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MANAGEMENT OF FRACTURES OF SHAFT OF HUMERUS WITH LOCKING COMPRESSION PLATE: A PROSPECTIVE STUDY

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ABSTRACT: BACKGROUND: The surgical treatment of fractures, according to A O principles has seen a change in the past decade, from anatomical reduction and rigid fixation to the current concept of Biological fixation, precise reduction being a goal only in intra-articular fractures. With the advent of internal fixators like PC-Fix and LISS (Less Invasive Stabilizing System) this was being achieved to some extent. There cent development of LCP has revolutionized the treatment by over-coming the few drawbacks of these internal fixators. The present study is aimed at the assessment of results of plate osteosynthesis of diaphyseal fractures of humerus using locking compression plate and to assess the functional recovery with this procedure. **MATERIALS & METHODOLOGY:** It is a prospective study which was carried out from October 2011 to March 2013 in Sri Siddhartha Medical College & Research Centre, Tumkur. In this study period, 60 cases of fracture shaft of the humerus were treated by open reduction and internal fixation using Locking Compression Plate. **RESULTS:** In our series, the majority of the patients were males, middle aged, with road traffic accidents being the commonest mode of injury, involving middle third of shaft of humerus. We followed up all the patients and the duration ranged from 6 weeks to 24 weeks. All the fracture eventually united including 3 which had delayed union. Functional recovery was assessed using DASH scoring and Rommens et al grading. There was significant improvement in DASH scores ($P=0.001$) in all the 60 cases indicating the functional recovery. According to Rommens et al grading, 51 cases had excellent results while 9 cases had good results. **CONCLUSION:** This is a prospective study with age incidence varied from 21-40 years (65%) with male predominance (70%), with type A3 as the commonest fracture (50%) involving the mid shaft (70%) of humerus, underwent open reduction and internal fixation using locking compression plate. All the cases had adequate physiotherapy started on 3rd or 4th postoperative day and continued for 3-4 weeks, which had contributed to the excellent functional recovery. The results were assessed using the DASH score and the significant functional recovery was achieved in all the cases ($P=0.001$), with Rommen's grading, excellent and good results were achieved. It is a very good procedure for fractures of shaft of humerus, however the small sample size and short duration of study were the limitations of this study.

KEYWORDS: Fracture shaft humerus, LCP, locking compression plate.

INTRODUCTION: increasing vehicular traffic, has led to considerable increasing in the number of road traffic accidents. Speedy vehicles have high velocity injuries associated with complicated fracture. Fracture pattern is often grossly committed and often open fractures resulting in greater morbidity among the working population. The other cause of fracture are being directly below, fall from height, assault, gunshot injuries and blast victims of terrorist activities.

Fractures of shaft of humerus account for 1% to 3% of all fractures and approximately 20% of all fractures involving the bone, but little is known about their epidemiology.¹

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When operative fixation is indicated for humeral shaft fractures, plate osteosynthesis is the gold standard to which other methods must be compared.²

Biomechanical studies have shown that compared to other types of available implants, the locking plate is comparatively flexible and maximizes fracture stabilization by minimizing the peak stresses at the bone-implant interface.³

It has also been theorized that locking constructs may have a lower incidence of re-fracture because the more exuberant callus created by secondary bone healing may lead to mechanically more stable construct.⁴

This study was aimed to assess the results of plate osteosynthesis of Diaphysial fractures of humerus using locking compression plate and to assess the functional recovery with this procedure.

MATERIAL & METHODS: 60 Patients with fracture of shaft of humerus admitted in the Sri Siddhartha Medical College & Research Centre, Tumkur, during the period of October 2011- March 2013 who met the following inclusion criteria were taken up for the study after obtaining consent.

All the patients were admitted and subjected to clinical & radiological examination, necessary lab investigations are carried out for proposed surgery. Regular follow up was carried out by clinical examination and with X-rays at 6 weeks, 3 months, and 6 months. The inclusion criteria being 1) All the patients in the age group of 15 years and above, 2) All Closed and Grade 1 open fractures (Gustillo & Anderson type), 3) nonunion, 4) Polytrauma patients, 5) Associated with Radial nerve palsy and the exclusion criteria being 1) Pathological fractures, 2) Open grade 2 & 3 fractures, 3) Segmental fractures, 4) Malunion, 5) Medically unfit patient.

