



The use of precontoured plates for midshaft clavicle fractures is not always the best course of treatment

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Abstract: Plate fixation has become the preferred approach for treating displaced midshaft clavicle fractures. However, plate fixation of the clavicle presents several unique challenges, including its complex bony architecture and its immediate subcutaneous location. In many cases, we have observed that precontoured implants do not conform to the clavicular anatomy, and many patients complain of postoperative implant-related discomfort. A total of 111 clavicles, both left and right sides, were examined to match two commonly used designs of anatomical pre-contoured superior anterior clavicle plates, with and without lateral extension. The anteroposterior (AP) plane congruence of the plate to the underlying bone, the vertical gap between the bone and plate, and the length of the plate that was off the bone either anteriorly and/or posteriorly at both ends of the clavicle were measured. The scoring system was used to determine the fit of the implant on the clavicle as anatomic, good, or poor. We found that the maximum superior bow of the clavicle was lateral to the midline by 30.75 mm and 30.5 mm on the right and left sides, respectively. The magnitude of the bow was 4.28 mm and 4.46 mm on the right and left sides, respectively. We also found that the plate was a poor fit in 75.86% of cases on the left side and 73.5% of cases on the right side. Manipulating the plates during surgery was very difficult in the AP plane.

Key words: Clavicle, Bone plate, Fracture malunion, Fracture fixation, Orthopedic procedures

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Introduction

Plate fixation is the preferred treatment for displaced midshaft clavicle fractures. It has been shown to improve functional outcomes, patient satisfaction, and return to sports, with lower rates of malunion and nonunion than nonoperative treatment [1, 2]. However, plate fixation of the clavicle

presents several unique challenges, including its complex bony architecture and its immediate subcutaneous location [3, 4]. These challenges can lead to postoperative complications, such as implant irritation, implant failure, persistent loss of sensation, and wound complications requiring secondary operations for implant removal [2, 5-8].

To address and minimize the risk of hardware-related complications, there are various designs of anatomical precontoured plates available for the fixation of clavicle fractures. Ideally, these 3.5 mm anatomical precontoured plates, which are designed to fit on the superior surface of the clavicle, should conform universally and have minimal hardware-related complications compared to standard non-contoured plates. However, the morphological variability

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of the clavicle in different populations makes it difficult to provide a standard pre-contoured implant that fits the wide range of clavicular shapes [9].

In many cases, when precontoured implants are used to fix clavicle fractures, we have observed that the plates do not conform to the clavicular anatomy. This can lead to postoperative implant-related discomfort for many patients. We conducted this study to confirm the congruence of commercially available anatomical pre-contoured plates with dry clavicles from the central Indian population. We also aimed to suggest modifications to implant design based on our findings.

Materials and Methods

One hundred and fifty skeletally mature dry clavicle bones of either sex were examined for this study. These bones were obtained from the departments of anatomy at two government medical colleges in central India. Thirty-nine specimens were excluded from the study because they had gross anomalies, obvious callus, or broken parts. Two commonly used designs of anatomical pre-contoured superior anterior clavicle plates (SACPs), with and without lateral extension as shown in Fig. 1, were obtained from the market. The Institutional Human Ethics Committee approval was obtained through letter number IHEC-LOP/2020/IM0353, and IEC/2021/1800 from AIIMS Bhopal and NSCB Medical College before commencing the study.



Fig. 1. (A) Showing anatomical pre-counter superior anterior clavicle plate (SACP) without lateral extension (B) anatomical pre-counter superior anterior clavicle plate (SACP), with lateral extension.

To measure the congruence of the plates, the clavicle was secured on a stand designed for the study. The plates were then fixed to the clavicle with elastic bands in the best possible congruent position, as would be done during surgery. The mismatch of congruence, *i.e.*, the difference in length or distance between the medial and lateral ends of the plate, was measured with digital vernier calipers with a resolution of 0.1 mm, as shown in Fig. 2.

