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Outcome of Surgical Management of Proximal Humerus Fractures Treated By Open Reduction and Internal Fixation Using Locking Plate System

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ABSTRACT

Objectives: *The goal of the study is to test the efficacy and functional outcome of Locking compression plate in proximal humerus fractures and to evaluate the incidence of complications that may occur .*

Methodology: *34 patients with proximal humerus fractures admitted and examined according to protocol. Consecutive patients selected in a non-randomised manner were . Clinical and Radiological evaluation done. Fractures classified using Neer's classification Patients underwent Open reduction internal fixation with locking compression plate for the sustained fracture under general anaesthesia. Post operative physiotherapy was given*

Results: *The first follow-up visit at 11/2 months 34(100%) of the patients had a Relative Constant Score in the 0-55%. The score increases over the next follow-up visits .At the end of 6 months 9(26.5%) patients had a relative constant score in the range 0-55% (poor outcome) ; 15(44.1%) patients in the range 56-70% (moderate outcome) and 10(29.4%) patients in the range of 71-85% (good outcome). None of the patients studied had an excellent outcome .Complication incidence proportions increased in older patients .*

Conclusion *The proximal humerus locking plate system is effective in maintaining fracture reduction in proximal humerus fractures. Due to stable restoration, early functional aftercare is possible and allows the patient to regain good shoulder function and return to work earlier Fixation with the proximal humerus locking plate is a near ideal technique with a high union rate in the treatment of proximal humeral fractures*

KEYWORDS : – Locking compression plate ; proximal humerus fractures

INTRODUCTION

Apart from the distal fracture of the radius and fractures adjacent to the hip joint ;the proximal humerus fracture is the most common fracture in elderly people. Fracture of the proximal humerus, representing 5 % of all extremity fractures, is a common fracture in everyday clinical life(1,2). According to data in the literature the incidence in the total population is 70/100,000 per annum, but this rises in women over 70 years to 400/100,000 per annum (3). Three fourths of the fractures occur in older individuals with an occurrence three times more often in women than in men. In the elderly population, most of these fractures are related to osteoporosis while injury in younger people is likely to be the consequence of high energy trauma(3).

These fractures are often nondisplaced and nondisplaced or stable minimally displaced two-part fractures can be treated conservatively(5-7), whereas displaced fractures with two or more fragments require surgical treatment for good functional results.[2]

Because of increasing incidence of high velocity trauma, the fracture pattern in proximal humerus fracture are becoming complicated. It has been always engima of management because of numerous muscles attachment and paucity of space for fixing implant in fracture of proximal humerus. The treatment is more controversial for articular fractures which carry a high risk of the humeral head necrosis. In Neer's classification, these are two part anatomical neck, three-part and four–part fracture and those with dislocation of head of humerus. A review of published result suggests that there is no universally accepted form of treatment. Conservative management may be associated with non union, malunion, and avascular necrosis resulting in painful dysfunction(4,5).

Treatment of this complicated fracture is guided by bone quality, fracture pattern, degree of comminution as well as patient factors such as age and activity level. Ultimate goal should be minimum shoulder pain and maximum range of motion. Surgical options include closed reduction and percutaneus pinning(CRPP), transosseous suture fixation(TOSF), open reduction and internal fixation with either conventional or locking plate and hemiarthroplasty. Fracture must be evaluated on individual basis and treatment tailored accordingly.

Recently, the advent of the locking-compression plate (LCP) suggests promising results for displaced osteoporotic proximal humeral fractures.(8,9)The mechanical advantage of an LCP is that it improves fracture stability due to the fixed-angle construct, that is, the bone–plate interface creates a 'single beam' construct; in that there is no movement between individual parts resulting in an increased resistance to pullout. Consequently, locking the screw to the plate mechanically recreates a point of cortical bone contact when it is deficient, which may be useful in poor-quality cancellous bone of the proximal humerus.(8) Although LCP overcame some drawbacks of conventional plating techniques, complications have been reported, including avascular necrosis (AVN) of the humeral head, screw cut-out, head collapse, plate impingement, implant failure and infection.(9,10,11) These complications generally increase with the complexity of the fracture pattern.