Though many standard approaches to humerus are available like Antero-lateral, Posterior, Modified lateral approach in this study, Antero-lateral approach was used in 36 patients, and posterior approach was used in 24 patients.

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All the cases were performed without using a tourniquet. Blood loss was minimal. Maximum blood loss found was 200 ml. Overall time taken for surgery was 35-45 minutes. In all the cases the intraoperative period was uneventful. Haemostasis was achieved using bipolar cautery in all cases. Radial nerve was visible in few cases and was secured.

The immediate postoperative period was uneventful. All the cases were put in the intensive care unit for 24hrs postoperatively. In the immediate post-operative period, care was given to the general condition and fluid balance. Parenteral cephalosporins for 3 days, parenteral salbactam for 3 days, and analgesics were given. Oral antibiotics were given for next 3-4 days. Oral analgesia was started from 2nd day till adequate pain relief was obtained. Suture removal was done after 1 week. This also helped us to mobilize the patients faster.

Post operatively shoulder range of motion and elbow movements is begun actively within the 3rd or 4th post-operative day. None of the cases were given POP immobilization postoperatively. After around 1 week, sutures were removed and patients were discharged and advised to come for follow up after 6 weeks. Patients were advised to continue exercise therapy and arm support with arm pouch for 3-4 weeks.

The first follow up was usually at 6 weeks and later on patients were followed up at 3 months and 6 months.

During the Follow up: Each case was examined for pain, functional recovery of shoulder, elbow, and hand. The course of fracture healing was documented radiologically (with minimum of 6 weeks between successive radiographs). The moment of complete healing was defined as radiologically complete bone regeneration at the fracture site., Radiological assessment of implant position, fracture reduction and healing in progress (i.e., observing whether if there is any widening of fracture line or decrease in the fracture gap),.

Evaluation of any possible loss of reduction that might have occurred, compared to immediate post of radiographs. Assessment and analysis of any complications observed. Addressing patients' problems, if any, and DASH scoring, ROMMENS et al Series Grading 56 was done. Follow up of our patients ranged from 6 weeks to 24 weeks. No patient was lost to follow up.

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OBSERVATION AND RESULTS: The age group of the patients in our study ranged from 15 years to 65 years. Most of the patients belonged to 21-40 years (Table 1). Most of our patients were male, It reflected the general population, which visits our both outpatients as well as the emergency trauma section (Table 2).

In our series, 30 (50%) fractures are right sided and 30(50%) fractures are left sided, 42(70%) cases were having fracture located in middle third of shaft, in 18(30%) cases the fractures was in lower third of humeral shaft (Table 3). In our study the fracture pattern was taken into account and the figures give the general fracture pattern, which is most prevalent in humerus diaphyseal fracture.

In our study the most common fracture pattern is A3 (Transverse) in AO classification which accounts for 50% of the overall fracture pattern (Table 4) and the commonest mode of injury was road traffic accidents (55%) seen in 33 patients. Twenty seven patients had a history of falls (45%) (Table 5) 3 patients (5%) had ipsilateral fracture radius and ulna along with the fracture shaft of humerus (Table 6). All the follow up observations were summarized in Table 7.

There was improvement in the DASH scores indicating the functional recovery with this procedure (Table 8). The following results were obtained for this study using ANOVA statistical analysis; the F value: 118.77, P value: 0.001, and the Interpretation was Significant. We had 51(85%) patients with Excellent and 9(15%) patients with Good results (Table 9).

In the present study, 9 cases of superficial infection were noted. Suture removal was delayed and prolonged administration of oral antibiotics was given and eventually healed without any further complication. We had no case of any pure implant related complication like loosening, screw breakage or plate failure (Table 10).

Age group (yrs)	Frequency	Percent
<20	9	15
21-30	18	30
31-40	21	35
>40	12	20
Total	60	100

Table 1: Age distribution

Gender	No. of patients	Percentage
Male	42	70%
Female	18	30%
Total	60	100%

Table 2: Sex Distribution

	Right humerus	%	Left humerus	%
Upper 1/3 rd shaft	-		-	
Middle 1/3 rd shaft	24		18	
Lower 1/3 rd shaft	6		12	
Total	30	50%	30	50%

Table 3: Side & Site of Injury

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Type of fracture	Frequency	Percent	Type of fracture
Type A1	3	5.00%	Type A1
Type A2	21	35.00%	Type A2
Type A3	30	50.00%	Type A3
Type B2	6	10.00%	Type B2
Total	60	100.00%	Total

