

**“A COMPREHENSIVE
STUDY OF OSTEOSYNTHESIS OF
PROXIMAL HUMERUS FRACTURES
IN ADULTS”**

*A dissertation submitted for the M.Ch. Certification Program In Orthopaedic Surgery
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CERTIFICATE BY THE CANDIDATE

*I certify that this dissertation is the result of my three years of study, record and follow up of the cases during private practice carried out under the guidance and supervision of **Dr. Amrit Gupta**, M.S. Ortho, Senior Consultant Orthopaedic Surgeon of Gupta Hospital , Bathinda(Punjab) and prepared in fulfillment to the requirement of M.Ch. Certification Program In Orthopaedic Surgery in accordance with standards and guidelines set by the University of Seychelles, American Institute of Medicine (USAIM) and Boolean Education.*

I undertake that the thesis is original and that no copyrights have been infringed upon.

Date :12/11/09

Dr. Mohit Gupta

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My study “*Comprehensive Study of Osteosynthesis of Proximal Humerus Fractures in Adults*” has been done with aim to -

1. study the occurrence, mechanism of injury and displacement of various types of fractures.
2. study different modalities of the fixations in proximal humerus fractures.
3. assess and compare the results.
4. come to conclusion about preferred modality of treatment of proximal humerus fractures.

Fractures of the proximal humerus are complex injuries with significant morbidity . Although various options of management available including non-operative management are 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 Patient , the physical activity and the medical fitness also largely influence the treatment options.

Treatment options for these displaced fractures include closed reduction and percutaneous screws fixation (7% cases), closed reduction and percutaneous k- wires fixation (10% cases) & open reduction and internal fixation (83 % cases).

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.

So almost all forms operative osteosynthesis have good success rate although it is variable with available fracture pattern and other patient and surgeon dependent factors.

Introduction

Proximal humerus fractures are one of the commonest fractures occurring in the skeleton. They account for approximately 4 – 5% of the fracture attendance at the hospital ^{1,2}.

They occur more commonly in elderly patients, after cancellous bone of the humeral neck has weakened by senility but these fracture are seen in patients of all ages & merge with epiphyseal separations.

The most serious fractures and fracture dislocations are often seen in active, middle aged patients. These fractures can be extremely disabling and their management often demands experienced surgical skills and judgment ².

Because of increasing incidence of high velocity trauma, complicated fracture pattern in proximal humerus are becoming increasingly common. It has been always engima of management because of numerous muscles attachment and paucity of space for fixing implant in fracture of proximal humerus.

Voluminous literature is available on this topic and treatment pattern is differ very much. The preferred treatment varies depend on the patient's age and bone quality, the expertise surgical team and the patients expectations. Although a number of report have described the outcome of treatment of proximal humeral fractures. Comparison of these fractures is hampered by inconsistence in fracture classification, treatment and evaluation method.

The surgery should be carried out as soon as the patients general condition permit. A delay of several days makes reduction more difficult and a significant delay results in absorption of bone, making secure internal fixation impossible ⁴.

The object of the osteosynthesis is to reduce the displacement (usually rotation) of each fragment and hold it in place with an implant. Thus the greater tuberosity fragment which has usually been displaced proximally and rotated upward by rotator cuff muscles

inserted into it, is replaced and fixed to the major humeral head fragment, lesser tuberosity fragment similarly displaced by subscapularis is replaced and fixed.

Three & four part fractures represent 13 to 16 % of proximal humeral fractures. Treatment options for these displaced fractures include open reduction and fixation. Neer recommended open reduction and internal fixation for displaced two and three parts fractures³. Most of the poor results following open reduction and internal fixation of three part fracture are due to imperfect technique. In a three or four part fracture dislocation when the head of the humerus is entirely devoid of any blood supply it can be replaced by a humeral prosthesis.

This dissertation tries to bring out the salient features of all operable fractures of proximal humerus which require open reduction and fixation especially in adult patients in whom the duration of stay in hospital reflect on the earning capacity of the person and in elderly patients in whom immobilization of upper limb is associated with reflex sympathetic dystrophy, stiffness and shoulder hand syndrome. Thus the requirement of early mobilization without any undue risk of loss of fixation and reduction.

This study was carried out in Gupta Hospital , Bathinda from Feb. 2006 to October 2009, thirty patients of proximal humerus fractures were attended in the casualty and OPD and were admitted in this hospital and were treated surgically.

We collected records of the patients by asking the patients history and examining the patients. Essential investigations of all the patients were done. The patients were operated in our institute with our methods of fixation. Patients coming for follow up were studied regularly.

Inclusion criteria:

All adults patients admitted with proximal humerus fractures.

[Neer's classification : grade 2 to grade 4].

Exclusion criteria:

- A] Medically unfit patients.
- B] Pathological fractures.
- C] Fractures in pediatric age group.
- D] Shaft humerus fractures with proximal extension.
- E] Neer's one part fracture.

Sample size: 30 patients.

After the patients with proximal humerus were admitted to the hospital, all the necessary clinical details were recorded in a trauma sheet comprising of:

1. Age of the patient.
2. History of trauma whether injury was due to fall or road traffic accident.
3. Time and place of injury.
4. Time interval between injury and treatment in our casualty department. This period was less than three days in all cases.
5. Occupation of the patient.
6. Associated injuries e.g. neuro-vascular status, tendon injury.
7. Medical history of the patient.

Then complete clinical examination comprising of local and systemic examination was recorded on trauma sheet itself.

1. Systemic Examination
2. Local Examination
 - a) Swelling and Deformity of the shoulder.
 - b) Check for circulatory status.
 - c) Sensation of the shoulder and arm.
 - d) Condition of the skin.

Radiographic evaluation of the shoulder were done according to Neer's trauma series which consists of:

- ❑ A true anteroposterior (AP) view of the scapula,
- ❑ A lateral ' Y-view ' of scapula, and
- ❑ An axillary view.

Fractures were classified according to the Neer's classification and patients were shifted to the ward after initial temporary immobilization with Universal shoulder immobilizer. All the routine investigations were done on all the patients pre-operatively with complete medical and anesthetic fitness of patient for surgery.

