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ORIGINAL ARTICLE

SURGICAL MANAGEMENT OF PROXIMAL HUMERUS FRACTURE BY JOSHI'S EXTERNAL STABILIZING SYSTEM

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ABSTRACT: Proximal humerus fractures account for 4-5% of all fractures. Traditionally, the surgical treatment options for fractures of proximal humerus includes transosseous suture fixation, intramedullary nailing, plate-and-screw constructs and percutaneous pinning. The ideal treatment of displaced proximal humeral fracture is still the centre of scientific debate. The use of external fixators in the management of proximal humeral fractures has begun to gain acceptance over the last 10 years. The idea of biological fixation now leads to the fact that the blood supply to the head of the humerus is preserved. The smaller K-wires used in JESS have lesser risk of soft tissue, neural, and vascular injury. Multiple K-wires used add to the rotational stability to a reduced fracture. We hereby present our clinical experience in treating 18 such patients over a period of4 Years and 9 months by JESS. We used a novel frame structure as compared to those described elsewhere. The mean Constant – Murley score was 81 in our series. Overall, the results could be regarded as good. In our view, JESS should be considered as an alternative option in treating Neer's 2 part, 3 part and 4 part valgus impacted fractures with minimal complications and good results.
KEYWORDS: Proximal Humerus Fracture, JESS external stabilizing system, closed reduction.

INTRODUCTION: Proximal humerus fractures are common injuries accounting for 4-5% of all fractures & third most common fracture in patients >65 years. Majority of these fractures are undisplaced & can be treated non-operatively. The ideal treatment of displaced proximal humeral fracture is still the centre of scientific debate. Anatomic reduction & stable internal fixation should be the aim of treatment to allow early mobilisation. Recently, a new method has developed to treat these complex fractures using external fixator (JESS) which has advantages of fixed angle stability even in severe communited (C3) type fracture that can provide effective stabilities for the fractures even in osteoporotic bone. The early results with the use of external fixator (JESS) are encouraging,[1] however there are presently insufficient data comparing these devices to conservative treatment, conventional plating or hemiarthroplasty.

SPECIAL ANATOMY OF THE PROXIMAL HUMERUS: Due to the particular blood flow situation in the area of the proximal humerus it is known that the risk of a necrosis developing in the humeral head as a result of surgical manipulation is high and can result from the fractures alone. The blood supply of the proximal humerus is provided mainly by the circumflex humeral arteries, which branch off the axillary artery. The ascending branch running through the area of the bicipital groove is significant as it also flows through a substantial part of the calvaria. More recently, using more refined preparation and drainage techniques, additional periosteal irradiating vessels were identified in the area of the lesser tubercle in the humeral head. This periosteal blood flow is only disturbed when the humeral

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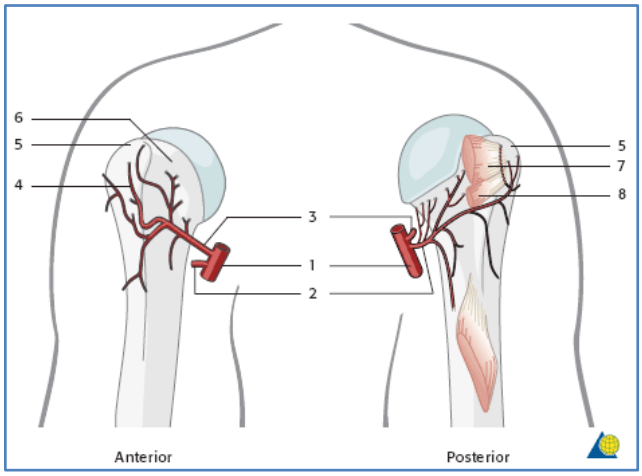
head suffers gross dislocation and usually continues to ensure residual blood flow to the calvaria. Studies also show that the periosteal blood flow plays an important role in the area of the calcarine spur and that the size of the fracture fragment and the extent of the dislocation permits conclusions to be drawn about the risk of necrosis developing in and around the humeral head.[2,3] Manipulation during surgery can also slightly upset or even destroy the blood flow. Blood flow is usually further reduced by the pressure of conventional plates/screws on the periosteum.



