

Outcomes of Two Surgical Techniques for Mid-Shaft Clavicle Fractures Fixation

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ABSTRACT

Background: Fractures of the clavicle account for 44% of injuries around the shoulder girdle, several techniques of fixation have been described in literature, including the use of plates, Kirschner wires, Steinman pins, external fixators and even plaster constructs.

Objective: The purpose of this prospective cohort study was to compare the outcomes of intra-medullary fixation and plating in the treatment of mid-shaft clavicle fractures.

Patients and Methods: In this study, 24 patients ranging in age from 18 to 60 were enrolled. They were split into two groups and given intra-medullary nailing or plating as their treatment options. Comparison of the two groups' outcomes and complications was done.

Results: The nail group's union time was markedly reduced. In terms of the functional outcome, as measured by the Quick DASH Score, there was no significant difference between groups. A higher rate of infection and nonunion was found in those who used plates, although there was no statistically significant difference between the groups. The nail group had much more skin irritation (hardware prominence) than the control group. When compared to the plate group, patient dissatisfaction was much higher due to scar development.

Conclusion: It is possible to employ intra-medullary fixation in the treatment of mid-shaft clavicle fractures as a viable alternative to plate fixation since it is a minimally invasive procedure with fewer risks, faster healing, and better cosmetic and functional outcomes.

Keywords: Intra-medullary nailing, Mid-shaft clavicle fracture, Plating.

INTRODUCTION

In the past few years, the incidence of clavicle fractures has risen from an annual average of 24 per 100,000 to 71 per 100,000 people^(1, 2). The most common type of clavicle fracture is the mid-shaft clavicular fracture, which accounts for between 69 and 82% of all clavicle fractures^(3,4).

Rehabilitation focuses on getting the shoulder back to its pre-injury state as quickly as possible. With minor deformation of the clavicle, there will be less pain and less loss of motion⁽³⁾. Even when the fractures were clearly displaced, non-operative therapy for mid-shaft clavicle fractures was the norm, with satisfactory to excellent results. New research demonstrates that non-operative treatment of middle shaft clavicle fractures, especially those with substantial displacement or shortening, may result in greater rates of non-union and delayed union as well as pain and weakness in the shoulder after the fractures have healed⁽⁵⁾.

Intramedullary or plate-and-screw open reduction and internal fixation (ORIF) surgery are both options for surgical therapy⁽⁶⁾. Patients who require traditional surgical intervention usually have one of the following: open fractures, skin damage, neurovascular problems, fractures that are badly comminuted and dislocated, painful non- or malunion, or an additional scapular neck fracture (floating shoulder)⁽⁷⁾.

The most common surgical treatment for a mid-shaft clavicle fracture is open reduction and plating mid-shaft clavicle fractures (MCF). It is employed because of its capacity to restore and maintain the clavicle's length and structure. However, the procedure

has its drawbacks, including infection, non-union, and poor cosmetic results due to the scarring of the big incisions⁽⁸⁾.

However, intramedullary fixation is another surgical option for mid-shaft clavicle fracture stabilization, and a variety of devices, such as smooth K-wires, Hagie pins, Knowles pins, Rockwood clavicle pins, and titanium elastic nails, have been utilised for intramedullary clavicle fixation over the years, with the last option being the most widely used alternative today⁽⁸⁾.

Intra-medullary fixation (IMF) prefers a minimally invasive method since it requires just a short incision and no periosteal stripping, which reduces the risk of small scars, infection as well as nonunion⁽⁸⁾. However, it comes with its own set of drawbacks, including the requirement for radiological intervention, which entails radiation exposure, iatrogenic damage to neurovascular systems, and the possibility of implant migration, all of which necessitate removal of the implant⁽⁹⁾.

The purpose of this prospective cohort study was to compare the outcomes of intra-medullary fixation and plating in the treatment of mid-shaft clavicle fractures.

PATIENTS AND METHODS

At The Zagazig University Hospital, we conducted a prospective cohort study of 24 individuals. All of the patients were eligible because they met the study's inclusion and exclusion criteria.

Inclusion criteria: Mid-shaft dislocation of the clavicle, with no cortical contact between the major

components. Aged from 16 to 65. There was a loss of soft tissue at the fracture site (tenting of skin). Floating shoulder. Open fractures type I and II. Segmental fracture, and bilateral clavicle fractures.

Exclusion criteria: Age older than 65 and younger than 16. A fracture of the clavicle's upper and lower thirds. Fractures with severe comminution, and medical contraindication to surgery and / or anesthesia.