Following factors were taken into consideration while deciding the modality of treatment to be used:

1. Neer's classification two, three or four part fracture with associated displacement.
2. Presence of humeral head dislocation and humeral head comminution.
3. Valgus impaction.
4. Comminution.
5. Quality of bone.
6. Open or compound fracture.
7. Age of the patient.
8. Associated general and medical condition of the patient.
9. Other associated lesions e.g. brachial plexus palsy.
10. Functional requirements of the patient.

Method of Treatment:

All the patients were operated on elective basis after overcoming the avoidable anesthetic risks. All patients were treated by one of the following methods.

1. Closed reduction and Percutaneous K- wires fixation.
2. Closed reduction and Percutaneous Screws fixation.
3. Open reduction and Internal fixation with various implants e.g. Cloverleaf plate, Cobra plate, Locking compression plate.

Inclusion criteria for closed reduction and Percutaneous fixation:

1. Un-displaced two, three or four part fractures defined as < 45 degree of angulation of articular surface or less than 1 cm of displacement between major fragments³¹.
2. Where fracture is un-displaced or displaced, but there is no comminution³².
3. Where fracture can be reduced close but is stable.^{33, 34}
4. Maintenance of glenohumeral congruity.
5. Poor general or medical condition of the patient especially elderly where short procedure is required.
6. Two, three and four part valgus impacted fracture without lateral displacement.^{35, 36}

Exclusion criteria for closed reduction and Percutaneous fixation :

1. Severely displaced fractures.
2. Comminuted fractures.
3. Irreducible two, three and four-part fractures.
4. Fractures involving splitting of the articular surface of the Humeral head

Inclusion criteria for open reduction and internal fixation :

1. Young age³⁷
2. Absence of comminution of head (intact humeral head).
3. Good bone quality.
4. An angulation of the articular surface of more than 45 degree.
5. Displacement between the major fragments of more than 1cm.

Exclusion criteria for open reduction and internal fixation:

1. Open fracture.
2. Presence of severe head comminution.

Functional Assessment Key:

1. Pain

Total 35 Units

- A. No Pain 5
- 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

- | | | |
|--|---|---|
| <p>a) Strength</p> <ul style="list-style-type: none"> ▪ Normal 10 ▪ Good 8 ▪ Fair 6 ▪ Poor 4 ▪ Trace 2 ▪ Zero 0 | <p>b) Reaching</p> <ul style="list-style-type: none"> ▪ Above head 2 ▪ Mouth 2 ▪ Belt buckle 2 ▪ Opposite axilla 2 ▪ Brassiere hook 2 | <p>c) Stability</p> <ul style="list-style-type: none"> ▪ Lifting 2 ▪ Throwing 2 ▪ Carrying 2 ▪ Pushing 2 ▪ Hold over head 2 |
|--|---|---|

3. Range of Motion

Total 25 Units

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

4. Anatomy

Total 10 Units

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

- None 10
- Mild 8
- Moderate 4
- Severe 0 – 2

These criteria were proposed by Neer. The maximum points are 100 units:

Pain	:	35 Units
Function	:	30 Units
Range Of Movement	:	25 Units
Anatomy	:	10 Units

On overall scores, the patients were grouped into:

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

Application of Biostatistics :

To compare results of our study with other standard studies we have used 'Chi-Square' test. By using this test we have calculated P value. If P value is >0.05 , the test result is not significant. That means these two study population are comparable.

If P value is < 0.05 , the test result is significant. That means these two study population are not comparable.

Observations & Statistical Analysis

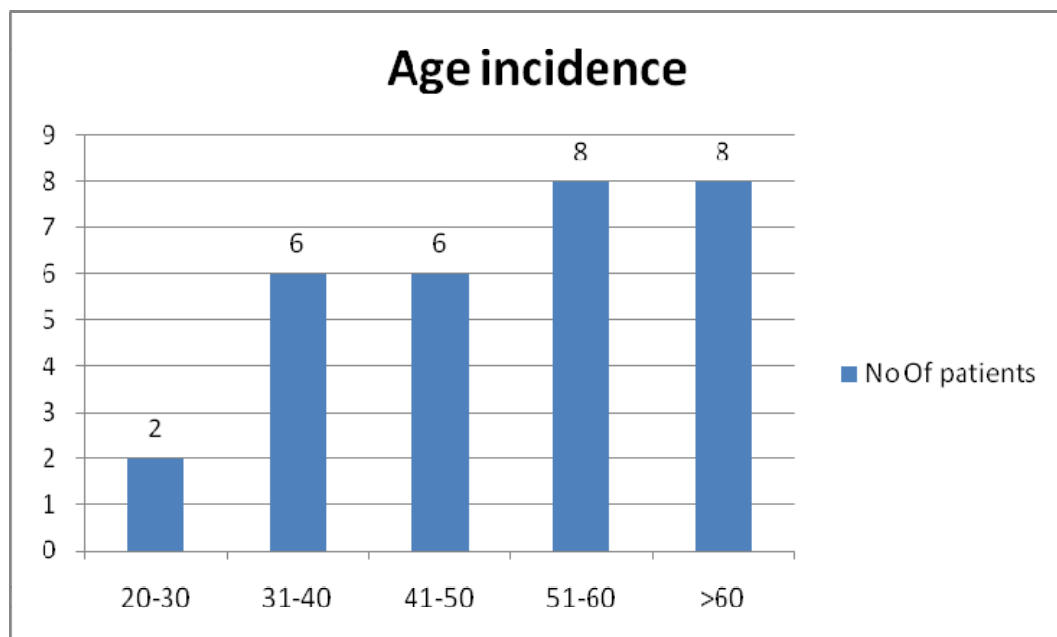
The study consists of 30 cases of proximal humerus fractures in adult treated surgically who reported in Gupta hospital from Feb. 2006 to October 2009. The data analysis of these patients received as, The material for the study was analyzed to the following finding –

1) Age incidence

Age variation in the series were from 20 to 65 years. Proximal humerus fractures were found to have high incidence in the 50 to 65 age group. The incidence of the study was as follows:

Table 1: Age incidence

Age of patients (yrs)	No of patients
20-30	2
31-40	6
41-50	6
51-60	8
>60	8
Total	30



