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CLINICAL OUTCOMES OF ELASTIC STABLE INTRAMEDULLARY NAILING WITH SELECTIVE PLATE CONVERSION IN ADULT MIDSHAFT CLAVICLE FRACTURES

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ABSTRACT

Background: Midshaft clavicle fractures are common injuries in adults and may require operative fixation when significantly displaced or shortened. Elastic stable intramedullary nailing is a minimally invasive technique that preserves fracture biology and provides internal stabilization with a small surgical scar. **Objectives:** To evaluate the clinical outcomes and complications of elastic stable intramedullary nailing with selective plate conversion in adult patients with displaced midshaft clavicle fractures. **Methods:** This prospective observational study included 48 adult patients with displaced midshaft clavicle fractures initially planned for elastic stable intramedullary nailing at Al Salam Teaching Hospital from January 2023 to March 2026. Patients were assessed clinically and radiologically during follow-up at approximately 2 weeks, 6 weeks, 12 weeks, 6 months, and at the stage of nail removal when applicable. Operative outcome, fracture union, implant stability, complications, and final clinical outcome were evaluated. **Results:** Closed reduction with elastic nail fixation was successful in 20 patients (41.7%), while 25 patients (52.1%) required small incision open reduction followed by elastic nail fixation after failed closed reduction. Three patients (6.3%) with comminuted fractures were converted to open reduction with plate and screw fixation. Satisfactory clavicular alignment was achieved in 46 patients (95.8%), and stable implant position was confirmed in all patients. Early callus formation was observed in 44 patients (91.7%) at 6 weeks, while radiological union or progressive union was seen in 46 patients (95.8%) at 12 weeks. Complete union with maintained alignment was achieved in all patients by 6 months. The most common complication was medial nail-end irritation in 5 patients (10.4%), followed by delayed union in 3 patients (6.3%), superficial wound infection in 2 patients (4.2%), hypertrophic scar in 1 patient (2.1%), and implant migration in 1 patient (2.1%). No deep infection, neurovascular injury, nonunion, or refracture after implant removal was recorded. Final clinical outcome was excellent in 35 patients (72.9%), good in 11 patients (22.9%), and fair in 2 patients (4.2%). **Conclusions:** Elastic stable intramedullary nailing with selective plate conversion is a safe and effective operative strategy for selected adult midshaft clavicle fractures, providing high union rates, stable fixation, good cosmetic results, and favorable clinical outcomes with a low rate of major complications.

KEYWORDS: Clavicle fracture; Elastic nail; Intramedullary fixation; Midshaft fracture.

1- INTRODUCTION

In adult orthopedic trauma, clavicle fractures are a frequent injury and account for a significant portion of shoulder girdle fractures. The clavicle serves as a strut between the axial skeleton and the upper limb, providing the width of the shoulder, facilitating scapulothoracic movement, and protecting the underlying neurovascular structures. The clavicle is susceptible to direct trauma and axial loading that is transmitted through the shoulder due to its distinct S-shape and subcutaneous position. Midclavicular fractures are the most frequent pattern, accounting for the majority of clavicle fractures, largely because the middle third represents the thinnest part of the bone and lacks the strong ligamentous reinforcement present medially and laterally. These fractures are particularly common among young and active adults,

often resulting from road traffic accidents, sports-related trauma, falls, or direct impact to the shoulder region.[1-2]

Traditionally, most midclavicular fractures were treated non-operatively using an arm sling or figure-of-eight bandage, as earlier reports suggested high union rates and acceptable functional outcomes. However, contemporary evidence has challenged this approach, especially for displaced, shortened, comminuted, or completely displaced midshaft fractures. Non-operative management in such cases may be associated with delayed union, nonunion, symptomatic malunion, persistent pain, shoulder weakness, cosmetic deformity, and dissatisfaction with functional recovery. Shortening and displacement may alter shoulder biomechanics, reduce endurance, and impair overhead activity, particularly in physically active adults. As a result, the indications for operative fixation have expanded over the last two decades, with increasing emphasis on restoring clavicular length, alignment, and early shoulder function.[3-4]

Surgical fixation of displaced midclavicular fractures aims to achieve stable reduction, promote early mobilization, reduce the risk of nonunion or malunion, and improve functional outcomes. Plate osteosynthesis has long been considered the standard operative method because it provides rigid fixation and allows direct anatomical reduction, particularly in comminuted fractures. Nevertheless, plating requires relatively extensive soft-tissue dissection and periosteal stripping, which may compromise local biology and increase the risk of wound complications. In addition, plate fixation may be associated with implant prominence, hypertrophic scarring, infection, supraclavicular nerve irritation, hardware failure, refracture after implant removal, and the need for a second operation due to symptomatic implants. These limitations have encouraged interest in less invasive fixation techniques that preserve fracture biology while providing adequate mechanical stability.[5-6]

