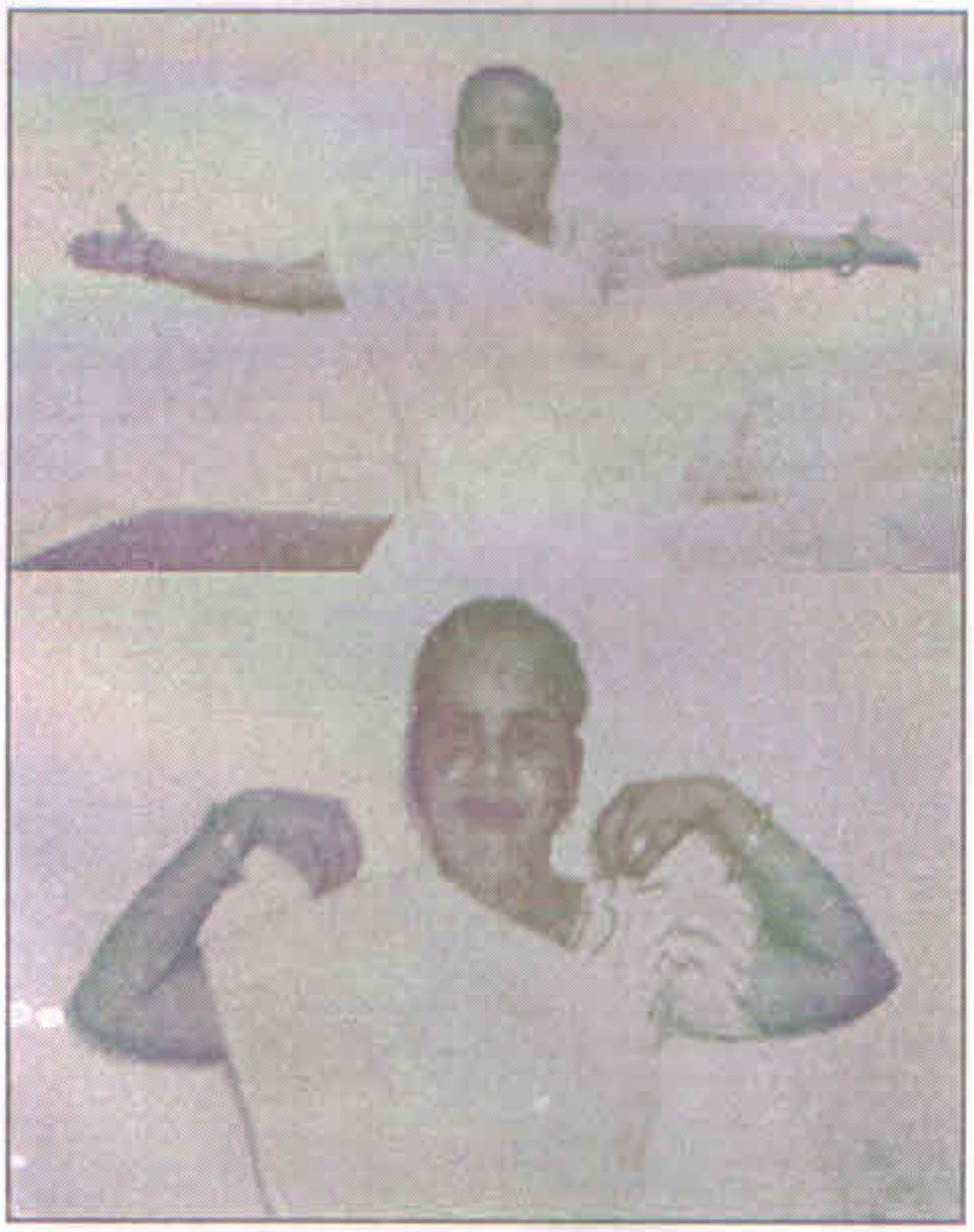

Figure 6 : Final outcome- Excellent

RESULTS

Out of 28 patients 16 were males, 12 were females. Mean age of the patients was 37 yrs, most common age group being 21-40 yrs.

Most common mode of injury was RTA which was more common in young age group while fall on ground(trivial trauma) was more common in older age groups. Right side was more commonly involved.

Most common type of fracture encountered was of type C2 (Table 2).

Table 2
Types of fractures encountered

Type of Fracture	No. of Patients	Percentage
C1	10	35.71%
C2	12	42.86%
C3	6	21.43%

85.71% of patients were having loss of extension = 300, only 2 patients (7.14%) had loss of extension more than 400 (Figure 7). Average loss of extension was about 18.750. Average arc of motion at elbow was 101.30.

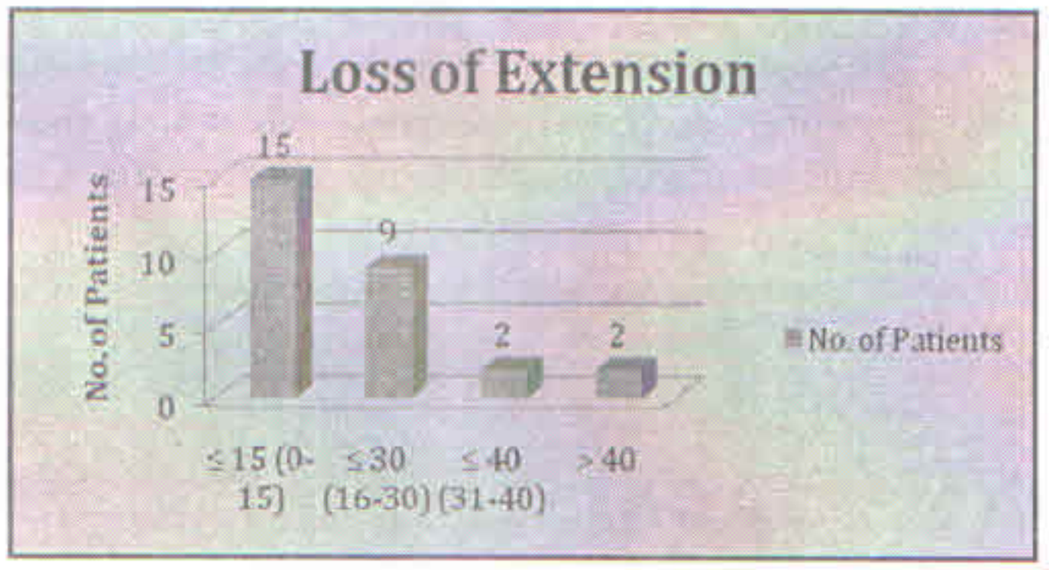

Figure 7 : Loss of extension

Final results as per Mayo index were 78.57% of the cases achieved excellent to good resultswhereas only 7.14% patients had poor results. (Table 3). Mean score in our study was 89.

Table 3
Final results as per Mayo index

Result	No. of Patients	Percentage
Excellent	9	32.14%
Good	13	46.43%
Fair	4	14.29%
Poor	2	7.14%

Majority of the excellent results (6 out of 9) belonged to fracture type C1 whereas two poor results belonged to fracture type C3. Majority of the good results (7 out of 13) were associated with fracture type C2. (Figure 8)

Triceps strength was normal in all the patients. There was no extension lag in any of the cases.

All patients had a stable elbow with no residual pain. Average time of fracture union was 14 weeks.

Most common complication in our series was discomfort due to hardware protrusion, seen in 5 cases but it had no effect on functional outcome. Superficial infection occurred in 3 cases which was managed by antibiotics and regular dressings. There were no deep infections.

DISCUSSION

Triceps mobilization is important for exposure of distal intra-articular humerus for which many modifications have been mentioned in literature viz. olecranon osteotomy, triceps splitting, triceps reflecting, triceps reflecting anconeus pedicle, anconeus flap transolecranon (AFT) & paratriciptial approaches.[6,7]

Olecranon osteotomy first described by Mac Ausland[11] is the gold standard against which other approaches are compared. Olecranon osteotomy provides the best visualisation of the distal humerus articular surface.[7] However its drawbacks like delayed or non-union of osteotomy, hardware complications (prominence/migration) and triceps weakness have led to other avenues of dealing with the extensor mechanism.[12]

Paratricipital approach avoids these complications but the disadvantage is the limited visualization of the articular suface of distal humerus therefore approach is usually inadequate for fixation of type C3 fractures.

Triceps-splitting or peeling approaches have postulated a negative effect on muscle strength on the basis of the potential for weakened reattachment, direct muscle injury with resultant

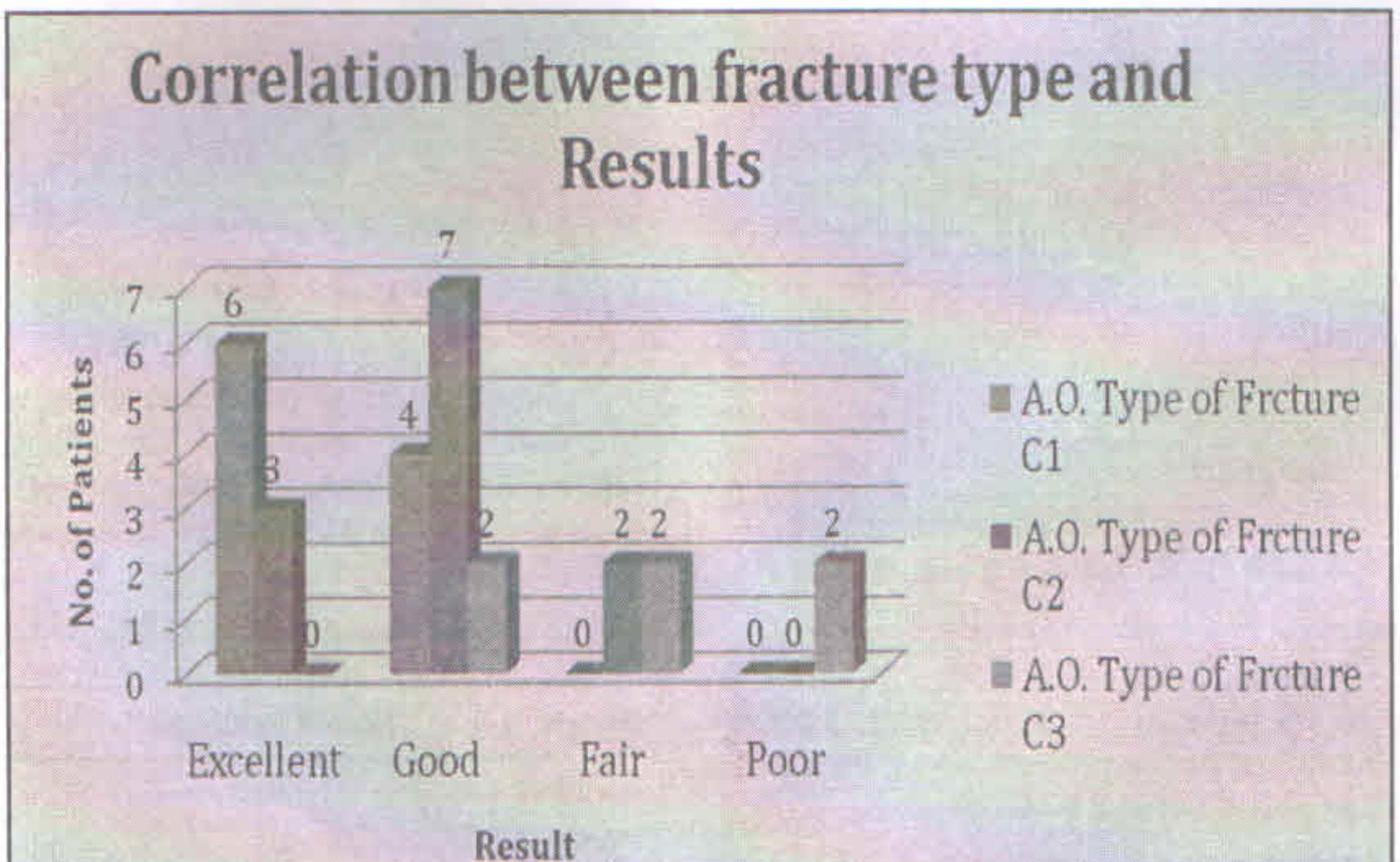

Figure 8 : Correlation between fracture type and Results

fibrosis and injury to intramuscular nerve branches.[13] In the TRAP approach the dissection is in the internervous planes and hence muscle injury and injury to intramuscular nerve branches are avoided with this approach. It protects the nerve supply to the anconeus which is an important lateral stabilizer of the elbow.[3] Moreover, extensor mechanism repair following TRAP approach is easy and strong enough to early aggressive elbow rehabilitation.[14,15]

Olecranon osteotomy exposes more articular surface than other approaches but was not significantly greater than the triceps-reflecting approach.[7] Extreme flexion of elbow allows visualization of most of the anterior articular surface of the humerus. TRAP avoids all the complications of an osteotomy and an intact olecranon acts as a template around which critical intra-articular reduction is afforded and also prevents inadvertent interfragmentry over compression in the intercondylar region.[16]

A review of previous studies on TRAP shows that our results were quite comparable (Table 4).

The reasons for poor result in two cases in our study were late reporting to the hospital, both were type c fractures and lack of supervised physiotherapy as both the patients belonged to rural background.

TRAP has given better functional outcome than olecranon osteotomy. B. Garg et al[17] compared TRAP approach from olecranon osteotomy for distal humerus fracture and found that final ROM was higher in TRAP approach and 5 patients with olecranon osteotomy needed removal of hardware due to its complications. There was no difference in tricpes power in both approaches.

To conclude Triceps reflecting anconeus pedicle (TRAP) approach is extensile enough to provide good exposure of distal intra-articular humerus for a stable fixation, without creating an iatrogenic fracture of olecranon and preserving the nerve supply to the anconeus as well. Easy and strong extensor mechanism repair allows early rehabilitation without any untoward effect on triceps strength.

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Table 4
A review of other studies

Series	Results in % of Total Cases as per Mayo index			
	Excellent	Good	Fair	Poor
Ozer H et al.	9.09	81.82	9.09	0
Pankaj A et al.	0	87.5	10	2.5
Dr. Puneet Mishra et al.	40	26.67	33.33	0
Current study	32.14	46.43	14.29	7.14

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PEDICAL APPROACH FOR INTRAARTICULAR LOWER END HUMERUS FRACTURES

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ABSTRACT

Background: Operative fixation of intra-articular fractures of the distal humerus requires adequate exposure. The transolecranon approach is a commonly used approach. The olecranon osteotomy has potential complications related to prominence/ migration of hardware, displacement/ nonunion of osteotomy and triceps weakness. Triceps reflecting anconeus pedicle (TRAP) avoids the olecranon osteotomy without compromising the operative exposure. We present outcome of fixation of displaced intra-articular distal humeral fractures with the use of TRAP approach.

Materials and Methods:We prospectively reviewed results of TRAP approach on cohort of 30 patients with intraarticular fracture lower end humerus over a duration of June 2012 to Aug. 2014. Results were evaluated on clinical grounds by Mayo Elbow Performance Index for functional recovery,stability, triceps strength and on radiological ground with mean follow-up of 12 month.

Results: In cohort of 30 patients (18 male, 12 female) more than 95 %showed good clinical or functional results on Mayo Elbow Performance Index. Patients were assessed for the functional status of the elbow joint and We found that 80% of them had a range of flexion as given by the Mayo classification of more than 100 degrees. The extension in 85% of the patients was more than 5 degrees in regard to range of motion and . Long term follow up of 6 months for triceps strength gave encouraging results as 96% had strengths in the range of 4-5 and none of them had triceps rupture. Radiological evaluation showed union in all . No patient needed a reoperation and none of them showed elbow instability or tricep weakness.

Conclusions: The TRAP approach provides good visualization for fixation of intercondylar fractures of the humerus, without any noticeable untoward effect on triceps strength and postoperative rehabilitation; and one can avoid iatrogenic fractureof the olecranon and its associated complications.

Key Word: Humerus, Intraarticular fracture, Triceps-reflecting anoceneus pedicle approach

INTRODUCTION

Distal humerus fractures demand technically difficult operative treatment, often with relatively high morbidity. Adequate exposure of the articular surface of the distal humerus and elbow joint is required for operative stabilization of bicolumnar intraarticular distal humerus fractures. The transolecranon approach, which provides complete posterior visualization and access to the distal humerus, is the most commonly used surgical approach but have risks and possible complications such as prominence/migration of hardware, displacement/ nonunion of osteotomy and triceps weakness.

Need for better surgical visualization of fracture geometry has produced numerous new approaches and their modification. Surgical approaches to the elbow joint that dissociate the

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triceps from the olecranon i.e. Triceps-reflecting Anconeus Pedicle (TRAP) have several advantages. This approach avoids an osteotomy and mobilizes the triceps and anconeus muscle off the posterior humerus and the intermuscular septae and provides adequate exposure for open reduction and internal fixation. Furthermore, this approach preserves neurovascular supply of anconeus, which is a dynamic stabilizer of the elbow. With all posterior approaches, the ulnar nerve must be carefully dissected without excessive stripping and usually is transposed anterior to the medial epicondyle at the end of the olecranon osteotomy which is not required with triceps-reflecting anconeus pedicle (TRAP) approach. Though this approach has disadvantages like more extensive dissection, triceps weakness and failures and delayed post op rehabilitation. The purpose of our study was to determine the functional outcome of fixation of displaced intra-articular distal humeral fractures with use of triceps-reflecting anconeus pedicle approach.

MATERIAL AND METHODS

This prospective study was carried out in Department of Orthopaedics and Traumatology, M.G.M. Medical College and M.Y. Hospital, Indore from June 2012 to August 14. After receiving approval from Institutional Scientific Review Board 30 cases with fracture distal end intraarticular humerus fractures in patients between age 18 to 60 years, treated by Triceps-reflecting Anconeus Pedicle (TRAP) were included in the study. Cases with Compound injury, associated trauma of upper limb same side, preexisting musculoskeletal disease, systemic disease, immune system disorders or other comorbid condition like diabetes mellitus, chronic liver and kidney diseases and thyroid disorders and patients on immunosuppressive drugs and those who gave refusal for study were excluded.

