

Functional Outcome of Clavicle Shaft Fractures with Intramedullary Nailing: An Observational Study**Tanish Patil¹, Shouryashil Khambalkar², Kapil Ghorpade³, Jaydeep Patil⁴, Nagesh Naik⁵**^{1,2,3,4,5}Department of Orthopedics, Prakash Institute of Medical Sciences and Research Centre, Islampur, Sangli, India

Received: 25-06-2023 / Revised: 28-07-2023 / Accepted: 30-08-2023

Corresponding author: Dr. Jaydeep Patil

Conflict of interest: Nil

Abstract:**Objectives:** The aim of the study was to analyse functional and radiological outcomes associated with clavicle fractures managed using intramedullary nailing.**Methods:** This was an observational study in which 80 patients with midshaft clavicular fractures were included on the basis of a predefined inclusion and exclusion criteria. The study was conducted in the department of orthopaedics of a tertiary care medical college situated in a semi-urban area. Demographic details and mechanism of injury was noted. All patients were treated by intramedullary nailing. Patients were followed up for 4 months. Clinical and radiological union was assessed at each follow up visit. Functional outcome was assessed by Quick DASH score. P value less than 0.05 was taken as statistically significant.**Results:** Out of 80 studied patients there were 58 (72.50%) males and 22 (27.50%) females with a male to female ratio of 1:0.37. The mean age of affected cases was found to be 34.86 +/- 8.25 years. Road traffic accidents (70.00%) followed by fall on outstretched hand (23.75%) were the most common mechanism of injury. At the time of final follow up (at 16 weeks after surgery) 79 (98.75%) patients were found to have clinical as well as radiological union and only 1 (1.25%) patient was found to have clinical union but radiological non-union. 64 (80%) patients had excellent functional outcome whereas 12 (15%) 4 (5 %) patients were found to have good and satisfactory outcome.**Conclusion:** Patients with clavicular fracture treated by intramedullary nailing have excellent functional outcome in terms of pain relief, daily activities and range of motion.**Keywords:** Clavicular Fractures, Intramedullary nailing, Quick DASH score, Functional Outcome.

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Clavicle fractures are among the most common fractures encountered in orthopaedic practice and accounts for a significant proportion of musculoskeletal injuries. These fractures occur either following a direct blow to the anterior chest wall or after a fall on the outstretched hand and are categorized into proximal, mid-shaft and distal fracture. Mid-shaft is the most common site of fracture because of narrow cross section of clavicle at this site. [1]

Clavicular fractures present unique challenges due to their anatomical location, which plays a crucial role in maintaining upper limb function and stability. Over the years, various surgical techniques have been used to manage clavicle fractures, with the aim of achieving optimal functional and radiological outcomes with acceptable complication rates. Intramedullary nailing is one such technique that has gained increasing attention and acceptance. The management of clavicle fractures has evolved

significantly, moving from non-operative methods to a more surgical approach. Intramedullary nailing, in particular, has emerged as a promising alternative to traditional plate fixation and conservative management. Intramedullary nailing provides stable fixation and promotes early mobilization. [2]

Whether to manage clavicle fractures by conservative measures or to do surgical intervention has been a subject of intense debate in the orthopaedic community. Unlike in the past when non-operative management has traditionally been favoured for many clavicle fractures, recent studies have highlighted the limitations of this approach. Non-operative management is found to result in residual deformities, non-unions, and functional deficits, especially in cases of patients having displaced fractures. Moreover, conservative treatment often requires prolonged immobilization, which can lead to muscle atrophy, joint stiffness, and other complications. [3]

With the introduction of modern implant materials and improved surgical instrumentation there is wide acceptance of intramedullary nailing for clavicular fractures. The early use of K-wires had limitations, including the risk of migration, pin tract infections, and limited rotational stability. These drawbacks spurred the development of more sophisticated intramedullary devices, such as elastic nails, threaded pins, and rigid nails. Modern intramedullary nails are designed to provide stable fixation, resist bending, and allow early functional recovery. [4]

Intramedullary nailing is found to have several potential advantages over non-operative management as well as over traditional plate fixation. [5] By providing rigid fixation and stability, it allows for early mobilization, reducing the risk of complications associated with prolonged immobilization. Additionally, intramedullary nailing minimizes soft tissue disruption, leading to better cosmesis and potentially lower rates of infection. These potential benefits make intramedullary nailing an attractive option for managing clavicle fractures. [6]