1) Axillary artery.
2) Posterior humeral circumflex artery.
3) Anterior humeral circumflex artery.
4) Lateral ascending branch of the anterior humeral circumflex artery.
5) Greater tuberosity.
6) Lesser tuberosity.
7) Tendon insertion of the infraspinatus muscle.
8) Tendon insertion of the teres minor muscle.

FRACTURE CLASSIFICATION:

Three different classifications exist for the proximal humerus to determine the fracture type. Codman's definition is based on the fact that the fracture lines follow the epiphyseal plate. The AO-classification is divided into three subsequent categories based on the severity of injury and the presence of avascular necrosis of the humeral head. If no vascular isolation of the articular segment is detected, the fracture is defined as type A. Type B fractures describe a partial vascular isolation of the articular segment and in type C fractures, a total isolation of the articular segment is seen. The Neer classification system includes 4 segments. Displacement and vascular isolation are also considered. A fracture is considered to be displaced if more than 1 cm of interfragmentary distance and/or 45° of angulation of any one fragment with respect to the others is observed.

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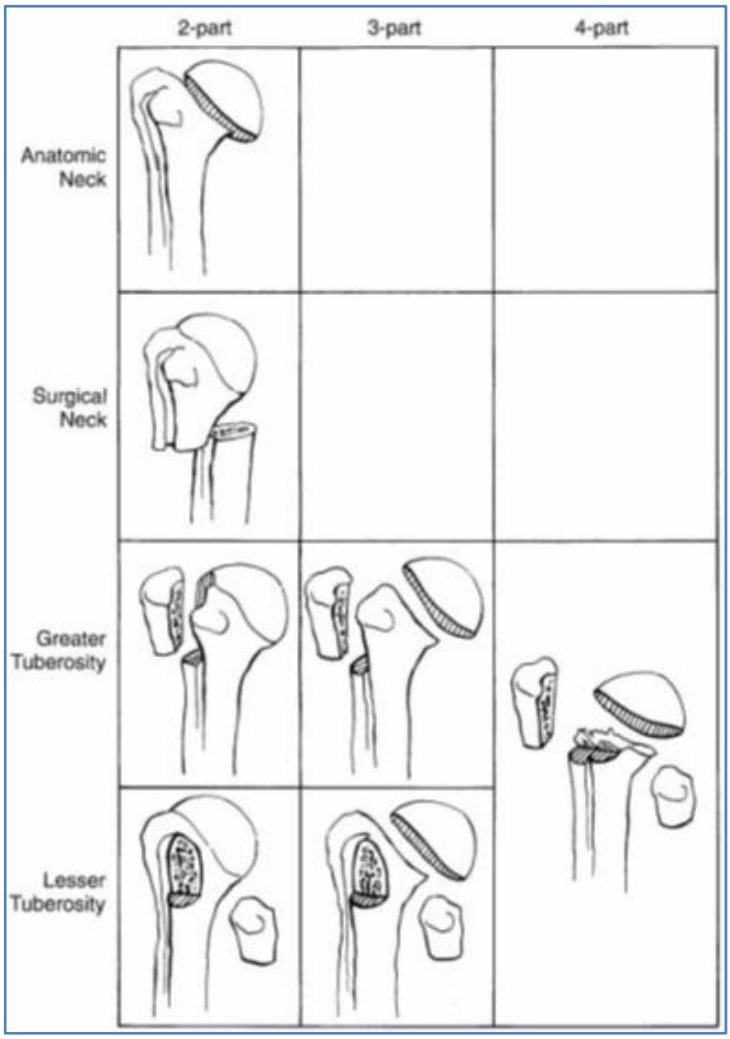