SURGICALTECHNIQUE

Alloperationsweredoneundergeneralanesthesia or regional blocks depending upon the patient profile. The patients were placed in lateral position and tourniquet applied. A straight posterior incision was made just lateral to theolecranon tip, approximately 10 cm proximal and 8cm distal.

Medialand lateral skin flaps were raised to expose the supracondylar ridge so neither side of the distal humerus. The ulnar nerve was first localized proximally where it emerged beneath thetricepst end on. The distal aspect of the intermuscular septum was relea sed to increase the mobility of the ulnarnerve. The nerve was followed and preserved and secured in a feeding tube loop. Its branches to the flex or carpiulnaris were care fully preserved.

Laterally, the flap was elevated to expose the interval between the anconeus and the extensor carpiulnaris. The anconeus-triceps flap was detached from its distal attachment (5-7cm from the tip of olecranon) and dissected off the lateral side of the elbow and proximal ulna, preserving the integrity of the lateral collateral ligament complex, including annular ligament. This was accomplished easily by commencing the dissection distally and working proximally. The posterior capsule was incised and the dissection was carried out proximally between the triceps and posterior humerus. The fibers of the deep head of the triceps were dissected off the posterior humerus by sharp and blunt dissection.

The intra-articular component was reduced first, after which the reconstituted condylar block was reduced and fixed provisionally to the medial and lateral columns with 1.6 or 2.0-mm Kirschnerwires . 3.5-mm reconstruction plates were contouredt of it along the involved columns. As per fracture pattern one or both columns were fixed.

Long screws aiming from the medial or lateral epicondyles through the medial and lateral columns provided additional fixation in appropriate cases.

Intraoperativeradiographic assessment under IITV control were made to confirm adequate placement of the hardware and reconstitution of the osseousanatomy, the elbow was moved

through arange of motion to test the stability of the repair and also to guide the goals of post operative rehabilitation. The triceps was reattached within terruptednumber-2 braided polyestersutures, with use of drill-holes through bone in the region of the olecranon. A hemovacdrain was placed on the triceps fascia and the subcutaneous tissue and skin closed in layers. Above elbows lab was applied in 60° flexion for two weeks.

POST-OPERATIVE SPLINTAGE

Done with above elbow slab in 60o flexion. Suture removal done at 2 weeks. Gentle active and active-assisted range-of-motion exercises were started under the supervision of a physiotherapist after two weeks. Active extension was prohibited until six weeks postoperatively to avoid undue stress on the extensor mechanism repair.

FOLLOW-UP

Done at 2 weeks, 4 weeks, 6 weeks, 3 months, 6 months. On each follow up patient was assessed on following parameters.

1. Radiographic Analysis: Union
2. Clinical Assessment
3. Triceps Strength
4. Range of motion
5. Stability: by manual elbow examination.
6. Neurological : for ulnar nerve
7. Elbow functional assessment (Mayo elbow performance index)

Table 1
Mayo elbow performance index

Variable	Definition	No. of points
Pain (max., 45 points)	None	45
	Mild	30
	Moderate	15
	Severe	0
Range of motion (max., 100 points)	Arc > 100 degree	20
	Arc 50 to 100 degrees	15
	Arc < 50 degrees	5
Stability (max., 10 points)	Stable	10
	Moderately unstable	5
	Grossly unstable	0
Function (max., 25 points)	Able to comb hair	5
	Able to feed oneself	5
	Able to perform personal hygiene tasks	5
	Able to put on shirt	5
	Able to put shoes	5

75-100: Good (satisfactory) (n = 10),
50-74: Fair (n = 5), < 50: Poor (n = 0).

Figure 1 : Skin incision for Triceps-reflecting Anconeus Pedicle approach

Figure 2 : Ulnar nerve Isolated

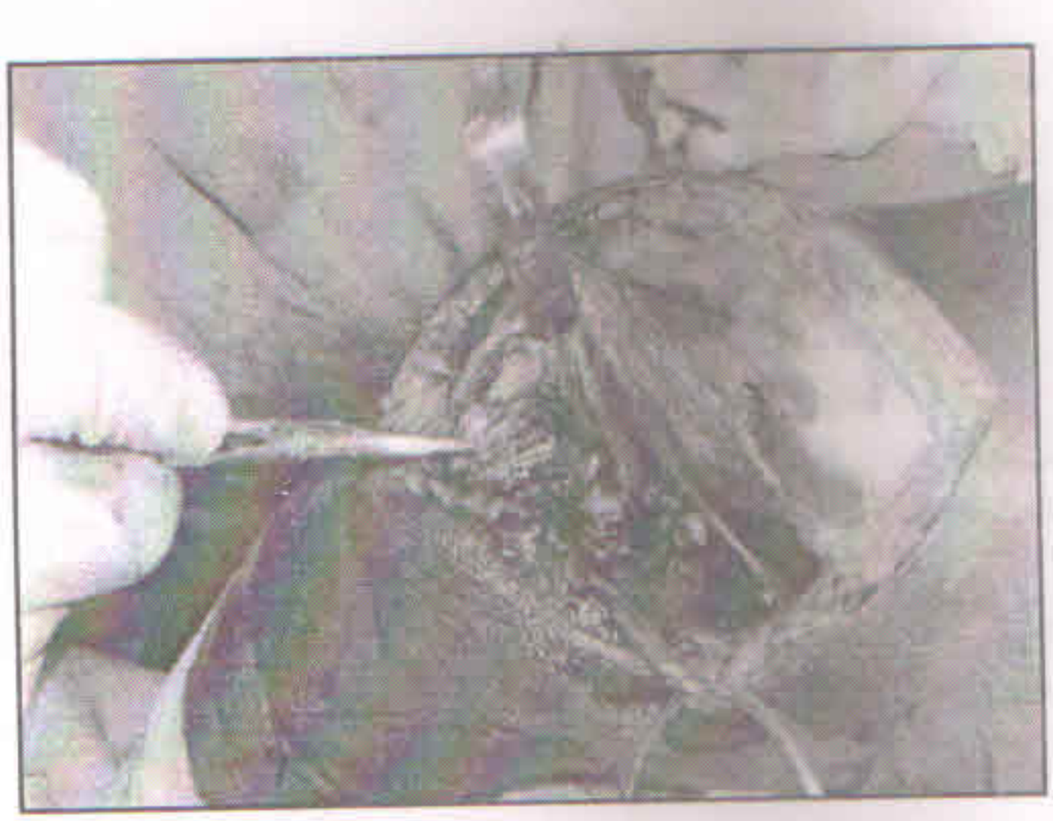

Figure 3 : The anconeus-triceps flap is detached from its distal attachment and the flap is reflected to expose the lower end of the humerus

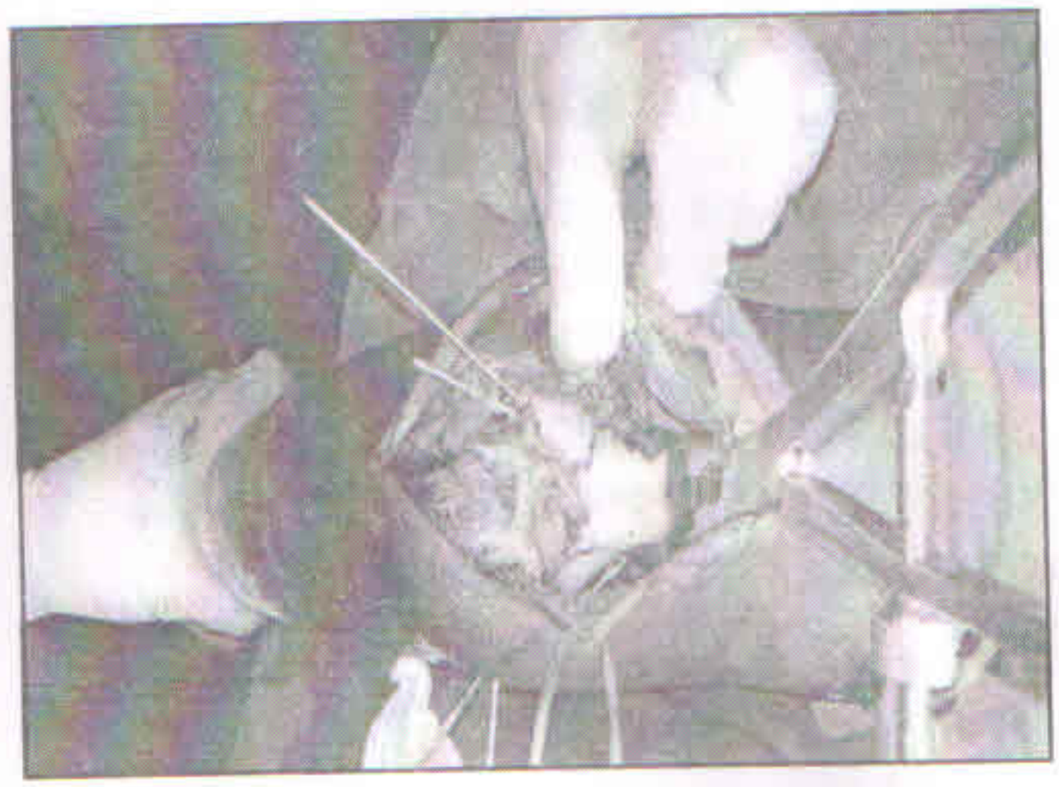

Figure 4 : Good visualization of the fracture and an intact olecranon helps in reconstituting the distal humerus

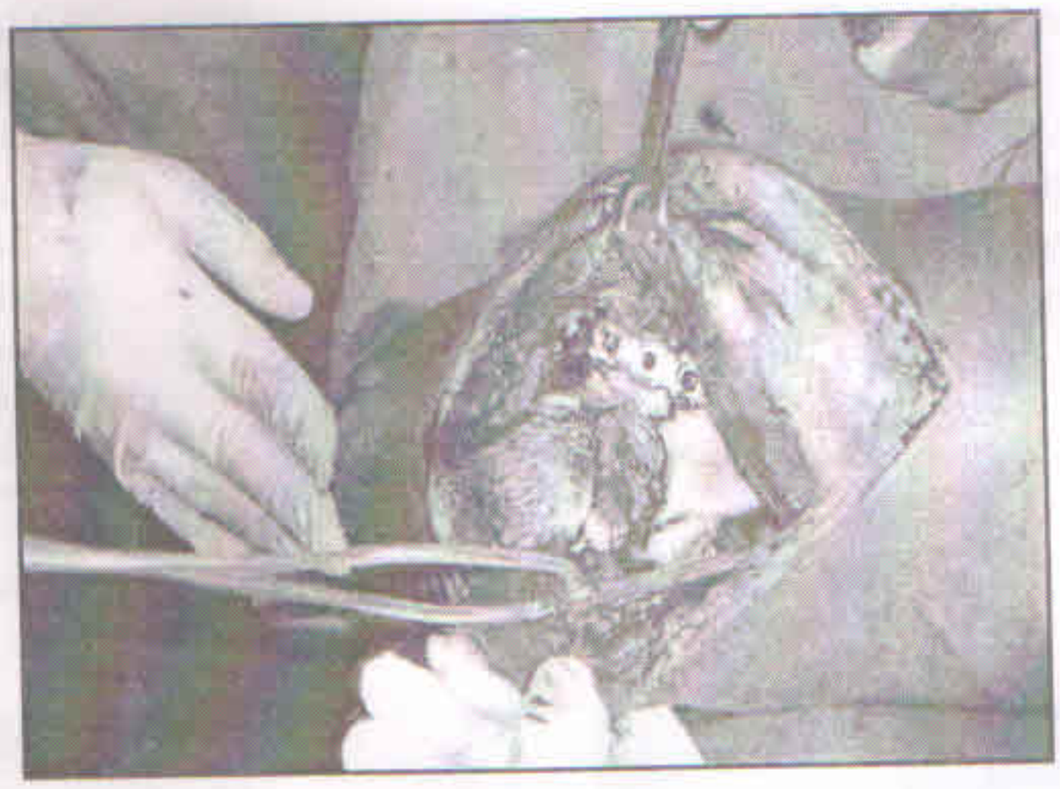

Figure 5 : Plate fixation
Final reduction and anatomical fixation of distal humerus with plate and screws

RESULTS

Our study included total 30 cases 18were Males and 12 were females with age range of 21-60 years with a mean age of 34.4 years. Right sided injuries were more common (67%) with fall on outstretched hand (67%) being Commonest mode of injury. More than (70%) cases were having AO type C fractures. Out of 30 patients more than 95 %showed good clinical or functional results on Mayo Elbow Performance Index. Patients were assessed for the functional status of the elbow joint and We found that 80% of them had a range of flexion of more than 100 degrees. The extension in 85% of the patients was more than 5 degrees in regard to range of motion and long term follow up of 6 months for triceps strength gave encouraging results as 96% had strengths in the range of 4-5 and none of them had triceps rupture only one patient had weakness grade III due to Poor compliance to physiotherapy Radiological evaluation showed union in all . No patient needed a reoperation and none of them showed elbow instability or tricep weakness.

DISCUSSION

Adequate exposure of the articular surface of the distal humerus and elbow joint is required for operative stabilization of bicolumnar distal humerus fractures. Need for better surgical visualization of fracture geometry has produced numerous new approaches and their modification. There are many studies on the various surgical approaches for treatment of distal intra-articular humeral fractures but literature on evaluation of patients only by Triceps-reflecting Anconeus Pedicle procedure is scanty.

Triceps-splitting, Triceps-reflecting and Olecranonosteotomy are the most common posterior surgical approaches to the adult elbow. Triceps-splitting or-peeling approaches have postulated an egative effect on muscle strength on the basis of the potential for weak enedre attachment, direct muscle injury with resultant fibrosis, elbow stiffness and injury to intramuscular nerve branches. In the TRAP approach the dissection is in the inter nervous planes and hence muscle injury with resultant fibrosis and injury to intramuscular nerve branches are avoided with this approach. The median exposed articular surface for triceps splitting, triceps reflecting and olecranon osteotomy approaches has shown to be 35%, 46% and 57% respectively in a cadaver study.

There is consensus that best approach and visualization in these challenging fractures is through the posterior approach. It is generally thought that a posterior surgical approach provides optimal exposure of the intra-articular aspect of the distal part of the humerus and the olecranonosteotomy is the gold standard against which ot her approaches are compared. However, its drawbacks (delayed union or nonunion, prominent hardware and soon) have led too the ravenues of dealing with the extens or mechanism. Several authors have reported various complications associated with tension band wiring of olecranon. Mackoetal reported elbow symptoms due to prominent K-wire 15 cases (75%) out of their 20 cases and skin break down in four (20%).9 In a study of 88 fractures of the olecranon, Horneetal reported that 66 (75%) patients required removal of the wire within one year because of pain and 7% patients had nonunion. Ringetal reported an on-union rate of 30% of transverse olecranonosteotomy insurgical fixation of fractures o f distal humerus. Gainor et al observed that 27% of their patients necessitated removal of hardware because of symptoms related to wires and septicolecranonbursitis.

Triceps-reflecting anconeuspedicle approachc an avoid such problems altogether. The median exposed articular surface for the triceps-splitting, triceps-reflecting and olecranonosteotomy approaches was 35%, 46% and 57%, respectively. Moreover, extensor mechanism repair following trap approach is easy and strong enough to allow early aggressive elbow rehabilitation. It preserves the nerve supply to anconeus which acts as an important lateral stabilizer of the elbow. Good to excellent intra-articular reduction is obtained. No fracture was fixed with > 2mm intra-articular step or gap. This approach affords excellent articular visualization.

Olecranonosteotomy exposed more articularsur face than the triceps-splitting approach but was not significantly greater than the triceps-reflecting approach.

Extreme flexion of elbow allows visualization of most of the anterior articularsur face of the humerus. We had no problem even in comminuted bicondylar fractures with triceps-reflecting anconeuspedicle approach.

In our study 87.5% of patients regained normal strength by 12 months while Askewetal reported loss of st rength of triceps in all patients with olecranonosteotomy or triceps-splitting approach.

The TRAP approach a llows extensive distal humerus exposure, including the supracondylar/ intercondylar region. The TRAP approach is extensile enough in treating complex humeral fractures. Both articular reconstruction and fixation can be easily managed without creating an

olecranon fracture. The repair is easy and strong enough to allow a rapid rehabilitation. No significant triceps weakness and dysfunction was observed after the TRAP approach in the treatment of the intra-articular fractures of the humerus.

Our study has certain short comings. We measured muscle strength manually and that may insinuatethepotential of subjective bias; objective testing of the muscle strength would have avoided this bias. The rate of post traumaticde generative changes in the elbow may increase with time, negatively affecting function and hence along er follow-up is required.

SUMMARY AND CONCLUSION

Adequate exposure is a prerequisite for treatment of distal humeral fractures, as with most surgical procedures. Challenging as they may be to reduce and fix, these fractures can be made more or less difficult to treat based on exposure; complications of successful treatment may arise as a result of the exposure. In this article we describe the triceps-reflecting anconeus pedicle (TRAP) approach to the distal humerus, which provides an extensile and versatile approach for treatment of fractures and nonunions. The TRAP approach provides almost the same exposure as an olecranon osteotomy, without the complications of the osteotomy, and has the added advantage of retaining the whole olecranon to use as a template against which to assemble the articular fragments of the trochlea.

Triceps-reflecting anconeuspedicle approach provides good visualization for fixation of intra-articular fractures of the humerus, without any untoward effetontriceps strength and post operative rehabilitation; and one can avoid iatrogenic fracture of the olecranonandits associated complications.