Several studies have reported favourable functional outcomes following clavicle fracture management with intramedullary nailing. [7] The ability to start early mobilization and rehabilitation is a significant advantage of this technique. Furthermore, the minimally invasive nature of intramedullary nailing reduces the disruption of soft tissues surrounding the fracture site. This may lead to decreased pain, reduced risk of infection, and improved cosmetic outcomes, all of which can positively impact patient satisfaction and overall quality of life. [8]

Many Studies investigating clavicle fractures managed with intramedullary nailing have shown promising functional as well as radiological outcomes. [9] We therefor conducted this study to comprehensively explore the functional and radiological outcomes associated with clavicle fractures managed using intramedullary nailing.

Materials and Methods:

This was an observational study in which 80 patients with midshaft clavicular fractures were included on the basis of a predefined inclusion and exclusion criteria. The study was conducted in the department of orthopaedics of a tertiary care medical college situated in a semi-urban area. Written informed consent was obtained from all the patients.

Demographic details such as age, Sex and area of residence was noted. A detailed history was taken in all the cases with regards to the mechanism of injury, duration since injury. A detailed clinical examination was done in all the cases so as to find out the site and type of clavicular fractures and to rule out presence of fractures at other sites.

Upon arrival a detailed assessment of injured limb was done with regards to the possibility of associated injuries as well as possibility of vascular compromise of affected limb. Primary immobilization was done and patients were sent for X-Ray of the affected clavicle. Anteroposterior and Cephalic tilt radiographs were obtained. Clavicular fractures were classified on the basis of AO classification into Type A (Non-displaced Fractures), Type B (Displaced Fractures with intact coracoclavicular ligament) and Type C (Displaced Fractures with torn coracoclavicular ligament). [10] All patients underwent basic investigations such as complete blood count, kidney function tests (Blood urea and serum creatinine levels), Hepatic function test (Serum Bilirubin, SGOT, and SGPT), Blood group as well as Rh typing, Bleeding time, clotting time and prothrombin time.

All patients underwent intramedullary nailing under general anaesthesia. Post-operative the affected side was immobilised in an arm pouch. Antibiotics were continued till 3 days after surgery. Patients were discharged on 4th post-operative day after wound inspection provided that there were no signs of wound infection. Patients were called for follow up after 2 weeks and sutures were removed. All patients were followed up for 4 months. Active range of motion in all planes was allowed after 6 weeks. For initial 2 months patients were asked to come for follow up every 15 days and after that monthly follow up was done till 4 months. During follow up radiological union was assessed by anteroposterior x-ray and functional outcome was assessed by modified DASH score. [11]

Statistical analysis was done using SPSS version 21.0 software. Quantitative data was presented as mean and standard deviation. Qualitative data was presented with incidence and percentage tables. For quantitative data, unpaired t-test was applied and for qualitative data, Chi-square test was used. p value less than 0.05 was taken as statistically significant.

Inclusion Criteria:

1. All patients presenting with displaced clavicular fracture (Type B and Type C of AO classification).
2. Age above 18 years.
3. Those who gave informed written consent to be part of study.

Exclusion Criteria:

1. Patients presenting with multiple fractures.
2. Age less than 18 years.
3. Parents Refused consent to be part of study.
4. Type A (Undisplaced) fractures.
5. Pathological Fractures.
6. Patients who were lost to follow up.

7. Patients with conditions such as rheumatoid arthritis and frozen shoulder or any other condition likely to affect functional outcome.

Results:

The study comprised of 80 patients having displaced clavicular fractures who were treated by intramedullary nailing. Out of 80 studied patients there were 58 (72.50%) males and 22 (27.50%) females with a male to female ratio of 1:0.37.

The analysis of the age group of the patients showed that the most common affected age group was 31-40 years (52.50%) followed by above 41-50 years (27.50%). Relatively fewer patients were present in the age group above 50 years (8.75 %) and less than 30 years (11.25%). The mean age of affected cases was found to be 34.86 +/- 8.25 years.