Fig 1: Neer classification for proximal humerus fractures

TREATMENT OPTIONS: Although Neer intended his classification to be an aid for determining the indications for conservative or surgical treatment of proximal humerus fractures, it has not, in the end, according to the criteria of evidence- based-medicine, resulted in a final "gold standard" for the treatment of proximal humerus fractures.[4,5,6]The advantages and disadvantages of both conservative and surgical procedures are still discussed controversially and both very good and also poor outcomes for both procedures are described. Traditionally, the treatment options for fractures of proximal humerus includes the following methods:-

1) Non-operative
2) Operative:-
    a) Transosseous suture fixation.
    b) Intramedullary nailing.
    c) Plate-and-screw constructs.
    d) Percutaneous pinning.

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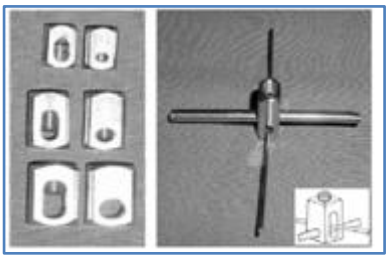
JOSHI"S EXTERNAL STABLISATION SYSTEM (JESS):

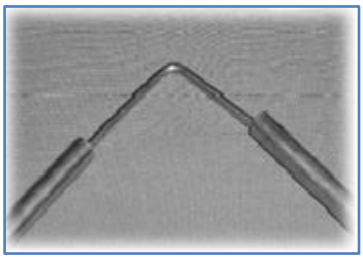
A simple, light, highly modular mini external fixator system which systematically addresses a wide range of complex problems in the management of forearm and hand. Invented by Dr.B.B. Joshi from Bombay. This system has high safety profile and unparalleled ease of application. It can be applied easily by any surgeon in even the most remote areas with minimum instrumentation[7]. It provides a simpler alternative to the presently available modalities of treatment. It allows minimum invasive techniques.

JESS has following components:-



Link Joints: This is the basic clamping unit of JESS system. It has cross holes at different levels. One oval hole and other round hole perpendicular to it. Three sizes, 2x2, 3x3, 4x4. The small size and design of the clamping unit allows inter digital application comfortable. It can hold wires of very small sizes. Tightening of the grub screw clamps the rods and wires. The connecting rod is placed through the lower hole and the wire placed in the upper hole. The wire has pressure from both sides, hence has less chances of loosening.

Universal Link Joint: It has a tightening screw on both ends this link joint can hold all size rods up to 4mm diameter. It has an advantage over the other joints as when part of assembly is removed, it does not affect the other components. It independently clamps both rods.



Connecting Rods: These are smooth steel rods of diameter varying from 2mm to 4mm. They are available in different length as per indication. The connecting rods can be bent to the required shape using simple instrumentation.

MATERIALSAND METHODS: 18 patients with proximal humeral fractures were managed at our hospital from June 2007 to March 2012 by JESS fixation. There were 12 male and 6 female patients, with a mean age of 37.33 years. Road traffic accidents were the most common mode of injury in patients less than 45 years old, while fall on the ground was the most common cause in fractures in patients >60 years. Fractures of proximal humerus were classified by Neer's classification system. Displaced 2 and 3 part fractures and 4 part valgus impacted fractures in patients of age >20 years were included in the study. Dislocations, open fractures and those with other associated injuries were excluded from the study.