2) Sex incidence

From 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 males to female was 1.30:1

Table 2 : Sex incidence

Sex of patients	No of patients
Male	17
Female	13
Total	30

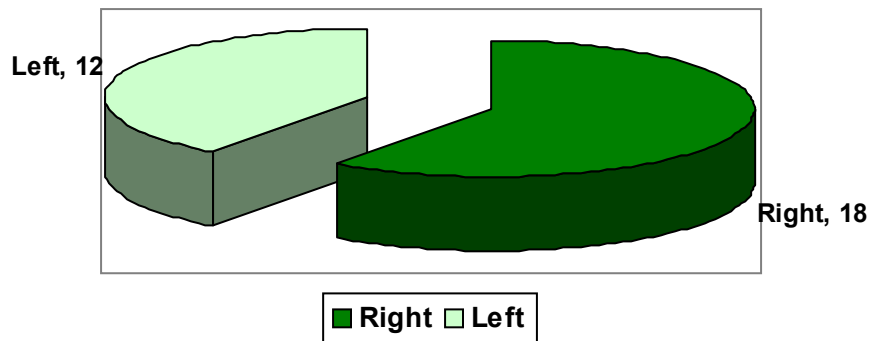
3) Side of fracture:

Right sided was involved in more patients. 18 cases had right side involved. None had both the sides involved in the same patient.

Table 3 : Side distribution

Side of injury	No of patients
Right	18
Left	12
Total	30

SIDE DISTRIBUTION



4) Causes 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 4: Mode of injury

Mode of injury	No of patients
Domestic	17
Vehicular	13
Total	30

5) Residence:

More patients were from rural population.

6) Socio-economic status :

Majority of the patients were from low socioeconomic status.

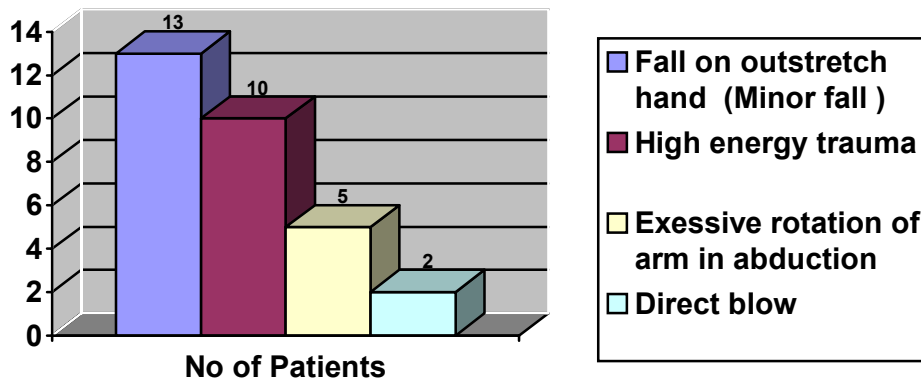
7) Mechanism of Injury-

In our series of proximal humerus fractures, the most common mechanism of injury were fall onto the outstretched hand from a standing height or less, the trauma was minor in degree, because bone were osteoporotic. High energy trauma was more frequently involved in younger patients. Excessive rotation of the arm, especially in the abducted position was another mechanism of injury, especially in older patients with osteoporotic bone. Direct blow to the side of the shoulder in the lateral position was another mechanism of injury, result in fracture of the greater tuberosity.

Table 5 : Mechanism of Injury

Mechanism of injury	No of pts
Fall on outstretch hand (Minor fall)	13
High energy trauma	10
Excessive rotation of arm in abduction	5
Direct blow	2
Total	30

Mechanism of Injury

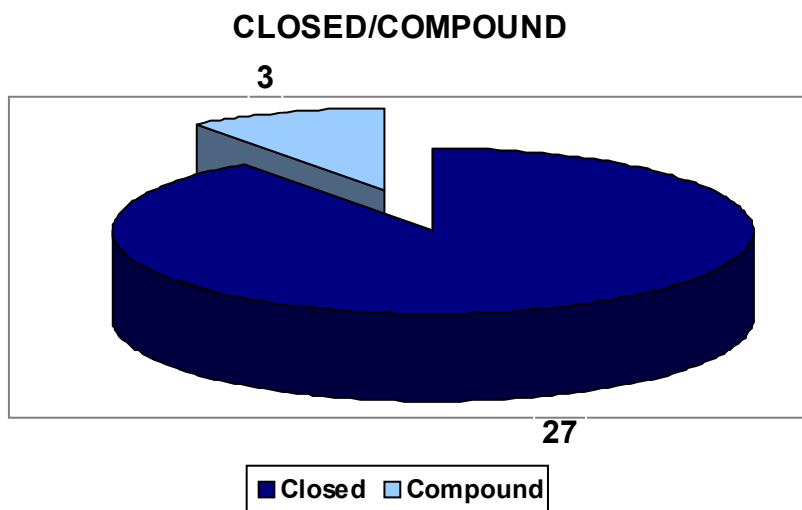


8) Closed or Compound injury

Majority of the cases were closed type of proximal humerus fracture. All of the compound fractures were of Grade-1.