Table 1: Gender and Age Distribution of the affected cases

| Age | | No of cases | Percentage |
|---------------|-------------------|-------------|------------------------------|
| Gender | Males | 58 | 72.50% |
| | Females | 22 | 27.50% |
| | Total | 80 | 100.00 % |
| Age | 18-30 years | 9 | 11.25% |
| | 31-40 years | 42 | 52.50% |
| | 41-50 years | 22 | 27.50% |
| | Above 50 | 7 | 8.75% |
| | Total | 80 | 100.00% |
| | Mean Age = | | 34.86 +/- 8.25 years. |

The analysis of patients on the basis of mechanism of injury showed that in majority of the cases road traffic accidents (70.00%) followed by fall on outstretched hand (23.75%) were the most common mechanism of injury. In remaining 5 (6.25 %) cases direct trauma or assault was the cause of clavicular fracture.

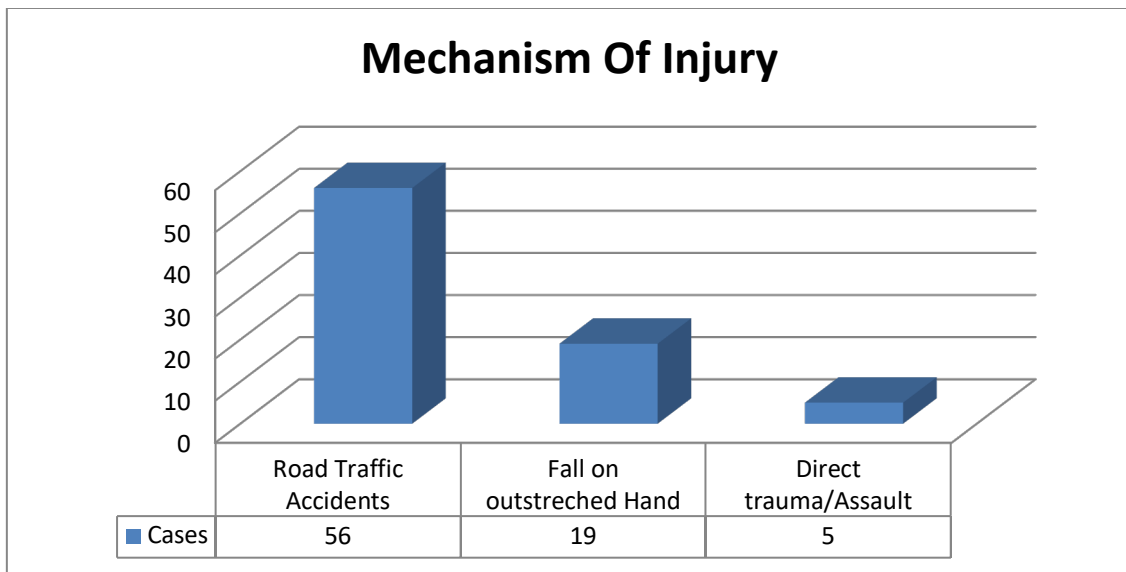


Figure 1: Mechanism of injury in studied cases

Dominant hand was involved in 57 (71.25%) whereas non-dominant hand was involved in remaining 23 (28.75%) cases. 74 (92.50%) patients were found to have Type B (Displaced Fractures with intact coracoclavicular ligament) whereas Type C (Displaced Fractures with torn coracoclavicular ligament) fractures were seen in 6 (7.50%) patients.

Table 2: Affected side and AO classification of fracture.

| | Age | No of cases | Percentage |
|--------------------------------------|--|-------------|------------|
| Dominant Vs Non-Dominant Side | Dominant | 57 | 71.25 % |
| | Non-Dominant | 23 | 28.75 % |
| | Total | 80 | 100.00 % |
| AO Classification of Fracture | Type B (Displaced Fractures with intact coracoclavicular ligament) | 74 | 92.50 % |
| | Type C (Displaced Fractures with torn coracoclavicular ligament) | 6 | 7.50 % |
| | Total | 80 | 100 % |

All patients underwent intramedullary nailing. Patients were followed up for 4 months. By 8 weeks follow up 72 (80.0 %) of the 80 patients (10.0%) had signs of clinical union as determined by absence of mobility and pain at fracture site. Radiological union was found in 68 (85.0%) patients. At the time of final follow up (at 16 weeks after surgery) 79 (98.75%) patients were found to have clinical as well as radiological union and only 1 (1.25%) patient was found to have clinical union but radiological non-union.