Elastic Stable Intramedullary Nailing (ESIN), commonly performed using titanium elastic nails, has emerged as a minimally invasive alternative for selected adult midclavicular fractures. The principle of ESIN is based on internal splintage of the clavicle through the medullary canal, providing elastic stability while minimizing soft-tissue disruption. Compared with plate fixation, ESIN generally requires a smaller incision, less periosteal stripping, reduced blood loss, shorter operative time, and improved cosmetic appearance. By preserving the fracture hematoma and periosteal blood supply, intramedullary fixation may support biological healing and facilitate earlier rehabilitation. These features make ESIN particularly attractive for simple transverse or short oblique displaced midshaft fractures in adults, where closed or minimally open reduction can be achieved.[7-8]

Recent comparative studies and meta-analyses have reported that intramedullary fixation can provide functional outcomes comparable to plate fixation in appropriately selected patients with displaced midshaft clavicle fractures. Some studies have shown advantages of intramedullary fixation, including shorter surgical time, smaller incision length, shorter hospital stay, lower infection risk, faster union, and better early Disabilities of the Arm, Shoulder and Hand scores. However, long-term shoulder function, including Constant-Murley scores, may be similar between intramedullary fixation and plating. Therefore, the choice of fixation method should be individualized according to fracture morphology, degree of comminution, surgeon experience, patient expectations, and the need for rapid functional recovery.[9-10]

Despite its advantages, ESIN is not free from complications. Reported problems include nail migration, medial or lateral nail prominence, skin irritation, entry-site pain, implant bending, cortical perforation, telescoping or shortening at the fracture site, rotational instability, and the frequent need for implant removal after union. The technique may also be less suitable for markedly comminuted fractures, segmental fractures, or fractures with severe shortening, where rotational and axial stability may be insufficient. Therefore, proper patient selection, accurate nail sizing, careful insertion technique, secure nail end management, and regular postoperative follow-up are essential to reduce complications and optimize outcomes.[11-12] Evaluating the clinical, radiological, and functional outcomes of ESIN in adult midclavicular fractures is therefore important to clarify its effectiveness, safety, complication profile, and its role in contemporary orthopedic trauma practice.

2-PATIENTS AND METHODS

Ethical approval was obtained from Nineveh Directorate of Health ethical committee before data collection. Verbal or written informed consent was obtained from all participants before inclusion in the study. Patient confidentiality was maintained throughout the study by using anonymous data collection forms, and all collected information was used only for scientific research purposes.

This was a hospital-based prospective observational study conducted to evaluate the clinical outcomes and complications of operative fixation initially planned as elastic stable intramedullary nailing in adult patients with displaced midshaft clavicle fractures. The study was carried out at the Department of Orthopedic Surgery in Al Salam Teaching Hospital. The hospital receives a large number of trauma and orthopedic cases, including upper limb and shoulder girdle injuries. Patients were recruited from the emergency department and orthopedic outpatient clinic. All surgical procedures were performed in the operating theater of the same hospital by the investigators themselves.

The study was conducted during the period from January 2023 to March 2026. A total of 48 adult patients with displaced midshaft clavicle fractures were included in the study. All patients were initially planned for elastic stable intramedullary nailing. Closed reduction and elastic nail fixation were successfully completed in 20 patients. In 25 patients, closed reduction failed; therefore, a small incision open reduction was performed to achieve fracture alignment, followed by elastic nail fixation. Three patients had comminuted fractures that were unsuitable for stable intramedullary fixation and were converted intraoperatively to open reduction with plate and screw fixation.

Patients were included in the study if they were aged 18 years or older and had an acute displaced midshaft clavicle fracture indicated for operative fixation. Patients with closed fractures and selected low-grade open fractures were considered eligible if they were medically fit for anesthesia and agreed to participate in the study and attend follow-up visits. Patients were excluded if they were younger than 18 years, had medial-third or lateral-third clavicle fractures, pathological fractures, old neglected fractures, established nonunion, high-grade open fractures, associated neurovascular injury requiring vascular repair, previous surgery on the affected clavicle or shoulder, or incomplete follow-up data. Severely comminuted fractures were not excluded from operative management; however, when intraoperative assessment showed that elastic nailing could not provide adequate stability, fixation was changed to plate and screw fixation.