The following measurements were recorded: (1) antero-

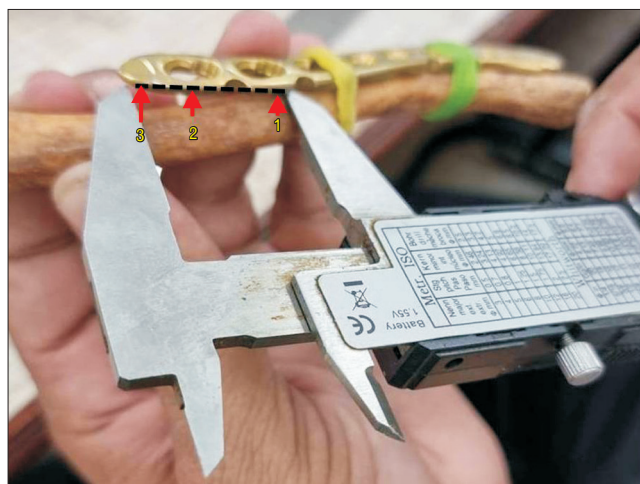


Fig. 2. Showing the mismatch of congruence of length/distance at the medial end of clavicle marked by black dotted line and red arrow indicating the gap between clavicle and plate. At arrow 1, there is minimum gap while at arrow 3 the gap is maximum.

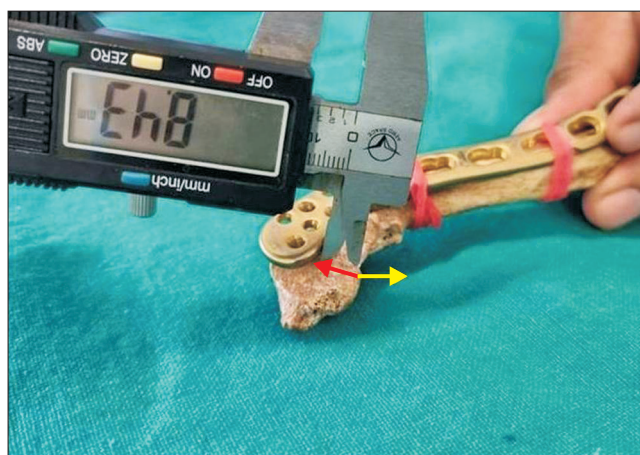


Fig. 3. Showing the measurement of anteroposterior congruence of plate to the underlying clavicle at lateral end with reference to anterior margin. If the plate is directed backwards as direction of red arrow, the value noted in positive number and if it extends beyond the border of bone, the value noted as negative as directed by yellow arrow.

posterior plane congruence:the congruence of the plate to the underlying bone was observed at the medial and lateral ends of the clavicle. A negative value was recorded when the plate extended beyond the margin of the underlying bone, and a positive value was recorded for the width of bone that was not covered by the plate, in either the anterior or posterior directions (Fig. 3). (2) Vertical gap between the bone and plate:the vertical gap between the bone and plate was measured at the medial and lateral ends of the clavicle (Fig. 4). (3) Length of the plate off the bone:the length of the plate that was off the bone either anteriorly and/or posteriorly at either the medial or lateral end of the implant was measured (Fig. 2).

The scoring system proposed by Malhas et al. [10] was used to determine the fit of the implant on the clavicle as anatomic, good, or poor.

- Anatomic fit: the plate conformed perfectly to the bone and each hole of the plate was well centered over the bone with no significant anterior or posterior overhang and with less than 1 mm gap between the plate and bone.
- Good fit: the plate deviated from the bone by more than

1 mm, displayed anterior or posterior overhang, and required further contouring of the plate up to 30 degrees.

- Poor fit: there was a complete mismatch between the plate and bone with at least one hole not over the bone, significant overhang anteriorly and posteriorly, and a requirement to bend the plate more than 30 degrees.

The findings were tabulated in MS Excel software (Microsoft) for statistical analysis.