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EVALUATION OF ROLE OF ANTIBIOTIC CEMENT IMPREGNATED INTRAMEDULLARY NAIL IN INFECTED LONG BONE FRACTURES

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ABSTRACT

Infected long bone fracture is a debilitating disorder. Traditionally treatment of infected long bone fracture follows the multistage procedure such as debridement and systemic antibiotics with temporary fixation and than permanent fixation and bone grafting when required or bone transport.For the treatment of infected long bone fracture Single staged procedures such as debridement and application of Ilizarov fixator and limb reconstruction system (LRS) are also available but these procedures are technically demanding, need good patients compliance and regular long term follow up.This study was to evaluate the role of antibiotic cement impregnated intramedullary nail (ACIIN) in treatment ofinfected long bone fractures. ACIINs provide a high concentration of antibiotics locally, provide mechanical stability, good infection control, promotes bone union by simple and one stage procedure.

We prospectively studied a cohort of 25 culture positive cases with infected long bone fracture with bone defect less then 2 cm (22 tibia and 3 femur), mean age being 35.4 year were treated by ACIINs. Most common organism isolated in culture was staphylococus aureus. Infection control was judged on the basis of discharge through the wound and laboratory parameters at regular follow up. 24 cases achieved infection control and bone union without need of other secondary procedure and only one patient shows poor result that lost to follow up. So we find ACIINs as single stage procedure for controlling infection, providing mechanical stability and there by promoting bone union in infected long bone fracture.

Key words: Antibiotic Cement impregnated intramedullary nail [ACIINs]; Infected long bone fracture.

INTRODUCTION

Infected long bone fracture is a debilitating disorder that still poses a very complex problem to the surgeon today in term of cost and long duration of treatment.[1] Causes of infected long bone fracture are generally inherent to the fracture, like compound fracture, loss of soft tissue or bone, severe comminution and gross displacement, insufficient immobilisation etc.[2] Traditionally treatment of infected long bone fracture follows the multistage proceduresuch as debridement and systemic antibiotics with temporary fixation and than permanent fixation and bone grafting when required or bone transport.[2,3] For the treatment of infected long bone fracture Single staged procedures such as debridement and application of Ilizarov fixator and limb reconstruction system (LRS) are also available but these procedures are technically demanding, costly, requires long term follow up, low patient compliance and have significant complications. These procedures are best suited for large segmental bone defect[4] and both these procedure do not address to the infection control. This led to development of

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infection control by local antibiotic delivery systems, initially antibiotic cement beads then antibiotic cement impregnated intramedullary nail (ACIINs). The antibiotic cement beads control infection and fills dead space but does not provide any mechanical stability. Also require another procedure to remove and at time difficult to remove. Antibiotic cement impregnated intramedullary nail (ACIINs) provides a high concentration of antibiotics locally, fills dead space, gives good mechanical stability at fracture site and there by promotes bone healing.[5,6] Thus ACIINs provides all advantages of cement beads.[7] This study was undertaken to analyze the usefulness of antibiotic cement impregnated intramedullary nail in case of infected fracture of long bones.

MATERIAL AND METHOD

Thisnon randomised prospective study was undertaken atour institute in department of Orthopaedics and Traumatology after approval from Institutional Review Board (Scientific). We studied a cohort of 25 patients who had undergone treatment by antibiotic cement impregnated intramedullary nails (ACIINs) for infected fracture of long bone during June 2012-July 2014. Study included all patients between age 18 yrs-60 yrs with Primarily infected fracture(in which no primary intervention had been done) and secondarily infected fractures(in which the prior intervention was done and got infected) with bone defect less than 2cm. preoperative investigation CBC, ESR, CRP done in all patients. All cases were culture positive. Open wound Gustilo type I, II & IIIA were included. Patients with pathological fracture, immunocompromise and other comorbid condition, bone gap defect more than 2cm were excluded.Functional results were evaluated with regard to control of infection, bony union using RUST score,[15] clinical assessment of fracture union,[16] compliance of patient and complication.

SURGICAL TECHNIQUE

Preoperative planning needed to determine appropriate size and diameter of nail and also important to know whether patient is allergic to some antibiotic as those will not be mixed with bone cement and decrease the procedure time intraoperatively. In primary cases (i.e. without prior intervention) radical debridement of wound and sinus was done by opening the wound and fracture site with excision of infected bone ends and soft tissue. In addition to above implant removal was done in secondary cases. Medullary canal was reamed with reamers of increasing size so as to debride canal completely,culture swab taken from reamed material and sent for culture sensitivity test. Then medullarycavity thoroughly irrigated by antiseptic solution and normal saline with help of K-90 catheter and 100 ml syringe.

In this study K-nail was used for both femur and tibia of diameter 1 mm less than last reamer size and length measured either by pre-operative X-ray or intra-operatively under C-arm guidance. The size of eye of k nail was widened for locking locking bolt by electric drill using metal cutting drill bit [Figures 5 & 6]. In case of tibia, proximal end of the nail (at proximal one fourth and distal three fourth junction) was bend by nail bender like Herzogs bend of tibia interlocking nail (Figure 4). A SS wire loop was attached in proximal eye for easy removal in future (Figure 7).Thermostable Antibiotics 1gm of vancomycin powder and 1.5 gm powder of cefuroxime sodium mixed with 20 gm gentamicin impregnated PMMA bone cement powder before mixing solvent, added then solvent added and then cement paste inserted in nail slot sparing the k nail eyes. Cement outside the nail was removed so that original outer diameter of nail remains unchangedthen setting and hardening is allowed and then nail is ready (Figure 2). Antegrade insertion of nail for both femur and tibia cases. Proximal and distal locking done by free hand technique. Wound was again irrigated thoroughly and closure performed if possible otherwise skin grafting done on same sitting or later depending on wound size.

Postoperative management as routine protocol like any other intramedullary nailing. Antibiotic as preoperative culture report continued till culture sensitivity report of medullary reaming was available

then modify antibiotics according to culture sensitivity report. A complete blood count (CBC), erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP) levels were performed initially and then at fortnightly intervals regularly to record rising or falling trends till 2 months. After 2 months patients followed up every month upto six month then in every two month. On every visit patients was evaluated as per above clinical, radiological and laboratory parameter for bone union.

Why K used in this study nail and why modification needed in this nail preparation:-using a modified k nail has following advantages -

(1) Clover leaf shape which holds cement in slot, provides rotational stability and rigidity (Figure 1).

(2) Slot of k nail which accommodate good amount of cement (Figure 2).

(3) Cement could be filled in the slot not over the surface so that outer diameter of nail does not change (Figure 3).

(4) Cement mantle doesn't remain insitu while nail removed which could happen with v nail and other ACIINs with cement on the surfacedue to debonding.

(5) Universal acceptance because herzogs bend could be made in proximal end to accommodate in medullary canal of tibia (Figure 4). K nail used in other long bone femur and humerus as well.

(6) Custom preparation of locking holes for static fixation and rotational stability (Figures 5, 6 & 8).

(7) Attaching SS wire loop in proximal end for easy removal in future (Figure 7).

RESULT

25cases of infected long bone fractures (22 tibia and 3 femur) with 23 patients being male were treated with antibiotic cement impregnated intramedullary nail (ACIIN). Meanage being 35.4 years (range 18-60 years). Roadtraffic accident was the most common mode of injury andmost common isolated organism on culture was staphylococus aureus (80%). Average duration for infection control was 3.7 weeks and infection control was indicated by decrease in inflammatory marker like differential leukocyte counts, ESR and CRP. Wounds was healed in average duration of 4.1 weeks. Only 5 patients needed split thickness skin graft for wound closure. No secondary procedure needed to hasten the bone union because 96% patients shows bone union without any other procedure. Bone grafting not required because docking at fracture site. 5 patients showed average shortening of 0.36cm but in any case it was not more than 2cm.

Table 1
Criteria for assessment of the result

S.No.	Variable	Excellent	Good	Fair	Poor
1	Infection at 4 weeks	Control	Control	Control	Not control
2	Wound healed at	5 weaks	7 weaks	10 weaks	Not heal
3	Radiological union at 6 month (RUST Score)	12 score	10 score	8 score	4 score
4	Weight bearing without pain at 6 months	Yes	Yes	No	No
5	Neurovascular complication	Absent	Absent	Absent	+/-
6	Patient compliance	Very good	Good	Fair	Poor compliance
7	Results in out of 25 patients	5	15	4	1
8	Percentage	20%	80%	16%	4%

(RUST Score = Radiological union scale for tibia)

In this study 20% patients showed excellent result with fracture unionin average duration of 4.9 months and 60% patients showed good result in which fracture united in average duration of 7.8 months. 4 patients shows fair result with mean duration of union 10.4 months. 1 patient has poor result and lost to followed up.

DISCUSSION

Infected long bone fractures requires procedure to control infection, provide stability, and achieve union. Surgical debridement and delivery of antibiotic locally and systemically are used to control the infection.[8] Local antibiotic therapy results in high local concentration of antibiotic with minimum systemic level.[8] Antibiotic impregnated PMMA beads are used in treatment of osteomyelites and infected open fracture.[9] However a second procedure is required to remove the beads. The infected foci within the bone are surrounded by a sclerotic, relatively avascular bone covered by a thickened periosteum, scarred muscle and subcutaneous tissue. This avascular envelope of scar tissue leaves systemic antibiotics essentially ineffective.[10] This nesseciates the use of locally antibiotic delivery system. Gentamicin has been the most widely used agent followed by vancomycin.[8,11] In this study we use another heatstable antibiotic cefuroxime sodium. These antibiotics have shown to be heat stable with good elution properties from bone cement.[8,12] Use of these antibiotics with bone cement widens the spectrum of activity and also enhances the elution properties of these antibiotics.[11,13] The effectiveness of the antibiotic impregnated cement beads in the control of bone infection is well established. However, they offer no mechanical stability and are difficult to remove after few weeks.[14] ACIINs fills dead space, provide good stability at fracture site, easy to remove, and also provides all the advantages of the cement beads. A high local concentration of antibiotics and low systemic side effects with good mechanical stability are the major advantage of ACIINs.[8]

Raghuram Thonse, Janet D. Conway (2007) has studied cases of infected non-union with bone defects in 52 patients. They were able to achieve osseous union by use of ACIIN in 84% cases with bone defect but 27% patient's required additional procedure to hasten osseous union. They reported infection control in 95% of their cases. In this study ACIINs was made with use of a chest tube as a template.[6]

In study by Ashok k Shyam, Parag K Sancheti et al. (2009) only three patients achieved primary bone union with the use of ACIIN, of which two patients did not have any bone defect and one patient had a bone defect of 2 cm. In other patients with bone defects more than 2 cm needed secondory procedure for infection control and bony union.[10]

In this study 80% patients showed good to excellent results. 20% patient shows fair result in which fracture united in 10.4 months. One patient has poor result that lost to follow up. None of the patients required additional procedure to hasten osseous union. Average time for infection control was 3.7 weeks. Mean duration of follow up in our study was 16.04 months.

MERITS OF ACIINS

1. Simple, feasible and cost effective procedure.
2. Custom made locking holes and locking bolts provides stability.
3. Diameter of the nail does not changes because cement is filled in k nail slot not applied over nail surface.
4. Easy removal because ss wire loop is attached to eye of the k nail.
5. Easy to prepare intraoperatively.
6. Control of infection, stability, bone union achieved by a single stage procedure.
7. Planning for soft tissue plastic procedure is easier.
8. Removal of implant not mandatory.
9. Very less chances of cement mantle to left insitu while removal.

10. Routine postoperative protocol as of any intramedullary nailing procedure.

DEMERITS OF ACIINS

1. Loosening of screw causes pain at local site.
2. In case of Improper size or improper insertion of nail, SS wire loop irritate patellar tendon and causes knee pain.
3. Readymade ACIIN are not easily available.

CONCLUSION

We find in our study that antibiotic cement impregnated intramedullary nail (ACIINs) is a good procedure to achieve early infection control, provide stability and bone union with single stage procedure in infected long bone fractures with bone gap defect less than 2cm. The ACIINs enhance bone healing by reducing infections, it also reduces the chances of chronic osteomyelites and non union. It is a simple, cost effective, feasible and single stage procedure with excellent and good results for infected fracture of long bones with bone defect less than 2 cm.

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GIANT CELL TUMOUR OF DISTAL END RADIUS:VARIOUS TREATMENT PROTOCOL AND RESULTS

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ABSTRACT

Introduction: Giant cell tumor are benign aggressive type of tumor which account 20% of benign bone tumors and 6% of all bone tumors. GCT usually occurs at metaphysis of long bones and distal end radius is 3rd most common site after distal end of femur and proximal end tibia. Various treatment modalities are mentioned in literature from simple curettage to reconstruction or prosthetic replacement of distal radius.

Material and method: A prospective study of 26 patients of GCT of distal end of radius treated by various procedures in our institute and followed upto 24 months to evaluate complications and functional outcome based on The Musculo Skeletal Tumour Society Score.

Results: All patients had been followed strictly so no loss of follow up of a single patient. After 24 months of follow up functional score evaluated as 80% in patients treated as curettage with PMMA augmentation or iliac bone grafting, 73% in treated as resection with fibular autografting or ulnar translocation with osteosynthesis and 60% in those who are undergone as resection and centralization of ulna with osteosynthesis.

Conclusion: A careful clinical and radiological assessment of distal radius GCT and judicious treatment plan is the key for successful outcome in these lesions.

Keywords: Giant cell tumour, Distal end radius, Musculo Skeletal Tumour Society Score, Assessment

INTRODUCTION

Giant cell tumors (GCT) is a benign aggressive tumors of bone with features of local recurrence, potential for metastases and malignant transformation[1] and usually seen at the end of long bone after skeletal maturity.[2] Giant cell tumors accounts for approximately 6% of all bone tumors, 4% of all primary bone tumuors and 20% of benign bone tumors.[3] The distal end of radius is a relatively common site of skeletal neoplasm and is the third most common location(after the distal end of femur and proximal end of tibia) of giant cell tumor. The peak incidence is between 20-45 years of age.[4] 70% of cases of GCT fall in this age group.[5] It is rarely found in less than 10 years of age group. The tumor usually involved the metaphysis and the epiphysis, but is occasionally limited to the metaphysis, and in only 2% of patients is it adjacent to an open growth plate. The tumor occasionally invades the articular space involve ligament and synovial membranes. Extension to an adjacent bone through the joint occurs in 5% of the tumors. Less frequently, GCT occurs in the vertebrae (2-5%) and in the sacrum 10%.[6]

GCT of bone remain a difficult and

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challenging management problem because there are no absolute clinical radiological or histologic parameters that accurately predict the tendency of any single lesion to recur ormetastasise.[7]

Various treatment modalities are advocated in the literature these include:

1. Extended Currettage[8] with or without reconstruction using autogenic/ allogenic bone grafts or polymethylmethacylate.[9,10]
2. Resection and construction with vascularized or non vascularized proximal fibula (fibular head arthroplasty).[11,12]
3. Resection with partial wrist arthrodesis(radio-scapho-lunate arthrodesis) using a strut bone graft.[13]
4. Resection and complete wrist arthrodesis using an intervening strut bone graft.[14-17]
5. Resection and reconstruction techniques includes arthrodesis with different autografts. [11,18-22]

In recurrence or local aggressive cases of GCT as well as in malignant lesions, resection and subsequent reconstruction of the distal radius is indicated.[23-25] Reconstruction of the wrist after exicision of the distal aspect of the radius is a challenge because of the high functional demands on the hand, the young age and relatively long life expectancy of many patient who have a get, the limited surrounding soft tissue ,and the proximity of adjacent nerve and tendons.

We undertook a retrospective study of the surgically treated GCT of distal radius to analyze the treatment protocol, recurrence rate, complication and functional outcome.

MATERIAL AND METHODS

A prospective study of 26 patients of GCT of the distal end of radius, treated from January 2010 to December 2012 in Gandhi Medical College and Hamidia hospital, Bhopal. These included the case treated primarily as well as the case with a recurrence. All the lesions were biopsy proven GCTs. The minimum follow up was 24 months after the surgery.

All patients evaluated preoperatively with plain radiographs, computed tomography (CT) scan and magnetic resonance imaging (MRI) scans of involved wrist and with plain x-rays of chest. Serum calcium, phosphorus and alkaline phosphatase were also determined to rule out hyperparathyroidism.

Radiologically grading of the lesion was done by campanacci grading.[23] Grade I is well defined border of a thin rim of mature bone and bony cortex was intact. Grade II lesion had relatively well defined margin but there was no radio-opaque cortical rim. Grade III lesion with fizzy borders, suggest a rapid and possibly a permeative, growth of the tumour. All patients with grade I tumour are treated with extended curretagge with bone grafting or PMMA to avoid more radical surgeries. Grade III tumours have been uniformly treated by autografts reconstruction in our institute. However the decision type of operative intervention in grade II was based on individual case with one of the important consideration being the subcortical bone stack likely to be available after curettage. Five types of procedure were performed in our institute:

1. Currettage with bone cementing (PMMA).
2. Currettage with autografting (Iliac bone grafting).
3. Resection of tumour and reconstruction with nonvasularized fibular graft with fixation by osteosynthesis.
4. Resection of tumour and reconstruction by centralization of ulna with osteosynthesis.
5. Resection of tumour and reconstruction with ulnar translocation and fixation with osteosynthesis.

At every 3 months, plain radiographs of forearm were repeated to see union, recurrence of tumour or graft related complication. After first year, follow up was at every 4 months till 24 months. A dynamometerwas employed to measure grip strength and compared to opposite normal site. Grip strength was defined good if device

compresses more than 50%, fair if device compresses 33-50% and poor if devices compresses less than 33%. Similarly goniometer was used to measure range of movements and compared to opposite side.

The functional scoring of the outcome was done by using The Musculo Skeletal Tumour Society System.[26] This scoring system measures the function in the upper extremity of assigning points (0-5) under six different heading: pain, function, emotional acceptance , hand positioning, manual dexterity and ability of lifting weight. The functional score was expressed in percentage of the actual points scored out of the total 30.