All patients underwent detailed preoperative evaluation. A complete history was obtained, including age, sex, occupation, hand dominance, mechanism of injury, time from injury to presentation, affected side, associated injuries, and relevant medical comorbidities. Clinical examination included assessment of swelling, deformity, tenderness, skin condition, bruising, skin tenting, open wounds, shoulder asymmetry, and range of motion when possible. Neurovascular examination of the affected upper limb was performed carefully and documented before surgery.

Radiological assessment was performed using standard anteroposterior radiographs of the clavicle, with additional shoulder or clavicle views when required. Radiographs were used to confirm the diagnosis, determine the fracture location, assess displacement and shortening, identify comminution, and evaluate suitability for elastic stable intramedullary nailing (figure 1). Routine preoperative investigations were performed for all patients according to hospital protocol, including complete blood count, blood sugar, renal function tests, viral screening, electrocardiography, and anesthetic evaluation.

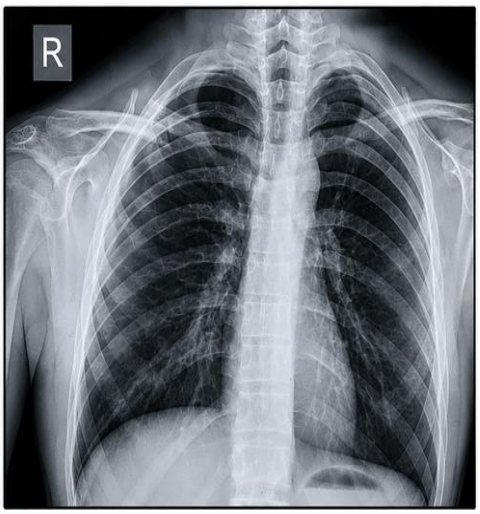

Figure 1: Preoperative anteroposterior radiographs showing a displaced midshaft fracture of the right clavicle with overriding of the fracture fragments. No obvious associated rib fracture or pneumothorax is seen on the available radiographs.

All patients were initially prepared for elastic stable intramedullary nailing using a titanium elastic nail of suitable diameter; however, 3 patients with comminuted fractures were converted intraoperatively to plate and screw fixation. The operation was performed under general or regional anesthesia according to anesthetic assessment and patient condition. The patient was placed in a supine position on a radiolucent operating table, with a small support placed between the scapulae to improve exposure and clavicular alignment. The shoulder and upper limb were prepared and draped under strict aseptic precautions.

A small incision was made near the medial end of the clavicle, lateral to the sternoclavicular joint. As shown in figure 2.

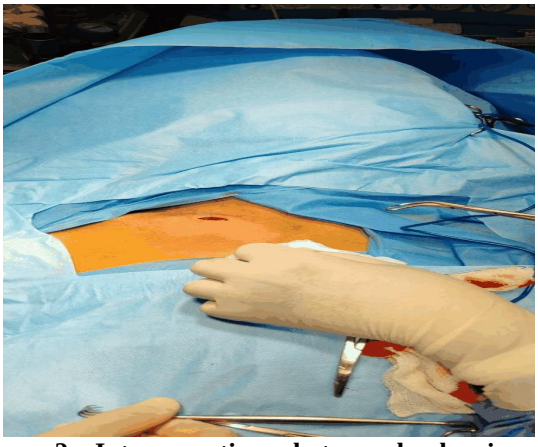

Figure 2: Intraoperative photograph showing the patient positioned and draped under sterile conditions for elastic stable intramedullary nailing of a right midshaft clavicle fracture. A small skin incision is made near the medial end of the clavicle to create the entry point for insertion of the titanium

elastic nail, reflecting the minimally invasive nature of the procedure.

An entry point was created carefully in the anterior cortex of the medial clavicle using an awl or drill. The titanium elastic nail was introduced into the medullary canal and advanced laterally under fluoroscopic guidance. Closed reduction of the fracture was attempted by manipulation of the shoulder and fracture fragments. If closed reduction was successful, the nail was advanced across the fracture site into the lateral fragment while avoiding penetration of the lateral cortex or acromioclavicular joint. If closed reduction failed, limited open reduction was performed through a small incision over the fracture site. After achieving satisfactory reduction, the nail was advanced across the fracture under fluoroscopic control. Final fracture alignment, nail position, and stability were confirmed by fluoroscopy. The medial end of the nail was cut and bent appropriately to reduce the risk of migration and soft-tissue irritation. The wound was closed in layers, sterile dressing was applied, and the limb was supported in an arm sling. This is shown in figure 3.

