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Management of Proximal Humerus Fracture - A Case Control Prospective Study

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ABSTRACT:

Objective: To study the management and functional outcome of the treatment of the fracture of neck humerus.

Material and methods: 30 cases of neck humerus fractures were managed with closed reduction with U-Slab application or closed reduction with P/C K-wire fixation to achieve reduction. ¾ Post-reduction mobilization i.e. pendulum exercises were started after 4 weeks in cases in whom reduction was good and in others it was delayed for 6-8 weeks. The study included 57% of male patients and 43% of female patients. 57% of the fracture occurred in 50 to 80 years age group.

Results: Domestic fall accounts for 60% of the cases. ¾ According to the Neer's classification there were two part fracture (73.33%), three- part fracture (20%) and four - part fracture (6.67%). Most of the patients managed conservatively with closed reduction with U-slab application with good reduction had excellent to satisfactory results (92.5%cases). All patients managed with percutaneous k- wires fixation (10% cases) had satisfactory results.

Biologically, the technique of closed reduction and percutaneous pinning is good from the standpoint of retaining the vascularity of the humeral head. In our study, majority of the cases had satisfactory functional results. It can be used for un-displaced or displaced two- three- or four- part fracture of the proximal humerus without communication in the younger age groups with good bone quality.

Conclusion: An adequate management technique will minimize complications and an aggressive rehabilitation regime will ensure the best possible result.

Introduction

- Proximal humeral fractures are one of the most common osteoporotic fractures.They account for 5% of all the injuries to the appendicular skeleton[1,2].
- In shoulder injuries among patients aged 15 to 64 years, one - third of the injuries were proximal humeral fractures, one- third were clavicular fractures, and one - sixth were primary glenohumeral dislocations[3].
- Fractures of the proximal humerus follow a unimodal elderly distribution curve with a low incidence under the age of 40 years and an exponential increase thereafter[1].The majority of fractures are undisplaced or stable two-, three-, and four-part fractures.
- Fractures in adolescents and younger adults are usually produced by high-energy injuries, mainly from road traffic accidents, sports injuries, falls from height, or gunshot wounds. However, these are much less common than fractures in the elderly, which are usually low-energy osteoporotic injuries[4,5,6,7,2]. More than three - quarters follow low-energy domestic falls[5,6,2,8] and the risk of fracture is increased in sedentary

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individuals with low bone mineral density, a family history of osteoporotic fracture, frequent falls, and evidence of impaired balance[9]. Middle-aged patients who sustain low-energy fractures frequently have a predisposing medical comorbidity or are physiologically older through the effects of alcohol, drug, or tobacco overuse[10,11].Any other condition that produces osteoporosis at an earlier age will also increase the risk of fracture.

- In females, an early menopause is probably the most common cause of this.
- Elderly patients, with advanced osteoporosis or with medical comorbidities, are more likely to have displaced fractures[12].
- A proximal humeral fracture may occur from direct impact to the shoulder or indirectly by transmission of forces from a fall onto the outstretched arm.
- The non-dominant arm is also affected in up to three - quarters of cases[13,14] suggesting an association with reduced strength and neuromuscular coordination.
- Fractures of the proximal humerus are complex injuries with significant morbidity. Although various options of management are available including non-operative management, at present, the choice of treatment depends upon the pattern of the fracture, the quality of the bone encountered, the patient's goals and the surgeon's familiarity with the techniques. The age of the patient, the physical activity and the medical fitness also largely influence the treatment options.
- Treatment options for these displaced fractures include closed reduction and plaster application, closed reduction and percutaneous k-wires fixation & open reduction and internal fixation.
- The main principle of fixation is reconstruction of the articular surface, including the restoration of the anatomy, stable fixation with minimal injury to the soft tissues preserving the vascular supply.
- To study the management and functional outcome of the treatment of the fracture of neck humerus.
- To study the complications, if any and their management.

METHODS OF TREATMENT

- The ultimate goal in the treatment of all fractures is return to usual activities as soon as and to as nearly normal an extent as possible. Many methods of treatment of proximal humeral fractures have been proposed through the years, creating a great deal of controversy and at times confusion. Sound judgement is required to determine the appropriate treatment for each fracture.
- The various methods that are available are :
  - Closed reduction.
  - Initial immobilization and early motion
  - Percutaneous pinning & External fixation
  - Plaster splint and cast
  - Skeletal traction
  - Open reduction and Internal fixation
  - Prosthetic replacement

Closed Reduction

- For years, closed reduction has been a popular method of treatment for many types of proximal humeral fractures. However, it is important to differentiate between those fractures, which are suitable for closed reduction and those which are not.
- Repeated and forcible attempts at closed reduction may complicate a fracture by causing further displacement, fragmentation or neurovascular injury. Various types of reduction maneuvers have been used with mixed results.
- Watson-Jones described a classic technique of hyper-abduction and traction to achieve a closed reduction.
- Displaced anatomical neck fractures are difficult to treat by closed reduction because head is small and rotated or angulated in the capsule.
- Displaced surgical neck fractures can be reduced with gentle traction with flexion and some adduction, but many a times, there is soft tissues interposition requiring surgery.

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- Greater tuberosity fractures are retracted posteriorly and superiorly and hence, closed reduction is difficult or even if achieved, is unstable resulting in mal-union and loss of movements.
- Displaced lesser tuberosity fractures can be treated by closed reduction if it does not block internal rotation.
- Three- and four- part fractures are unstable and difficult to treat by closed reduction.Recent literature has reported poor results with closed reduction, with high incidence of pain, mal-union and avascular necrosis.

Initial immobilization and early motion:

- Initial immobilization and early motion has been described with varying degrees of success for minimally displaced fractures. The shoulder has a large capsule, allowing a wide range of motion that can compensate for even moderate amounts of displacement. The arm is supported by a sling at the side or in the velpeauposition. Gentle range of motion exercise is started by 7 to 10 days, when pain has reduced and patient is less apprehensive.

Plaster Splints & Casts:

- Older literature suggested that reduction in an abducted and flexed position was essential for proper alignment and advocated shoulder spica casts and braces to maintain reduction, which were extremely cumbersome and uncomfortable for the patient. The use of hanging arm casts for fracture of proximal humerus should be avoided, because of the tendency of distraction at the fracture site leading to non –union or mal-union.

Percutaneous Pins & External Fixation:

- Percutaneous pinning may be used after closed reduction if reduction is unstable. Jacob& co-workers have outlined the technique and reported satisfactory results in 35 of 40 cases. This method of treatment is technically demanding but it offers advantage of less disruption of soft tissues and minimal fixation, thus reducing the prevalence of avascular necrosis.

Skeletal Traction:

- The use of traction is not commonly indicated but may be helpful in the management of comminuted fracture. The shoulder is flexed to 90º and elbow is also flexed to 90º. A threaded 'K' wire or Steinmann pin is placed in the ulna and the forearm and wrist suspended in a sling. The goal is to try to hold the shaft fragments in a neutral position. When there is sufficient callus formation, the traction can be discontinued and the patient's arm placed in a sling or spica cast.

Open reduction and internal fixation

- Closed reduction and external fixation has been unable to correct deformity and maintain reduction sufficiently. The goal of internal fixation should be stable reduction, allowing for early motion of the shoulder. The current trend is towards limited dissection of the soft tissue about the fracture fragments and the use of minimal amount of hardware required for stable fixation.