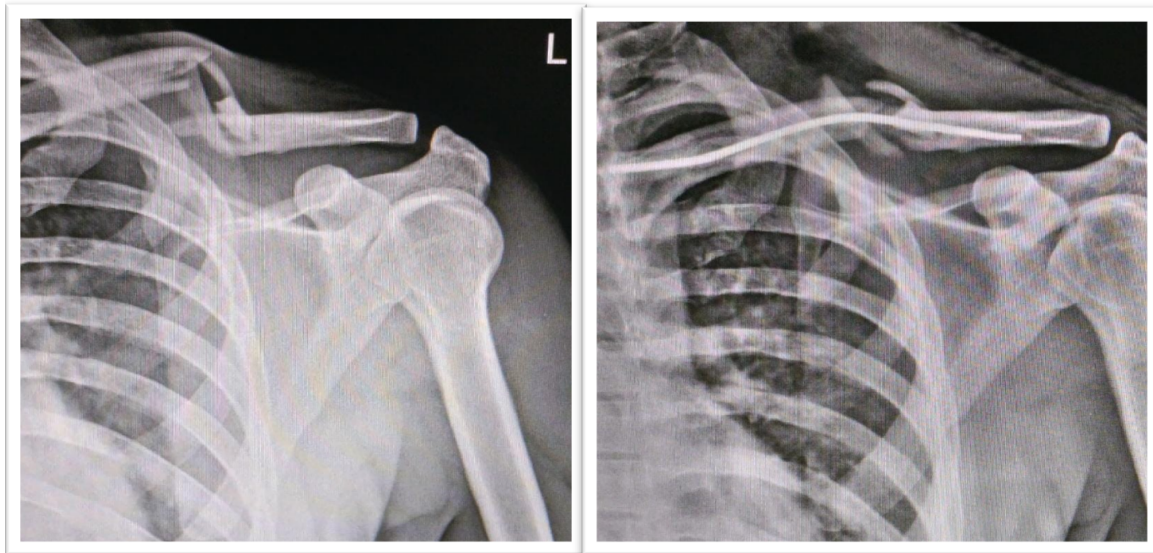


Figure 2: X-Rays showing Displaced fracture of shaft of left clavicle Before (Left) and after intramedullary Nailing (Right)

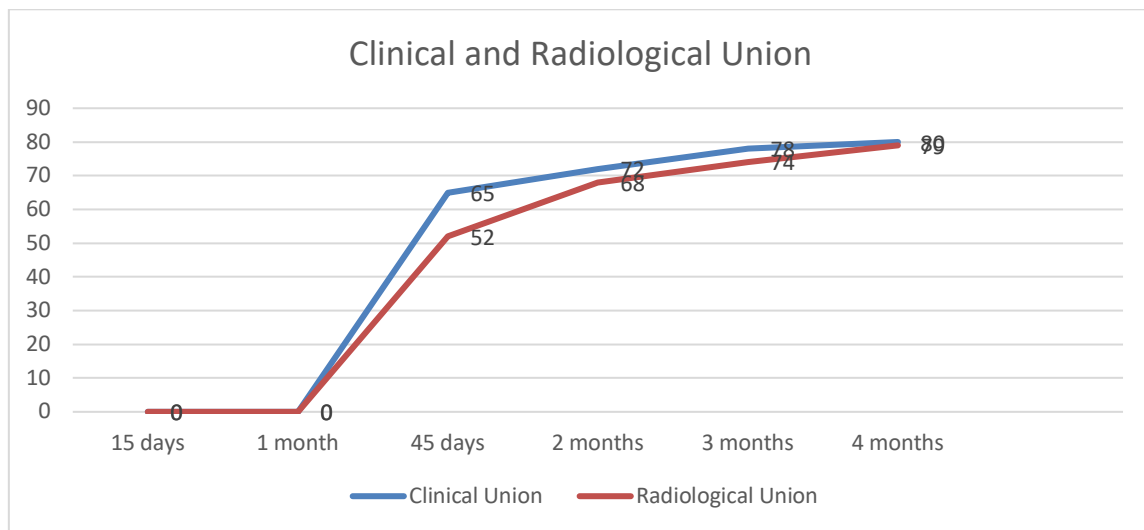


Figure 3: Number of cases with clinical and radiological signs of union during follow up

The analysis of the patients on the basis of achieved range of motions showed that at the time of 8 weeks follow up visit 45 (56.25%) patients had achieved complete range of motion whereas at the time of final follow up visit (16 weeks) all 80 (100%) patients attained complete range of motion. There was a statistically significant difference in range of motion at 8 weeks and 16 weeks follow up visits.

