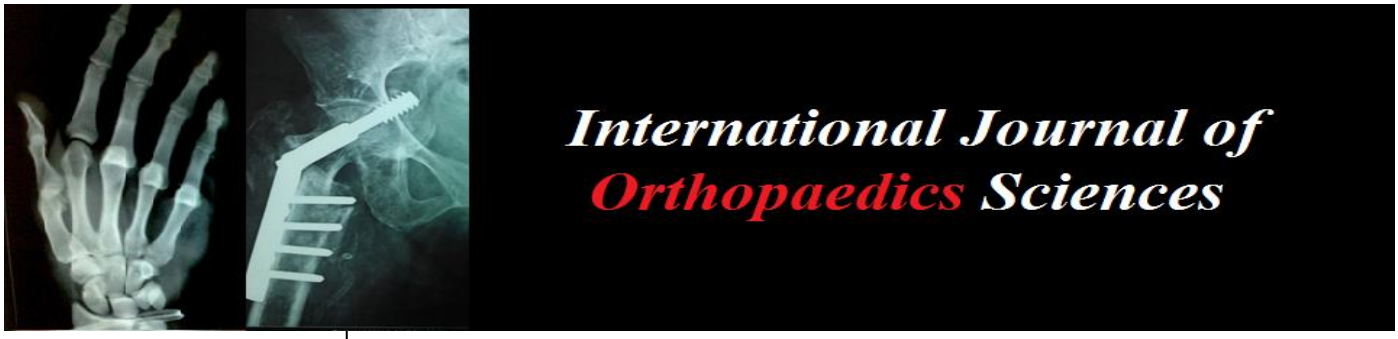

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To asses the functional outcome of 2-part and 3-part proximal humerus fracture treated by proximal humerus nail and percutaneous fixation

Dr. Mrinal Jaiswal, Dr. SK Kaushik and Dr. Utkal Kumar Gupta

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Abstract
Introduction: Fractures of the proximal humerus are relatively common injuries in adults, representing 4%-5% of all fractures presenting to the accident emergency department and approximately 5% of fractures of the appendicular skeleton. The vast majority are low-energy osteoporotic fractures with a 2-3 to 1 female to male preponderance. In the current study proximal humerus fracture 2 and 3 part, were treated by intermedullary locking nail and percutaneous fixation technique depending on the fracture pattern and assessment of the functional outcome was done so as to provide some inference regarding the suitable techniques that can be used with optimum results.
Material and Methods: We received 183 patient with proximal humerus fracture in our institute from December 2017 to December 2018, out of which 43 were 2- part and 33 were 3-part, with predominance to elderly and female. Out of 76 total patients 68 (32 3-part and 36 2-part) were operated (32 – PHN and 36- percutaneous fixation).
Results: In 2-part fracture both the fixation technique showed the similar radiological union time of 6 week and functional outcome of PHN (16 cases) was ASES-85.5 and CMS-79.8, and Percutaneous fixation (20 cases) mean ASES- 87.4 and CMS-84.6
In 3 part fixation the radiological union showed by the PHN (18 cases) was 8.6 week and the ASES -83.5 and CMS- 77.8, in percutaneous fixation (14 cases) was 10.2 week and mean ASES -80.7 and CMS-78.1.
Conclusion: Patient with 2-part fracture favours the fixation with percutaneous fixation given the adequate bone quality and no metaphyseal involvement, and also have the better functional outcome. In 3-part fracture the PHN has a better functional outcome and union time. The proximal humerus fracture along the factors of fracture type, is still varied on the fracture anatomy and the bone condition to decide the method of fixation.

Keywords: Asses, 2-part and 3-part, proximal humerus

Introduction
The shoulder joint and its associated joints form one of the most complex joint systems of the human locomotor system. Its large range of motion is made possible by the interplay of 5 joints: sternoclavicular-joint, acromioclavicular-joint, glenohumeral joint, thoracoscapular joint and subacromial joint [1]. The proximal humerus consists of the head, anatomical neck and the greater and lesser tuberosities. The intertubercular or bicipital groove is located between the greater and lesser tuberosities along the anterior surface of the humerus [2].
Fractures of the proximal humerus are relatively common injuries in adults, representing 4%-5% of all fractures presenting to the accident emergency department and approximately 5% of fractures of the appendicular skeleton. The vast majority are low-energy osteoporotic fractures with a 2-3 to 1 female to male preponderance [3].
In younger patients, proximal humeral fractures are usually caused by high-energy trauma, such as traffic accidents, sporting accidents, direct assault etc. In elderly patients, the most common cause is a fall onto the outstretched arm from a standing position, which is a type of low-energy trauma [4].
Fracture is mostly isolated in elderly, but may be associated with glenohumeral dislocation, clavicle fracture, shaft humerus fracture, in young patients high energy trauma is more common are associated with multiple fracture, head injury and the associated injury affects the rehabilitation.

