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Functional Outcomes of Displaced Fracture Clavicle Treated With Anatomical Locking Plate.

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KEYWORDS

Displaced clavicle fracture, Anatomical locking plate, functional outcome, radiological outcome, complications and ORIF with plate osteosynthesis

ABSTRACT:

Introduction:

Clavicle fracture is one of the most common bony injuries.

They account for 2.6% to 4% of adult fractures and 35% of injuries to the shoulder girdle.The clavicle is an S-shaped bone. It acts as a strut between the glenohumeral joint and the sternum and also has a suspensory function to the shoulder girdle . The shoulder hangs from the clavicle by the coraco-clavicular ligament

Objectives:

To analyze the functional results of displaced fracture clavicle treated with open reduction and internal fixation with anatomical locking plate To study the duration of union. To study the complications of displaced fracture clavicle and their management.

Methodology:

Study design:

This is a prospective study of functional outcome of functional outcome of displaced fracture clavicle treated with anatomical locking plate.The study is conducted in the department of Orthopaedic surgery at VMKV Medical College and Hospitals, Salem.

Inclusion Criteria:

1) Either sex, aged more than 18 years
2) Patients who were medically fit and willing for surgery.
3) Patients who have given a written informed consent
4) Comminuted fractures
5) Displaced fractures (>2cms)
6) Shortening (>2cms)
7) Segmental fractures
8) Fractures with tenting of the skin.

Exclusion criteria:

1) Open fractures
2) Pathological fractures
3) Established nonunion from previous fractures
4) Associated neurovascular injury or injuries of shoulder girdle
5) Clinically important neuromuscular upper limb disability

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6) Previous operations to shoulder or clavicle
7) Previous fractures around the clavicle

Results:
This study is a prospective study which was conducted in the Department of Orthopaedics. A total of 30 cases who sustained fractures of clavicle were included in the study as per the inclusion and exclusion criteria.

Table 1: Distribution of sample based on age:
AGE IN YEARS
NO OF CASES PERCENTAGE
18 – 30
9
30
31 – 40
6
20
41 – 50
7
23.33
51 – 60
5
16.66
61 – 70
3
10
Graph 1: Distribution of sample based on age: 70

Table 2: Distribution of sample based on gender:
SEX NO OF CASES
PERCENTAGE
MALE
22
73.33
FEMALE
8
26.66
Graph 2: Distribution of sample based on gender: 71

Table 3: Distribution of the sample based on side of involvement
Side
NO OF CASES
PERCENTAGE
RIGHT
11
36.66%
LEFT
19
63.33%
Graph 3: Distribution of the sample based on side of involvement : 72

Table 4 : Distribution of sample based on mode of injury:
MODE OF INJURY
NO OF CASES
PERCENTAGE
FALL ON AN OUT STRECHED HAND
6
20%
RTA
24
80%
Graph 4: Distribution of sample based on mode of injury: 73

Table 5: Fracture type based on Allman's Classification
TYPE
NO OF CASES
PERCENTAGE
I
26
86.66
II
4
13.33
III
0
0

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Graph 5: Fracture type based on Allman's Classification : 74

Table 6: Distribution of sample based on functional outcome:

Constant Murley score:
Constant Murley score
NO OF CASES
PERCENTAGE
RESULT
90-100
28
93.33%
Excellent
80-89
2
6.66%
Good
70-79
-
-
Fair
0-70
-
-
Poor

Graph 5: Distribution of sample based on functional outcome

Conclusion :

There are various operative methods for the treatment of displaced clavicle fractures, they include intramedullary K-wire fixation or Steinmann pin fixation and plate fixation. The procedures using the former two materials have disadvantages of resulting in low resistance to torque, carry risks of pin loosening and also infection, they require a long-term fixation period.

Open reduction and internal fixation with plates, which can be effective in obtaining anatomical reduction and help in applying direct compression to the fracture site, and also producing resistance to torque. Some of which include Sherman plates, dynamic compression plates, and sernitubular plates, etc. However, it is disadvantageous in the sense of achieving firm fixation as it is difficult for the plates to hold the clavicle in cases of severely comminuted clavicle fractures. In such cases reconstruction plates which can be manipulated to fit the contour of the clavicle can be used.

In this study, the use of anatomical locking plates did not result in
complications, such as injury to subclavian artery and brachial plexus injuries.