Table 4: Type of Fracture

Mode of injury	Frequency	Percent
RTA	33	55.00%
Fall	27	45.00%
Total	60	100.00%

Table 5: Mode of Injury

Associated injuries	Frequency	Percent
No injury	57	95.00%
Ipsilateral fracture both bones-forearm (Radius & Ulna)	3	5.00%
Total	60	100.00%

Table 6: Associated Injuries

Parameters	Overall Observations in 20 patients		
	6 weeks follow up	3 months follow up	6 months follow up
Pain	Pain (mild) was present in 18 cases	No pain	No pain
Course of fracture healing, Radiological assessment of implant position, fracture reduction and healing in progress, Evaluation of any possible loss of reduction	Fracture line was visible in 36 cases, Implant position satisfactory in all the cases, No signs of loss of reduction in any case	Fracture line not visible except in 3 cases, Implant position satisfactory in all the cases	Fracture line not visible in all the cases, implant position satisfactory in all the cases
Assessment & analysis of any complications	superficial wound infection seen in 9 cases	No complications	No complications
DASH scoring, Rommens grading.	DASH: 25.55 ± 4.41	DASH: 16.75 ± 4.07	DASH: 6.05 ± 3.47 Excellent: In 51 cases solid union seen, no loss of range of movements, and no significant subjective complaints.

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			<p>Good: In 9 cases solid union seen, 10-20% loss of range of motion at elbow and shoulder.</p>
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Table 7: Follow-up Observations

DASH score	Mean $\pm$ SD
6 weeks	25.55 $\pm$ 4.41
3 months	16.75 $\pm$ 4.07
6 months	6.05 $\pm$ 3.47

Table 8: DASH scoring

Rommens Grading	Frequency	Percentage
Excellent	51	85.00%
Good	9	15.00%
Total	60	100.00%

Table 9: ROMMENS grading

Complications	Frequency	Percent
No complication	51	85.00%
Superficial infection	9	15.00%
Total	60	100.00%

Table 10: Complications

CLINICAL PHOTOGRAPHS

Pre-Operative x-rays:

Post-Operative X-rays:

Follow-up X-rays:

Clinical Pictures:

Flexion

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Abduction

External Rotation

DISCUSSION: We evaluated our results and compared them with those obtained by various other studies utilizing different modalities of treatment. Our analysis is as follows:

Series	Year	Total no. of patients	Average Age
McCormack R G et al ⁵	2000	44	49
Wilairatana V, Prasongchin P ⁶	2001	21	29
Gongol T, Mracek D ⁷	2002	32	47
Present Study	2013	60	35
AGE INCIDENCE IN VARIOUS STUDIES			

Series	Year	M: F ratio	% of males
Strong GT, Walls N, McQueen M M ⁸	1998	111:138	44.6
Tingstad E Metal ⁹	2000	44:38	53.6
Mc Cormack R Getal ⁵	2000	28:16	63.6
Wilairatana V, Prasongchin P ⁶	2001	16:5	76.2
Present Study	2013	42:18	70
SEX INCIDENCE IN VARIOUS STUDIES			

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MODE OF INJURY IN VARIOUS STUDIES	MODE OF INJURY IN VARIOUS STUDIES	MODE OF INJURY IN VARIOUS STUDIES	MODE OF INJURY IN VARIOUS STUDIES	MODE OF INJURY IN VARIOUS STUDIES
Klenerman L ¹⁰	1966	98	Middle third	44(44.9%)
Bell M J et al ¹¹	1985	38	Upper third and middle	15(38.5%)
Griend R V, Tomasin J, Ward et al ¹²	1999	36	Middle third	23(63.9%)
Strong GT, Walls N and McQueen MM ⁸	1998	249	Middle third	160(64.2%)
Present study	2013	60	Middle third	42 (70%)
SITE OF FRACTURE				

Series	Year	Total no. of patients	Maximum Fracture type	No. of cases	%
Griend R V, Tomasin J, Wardetal ¹²	1986	36	Transverse and short oblique	20	55.6
Strong GT, Walls N, McQueen MM ⁸	1998	249	Transverse and short oblique	158	63.3
Tingstad E Metal ⁹	2000	83	Transverse and short oblique	53	64
Present study	2013	60	Transverse	30	50
COMMONEST TYPE OF FRACTURE IN VARIOUS STUDIES					

Series	Year	Total no. of patients	Commonest mode of injury
Strong GT, Walls N, McQueen M M ⁸	1998	249	RTA
Tingstad E Metal ⁹	2000	83	RTA
McCormack R Getal ⁵	2000	44	RTA

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Dayez J ¹³	1999	36	RTA and Sports
Present study	2013	60	RTA

MODE OF INJURY IN VARIOUS STUDIES

DASH scores were showing significant ($P=0.001$) improvement in the followup period indicating the functional recovery with this procedure. ANOVA statistical analysis was helpful in calculating our results. The functional results were graded into excellent, good, fair and poor.