The patients were split into two groups and given intramedullary nailing or plating as their treatment options.

Ethical approval:

The study was approved by the Ethics Board of Zagazig .This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Surgical technique for plating:

Drastically reducing the clavicle's thickness, a skin incision was made over the fracture site. Protecting any visible cutaneous nerve branches, the skin and subcutaneous tissue were lifted and reflected upward to identify any underlying myofascia. Using contiguous flaps, this layer, including the deltopectoral muscle attachment, was elevated as a two-layer closure over the plate. In order to find the exact location of the fracture, a reduction forceps was used to hold the proximal and distal fragments in place while the clavicle was straightened (Fig. 1).



Figure (1): Identification of the fracture site.

To ensure proper repositioning and apposition of the fracture, as little soft-tissue dissection as possible was employed. It was possible to stabilise the fracture using a 2.0-mm K-wire aimed perpendicularly at the fracture line following a successful reduction. To hold the plate in place, a reduction clamp was used with a minimum of six holes and a maximum of ten. An opening was made on the fracture site opposite to the location of the K wire and reduction clamp, where the first screw was placed. In order to avoid damaging the subclavian structures and the lung, care was used when

drilling and putting screws. Protective instruments were placed along the lower surface of the clavicle to avoid the drill from mistakenly injuring any critical structures (Fig. 2).



Figure (2): placing a protective instrument along the inferior surface of the clavicle to prevent the drill from inadvertently damaging any vital structures.

Placing no less than three screws per side of the fracture ensured that all six cortical bones are held together.

Immediately after all of the screws were inserted, the field was sprayed with normal saline to ensure the integrity of the structure. Myofascial, subcutaneous, and skin closure was done in layers, using absorbable sutures ranging from number 1 to number 2/0 or 1/0, and clips or simple stitches for the skin.

Surgical technique for intramedullary nailing:

Slightly larger than a centimetre, the bone was dissected with a blunt instrument until the wound was closed. Drilling 2.5 or 2.7 mm through the anterior cortex of the clavicle's medial side opened the anterior cortex (Fig. 3).



Figure (3): Intraoperative radiograph of mid-shaft clavicle fracture fixed by plating Using fluoroscopy to guide placement, the awl was placed after unicortical opening and oriented lateral to

the medullary canal's orientation. The TEN was pushed to the fracture site after being put directly into the canal. To facilitate manipulation and open reduction, a tiny incision was created at the fracture site and a pair of pointed reduction clamps were used to do a percutaneous close reduction (Fig. 4 and 5).



Figure (4): Opening of the anterior cortex of the medial side of the clavicle

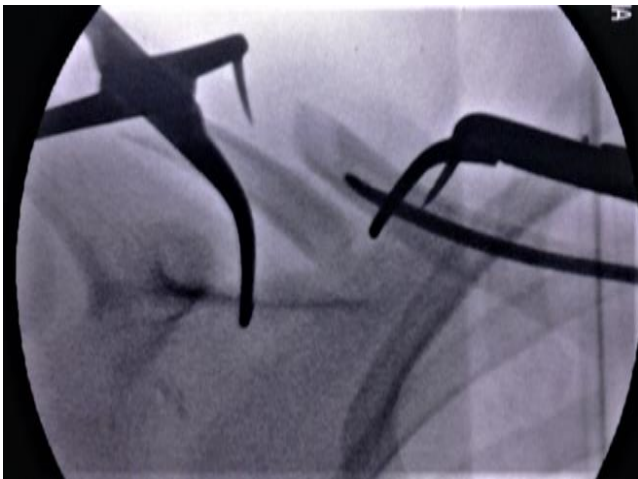


Figure (5): Close reduction of the fracture.

When the TEN was placed in the lateral part of the clavicle, it was inserted as close to the lateral cortex as feasible without damaging it. Lateral shoulder manual compression alleviated any distraction at the fracture site.

Mid-shaft clavicle fracture fixed by intramedullary nailing is shown in figure 6.



Figure (6): Intraoperative radiograph of mid-shaft clavicle fracture fixed by intramedullary nailing

The medial end of the implant was trimmed to the bare minimum. Manipulation under fluoroscopic control confirmed good reduction and fixation. The wounds were stitched together, dressed, and the patient's arm was strapped into a sling.