Despite piercing either cortex in a few badly comminuted cases, except that there were 2 cases which had delayed union which is comparatively less than that treated with conservative methods. No nonunion, or functional disabilities were observed in these cases.

The advantages of anatomical locking plate include: it ensures strong
fixation due to locking between the screw and plate, blood supply preservation as there is minimal contact between plate and cortical bone. Screws are to be fixed onto both cortexes which helps in preventing screw loosening or instability.

Limitations: Unfortunately, surgical treatments for clavicle fractures leave distinct scar at the fracture site near the shoulder. Surgical scars are currently considered major limitation due to the increasing demand for aesthetics these days.

But no patients in our study had any hypertrophic scarring or any infection after the surgery and none complained of any discomfort in carrying out their daily activities.

However, the patients should be informed about the possible appearance of surgical scar and surgical techniques should be improved in order to minimise the problem. The other limitation is that the conclusions drawn from this analysis cannot be generalized because of the sample size is less.

Keywords:
Displaced clavicle fracture, Anatomical locking plate, functional outcome, radiological outcome, complications and ORIF with plate osteosynthesis.

Introduction:

Clavicle fracture is one of the most common bony injuries. They account for 2.6% to 4% of adult fractures and 35% of injuries to the
shoulder girdle.1 The clavicle is an S-shaped bone. It acts as a strut
between the glenohumeral joint and the sternum and also has a
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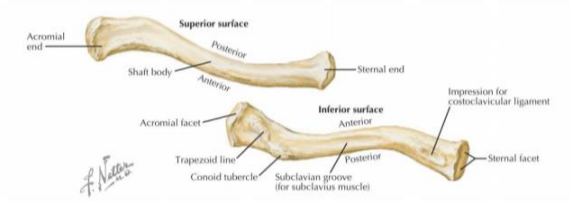

According to the Allmans system of classification, clavicular fractures
are divided into 3 groups.
• Group I: Middle-third fractures.
• Group II: Lateral-third fractures.
• Group III: Medial- third fractures.

Allmans classification, clavicular fractures

Most common site of fracture is the middle third segment of the
clavicle (midclavicular region) because its weakest point is at the junction of the middle and lateral third of the clavicle and which accounts for most
fractures occurring in this region.
Numerous forces (ligamentous and muscular) act on the clavicle. In
order to understand the nature of displacement of clavicle fractures and why certain fracture patterns need to be surgically stabilized, knowledge of these differing forces is necessary.
- Ligamentous and muscular attachments of clavicle
Midclavicular fracture is one of the most common injuries of the skeleton, representing 3% to 5% of all fractures and 45% of shoulder injuries and its annual incidence is about 64/ 100 000 population. Breaks of the shaft form 70% to 80% of all clavicular fractures; lateral fractures contribute 15% to 30%, and medial fractures, at 3%, are relatively rare.
Open clavicular fracture is an absolute rarity, found in only 0.1% to 1%
of cases. The rate of clavicular fractures is more than twice as high in men as in women. The peak incidence was found to usually occur in the third decade.
The mainstay of treatment has long been non-operative.
More recent data, based on detailed classification of fractures, suggest that the
incidence of nonunion in displaced clavicular fractures in adults is between 10 and 15%. Clavicular fractures have traditionally been treated non-operatively.

Surgical treatment of clavicular fractures was not favored due to relatively frequent and serious complications. However, the prevalence of non-union or mal-union in displaced clavicular fractures after conservative treatment is higher than previously presumed and fixation methods have evolved. Surgery is accepted more and more as primary treatment for displaced clavicular fractures, mainly because the results of non-operative treatment are interpreted as inferior to operative treatment both clinically and functionally. If there is wide separation of fragments persistently with
the interposition of soft tissue it may lead to failure of closed reduction. There is 15% nonunion rate in widely displaced fractures of the clavicle treated without surgery. And all fractures with displacement of more than 2cm resulted in nonunion.
Several studies have examined the safety and efficacy of primary open reduction and internal fixation for completely displaced clavicular fractures and have noted high union rate with a low complication rate.**7** Using anatomical locking plate in a large number of complex clavicle fractures a satisfactory outcome with a low complication rate has been demonstrated in few studies. Primary internal fixation of displaced clavicular fractures has shown a predictable outcome and an early return to functioning.**9** While majority of clavicle fractures are benign, but associated life- threatening intrathoracic injuries are also possible. Complications vary based on location of fracture. Fracture of the clavicle is associated with many complications like delayed union, nonunion, brachial plexus compression (which is a result of hypertrophic callus formation), compression or laceration of the great vessels, injuries to the neurovascular bundle, trachea, or esophagus, and the pleural dome, poor cosmetic appearance, intrathoracic injury and life threatening pneumothorax.
Neurovascular structures in the vicinity of clavicle The consensus that a great majority of clavicular fractures will heal with non operative treatment is now no longer valid. The amount of pain and disability during the first three weeks of conservative treatment has been underrated and the common view that nonunion does not occur is wrong. After conservative treatment a displaced fragment may cause
pressure on the retro clavicular part of the brachial plexus and can cause symptoms.
Hence there can be a spectrum of injuries requiring careful assessment and individualized treatment. There are