Two classification systems are most commonly used. Neer's classification system is based on six groups and four main fracture segments (parts) comprising the head, greater tuberosity, lesser tuberosity and shaft. Displacement is defined as more than 1cm of translation or 45 degrees of angulation of the respective fracture part. The AO/OTA classification employs a combination of letters and numbers to describe different levels and patterns of proximal humerus fractures [5].

Broad range of techniques for management according to various fracture pattern include Conservative, trans-osseous suture fixation, Closed reduction percutaneous fixation, Open reduction and internal fixation with conventional and locked-plate fixation, and Hemiarthoplasty. The goals of operative fixation are to restore the anatomy of the proximal humerus to allow for successful union and maximize function. The articular surface's relationship to the shaft must be restored to maximize range of motion as well as stability [6].

Nondisplaced fractures and fractures with minimal displacement and displaced with adequate stability and some time where surgery is avoided due to morbidity of patient, respond satisfactorily to simple conservative treatment including short sling immobilization and functional after treatment under supervision of the physiotherapist.[7] there is prolong immobilization, with follow up to avoid the displacement and malunion.

Percutaneous fixation by CCS (Cannulated Cancellous Screw) and "K" wire (Kirshner wire) is chosen in cases of simple fractures, displaced part 2-3 and fracture with greater and lesser tuberosity, is suitable mainly for fractures without metaphyseal comminution only if the bone was of good enough quality and the fragments were of adequate size. This method is technically demanding and was performed only in case of effective close reduction. Due to minimally invasive technique, the perfusion of the humeral head was not compromised. Loosening of implant and fixation is checked in follow up and splintage is given and regulated physiotherapy is done [8].

Proximal Humeral Nail is also the new technique. It is performed to utilize the combination of high stability of rigid implants along with the soft-tissue preservation of minimally invasive techniques. It is indicated in cases with marked metaphyseal spiral or comminuted fractures extending into the humeral shaft. as it provide facility to fix the communited fragments due to specialized design, thus enabling to be used in cases of 2 part, 3 part fracture, this gives the option of quick fixation of the fracture, but due to the entry point there is chances of supraspinatus injury, impingement and also require controlled physiotherapy.

The main challenge in the operative treatment of displaced and unstable proximal humerus fractures is to achieve effective stabilization of an adequately reduced fracture to maximize the functional patient outcome. Especially in osteoporotic bone and comminuted fractures operative stabilization is challenging and the management of displaced and unstable fractures remains controversial.

In the current study proximal humerus fracture 2 and 3 part, were treated by intermedullary locking nail and percutaneous fixation technique depending on the fracture pattern and assessment of the functional outcome was done so as to provide some inference regarding the suitable techniques that can be used with optimum results.

Material and methods

We received 183 patient with proximal humerus fracture in our institute from December 2017 to December 2018, out of which 43 were 2- part and 33 were 3-part, with predominance to elderly and female. Out of 76 total patients 68 (32 3-part and 36 2-part) were operated (32 – PHN and 36- percutaneous fixation). Patient were regularly followed up at 2 week, 6 week, 3 month and 6 month, and regular appropriate physiotherapy were instructed along side. At 6 month functional assessment was done on the basis of ASES (American shoulder and elbow surgeon score) and CMS (constant murley score). And the results were assessed and complication were noted accordingly.

Study Design

- A Comparative Prospective study design was adopted.
- Cases was recruited from Orthopaedics OPD and casualty department. All the cases were carefully evaluated preoperatively which included detailed history to determine the cause of fracture and other diseases.

Inclusion Criteria

1. All skeletally mature patients (16yr above).
2. Closed fractures or grade 1 compound/open fractures (Gustiello Anderson Classification).

Exclusion Criteria

1. Pathological fracture
2. Fracture in children<16 yrs
3. Old fractures associated with AVN
4. Fracture with nerve injury
5. Fracture with associated injuries like (fracture of clavicle and scapula, dislocation of shoulder joint and acromio-clavicular joint etc), rotator cuff injuries

All the protocols and procedures applied in this study were as per guidelines of Ethics Committee of this institution.