This study conducted to analyze fractures of the proximal humerus that were treated with the locking compression plate and documents their clinical and functional outcome

METHODOLOGY

All patients fulfilling the inclusion criteria admitted in our tertiary care centre during the study period from june 2013 to nov 2014. The study purpose to include patients with proximal humerus fractures admitted and examined according to protocol, associated injuries noted. Consecutive patients selected in a non-randomised manner were selected. Clinical and Radiological evaluation done. Fractures classified using Neer's classification. Routine investigation carried out to get fitness for surgery. Patients will undergo Open reduction internal fixation with Locking Compression plate for the sustained fracture under general anaesthesia. Post operative physiotherapy followed according to protocol. 30 cases were studied without any sampling procedure.

Inclusion criteria:

Fractures meeting the indication for operative treatment as outlined by Neer (i.e. angulation of the articular surface >45^0 or displacement >1 cm between the major fracture segments) - two part, three part and four part proximal humeral fractures as per Neer's classification of proximal humerus fractures .

Acute fracture presenting within the first 14 days of trauma.

Age above 18 years and skeletally mature

Patient fit for surgery with controlled blood sugar levels in case of diabetics.

Exclusion criteria:
Associated ipsilateral humerus shaft or distal humerus or the elbow joint – since it may affect the scoring of the functional outcome.

Associated ipsilateral neurovascular injury.

Open fractures.

Pathological fractures or refractures.

Pre-existing medical co-morbidities which may hamper fracture and surgical wound healing such as uncontrolled diabetes mellitus, multiple sclerosis, peripheral neuropathy due to any cause, paraplegia.

OBSERVATION TABLES
Thirty-four patients with a closed proximal humerus fracture managed in our institute at LTMMC AND LTMGH, SION and operated using proximal humerus locking plate system meeting the inclusion criteria were evaluated in our study. The following observations were made.

TABLE 1 : AGE AND SEX-WISE DISTRIBUTION OF THE STUDY POPULATION

Age group (in years)	Gender		Total no. of patients (%)
	No. of Males (%)	No. of Females (%)	
18 - 30	4(11.8%)	2(5.8%)	6(17.6%)
31 - 50	10(29.4%)	4(11.8%)	14(41.2%)
51 - 70	5(14.7%)	5(14.7%)	10(29.4%)
> 70	3(8.8%)	1(3%)	4(11.8%)
Total	22(64.7%)	12(35.3%)	34

TABLE 2 : DISTRIBUTION OF RELATIVE RANGE OF FLEXION AND ABDUCTION AT EACH FOLLOW-UP VISIT IN THE STUDY POPULATION

Relative Flexion/ Abduction (%)	Number of patients for Flexion			Number of patients for Abduction		
	1 1/2 month	3rd month	6th month	1 1/2 month	3rd month	6th month
> 25%	15	0	0	20	4	0
25 - 50 %	19	21	5	14	27	16
50 - 75%	0	13	26	0	3	18
75 - 100%	0	0	3	0	0	0
Total	34	34	34	34	34	34

TABLE 3: MEAN RANGE OF MOTION- EXTERNAL AND INTERNAL ROTATION OF THE INJURED AND CONTRALATERAL SHOULDERS AT FOLLOW UP VISITS.