Statistical analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for the Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Data were tested for normal distribution using the Shapiro Wilk test. Quantitative data were presented as mean, standard deviation (SD), and range and were compared by independent samples t-test. Qualitative data were presented as frequency and percentage and were compared by Fisher's exact test. P value < 0.05 was considered significant.

RESULTS

The mean of Quick DASH Score was not significantly different between the nail and the plate fixation groups (Table 1).

Table (1): Functional outcome among the studied groups

Quick DASH Score			
	Nail	Plate	P value
N	12	12	
Mean	6.3	6.9	0.695
SD	1.13	1.21	
Range	0-13	0-14	

The time of union in the plate group had a mean of 12 weeks (Figs. 7, 8), while in the nail group had a mean of 9.77 weeks (Figs. 9, 10). There was a substantial difference in the average time to union between the nail group and the plate group (Table 2).



Figure (7): Preoperative radiograph of right mid-shaft clavicle fracture



Figure (8): Radiograph at 12 weeks showing healing callus at the fracture site.



Figure (9): Intraoperative radiograph of mid-shaft clavicle fracture fixed by intramedullary nailing



Figure (10): Radiograph at 12 weeks showing healing callus at the fracture site

Table (2): Union time among the studied groups

Time of union			
	Nail	Plate	P value
N	12	12	
Mean	9.77	12	0.179
SD	1.39	2.73	
Range	8-12	8-16	

Neither the plate nor the nail groups were significantly different when it came to nonunion (**Table 3**).

Table (3): Nonunion frequency among the studied groups

Nonunion			
	Nail	plate	P value
N	12	12	
Nonunion	1	2	0.859
%	8%	17%	

No significant difference could be found between the two groups when it came to cases of superficial infection following plate fixation and nail fixation (**Table 4**).

Table (4): Infection distribution among the studied groups

Infection			
	Nail	plate	P value
N	12	12	
Infection	2	3	0.617
%	17%	25%	

There was no significant difference between the two groups as regard skin irritation (**Table 5**).

Table (5): Skin irritation among the studied group

Skin irritation			
	Nail	Plate	P value
N	12	12	
Skin irritation	5	2	0.196
%	42%	17%	

There was no significant difference between the two groups as regard frequency of hypertrophic scars (**Table 6**).

Table (6): Hypertrophic scar distribution among the studied group

Hypertrophic scar			
	Nail	Plate	P value
N	12	12	
Hypertrophic scar	0	3	0.122
%	0%	33%	

DISCUSSION

In our study, we aimed to evaluate the clinical, radiological, cosmetic and functional outcomes of both

the intra-medullary fixation by elastic stable intra-medullary nailing (ESIN) and the plate fixation of the MCF.

In our study, 24 patients with MCF were divided into two groups of 12 patients each. Where 12 patients were treated with plate fixation, and the other 12 patients were treated by IMF.

After 6 months of follow up, the 12 patients of the nail group demonstrated that 92% of patients had union and only 8% had non-union, with a union time had a mean of 9.77 weeks. The mean Quick Dash Score was 6.3. Infection occurred in 17% of patients, while skin irritation occurred in 42% of patients.

On the other hand, the 12 patients of the plate group demonstrated that 83% of patients had union and only 17% had non-union, with a union time had a mean of 12 weeks. The mean Quick Dash Score was 6.9. Infection occurred in 25% of patients, while skin irritation occurred in 17% of patients.

We compared our study with other studies that were done and discussing the effectiveness of both the intra-medullary fixation by elastic stable intra-medullary nailing (ESIN) and the plate fixation of the MCF, as follow:

In our study, the nail group had a mean age of 33.33 years (SD: 12.62 years, range 18-60 years), while the plate group had a mean of 31.75 years (SD 11.36 years, range 20-55 years). **Sahu et al.**⁽¹⁰⁾ reported that the mean age in plating group was 34.76 years (SD: 11.87) and in nailing group was 33.28 years (SD: 10.73). Another study by **Saha et al.**⁽¹¹⁾ reported that the mean of age was 33.32 years (SD: 11.84 years, range 15-55 years) in the nail group, while the plate group had a mean of 33.03 years (SD 12.64 years, range 15-58 years).

Regarding the gender distribution, our study demonstrate that out of the 12 patients of the nail group, 8 patients were males (67%), and 4 patients were females (33%). As for the plate group, which was made of 12 patients also, 9 were males (75%), 3 were females (25%). **Park et al.**⁽⁸⁾ reported that in the nail group, the male patients were 34 (96.4%), and the female patients were 15 (30.6%). While the plate group had a distribution of 40 male patients (83.3%), and 8 female patients (16.7%). Another study by **Sahu, et al.**⁽¹⁰⁾ reported that the nail group was made of 18 males (72%), and 7 females (28%). As for the plate group was made of the same numbers, 18 male patients (72%), and 7 female patients (28%).