Prosthetic Replacement

- The use of humeral head prosthesis for fracture of proximal humerus was first reported in the early 1950s. The original Neer I prosthesis was designed in 1951.In 1953,Neer reported the first use of this prosthesis for complex fracture-dislocation of proximal humerus. The original prosthesis was revised by Neer in 1973(Neer II) to a more anatomic surface design.
- The prosthesis has two head sizes-15 to 22 mm in thickness. The larger size gives better leverage and mechanical advantage for forward elevation, but the smaller size may be required for coverage by the rotator cuff. There are three stem sizes-7,9.5 and 12mm and two stem lengths 125 and 150mm.Longer stem lengths are available if needed to bridge a shaft fracture.
- Recently, modular hemi- arthroplasty has been used in treatment of complex fractures of proximal humerus. The modular humeral design offers greater flexibility in head sizes, perhaps allowing more precise tensioning of soft tissues. Moreover,the ability to disassemble the component allows easier access to the glenoid, if revision to a total shoulder replacement is contemplated later.

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COMPLICATIONS

- Potential complications may occur with any mode of treatment. An awareness of these complications is the first step in protecting them. It can be divided into :
  - Bony complications
  - Muscle complications
  - Soft tissue complications and
  - Hardware complications.

A.BONY COMPLICATIONS

- **MALUNION-** Mal-union occurs after inadequate closed reduction or failed ORIF. Mal-union of greater tuberosity leads to impingement syndrome.Mal-union of surgical neck fractures with increased anterior angulation can limit forward elevation. Mal-union and avascular necrosis of three-& four- part fractures are more complex and usually require a prosthesis.
- **NON UNION-** Non-union can occur due to many reasons namely :
  - Loss of blood supply due to excessive surgical stripping.
  - Distraction caused by pin traction or hanging arm cast.
  - Interposition of long head of biceps.
  - Inadequate holding power of screws in elderly osteoporotic bones.
  - Early mobilization in the absence of adequate fixation.
- **AVASCULAR NECROSIS**- Avascular necrosis is not uncommon after three- and four-part fractures and joint. Apart from nature of injury, excessive dissection of soft tissue is also a major contributing factor.
- **GLENOHUMERAL ARTHRITIS**- This can follow mal-union or avascular necrosis, non-union, recurrent shoulder instability or significant shoulder stiffness. This results in painful loss of glenohumeral movements.
- **RECURRENT INSTABILITY**- Recurrent instability occurs as a result of overlooked glenoid fracture or rotator cuff injuries.

B. MUSCLE COMPLICATIONS

- **MUSCLE CONTRACTURE & JOINT STIFFNESS**- This usually results if post-operative motion is not started early. The patient has a stiff, painful, dysfunctional shoulder from prolonged immobilization which is required for healing.
- **MUSCLE ATONY**- Muscle atony with inferior subluxation of humerus occurs frequently after a fracture or almost universally immediately after ORIF.Support with sling and isometric exercises for deltoid and affected muscles are required.
- **MYOSITIS OSSIFICANS**- Repeated closed reductions or delay in treatment for more than two weeks, are associated with increased of this dreaded complication.
- **ROTATOR CUFF OR DELTOID DEHISCENCE**- Rotator cuff dehiscence may occur with disruption of tuberosity repair or as a result of aggressive early rotation. It can also occur with prominent and mal-united greater tuberosity. Deltoid dehiscence is seen after anterior acromioplasty and more so, with lateral acromionectomy and is very much disabling.

C. SOFT TISSUE COMPLICATIONS

- **INFECTION**- Infection is a given risk with any open injury. It is seldom a problem with elective surgery provided prophylactic antibiotics are added before skin incision and continued for 24 to 48 hours post-operatively.
- **VASCULAR INJURY**- Injury to the axillary artery accounts for 6% of all arterial traumas. It occurs secondary to fracture of proximal humerus and is the most common vascular injury seen in this fracture. The most common site of injury to axillary artery is proximal to take-off of anterior circumflex artery.
- **BRACHIAL PLEXUS INJURY**-This can occur after fracture of proximal humerus. Stableforth reported an incidence of 6% after fractures of proximal humerus. Any or all components of the plexus may be involved.
- **AXILLARY NERVE INJURY**-Isolated injury to axillary nerve is not uncommon and usually occurs after surgical repair.

D. HARDWARE COMPLICATIONS

- Wires, screws, staples and plates may loosen, break, migrate to nearby neurovascular structures or impinge upon glenoid humeral head or

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acromion. Similarly, prosthesis may get loosened requiring revision surgery.

RESULTS

- In this study, 30 patients with fracture neck humerus were treated by close reduction with U-slab application and CRIF with K wire fixation. This study was conducted from January 2017 to January 2018 at department of orthopedics in SSIMS Medical College and Hospital, Bhilai, C.G.
- The patients were followed up at regular intervals (i.e.) every 1,2,3 and 4 months thereafter. The minimum follow – up period was 12 months. The mean follow-up period in this study was 12-36 months.
- The results were evaluated during follow-up by considering the symptoms like pain, range of motion, strength, stability, function, radiographic documentation of fracture healing, anatomic restoration.

There are various methods of functional outcome evaluation:-

1. American shoulder and elbow surgeon's basic data evaluation[60].
2. The university of California at Los Angles[61] (UCLA Score)
3. Oxford Shoulder Score[62].
4. Neer's 100 point rating system.

Out of the above mentioned scores, we have graded the results of our study using Neer's 100 points rating system. This grading system consists of:

- 35 points for pain
- 30 points for function
- 25 points for motion
- 10 points for anatomy

Functional Assessment Key According Neer's 100 points rating system

1.	**Pain**	**Total 35 Units**
	A. No Pain	35
	B. Slight or Occasional	30
	C. Mild, No effect in ordinary activity	25
	D. Moderate, tolerable, starting to affect ordinary activity	15
	E. Marked, serious limitation of ordinary activity	5
	F. Total Disablement	0

2. Functional Ability **Total 30 Units**

a) Strength		**b) Reaching**		**c) Stability**	
Normal	10	Above head	2	Lifting	2
Good	8	Mouth	2	Throwing	2
Fair	6	Belt buckle	2	Carrying	2
Poor	4	Opposite axilla	2	Pushing	2
Trace	2	Brassiere hook	2	Hold over head	2
Zero	0				

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3. Range of Motion **Total 25 Units**

Flexion		Extension		Abduction		External rotation		Internal rotation	
180^0	6	45^0	3	180^0	6	60^0	5	90^0(T6)	5
170^0	5	30^0	2	170^0	5	30^0	3	70^0(T12)	4
130^0	4	15^0	1	140^0	4	10^0	1	50^0(L5)	3
100^0	2	$<15^0$	0	100^0	2	$<10^0$	0	30^0	2
80^0	1			80^0	1			$<30^0$	0
$<80^0$	0			$<80^0$	0				

4. Anatomy **Total 10 Units**

Rotation, Angulation, Joint incongruity, Retracted Tuberosities, Non-union, AVN.

None : 10

Mild : 8

Moderate : 4

Severe : 0 – 2

On overall scores, the patients were grouped into:

Results		**Score**
Excellent	:	> 89 units
Satisfactory	:	80-89 units
Un-Satisfactory	:	70-79 units
Failure	:	< 70 units

Inclusion criteria was patients>18 yrs old with proximal humerus fracture

Exclusion criteria was paediatric age group, open fracture, psychiatric patient, fractures involving gleno-humeral joints, fractures involving diaphysis of humerus.

The patients were followed up for a minimum period of 12 months at regular intervals (1 month, 2 months, 3 months, 4 months, 12 months).