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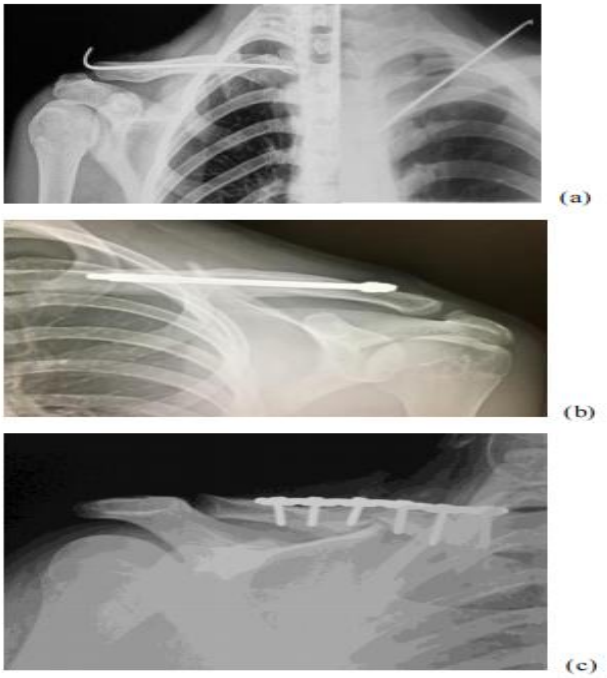
subgroups of individuals who appear to be predisposed to the development of non-union as a complication either from intrinsic factors such as age or gender, or from the type of injury sustained. There are various methods for treating clavicle fractures:

• intramedullary K-wires
• Steinmann pins fixation
• plate fixation.

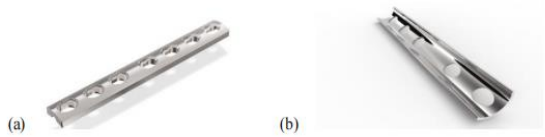


Various methods for treating clavicle fractures :

There are various plates used in treatment of clavicular fractures

Which include:

• Anatomical locking plates,
• Recon plate,
• Sherman plates,
• Dynamic compression plates and
• Semitubular plates.



(a) Dynamic compression plate (b) semi tubular plates used in clavicle
fracture fixation.

We have taken up this study to evaluate the functional outcome after fixation of displaced clavicular fractures with anatomical locking plate and to gain a deeper understanding of results and problems associated with this procedure.

Four different plate variants (Anatomical locking plates) allow surgical
treatment for numerous types of clavicle fractures

Methodology:

Study design:

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outcome of displaced fracture clavicle treated with anatomical locking plate The study is conducted in the department of Orthopaedic surgery at VMKV Medical College and Hospitals.salem

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5) Clinically important neuromuscular upper limb disability
6) Previous operations to shoulder or clavicle
7) Previous fractures around the clavicle

Participants:

Patients meeting the inclusion and exclusion criteria were recruited
from the VMKV. Participants were given information sheet, and written
informed consent is obtained from those willing to participate in the study.

Study approval and registration:

The study was approved by the Instituitional Ethics Committee, and

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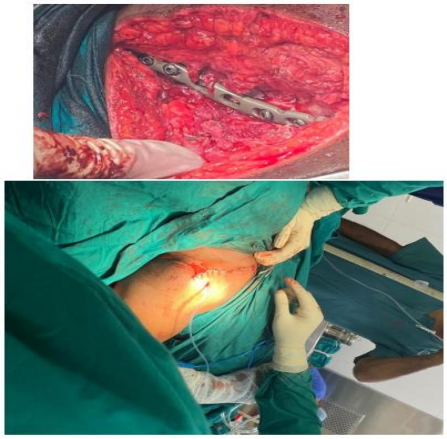
registered VMKVMC&H / IEC/ 21/ 052.

