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Original Article

A Retrospective Observational Study to Assess Functional Outcome of Closed Clavicle Fractures Treated with Locking Compression Plate Verses Elastic Intramedullary Nail

Kumar Rajnand[1], Himanshu K Sujeet[2], Chaurasiya Suresh[3]

[1]Associate Professor, Department of Orthopaedics, All India Institute of Medical Sciences, Gorakhpur, Uttar Pradesh, India, [2]Senior Resident, Department of Orthopaedics, All India Institute of Medical Sciences, Gorakhpur, Uttar Pradesh, India, [3]Junior Resident, Department of Orthopaedics, All India Institute of Medical Sciences, Gorakhpur, Uttar Pradesh, India

Abstract

Purpose: This retrospective observational study was done to evaluate the functional outcome of displaced mid-shaft clavicular fractures treated with different types of implants.

Materials and Methods: The data of 60 patients between 18 and 60 years of age who were operated for clavicle fracture were included in this study. These patients had been either operated with elastic intramedullary nail (EIN) or 3.5 mm pre-contoured locking compression plate (LCP). Data of clinical and hospital records were assessed for comparing functional outcome in both groups.

Results: LCP fixation offered better functional outcome in the early post-operative period but on long-term follow-up disabilities of arm, shoulder, and hand score and Visual Analog Scale score of both groups were comparable. The nail group united early, required less operative time and had less complications.

Conclusion: EIN is a minimally invasive surgical technique with fewer complication, achieves early union, required less operative time, and had comparable functional outcome in long term follow-up, which can be regarded as an alternative to plate fixation of displaced mid-shaft clavicular fractures.

Key words: Anatomical pre-contoured plating, Displaced mid-shaft clavicle fractures, Elastic intramedullary nailing

INTRODUCTION

Clavicle fractures account for around 2.6–4% of adult fractures with majority (69–82%) occurring in the middle-third.[1,2] Literature suggests second and third decades are the common age group to have clavicular fracture with male preponderance.[3] Clavicle fracture occurs most commonly after fall or direct trauma to shoulder due to axial compression.[4,5] Conventionally, all clavicle fractures were managed non-operatively with arm slings or figure of eight bandages offering good union. However, some studies have reported increased risks of delayed union, non-union, and persistent pain at fracture site when significantly displaced fractures are managed non-operatively.

Surgical intervention facilitates earlier functional recovery in isolated injuries having marked displacement, open fractures, floating shoulders, and poly-trauma scenarios.[6] Operative fixation methods include titanium elastic intramedullary nail (EIN), Kirschner wires, pins and anatomically pre-contoured plate, each having its own advantages and limitations.[7-9]

This study was designed for retrospective assessment of functional outcome in surgically intervened clavicle fracture fixed with 3.5 mm pre-contoured locking compression plates (LCP) or single titanium EIN in selected cases.

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Corresponding Author: Dr. Himanshu K Sujeet, Sandha Bazar Samiti, A.T +P.O – Sandha, District - Saran - 841301, Bihar, India.

MATERIALS AND METHODS

We retrospectively studied data of 60 patients who underwent surgical intervention for displaced clavicle fracture at a tertiary care teaching hospital. The data of 30 patients who have underwent open reduction and internal fixation with a 3.5 mm pre-contoured LCPs were categorized as plate group and it was compared with the data of 30 patients, who were treated with single titanium EINs. The second group was categorized as nail group.

The data of all the patients in the age group of 18–60 years of age who had presented within 2 weeks post-injury with shortening of over 15 mm[10] and axial mal-alignment of over 30° with no cortical bone contact[11] were included in this study for retrospective analysis regarding functional outcome.

All the patients included in this study were operated within 2 weeks of sustaining injury either by a pre-contoured 3.5-mm LCP by following AO principle of fracture management or single EIN.

Fracture fixation was supported in an arm sling in all the patients for 2 weeks in post-operative period. Early mobilization had been started to pain tolerance. Patients were encouraged to resume their normal daily activities after a 4th post-operative week.

The data of disabilities of arm, shoulder, and hand (DASH) score and Visual Analog Scale (VAS) score was studied for functional outcome assessment. Serial radiographs, record of operative time, length of incision, hospital stay, blood loss, and post-operative complication were also studied for any significant statistical co-relations.

Statistical Analysis

Comparisons of the DASH score, VAS score at 6 weeks, 12 weeks, and 6 months along with time of union and surgical duration of both the groups were performed using the unpaired *t*-test. The level of statistical significance was set at $P < 0.05$.

The statistical analysis aimed to provide a clear understanding of whether the displaced clavicle fracture treated with a single intramedullary nail offered any significant functional benefit over pre-contoured LCP.