Results

One hundred and eleven dry clavicles were examined, 54 of which were from the right side and 57 from the left side. For the SACP with lateral extension, the fit was anatomic in 17 clavicles (15.3%), good in 11 clavicles (10%), and poor in 83 clavicles (74.7%). Similarly, for the SACP without lateral extension, the fit was anatomic in 56 clavicles (50.4%), good in 26 clavicles (23.4%), and poor in 29 clavicles (26.1%).

Right SACP without lateral extension

For the right SACP without lateral extension, the average anterior mismatch at the medial end of the clavicle was 1.20 mm, with a standard deviation of 3.89 mm and a range of -5.61 mm to 8.63 mm. The average posterior mismatch was 5.53 mm, with a standard deviation of 2.64 mm and a range of -3.09 mm to 9.78 mm. The average vertical gap was 2.43 mm, with a standard deviation of 1.60 mm and a range of 0.00 mm to 6.78 mm. The average length of the plate that was off the bone anteriorly was 19.63 mm, with a standard deviation of 10.77 mm and a range of 0.00 mm to 35.12 mm. The average length of the plate that was off the bone posteriorly was 19.27 mm, with a standard deviation of 13.36 mm and a range of 0.00 mm to 44.57 mm (Table 1).

At the lateral end of the clavicle, the average anterior mismatch was 6.79 mm, with a standard deviation of 3.82 mm and a range of -5.14 mm to 12.34 mm. The average posterior



Fig. 4. Showing vertical gap between the bone and plate at the medial end of the clavicle. The gap is indicated by red arrow.

Table 1. Congruence of right superior anterior clavicle plate without lateral extension (n=54)

	Medial end of plate				Lateral end of plate					
	Vertical gap	Anterior mismatch	Posterior mismatch	Horizontal distance from point of elevation anteriorly	Horizontal distance from point of elevation posteriorly	Vertical gap	Anterior mismatch	Posterior mismatch	Horizontal distance from point of elevation anteriorly	Horizontal distance from point of elevation posteriorly
Avg	2.43	1.20	5.53	19.63	19.27	2.70	6.79	4.53	22.77	15.29
Max	6.78	8.63	9.78	35.12	44.57	8.00	12.34	11.22	53.74	32.20
Min	0.00	-5.61	-3.09	0.00	0.00	0.00	-5.14	-4.76	0.00	0.00
SD	1.60	3.89	2.64	10.77	13.36	1.88	3.82	3.53	14.65	9.35

Avg, average; Max, maximum; Min, minimum.

mismatch was 4.53 mm, with a standard deviation of 3.53 mm and a range of -4.76 mm to 11.22 mm. The average vertical gap was 2.70 mm, with a standard deviation of 1.88 mm and a range of 0.00 mm to 8.00 mm. The average length of the plate that was off the bone anteriorly was 22.77 mm, with a standard deviation of 14.65 mm and a range of 0.00 mm to 53.74 mm. The average length of the plate that was off the bone posteriorly was 15.29 mm, with a standard deviation of 9.35 mm and a range of 0.00 mm to 32.20 mm (Table 1).

At the medial end of the clavicle, the overhang was anterior in 22 out of 54 clavicles, and posterior in 2 clavicles. On the lateral end of the clavicle, the plate overhung the bone anteriorly in 5 instances and posteriorly in 4 instances.

Left SACP without lateral extension

For the left SACP without lateral extension, the average anterior mismatch at the medial end of the clavicle was 1.59 mm, with a standard deviation of 4.00 mm and a range of -4.55 mm to 9.73 mm. The average posterior mismatch was 4.38 mm, with a standard deviation of 2.26 mm and a range of -1.66 mm to 9.84 mm. The average vertical gap was 2.14 mm, with a standard deviation of 1.60 mm and a range of 0.00 mm to 6.29 mm. The average length of the plate that was off the bone anteriorly was 18.70 mm, with a standard deviation of 12.05 mm and a range of 0.00 mm to 35.27 mm. The average length of the plate that was off the bone posteriorly was 14.33 mm, with a standard deviation of 14.15 mm and a range of 0.00 mm to 39.76 mm (Table 2).