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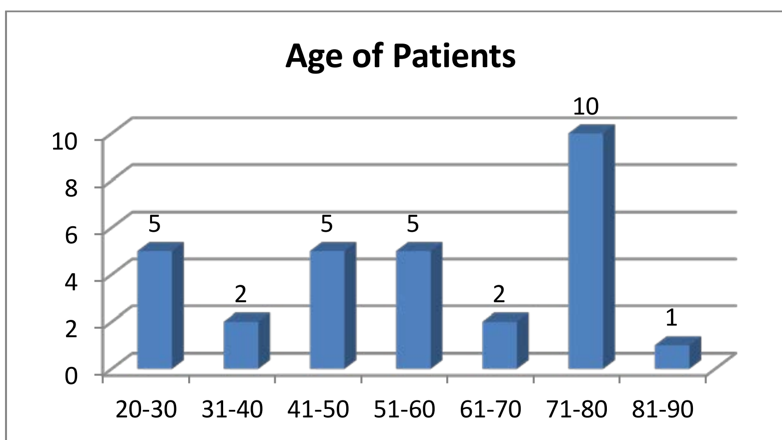
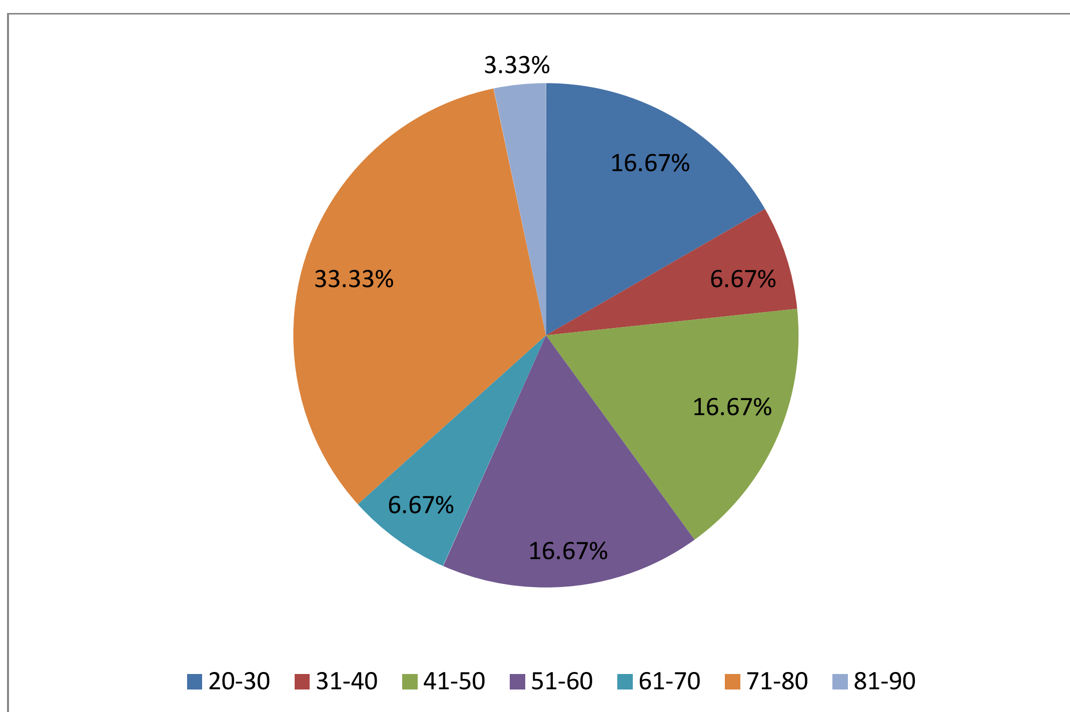
Age variation in the series was from 20 to 90 years. Neck humerus fractures were found to have high incidence in the 70 to 80 age group. The incidence of the study was as follows:

Table No. 1

Age Of Patients(Year)	No of Patients	Percentage
20-30	5	16.67%
31-40	2	6.67%
41-50	5	16.67%
51-60	5	16.67%
61-70	2	6.67%
71-80	10	33.33%
81-90	1	3.33%
Total	30	100%





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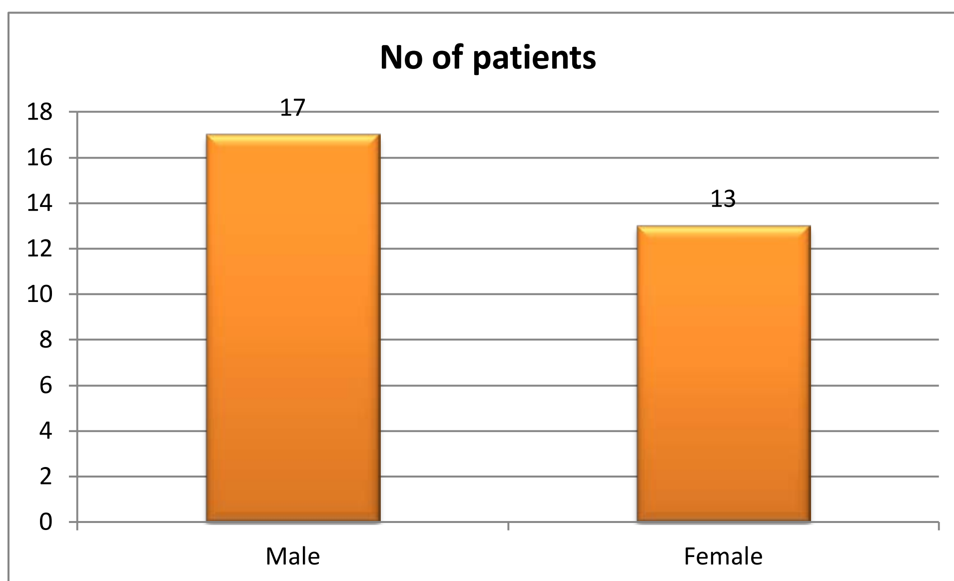
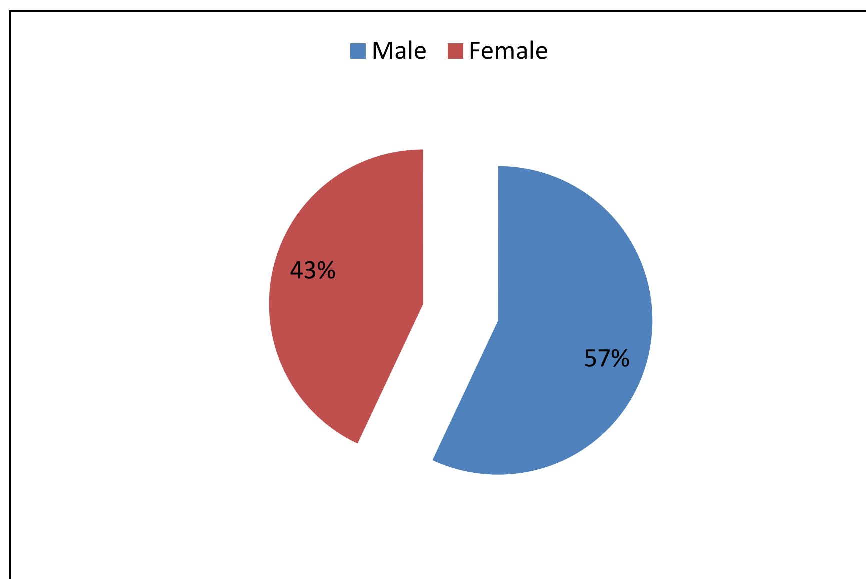
Sex incidence: Among 30 cases, there were 17 males and 13 females i.e. 57% males and 43% females. Males predominated over females in our study. Ratio of females to male was 1.30:1.