Table 6 Types of fractures

Closed/Compound	No of pts
Closed	27
Compound	03
Total	30

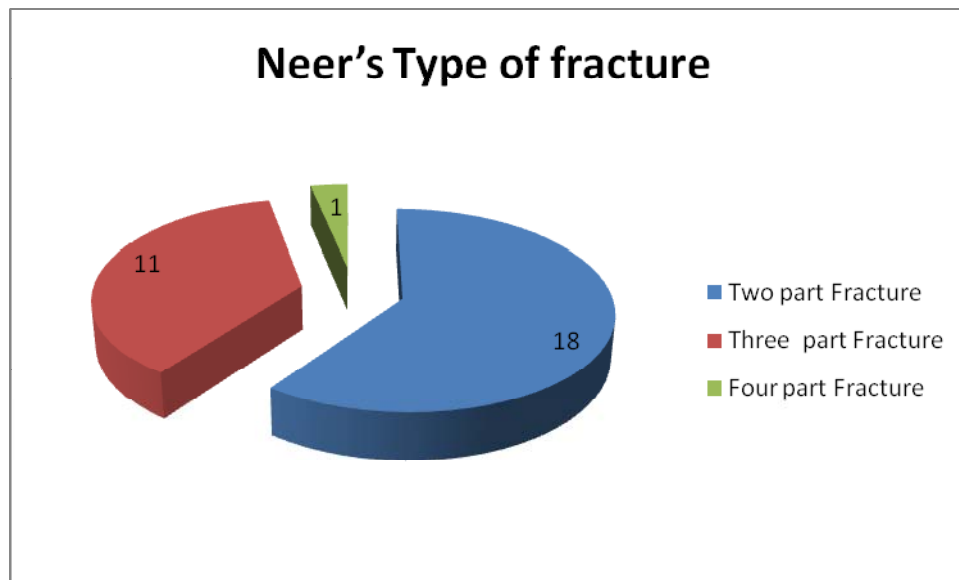


9) Neer's Type of fracture:

Two part fractures constituted the most common type.

Table 7 Neer's type of fracture

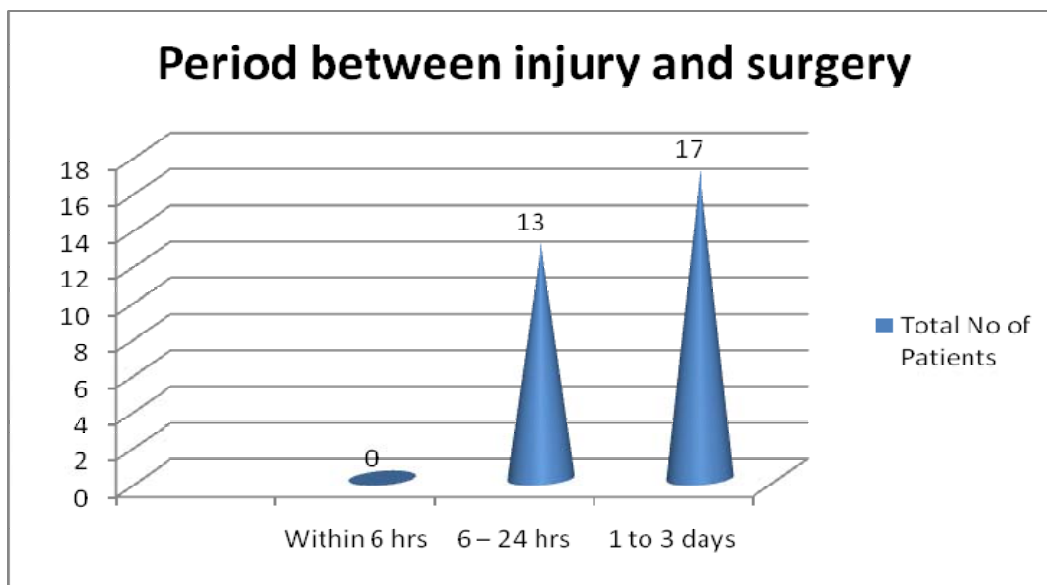
Types of Fractures	No. of Patients	Percentage
Two part Fracture	18	60%
Three part Fracture	11	37%
Four part Fracture	1	3%
Total	30	100%



10) Period between injury and surgery

Table 8 Period between injury and surgery

Period between injury and surgery	Total No. of patients	Percentage
Within 6 hrs	0	0%
6 – 24 hrs	13	43.34%
1 to 3 days	17	56.66%
Total	30	100%

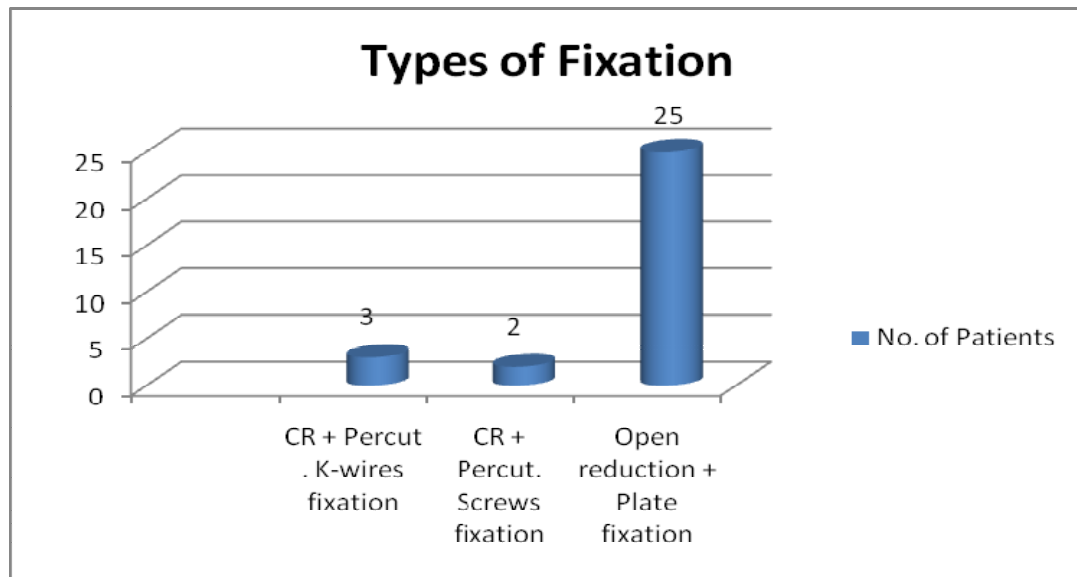


11) Types of fixations for proximal humerus fractures:

Most proximal humerus fractures were fixed with open reduction and plate fixation. Others were treated with either close reduction and percutaneous k-wires fixation or close reduction and percutaneous screws fixation.