At the lateral end of the clavicle, the average anterior mismatch was 4.92 mm, with a standard deviation of 3.53 mm and a range of -5.72 mm to 11.78 mm. The average posterior mismatch was 5.48 mm, with a standard deviation of 3.02 mm and a range of -3.94 mm to 10.57 mm. The average vertical gap was 3.03 mm, with a standard deviation of 1.70 mm and a range of 0.00 mm to 7.02 mm. The average length of the plate that was off the bone anteriorly was 25.85 mm, with

a standard deviation of 14.55 mm and a range of 0.00 mm to 43.47 mm. The average length of the plate that was off the bone posteriorly was 18.63 mm, with a standard deviation of 9.11 mm and a range of 0.00 mm to 32.47 mm (Table 2).

There was no vertical gap at both ends in 4 clavicles, no vertical gap at the medial end and lateral ends in 14 and 7 clavicles, respectively. At the medial end, the plate overhung towards the anterior side in 22 cases and only in 2 clavicles, the plate projected to the posterior side. On the lateral end, the plate overhung the bone only in 5 and 4 bones anteriorly and posteriorly, respectively.

Right SACP with lateral extension

For the right SACP with lateral extension, the average anterior mismatch at the medial end of the clavicle was 3.28 mm, with a standard deviation of 4.98 mm and a range of -7.24 mm to 10.12 mm. The average posterior mismatch was 0.55 mm, with a standard deviation of 4.56 mm and a range of -5.96 mm to 9.12 mm. The average vertical gap was 3.83 mm, with a standard deviation of 2.52 mm and a range of 0.00 mm to 8.46 mm. The average length of the plate that was off the bone anteriorly was 20.54 mm, with a standard deviation of 14.19 mm and a range of 0.00 mm to 42.03 mm. The average length of the plate that was off the bone posteriorly was 25.66 mm, with a standard deviation of 17.79 mm and a range of 0.00 mm to 44.53 mm (Table 3).

At the lateral end of the clavicle, the average anterior mismatch was 1.43 mm, with a standard deviation of 5.76 mm and a range of -11.19 mm to 10.40 mm. The average posterior mismatch was 1.82 mm, with a standard deviation of 6.24 mm and a range of -11.54 mm to 11.92 mm. The average vertical gap was 4.28 mm, with a standard deviation of 2.24 mm and a range of 0.00 mm to 9.67 mm. The average length of the plate that was off the bone anteriorly was 26.06 mm, with a standard deviation of 17.74 mm and a range of 0.00 mm to 58.06 mm. The average length of the plate that was off the

Table 2. Congruence of left superior anterior clavicle plate without lateral extension (n=57)

	Medial end of plate					Lateral end of plate				
	Vertical gap	Anterior mismatch	Posterior mismatch	Horizontal distance from point of elevation anteriorly	Horizontal distance from point of elevation posteriorly	Vertical gap	Anterior mismatch	Posterior mismatch	Horizontal distance from point of elevation anteriorly	Horizontal distance from point of elevation posteriorly
Avg	2.14	1.59	4.38	18.70	14.33	3.03	4.92	5.48	25.85	18.63
Max	6.29	9.73	9.84	35.27	39.76	7.02	11.78	10.57	43.47	32.47
Min	0.00	-4.55	-1.66	0.00	0.00	0.00	-5.72	-3.94	0.00	0.00
SD	1.60	4.00	2.26	12.05	14.15	1.70	3.53	3.02	14.55	9.11

Avg, average; Max, maximum; Min, minimum.