Table no. 2

Sex of Patients	No of patients	Percentage
Male	17	57%
Female	13	43%
Total	30	100%





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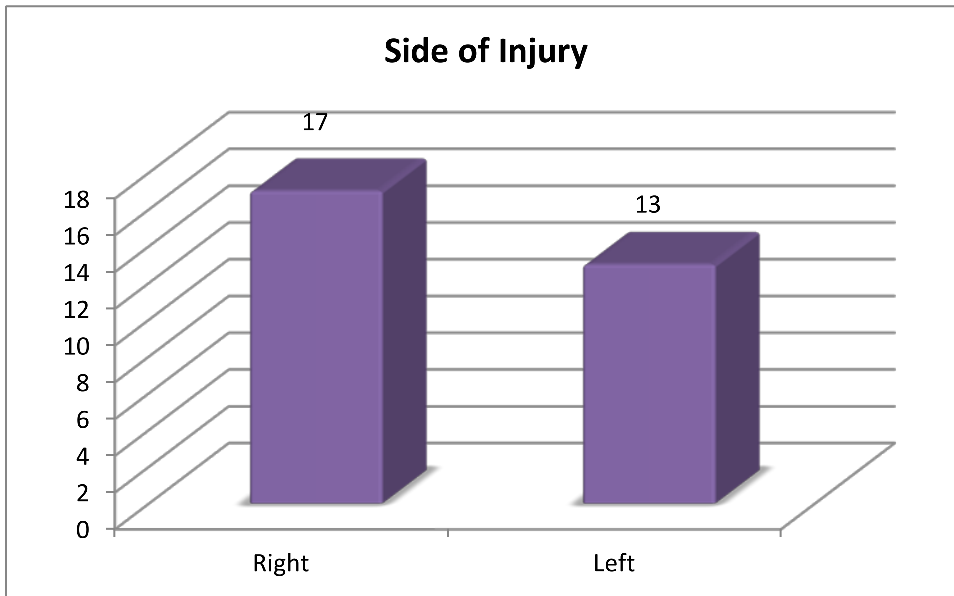
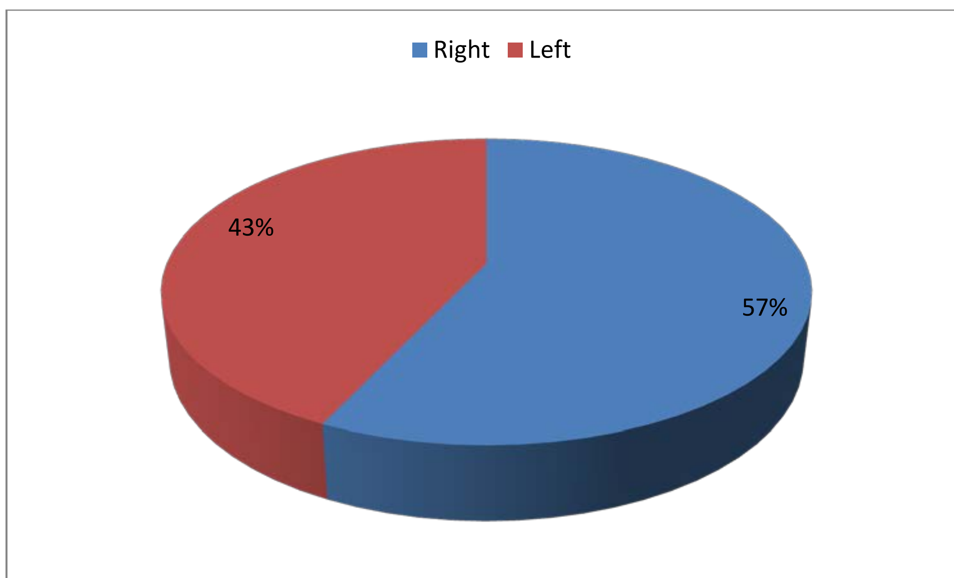
Side of fracture: In our study, right side was more commonly involved than left side. Right side was involved in 17 cases (57%). Left side was involved in 13 cases (43%). None had both the sides involved in the same patient.

Table no. 3

Side of injury	No of patients	Percentage
Right	17	57%
Left	13	43%
Total	30	100%





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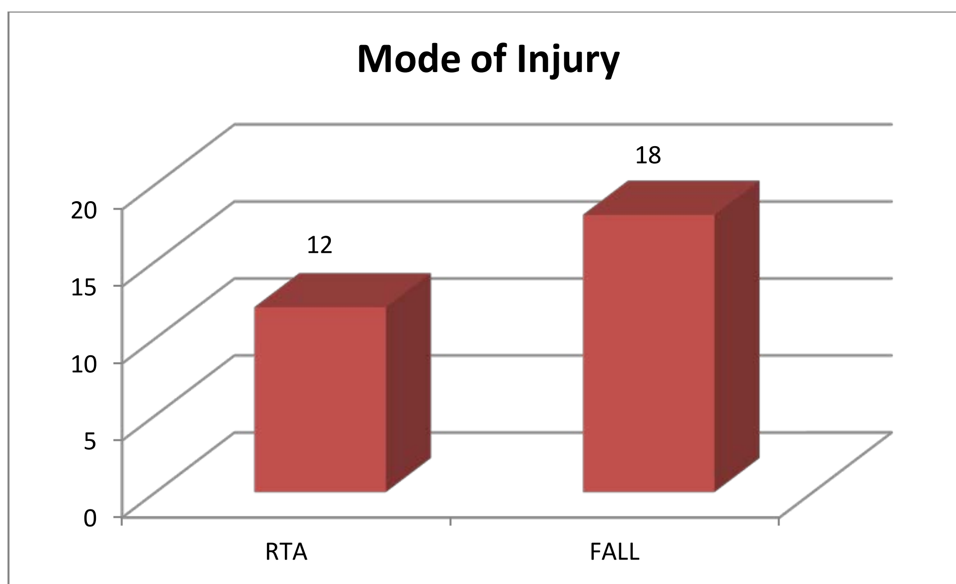
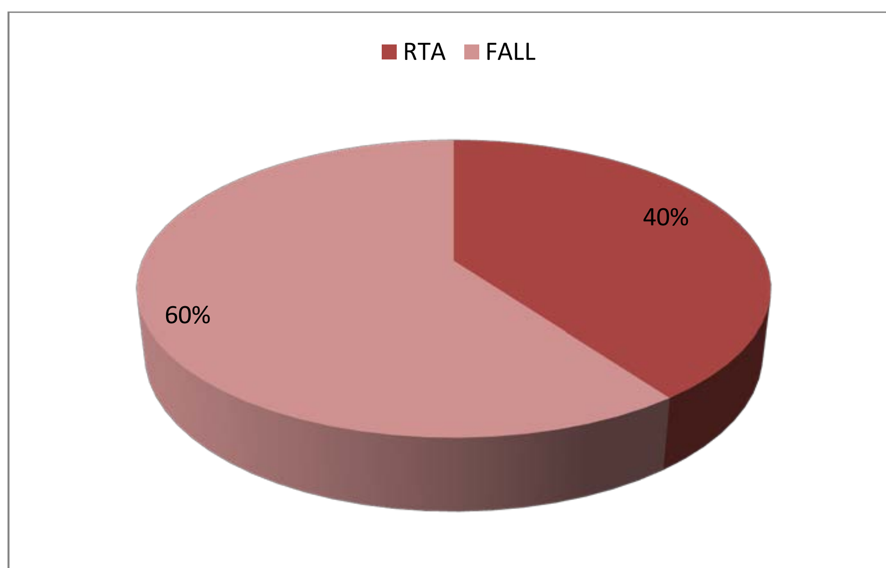
Mode of injury: Most of the injuries were caused by domestic fall due to minor fall, slipping, or agricultural injury and another cause were road traffic accident due to vehicular accident especially in younger age group.