Operative technique: The procedure was performed with the patient under general/regional anesthesia in a supine position, using a sandbag to elevate the shoulder. The important structures at risk are the axillary nerve and the posterior humeral circumflex artery, the anterior branch of the

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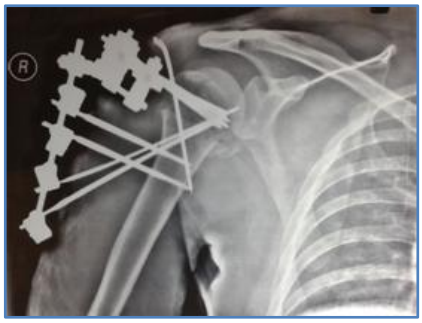
axillary nerve, and the cephalic vein, biceps tendon, and musculocutaneous nerve. Three 2.5mm schantz pins at humeral head were placed at 30° to each other in the same horizontal plane: The first one in true lateral / coronal plane. The second one (anterior schantz pin) just lateral to bicipital groove, 30° anterior to the first schantz pin. And the third one 30° posterior to the central / first schantz pin. One K-wire was inserted from the tip of the greater tuberosity, across the fracture site, upto the far medial cortex of humerus (This K-wire was not included in the frame construct and was removed 4 weeks post operatively). Next, one 2.5mm schantz pin was inserted in the coronal plane, in line with the central / first schantz pin approximately 4cm or three finger widths below the central / first schantz pin in the upper3rd shaft of humerus below the fracture. A third 2.5mm schantz pin was inserted approximately 2cm below the above schantz pin in the same coronal / true lateral plane in shaft humerus. One K-wire were inserted in the same coronal / true lateral plane from the lateral cortex upwards and medially towards the humeral head upto the subchondral region of the humeral head, one more similar k wire could be placed just below it into the humeral head or a schanz pin below it into the shaft of humerus. The fixator wires were then used as joysticks to obtain a reduction before attaching the frame. Aim of reduction was to bring the fragments in an acceptable position, i.e. less than 45° of angulation and less than 1 cm of displacement, and to hold these fragments in place. Three schantz pins of head were joined to each other using a curved knurled rod. The central / first schantz pin of the head was connected to the distal 2 -3schantz pins and the distal K-wire(s) in the same coronal / true lateral plane by a connecting rod. Pin tract dressings were applied.

Post-operative care and rehabilitation: A triangular sling was applied for comfort and patients were encouraged to begin active mobilization of the involved extremity from postoperative day 1. The schantz pins were cleaned twice a day with hydrogen peroxide and Povidine Iodine solution and the patient was taught to do these by themselves. Physical therapy was started immediately, beginning with pendulum exercises progressing to unrestricted range of motion by 6-7 weeks after fracture fixation. Patients were followed at 2 weeks, 4 weeks, 6 six weeks, 8 weeks, and then at 4 weekly interval for a minimum of 1 year, looking for clinical and radiological union, Constant - Murley score[8,9] and for any complication. The proximal K-wire was removed at 4 weeks and the whole JESS frame construct was removed by 6-8 weeks.

FRACTURE



IMMEDIATE POST OPERATIVE RADIOGRAPH

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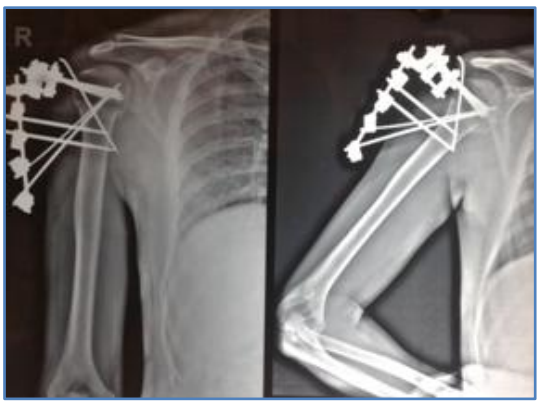
2 WEEKS POST OPERATIVE



4 WEEKS POST OPERATIVE

6 WEEKS POST OPERATIVE

8 WEEKS POST OPERATIVE

6 MONTHS FOLLOW UP

2 YEARS FOLLOW UP

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RESULTS: The results are summarized in Table 1. The mean interval between the injury and surgery was 1.65 days (Range 0-4 days). 23% of the patients were operated within 24 hours of the injury. The maximum follow up was 36 months and the minimum follow up was 6 months with a mean follow up of 18.5 months. The mean Constant-Murley Score[9] was 81 with 22.22% of the patients (4/18) showing excellent results and 44.44% of the patients (8/18) showing good results. 2 cases had an eventual failure. 1 Patient had pin tract infection requiring removal of the JESS. He was eventually treated by POP cast. 1 patient had avascular necrosis of the head of humerus and was eventually treated by shoulder hemiarthroplasty. No case had any iatrogenic neurovascular injury as a complication.