Table 3. Congruence of the right superior anterior clavicle plate with lateral extension (n=53)

	Medial end of plate					Lateral end of plate				
	Vertical gap	Anterior mismatch	Posterior mismatch	Horizontal distance from point of elevation anteriorly	Horizontal distance from point of elevation posteriorly	Vertical gap	Anterior mismatch	Posterior mismatch	Horizontal distance from point of elevation anteriorly	Horizontal distance from point of elevation posteriorly
Avg	3.83	3.28	0.55	20.54	25.66	4.28	1.43	1.82	26.06	30.75
Max	8.46	10.12	9.12	42.03	44.53	9.67	10.40	11.92	58.06	49.96
Min	0.00	-7.24	-5.96	0.00	0.00	0.00	-11.19	-11.54	0.00	0.00
SD	2.52	4.98	4.56	14.19	17.79	2.24	5.76	6.24	17.74	11.70

Avg, average; Max, maximum; Min, minimum.

Table 4. Congruence of the left superior anterior clavicle plate with lateral extension (n=58)

	Medial end of plate					Lateral end of plate				
	Vertical gap	Anterior mismatch	Posterior mismatch	Horizontal distance from point of elevation anteriorly	Horizontal distance from point of elevation posteriorly	Vertical gap	Anterior mismatch	Posterior mismatch	Horizontal distance from point of elevation anteriorly	Horizontal distance from point of elevation posteriorly
Avg	2.96	2.24	2.38	19.15	24.27	4.46	0.00	4.72	27.64	35.50
Max	8.68	10.53	9.24	44.18	49.21	9.45	9.26	12.44	59.73	50.92
Min	0.00	-5.78	-7.30	0.00	0.00	0.00	-7.44	-6.84	0.00	0.00
SD	2.39	4.44	4.28	15.27	17.99	1.76	5.23	5.48	16.09	8.52

Avg, average; Max, maximum; Min, minimum.

bone posteriorly was 30.75 mm, with a standard deviation of 11.70 mm and a range of 0.00 mm to 49.96 mm (Table 3).

There was no vertical gap in 18 bones at the medial end and 1 on the lateral end. However, in 1 bone, the plate had no vertical gap at both ends. At the medial end, in 19 out of 53 cases, the plate overhung towards the anterior side and in 18 clavicles, the plate projected to the posterior side. On the lateral end, the plate overhung the bone only in 23 and 17 bones anteriorly and posteriorly, respectively.

Left SACP with lateral extension

For the left SACP with lateral extension, the average anterior mismatch at the medial end of the clavicle was 2.24 mm, with a standard deviation of 4.44 mm and a range of -5.78 mm to 10.53 mm. The average posterior mismatch was 2.38 mm, with a standard deviation of 4.28 mm and a range of -7.30 mm to 9.24 mm. The average vertical gap was 2.96 mm, with a standard deviation of 2.39 mm and a range of 0.00 mm to 8.68 mm. The average length of the plate that was off the bone anteriorly was 19.15 mm, with a standard deviation of 15.27 mm and a range of 0.00 mm to 44.18 mm. The average length of the plate that was off the bone posteriorly was 24.27 mm, with a standard deviation of 17.99 mm and a range of 0.00 mm to 49.21 mm (Table 4).

At the lateral end of the clavicle, the average anterior mismatch was 0.00 mm, with a standard deviation of 5.23 mm

Table 5. Showing the comparison of results of two studies with present study

Study	Malhas et al. [10]	Huang et al. [11]	Present study			
			Medial plate		Lateral plate	
Samples	79 right	100 pairs	Right	Left	Right	Left
Anatomical fit/ best fit (%)	9.00	45.50	46.29	54.38	16.98	13.79
Fair fit (%)	59.00	41.50	27.77	19.29	21.70	10.34
Poor fit (%)	32.00	13.00	25.92	26.30	73.50	75.86

and a range of -7.44 mm to 9.26 mm. The average posterior mismatch was 4.72 mm, with a standard deviation of 5.48 mm and a range of -6.84 mm to 12.44 mm. The average vertical gap was 4.46 mm, with a standard deviation of 1.76 mm and a range of 0.00 mm to 9.45 mm. The average length of the plate that was off the bone anteriorly was 27.64 mm, with a standard deviation of 16.09 mm and a range of 0.00 mm to 59.73 mm. The average length of the plate that was off the bone posteriorly was 35.50 mm, with a standard deviation of 8.52 mm and a range of 0.00 mm to 50.92 mm (Table 4).