RESULTS

A total of 26 patients were analyzed, there were 16 males and 10 females with 11 right sided and 15 left sided involvement of distal radius. The age distribution ranged from 14 years (youngest) to 53 years (oldest) with a average age of 27.47 yrs and median of 28 yrs (see Table 2). The commonest presenting symptom was swelling (n=14), followed by swelling and pain (n=11). Pain was the only presenting complaint in one case.

The lesion were graded radiologically as per the campanacci grading system. Only 9 of the lesion was grade I; while 10 were grade II and 7 were grade III.

Grade I lesion (n=9) was treated as:

Curettage and cementing i.e. poly methyl metha acrylate(PMMA) (n=4) and

Curettage and iliac bone grafting (n=5).

Grade II lesion (n=10) were treated as:

En bloc resection with fibular grafting with osteosynthesis (n=5),

En bloc resection with centralization of ulna (n=4) and

En bloc resection with ulnar translocation (n=1).

Grade III lesion (n=7) were treated as:

En bloc resection with fibular grafting with osteosynthesis (n=5),

En bloc resection with centralization of ulna (n=1) and

En bloc resection with ulnar translocation (n=1). (see Table 3)

The patient were followed up clinic-radiologically with the ranging from 18 months to 26 months with an average of 24 months. All patients were regularly kept in follow up so none of them lost follow up.

Complication as a result of the disease or the treatment modality did occur. There were 4 recurrent which were reoperated, one nonunion which was managed by bone grafting at the graft-host bone junction, 2 delayed union cured by 6 weeks above elbow cast, 3 infection which was cured by 6weeks period of antibiotics and one case of instability at wrist presented as a deformity of wrist in our study (see Table 4).The average range of motion were 50 degree forearm supination, 39 degree pronation, 46 degree palmar flexion, 31 degree dorsiflexion with combined movement of 166 degree. The average time of union was 3.25 months was observed in our study.

The functional score in this study ranged between 58-90% with the average being 77%. The patients treated with curettage and bone cementing or bone grafting has the best functional outcome with scores of around 80%. The patients who had undergone en bloc resection with wrist arthrodesis either by fibular graft with osteosynthesis or ulnar translocation with osteosynthesis found well with score around 73%. The lesion treated with en bloc resection and centralization of ulna had the least functional score which was 60%.

DISCUSSION

The ideal treatment for a GCT of distal end radius has been a topic of consternation for hand and wrist over world. Many different modalities of

treatment have been used over the years, each with it's own prospectives and consequences. The radius is the major bone of the forearm. It's distal end is the major participants in the wrist joint whose function is quite essential to sustenance of a normal life style. It's removal from the bone will jeopardize function of the forearm, compromise ROM of wrist and cause instability of the wrist unless a reconstruction be under taken to restore anatomy.

The clinical behavior of GCT is unrelated to histological or radiological grading,[23,27] and thus the decision to either salvage ar excise the tumourous bone is based on ability to achieve stability and function whatever may be the means used.[10]

Most authors agree that the completeness of the curettage and exicision is the single most important factor to prevent recurrence.[8,9,19] A campanacci grade I and II GCT of distal radius is usually treated by curettage and reconstruction with either PMMA or bone graft. The recurrence is easier to be noticed with a cement reconstruction and it also gives immediate structural stability. The exothermic reaction of cementing cures is also supposed to increase the tumoricidal effect.[19] However, there are recent reports throwing light on the cartilaginous degeneration arising there of. There are a lot of studies advocating proximal fibular replacement as the reconstructive option after distal radius exicision. It has been found to have good functional result in the other series literature.[11,28]

Ipsilateral fibular nonvascularised autograft reconstruction of the large defect created after resection of distal radius offers many advantage over procedures. It has low donor site morbidity, if any, with predictable and satisfactory functional results and is relatively free of major complication although minor complication occur frequently.[21,29-36] In order to preserve some wrist motion partial arthrodesis with graft fixation only to the scapho-lunate portion of the carpal row, can be performed. This method provides a stable and pain free wrist sufficient range of motion for daily life activites,[12,17] where fore it is recommended by Muramatsu et al[17] especially for young patients.

Translocation of ulna to the distal radial defect with carpoulnar arthrodesis was performed in 2 patients reported on by Seradge,[15] 6 patients reported on by Bhan and Biyani,[16] 1 patient reported on by Lalla and Bhupathi[37] and 1 patient reported on by Turcotte et al.[38] The distal fusion was carried out to a slot between the scaphoid and lunate, and stabilization was achieved with a long Steinmann pin driver from the 3rd metacarpal and lunate to the medullary cavity of the proximal radius.[15] The patients had good grip strength and forearm rotation without the proximal stump to cause or functional disturbance. Translocation of ulna is another procedure which has been frequently used with good result but may not give cosmetically acceptable results as there is narrowing of wrist and distal forearm giving hourglass appearance to limb.[16,19,39]

Result similar to fibular grafting have been reported with allograft reconstructed by several authors.[40-42] Moreover, lack of availability of allograft and specialized bone bank facilities many prevent its frequent use

We had observed one case of deformity of wrist due to instability of joint in our study which can compare with Aithal et al[32] reported 3 amongst 30 and Maruthainar et al[33] reported 4 amongst 13 in their study. In our series another complication was non union in one of our patient which was treated with bone grafting and delayed union in two patient which also treated as conservative cast for 6 weeks

We also had 15.38 % (n=3) case of superficial infection which was treated with prolonged course of antibiotics and more than Szabo[41] study in which it was (11.8%), alsocan compared with Mankin's and Bianchi's study.[7,42] Overall complication were seen 42.30% in our series.

Table 1
Literature review of case series regarding the management of GCT of distal radius

Author	No.	Type of Procedure	Time for Union (Months)	Complication Rate	Infection	Non Union	Instability	ROM	Results
Salenius et al (30)	6	Resection Arthoplasty	NA	0/6	-	-	-	<20% decrease	All Good
Vander Griend et al (19)	8	Arthoplasty-2 Arthodesis-6	NA	6/8=75%	0	0	1	Not Specified	
Aithal et al (32)	30	Arthoplasty	4-6.5 (5.2)	14/30=46.67				>65% in 7 35-64% in 7 <34% in 3 Fused wrist 3	Good 11 Fair 7 Poor 2 (Excluding Recurrence)
Chadha et al (31)	9	Arthoplasty	6	5/9 =55.56				DF - 40° PF - 30° Su - 45° Pr - 45°	
Szabo et al (41)	9				1 (11%)	0	0	DF - 52° PF - 26° Su - 67° Pr - 80°	
Bianchi et al (43)	12				0	1(8.3%)	7 (58.3%)	DF - 37° PF - 51°	
Kocher et al (40)	24				0	0	0	DF - 21° PF - 36° Su - 58° Pr - 72°	
Harness and Mankin(7)	15				0	2(13.3%)	2 (13.3%)	Not specified	

DF - Dorsiflexion, PF - Palmar flexion, Su - supination, Pr - Pronation

Table 2
Age wise distribution of patients

Age (years)	No. of patients
<10	0
11-20	5
21-30	11
31-40	7
41-50	2
51-60	1

Table 3
Performed procedures with functional outcome

I	Currettage and PMMA augmentation	N=4	80%
II	Curettage and iliac bone grafting	N=5	
III	Resection with fibular autografting with osteosynthesis	N=10	73%
IV	Resection with ulnar translocation with osteosynthesis	N=2	
V	Resection with centralization of ulna with osteosynthesis	N=5	60%

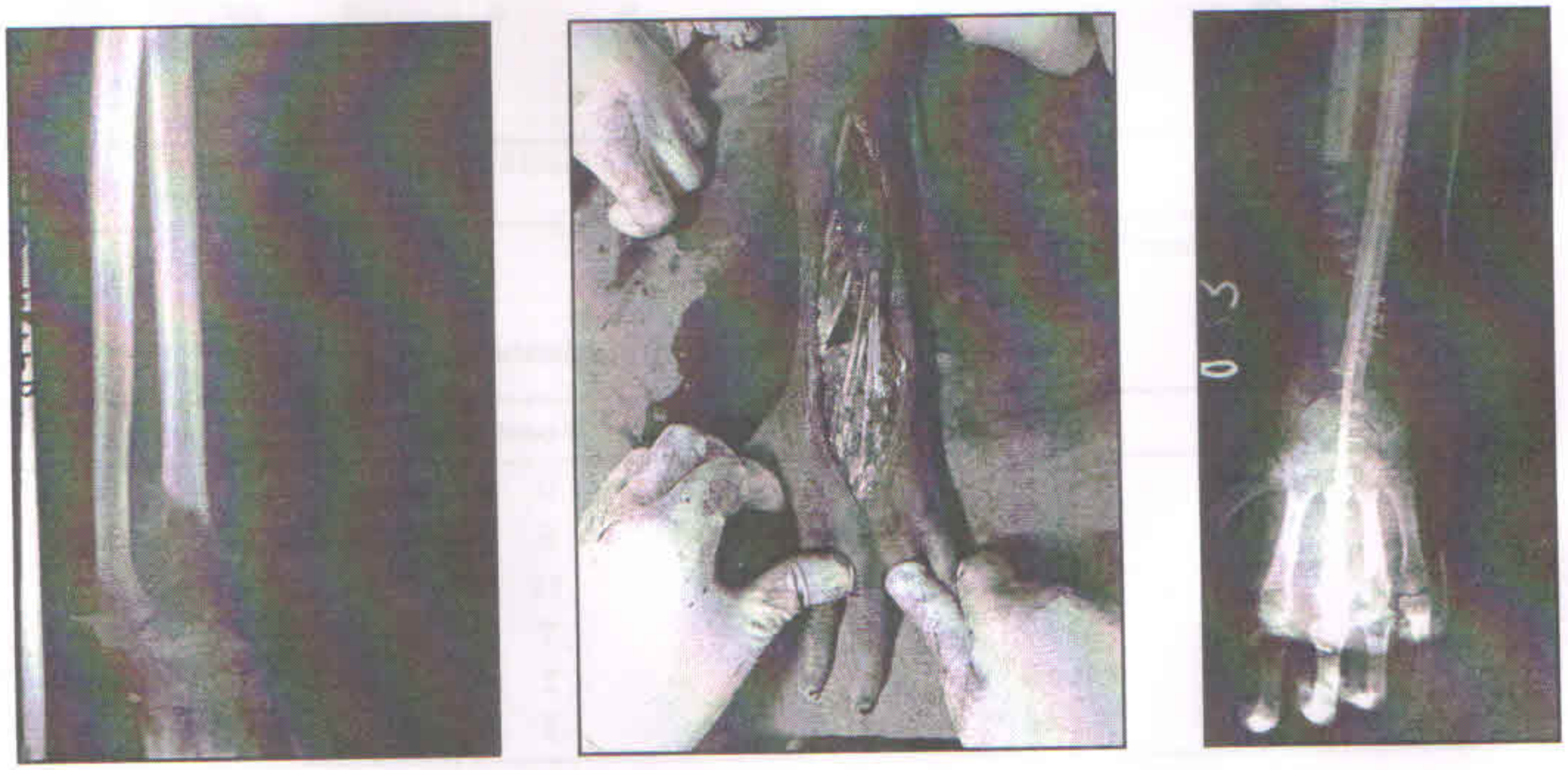
Table 4
Observed complications

Complications	No. of patients (%age)
Recurrence	4 (15.38)
Infection	3 (11.54)
Delayed union	2 (7.7)
Non-union	1 (3.85)
Instability of wrist (Deformity of wrist)	1 (3.85)
Total	**11 (42.30)**

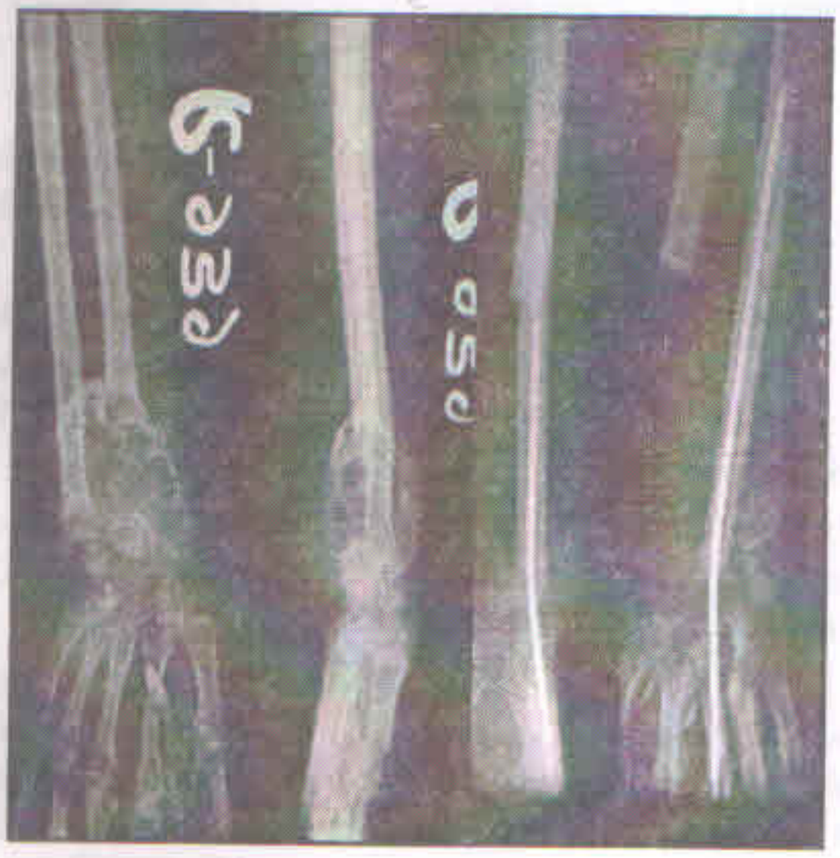
CONCLUSION

The more localized lesion are best treated with curettage. Those with extensive cortical destruction and large soft tissue component usually need en bloc resection. We believe that although results of non vascularised fibular autograft reconstruction of distal radius show substantial loss of subjective results acceptable to most patients and comparable to all other available methods of such reconstruction. Campanacci grade III lesion may be treated with resection and appropriate stabilization if the bone stock permit. A carefull clinical and radiological assessment of distal radius GCT and judicious treatment plan is the key for successful outcome in these lesion.

CASE 1



CASE 2



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A COMPARATIVE STUDY OF FIXATION OF FRACTURE INTERTROCHANTERIC FEMUR WITH D.H.S. BY M.I.S. VERSUS CONVENTIONAL MUSCLE REFLECTION SURGICAL APPROACH

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ABSTRACT

Background: Hip fractures are a common cause of morbidity and mortality and are associated with considerable health expenditure. The dynamic hip screw (DHS) has been the standard type of fixation for intertrochanteric fractures. We have used a prospective study design to ascertain the short/ long-term safety and effectiveness of a standardised DHS device inserted using a minimally invasive technique compared with the same implant inserted in a traditional fashion to manage fracture intertrochanteric femur.

Materials and Methods: In the period June 2011 to June 2012, all patients admitted in orthopaedic ward of Jayarogya Group of Hospitals with fracture intertrochanteric femur needing surgical fixation, were evaluated with inclusion/exclusion criterion.They were assigned randomly in minimally invasive DHS approach or a conventional open/muscle reflection approach group and evaluated for following outcome measures: duration of surgery, intraoperative blood loss, drain use/ output, requirement of blood transfusion intra/postoperatively, analgesic intake, length of hospital stay, rate of infection, time to mobilisation and weight bearing postoperatively & overall functional outcome.

Conclusion: Minimally invasive surgical techniques, as a whole, reduce operative complications and postoperative morbidity. Our study shows that, when compared with the conventional approach in the implantation of the DHS device, the minimally invasive surgical technique described here resulted in shorter duration of surgery and length of hospital stay, as well as less intraoperative blood loss. This is accomplished without compromising the stability of fracture fixation

Keywords: fracture intertrochanteric femur, dynamic hip screw and barrel plate, conventional muscle reflection approach, minimal invasive approach.

INTRODUCTION

Hip fractures are a common cause of morbidity and mortality in the elderly population and are associated with considerable health expenditure in most developing countries.[4] The dynamic hip screw (DHS) has been the standard type of fixation for intertrochanteric fractures.[3,20] In the attempt to find less invasive techniques to simplify surgery and minimise complications by reducing surgical time and blood loss,[1] some authors used custom made implants[11] or new devices which require the purchase of additional armamentarium by the hospital.[5] We have used a prospective study design to ascertain the short/ long-term safety and effectiveness of a standardised DHS device inserted using a minimally invasive technique compared with the same implant inserted in a traditional fashion to

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manage fracture intertrochanteric femur A.O. type 31-A1.1 and 31-A1.2 & 31-A2.1 and 31-A2.2.

We have compared/evaluated a minimally invasive surgical technique to the conventional (open/muscle reflection approach) surgical technique used in fixation of hip fractures with the dynamic hip screw (DHS) device. Using a case-control design with prospective inclusion of patients, we test the null hypothesis that there is no difference between the two techniques in the following outcome measures: duration of surgery, intraoperative blood loss, requirement of blood transfusion intra/ postoperatively, analgesic intake, length of hospital stay, duration of antibiotic intake, rate of infection, time to mobilisation and weight bearing postoperatively & overall functional outcome.

The minimally invasive DHS technique has significantly shorter duration of surgery and length of hospital stay in previous done studies. There is also less blood loss in the minimally invasive DHS technique. The minimally invasive DHS technique produces better outcome measures in the operating time, length of hospital stay, and blood loss compared to the conventional approach while maintaining equal fixation stability.

MATERIAL AND METHODS

The present study is being carried out in the Department of Orthopaedics, G.R. Medical College & Jay Arogya Group of Hospitals, Gwalior, M.P.

The study includes patients with fractures intertrochanteric femur presenting at the Casualty Department of Jay Arogya Group of Hospitals, Gwalior from June 2011 to June 2012.