Table 3: Duration for Full Range of motion achieved

| Follow Up visit | Complete Range of Motion | | | |
|-----------------|--------------------------|---------|--------------|--------|
| | Achieved | | Not Achieved | |
| | Number | % | Number | % |
| 8 weeks | 45 | 56.25 % | 35 | 43.75% |
| 16 weeks | 80 | 100% | 0 | 0 |

The analysis of Quick-DASH (comprising of manoeuvres such as opening jar, presence or absence of pain, tingling, sleep disturbance, ability

to socialize, ability to perform relatively heavy chores, ability to carry a bag and limitation in routine work) at the time of 16 weeks follow up showed that

64 (80%) patients had excellent functional outcome whereas 12 (15%) patients had good functional outcome and 4 (5 %) patients were found to have satisfactory outcome.

There was no patient with poor outcome as assessed on the basis of Quick-DASH scores. Only 1 patient was found to have mild stiffness and pain during day today work. He was managed conservatively by physiotherapy to which he responded well.

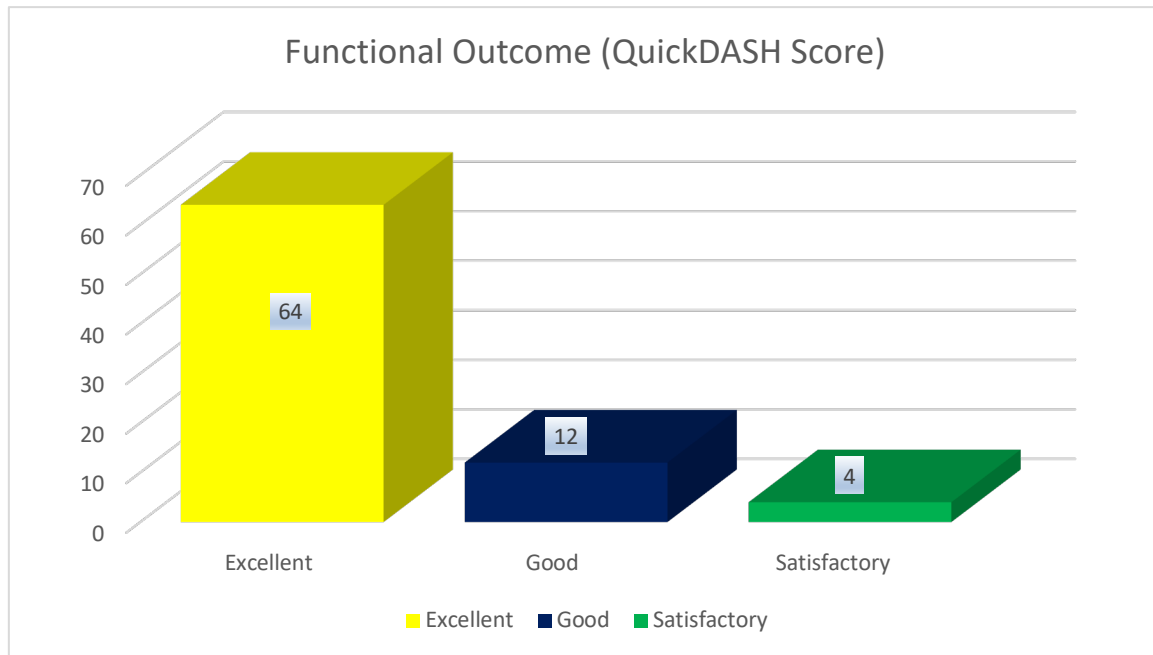


Figure 4: Outcome as Assessed by Quick-DASH score

Discussion

This study comprised of 80 adult patients with displaced clavicular fractures. Out of these 80 there were 58 (72.50%) males and 22 (27.50%) females with a male to female ratio of 1:0.37. Kihlström C et al undertook a review study to describe the epidemiology, classification and treatment of clavicle fractures. [12] For this purpose data was retrieved from the SFR on all clavicle fractures sustained by patients ≥ 15 years of age in 2013–2014 ($n = 2422$) with regards to date of injury, cause of injury, fracture classification and treatment. Out of 2422 cases Sixty-eight per cent ($n = 1654$) of the clavicle fractures occurred in males and 32% (768) in females, creating a male: female ratio of 2.2:1. Similar male predominance was also reported by the authors such as Vajrangi A et al [13] and Mishra PK et al [14].