Table No. 4

Mode of injury	No of patients	Percentage
RTA	12	40%
FALL	18	60%
Total	30	100%





Neer's Type of fracture: Two- part fractures constituted the most common type either displaced or un-displaced.

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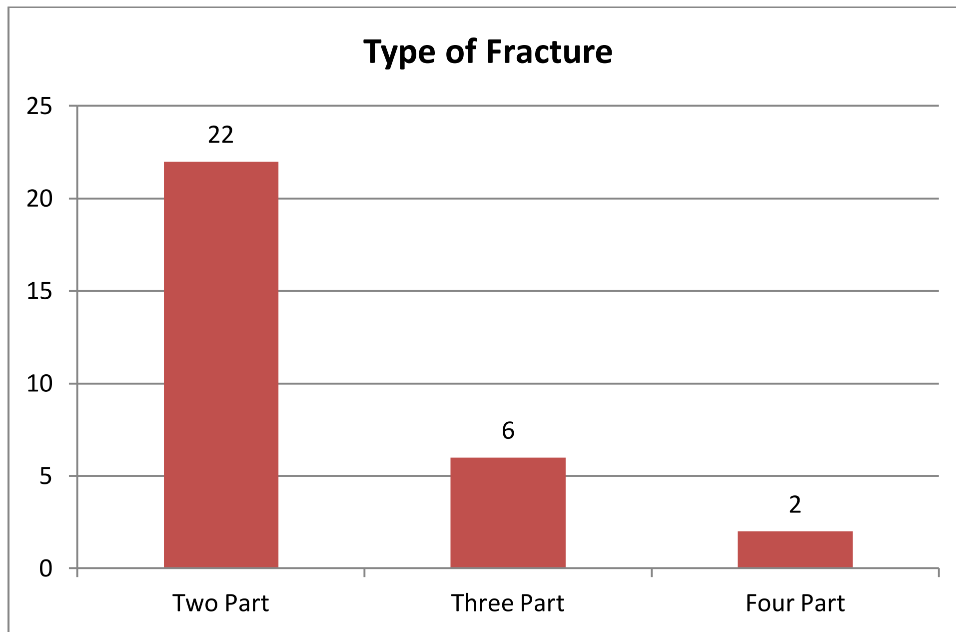
Table No. 5

Type of Fracture	No of Patients	Percentage
Two Part	22	73.33%
Three Part	6	20%
Four Part	2	6.67%
Total	30	100%



ASSOCIATED INJURY

Table No. 6

Associated injuries were noted in 7 cases. It did not affect the treatment.

Associated Injury	No of patients
#Pelvis	1
#Tibia-Fibula	1
#Bimalleoller	1
#Vertebra	1
#Distal end Radius	1
Head Injury	1
#Metacarpal	1
Total Associated Injury	7

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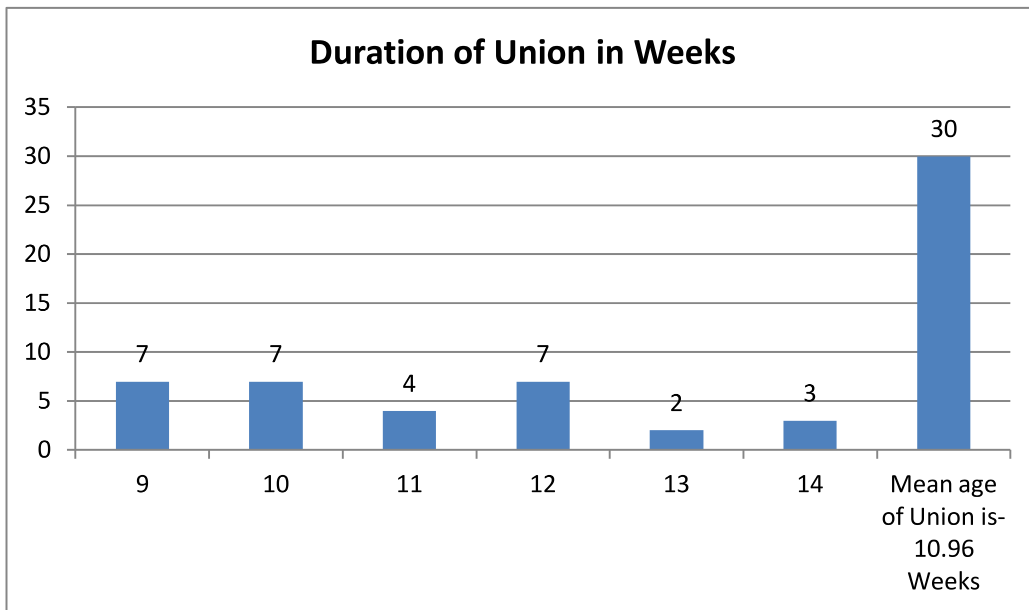
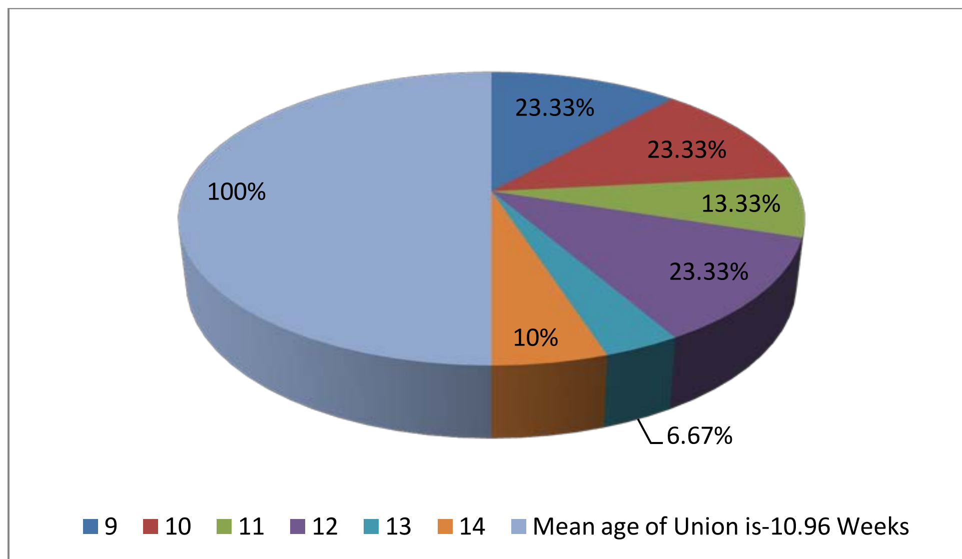
Duration of Union

Most of the patients had union at the age of 9-12 weeks with mean age of union of 10.96 weeks.