The patients with suspected proximal humerus fracture of were seen either at casualty or orthopedic outpatient department. Detailed history was taken and examination was done and were also assessed for vascular and neurological status. Anteroposterior and axillary radiographs were done, fracture classified according to NEER & AO classification, All proximal humerus fractures were admitted and were immobilized in splint /U slab/ shoulder immobilizer or arm sling/pouch.

Investigations

- HB, TLC, DLC, ESR, CRP, Platelet Count
- Bleeding time, clotting time
- Blood grouping
- Blood urea
- Serum creatinine
- Serum electrolytes
- Other lab investigations (if needed)
- Radiological investigations such as X-ray true AP and true axillary views.
- USG/MRI to diagnose rotator cuff injuries if required
- BMD, CT scan if required

Imaging Studies

Appropriate radiographs are essential in planning of treatment and determining prognosis [77, 78]. Trauma series consists of anantero-posterior (AP) view of scapula, m and an axillary view. These views was done with patient sitting, standing or prone. This series allows evaluation of the fracture in three

perpendicular planes. So fracture displacement can be accurately assessed [9].

Trans deltoid split approach

It was used in cases of isolated fractures of the tuberosity or for medullary device employment. Patient was in semi sitting position, skin incision followed the direction of the muscle fibres along the upper deltoid at the junction of anterior and middle third or as a vertical sabre-cut. Deltoid was split not more than 5cm from the acromion to avoid injury of the axillary nerve. Cuff was identified, subacromial bursa was removed and fragments of the fracture were identified, reduced and fixed by means of isolated screw, wiring or heavy sutures etc. If intramedullary nailing was opted then split the supraspinatous tendon to allow nail insertion [10, 11].

Fig 1: Surface marking for incision.

Fig 2: Incision

Fig 3: Deltoid exposure

Operative procedures

Percutaneous pinning

After pre-operative preparation, Prophylactic antibiotics are administered 30 min prior to incision. Patients were operated in supine position with head kept at foot end of table so that enough space is there for C-arm image intensifier to get both AP and Transaxillary view can be taken during K-wire placement. Long sandbag was kept in upper back medial to the scapula to ensure that the entire shoulder girdle is freely exposed for fluoroscopic imaging and is clear off the table. The necessary implants like 2 mm, 2.5 mm, 3.0 mm terminally threaded or 'K" wire and a drill for a quick-release for the pins and the appropriate chuck attachments were also made, Reduction maneuver is performed before draping and is confirmed on Image intensifier, after draping stab incision is given on the lateral aspect of the arm considering that the distal "K" wire is approx 2cm proximal to deltoid insertion or insertion point is twice the distance from top of humerus head to most inferior margin of articular cartilage but not below the deltoid tuberosity, the wire was angulated 45 degree to the cortex facing toward head, K-wire was drilled initially horizontally to breach the cortex. It was followed by change in the direction of required angulation and insertion was done under fluoroscopic control so that K-wire entered the centre of head. Second K-wire was placed such that it was separated by at least 1.5 cm from first pin and parallel to it in retrograde fashion with divergence in the head. Third K-sire was inserted in anterior cortex from anterior to posterior direction avoiding injury to long head of biceps or cephalic vein. In patients in whom the greater tuberosity remains superiorly or posteriorly displaced, a 2.5 mm pin was used as a joystick to manipulate the fragment into place and fixed to the humeral segment. It wass fixed with two additional K-wires drilled in retrograde manner through properly reduced greater tuberosity toward a point at least 2.0 cm distal to inferior margin of head. The K-wires were bent cut and left out on skin, sterile antiseptic dressing done. Arm is supported in sling or immobilizer.