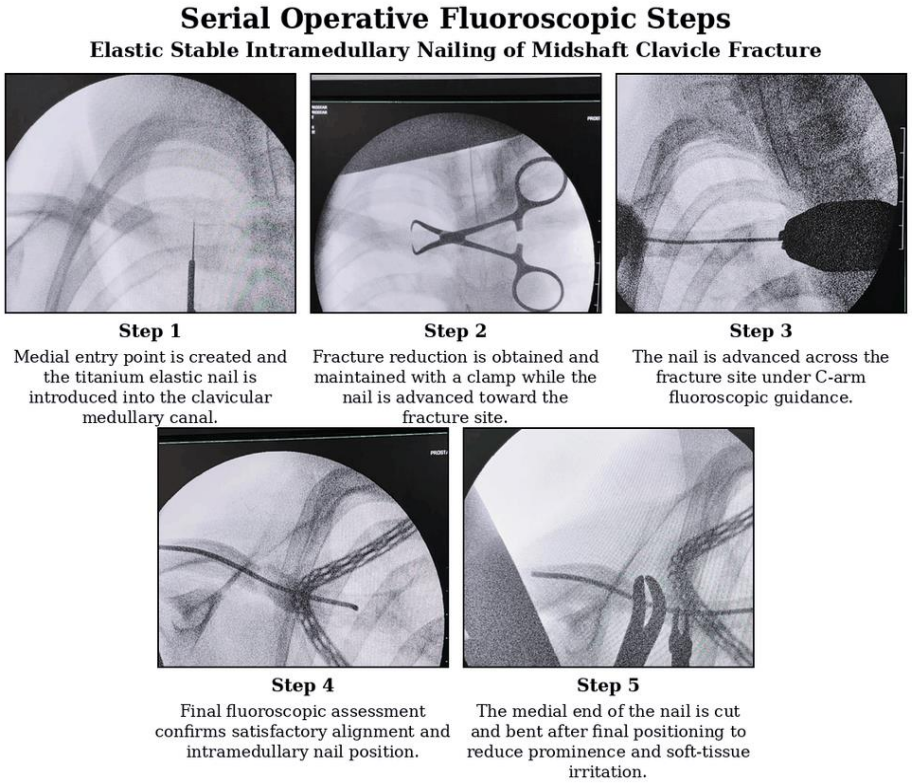

Figure 3: Intraoperative fluoroscopic images demonstrate sequential steps of elastic stable intramedullary nailing for a midshaft clavicle fracture. The titanium elastic nail is introduced through a medial clavicular entry point and advanced within the medullary canal under C-arm fluoroscopic guidance. Fracture reduction is achieved and maintained during nail passage, with confirmation of alignment and proper intramedullary positioning across the fracture site. Final fluoroscopic assessment confirms satisfactory fracture alignment, stable fixation, and appropriate nail placement before wound closure.

In patients with comminuted fractures in whom elastic stable intramedullary nailing was not able to provide adequate length, rotation, or fracture stability, the operative plan was changed to open reduction and internal fixation using plate and screws. The fracture site was exposed through a clavicular incision, the comminuted fragments were reduced as anatomically as possible, and a plate of suitable length was applied to maintain clavicular alignment and stability. Screw fixation was performed according to fracture configuration and bone quality. Final reduction, plate position, screw placement, and stability were confirmed clinically and radiologically before wound closure. As shown in figure 4.

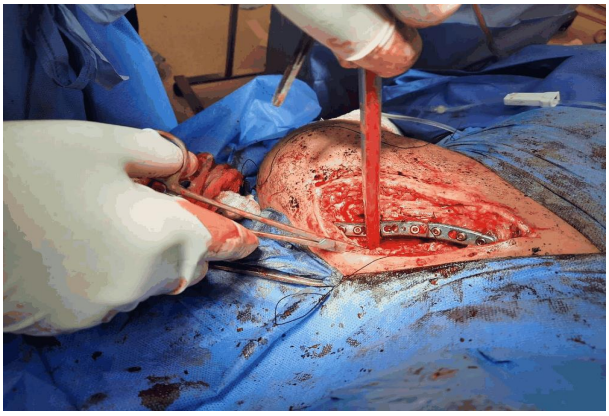

Figure 4: Intraoperative photograph showing open reduction and internal fixation of a comminuted midshaft clavicle fracture using plate and screw fixation after the fracture was judged unsuitable for stable elastic intramedullary nailing.