		External rotation			Internal rotation		
		Mean	SD	Median	Mean	SD	Median
Healthy shoulder		80.88	7.03	81.00	86.71	5.47	90.00
Injured Shoulder	1 1/2 month	33.35	7.09	34.00	54.00	5.35	55.00
	3rd month	43.03	7.69	41.00	58.62	5.15	60.00
	6th month	54.44	8.64	54.00	62.82	4.27	63.00
Ratio	1 1/2 month	41.52%	9.17%	43.19%	62.56%	7.70%	61.11%
	3rd month	53.36%	9.29%	55.22%	67.87%	7.37%	66.67%
	6th month	67.54%	10.54%	68.75%	72.77%	7.09%	72.22%

TABLE 4 : FUNCTIONAL OUTCOME WITH RESPECT TO CONSTANT SCORE AND DASH SCORE AT 6 MONTHS

OUTCOME	CONSTANT SCORE[12]		DASH SCORE[13]	
	No. of patients	Percentage(%)	No. of patients	Percentage(%)
Excellent	0	0	14	41.2
Good	15	44.1	15	44.1
Moderate	10	29.4	5	14.7
Poor	9	26.5	0	0
TOTAL	34	100	34	100

RESULTS
Functional outcome was assessed using the CONSTANT Score and THE DISABILITIES OF THE ARM,

SHOULDER AND HAND (DASH) Score. [12,13]**It** was done at each follow-up visit using the Constant Score – at 1 ½ , 3 and 6 months ; and DASH Score – at 3 and 6 months. The DASH score could not be calculated at 1 ½ months as the patients were not able to perform most of the activities as described in the questionnaire at 1 ½ months The mean range of movements for flexion , abduction , external rotation and internal rotation was studied and it continued to increase significantly (p-value < 0.05) over the period of 6 months post-operatively.

With each follow-up visit there is improvement in the range of movements of the patients as noted by the increasing number of patients in the higher ranges. At the end of 6 months 41.1%(14 out of 34) attained a relative external rotation in the range of 70-100% while 58.8%(20 out of 34) in the range 30-70%. At the end of 6 months 64.7%(22 out of 34) attained a relative internal rotation in the range of 70-100% and 35.2%(12 out of 34) in the range 30-70%.

The relative constant defined as the ratio of the absolute constant score of the injured to the healthy shoulder and expressed as percentage (%) of the healthy shoulder is calculated and the distribution among the population noted and tabulated. The Relative Constant score was graded as excellent (86–100 %), good (71–85 %), moderate (56–70 %), or poor (0–55 %).(64,65)From our study we found that in the first follow-up visit at 11/2 months 34(100%) of the patients had a Relative Constant Score in the 0-55%. The score increases over the next follow-up visits following start of physiotherapy and active range of movements, correlating with decreased pain over the injured shoulder and initiation of fracture union. At the end of 3 months 22(64.7%) patients had a score in the range 0-55% and 12(35.3%) patients were in the range 56-70%.

The mean absolute and relative constant score at each follow-up visit is tabulated. The increase in both the mean scores over the period of 6 months was found to be statistically significant (p < 0.05). At 6 months the mean absolute constant score was 57.6 + 11.8 (range 38-74) and the relative constant score was 64.9 + 11.6 (46.3-79.5).

In our study, we found 9 out of 34 (26%) patients to have suffered complications. The most common complication was found to be subacromial impingement and varus malalignment (in 9% of the cases each;3 out of 34 cases).

DISCUSSION
The incidence of proximal humerus fractures has increased in last few years due to changes in life style and increase in road traffic accidents. Many studies have shown that the displaced fracture of the proximal humerus have a poor functional prognosis when left untreated because of severe displacement of fragments. 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.

Overall, open reduction and internal fixation have yielded satisfactory results. The best results are obtained if the fracture is well reduced and planned rehabilitation program followed. It must be the goal to select fractures for open reduction and internal fixation which can be anatomically reduced .The present study was conducted to assess the results of two part, three part and four proximal humeral fracture treated by open reduction internal fixation by locking compression plate.