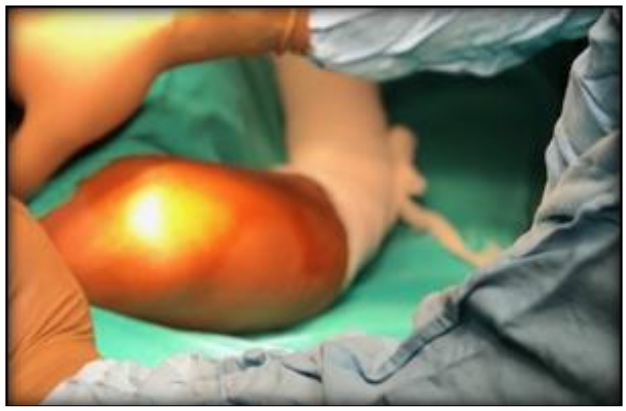


Fig 4: Patient preparation and positioning

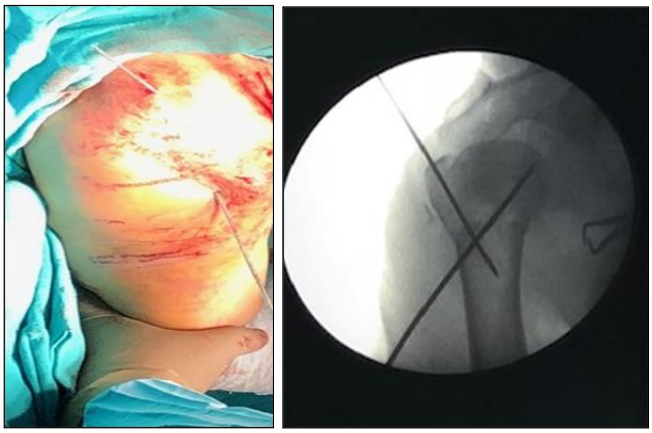


Fig 5: Percutaneous "k wire fixation under fluroscopy

2. Percutaneous/ORIF with "Cannulated Cancellous Screws"

After pre-operative preparation, Prophylactic antibiotics are administered 30 min prior to incision. Patients were operated in supine position with head kept at foot end of table so that enough space is there for C-arm image intensifier to get both AP and Transaxillary view can be taken during guid wire

placement. Long sandbag was kept in upper back medial to the scapula to ensure that the entire shoulder girdle is freely exposed for fluoroscopic imaging and is clear off the table. Reduction maneuver is performed before draping and is confirmed on Image intensifier on anteroposterior and axillary radiographs. Made a stab incision at the level of the greater tuberosity and inserted the drill sleeve with the Kirschner wire in place. A wide spread of the pins within the head ensures the stability of the fixation.

A 3.0-mm Schanz pin was inserted as a joystick into the free fragment of the greater tuberosity and then, after the tuberosity has been maneuvered into position with the Schanz pin, the pin can be advanced as provisional fixation across the fracture site. Reduced the greater tuberosity to, or to no more than 5 mm below, the articular surface of the humeral head to restore rotator cuff dynamics. Placed the guide pins for 4.5-mm cannulated screws. Placed the distal perpendicular pin first, and then inserted a diagonal pin through a more proximal portion of the tuberosity, aiming toward the medial calcar, after drilling by cannulated drill bit of 3.5 mm placed the perpendicular screw first, which prevented over reduction of the greater tuberosity downward. Then inserted the 4.5-mm cannulated screws over the guide pins through the drill sleeve. Medial aspect of the shaft was penetrated with the diagonal screw. After fixation of the greater tuberosity, lesser tuberosity was assesed. Checked under continuous fluoroscopy for movement of the lesser tuberosity with internal and external rotation of the arm. If the lesser tuberosity needed to be fixed, used unicortical cannulated screws for fragment fixation by inserting guide pins from anterior to posterior followed by the cannulated screw. The arm remains in neutral position, The starting point for the anterior Kirschner wires was lateral to the coracoid in order to capture the fragment without risking damage to local neurovascular structures.

If the lesser tuberosity was substantially displaced medially, an incision was made through the skin that is just large enough for an index finger. Blunt clamp used to spread to the bone of the humeral head, then manually freed the fragment from soft tissue. Advanced the anterior Kirschner wire under fluoroscopic guidance into the lesser tuberosity fragment and use it as a joystick to manipulate the piece into the proper position. With the lesser tuberosity fracture reduced, advance the Kirschner wire and insert a cannulated screw of 3.5 or 4.5mm over the wire after drilling it with the appropriate cannulated drill bit. The wound was closed in layers and sterile dressing was done with arm sling was given