Procedure:
Data of 30 patients is being collected who presented to VMKV, Salem with displaced fracture clavicle and informed consent is taken from all those patients for their inclusion in this study.

A detailed history is taken, to ascertain the mode of injury and plain
radiograph AP view of the involved shoulder and chest Xray AP view is also taken. All routine blood investigations are done, as required for anaesthetic clearance, and under general anaesthesia, patient is treated by open reduction and internal fixation with anterosuperior plating.

Intra operative images :

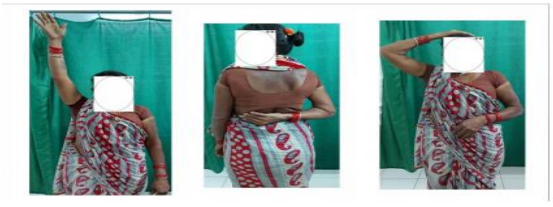


Photograph 1: Surgical procedure for displaced clavicle fracture with anatomical locking plate

Photograph 2: Pre-op and immediate post op X-ray of a patient with clavicle fracture

Photograph 3: 6weeks, 12 weeks, 12 months follow up X-rays

Photograph 4: CASE1 - Images depicting range of movements at follow up



Photograph 5: CASE 2- Images depicting range of movements at follow up

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61 – 70	3	10

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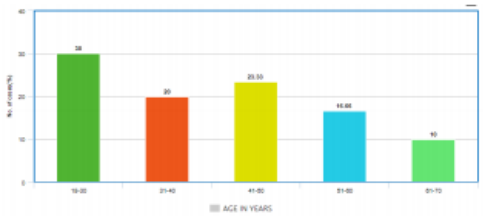
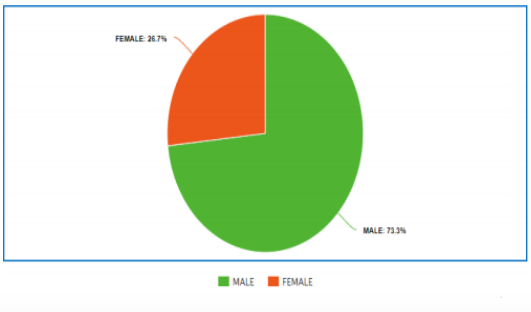


Table 2: Distibution of sample based on gender:

SEX	NO OF CASES	PERCENTAGE
MALE	22	73.33
FEMALE	8	26.66

Graph 2: **Distibution of sample based on gender:**



Discussion:

There are various operative methods for the treatment of displaced clavicle fractures, they include intramedullary K-wire fixation or Steinmann pin fixation and plate fixation. The procedures using the former two materials have disadvantages of resulting in low resistance to torque, carry risks of pin loosening and also infection, they require a long-term fixation period.

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References:

1. Postacchini, F., Gumina, S., De Santis, P., & Albo, F. (2002). Epidemiology of clavicle fractures. *Journal of shoulder and elbow surgery*, *11*(5), 452–456. https://doi.org/10.1067/mse.2002.126613
2. Hyland S, Charlick M, Varacallo M. Anatomy, Shoulder and Upper Limb, Clavicle. [Updated 2022 Jul 25]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK525990/
3. O'Neill BJ, Hirpara KM, O'Briain D, McGarr C, Kaar TK. Clavicle fractures: a comparison of five

Journal of Chemical Health Risks

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JCHR (2024) 14(3), 3265-3273 | ISSN:2251-6727

classification systems and their relationship to treatment outcomes. *Int Orthop*. 2011;35(6):909-914. doi:10.1007/s00264-010-1151-0