The age distribution of the study population was from 19 to 83 years. The highest incidence of proximal humerus fractures was found in the age group of 31 to 70 years accounting for 70% (24 out of 34) of the study population. Out of the 34 cases 22 (64.7%) were male and 12 (35.3%) were female. Among males, the incidence was found to be more in the younger population. Korkmaz et al (14) reported a higher incidence among the younger age group (24 out of 41 in <65 years old) as compared to the elderly age group (17 out of 41 in > 65 years old). Shahid et al (15) similarly reported an almost equal incidence in the young and elderly age group (21 in <65 years ; 20 in > 65 years). Fazal et al (16) in their study of 27 consecutive fractures reported 11 patients aged 60 years or younger and 16 older than 60 years. In the study by Kiliç B (17) et al of 22 patients of proximal humerus fractures treated with proximal humerus locking plate there were 13 males, 9 females; mean age 57 years; range 35 to 83 years.

The most common mechanism of injury was due to fall on outstretched hand (44.1%) followed by road traffic accident (38.2 %) and direct trauma due to fall over the involved shoulder (17.6%). The incidence of fracture due to fall was more common in the elderly age group while that due to road traffic accidents was more common in the young though the difference was not significant (p-value > 0.05). In the study by Südkamp N et al (18) the most common mode of trauma was due to low energy mechanisms in 162(87%) of the cases and by high energy mechanisms in 25 (13%) of the cases. Of the 21 patients studied by Altman et al (19) the mode of injury was due to fall in 15 patients (71%) and due to road traffic accident in 6 patients (29 %). In the study by Geiger et al (20), out of 28 patients studied, fractures were caused by low-energy trauma (fall from standing height) in 21 patients, and by an accident while skiing or cycling in seven patients .

According to Neer's classification of proximal humerus fractures, the incidence of the various fracture patterns are as follows. Type-2 fracture pattern was found to be the commonest in our study population accounting for 61.8% All the cases of type-3 fractures involved the surgical neck and greater tuberosity (SN + GT). The incidence of type-4 fracture was found only in the elderly age group(>50years) while the incidence of type-2 and type-3 were more common in the younger population.The mean time of surgery from the day of trauma was 4 + 1.8 days (range 2-10 days). Active range of motion was started in a mean time of 5 weeks (range 4-6 weeks). According to Shahid et al (15), the incidence of both type-2 and type-3 fractures was 27% (11 out of 41) and type-4 in 46% (19 out of 41).

In the study by Björkenheim et al (21), type-2 fracture was seen in 53% of patients (38 out of 72); type-3 in 30.5% (22 out of 72); type-4 in 16.5% (12 out of 72). In the study by Gerber C. et al (22), there were two displaced two part anatomical neck fractures and 16 three-part fractures.The remaining 16 four-part fractures consisted of ten classic four-part fractures, five four-part fracture-dislocations, and one four-part fracture with an additional head split component. Of the 16 type-3 fractures 10 were males and 6 females. Of the 16 type-4 fractures 10 were females and 6 were males. This study also showed a higher incidence of type-3 fractures in males and type -4 fractures in females. Among the age group of 18-50 years the incidence of type-3 fracture was 12 out of 21 and type 4 was 7 out of 21. In the > 50 age group the incidence of type-3 fractures was 4 out of 13 and type-4 was 9 out of 13.

The mean range of movements for flexion , abduction , external rotation and internal rotation continued to increase significantly (p-value < 0.05) over the period of 6 months post-operatively. The data shows a relatively more restriction of abduction than flexion and a relatively more restriction of external rotation than internal rotation. None of the patients attained > 75% of abduction compared to that of the opposite healthy shoulder. Barbosa et al (23) also had a similar observation ; they showed that flexion, abduction and external rotation movements were the ones most impaired.