RESULTS

The average age of the plate group was 32.33 ± 9.55 years ranging from 19 years to 55 years whereas for the nail group, it was 28.70 ± 7.64 years with minimum age of 19 years and a maximum age of 58 years. Both groups had comparable age distribution ($P = 0.11$). Plate group had 22 males and eight females whereas nail group had 25 males and five females.

The fracture type (Robinson Classification) in the plate group was 2A2 type 6 and 2B1 type 24; in nail group 2A2 type 10 and 2B1 type 20. Table 1 provides clinical data comparing two groups of patients who underwent different treatments (Plate Group vs. Nail Group) for fractures, and includes details on fracture type according to the Robinson Classification, sex ratio, and various complications.

Patients in both plate group and nail group showed improvement in DASH score when calculated at 6th week, 12th week, and at 6th months. The mean DASH score in plate group was 18.66 ± 5.28, 7.60 ± 8.35, and 5.80 ± 8.72 at 6th week, 12th week, and at 6th months, respectively, whereas for the nail group, it was 19.25 ± 3.64, 8.33 ± 6.49 and 4.93 ± 8.09 for 6th week, 12th week and at 6th months. The *P*-value calculated with unpaired t-test for DASH score of both the groups at 6 weeks ($P = 0.61$), 12 weeks ($P = 0.71$) and at 6 months ($P = 0.69$) did not find any significant statistical difference.

The VAS score had been calculated on scale of 0–100 for both groups. Score improved in both the groups and its mean value was 19.07 ± 11.19, 8.73 ± 13.37, 1.63 ± 3.70 for plate group and 16.77 ± 10.11, 12.03 ± 10.14, 2.17 ± 3.33 for nail group at 6th week, 12th week and at 6th months respectively. Similarly, *P*-value for VAS score at 6 weeks ($P = 0.40$), 12 weeks ($P = 0.29$) and at 6 months ($P = 0.56$) did not find any significant statistical difference on unpaired *t*-test.

The mean time taken for bone union was 9.45 ± 1.53 weeks in nail group as compared to 10.20 ± 1.24 weeks for plate group. The difference in time of union was statically significant ($P = 0.04$). The mean time taken to perform nailing was 37.10 ± 6.89 min while to operate this fracture with pre-contoured LCP was 76.17 ± 9.26. Duration of

Table 1: Comparison of clinical outcomes between plate and nail groups in fracture treatment

Clinical variables	Plate group	Nail group
Fracture type (Robinson classification)		
2A2	06	10
2B1	24	20
Sex Ratio		
Male	22	25
Female	08	05
Complications		
Infection (No. of cases)	2	1
Numbness over the anteromedial aspect of the shoulder over operated side	3	0
Hardware prominence/painful hardware/irritation	3	8
Non-union	2	1
Hypertrophic scar	5	1

surgery for nail group was less and statistically highly significant ($P = 0.0001$).

Table 2 provides a statistical comparison of various clinical outcomes between two groups (Plate group vs. Nail group), including age distribution, DASH scores, VAS scores, union time, and duration of surgery.

Incidence of complications such as infection (2 cases), neural symptoms (3 cases), non-union (2 cases), and hypertrophic scar (5 cases) was more in the plate group as compared to the nail group whereas the incidence of infection, non-union and scar related complication was present in one case each. Hardware prominence/irritation due to implant position was higher in eight cases of nail group over three cases in the plate group, where it was mainly at medial aspect on insertion site.

DISCUSSION

The universally accepted treatment strategy for displaced mid-shaft clavicle fractures is still widely debated. Although non-operative management of mid-shaft clavicle fractures achieves up to 95% union rate and remains preferred method for managing this condition.[4] The indications for surgical intervention are expanding and literatures clearly document conditions in which surgical interventions offer better outcome as compared to conservative management.

Many authors advocate for plating as the preferred method for acute clavicle fractures.[12,13] Biomechanically, plate fixation is superior to intramedullary fixation as it offers better resistance to the bending and torsional forces encountered during overhead abduction of upper limb.[14] Patients treated with plate fixation can often start full range of motion after soft-tissue healing. However, this benefit is gained at the cost of increased surgical incision, soft-tissue stripping, risk of damage to the supraclavicular nerve, increased infection rate, and theoretical risk of re-fracture after plate removal.[6] At present, open reduction and internal fixation with a 3.5-mm LCP is considered the preferred method for treating mid-shaft clavicle fracture in indicated cases,[15,16] though intramedullary fixation is also a viable alternative.[17,18]

Table 2: Statistical comparison of clinical outcomes between plate and nail groups