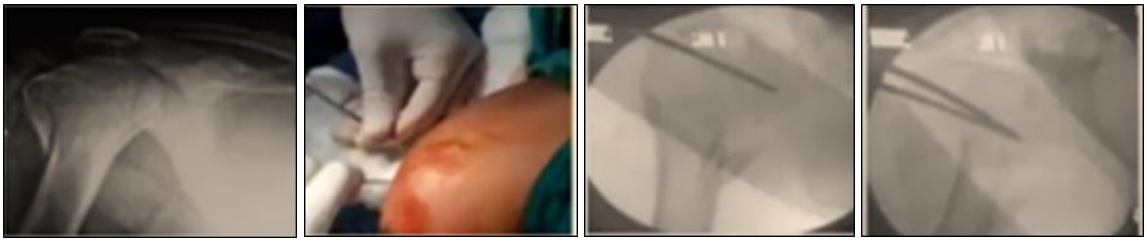


Fig 6: Percutaneous reduction with the guide wire under fluroscopy

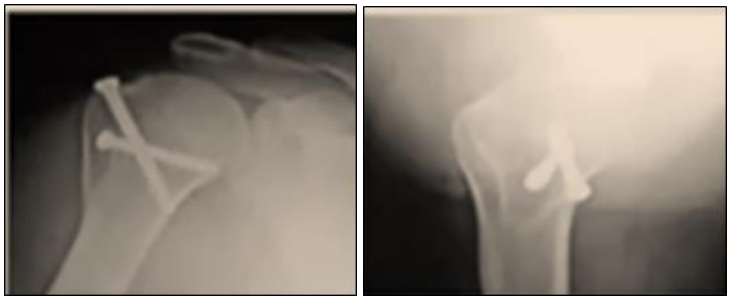


Fig 7: CCS fixation done over guide wire

3. Intramedullary nailing

After the pre-op preparation the Position the patient on a radiolucent table with the thorax was “bumped” 30 to 40 degrees. The image intensifier was placed on the opposite side of the table from the surgeon; Diagonal incision was made of 3-4 cm from the anterolateral corner of the acromion, splitting the deltoid in line with its fibers in the raphe between the anterior and middle thirds of the deltoid. To protect the axillary nerve,splitting of the deltoid was avoided more than 5 cm distal to the acromion. Under direct observation, incised the rotator cuff in line with its fibers. Used full-thickness sutures to protect the cuff from damage during reaming of the humeral canal. Used a threaded pin as a “joystick” in the posterior humeral head to derotate the head into a reduced position.

Placed the initial guidewire posterior to the biceps tendon, and advanced it under fluoroscopic guidance into a appropriate position in anteroposterior and lateral views. Carefully advanced the proximal reamer, protecting the rotator cuff. Used the reduction device to reduce the fracture, and passed the bead-tipped guidewire. With sequentially larger reamers, reamed the humerus to the predetermined diameter, usually 1.0 to 1.5 mm larger than the nail diameter. When reaming was completed, passed the nail down the humeral canal, avoiding distraction of the fracture; we ensured that the nail is below the articular surface of the humeral head. With the use of the outrigger device, inserted the proximal locking bolts. Soft were carefully retracted tissues to avoid injury to the axillary nerve. Repaired the rotator cuff with full-thickness sutures under direct observation. Confirmed reduction and screw placement and length on anteroposterior and lateral fluoroscopy images. The wound was closed in layers with the sterile dressings.