Table 9. Fixation of Proximal humerus fractures

Types of fixation	No. of Patients	Percentage
CR + P\C K-wires fixation	3	10%
CR + P\C Screws fixation	2	7%
Open reduction + Plate fixation	25	83%
Total	30	100%



12) Immobilization:

Each operated patient was given a Universal shoulder immobilizer immediate post-operatively. The dressing was done accordingly at third and seventh day and the sutures were removed by 12 day in open surgeries. The patient was also encouraged to exercise the hand, wrist and elbow. This is continued for six weeks. After 3 weeks k-wires were removed and pendulum exercises were started (In percutaneous k-wire fixation method). In the 3cases of open reduction and plate fixation bone were severely osteoporotic so fixation was not so rigid, motion was delayed. Gentle passive forward flexion and internal and external rotation exercises were started by the third or fourth week. Active or resistive exercises were permitted by 4 to 6 weeks. It usually took about a year to achieve optimum function.

13) Associated injuries:

One patient had associated fracture of bicondylar tibia. Remaining 29 patients had isolated fracture of proximal humerus.

14) Complication:

Complications after closed reduction and k-wires fixation :

In our series, total 3 patients were treated with closed reduction and k- wires fixation. All patient treated by k-wire fixation were having compound fracture grade-1. K-wire were fixed after debridment, out of which one had pin infection which was subsequently removed at 2 weeks and the rehab. postponed and universal shoulder immobilizer was given. The wound healed and the patient had satisfactory result. Loss of reduction occurred in another one patient. He required repeated closed reduction and percutaneous fixation. He had un-satisfactory results

Complications after open reduction and internal fixation with plate :

In our series 25 patients were treated by open reduction and plate fixation, in three cases reduction was difficult due to rotation of the fragments but it could be managed intra operatively. Intra-operative bleeding was managed by adequate blood transfusion in the cases which had considerable bleeding.

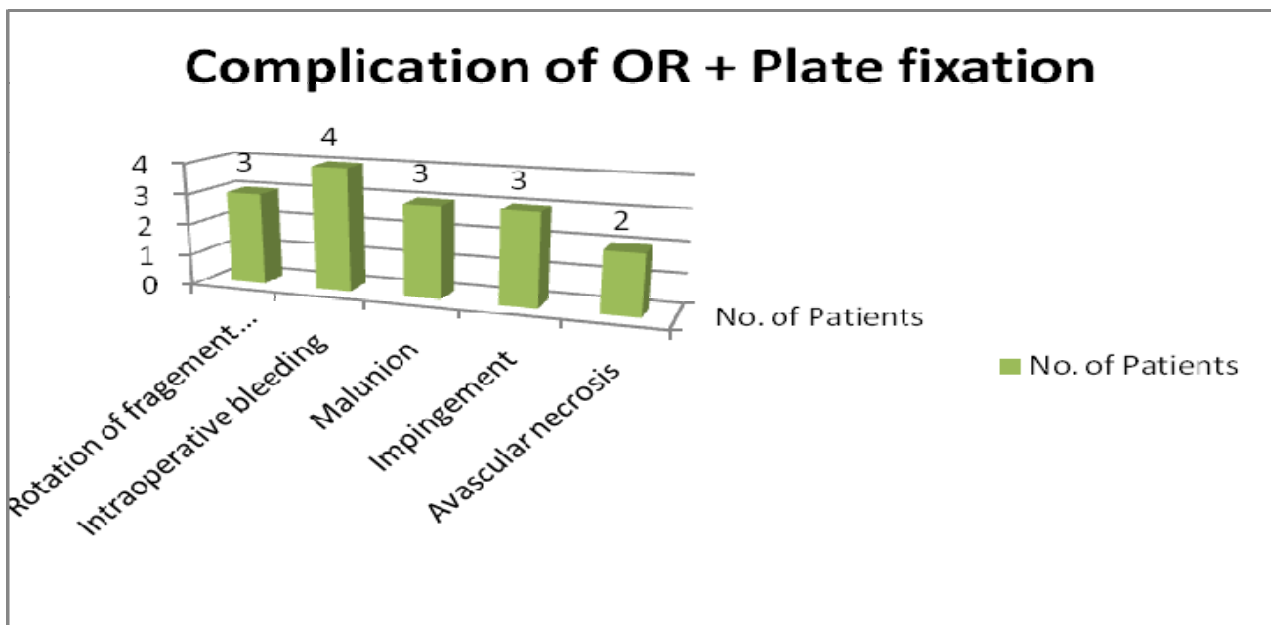
There were three cases who had abduction between 50-100 degree due to malunion of the fracture fragment.

Complication	No. of Patients	Percentage
Pin infection	1	33%
Loss of reduction	1	33%

Three patients had restricted range of movement who were fixed with Cloverleaf plate, due to Impingement, they were treated with plate removal at 8 months when the fracture had united. All three regained good range of movement after good supervised rehabilitation. We did not get complication of impingement in the patients who were fixed with Locking compression plate.

We observe changes of avascular necrosis in two patients at an average follow up of 20 months and the patient went into failure. The reason might be extensive soft tissue dissection.

Complication	No. of Patients	Percentage
Rotation of fragment intraoperatively	3	12%
Intraoperative bleeding	4	16%
Malunion	3	12%
Impingement	3	12%
Avascular necrosis	2	8%



15) End Result:

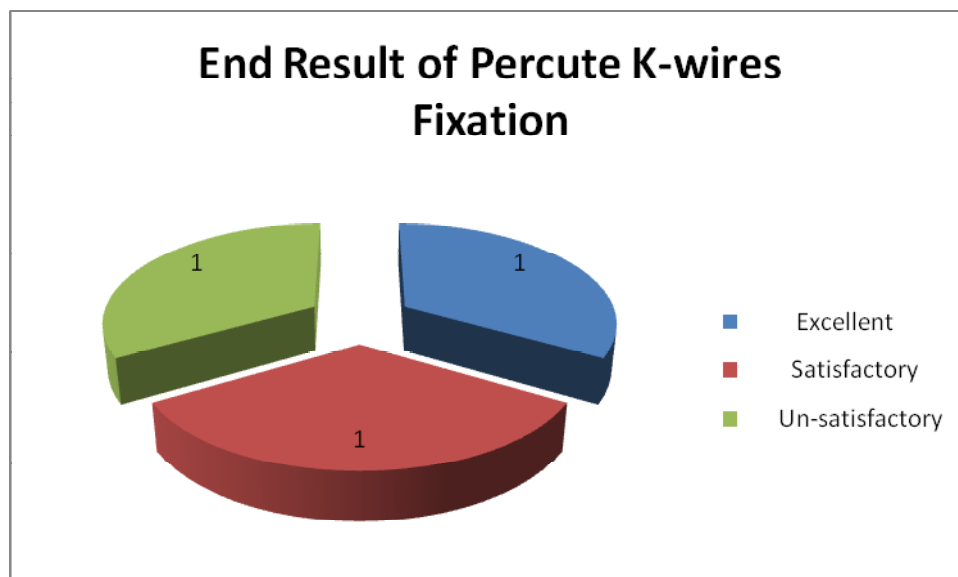
The Neer's scoring system of the severity of Pain, Function, Range of Movement, Anatomy, was done to determine the end results. The end results of 30 patients of proximal humerus fractures which were surgically treated could be categorized as -