The mean flexion at 6 months was 104^{0}+ 18.07^{0} for the injured shoulder and abduction found to be 86.88^{0}+24.37^{0}. The mean external rotation at 6 months for the injured shoulder was 54.44^{0}+ 8.64^{0} and internal rotation to be 62.82^{0}+4.27^{0}**.** In the study by Sudkamp et al (18) of 187 patients treated with minimally invasive locking plate fixation with a follow-up of at 3 , 6 and 12 months;**at** 6 months the mean (SD) active ROM was 122° (35°) for forward flexion, 114° (38°) for abduction, and 39° (19°; range) for external rotation and 76^{0}(23^{0}).The range of motion values further increase at 1 year. There was an increase in the ROM at each follow-up visit which was significant (p-value < 0.05). In the study by Altman et al (19) of 21 patients treated with minimally invasive locking plate fixation with a mean follow-up of 24 months (range, 5-38 months); the mean (SD) active ROM was 143° (35.04°;range, 80°-180°) for forward flexion, 118° (46.8°; range 45°-180°) for elevation in the plane of the scapula, and 33° (19.2°; range, 10°-65°) for external rotation at 0° of abduction.

Even though the mean flexion, abduction and internal rotation were similar to the above-mentioned studies ; the mean external rotation in our study was found to be better in our study which may be due to the more number of less complex type-2 fractures in our study, more number of patients in the younger age group and more number of males in the study.

At 6 months the constant score was 57.6 + 11.8 (range 38-74) **.**The increase in constant scores over the period of 6 months was found to be statistically significant (p < 0.05). In the study by Sudkamp et al (18) of 187 patients , at the end of 6 months the absolute constant score was 64 ± 13and relative constant score was 77 ± 14. At 1 year the absolute constant score was 71 ± 14 and the relative constant score was 85 ± 14.

The Constant score increased significantly from the three-month to the six and twelve-month follow-up evaluations (p < 0.05). The mean DASH score was 15.2 ± 16.8 points after 1 year. According to Plecko M et al (24), of the 36 patients studied with a minimal follow-up of 12 months,a mean Constant Score of 62.6 points and an age-related Constant Score of 80.7% on average, as well as a DASH Score of 18.0 points were obtained, constituting a satisfactory result in three quarters of all patients. According to the study by Geiger et al (20) The PHILOS (proximal humerus locking plate system) plate was used for internal fixation of displaced proximal humeral fractures in 28 patients (20 females, 8 males; mean age 60.7+/-12.9 years).

In the study by Björkenheim et al (21) of 72 patients (38 type-2, 22 type-3 and 12 type-4 fractures) , based on the Constant score, 4 of the patients had an excellent functional outcome, 32 patients had a good score, 31 patients a moderate score, and 5 patients had a poor outcome**.** Parmaksizoğlu AS(25) reviewed 32 consecutive patients (22 women, 10 men; mean age 63 years; range 29 to 82 years) who were treated with open reduction and internal fixation using the PHILOS locking plate for comminuted proximal humeral fractures. The mean Constant score of the patients was 79.5 (range 50 to 100).In our study , at the end of 6 months 9(26.5%) patients had a Relative Constant Score in the range 0-55% (poor outcome) ; 15(44.1%) patients in the range 56-70% (moderate outcome) and 10(29.4%) patients in the range of 71-85% (good outcome). None of the patients studied had an excellent outcome(score in the range of 85-100%). With respect to DASH score the outcome was found to be excellent in 14 (41.2%) patients, good in 15 (44.1%) cases and moderate in 5(14.7%) cases at the end of 6 months.

In our study, we found 9 out of 34 (26%) patients to have suffered complications. The most common complication was found to be subacromial impingement and varus malalignment (in 9% of the cases each;3 out of 34 cases). Shahid et al (15) also noted an increasing rate of complications with increase in the number of fracture fragments..

CONCLUSION:-

The proximal humerus locking plate system is effective in maintaining fracture reduction in proximal humerus fractures. Due to stable restoration, early functional aftercare is possible and allows the patient to regain good shoulder function and return to work earlier. Loss of re-

duction was rarely seen compared with other implants. Complication incidence proportions increased in older patients due to higher rates of secondary impaction, screw perforations, and humeral head necrosis, Patients older than 50 years had a higher incidence of developing any type of complication. Osteonecrosis was mostly seen in severe fracture types. Fixation with the proximal humerus locking plate is a near ideal technique with a high union rate in the treatment of proximal humeral fractures.

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