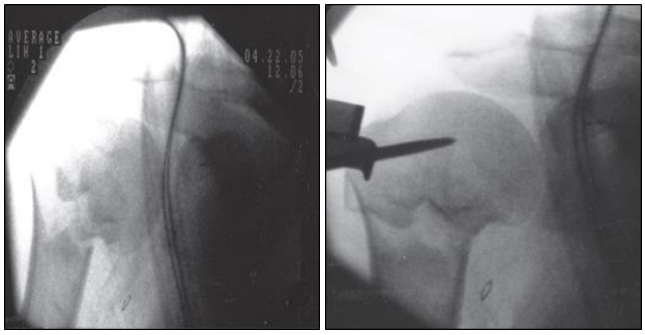


Fig 8: Closed reduction with the help of "K" wire used as joystick

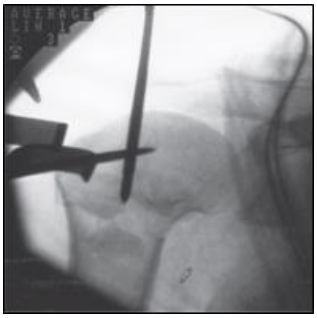


Fig 9: Making entry point for nail

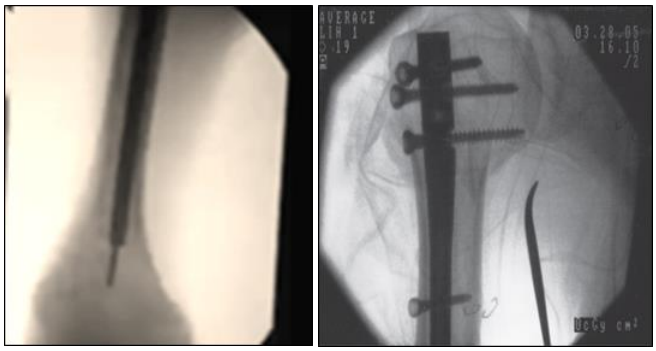


Fig 10: Distal and proximal assessment of reduction and locking

Post Op Regimen

The limb was kept elevated at all times and active arm movements are encouraged. The patient is watched for excessive swelling, pain and distal circulation. The first dressing is done after 3 days of the operation. Antibiotic coverage was given till 5th postoperative day, If suture line is clean, suture removal done after 14 days under full asepsis. Active shoulder and elbow mobilization is started immediately after the dressing, limb is kept in a arm sling, patient is kept on pain killers till suture removal then analgesic is given as needed. Passive assisted ROM of shoulder was done for 3-4 weeks, then the active exercises were started.

In "K" wire fixation the "K" wire is removed after 6-10 weeks after checking radiologically and further aggressive exercises were started.

Rehabilitation

Most of the functional outcomes following shoulder injury of proximal humeral fractures are directly dependent on a good rehabilitative programme initiated as early as 1st week depending on fixation, stability and healing. Following is the recommended rehabilitation programme [82, 79, 83, 84]. under the supervision of physiotherapist.

Rehabilitation in percutaneous "K" wire fixation

Post-operatively arm was kept in arm sling and regular passive exercises were started as soon as patient can tolerate pain, pin loosening and discharge were assessed, Codman's pendulum exercise was started at 4 weeks after removal of K-wire from greater tuberosity. Rest of pins were removed at visible union in Xrays, active assisted motion in a supervised physical therapy program started. Generally K-Wire back out on their own as fracture unites with some degree of collapse. Braces were permanently removed after diagnosis of radiological healing and hardware removal.

Follow Up

Patient was followed up after two weeks, six weeks, three month and 6 months. On each subsequent visit, clinical and radiological examination was done. Functional outcome was assessed at the 3rd month and final follow up 6th month on the basis of Constant –Murley Score and American Shoulder and Elbow Surgeon Score.

Results

Observation and result will be made on the basis of

1. Various surgical modalities
2. Radiological outcome
3. Functional outcome

Score

The Constant-Murley score (CMS) is a 100-points scale composed of a number of individual parameters. These parameters define the level of pain and the ability to carry out the normal daily activities of the patient, The test is divided into four subscales: pain (15 points), activities of daily living (20 points), strength (25 points) and range of motion: forward elevation, external rotation, abduction and internal rotation of the shoulder (40 points). The higher the score, the higher the quality of the function.

Grading the Constant Shoulder Score (Difference between normal and Abnormal Side)

>30 Poor, 21-30 Fair, 11-20 Good, <11 Excellent

ASES (American Shoulder and Elbow Surgeons) Score

The score is based on patient and physician evaluation scoring along with the visual analog score The shoulder score is derived by the following formula: (10 - Visual analog scale pain score) x 5 = • + (5/3) x Cumulative ADL score. (Maximum 100)

Observations

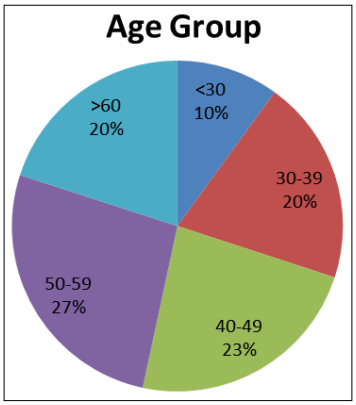
Distribution of fracture in age group, tends to show the increase in fracture tendency from the adolescent age group to the adult and elderly with slight decrease in the incidence in the above 60 years of age. May be due to more sedentary activity of the elderly and the less use of motor vehicle which are the most common mode of injury.

With the increase of age the osteoporosis sets in and thus the tendency of the fracture increases from young age to older age groups.

Table 1: Distribution according to age

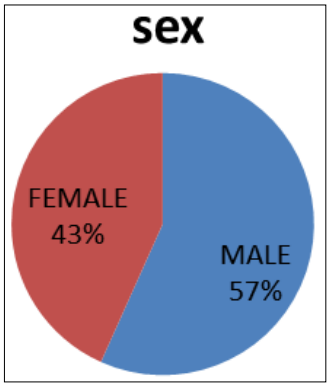
Age Group (Years)	Number	Percentage
<30	8	10%
30-39	15	20%
40-49	18	23.33%
50-59	20	26.67 %
>60	15	20 %