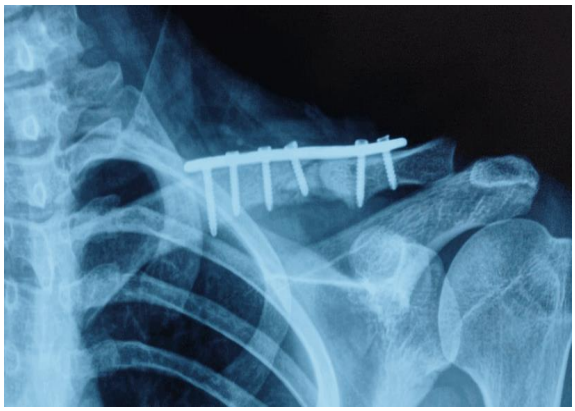

Figure 5: Postoperative anteroposterior radiograph showing plate and screw fixation of a midshaft clavicle fracture with restoration of clavicular alignment and stable internal fixation.

Radiographs were obtained during follow-up to evaluate fracture alignment, callus formation, implant or plate position, and progression of union. As shown in figure 6.

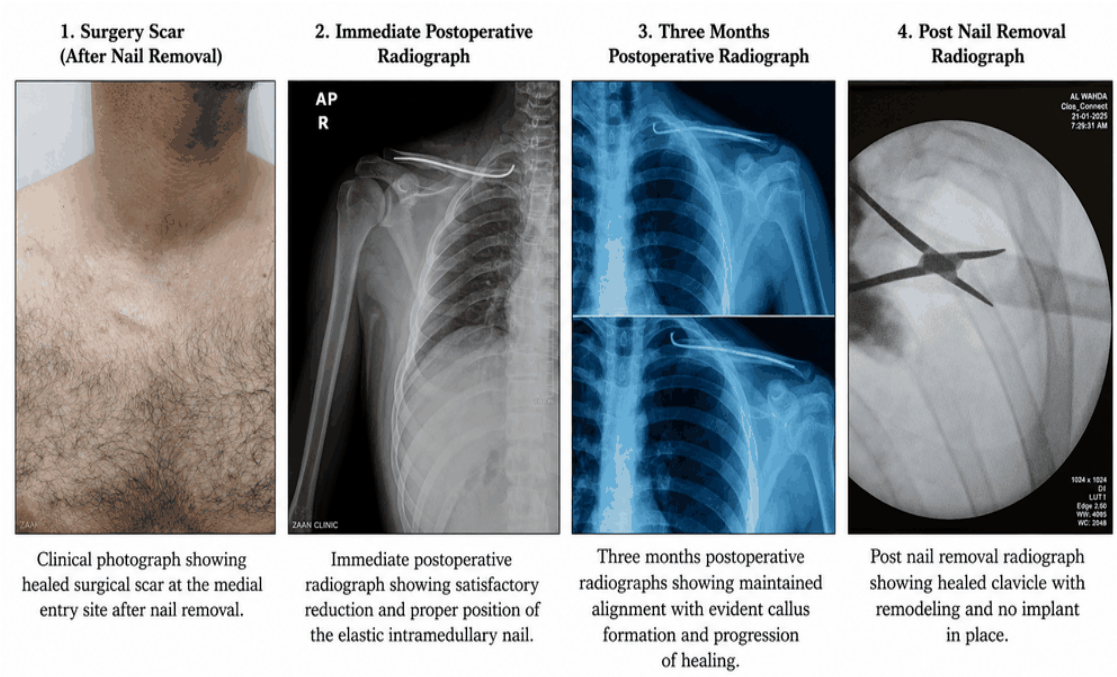

Figure 6: 0
up visiting.

The main outcomes assessed in this study were clinical outcome, radiological union, functional recovery, and complications. Clinical outcome was evaluated by pain relief, shoulder range of motion, ability to perform daily activities, return to work, and patient satisfaction. Functional recovery was assessed using clinical shoulder function parameters, and when applicable, standardized scoring systems such as the Constant-Murley Shoulder Score and the Disabilities of the Arm, Shoulder and Hand score were used. Radiological union was defined as the presence of bridging callus across the fracture site on radiographs, absence of progressive fracture gap, and absence of local tenderness at the fracture site. Delayed union was considered when healing was slower than expected but showed progressive radiological improvement, while nonunion was defined as failure of clinical and radiological union after an extended follow-up period without progression toward healing.