The analysis of the patients on the basis of analysis of injury showed that in majority of the cases road traffic accidents (70.00%) followed by fall on outstretched hand (23.75%) were the most common mechanism of injury. In remaining 5 (6.25 %) cases direct trauma or assault was the cause of clavicular fracture. Asadollahi S et al conducted a prospective study to review the complication rate and profile associated with surgical fixation of acute midshaft clavicle fracture. [15]

The study found that the most common mechanism of injury was a road traffic accident (78%). Sixty percent ($n=83$) had an injury severity score of ≥ 15 indicating major trauma. The most common fracture type (75%) was simple or wedge comminuted. Similar to our study road traffic accidents was found to be most common cause of clavicular fracture in this study. Similarly, road traffic accidents were found to be the most common cause of clavicular fractures in studies conducted by Nourian A et al [16] and Chan G et al [17].

The assessment of union at the time of final follow up showed that out of 80 studied cases, 79 (98.75%) patients were found to have clinical as well as radiological union and only 1 (1.25%) patient was found to have clinical union but radiological non-union. Functional outcome as assessed by Quick DASH score showed that at the time of final follow up 64 (80%) patients had excellent functional outcome whereas 12 (15%) patients had good functional outcome and 4 (5 %) patients were found to have satisfactory outcome. Vlček M et al conducted a study to assess treatment outcomes in fractures of the middle part of the clavicle using an intramedullary nail. [18]

For this purpose the authors evaluated a total of 58 patients with a clavicle bone fracture stabilized by the Hofer Clavícula Pin implant. In this study A very good functional finding in the shoulder joint was observed in 57 patients (98.2%). The DASH score

reached an average of 8.1 points (range 0.8-30.8, SD 4.4). Constant score was 93.1 (range 42.8-98.1, SD 3.2).

On the basis of these findings the authors concluded that Intramedullary stabilization of two, three and four fragment fractures of the middle part of the clavicle using the Hofer Clavicle Pin provides very good stability during healing and leads to good healing of fractures. Similar excellent outcome of patients with clavicular fractures treated by intramedullary nailing was also reported by the authors such as Zhao JX et al [19] and Genena A et al [20].

Limitation of the study:

Patients were only followed up for 16 weeks hence long-term complications could not be studied. Furthermore, this was a purely observational study. These were the 2 limitations of our study. Larger randomised controlled trials are further needed to substantiate findings of our study.

Conclusion:

Internal fixation by intramedullary nailing in patients with displaced fractures of clavicle is associated with excellent outcome in terms of pain relief, daily activities, range of motion and allow early functional recovery.

Acknowledgement:

The authors would like to acknowledge the support extended by faculty and staff of Department of Orthopaedics, Prakash Institute of Medical Sciences and Research, Urun Islampur Dist Sangli Maharashtra India for undertaking this study.

Authors Contribution:

TP- Concept and design of the study; interpreted the results, prepared first draft of manuscript and critical revision of the manuscript; **SK-** Statistically analysed and interpreted; reviewed the literature and manuscript preparation; **KG-** Design of the study, statistically analysed and interpreted, preparation of manuscript and revision of the manuscript; **JP & NN-** Concept and coordination of the overall study.

References:

- Toogood P, Horst P, Samagh S, Feeley BT. Clavicle fractures: a review of the literature and update on treatment. *Phys Sportsmed.* 2011 Sep; 39(3):142-50.
- Smekal V, Irenberger A, Attal RE, Oberladstaetter J, Krappinger D, Kralinger F. Elastic stable intramedullary nailing is best for mid-shaft clavicular fractures without comminution: results in 60 patients. *Injury.* 2011; 42(4):324-329.
- Lenza M, Faloppa F. Conservative interventions for treating middle third clavicle fractures in adolescents and adults. *Cochrane Database Syst Rev.* 2016; 12(12):CD007121. Published 2016 Dec 15.
- Gadegone WM, Lokhande V. Screw Intramedullary Elastic Nail Fixation in Midshaft Clavicle Fractures: A Clinical Outcome in 36 Patients. *Indian J Orthop.* 2018; 52(3):322-327.
- Hussain N, Sermer C, Prusick PJ, Banfield L, Atrey A, Bhandari M. Intramedullary Nailing Versus Plate Fixation for the Treatment Displaced Midshaft Clavicular Fractures: A Systematic Review and Meta-Analysis. *Sci Rep.* 2016; 6: 34912. Published 2016 Oct 20.
- King PR, Lamberts RP. Management of clavicle shaft fractures with intramedullary devices: a narrative review. *Expert Rev Med Devices.* 2020; 17(8):807-815.
- Hoogervorst P, van Dam T, Verdonschot N, Hannink G. Functional outcomes and complications of intramedullary fixation devices for Midshaft clavicle fractures: a systematic review and meta-analysis. *BMC Musculoskelet Disord.* 2020; 21(1):395. Published 2020 Jun 22.
- Ju W, Mohamed SO, Qi B. Comparison of plate fixation vs. intramedullary fixation for the management of mid-shaft clavicle fractures: A systematic review and meta-analysis of randomised controlled trials. *Exp Ther Med.* 2020; 20(3):2783-2793.
- Braun KF, Siebenlist S, Sandmann GH, et al. Functional results following titanium elastic-stable intramedullary nailing (ESIN) of mid-shaft clavicle fractures. *Acta Chir Orthop Traumatol Cech.* 2014; 81(2):118-121.
- Mukhopadhaya J, Jain AK. AO Principles of Fracture Management. *Indian J Orthop.* 2019; 53(1):217-218.
- Aasheim T, Finsen V. The DASH and the QuickDASH instruments. Normative values in the general population in Norway. *J Hand Surg Eur Vol.* 2014; 39(2):140-144.
- Kihlström C, Möller M, Lönn K, Wolf O. Clavicle fractures: epidemiology, classification and treatment of 2 422 fractures in the Swedish Fracture Register; an observational study. *BMC Musculoskelet Disord.* 2017; 18(1):82. Published 2017 Feb 15.
- Vajrangi A, Shetty SV, Shenoy RM. A Comparative Study between Plate Fixation and Intramedullary Fixation for Displaced Mid-Shaft Clavicle Fractures in Adults. *Malays Orthop J.* 2022; 16(1):40-45.
- Mishra PK, Gupta A, Gaur SC. Midshaft Clavicular Fracture and Titanium Elastic Intramedullary Nail. *J Clin Diagn Res.* 2014; 8(1):129-132.
- Asadollahi S, Hau RC, Page RS, Richardson M, Edwards ER. Complications associated with

- operative fixation of acute midshaft clavicle fractures. *Injury*. 2016 Jun; 47(6):1248-52.
16. Nourian A, Dhaliwal S, Vangala S, Vezeridis PS. Midshaft Fractures of the Clavicle: A Meta-analysis Comparing Surgical Fixation Using Anteroinferior Plating Versus Superior Plating. *J Orthop Trauma*. 2017 Sep;31(9):461-467.
 17. Chan G, Korac Z, Miletic M, Vidovic D, Phadnis J, Bakota B. Plate versus intramedullary fixation of two-part and multifragmentary displaced midshaft clavicle fractures - a long-term analysis. *Injury*. 2017 Nov; 48 Suppl 5:S21-S26.
 18. Vlček M, Niedoba M, Jakubička J, Pech J, Kalvach J. Operační řešení zlomenin střední části klíční kosti pomocí nitrodřeňového hřebu [Surgical treatment of midshaft clavicular fractures using intramedullary nail]. *Rozhl Chir*. 2018; 97(4):176-188.
 19. Zhao JX, Zhao YP, Mao Z, et al. Intramedullary nailing versus plating fixation for the treatment of midshaft clavicular fractures: A meta-analysis of randomized controlled trials. *Injury*. 2023; 54 Suppl 2:S70-S77.
 20. Genena A, Abouelela A, Mohamed R, Nagi A. Clinical Outcome of Percutaneous Intramedullary Fixation for Midshaft Clavicular Fractures Using Elastic Stable Nails. *Ortop Traumatol Rehabil*. 2021; 23(1):15-20.