Table 2: Distribution according to sex



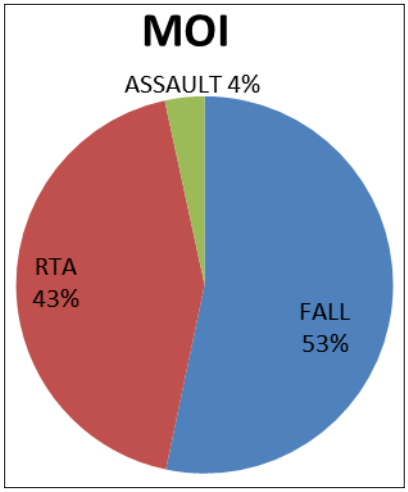
The study concluded that the males 43 (56.7%) are more prone to suffer from the proximal humerus fracture as compared to the female 33 (43.3%), suggesting their work environment and activites makes them more likely of getting it.

Table 3: Distribution according to mode of injury



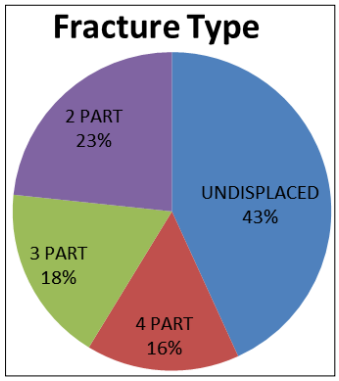
Fall looks like to more common mode of injury 41 (53.3%) in case of proximal humerus fracture which is generally from a standing height over the shoulder/arm, followed by high intensity injury (RTA, Fall from height) 32 (43.3%), and the other is assault 3(3.4%) with the impact over the upper arm with high intensity.

Table 4: Distribution according to type of fracture



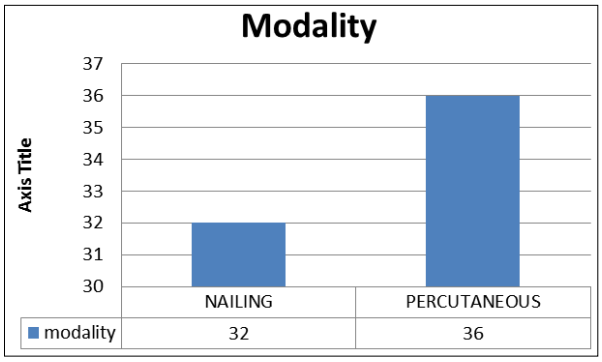
Most common type of fracture is Undisplaced type fracture 79 cases (43.33%), followed by, type 4 28 cases (15.6%) and 33 (18%) respectively in the study, and the type 2 43 cases (23.49%).

Table 5: Distribution according to modality



Out of 76 total patients of 2 and 3 part fracture 68 were operated, 32- Nailing, 36- Percutaneous fixation.

Table 6: Union time



2-part fracture showed same mean union time of 6 weeks by both the methods of treatment, in 3-part fracture showed mean union time of 10.2 week by percutaneous fixation and 8.6 week in PHN.

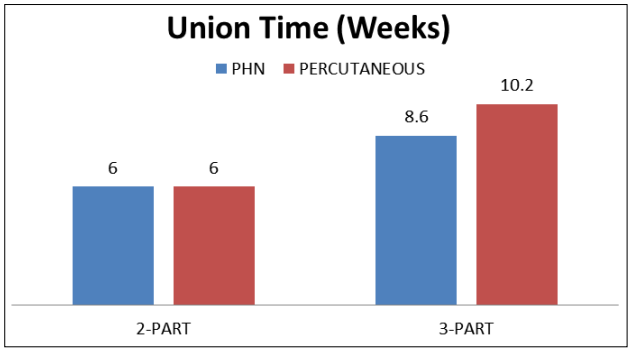
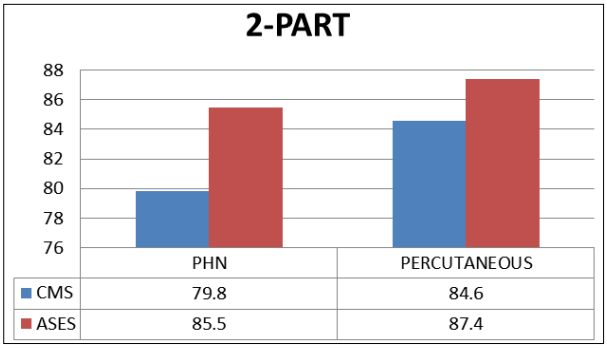
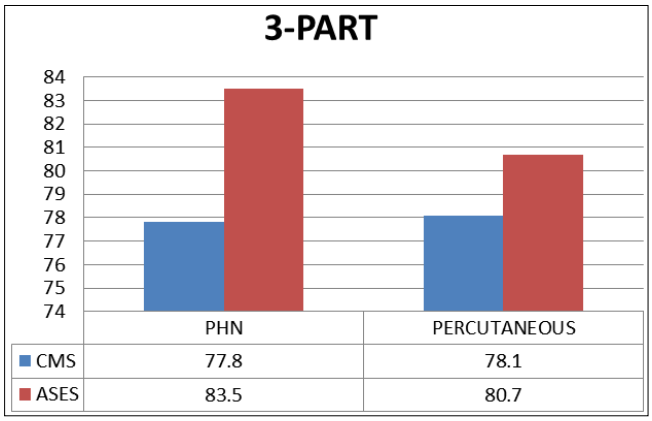