4. Carl J.BasamaniaElizabeth G.MatzkinGeorge K.Bal. Clavicle Fractures and Sternoclavicular Injuries. Clinical Sports Medicine. 2006, Pages 265-273
5. Schiffer G, Faymonville C, Skouras E, Andermahr J, Jubel A : Midclavicular fracture: Not just a trivial injury – *current treatment options* .Dtsch Arztebl Int 2010;107(41);711-
6. Wun-Jer Shen M.D. Tsung-Jen Liu M.D, Young-Shung Shen M.D. Po-Cheng Orthopaedic Institute, 100 Po-Ai 2nd Road, Kaohsiung, 813, Taiwan. Plate Fixation Of Fresh Displaced Midshaft Clavicle Fractures,*J Bone Joint Surg[Br]2008;90- B:1495-B*
7. Stegeman Et Al. Displaced Midshaft Fractures Of The Clavicle:Non-Operative Treatment Versus Plate Fixation (Sleutel-TRIAL). A Multicentre Randomised Controlled Trial. *BMC Musculoskeletal Disorders 2011,12: 196.* 83
8. N. Modi, A.D. Patel, P. Hallam Norfolk And Norwich University Hospital NHS Foundation Trust,Norwich,UK. Outcome Of 62 Clavicle Fracture Fixations With Locked Compression Plate: Is This The Right Way To Go? *doi:10.1016/j.injury.2011.06.266.*
9. Wg Cdr V Kulshrestha, Primary Plating Of Displaced Mid-Shaft Clavicular Fractures. *MJAFI* 2008; 64: 208-211.
10. Bentley TP, Hosseinzadeh S. Clavicle Fractures. [Updated 2022 Aug 1]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK507892/
11. Paladini P, Pellegrini A, Merolla G, Campi F, Porcellini G. Treatment of clavicle fractures. *Transl Med UniSa*. 2012;2:47-58. Published 2012 Jan 18.
12. Zenni EJ Jr, Krieg JK, Rosen MJ. Open reduction and internal fixation of clavicular fractures. J Bone Joint Surg Am. 1981; 63:147-51.
13. Jupiter JB, Leffert RD. Non-union of the clavicle. Associated complications and surgical management. J Bone Joint Surg Am. 1987; 69:753-60.
14. Iannotti MR, Crosby LA, Stafford P, Grayson G, Goulet R. Effects of plate location and selection on the stability of midshaft clavicle osteotomies: a biomechanical study. J Shoulder Elbow Surg. 2002; 11:457-62.
15. McKee MD, Wild LM, Schemitsch EH. Midshaft malunion of the clavicle. J Bone Joint Surg Am. 2003; 85:790-7.
16. McKee MD, Pedersen EM, Jones C, Stephen DJ, Kreder HJ, Schemitsch EH, Wild LM, Potter J. Deficits following nonoperative treatment of displaced midshaft clavicular fractures. J Bone Joint Surg Am. 2006; 88:35-40. 84
17. Canadian Orthopedic Trauma Society. Nonoperative treatment compared with plate fixation of displaced midshaft clavicular fractures. A multicenter randomized clinical trial. *J Bone Joint Surg Am.* Jan 2007; 89(1):1-10.
18. Huang JI, Toogood P, Chen MR, Wilber JH, Cooperman DR. Clavicular anatomy and the applicability of precontoured plates. J Bone Joint Surg Am. 2007; 89:2260-5.
19. Chul-Hyun Cho, MD, Kwang-Soon Song, MD, Byung-Woo Min, MD, Ki-Cheor Bae, MD, Kyung-Jae Lee, MD. Reconstruction Plate versus Reconstruction Locking Compression Plate for Clavicle Fractures. 2008
20. Darren S. Drosdowech, MD, Frcsc, Biomechanical Analysis Of Fixation Of Middle Third Fractures Of Clavicle, *Journal Of Ortopaedic Trauma 2011*.
21. Dhakad RK, Panwar M, Gupta S. Plating versus conservative treatment in mid shaft fractures of clavicle: A comparative study. *J Clin Orthop Trauma*. 2016;7(Suppl 2):166- 170. doi:10.1016/j.jcot.2015.11.002
22. Saraf, H. and Kasture, S. (2016) Treatment of Displaced Mid-Clavicle Fractures by Closed Titanium Elastic Nail. *Surgical Science*, **7**, 49-53. doi: 10.4236/ss.2016.72006.
23. Woltz, S., Stegeman, S. A., Krijnen, P., van Dijkman, B. A., van Thiel, T. P., Schep, N. W., de Rijcke, P. A., Frölke, J. P., & Schipper, I. B. (2017). Plate Fixation Compared with Nonoperative Treatment for Displaced Midshaft Clavicular Fractures: A Multicenter Randomized Controlled Trial. *The Journal of bone and joint surgery. American volume*, *99*(2), 106–112. https://doi.org/10.2106/JBJS.15.01394
24. Calişal, E., & Uğur, L. (2018). Evaluation of the plate location used in clavicle fractures during shoulder abduction and flexion movements: a finite element analysis. *Acta of bioengineering and biomechanics*, *20*(4), 41–46 85