PATIENTS

In the period June 2011 to June 2012, all patients admitted in orthopaedic ward of Jay Arogya Group Of Hospitals with fracture intertrochanteric femur needing surgical fixation, has been evaluated with inclusion/exclusion criterion. All minimal invasive operations were performed by a single, fully trained orthopaedic surgeon (RKS) with a special interest in the procedure. The patients represented the whole cohort of patients with extracapsular hip fractures operated on by that surgeon in the period of study. Patients who received a conventional DHS were operated on by fully trained orthopaedic surgeons in the same period. The patients werenotpreselected for the procedure and were part of a cohort of patients with extracapsular hip fractures operated on by those surgeons in the period between June 2011 to June 2012. Each patient within the 'minimally invasive DHS' group were matched, according to their sex, age, ASA grade, and fracture type according to the AO classification, to a patient who had their hip fracture fixed with a DHS placed through the conventional muscle reflection approach.

We test the null hypothesis that there is no difference between a minimally invasive DHS approach or a conventional (open/muscle reflection approach) procedure DHS approach in the following outcome measures:duration of surgery, intraoperative blood loss, drain use/output, requirement of blood transfusion intra/ postoperatively, mean difference of pre- and postoperative haemoglobin levels, analgesic intake, length of hospital stay, duration of antibiotic intake, rate of infection, time to mobilisation and weight bearing postoperatively & overall functional outcome.

1. **Inclusion Criterion:**
   1. More than 16 year old, i.e. skeletally mature
   2. A.O. type 31-A1.1, 31-A1.2, 31-A2.1, 31-A2.2
   3. Closed Fractures
   4. Multi-system & Multi-skeletal trauma
   5. ASA Grade 1 & 2.
2. **Exclusion Criterion:**
   1. A.O. types 31-A1.3, 31-A2.3, 31-A3.1, 31A-3.2, & 31A-3.
   2. Pathological fractures
   3. Patient not giving consent for surgery
   4. Patient not medically fit for surgery
   5. ASA Grade 3, 4, & 5.

MINIMALLY INVASIVE SURGICAL TECHNIQUE

All patients in this study had adequate closed reduction (anatomical to 10° of valgus on antero-posterior radiograph nd anatomical on lateral) prior to the start of surgery. The incision is placed under fluoroscopic guidance by identification of the site on the hip that corresponds to the position of the neck of femur. The size of the incision is no longer than 5 cm. The iliotibial band and muscle are split in one incision with the scalpel blade.[1] After the insertion of a guide wire, reaming is carried out through this incision. The standard AO screw and side plates are introduced through the small incision under fluoroscopic guidance. The side plate is then placed over the guide wire as in the conventional technique and then rotated until it lies under the skin and fascia. The side plate screws are placed in the usual manner by retracting the skin and subcutaneous tissue with a right angle retractor. No drain is used, and deep layers and the skin incision closure are performed in the usual fashion. Final fluoroscopy views are taken as in any other conventional side plate fixation technique.

CONVENTIONAL MUSCLE REFLECTION TECHNIQUE

All the operations in a given centre were performed by fully trained orthopaedic surgeons. Through a skin incision 15 cm long, the fascia lata is incised longitudinally. The vastus lateralis muscle is split under direct vision.[12] A dissector is then used to gently sweep the musculature off the intermuscular septum to allow identification and electro-coagulation of the perforators from posterior to anterior. Following fixation of the fracture in the standard fashion, a drain is placed and the incision is closed in layers.

OUTCOME MEASURES AND STATISTICAL ANALYSIS

Demographic data for both case and control groups of patients were collected. Descriptive statistics for ASA grade and type of anaesthesia were determined. Nonparametric outcome measure were compared like length of time from admission to operation, duration of surgery, time to mobilisation and weight bearing postoperatively, and length of hospital stay. In both groups, bleeding was measured by the summation of the blood collected from a plastic bag taped to the surgical drapes, below the operative field, and from the weighed swabs. Herris hip score was used as outcome measure evaluation.

The location of the tip of the DHS screw in the femoral head was recorded as defined previously.[12] The tip-apex distance[2] was also measured. Antero-posterior and lateral postoperative radiographs were viewed to obtain these two measurements. The mean difference of pre- and postoperative Hb levels and the tip-apex distance was compared using the independent two-tailed t test (95% confidence interval for difference between The fluoroscopic images for both groups of patients were assessed as an means) for parametric data.

RESULTS

PATIENTS

Forty-four patients constituted the minimally invasive DHS group. They were matched with 44 patients in the conventional DHS groups according to the matching criteria described above (Table 1).

Table 1
Demographic data for the minimally invasive DHS and conventional DHS groups

	MIS Group	Conventional Group
Mean Age	69.5+/-9.7	70.5+/-0.1
Range	59-97	60-94
Gender		
Male	10 (23%)	10 (23%)
Female	34 (77%)	34 (77%)
Source of Admission		
Trauma Centre	36 (82%)	23 (62%)
OPD	8 (18%)	21 (41%)

Patients received routine antibiotic prophylaxis with 1.5g of cefuroxime given intravenously on induction of anaesthesia.

In the 24 patients in the conventional DHS group who had drains inserted after surgery, these were removed 24-48 hours after surgery. Drains were not used in the minimally invasive DHS group. All the patients in both cohorts had the same postoperative rehabilitative regime, starting mobilisation and weight bearing within 24 hours of surgery unless specified otherwise by the surgeon. The difference of the median duration of surgery and median length of hospital stay were statistically significant between the two groups of patients. These outcome measures were more favourable in the minimally invasive group than the conventional DHS group. The mean difference of preoperative and postoperative Hb levels was lower in the minimally DHS group when compared to the conventional DHS group, but this was found to be not significant statistically. The mean tip-apex distance in both groups of patients was similar. One patient in the minimally invasive DHS group and two patients in the conventional DHS group had tip-apex distances of more than 27 mm. Table 2 shows the summary of statistical data from the outcome measures outlined above and the amount of postoperative analgesia used.

Table 2
Statistical data from outcome measures

	MIS Group		Conventional Group	
	Median	**Mean**	**Median**	**Mean**
Interval between admission to surgery (Days)	1	1.4+/-1.5	1	3.2=/-2.2
Duration of surgery (Min)	42	30+/-10.6	60	53.5+/-17.7
Time from surgery to mobilisation (Days)	1	1.3+/-0.4	1	2.4+/-2
Time from surgery to weight bearing	2	2.2+/-1.4	2	2.4+/-2

The distribution of the location of the tip of the screw in the femoral head was similar in both groups (Table 3).

Table 3
Position of DHS screw in the femoral head

	Anterior	**Central**	**Posterior**	**Total**
MIS Group				
Superior	5	27	2	34
Middle	5	5	0	10
Inferior	0	0	0	0
Total	**10**	**32**	**2**	**44**
Conventional Group				
Superior	10	27	2	30
Middle	0	2	3	5
Inferior	0	0	0	0
Total	**10**	**29**	**5**	**44**

COMPLICATIONS

Five patients from the conventional DHS group required transfusion of two units of blood each due to perioperative blood loss. A transfusion threshold of 9 g/dL of haemoglobin was used as an indication for transfusion. Two patients from the minimally invasive DHS group had dehiscence of the wound site. This was managed by dressing of the wound, which healed uneventfully. In the conventional DHS group, four patients developed infection of the surgical wound which required treatment with systemic antibiotics and wound dressing.

In one patient in the minimally invasive DHS group, a two-hole side plate pulled out of the femoral shaft five weeks after the index operation. It was replaced with a four-hole side plate extending the original wound to a length of 6 cm, with no adverse effect.

DISCUSSION

In this study, 94% (83/88 patients) of the

fractures in both the minimally invasive and conventional DHS surgery groups healed without any complication. In this respect, both techniques of fixation of hip fractures worked well. There was no difference in the following outcome measures when the two groups of patients were compared: time from surgery to mobilisation and weight bearing postoperatively, position of the lag screw of the DHS device in the femoral head and the tip-apex distance. On the other hand, there were significant differences in the duration of surgery and length of hospital stay between the two cohorts of patients. Although the mean differences of pre- and postoperative haemoglobin levels between the two groups were not significant statistically, clinically this may have great significance, as five patients in the conventional DHS group required blood transfusion postoperatively while none of the patients in the minimally invasive DHS group required any blood transfusion. The minimally invasive DHS requires less operating time, reduces the amount of intraoperative blood loss, and allows patients to be discharged earlier. This may carry benefit to the patients, and has significant financial implications to the patient as well as to hospital.[7,9,10,14,18,19,21]

The percutaneous compression plate (PCCP) is a new implant for the minimally invasive treatment of pertrochanteric hip fractures.[5] The PCCP seems to be similar to the DHS in relation to bone and stability, but has significant advantages for blood loss, soft tissue healing, and operation time.[5] While the results were promising, the economic and logistical disadvantage caused by the need to increase hospital inventory and the learning curve involved in familiarising oneself with the new equipment offsets its perceived advantage. On the other hand, the minimally invasive DHS technique uses the existing instruments with which the operating team is familiar and confident, with no need to purchase new instruments. This and other studies[1-8] have shown that the same advantages can be gained by modifying the surgical approach while using existing fixation devices, thus requiring neither a new plating system nor training of operating theatre staff to familiarise with them.

The type of DHS device used in both the minimally invasive surgical and conventional approaches were mainly four-hole side plates, but the choice of the length of the side plate was left to the individual surgeons. Biomechanical studies demonstrated equivalent peak load to failure results when comparing the two- and four-hole DHS plates.[15] In recent studies,[13,22] stable pertrochanteric fractures (AO classification 31-A1 and 31-A2) had successful fixation with two-hole DHS. It is possible that the widespread use of four-hole side plate DHS in stable pertrochanteric fractures is merely based on tradition, and needs reconsideration in this era of evidence-based medicine. Therefore, using the two-hole DHS may be at least as safe as the four-hole DHS, as the surgical exposure required will be smaller. It may be economical financially and in the use of operating time. In osteporotic bone, though, it may be safer to use longer side plates.

Recent studies using robust research methodology have ascertained the safety of limited access hip fracture surgery, and have demonstrated that it is associated with decreased bleeding and postoperative pain, reduced postoperative morbidity, and faster recovery of function.[17] Our results confirm these findings.

CONCLUSIONS

Minimally invasive surgical techniques, as a whole, reduce operative complications and postoperative morbidity.[5] Our study shows that, when compared with the conventional approach in the implantation of the DHS device, the minimally invasive surgical technique described here resulted in shorter duration of surgery and length of hospital stay, as well as less intraoperative blood loss. This is accomplished without compromising the stability of fracture fixation.

STRENGTHS AND LIMITATIONS

There are limitations to this study. For example, this is a case control study; therefore,

several variables could not be accounted for and may produce differences in outcome. This is true, for example, for the choice of anaesthesia. In the minimally invasive DHS group, few patients received general anaesthesia. However, as spinal and epidural anaesthesia produce less blood loss than general anaesthesia,[16] the differences found in this investigation are even more remarkable.

This is a short term investigation. But the same study is still very much on to see the long term outcome of the same and we are confident that we are unlikely to have produced adverse effects on our patients undergoing minimally invasive DHS fixation

IMPLICATIONS FOR FUTURE RESEARCH

If this investigation is being performed even at larger scale and more importantly, involving long term follow up and outcome, it can radically change the standard approach as well as traditional way to treat fracture intertrochanteric femur , once results of the same come affirmative.

PREVIOUS LITERATURE

The results of this study are comparable with the results of a randomised controlled trial[1] where a prospective, surgeon-randomised, blinded-outcome clinical study comparing the use of the standard DHS device in a minimally invasive and conventional surgical approach was carried out. The minimally invasive technique group of patients had significantly less blood loss and shorter operating time

There have been some other studies at different parts of world on the same topic as being cited in references[23,24] and almost all suggest similar outcome/conclusion as of this study.

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OPEN REDUCTION & INTERAL FIXATION OF INTRA ARTICULAR TYPE OF FRACTURE CALCANEUM WITH LOCKING CALCANEUM PLATE- A PROSPECTIVE STUDY

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ABSTRACT

Introduction: Displaced intra articular calcaneal fracture are associated with severe disability and it is recommended that open reduction and fixation should be done to restore anatomy of subtalar joint. The intent of our study is to evaluate outcome of open reduction and fixation with locking plates in terms of foot and ankle function and complications

Materials and Methods: 25 patients with 30 fracture calcaneum (less than 3 weeks old) aged less than 50 years were included and classified according to sanders classification. Radiographs were taken to evaluate the Bohlers angle and Gissanes angle. Open reduction and internal fixation was done with locking calcaneum plateusing a lateral approach. Outcome was evaluated using Maryland foot Score.

Results : Mean age in this study was 34.2 years (22-48 years). Sanders type III was commonest in our study (46.6%). Mean preoperative Bohlers angle was 15.16°±5.58°. Postoperative Bohlers angle was 29.5°±4.07. Mean Pre opearative Gissanes angle was 16°±7.95. Mean Post opearative Gissanes angle was 123°±11.75. Average Maryland foot score was 79.7 (Good). Complications were seen in 6 patients

Conclusion: Open reduction and internal fixation of displaced intraarticular fractures of calcaneum is an excellent method with minimal complications and good to excellent results

INTRODUCTION

Calcaneal fracture or Os calcis fracture is a complex injury that presents 1-2 % of all fractures. 10% of these are bilateral and another 10% are associated with fracture of spine. 70% of all calcaneal fractures are intra-articular.[1] Most of these fractures involve young working males, subsequently the economic impact of these fractures is significant.[2] It may seem like one of the densest bones in our body but the bone is actually hard on the outside and soft from inside because of sparse trabeculae. This makes it prone to impaction of articular surface, fragmentation and collapse on a high-velocity impact to the heel mostly during fall from height.

Despite extensive attempts during past century to improve functional out-come of a displaced intra-articular calcaneal fractures, the choice of method for treatment remain debatable. While some authors suggest that the best results are obtained by surgical methods (open reduction and internal fixation, subtalar arthrodesis or percutaneous screw fixation), others advocate a conservative treatment method.[3,4-8]

In recent years open reduction and rigid fixation is increasing in popularity as there is better understanding of fracture patterns with computed tomography (CT) scans, availability of good quality

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implants and refinement of surgical techniques that have led to fewer complication rates there by allowing early movement and weight bearing.

The purpose of our study was to assess the result of open reduction and internal fixation of fracture calcaneum of intra articular variety with locking plates, in terms of foot and ankle function and complications.

MATERIALS AND METHODS

This was a prospective interventional study.

25 fresh cases of closed fracture calcaneum (less than 3 weeks old) aged 18-50 years attending to Orthopaedics Emergency and the Out Patient Department of our institute during june 2011 and august 2014 were included in this study. Only intra-articular variety of Type 2, 3 & 4 (Sander's classification) were included.

After admission initially the injured limbs were placed in a posterior slab and elevated to reduce the swelling with NSAID. Pre-operative evaluation was done clinically and radiologically. X-ray calcaneum antero posterior, lateral view and Harris-heel axial view were done along with a CT-scan calcaneum in sagittal and axial plane to assess and classify the fracture according to Sander's classification.

All the fractures were operated on a radiolucent table in the lateral decubitis position so that the fractured extremity faced upwards. Spinal anaesthesia was used. All fractures were treated with a lateral approach, advocated by Sander 3 using Benirsche and Sangeorzan[9] (L shaped) incision. Surgery was delayed by an average of 7.1±4.5 days (range, 3-20 days) to resolve the soft tissue swelling and after appearance of wrinkle. Wrinkle test (Figure 1) according to Sander, is a good indication that swelling has subsided. This is performed by maximally planter flexing the ankle. Skin wrinkles are present when ankle is brought back to neutral position indicates edema has subsided

A large L shaped surgical incision was made deep down to the bone in order to make a subcutaneous flap. The flap was developed anteriorly to expose the posterior subtalar joint. The flap was elevated, along with the sural nerve and peroneal tendons. K wires were then inserted in to the lateral malleolus, neck of talus and cuboid, and then bent to hold the flap. The fractured lateral wall (whenever present) of the calcaneum was gently opened, leaving the fracture fragments within their periosteal envelope. The depressed facet was elevated. The articular surface was reduced, lateral wall reposited, and fixation was made using temporary Kirschner wires (Figure 2). Then an appropriate Calcaneal plate was contoured and positioned at the appropriate location on the lateral calcaneal wall. (Figure 3) K wires for soft tissue retraction and temporary fixation was removed . After putting drain, flap was closed meticulously with monofilament suture using Allgower-Donati technique.

Figure 1 :

Figure 2 :

Figure 3 :

Postoperatively all patients received antibiotic prophylaxis for one week. Drain removal was done at 48 hours. All patients irrespective of fracture pattern were immobilized in below knee slab. Suture and slab removal was done at 3 weeks. Active range of motion exercises of ankle and subtalar joint were started. Partial weight bearing was started at 8-10 weeks post operatively depending on radiological progress of union and gradually increased to full weight bearing.

Patients were followed up in orthopedic OPD at 6 weeks, 12 weeks, monthly till 6 months and once in a 3 month till 1 year. Each patient was evaluated on each visit radiologically and clinically using Maryland foot score.

RESULTS

25 patients with 30 closed fractures of calcaneum were studied. Majority of the patients were between the ages of 21-40 years group (80%) with the mean age being 34.2 years. The ratio of male: female in this series was 11.5:1.22 patients (88%) sustained injury due to fall from height. Right calcaneus was involved in 12 cases (48%) with 5 patients having bilateral fracture (20%). Mean delay in the surgery was 7.1 days. Sanders type 3 was commonest in our study (46.6%-14 cases) followed by type II (33.3%-10 cases) and type IV (20%-6 cases). Mean follow up duration was found to be 13.4±1.35 months. Maximum period of follow up was 16 months while minimum was 12 months.

The change in Bohler's angle, Gissane's angle, Height and Width of calcaneum pre and post operatively along with the Maryland foot score is shown in Table 1 according to fracture type.