Table 7: Functional outcome

Determined by the functional outcome of the patients at 6 month follow-up by Constant Murley Score and ASES (American Elbow and Shoulder Surgeon Score).





Discussion

Proximal humerus fracture accounts for 5-6 % of the total fracture reported in the casualty department and due to increase in the risk factors in the era the percentage is towards the increasing trend, thus the proper management of the same is necessary to enable the patient with the best functional capacity possible

The mean age in the study was 46.6 yr which is in the adult group which is comparable to various studies. Vijayvargiya *et al*. conducted a study from 2011-2013 in which mean age of the patients were 46yr [12], Zhu *et al*. 2011 found mean age for 50.5 yrs in 51 patients with the follow up of 3 yrs [13].

In the present study the different fracture management techniques are evaluated according to their union time percutaneous fixation is done in 36 patients (20- 2 part and 14 3-part) it has a mean l union of 6 wk in both the cases (Barkat *et al*. (2011) conducted a study on 18 patients with followup of 14 m concluded that The average time of healing was seven weeks [14], Nishikant Kumar *et al*. (2013) conducted a prospective study for 3 yr and concluded that the average time of healing was 7 weeks in fracture fixed by percutaneous pins [15] Satish *et al* published a study in 2016 evaluating 25 patients for followup of 6 m Mean duration for union was 6.5 (±1.18) weeks [16].

Mean CMS score at 6 month of present study in all fracture types treated by the percutaneous fixation was 84.6 in 2-part and 78.1 in 3-part, which was comparable to study published by Satish R Gawli *et al*. [16] in 2016 who found it to be 78.1 and study published by Barakat *et al*. [14] in 2011 who found it to be 73.

Mean ASES score at 6 month in percutaneous fixation was found to be 87.4 in 2-part and 80.7 in 3-part in the present study which was comparable to study published by Jiang CY *et al*. [17] in 2004 who found it to be 91.4.

Mean CMS at 6 month of present study in all fracture types treated by the Proximal Humeral Nail (PHN) was 79.8 in 2-part and 3-part 77.8 which was comparable to study published by Hao *et al*. [18] in 2017 who found it to be 75.1 and study published by Jason Wong *et al*. [19] in 2016 who found it to be 72.8

Mean ASES score at 6 month in PHN was found to be 85.5 in 2-part and 83.5 in 3-part in the present study which was comparable to study published by Hao *et al*. [18] in 2017 who found it to be 81.7 and Jason Wong *et al*. [19] who published a study in 2011 found it to be 84.3.

Results

In 2-part fracture both the fixation technique showed the similar radiological union time of 6 week and functional outcome of PHN (16 cases) was ASES-85.5 and CMS-79.8, and Percutaneous fixation (20 cases) mean ASES- 87.4 and CMS-84.6

In 3 part fixation the radiological union showed by the PHN (18 cases) was 8.6 week and the ASES -83.5 and CMS- 77.8, in percutaneous fixation (14 cases) was 10.2 week and mean ASES -80.7 and CMS-78.1.

There was pin loosening in 2 patient of 3-part fracture fixed with percutaneous pinning, 1 screw loosening in PHN of 3 – part fracture, 5 cases of malunion in percutaneous group (1in 2-part and 4 in 3-part type).

Conclusion

Patient with 2-part fracture favours the fixation with percutaneous fixation given the adequate bone quality and no metaphyseal involvement, and also have the better functional outcome. In 3-part fracture the PHN has a better functional outcome and union time. The proximal humerus fracture along the factors of fracture type, is still varied on the fracture anatomy and the bone condition to decide the method of fixation.

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