We had 51(85%) patients with Excellent and 9(15%) patients with Good results.

Series	Total no. of patients	Delayed union	Non union	Overall results
Klenerman L (1966) ¹⁰	98	8(8.2%)	-	98(100%)
Bell M J et al (1985) ¹¹	34	-	1(3%)	33(97%)
Griend RV, Tomasini J, Ward et al (1999) ¹²	36	5(14.6%)	1(3%)	35(97%)
Gongol T, M racek D(2002) ¹⁷	32	-	1(3.1%)	31(96.9%)
Present study (2013)	60	3 (5%)	-	57 (95%)

FRACTURE UNION RATE OBTAINED INVARIOUS STUDIES

Study	No. of Patients	Good range of Mobility	%
BellMJetal (1985) ¹¹	39	38	97
Griend R V, Tomasini J, Wardetal (1986) ¹²	36	30	85.4
Heim Detal (1993) ¹⁴	127	111	87.3
McCormack R Getal (2000) ⁵	44	44	100
Gongol T, M racek D (2002) ⁷	32	31	97
Present Study (2013)	60	60	100

RANGE OF MOBILITY OF ELBOW AND SHOULDER

SUMMARY: We studied 60 patients with fractures of diaphyseal humerus treated with locking compression plate at Sri Siddhartha Medical College Hospital, Tumkur. The study was done from October – 2011 to September – 2013. The age of the patient ranged from 15 years to 65. The majority of the patients were males. (M: F = 42:18).

The commonest mode of injury was road traffic accidents (55%) seen in 33 patients. Twenty seven patients had a history of falls (45%). In our series, left humerus was involved in 50% of cases,

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while the right was involved in the other 50% of cases. Most of the fractures in our series were transverse, Type A330 (50%) patients, and most common site of involvement is middle 1/3rd of shaft of humerus, i.e 42(70%) cases. Three cases had humerus fracture in association with ipsilateral radius & ulna fracture.

All the patients were treated by open reduction and internal fixation with locking compression plate and screws, with Antero-lateral approach in 36 patients and posterior approach in 24 patients.

Physiotherapy was started on the 3rd or 4th post operative day, and continued for 3-4 weeks. During follow-up at 6 weeks, mild pain was noted in 18 cases, fracture line was visible in 36 cases, implant position was satisfactory in all the cases, no signs of loss of reduction in any case, superficial wound infection seen in 9 cases, and the mean DASH score was 25.55 ± 4.41 .

During follow-up at 3 months, there was no pain in any case, fracture line was not visible except in 3 cases, implant position was satisfactory in all the cases, no complications were noted in any case, and the mean DASH score was 16.75 ± 4.07 . During follow-up at 6 months, there was no pain in any case, fracture line was not visible in any case, implant position was satisfactory in all the cases, no complications were noted, and the mean DASH score was 6.05 ± 3.47 .

In 51 cases, solid union was seen with no loss of range of movements and no significant complaints. In 9 cases, solid union was seen, but 10-20% loss of range of motion at the elbow and shoulder. There was statistical significance ($P=0.001$) in DASH scores in the follow up period, indicating the functional recovery with this procedure. The functional results grade was excellent in 51 cases, good in 9 cases according to Rommen's grading.

CONCLUSION: This is a prospective study with age incidence varied from 21-40 years (65%) with male predominance (70%), with type A3 as the commonest fracture (50%) involving the mid shaft (70%) of humerus, underwent open reduction and internal fixation using locking compression plate. All the cases had adequate physiotherapy started on the 3rd or 4th post operative day and continued for 3-4 weeks, which had contributed to the excellent functional recovery.

The results were assessed using the DASH score and the significant functional recovery was achieved in all the cases ($P=0.001$), with Rommen's grading, excellent and good results were achieved. It is a very good procedure for fractures of shaft of humerus, however the small sample size and short duration of study were the limitations of this study.

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