Table 1
Results

Fracture type	Samples	Bohlers angle		Gissanes angle		Height of calcaneum		Width of calcaneum		Maryland foot score			
		Pre operative	Post operative	Pre operative	Post operative	Pre operative	Post operative	Pre operative	Post operative	Grade	Number	Overall Score	Overall Grade
Type 2	10	18± 2.58	31± 3.8	154± 4.47	110± 6.67	3.8± 0.06	4.4± 0.1	4.1± 0.05	3.5± 0.08	E G F P	6 3 1 0	87.9 ±9	Good
Type 3	14	17± 3.58	30± 4	162± 6.18	126± 4.72	3.5± 0.11	4.1± 0.09	4.3± 0.08	3.8± 0.05	E G F P	0 10 3 1	79.5± 10.6	Good
Type 4	6	6± 2.89	26± 2.89	170± 5.76	138± 5.54	3.1± 0.14	3.7± 0.15	4.5± 0.05	4± 0.06	E G F P	0 1 4 1	66.5± 11.3	Fair
Overall		15.16± 5.58	29.5± 4.07	160.9± 7.95	123± 11.75	3.58± 0.3	4.17± 0.27	4.3± 0.17	3.7± 0.18			79.7± 12.5	Good

E - Excellent, G - Good, F - Fair, P - Poor

In the patients treated by open reduction & internal fixation, pre and post-operative comparative values for Bohler's angle, Gissane's angle, height and width shows the change is significant as p-value in each case is < 0.0001.

Average Maryland foot score was 79.7±12.5 (Good). Excellent results are seen in 20% cases (six) all of them being type 2 fractures.

On suture removal almost all patients of open reduction and internal fixation had healthy skin condition, except for 4 cases (86.67%) that showed edge necrosis although, wound healed after serial dressings.

2 patients suffered loss of reduction during follow up. We had 2 incidence of subatalar arthritis both being type 4 fractures that required subtalar arthritis.

DISCUSSION

In our study the calcaneal fractures were found most common in active young men more than 80% in the age group 21-40 years. This incidence is supported by other authors,[8,9,10] however it was contrary to some authors,[3,12] and may be explained by the fact that in our country the males are more indulged in outdoor activities, working on heights and thus more exposed to trauma.

In this present series the calcaneal fracture were found to be most common in laborers (24%), next common were mechanics (16%), followed by servicemen and farmers (12%). This shows considerable economic importance of calcaneal fractures in industrial workers, as observed by other authors also.[3,9]

In our study, mean delay in the surgery was 7.1 days. In the series of Christoph W. Geel and Flemister[13] surgery was delayed by an average of 12 days (range, 1-20 days) to allow for resolution of soft tissue swelling.

We used an L-shaped, sharp angulated extensile lateral approach as mentioned by many authors.[3,9,12,14] Proposed benefits of this modified lateral approach included better visualization of fracture fragments, protection of sural nerve, and less irritation to the peroneal tendons.[13,14]

There were 4 cases with edge necrosis which healed after few dressing immobilization and elevation.

Bohler's angle and Gissane angle as measured on plain radiographs have been used by most surgeons as the indication that satisfactory results have been obtained by either open or closed methods. Paul M, Peter R and Hoffmeyer P[15] reviewed 70 patients with a calcaneal fracture and suggested the prognostic relevance of Bohler's angle. Brudeaux B.D. (1983)[16] stressed to restore the heel width a deformity equal in significance to the loss of Bohler's angle, which produces morbidity.

In our series we emphasized on restoration of not only subtalar joint but realignment of overall shape of the calcaneum in terms of Bohler's angle, Gissane angle, height and width of calcaneum. We were able to achieve a mean Bohler's angle of 29.5° (±4.07) from 15.16° (±5.58), mean Gissane's angle of 123° (±11.75) from 160.9° (±7.95), mean height of 4.17 (±0.27) cms from 3.58 (±0.3) cms &

Table 2
Post-operative movements (in degrees)

Fracture type (Sander's classification)	No. of fractures	Plantar flexion (Mean)	Dorsiflexion (Mean)	Inversion (Mean)	Eversion (Mean)
Type 2	10	40.6±6.93	17.6±5	30±7.5	14.8±3.4
Type 3	14	31.86±5.5	11.57±3.29	21.85±5.6	11.28±2.7
Type 4	6	23.75±5.9	7.16±3	15.33±5.7	6.66±2.58
Overall	30	33.27±8.4	12.7±5.4	23.26±8.19	11.53±4

CASE 1

Figure 4 : Pre-operative radiograph

Figure 5 : Post-operative radiograph (Lateral view)

Figure 6 : X ray axial view at the end of 1 year

Figure 7 : X ray (Lateral view) at the end of 1 year

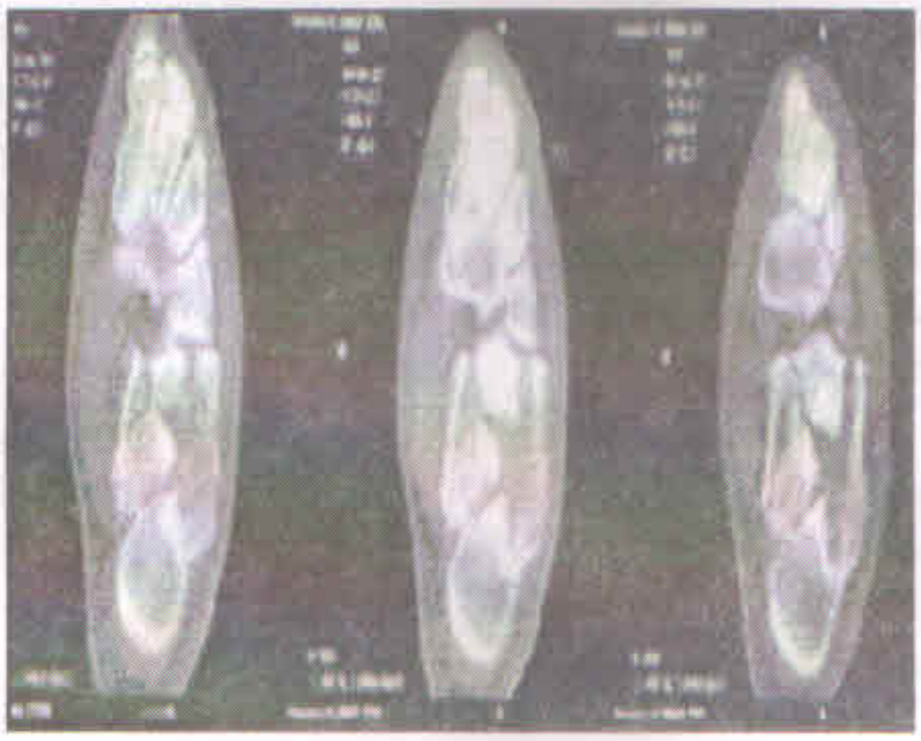

Figure 8 : Pre-operative CT Scan

Figure 9 : Post-operative radiograph (Axial view)

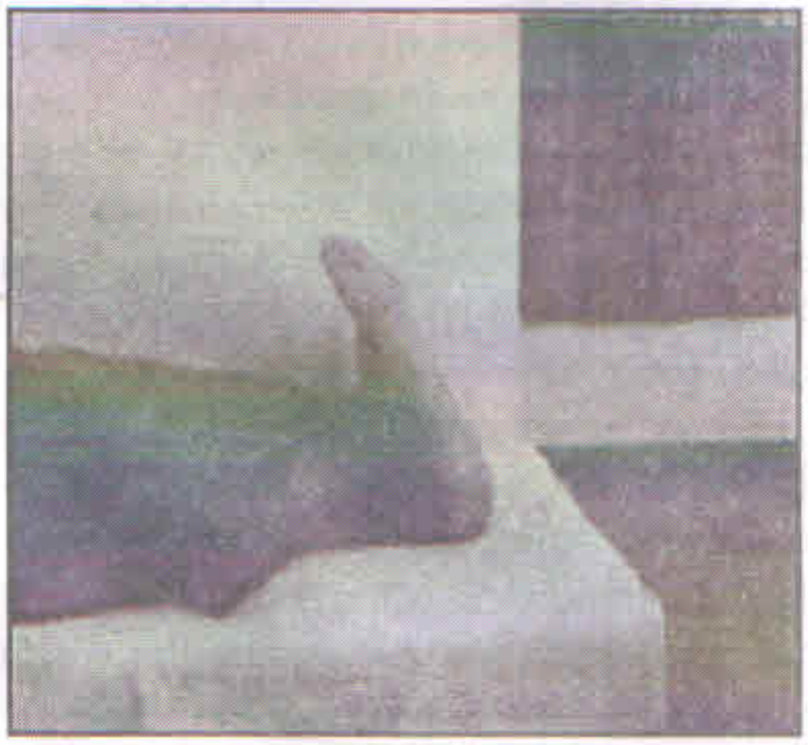

Figure 10 : Dorsiflexion at the end of 1 year

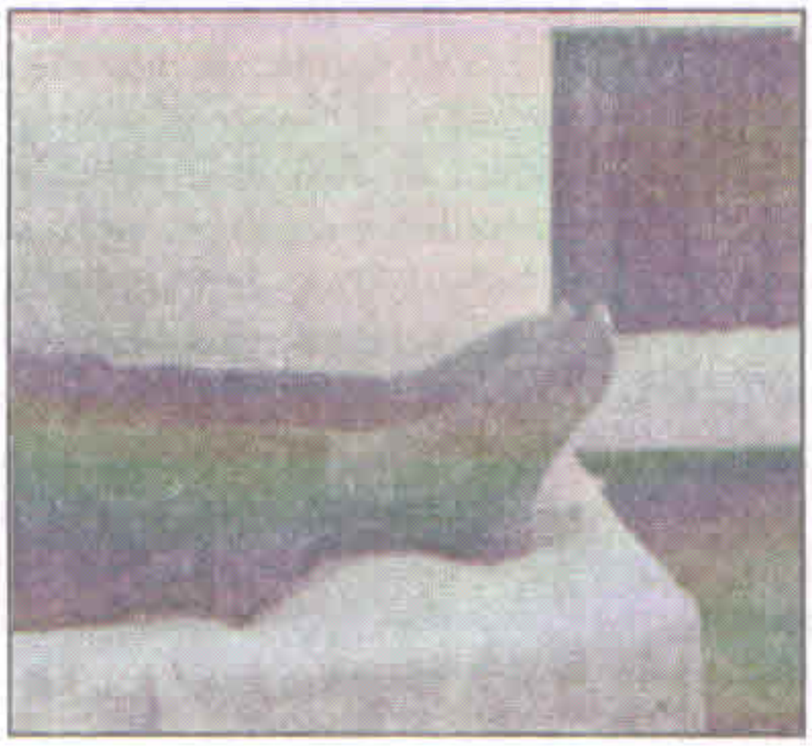

Figure 11 : Plaster flexion at the end of 1 year

mean width of 3.7 (±0.18) cms from 4.3 (±0.17) cms by open reduction and internal fixation method.Soeur and Remy using lateral approach reported an average postoperative Bohler's angle of 24°.

Although we had some restriction of movement but most patients of type 2 and 3 had returned to their pre injury activities having Maryland score of good to excellent.

Movement restriction in type 4 fracture was significant. 2 of our patients one each of type 3 and 4 fractures had persistent pain due to subtalar arthritis and required subtalar arthrodesis. The mean Maryland foot score in type 4 fracture was fair (66.5) with one patient having poor outcome. So we conclude that it is difficult to obtain a good outcome in patients having type 4 calcaneal fractures even with open reduction and internal fractures.

The open reduction with internal fixation group showed considerably lower complication rate (80% i.e. 24 cases had no complications). 4 cases (6.6%) had skin complications which healed after few dressings and immobilization and of these 1 developed subtalar arthritis later requiring subtalar arthritis. 2 other patients had loss of reduction during follow up also requiring subtalar arthritis. It was contrary to previous report that showed higher complication rate following surgery. The rate of wound complications in our study after open reduction and internal fixation was 13% which was lesser than that in many studies in the literature. Stephenson16 reported a 27% rate of wound edge necrosis while Sanders et al 3 in a series of 120 surgically managed patients reported eight wound dehiscence, three below knee amputations, and five mayocutaneous free flaps to cover wounds. This reduction in such complications in our series was possibly attributed to our method in which thick flap of skin, subcutaneous tissue and fat was raised from the bone and minimum damage was produced by keeping the flap retracted with the help of 3 k-wires.

The use of bone graft is still controversial. Palmer and Leung et al 17 believed that bone grafting was necessary to prevent subtalar joint collapse. On the other hand, Stephenson 18 and Sanders et al3 did not use bone graft in their cases and found only one case of late collapse, and suggested bone graft unnecessary. In our series we did not used any bone graft, the bone healed well and there were 2 cases of subtalar joint late collapse noted. One was a 30 year old male patient with type 3 fracture who was non-compliant and started weight bearing at 5 weeks. Other was a 48 year old female with type 4 fracture. Late collapse in her even with non-weight bearing for 8 weeks could possibly be attributed to osteoporosis and type of fracture. We agreed with Stephenson 18 and Sanders et al 3 that bone grafting is not necessary in open reduction for calcaneal fractures. We must emphasize here that it is critical to keep the patients in strict non weight bearing for at least 8 weeks and in case of osteoporotic patients for a longer duration if necessary to prevent any possible loss of joint reduction, as also suggested by others.[19]

We observed that the realignment of Bohler's angle, Gissane's angle, height and width of calcaneum results in pain free and mobile heel especially in type 2 and 3 fracures.

CONCLUSION

Considering the complex anatomy of calcaneum and the way calcaneal fractures are being treated at various centers, our conclusion is that intra-articular fractures of calcaneum should be approached in more practical and scientific manner so that normal anatomy of the subtalar joint and overall shape of the calcaneum can be restored with early range of motion. So in our experience, Open reduction and internal fixation of displaced intra articular fractures of calcaneum using a lateral approach, with meticulous dissection of soft tissue and careful positioning of a plate, even without the need of bone graft by experienced hands, is an excellent method with minimal complications and maximum excellent to good results in type 2 and 3 fractures but fair to poor results in type 4 intraarticular fractures.

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OUTCOME ANALYSIS OF TIBIAL PLATEAU FRACTURES FIXED BY SINGLE LATERAL PERIARTICULAR LOCKING PLATE

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ABSTRACT

Introduction: Tibial plateau fractures comprises of 1% of all fractures and 8% of fractures in the elderly.The severity of injury increases classified by schatzker classification. Intraarticular tibial bicondylar fractures are notoriously difficult to treat. Nowadays locking plate technology has allowed for a new approach to this difficult fracture.

Material and methods: This was a prospective study of 47 patients with tibial plateau fractures fixed with single lateral periarticular locking plate over lateral surface of tibia and followed upto 1year and evaluated by using Rasmussen knee score system.

Results: All patients were followed properly but three patients were lost to follow up so only remaining 44 patients were evaluated.at 1 year of follow up functional outcome was assessed and observed that 79.54% of patients had good to excellent results while 20.45% patients had fair results.

Conclusions: Tibial plateau articular fractures demands anatomical reduction and absolute stability to enhance the healing of articular fragments and make early motion possible .Periarticular locking plates combined with biological techniques have improved outcome with respect to union rate and decrease soft tissue complications.

Key words: Tibial plateau fractures, Schatzker classification ,Locking compression plate, Rasmussen knee score

INTRODUCTION

Tibial plateau fractures comprises of 1% of all fractures and 8% of fractures in the elderly.[1] Anotomically medial plateau is cancave and larger while lateral plateau is convex and smaller. The majority of tibial plateau fractures are secondary to high speed velocity accidents and fall from heights where fractures results from direct axial compression,usually with a valgus or varus moment and indirect shear forces. The severity of injury increases classified by schatzker classification.[2] Complex fractures include significant articular communition and depression, condylar displacement, metaphysical fracture extension, and open or closed soft tissue injuries.[3] Intra - articular tibialbicondylar fractures are notoriously difficult to treat[2,4] and functional outcome have decreased inspiteof experience surgeon.[5] Goal of treatment are restoration of joint surface, normal limb alignment, stable knee and good range of motion with preservation of surrounding soft tissue blood supply. Closed management of comminuted displaced fragments has proved ineffective, hence usually not recommended.[6] Open reduction of fracture fragments allow a good control of articular surface and correction of mechanical axis.

Recent advancement in angle-stable locking plate technology has allowed for a new approach to these difficult fractures to achieve goal.[7-11]

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Locking plates may decrease the need for dual plating in certain bicondylar fractures of tibia. Lateral LCP fixation in bicondylar fractures might be a stable, enough fixation when medial condyle is not displaced or comminuted.

The purpose of this study was to asses the results of single periarticular locking plate fixation in management of tibial plateau fractures.

MATERIAL AND METHODS

This was a prospective study of 47 patients with tibial plateau fractures at Gandhi Medical College and Hamidia Hospital, Bhopal over a period of 1 year from july 2013 to june 2014. Antero-posterior and lateral radiographs of knee with legs were taken to determine the fracture configuration of every patient of knee injury who participated in study. Fracture was classified by schatzker classification and for pre-operative planning.[2] Computed tomography (CT) scan done in cases where more detailed fracture configuration was needed.[12] The patients were stabilized and local soft tissue condition assessed pre-operatively, surgery was delayed till the skin regained wrinkle sign in some cases of severe trauma.[13] Minimally invasive plate osteosynthesis (MIPO) was used wherever the fracture fragments reduction seems to be acceptable along with good soft tissue condition.[14]

Inclusion criteria:

1. Age between 20-70 years.
2. Isolated closed tibial plateau fracture.
3. Comp. grade I (Gustillo-Anderson classification) fracture.[16]

Exclusion criteria:

1. Age < 20 and > 70 years.
2. Polytrauma patient.
3. Comp. grade II & III (Gustillo-Anderson classification) fractures.
4. Fracture-dislocation of knee injury.
5. Pathological fracture of tibial plateau.
6. H/O previous osteotomy or fracture over same region.
7. Systemically ill patient.