Table No. 7

Duration of Union in Weeks	No of Patients	Percentage
9	7	23.33%
10	7	23.33%
11	4	13.33%
12	7	23.33%
13	2	6.67%
14	3	10%
Mean age of Union is-10.96 Weeks	30	100%





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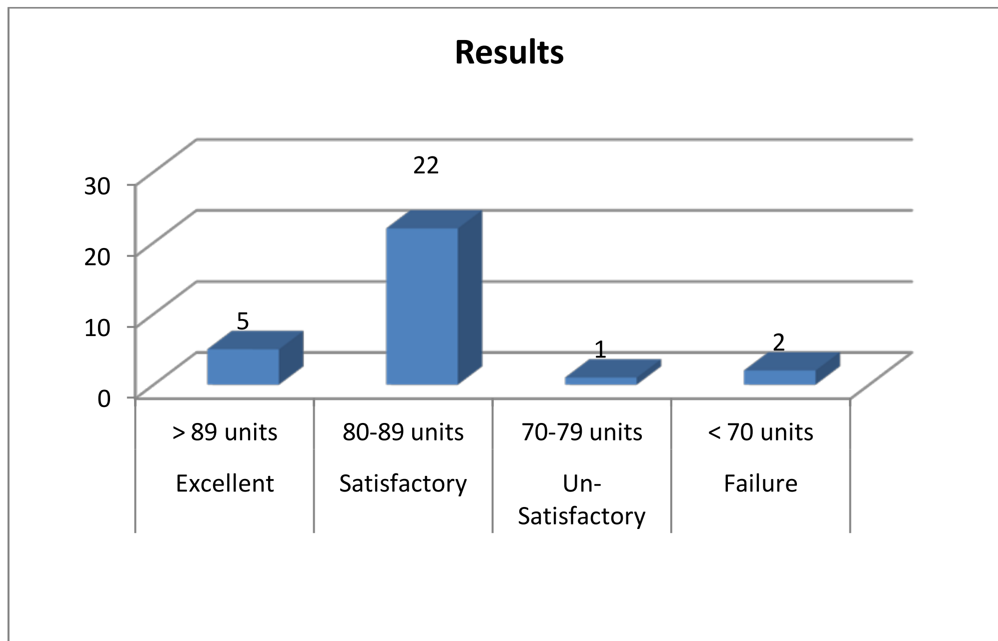
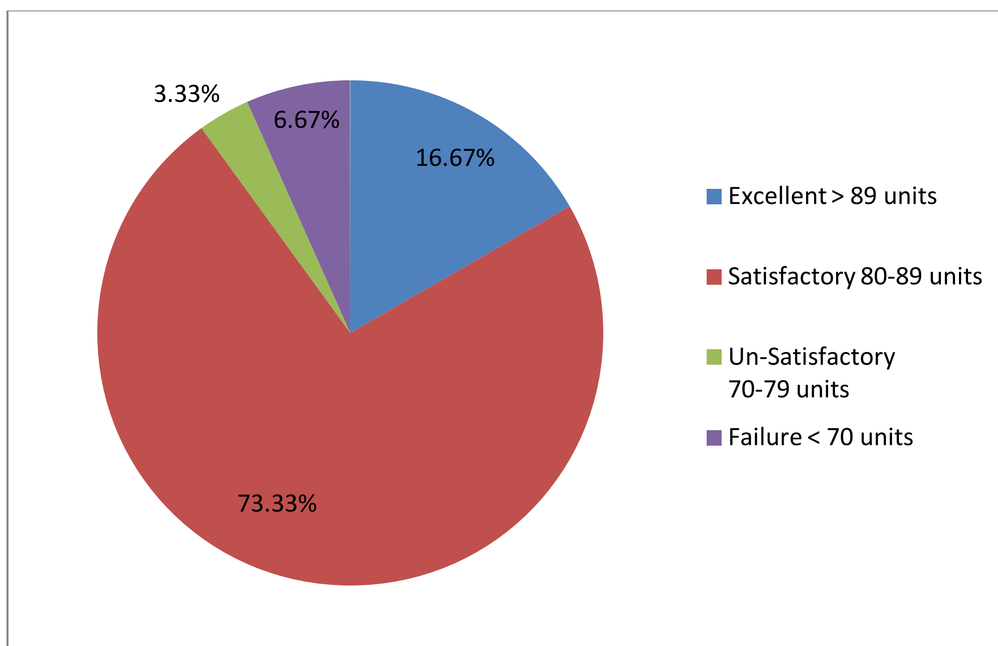
EVALUATION

According to Neer's grading system, 90% of patients had excellent to satisfactory results.

Table No. 8

Results	Score	No of Patients	Percentage
Excellent	> 89 units	5	16.67%
Satisfactory	80-89 units	22	73.33%
Un-Satisfactory	70-79 units	1	3.33%
Failure	< 70 units	2	6.67%
Total	**-**	30	100%





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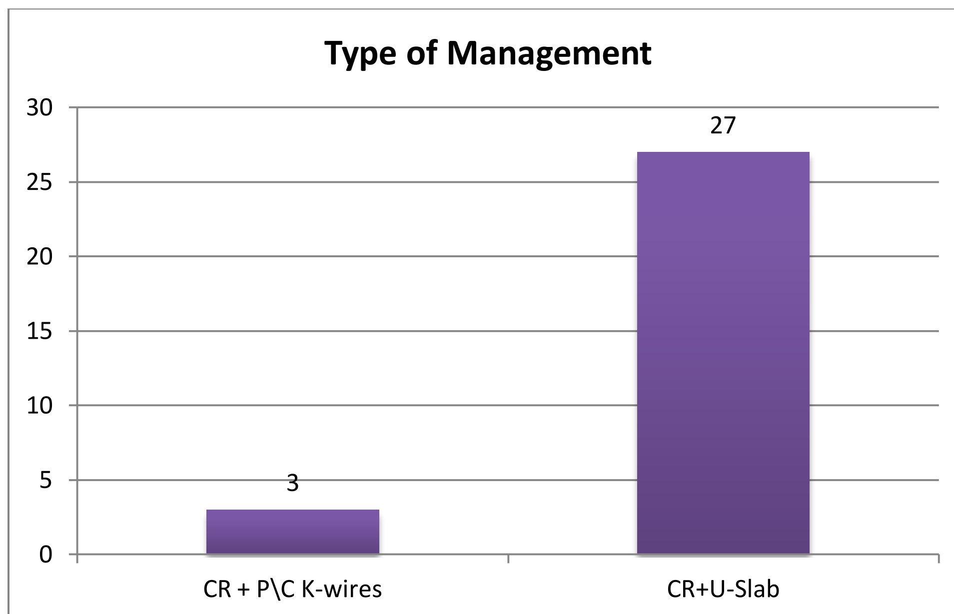
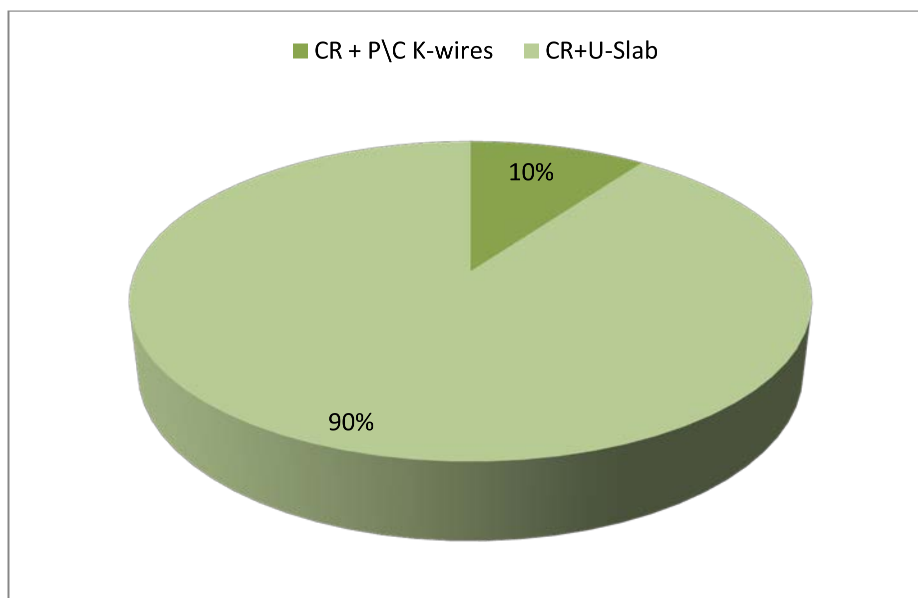
Type of management

Most of the neck humerus fractures were treated with close reduction and U-slab application which were undisplaced or minimally displaced. Others were treated with close reduction and percutaneous k-wires fixation which were grossly displaced with good bone quality.