Table 12 : End result of percutaneous k-wires fixation

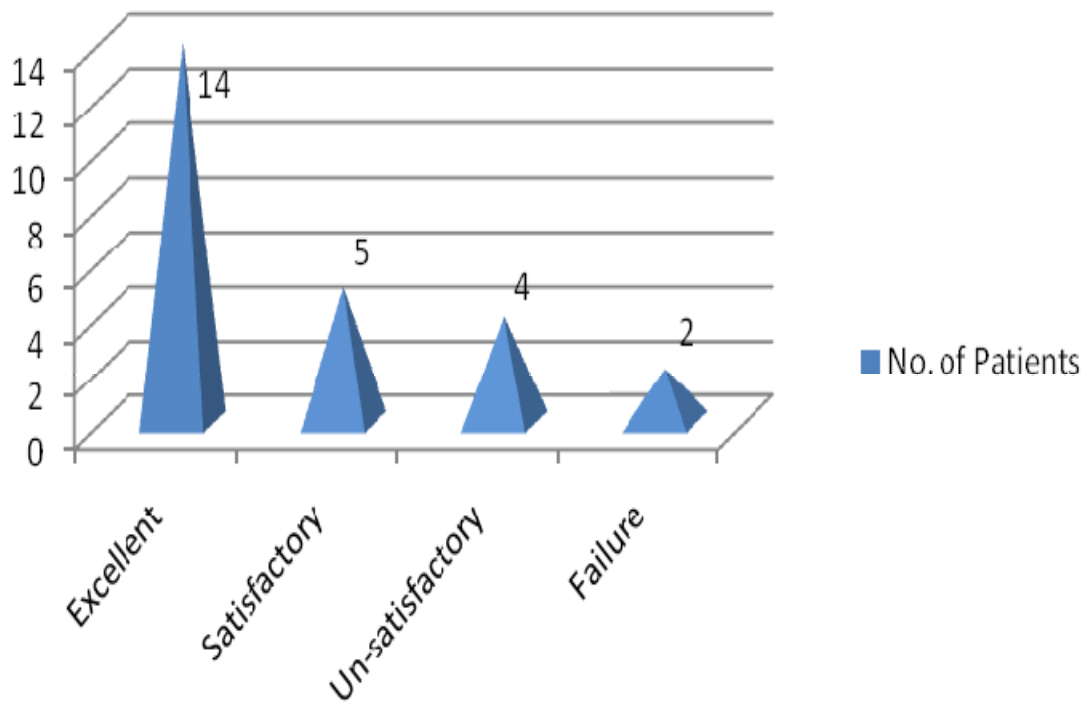
Grading	No. of Patients	Percentage
Excellent	1	33%
Satisfactory	1	33%
Un-satisfactory	1	33%

Table 13 : End result of open reduction and plate fixation

Grading	No. of Patients	Percentage
Excellent	14	56%
Satisfactory	5	20%
Un-satisfactory	4	16%
Failure	2	8%



End result of open reduction and plate fixation



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 men with a gender distribution of 1.30: 1 and were also more common in the age group of 50 to 65 years (53%). They were more common in the age group of 30 - 50 years in men and 50 - 65 years in women. The right side was affected more than the left Domestic falls were the most common cause of fractures and involved the older age groups. Motor vehicle accidents were the next cause of injury and involved the younger ages. Open fractures were also common after such accidents.

Most common mechanism of injury was fall on an outstretched hand in the older age group (44%), next common was high energy trauma (33%) Closed fracture accounted for most of the cases (90%), followed by open fracture (10 %) Two part fracture (commonly surgical neck) accounted for most of the cases (60%), followed by three part fracture (37%) and then four part fracture (3%) Closed, displaced, avulsion fractures of greater tuberosity (Two part) were treated with closed reduction and percutaneous screws (cancellous-screws). Open two part fracture however were stabilized with k-wires alone, fearing infection problems. On the other hand 83% of two, three and four part fracture were stabilized with plate and screws

As per the Neer's scoring system 57% patients had excellent results while 20% patients had satisfactory results. They were all pain free and successfully returned to their pre-injury work. 23% patients had unsatisfactory to failure result (Table 16). These patients had associated factors like older age etc to be the responsible causes.

Table 14: Overall Results on basis of Neer's Scoring System

Grading	No. of Patients	Percentage
Excellent	17	57
Satisfactory	6	20
Un-satisfactory	5	16
Failure	2	7

Table15 : Results according to Neer's different types of fracture on basis of Neer's Scoring System

Type of fracture	Total	Excellent	Satisfactory	Unsatisfactory	Failure
Two part fracture	18	11	4	3	0
Three part fracture	11	6	2	2	1
Four part fracture	1	0	0	0	1

The results show that most Neer's two part fracture had excellent to satisfactory results (84%). Neer's three part fracture also had 72% excellent to satisfactory results. In our series there was only one case of four part fracture which went into failure, another case which went into failure was a three part fracture fixed with cloverleaf plate (Table 17). The major reason for failures was avascular necrosis.

The study had its own set of complications. In our series 25 patients were treated by open reduction and plate fixation. In three cases reduction was difficult due to rotation of the

fragments but it could be managed intraoperatively. Intra-operative bleeding was managed by adequate blood transfusion, in the cases which had considerable bleeding. There were three cases who had abduction between 50-100 degree due to malunion of the fracture fragment.