All surgeries performed under spinal anesthesia under fluoroscopy control. Intrvenous antibiotic protocol was 3rd generation cephalosporin 1 hr before to surgery and upto 7 days followed by oral abtibioticupto suture removal. Post operative xrays was done and assessed for malreduction. Malreduction was defined as an intrarticularstepoff up to 2 mm or greater or a malalignment in the frontal and sagittal plane of greater than 5 degree. Intermittent passive knee mobilization was started 2nd postoperative day followed by active knee mobilization after suture removal which usually take 10-12 days from surgery. Above knee POP slab given upto 3 weeks. Non weight bearing crutch walk allowed after 3 weeks and progressive weight bearing was allowed according to the callus formation assessed on further followup radiographs which usually take 6-8 weeks. Full weight bearing (FWB) was allowed only after clinicoradiological appearance of union which usually take 12-16 weeks. Further followup done upto one year to see results. Union was defined bridging of 3 of the 4 cortices and disappearance of the fracture line on xrays for a patient who was able to FWB. Delayed union was defined if fracture in process of union but not united upto 6 months. If fracture did not heal within a year defined as a nonunion. Follow up done on 8, 12, 16 weeks then every 2 months upto one year, complication were observed in every visit of patient. Final functional outcome was evaluated by using the Rasmussen knee score[16] at one year of followup.

RESULT

There were 47 patients with tibial plateau fractures treated with periartcular locking plate system. Two patients were lost to follow up before one year and one patient died due to unrelated cause therefore 44 patients made the report of this study with a mean age of 40.9 years. The mean follow up was 9 months (range 6-12 months). 40 patients had history of RTA and 7 had domestic fall. There were 9 open fractures all of which were Gustillo Andrson grade I type, rest 38 patients were closed fractures. All fractures were classified according to the schatzker classification. 35

patients were treated with ORIF and 12 patients were by MIPO technique. Bone grafting was not performed in any case. Out of 47 patients 38 were male and 7 were female, age wise maximum number of patients were belonged to 41-50 years that was 12 patients (see Figure 1).

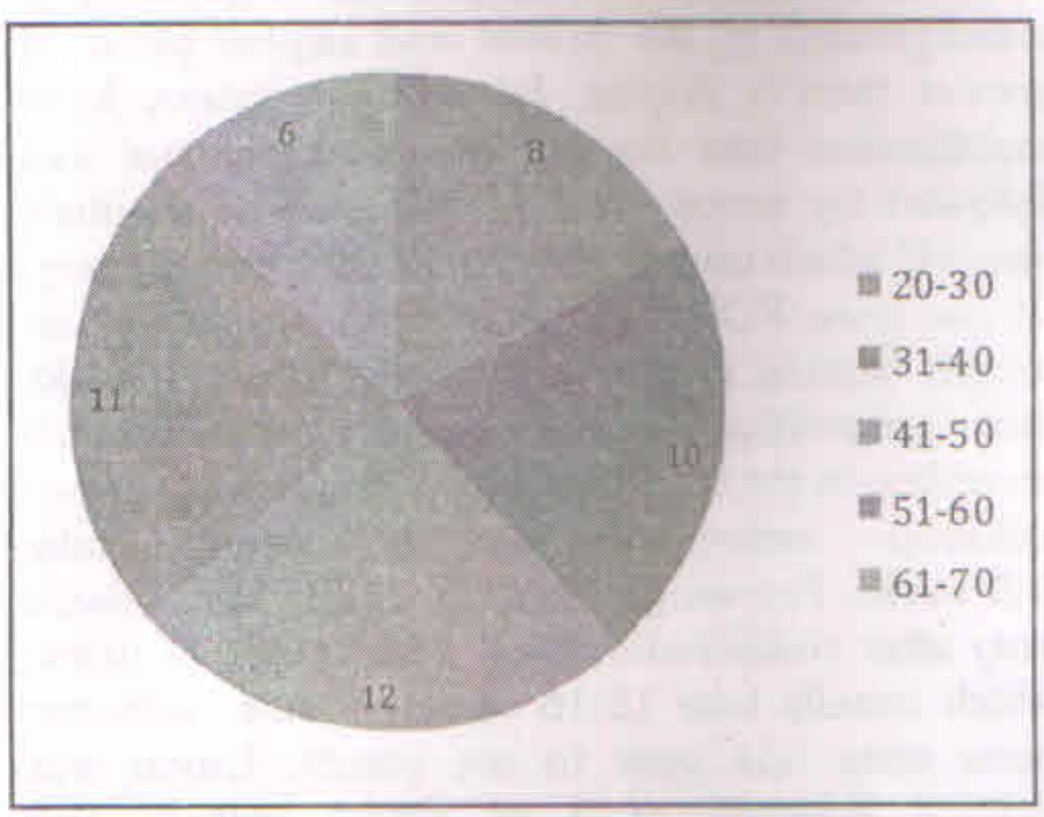

Figure 1 : Age wise distribution of patients

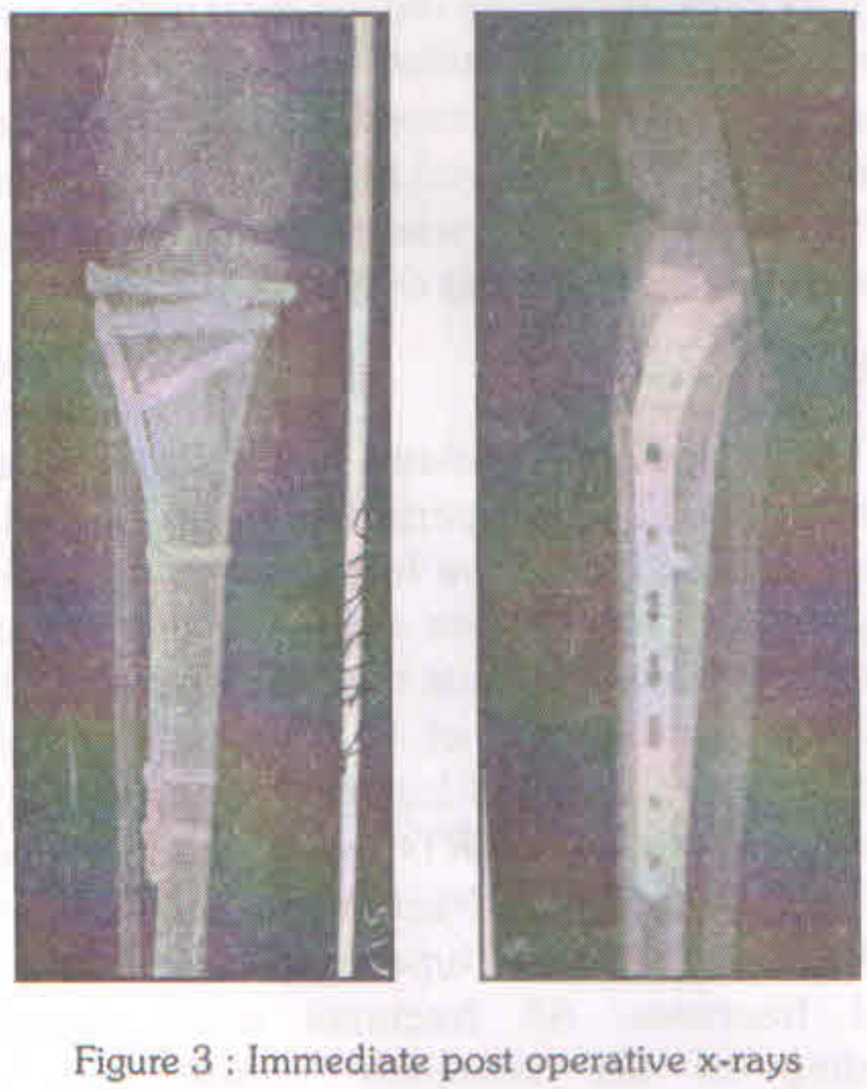

Figure 3 : Immediate post operative x-rays

Figure 2 : Pre operative X-rays

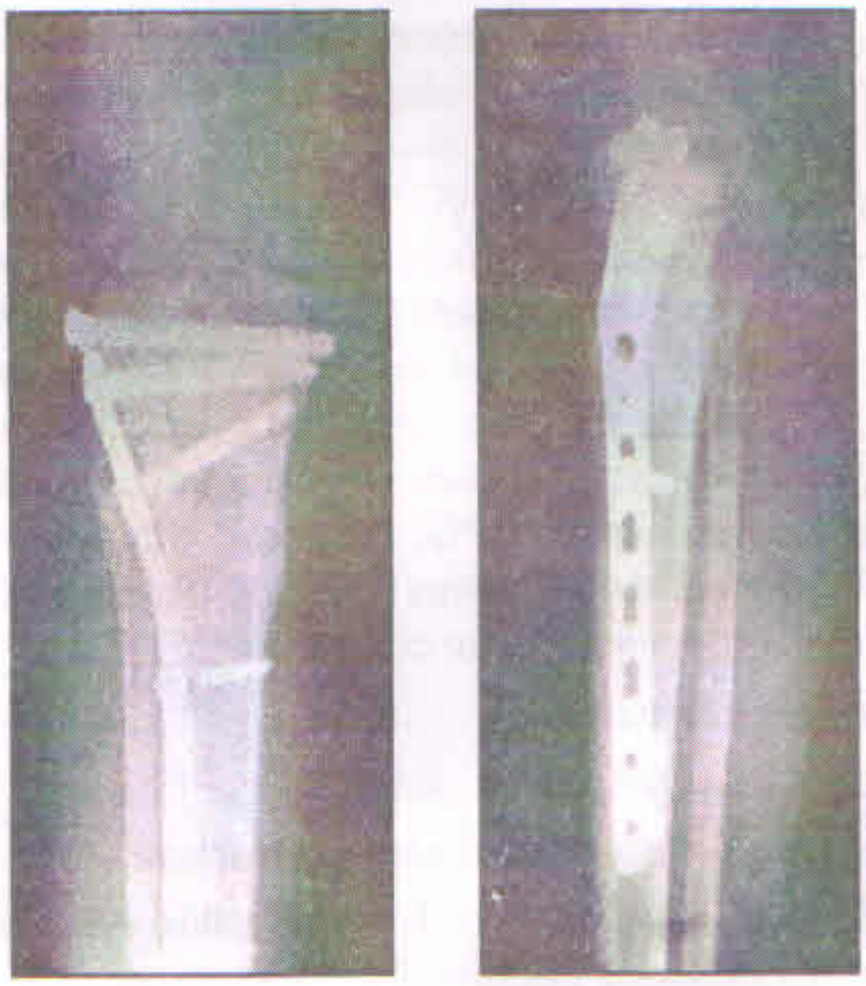

Figure 4 : After 10 months follow up

Table 1

RTA: Domestic fall	5.7 : 1
M : F	4.2 : 1
Close : Open fracture	4.2 : 1
ORIF : MIPO	3: 1
Avg. age	40.9 years
Avg. ROM	15-105 degree
Avg. union time	20.3 weeks

Table 2
Fracture classified percentagewise

Schatzker type	Number of pt.	Percentage
I	0	0
II	6	12.77
III	5	10.64
IV	9	19.15
V	12	25.53
VI	15	31.91

Wound infection was observed in the 5 cases, 3 were superficial infection which were controlled with an extended course of intravenous antibiotics and 2 were deep infection and positive culture had a open fracture with extensive comminution which underwent two times debridement and healed by secondary healing. There were 2 cases of malreduction belonged to schatzker type V and VI where medial condyle was not achieved satisfactory reduction which further resulted as varus,malunion and stiff knee. No delayed union or implant failure was observed upto 1 year of follow up (see Table 3). The average time to union was calculated to be 20.3 weeks (range 16-24 weeks).

Table 3
Observed Complication

Complications	Number of pateint	Percentage
Superficial infection	3	6.38
Deep infection	2	4.26
Stiffness (< 90 degree flexion)	2	4.26
Malreduction	2	4.26
Malunion	2	4.26
Nonunion	3	6.38
Delayed union	0	0
Implant failure	0	0
Varus	2	4.26

In this study Rasmussen knee score[16] was used to evaluate the final functional outcome at one year of follow up. After evaluation it was observed that 35 (79.54%) of patients had good to excellent result while 9 (20.45%) patients had fair results (see Table 4).

Table 4
Observed Rasmussen Knee Score

Score	Result	Number of patient	Percentage
27-30	Excellent	19	43.18
20-26	Good	16	36.36
10-19	Fair	9	20.45
< 10	Poor	0	0

DISCUSSION

Tibial plateau fractures are serious injuries and can result in considerable morbidity. These injuries are caused by high energy trauma with comminution and significant soft tissue damage. Stable fixation without compromising the soft tissue envelope is often difficult[17] and poor results are seen in 20-50% of all tibial plateau fractures.[18] Schatzker type V & VI notoriously difficult to treat that lead to high complication and poor clinical outcome, inspite this surgical treatment is the current standard of care.[4] Now a days internal fixation of tibial plateau fractures widely performed by use of locking plates with MIPO technique.[11,19-23] Krettek et al[24] described disadvantages of LCP fixation over lateral surface of tibia as (1) devitalisation of the fracture due to elevation of muscle from bone; (2) injury to superficial peroneal nerve; (3) increased risk of compartment syndrome; and (4) difficulties in placement of the implant into confined spaces. However, none of the above disadvantage was seen in our study.

Our study represent the subset of population presenting with complex fracture pattern (Schatzker type V & VI) accounting for 57.44% of cases which was due to high erengy trauma, which had only 14% in study of Rademakers et al [25] in Netherland. This was attributed to excellent road safety measures which lowers the incidence of high energy trauma.

Regardless the treatment the reported complications include: Wound dehiscence; Deep infection (2.8 to 80%); DVT (3.6 to 10%); Compartment syndrome ; Non union; Peroneal palsy, Implant failure and Stiffness.[17,18,24,26-33]

The mean time to union in our study was 20.3 weeks, which was comparable to contemporary studies with locked plating.[11,34,35] In our study infection was observed in 10.64% cases (n=5) which was reported by Lee et al 34 (8%), Gosling et al 9 (6%) ,Stannard et al 11 (5.9%) and Phisitkur et al 19 32% (n=12) in their series.

Coley et al 36 stated that postoperative malreduction are due to surgeons unfamiliarity with closed reduction technique. The increase in articular angulation of 6 degree in two patients (4.26%) revealed in this study appeared not to play an important clinical role ,as the overall range of motion averaged 15-105 degree and was compatible with other reported outcomes.[10,11,36]

An analysis of functional outcome using Rasmussen knee score showed that 43.18% (n=19) excellent and 36.36% (n=16) good result, which was comparable with study of Mathur et al[37] treated with conventional plates showed excellent score in 37% (n=10) and good in 52% (n=14.); Jain et al.[38] treated withlocking plates showed 41.2% (n=14) excellent and 41.2% (n=14) good results.

CONCLUSION

Tibial head articular fractures demands anatomical reduction and absolute stability to enhance the healing of articular fragments and make early motion possible. Periarticular locking plates combined with biological technique have improved outcome with respect to union rate, and decrease soft tissue complication. Single plating with locking head screws seems a reasonable option for treatment of complex tibial plateau fractures. It might not replace conventional ORIF dual plating technique as the standard treatment, but because of the minor infection rates and high union rates without bone grafting, it is an excellent alternative for treating complex tibial plateau fractures. Periarticular locking plates may decrease the need for dual plating in certain bicondylar fractures pattern; when medial condyle is not comminuted and there is no separate posteromedial fragments. Though long term follow up is required to complete recovery, still we feel that locking compression plate fixation is very useful in stabilization of these kind of fractures.

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MANAGEMENT OF POSTOPERATIVE VASCULAR COMPROMISE IN SUPRACONDYLAR FRACTURE OF THE HUMERUS IN CHILDREN

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ABSTRACT

Supracondylar fracture in children is frequently associated with neurovascular complication. It constitutes an orthopaedic emergency when it is associated with vascular compromise. Vascular complication is rarely seen with open reduction and k wire fixation. We retrospectively analysed results of two patients where vascular compromise was identified clinically and by pulse oximeter after open reduction and internal fixation and managed. Thus early recognition and adequate treatment provides good prognosis. Separate anterior incision for surgical exploration of vessel is recommended to avoid posterior skin necrosis. Regional anaesthesia should be avoided in supracondylar fracture as it hampers assessment of nerve function postoperatively.

Keywords: supracondylar fracture, vascular compromise, pulse oximeter.

INTRODUCTION

Supracondylar fracture is the most common elbow fracture in children. It is associated with neurological (3% to 22%) and vascular injury (10%). There is no controversy in surgical exploration for a pulseless, cool, pale hand. The observation is recommended for pink hand with absent pulses.[1] Particularly in patients with black skin, pulse oximeter which is easily available in operation theatre may provide a valuable information regarding ischaemia of limb.

The purpose of this article is to determine the role of pulse oximeter to detect the ischaemia in the operated limb.

MATERIAL AND METHOD

We retrospectively analysed management and results of vascular compromize of two patients. A 5 year old male child presented in outdoor patient clinic with one week old Gartland type III supracondylar fracture. There was clinically no neurovascular compromise preoperatively. Child was given supraclavicular block with sedation. After failure of close reduction, fracture was opened with posterior Cambelles' approach with pneumatic tourniquet in arm and ends of fracture was cleaned and reduced and fixed with cross K wires. Wound was closed in layers and dressing was done. Pneumatic tourniquet was deflated and the pulsation of radial artery was found absent. The capillary refill was inconclusive. The forearm and hand of operated limb was between cold and warm. Pulse oximeter was used to check the oxygen saturation of the operated limb that showed variable oxygen saturation (30% to 80%) that changed with position of elbow. Vascular spasm was suspected and all the posterior stitches were removed and waited for half an hour with warming the patient with heater fan. But the oxygen saturation would not return to 100% contrary to the opposite limb. In CT angiography, vascular supply break at the site of fracture was noticed although dye was going to both radial and

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ulnar artery through collateral circulation. Surgical exploration of antecubital fossa was done with the help of plastic surgeon. Intraoperatively kinking of brachial artery with median nerve was found adjacent to the fracture site due to soft tissue impingement. Brachial artery and medial nerve were released and 5 ml of Xylocaine (1%) is irrigated around the vessel to relieve spasm. Brachial artery started pulsating in 2-3 minutes and radial pulsation returned and oxygen saturation became 95 to 100%. Anterior wound is closed in layers and posterior wound is closed secondarily after one week. Postoperatively lomodex was given for 24 hr to prevent thrombus formation. Stitched wounds were healed. Fracture was united in 6 weeks. K-wires were removed and elbow mobilization was started. Postoperatively function of median nerve injury was recovered in 6 month of time.