Table No. 9

Type of management	No of Patients	Percentage
CR + P\C K-wires	3	10%
CR+U-Slab	27	90%
Total	30	100%





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End Result: The Neer's scoring system of the severity of Pain, Function, Range of Movement; Anatomy was done to determine the end results. The end results of 30 patients of neck humerus fractures which were treated, could be categorized as –

End result of percutaneous k-wires fixation

Table No. 10

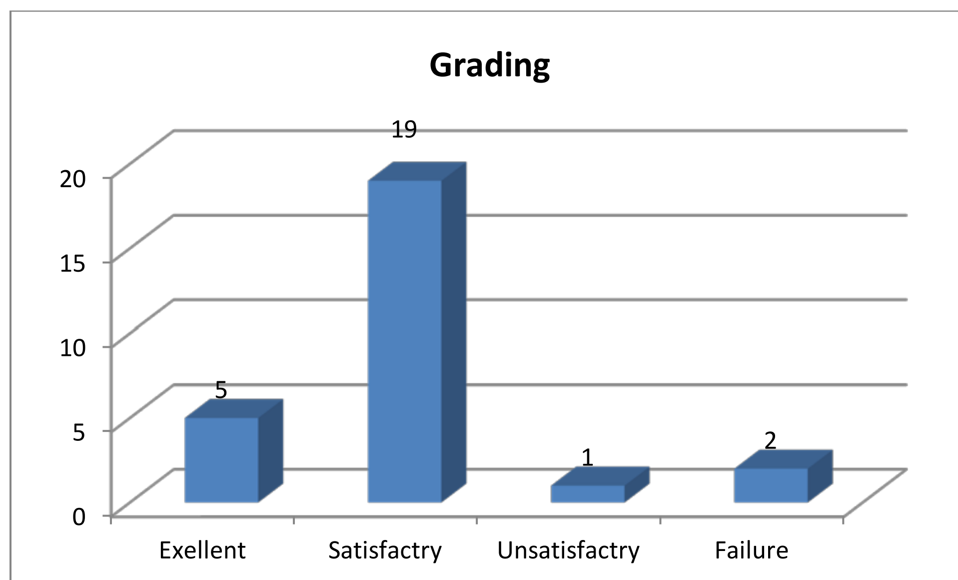
Grading	No of Patients	Percentage
Satisfactory	3	100%

End result of close reduction and U –Slab application

Patients with undisplaced or minimally displaced fracture were managed with closed reduction with U-slab application.

Table No. 11

Grading	No of Patients	Percentage
Excellent	5	18.51%
Satisfactory	19	70.37%
Unsatisfactory	1	3.70%
Failure	2	7.4%
Total	27	100%



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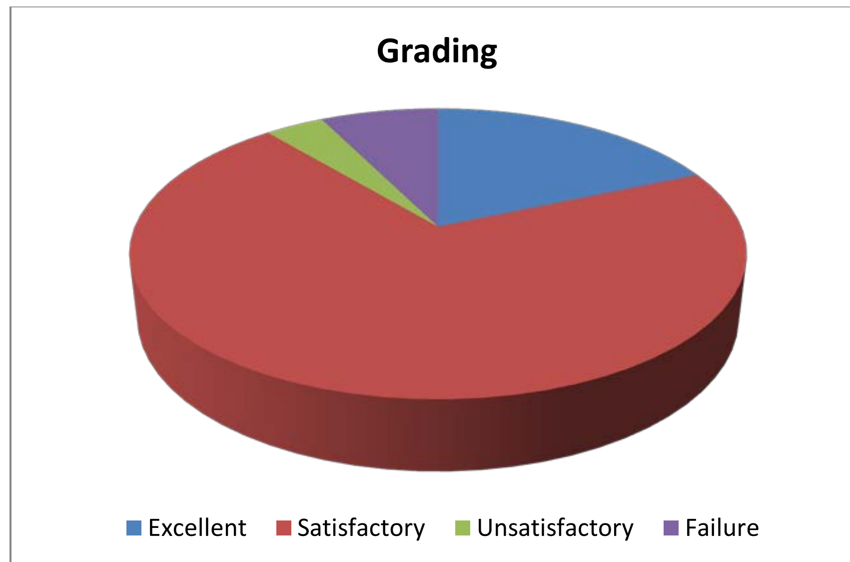

COMPLICATIONS:

1. Complications after closed reduction and k-wires fixation-In our study, total 3 patients were treated with closed reduction and k- wires fixation out of which one had pin infection which was subsequently removed at 3 weeks and universal shoulder immobilizer was given. The wound healed and the patient had satisfactory result.

2. Complication after closed reduction and U slab

In our study, 27 patients were treated by closed reduction and U slab application. In three cases, reduction was difficult due to rotation of the fragments but it could be managed. There were three cases who had abduction between 50-100 degree due to mal-union of the fracture fragment.

Table No. 12

Type of management	No. of patients	Complication	Percentage
CR +P\C K Wires	3	1(Infection)	33.33%
CR+U-Slab	27	3(Mal-union)	11.11%
Total	30	4(Infection + Mal-union)	13.33%

Immobilization:

Patients managed with CR-Uslab (conservative) application make slab in situ for 4 weeks and encouraged to exercise the hand, wrist and elbow. Active exercises were permitted by 4 to 6 weeks. It usually took about a year to achieve optimum function.

Each operated patient was given a Universal shoulder immobilizer immediate post-operatively. The dressing was done accordingly at third and seventh day. The patient was also encouraged to exercise the hand, wrist and elbow. This is continued for six weeks. After 4 weeks, k-wires were removed and pendulum exercises were started (In percutaneous k-wire fixation method). Active or resistive exercises were

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permitted by 4 to 6 weeks. It usually took about a year to achieve optimum function.

Analysis

All the fractures treated united clinically by 6 weeks and radiologically by 12 weeks. There were no problems of delayed union or non-union. The fractures were more common in women with a gender distribution of 1.30: 1 and were also more common in the age group of 70 to 80 years. The right side was affected more than the left. Domestic falls were the most common cause of fractures and involved the older age groups.Most common mechanism of injury was fall on an outstretched hand in the older age. Two- part fracture (commonly surgical neck) accounted for most of the cases (73.33%), followed by three-part fracture (20%)and four- part fracture (6.66%).

Out of three PC/K-wire fixation, one had superficial infectionand out of 27 patients managed conservatively, three had mal-union with limited abduction.

Table No. 13: FUNCTIONAL ASSESSMENT AS PER FRACTURE TYPE:

Type of fracture	Total no. Of patient	Excellent	Satisfactory	Unsatisfactory	Failure
2 Part	22	4	17	0	1
3Part	6	1	4	1	0
4 Part	2	0	1	0	1

The results show that most Neer's two part fracture had excellent to satisfactory results (95.5%). Neer's three part fracture also had 83% excellent to satisfactory results. In our study, one (50%) out of two four- part fractures had infection and one (50%) had failure.

DISCUSSION

The incidence of neck humerus fractures has increased in last few years due to changes in life style and increase in road traffic accidents [63,64]. The best management in these injuries is still uncertain. Studies have shown non-operative and operative treatments, both give favourable results, and the uncertainty remains[65,66].