All intraoperative and postoperative complications were recorded. Intraoperative complications included difficulty in reduction, failure of closed reduction, cortical perforation, nail bending, iatrogenic fracture comminution, and conversion to plate and screw fixation. Early postoperative complications included wound infection, hematoma, skin irritation, entry-site pain, implant prominence, and neurovascular symptoms. Late complications included nail migration, implant failure, delayed union, nonunion, malunion, shoulder stiffness, refracture, and the need for implant removal.

The study data were entered and analyzed using the Statistical Package for the Social Sciences software. Categorical variables were presented as frequencies and percentages. Continuous variables, when available, were expressed as mean, standard deviation, minimum, and maximum values. Because the study was descriptive and did not include a comparative control group, no formal hypothesis testing was performed.

3-RESULTS

A total of 48 patients with displaced midshaft clavicle fractures were included in this study. All patients were initially planned for elastic stable intramedullary nailing. Closed reduction was successful in 20 patients (41.7%), while 25 patients (52.1%) failed closed reduction and therefore proceeded to a small incision open reduction followed by elastic nail fixation. Three patients (6.3%) had comminuted fracture patterns that were not suitable for stable intramedullary fixation and were converted intraoperatively to open reduction with plate and screw fixation. The results are presented according to demographic characteristics, fracture side, mechanism of injury, fracture pattern, operative findings, postoperative radiological assessment, follow-up outcomes, complications, and final clinical outcome.

Table 1 shows the gender distribution of the studied patients. Males represented the majority of cases, accounting for more than two thirds of the study population.

Table 1: Demographic distribution of the studied patients.

Variable	Number	Percentage
Total patients	48	100%
Male	34	70.8%
Female	14	29.2%

Table 2 demonstrates the affected side among patients with midshaft clavicle fractures. Right-sided fractures were slightly more frequent than left-sided fractures.

Table 2: Side of clavicle fracture.

Fracture side	Number	Percentage
Right clavicle	27	56.3%
Left clavicle	21	43.8%
Total	48	100%

Table 3 presents the mechanism of trauma leading to clavicle fracture. Road traffic accidents were the most common mechanism, followed by falls on the shoulder or outstretched hand.

Table 3: Mechanism of injury.

Mechanism of injury	Number	Percentage
Road traffic accident	22	45.8%
Fall on shoulder/outstretched hand	18	37.5%
Sports-related injury	5	10.4%
Direct trauma	3	6.3%
Total	48	100%

Table 4 summarizes the radiological fracture configuration. Simple transverse or short oblique fractures were the most frequent pattern, followed by long oblique fractures and comminuted fractures.

Table 4: Radiological type of fracture.

Fracture pattern	Number	Percentage
Simple transverse/short oblique fracture	24	50.0%
Long oblique fracture	21	43.8%
Comminuted fracture	3	6.3%
Total	48	100%

Table 5 describes the intraoperative findings and technical outcome of fixation. Elastic stable intramedullary nailing was completed in 45 patients, including 20 patients treated after successful closed reduction and 25 patients who required a small incision open reduction because closed reduction failed. Three comminuted fractures were converted to open reduction with plate and screw fixation. No intraoperative neurovascular injury was recorded.

Table 5: Operative findings and fixation outcome.

Operative variable	Number	Percentage
Successful closed reduction with elastic nail fixation	20	41.7%
Failed closed reduction requiring small incision open reduction and elastic nail fixation	25	52.1%
Total elastic stable intramedullary nailing cases	45	93.8%
Conversion to open reduction with plate and screw fixation	3	6.3%
Intraoperative neurovascular injury	0	0%

Table 6 shows the immediate postoperative radiographic findings. Stable fixation and satisfactory clavicular alignment were achieved in most patients, while mild residual angulation or displacement was observed in a small proportion.

Table 6: Immediate postoperative radiological assessment.

Radiological finding	Number	Percentage
Satisfactory clavicular alignment	46	95.8%
Stable implant/fixation position	48	100%
Mild residual angulation/displacement	2	4.2%
Early implant migration	0	0%
Early loss of reduction	0	0%

Table 7 demonstrates the radiological and clinical progress during follow-up. Patients were followed at approximately 2 weeks, 6 weeks, 12 weeks, 6 months, and at the stage of implant removal when applicable, with progressive healing and maintained fixation stability.

Table 7: Follow-up schedule and radiological outcomes.

Follow-up time	Main finding	Number	Percentage
2 weeks	Stable wound and implant position	48	100%
6 weeks	Early callus formation	44	91.7%
12 weeks	Radiological union/progressive union	46	95.8%
6 months	Complete union with maintained alignment	48	100%
Implant removal stage	United fracture before nail removal among ESIN cases	45/45	100%

Table 8 presents the recorded postoperative complications. Medial nail-end irritation was the most common complication among patients treated with elastic nailing, while serious complications such as deep infection, neurovascular injury, nonunion, and refracture after implant removal were not observed.