Three patients had restricted range of movement who were fixed with cloverleaf plate, due to impingement. They were treated with plate removal at 8 months when the fracture had united. All patients after plate removal regained good range of movement under good supervised rehabilitation. We did not get complications of impingement in the patients who were fixed with locking compression plate. We observed changes of avascular necrosis in two patients at an average follow up of 20 months who went into failures.

The incidence of proximal humerus fractures has increased in last few years due to changes in life style and increase in road traffic accidents^{45,46}. The best management in these injuries is still uncertain. Studies have shown non-operative and operative treatments, both give favorable results, and the uncertainty remains^{47,48}.

However, with the aim of getting anatomically accurate reductions, rapid healing and early restoration of function, which is a demand of today's life, open reduction and internal fixation, is the preferred modality of treatment^{49,50}. It is to be noted that the risk of complications although is low after internal fixation, it is higher when compared with fractures which are managed percutaneously or conservatively⁵¹.

Table 16. Age related study pattern

Study	Age of patients studied	Mean age
Roland P.Jacob ³⁵	24-81	49.5
C.Gerber,C.M.L.Werner ⁵²	16– 73	44.9
Wijgman,W.Roolker ³	19 – 79	48
Evan L.Flatow,Francis Cuomo ⁵³	34-72	53
P.Moonot,N.Ashwood,M.Hamlet ⁵⁴	18-87	59.9
Present series	21 – 70	49.3

Proximal humerus fractures occur more commonly in older age group⁵⁵. This is due to 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 17. Gender related study pattern

Study	Male	Female
Roland P.Jacob³⁵	1.57	1.0
C.Gerber,C.M.L.Werner⁵²	1.35	1.0
Wijgman,W.Roolker ³	0.94	1.0
Evan L.Flatow,Francis Cuomo ⁵³	1.40	1.0
Present series	1.30	1.0

As P value is >0.05 in all series according to Chi-square test. It is not significant so these study groups are comparable.

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^{45, 56}. 57% of our patients had suffered a domestic fall and 43 % were involved in vehicular accidents.

As P value is >0.05 in all series according to “Chi-square test”. It is not significant so these study groups are comparable. Of the thirty patients in our study, twenty seven were closed fractures and three were open fractures. All open fractures were grade-1 two part fracture.

Eighteen patients had two part fracture. At surgery more than 60% of them had soft tissue interposition at the fracture site⁵⁷. Two cases of greater tuberosity avulsion fracture (Two part fracture) were treated with closed reduction and percutaneous screws fixation. Thus cancellous screws proved to be very effective in proximal humerus fracture fixation⁵⁸.

Three cases of grade-1 compound, two part fracture were treated with closed reduction and percutaneous k-wires fixation. Rest thirteen cases of two part fracture were treated by open reduction and Cloverleaf plate fixation⁵⁹.

Eleven patients had three part fracture. Restoration of greater and lesser tuberosity was a particular difficulty in these cases (Seven cases had surgical neck with greater tuberosity fracture and four had surgical neck with lesser tuberosity fracture). Seven of them were fixed with Cloverleaf plate, two with Cobra plate and rest two with Locking compression plate^{59, 60, 61, 62}.

In our study, one case of three part fracture was also having bicondylar tibia fracture, cause of injury was road traffic accident. He underwent a Locking compression plate for proximal humerus and simultaneously Locking hockey stick plate for lateral condyle and L-plate for medial condyle tibia. One patient had four part fracture who was treated by open reduction and Cloverleaf plate fixation.

Different studies, which have used the Neer's scoring system for assessment of results, demonstrate a fairly similar pattern of results with 70 - 80% patients having satisfactory to excellent results and 20 - 30% having un-satisfactory to failure results.

Table 18. Comparisons of result pattern with other study

Result	Roland P.Jacob³⁵	Present series
Excellent	21%	57%
Satisfactory	53%	20%
Un-satisfactory	10%	16%
Failure	16%	7%

As P value is >0.05 in study according to Chi-square test. It is not significant so this study group are comparable. In our series 77% patients had satisfactory to excellent results and 23% had un-satisfactory to failure results. These results are comparable with the other study.

Our poor results have shown strong association with

1. Open injuries, which developed infection.
2. Three, four part severely displaced fracture in which articular head is devoid of soft tissue attachment which are unstable.
3. Avascular necrosis of humeral head^{63, 64, 65}.

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

Complications:

The study had its own set of complications⁶⁶.

1. Pin infection in one case.
2. Loss of reduction occurred in one patient operated by percutaneous k-wires fixation.
3. Rotation of fragment intraoperatively in three cases.
4. Intraoperative bleeding in four cases.
5. Malunion noted in three cases.
6. Restricted range of movement due to impingement were noted in three cases.
7. Avascular necrosis in two patients.

Follow up and Final Result:

In this study maximum period of follow up was 25 months and minimum of 5 months.

Open fractures were treated immediately by IV antibiotics, debridement and percutaneous k-wires fixation. Of our three patients with open fractures, one had excellent result, another had loss of reduction (33 %) which gave satisfactory result and rest one had infection (33%), which did resolve with adequate treatment but gave unsatisfactory result.

- 30 cases of proximal humerus fractures managed surgically by various techniques and rigid fixation achieved.
- Post-operative mobilization i.e pendulum exercises were started after 3 weeks in cases in whom fixation was good and in others it was delayed for 6-8 weeks.
- The study included 57% of male patients and 43% of female patients.
- 54% of the fracture occurred in 50 to 65 years age group.
- Domestic fall accounts for 57% of the cases.
- According to the Neer's classification there were
 - Two part fracture - 60%
 - Three part fracture - 37%
 - four part fracture - 3%
- Associated injury to the Bicondylar tibia fracture in 1 case was noted. It did not affect the treatment.
- Surgical techniques used were closed reduction and percutaneous k-wires fixation, closed reduction and percutaneous cancellous screws fixation, open reduction and internal fixation with Cloverleaf plates, Cobra plates and Locking compression plates.
- Closed reduction and percutaneous cancellous screws fixation showed excellent results in all two cases of two-part greater tuberosity avulsion fracture.
- Open reduction and internal fixation with Locking compression plates showed good results among all implants used.