Journal of Chemical Health Risks

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JCHR (2024) 14(3), 3265-3273 | ISSN:2251-6727

25.Li, L., Li, Ty., Jiang, P. *et al.* Clavicle hook plate versus distal clavicle locking plate for Neer type II distal clavicle fractures. *J Orthop Surg Res* **14**, 472 (2019). https://doi.org/10.1186/s13018-019-1518-x

26.Anne Elisabeth Ljunggren (1979) Clavicular Function, Acta Orthopaedica Scandinavica, 50:3, 261-268, DOI: 10.3109/17453677908989766

27.Anne Elisabeth Ljunggren (1979) Clavicular Function, Acta Orthopaedica Scandinavica, 50:3, 261-268, DOI: 10.3109/17453677908989766

28.Gert Petje, Other Dysplasias in the Shoulder Girdle, Congenital and Acquired Deformities of the Pediatric Shoulder Girdle, 10.1007/978-3-030-81839-5_7, (79-86), (2022).

29. Ogata, S., & Uhthoff, H. K. (1990). The early development and ossification of the human clavicle--an embryologic study. *Acta orthopaedica Scandinavica*, *61*(4), 330–334. https://doi.org/10.3109/17453679008993529

30. Jorge Chahla, M.D., Ph.D., Daniel Cole Marchetti, B.A., Gilbert Moatshe, M.D., Márcio B. Ferrari, Quantitative Assessment of the Coracoacromial and the Coracoclavicular Ligaments With 3-Dimensional Mapping of the Coracoid Process Anatomy: A Cadaveric Study of Surgically Relevant Structures January 2018. Arthroscopy The Journal of Arthroscopic and Related Surgery 34(5) DOI:10.1016/j.arthro.2017.11.033

31.Vyas U, Meena M, Jhanwar P, Sharma SB. Study of outcome of using anatomically precontoured plates in the management of displaced fracture of midshaft clavicle. J Orthop Traumatol Rehabil 2021;13:90-107

32. Epperson TN, Varacallo M. Anatomy, Shoulder and Upper Limb, Sternoclavicular Joint. [Updated 2022 Jul 25]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-. https://www.ncbi.nlm.nih.gov/books/NBK537258/ 86

33. Warth, R.J., Millett, P.J. (2015). The Acromioclavicular Joint. In: Physical Examination of the Shoulder. Springer, New York, NY. https://doi.org/10.1007/978-1-4939-2593-3_7

34.Ludewig, P. M., Behrens, S. A., Meyer, S. M., Spoden, S. M., & Wilson, L. A. (2004). Three-dimensional clavicular motion during arm elevation: reliability and descriptive data. *The Journal of orthopaedic and sports physical therapy*, *34*(3), 140–149. https://doi.org/10.2519/jospt.2004.34.3.140

35.Oberle L, Spittler J, Khodaee M Segmental clavicle fracture following a road bike injury *BMJ Case Reports CP* 2022;**15:**e251659

36.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. doi:10.1186/s12891-017-1444-1

37.Trowbridge, E. A. and Stephen H. Norris. "THE MECHANISM OF CLAVICULAR FRACTURE." (2005). Medicine, Biology, Engineering

38. Pecci, Matthew & Kreher, Jeffrey. (2008). Clavicle fractures. American family physician. 77. 65-70.

39. Midshaft Clavicle Fractures: A Critical Review. Jeremy M. Burnham, MD; Daniel C. Kim, MD; Srinath Kamineni, MD. Orthopedics. September/October 2016 – Volume 39 · Issue 5: e814-e821

40. Lazarus MD. Fractures of the Clavicle. Chapter-26, In: Bucholz RW and Heckman JD, editors, Rockwood and Green's fractures in adults, 5th edition, Philadelphia : Lippincott Williams and Wilkins, 2001; 1041-1078.

41.van der Meijden, O. A., Gaskill, T. R., & Millett, P. J. (2012). Treatment of clavicle fractures: current concepts review. *Journal of shoulder and elbow surgery*, *21*(3), 423–429. https://doi.org/10.1016/j.jse.2011.08.053