Table 8: Postoperative complications.

Complication	Number	Percentage
Medial nail-end irritation	5	10.4%
Delayed union	3	6.3%
Superficial wound infection	2	4.2%
Hypertrophic scar	1	2.1%
Implant migration	1	2.1%
Nonunion	0	0%
Deep infection	0	0%
Neurovascular complication	0	0%
Refracture after implant removal	0	0%

Table 9 shows the final clinical outcome after treatment and follow-up. Most patients achieved excellent or good clinical results, while no poor outcome was recorded.

Table 9: Final clinical outcome.

Final outcome	Number	Percentage
Excellent clinical outcome	35	72.9%
Good clinical outcome	11	22.9%
Fair clinical outcome	2	4.2%
Poor clinical outcome	0	0%
Total	48	100%

4- DISCUSSION

The present study evaluated the clinical outcomes and complications of operative treatment in 48 adult patients with displaced midshaft clavicle fractures. All cases were initially planned for elastic stable intramedullary nailing; however, the intraoperative course showed that closed reduction was successful in 20 patients (41.7%), whereas 25 patients (52.1%) failed closed reduction and required a small incision open reduction before elastic nail fixation. In addition, 3 patients (6.3%) with comminuted fracture patterns were converted to open reduction with plate and screw fixation because stable intramedullary control was not considered adequate. These findings highlight that elastic stable intramedullary nailing is an effective minimally invasive technique in selected displaced midshaft clavicle fractures, but fracture morphology and reducibility strongly influence the final operative strategy.[9,12,13,14]

In the current study, males represented the majority of patients, accounting for 70.8% of cases, while females represented 29.2%. This male predominance is consistent with the epidemiological pattern of clavicle fractures, particularly among young and active adults, who are more commonly exposed to high-energy trauma, road traffic accidents, occupational injuries, and sports-related mechanisms. Road traffic accidents were the leading mechanism of injury in the present series, followed by falls on the shoulder or outstretched hand. This distribution agrees with contemporary studies indicating that adult midshaft clavicle fractures are commonly related to direct trauma to the shoulder girdle, road traffic accidents, and sports injuries. The relatively high proportion of road traffic accidents in the present study may reflect local trauma patterns and the role of traffic-related injuries as a major cause of adult orthopedic trauma.[12,15]

Regarding fracture characteristics, simple transverse or short oblique fractures were the most frequent pattern in this study, followed by long oblique fractures and comminuted fractures. This finding is clinically important because elastic stable intramedullary nailing is generally more suitable for simple displaced midshaft fractures than for markedly comminuted or segmental fractures. Intramedullary fixation provides internal splintage and preserves fracture biology, but its ability to control rotation and length may be reduced in highly comminuted patterns. Therefore, conversion of 3 comminuted fractures to plate and screw fixation was consistent with the mechanical limitations of elastic nails in fractures requiring stronger length and rotational control.[16-17]

The operative findings in the present study showed that elastic stable intramedullary nailing was completed in 45 patients (93.8%). Closed reduction was successful in 20 patients (41.7%), while 25 patients (52.1%) required a small incision open reduction to achieve acceptable alignment and facilitate nail passage. This reflects one of the technical characteristics of intramedullary clavicle fixation: although the procedure is minimally invasive, achieving closed reduction may be challenging in displaced, shortened, overriding, or locked fracture fragments. Limited open reduction may sometimes be necessary to guide nail passage and restore alignment. Similar observations have been reported in recent studies, where intramedullary fixation was associated with smaller incisions, reduced soft-tissue dissection, shorter operative time, and favorable early recovery, but technical difficulty may occur when reduction is not easily obtained by closed methods.[9,13,18]

Immediate postoperative radiographs in the current study showed stable implant/fixation position in all patients and satisfactory clavicular alignment in 95.8%. Only 4.2% had mild residual angulation or displacement, and no early loss of reduction was recorded. These findings support the mechanical adequacy of elastic stable intramedullary nailing in suitable fracture patterns, while also supporting plate fixation as a reasonable alternative when comminution prevents stable intramedullary control. The biological advantage of elastic nailing lies in preservation of the periosteal blood supply and fracture hematoma, which may contribute to callus formation and union. In comparison with plate fixation, intramedullary fixation usually requires less surgical exposure and may reduce soft-tissue morbidity, which is particularly relevant in a subcutaneous bone such as the clavicle.[19]