In our study, the fracture side right: left ratio in the nail group was 10: 2, whereas in the plate group 8:4. **Narsaria et al.**⁽¹²⁾ reported that fracture side right: left in the nail group was 18:15, whereas in the plate group 20:12.

In our study, the mechanism of injury was presented as a road traffic accident 63%, sport injury 21%, and fall on outstretched hand 17%. **Sahu et al.**⁽¹⁰⁾ presented the mechanism of injury into two groups, in the nail group the road traffic accident (RTA)

represented 48%, sport injury 24%, fall on outstretched hand 20%, and the remaining 8% represented by fall from height. While in the plate group, RTA represented 64%, sport injury 8%, fall on outstretched hand 4%, and fall from height 24%.

In our study, mean Quick DASH Score in the nail group was 6.3 (range, 0-13). **Kadokia et al.**⁽¹³⁾ mentioned that the average Quick DASH score was 6.7 (range, 0-13.6). As for the plate group in our study, the mean Quick DASH Score was 6.9 (range, 0-14). **Delvaque et al.**⁽¹⁴⁾ mentioned that the average Quick DASH score 6.8 (range, 2.27-15.9).

In our study, regarding time of union we found that the nail group had a mean of 9.77 weeks (SD = 1.39) (range, 8-12 weeks). **Kenan et al.**⁽¹⁵⁾ showed that the patient who were treated by nail fixation in their study had a mean of 10 weeks (SD = 1.33) (range, 8-12 weeks). As for the plate group in our study had a mean of 12 weeks (SD = 2.73) (range, 8-16 weeks). **Kilinc et al.**⁽¹⁶⁾ showed that the patients who were treated by plate fixation in their study had a mean of 9.1 weeks (SD = 1.3) (range, 8-13 weeks).

In our study, nonunion occurred in two cases in the plate group (17%), and only in one case in the nail group (8%). **Assobhi et al.**⁽⁴⁾ reported that nonunion occurred in only one case in the plate group (5.3%), and zero case in the nail group (0%). Another study **Narsaria, et al.**⁽¹²⁾ reported that no case of nonunion had occurred in the plate group (0%), while the nail group had only one case of nonunion (3.03%).

In our study, superficial infection was noticed in three cases with plate fixation (25%), and in two cases with nail fixation (17%). **Park et al.**⁽⁸⁾ mentioned that two cases had superficial infection in the plate group (4.2%), and only one case in the nail group (2%). In another study by **Narsaria et al.**⁽¹²⁾ the infection had occurred in two cases in the plate group (6.25%), and only in one case in the nail group (3.03%).

In our study, skin irritation had occurred in two cases in the plate group (17%), and in five cases in the nail group (42%). **Park et al.**⁽⁸⁾ reported that two cases had skin irritation in the plate group (4.2%) and ten cases in the nail group (20.4%).

In our study, hypertrophic scar (scar dissatisfaction) had occurred in three cases in the plate group (33%), while in the nail group no patient reported scar dissatisfaction (0%). **Assobhi et al.**⁽⁴⁾ mentioned that four cases in the plate group had hypertrophic scar (21.10%) and zero case in the nail group (0%). Another study by **Narsaria et al.**⁽¹²⁾ showed that four cases in the plate group had hypertrophic scar (12.50%) and zero case in the nail group (0%).

CONCLUSION

Our study had its own limitation of having a small sample size, and short follow up duration. Larger samples and longer follow up durations are needed for better evaluation and judgments.

We reached to a conclusion that both the plating and intramedullary titanium elastic nails fixation techniques are nearly equally effective alternatives for the surgical fixation of the MCF. However, both have their limitations.

There are many advantages to using intramedullary titanium elastic nails, including speed and safety. It's less intrusive, causes less soft tissue damage, heals faster, and has better cosmetic results, but it's more likely to cause skin irritation. Plate fixation is an option for surgical treatment of the MCF, but this approach has better functional outcomes, is easier to perform, is well-liked by patients, and has fewer complications than plate fixation.

A small skin incision can be made over the tip of the nail to remove the implant under local anesthetic.

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Author contribution: Authors contributed equally in the study.

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