Age (Years) / Gender	Mode of injury	NEER'S type	Time of Removal of JESS (Weeks)	CONSTANT – MURLEY Score	Complications
20/M	RTA	3 Part	6	95	None
45/F	FALL	2 Part	8	88	None
24/M	RTA	3 Part	6	50	Infection
34/M	RTA	3 Part	6	85	None
55/F	FALL	3 Part	8	69	None
28/M	RTA	4 Part Valgus impacted	6	93	None
38/M	RTA	2 Part	6	89	None
30/F	RTA	3 Part	6	82	None
45/F	FALL	2 Part	8	78	None
28/M	RTA	3 Part	6	98	None
54/M	FALL	4 Part Valgus impacted	8	55	AVN
22/F	RTA	3 Part	6	86	None
48/F	FALL	2 Part	8	65	None
42/M	RTA	2 Part	6	83	None
44/M	RTA	3 Part	8	75	None
22/M	RTA	4 Part Valgus impacted	6	88	None
21/M	RTA	2 Part	6	95	None
72/M	FALL	3 Part	8	84	None

Table 1: patient's data details of this study

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One year followup photographs of patient

DISSCUSION: The closed proximal humeral fractures have been treated with a wide range of options, namely non-operative, open reduction internal fixation, external fixation, closed K-wire fixation, percutaneous screw fixation, and tension band fixation. Each procedure is has some limitations and complications. A major disadvantage of non-operative treatment is failure to obtain early mobilization, which results in a high rate of shoulder stiffness and pain, and malunion or nonunion is likely with certain fracture types. JESS fixator application in our study allowed sound fracture union with functional mobility in our study. A disadvantage of open internal fixation is difficulty in achieving rigid fixation in the osteoporotic cancellous bone of proximal humerus. Cortical bone in osteoporosis constitutes only a thin shell of bone and provides weak purchase for the screws. Presence of comminution offers difficulty in internal fixation while external fixation works on principal of ligamentotaxis. Internal fixation has been reported to have increased complication rates in these patients due to hardware loosening and pullout of the screws. Additionally, the use of internal fixation device prolongs the operative time, increases intraoperative bleeding, and increases the risk of avascular necrosis of humeral head because of the disruption of the residual vascularity. Postoperative adhesions further limit the range of motion as a result of extensive dissection needed

in cases of open reduction and internal fixation. However, recent studies have shown good long term results of proximal humerus fractures managed by PHILOS plate.

The use of external fixators in the management of proximal humeral fractures has begun to gain acceptance over the last 10 years.[10-12] The idea of minimal fixation now leads to the fact that the blood supply to the head of the humerus is preserved. Hoffmann's external fixators were used for this type of fracture by many authors, but their use was hindered by bulky Steinman pins, increasing the risk of injury to soft tissue and limiting the space for application of multiple pins in different planes. The smaller K-wires and 2.5mm schanz pin used in JESS have lesser risk of soft tissue, neural, and vascular injury. Multiple K-wires used add to the rotational stability to a reduced fracture. The principles of management for complex proximal humeral fractures are minimal soft tissue dissection to avoid the occurrence of avascular necrosis of the humeral head, adequate fixation to provide good stability for early rehabilitation, and an intact rotator cuff for an optimal functional outcome. Closed reduction and the use of JESS achieve these principles adequately.

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