Another 8 year old female child presented in outdoor patient clinic with 12 days old Gartland type III supracondylar fracture with normal distal neurovascular status. Close reduction was tried and failed. Open reduction with Cambell's approach was done and Cross k wire fixation was done. Postoperatively radial artery pulsation was found absent. Pulse oximeter showed variable oxygen saturation with position of elbow. Brachial vessel was explored with extension of the same incision with the help of plastic surgeon. Thrombus in brachial vessel was found which was removed with window. Window was repaired and radial artery pulsation was returned and oxygen saturation became 95 to 100% in the operated limb.

Lomodex was given for 24 hr to prevent occlusion of vessel. Postoperatively no neurological complication was noted. There was necrosis of posterior skin which was managed with skin grafting. Fracture was united in 8 weeks and k wires were removed and elbow mobilization was started with loss of terminal extension.

DISCUSSION

Dormans et al reported 5 vascular injuries in his retrospective studies of 200 childrens with supracondylar fracture extension type 3, one of them associated with median nerve injury.[2]

Kumar et al successfully managed 4 out of 5 vascular injuries with surgical exploration in in his retrospective studies of 194 childrens with supracondylar fracture extension type 3.[3]

Appearance of pain, pulselessness, parasthesias, paralysis and pallor can be helpful in guiding the management of vascular injury.[4] The presence or abscece of radial pulse does not necessarily means ischaemia.[5] Vascular exploration in pulseless hand depends upon status of perfusion. Well perfused pulseless hand can be conserved.[6,7,8]

Blackey et al recommend urgent exploration of the vessels in a child with supracondylar fracture with a pink pulseless hand with increasing pain.[9]

Mangat et al recommend early anterior exploration vessel with a coexisting anterior interosseous or median nerve palsy in a child with Gartland type III supracondylar fracture.[10]

In our first case we encountered difficulty in assessing nerve function due to regional anaesthesia with sedation.

Arterial spasm is usually self-limiting but ischaemia after trauma is usually due to arterial injury.[11]

Freidman and Jupiter suggested use of arteriography in defining the nature of a vascular injury although Shaw et al. and Copley et al. favoured exploration without arteriography.[12,13,14]

In our first case we did arteriography to localize the vascular lesion as oxygen saturation in the limb was variable with position of elbow and also to explain patients' relative about prognosis in better way. It was readily available in our institute. After that case we started to take consent of vascular exploration preoperatively. That's why we explored vessel in second case without arteriography.

But in children with black skin it is difficult to assess status of perfusion by color of skin. Successful outcome depends upon the early

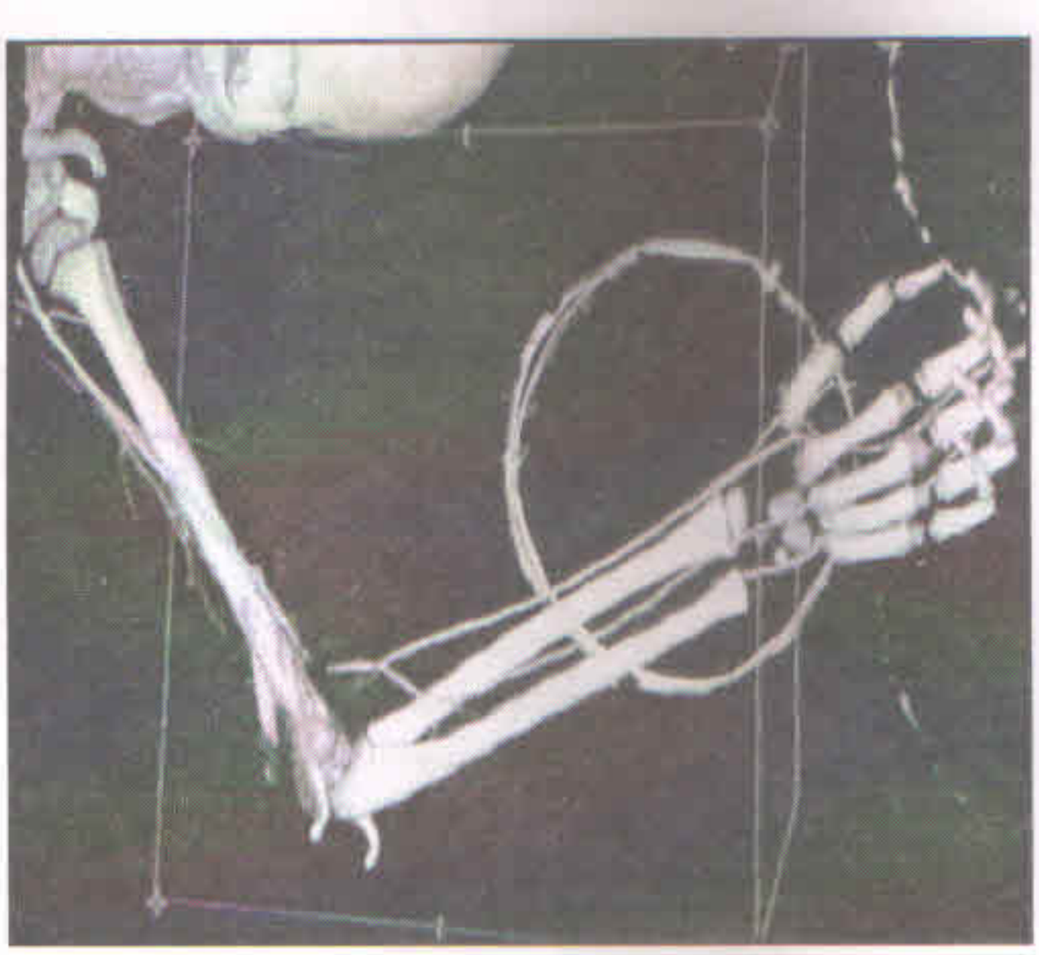

Figure 1 : CT angiography showing vascular cut-off with collateral circulation

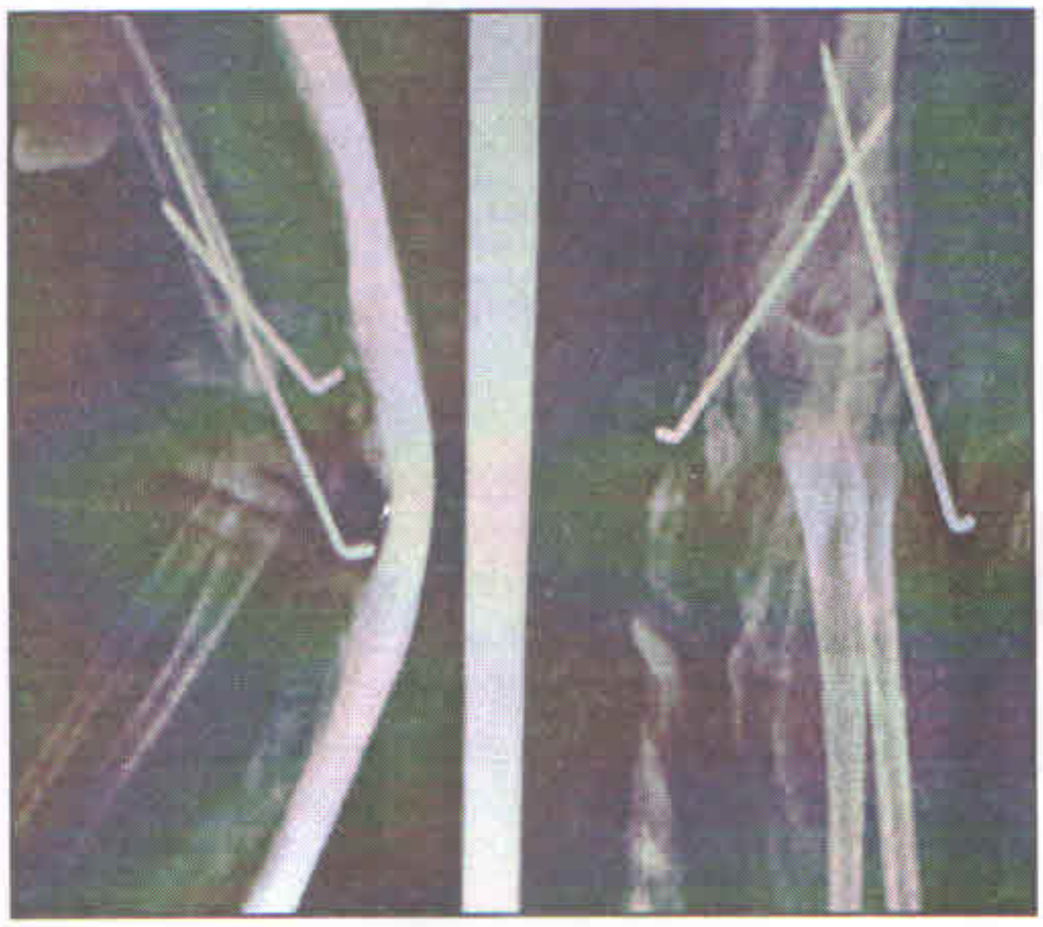

Figure 2 : Postoperative skiagram of fracture supracondylar humerus

Figure 3 : Intraoperative photograph of vascular exploration in second case

Figure 4 : Postoperative cilical picture of elbow with skin grafting in second case

recognition and decision. Due to collateral circulation sometimes it is difficult to assess exact warm and cold status of limb and capillary refill. We used pulse oximeter to assess ischaemia of the limb that gives a quantitative value of oxygen saturation and helps in taking decision of early exploration.

CONCLUSION

Early identification and intervention of the vascular compromise in supracondylar fracture of humerus saves the limb. In addition to clinical

examination,pulse oximeter can be used to recognize the vascular status of limbs after operationby oxygen saturation. Anterior incision for surgical exploration of vessel is recommended to avoid posterior skin necrosis. Regional anaesthesia should be avoided in supracondylar fracture as it hampers the assessment of nerve function postoperatively.

LIMITATION OF THE STUDY

Morenumber of patients are required to draw the significant conclusion.

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ROLE OF MRI IN ORTHOPAEDICS

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Musculoskeletal (MSK) imaging is an important diagnostic and teaching tool. Magnetic resonance imaging (MRI) in particular holds great potential for clinical and research purposes due to the ability to display high definition images of the MSK system. While the potential uses of MRI are exciting there are also reasons to be cautious primarily due to the expense and situations where the evidence for improved patient outcomes with increased use of MRI is lacking.

PRINCIPLE OF MRI

MRI is based on the reemission of an absorbed radio frequency (rf) signal while the patient is in a strong magnetic field. An external magnetic field is usually generated by a magnet with field strengths of 0.2 to 1.5 tesla (T). When the patient's tissues are subjected to this strong magnetic field, protons align themselves with respect to the field. In this steady state, a radiofrequency pulse is applied, which excites the magnetized protons in the field. After application of this pulse, a receiver coil or antenna listens for an emitted radiofrequency signal that is generated as these excited protons relax or return to equilibrium. This signal, with the help of localizing gradient fields and Fourier transformation, creates the MRI image.

The T1 relaxation time (longitudinal relaxation time) - used to describe the return of protons back to equilibrium after application and removal of the rf pulse 300-2000msec - Provide good anatomic detail T2 relaxation time (transverse relaxation time) used to describe the associated loss of coherence or phase between individual protons immediately after the application of the rf pulse 30-150 msec - used for evaluation of pathologic processes.

CLINICAL ASPECTS

Whenever an MRI is considered for orthopaedic condition, it is essential that the need for the imaging be based on the comprehensive patient examination, as gross diagnostic confusion can result from referred pain leading to MRIs of unrelated structures.

Another issue which should considered is whether or not the patient is likely to be better off as a result of the MRI.

APPLICATION IN ORTHOPAEDICS

Knee Joint

Knee MRI studies are frequently used to diagnose acute and chronic injuries to a variety of structures. Most important of them are the Meniscal injuries, however it has been shown that carefully performed clinical examinations may provide equal or better diagnostic information than MRI. Hence, MRI was generally more useful to rule out injuries than to diagnose them.

Detection and proper management of articular cartilage defects is important to preserve joint health particularly in weight bearing joints. MRI can supplement clinical examination in these cases.

In osteoarthritis, treatment decisions should be based on the clinical judgement and not on the MRI findings.

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Shoulder Joint

MR can obtain high quality images of the rotator cuff, glenoid labrum & other soft tissue structures. Rotator cuff attrition and long term instability can be assessed but CT is a better choice for bony lesions.

Hip

MR can assess acetabular labrum and quality of hyaline cartilage and hence finds application in adult AVN, Perthes' disease, Developmental dysplasia of hip (DDH) to ascertain the vascularity.

Ankle & Foot

To diagnose the osteochondritis dissecans of talar dome, integrity of tendons & ligaments, and in diagnosing tendinitis.

Avascular Necrosis

AVN is demonstrated in MR as a result of death of fatty marrow showing a altered/ high intensity signal in T2W images under the subarticular region. MRI changes become apparent only after several weeks.

Spinal Disorders

MRI allows a non-invasive evaluation of the spine and spinal canal, including the spinal cord. Most common indication for MRI of the spine being the Intervertebral disc disease. High soft-tissue contrast and high resolution allows ideal evaluation of the intervertebral discs, nerve roots, posterior longitudinal ligament, intervertebral foramen and spinal cord.

Normal disc appears as Low signal intensity on T1W images, slightly lower signal than adjacent normal red marrow and very similar to muscle. T2W images show diffuse high signal intensity throughout the disk except for the outer fibers of the annulus, which are homogeneously low signal intensity. Normal disks typically do not extend beyond the margins of the adjacent vertebral bodies.

In diseased conditions, here will be diffuse decreased signal intensity on T2W images from the increased collagen content in the nucleus and loss of disc height. However distinction need to be done among Disc protrusion, Disc extrusion, Sequestered Disc and other conditions which mimics prolapsed disc like Synovial cyst, Conjoined nerve root, Arachnoid diverticulum, Perineural (Tarlov) cyst, Nerve sheath tumors, Small epidural hematoma which can be readily made through MRI.

Infection

Acute osteomyelitis appears as low signal on T1W and high signal on T2W images, but have a non specific appearances and can be confused with transient osteoporosis.

Chronic Osteomyelitis displays the degree and extent of soft tissue involvement and any sinus tracks.

Trauma

MR in trauma is useful in showing fatigue/ stress fractures, epiphyseal bridging across the growth plate in pediatric population, acute muscle necrosis & hematoma.

Tumors

Excellent bone marrow delineation is most helpful in defining tumor extent and planning surgical and radiation therapy. Imaging should be performed in at least two planes, one of which should be axial (or transverse). This plane is most helpful in defining the relationship of lesions to nearby muscles and neurovascular structures and best shows extraosseous extension of bone tumors. Compartmental anatomy also is best shown in this imaging plane. The sagittal or coronal images define the proximal and distal extents of bone or soft-tissue involvement.

PATIENT SAFETY ISSUES

Devices whose function could be disrupted by the magnetic field as well as ferromagnetic implants or foreign bodies are considered contraindications for MRI studies.

Absolute contra-indications: Intracerebral aneurysm clips, Cardiac pacemakers, Automatic defibrillators, Biostimulators, Certain implanted infusion devices, Internal hearing aids, Metallic orbital foreign bodies.

Relative contraindications: First-trimester pregnancy, Middle ear prostheses, Penile prostheses.

CONCLUSION

Selective and appropriate use of MRI holds great potential for orthopaedic practice. MR can virtually replace all invasive investigations, dramatically improve diagnostic accuracy and provide management options.

As a result, scope and application MR in all aspects of orthopaedic practice is increasing drastically. However, Clinical examination should use the most appropriate clinical tests and measures first and then combine MRI, if indicated.

Inappropriate early use of MRI may complicate patient management and increase patient exposure to risk.

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Detailed report for 2014

"Orthopaedic Journal of M.P. Chapter"
"Orthopaedic Journal of M.P. Chapter"

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ICV 2014: 37.91

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"Orthopaedic Journal of M.P. Chapter"

(p-ISSN: 2320-6993)

ICV 2014: 37.91

ICI Value is composed of two elements: 37.91 + 0.00

We would like to inform, that due to feedback from the scientific community, ICI Journals Master List methodology has undergone some changes. ICV indicator is often used for bibliometric review of scientific achievements. In order to compare the current grade to previous value, one should use a standardized value, which, for this specific magazine amounts to: 4.17.

Detailed information regarding the grading methodology of ICI Journals Master List is available at www.journals.indexcopernicus.com in the **"Evaluation Methodology"** tab.

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Frequency of quotations	0.00
Change in number of quotations	0.00

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ICV 2014: 37.91

ICI Value is composed of two elements:

1. **The quality of the magazine is decided by the grade criteria: 37.91**
   The grade is composed of criteria from the following groups:
   - Editorial quality
   - Standards
   - Stability
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Menu
- About ICI Journals Master List
- ICI Journals Master List 2014 - Journals
- Evaluation methodology
- Contact

Archives of Annual Report of ICI Journals Master List
- ICI Journals Master List 2014
- IC Journals Master List 2013
- IC Journals Master List 2012
- IC Journals Master List 2011
- IC Journals Master List 2010 - Free
- IC Journals Master List 2009 - Free
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Orthopaedic Journal of M.P. Chapter [OJMP]

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