Parameters	Plate group (Mean±SD)	Nail group (Mean±SD)	*P*-value
Comparison of age distribution			
Age (years)	32.33±9.55	28.70±7.64	0.11
Comparison of DASH score			
DASH score at 6 weeks	18.66±5.28	19.25±3.64	0.61
DASH score at 12 weeks	7.60±8.35	8.33±6.49	0.71
DASH score at 6 months	5.80±8.72	4.93±8.09	0.69
Comparison of VAS score			
VAS score at 6 weeks	19.07±11.19	16.77±10.11	0.40
VAS score at 12 weeks	8.73±13.37	12.03±10.14	0.29
VAS score at 6 months	1.63±3.70	2.17±3.33	0.56
Comparison of union			
Union time (weeks)	10.20±1.24	9.45±1.53	0.04
Comparison of surgical time			
Duration of surgery (minutes)	76.17±9.26	37.10±6.89	0.0001

DASH: Disabilities of arm, shoulder, and hand, VAS: Visual Analog Scale

In this study, the average age of the patients was 30.5 years represented mainly by the patients of the second and third decades. Overall, there was male predominance with 78.3% as compared to 21.7% female. Ethiraj *et al.*[19] found that 41% of cases were in the 19–30 age group, with a mean age of 31.8 years.

We found in this study that the mean duration for union was 9.45 ± 1.53 weeks for the nail group and 10.20 ± 1.24 weeks for the plate group. A total of 24 patients (80%) from the nail group achieved radiological union in 8–10 weeks' time, while 25 patients (83.3%) achieved union in 10–12 weeks' time from plate group. One patient from nail (3.33%) and two patients (6.66%) from plate group did not unite by 6 months and required secondary intervention thereafter. Wu *et al.*[20] in their retrospective study comparing plate and intramedullary nail fixation for treating clavicle fracture, found an 18.2% non-union rate with plating and an 11.1% rate with nailing. They attributed that this finding was due to the nail's better ability to resist compressive stresses, although plating offered better rotational stability. The treatment with single intramedullary elastic nail proved to be superior in achieving radiological union for mid-shaft clavicle fractures compared to plate fixation. The difference in time taken for bone union in both the group was statistically significant ($P = 0.04$).

The DASH scores for the plate group fared better at 6 weeks (18.66 ± 5.28) and 12 weeks (7.60 ± 8.35) as compared to the nail group, which were 19.25 ± 3.64 and 8.33 ± 6.49 for a similar duration. The better functional outcome in the early post-operative period may be due to optimal resistance offered by LCP to torsional and bending forces. However, the statistical difference in functional outcome in both the groups was not significant ($P = 0.61$, 0.71, 0.69). Our study also supports Liu *et al.*[21] finding of no significant differences in functional outcomes or complication rates between the 59 patients treated with plating (using a reconstruction plate) and the 51 patients treated with titanium elastic nailing system.

The VAS score of patients within the nail group (16.77 ± 10.11) was better than the plate group (19.07 ± 11.19) at 6 weeks, probably due to less surgical soft-tissue dissection needed for nail insertion compared to plate fixation. Later in follow-up period, by offering stable fixation the plate group

had better VAS score (8.73 ± 13.37 and 1.63 ± 3.70 vs. 12.03 ± 10.14 and 2.17 ± 3.33). However, these differences in VAS scores were not statistically significant.

The plate group reported more complications such as infection, numbness over the anteromedial aspect of the shoulder, hypertrophic scar, and non-union. The extruded end of nail on the medial aspect at entry site caused more implant-related complications such as irritation and hardware prominence. Major complications reported in the literature for other intramedullary fixation methods, such as Kirschner wires and Rush pins – like neurovascular injury and implant migration into the chest cavity[22,23] were not observed in our study. No such complications have been documented in the literature using Titanium Elastic Nailing System for clavicle fractures.[17]

An additional advantage of intramedullary flexible nailing over plating is the ease of implant removal. In the plate group, removal required another surgery under general anesthesia with a large incision, whereas, in the nail group, the nails could be removed as an outpatient procedure under local anesthesia with a small incision over the nail tip.

CONCLUSION

We found in this study that both LCP and EIN are effective alternatives for surgical fixation of displaced mid-shaft clavicular fractures with comparable functional outcome in long-term follow-up.

However, EIN is a minimally invasive surgical technique with fewer complication, achieves early union, requiring less operative time, and comparable functional results in long term follow-up, which can be regarded as an alternative to LCP fixation of displaced mid-shaft clavicular fractures.

Limitations and Future Research

This was a retrospective observational study with a small sample size. Larger randomized controlled trials are needed to further evaluate outcomes and complications of pre-contoured plates and EIN in displaced mid-shaft clavicle fractures.

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