Conclusion

- Fractures of the upper end of humerus account for 4-5% of all fractures.
- Two and three-part fracture represent almost more than 95% of proximal humeral fractures.
- In older patients with osteoporosis, even less severe trauma (fall in 57%) can produce significant injury.
- In younger patients, proximal humeral fractures usually are caused by high- energy trauma (43 %).
- They occur more frequently in older patients after the cancellous bone has become weakened by senility and osteoporosis.
- Fractures of the proximal humerus are complex injuries involving two articulating surfaces, the glenohumeral joint and the subacromial arch.
- 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.
- 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, should be applied.
- Treatment options for these displaced fractures include closed reduction and percutaneous screws fixation (7% cases), closed reduction and percutaneous k- wires fixation (10% cases) open reduction and internal fixation (83 % cases).
- Biologically the technique of closed reduction and percutaneous pinning is good from the standpoint of retaining the vascularity of the humeral head. In our series 33 % cases had excellent functional results .It can be used for un-displaced or displaced two, three or four part fracture of the proximal humerus without comminution, in the younger age groups with good bone quality. It can be used in the elderly who are unfit for surgery .It can be useful as an alternative to open -reduction and internal fixation of un-displaced and displaced fractures of the proximal humerus.

- Patients who has two part greater tuberosity avulsion fracture are best treated by closed reduction and percutaneous screws fixation.
- Patients who have metaphyseal comminution are more appropriately treated by open reduction and Internal fixation with a plate (83% cases).
- In patients who have a three-part fracture with appreciable displacement of the greater tuberosity, open reduction, limited dissection and internal fixation should be performed.
- An adequate surgical technique will minimize complications and an aggressive rehabilitation regime will ensure the best possible result.
- Malunion and restriction of movement were associated with poor results.
- In case of compound fractures, immediate wound debridement and rigid fixation give better results.
- The results of our study is comparable with others series done by different authors by using bio-statistical method (Chi-square test).

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MASTER CHART

Sr. no	NAME	AGE	SEX	MOI	Side	Clo/Comp	Neer's Type of #	Mech of Inj.	Modulity of Treatment	D of Stay	Union weeks	Result	Complic	AI
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	RB	58	F	DF	R	Clo	3 PART	FOH	ORIF Clover Leaf Plate	12	12	FL	AVN	—
2	GP	36	M	VA	R	Comp	2 PART	HET	CR + P/C K WIRES	20	12	US	PI	—
3	JA	45	M	VA	R	Clo	2 PART	HET	ORIF Clover Leaf Plate	14	10	E	NO	—
4	JD	55	F	DF	L	Clo	3 PART	FOH	ORIF Clover Leaf Plate	14	11	E	NO	—
5	KM	53	M	DF	L	Clo	3 PART	FOH	ORIF Clover Leaf Plate	12	12	E	NO	—
6	UG	64	F	DF	R	Clo	2 PART	FOH	ORIF Clover Leaf Plate	13	12	S	RF	—
7	PN	47	M	VA	L	Clo	2 PART	HET	ORIF LCP	8	10	E	NO	—
8	PK	63	F	DF	L	Clo	2 PART	FOH	ORIF Clover Leaf Plate	12	12	S	RF	—
9	DL	62	F	DF	R	Clo	2 PART	FOH	ORIF Clover Leaf Plate	14	12	S	MALUNION	—
10	SK	36	M	VA	L	Clo	3 PART	HET	ORIF Clover Leaf Plate	14	10	E	NO	—
11	VS	51	M	DF	R	Clo	3 PART	FOH	ORIF Clover Leaf Plate	10	8	E	NO	—
12	AS	47	M	DF	R	Clo	3 PART	DB	ORIF Cobra Plate	10	10	S	RF	—
13	RB	63	F	DF	R	Clo	2 PART	FOH	ORIF Clover Leaf Plate	12	8	E	NO	—
14	PR	41	M	VA	L	Clo	2 PART	HET	ORIF Clover Leaf Plate	10	12	E	NO	—
15	AP	64	F	DF	R	Clo	4 PART	FOH	ORIF Clover Leaf Plate	12	12	FL	AVN	—
16	KP	26	M	VA	R	Comp	2 PART	HET	CR + P/C K WIRES	8	8	E	NO	—
17	SK	58	F	DF	L	Clo	3 PART	FOH	ORIF Clover Leaf Plate	11	8	E	NO	—
18	PS	65	F	DF	L	Clo	3 PART	FOH	ORIF Cobra Plate	12	8	US	MALUNION	—
19	ST	56	F	DF	L	Clo	3 PART	FOH	ORIF Clover Leaf Plate	12	10	US	IMPING	—
20	BG	25	M	VA	R	Clo	2 PART	HET	CR + P/C SCREWS	10	8	E	NO	—
21	BB	44	M	VA	L	Comp	2 PART	HET	CR + P/C K WIRES	18	12	S	RED LOSS	—
22	DG	65	F	DF	R	Clo	3 PART	FOH	ORIF Clover Leaf Plate	10	10	S	IMPING	—
23	AJ	63	F	DF	R	Clo	3 PART	RAA	ORIF LCP	8	8	E	NO	BTF
24	DJ	41	M	VA	R	Clo	2 PART	HET	ORIF Clover Leaf Plate	10	10	E	NO	—
25	MK	37	M	VA	R	Clo	2 PART	HET	CR + P/C SCREWS	12	8	E	NO	—
26	LS	54	F	DF	R	Clo	2 PART	RAA	ORIF Clover Leaf Plate	10	12	E	NO	—
27	SP	53	M	DF	L	Clo	2 PART	DB	ORIF Clover Leaf Plate	12	12	E	NO	—
28	MD	33	M	VA	L	Clo	2 PART	RAA	ORIF Clover Leaf Plate	12	10	US	MALUNION	—
29	CM	36	M	VA	R	Clo	2 PART	RAA	ORIF Clover Leaf Plate	12	10	E	NO	—
30	TG	38	M	VA	R	Clo	2 PART	RAA	ORIF Clover Leaf Plate	10	12	US	IMPING	—

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