Radiological follow-up in this study demonstrated early callus formation in 91.7% of patients at 6 weeks, radiological union or progressive union in 95.8% at 12 weeks, and complete union with maintained alignment in all patients by 6 months. These results are comparable to recent prospective and observational studies reporting high union rates following titanium elastic nailing for displaced midshaft clavicle fractures. The complete union rate in the present series may be related to appropriate intraoperative decision-making, including limited open reduction when closed reduction failed and conversion to plate fixation in comminuted fractures unsuitable for elastic nail fixation.[12,20]

The complication profile in the present study was acceptable. The most frequent complication was medial nail-end irritation in 5 patients (10.4%), followed by delayed union in 3 patients (6.3%), superficial wound infection in 2 patients (4.2%), hypertrophic scar in 1 patient (2.1%), and implant migration in 1 patient (2.1%). No deep infection, neurovascular injury, nonunion, or refracture after implant removal was recorded. Similar complications were reported by Govindasamy et al. who found skin irritation, superficial infection, implant migration, and delayed union after titanium elastic nailing.[21] Shaheen et al. also reported medial skin irritation, infection, implant migration, and hypertrophic scar following elastic intramedullary fixation.[22] In addition, Umatiya et al. reported superficial infection, nail migration, skin irritation, and hypertrophic scarring, with no nonunion or deep infection.[15]

The absence of deep infection and neurovascular injury in the present series is an important finding. The clavicle is anatomically close to major neurovascular structures, including the subclavian vessels and brachial plexus; therefore, safe nail insertion, fluoroscopic control, and careful advancement within the medullary canal are essential. The low infection rate in this study may be related to the minimally invasive nature of the technique, smaller incision size, and limited soft-tissue dissection. However, the need for small incision open reduction in more than half of the patients indicates that careful surgical planning is required and that surgeons should be prepared to convert the technique when closed reduction is not achievable or when fracture stability is inadequate. Ju et al. has suggested that intramedullary fixation may reduce infection risk and soft-tissue complications compared with plate fixation, although implant irritation and migration remain specific concerns.[19]

Final clinical outcomes in the current study were favorable, with 72.9% of patients achieving excellent outcomes and 22.9% achieving good outcomes. Only 4.2% had fair outcomes, and no poor outcomes were recorded. These results indicate that most patients regained satisfactory shoulder function after operative fixation. The high rate of excellent and good outcomes may be explained by restoration of clavicular alignment, early shoulder mobilization, biological fracture healing, and the use of the fixation method most appropriate to the fracture pattern. Recent studies and meta-analyses comparing intramedullary fixation with plate fixation have reported broadly comparable Constant-Murley and DASH outcomes, suggesting that both techniques can achieve satisfactory function when applied to suitable fracture patterns.[9,12,23]

This study had several limitations. First, it was conducted in a single center, which may limit the generalizability of the findings to other hospitals or populations. Second, the sample size was relatively limited, as only 48 patients were included. Third, the study did not include a nonoperative control group or a planned comparative plate fixation group, so direct comparison with other treatment methods was not possible. Fourth, the need for small incision open reduction in 25 patients and conversion to plate fixation in 3 patients indicates heterogeneity in operative technique. Fifth, the follow-up period may not have been sufficient to detect all long-term complications, especially late refracture, persistent shoulder symptoms, or long-term functional impairment. Finally, the suitability of elastic stable intramedullary nailing depends on fracture pattern, and the results may not be applicable to markedly comminuted, segmental, or complex clavicle fractures.

5- CONCLUSION AND RECOMMENDATION

Elastic stable intramedullary nailing was an effective and minimally invasive treatment option for selected adult patients with displaced midshaft clavicle fractures, providing satisfactory fracture reduction, stable intramedullary fixation, progressive radiological union, and favorable clinical outcomes in most cases. Complete union was achieved by 6 months, with no recorded nonunion, deep infection, neurovascular injury, or refracture after implant removal, while medial nail-end irritation was the most common complication. Therefore, this technique is recommended for properly selected simple transverse, short oblique, and selected long oblique midshaft clavicle fractures, especially when minimal soft-tissue dissection and better cosmetic results are desired. Careful preoperative fracture assessment, accurate nail sizing, proper bending and cutting of the medial nail end, fluoroscopic confirmation of implant position, and regular postoperative follow-up are essential to reduce complications and ensure successful outcomes. Further multicenter comparative studies with larger sample sizes and longer follow-up are recommended to compare elastic stable intramedullary nailing with plate fixation and conservative treatment.

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