However, with the aim of getting anatomically accurate reductions, rapid healing and early restoration of function

Table No. 14: Age related study pattern

Study	Age of Patients Studied (yrs)	Mean Age (yrs)
Roland P. Jacob[67]	24-81	49.5
C. Gerber, C.M.L. Werner[68]	16-73	44.5
Wijgman,W.Roolker[69]	19-79	48
Evan L.Flatow,Francis Cuomo[70]	34-72	53
P.Moonot,N.Ashwood,M.Hamlet[71]	18-87	59.9
Present Study	20 – 84	56.3

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Neck humerus fractures occur more commonly in older age group70-80. This is due senile osteoporosis. Numerous age related studies point towards this and our study is consistent with this finding. Further as with other studies, our study showed a higher incidence of fractures in men than in women. The gender ratio was 1.30: 1. This higher ratio can be explained by a higher involvement of male in day to day activities in compare to female.

Table No. 15

Study	Male	Female
Roland P.Jacob[67]	1.57	1.0
C.Gerber,C.M.L.Werner[68]	1.35	1.0
Wijgman,W.Roolker[69]	0.94	1.0
Evan L.Flatow,Francis Cuomo[70]	1.40	1.0
Present Study	1.30	1.0

Motor vehicle accidents constitute a major cause of musculoskeletal trauma worldwide. In our country too, it happens to be very common and is reflected in our study second most common cause after the domestic fall.[6372] 60% of our patients had suffered a domestic fall and 40 % were involved in vehicular accidents.

Different studies, which have used the Neer's scoring system for assessment of results, demonstrate a fairly similar pattern of results.

Table 16: Comparisons of result pattern with other study

Result	Roland P.Jacob[67]	Present Study
Excellent	21%	16.66%
Satisfactory	53%	73.33%
Un-Satisfactory	10%	3.33%
Failure	16%	6.66%

Our poor results have shown strong association with-

1.Three or four part severely displaced fracture.

2. Older patients with severe osteoporosis.

Results were consistently better in one part, less displaced two and three part fracture patterns.

Complication.

The study had its own set of complications[73].

1. Pin infection in one case.

2. Loss of reduction occurred in one patient operated by percutaneous k-wiresfixation.

3. Rotation of fragment intra-operatively in three cases.

4. Mal-union noted in three cases.

5. Restricted range of movement due to impingement were noted in three cases.

Follow - up and Final Result:

In this study, maximum period of follow - up was 14 months and minimum of 12 months.

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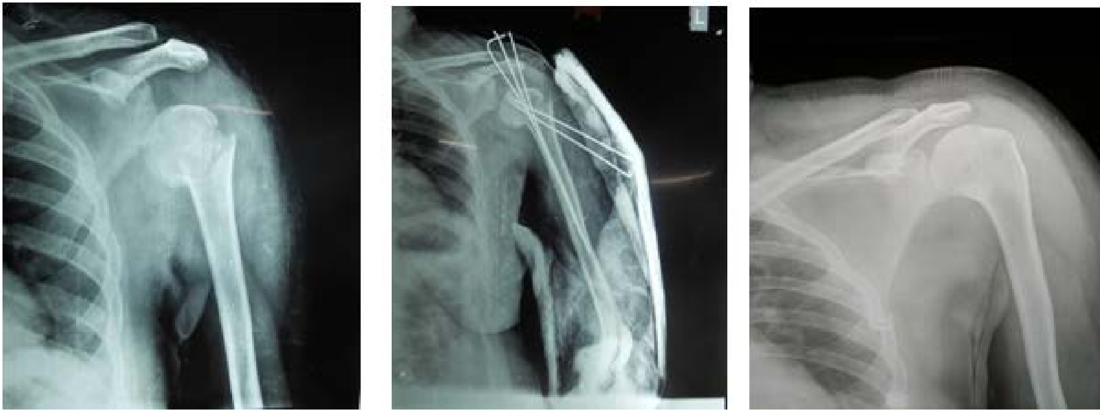
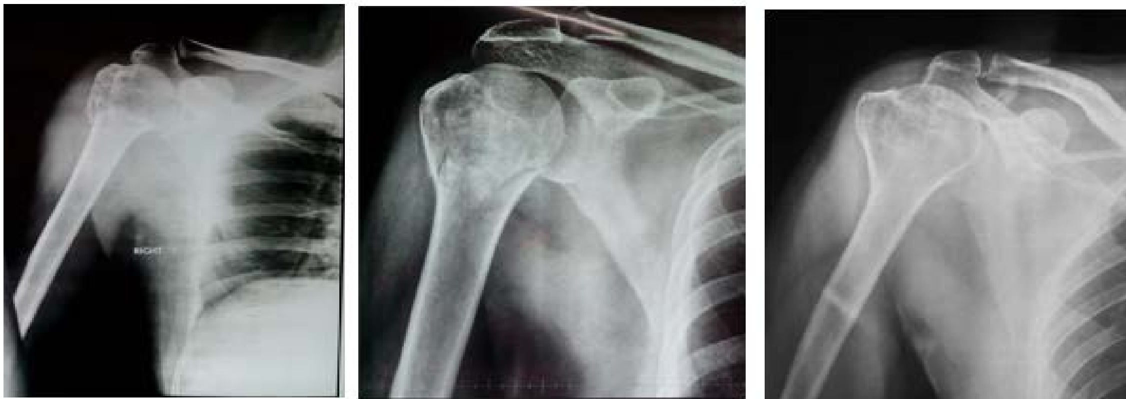
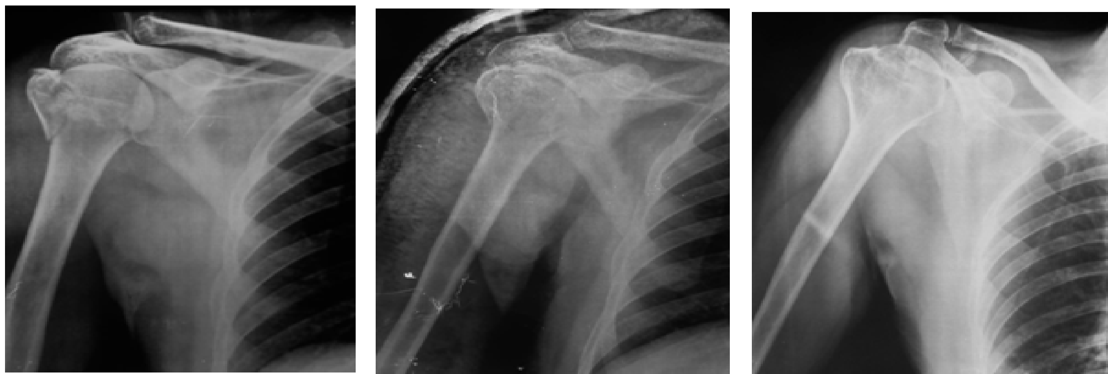
Case No. 1



Case No. 2



Case No. 3



CONCLUSION

- Fractures of the upper end of humerus, surgical neck humerus two- part is most common one.
- Two- and three-part fractures represent almost more than 93.33% of proximal humeral fractures.
- In older patients with osteoporosis, even less severe trauma can produce significant injury.
- In younger patients, neck humeral fractures usually are caused by high- energy trauma.
- They occur more frequently in older patients after the cancellous bone has become weakened by senility and osteoporosis.

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- The options as to the management modality used, depend on the pattern of the fracture, the quality of the bone encountered, the patient's goals and the surgeon's familiarity with the techniques.
- The principle of management is reconstruction of the articular surface, including the restoration of the anatomy, stable fixation, with minimal injury to the soft tissues preserving the vascular supply, should be applied.
- Treatment options for these neck humerus fractures include closed reduction with U- slab application(90%) and percutaneous k- wires fixation (10% cases).
- Treatment with closed reduction with U-slab application with good reduction have excellent to satisfactory results (92.5% cases).
- An adequate management technique will minimize complications and an aggressive rehabilitation regime will ensure the best possible result.
- Mal-union and restriction of movement were associated with poor results.

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