There was no vertical gap in 14 bones at the medial end and 3 on the lateral end. However, in 3 bones, the plate had no vertical gap at both ends. At the medial end, in 18 out of 58 cases, the plate overhung towards the anterior side and in 16 clavicles, the plate projected to the posterior side. On the lateral end, the plate overhung the bone only in 28 and 13 bones anteriorly and posteriorly, respectively.

Discussion

Huang et al. [11] found that the maximum superior bow of the clavicle was located laterally, with a mean distance of 37.2 mm from the acromial articulation and a mean magnitude of 5.1 mm. In our study, we found similar results, with a mean distance of 30.75 mm and 30.5 mm for the right and left clavicles, respectively, and a mean magnitude of 4.28 mm and 4.46 mm for the right and left clavicles, respectively.

In their study, Fang et al. [12] recorded that there were no implant deformities in the group treated with anatomically pre-contoured locking compression plates. However, in the reconstruction locking compression plates group, there were 6 patients (11.3%; $P=0.012$) with implant deformities, consisting of 5 occurrences of plate bending with fracture union, and 1 instance of plate breakage with non-union. Similarly, in our study, we also observed mismatches with the pre-contoured plates.

A study conducted by Zhao et al. [13] revealed a normal conoid tubercle angle of $164.540\pm 4.78^\circ$ and a mean value for bilateral 50 cases (45.13%). In the straight plate group, 50 cases (45.13%) showed plate overhang, which demonstrated a statistically significant difference when compared to the contoured group where no cases had plate overhang. However, in the present study, we observed a vertical gap in 55 cases (94.8%) on the left side and 52 cases (98.1%) on the right side in the SACP with lateral extension. These findings suggest that there should be some angular modification on the plate ends.

Malhas et al. [10] conducted a study on four clavicle plating systems, examining superior midshaft anatomic clavicle plates from four manufacturers by applying them to 79 dry right human clavicles. Their conclusion was that plating systems with multiple plate shape variations are more suitable for small-sized clavicles, such as those in females. In the present study, we observed that the data for the SACP without lateral extension indicated a fit similar to that reported by Malhas et al. [10] but higher than the findings from Huang et al. [11], as shown in Table 5. However, there was no available data for SACP with lateral extension. We found that in 75.86% of cases, the plate fit poorly on the left side and in 73.5% of cases on the right side. Manipulating the plates during surgery in the antero-posterior plane proved to be very difficult.

In our study, we discovered that both plates exhibited elevations on their medial and lateral ends, indicating the

need for angular bending to achieve better congruence. Additionally, we observed differences in the plate length, with portions of the plates extending off the bone anteriorly and posteriorly. Hence, modifications along the long axis of the plates are required. Furthermore, we propose conducting a study utilizing 3D software to impose the clavicle plates and determine the appropriate configuration for the plates in the central Indian region.

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Author Contributions

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Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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References

1. Wijdicks FJ, Van der Meijden OA, Millett PJ, Verleisdonk EJ, Houwert RM. Systematic review of the complications of plate fixation of clavicle fractures. *Arch Orthop Trauma Surg* 2012;

- 132:617-25.
2. Amer KM, Congiusta DV, Suri P, Choudhry A, Otero K, Adams M. Clavicle fractures: associated trauma and morbidity. *J Clin Orthop Trauma* 2020;13:53-6.
 3. VanBeek C, Boselli KJ, Cadet ER, Ahmad CS, Levine WN. Precontoured plating of clavicle fractures: decreased hardware-related complications? *Clin Orthop Relat Res* 2011;469:3337-43.
 4. Andersen JR, Willis MP, Nelson R, Mighell MA. Precontoured superior locked plating of distal clavicle fractures: a new strategy. *Clin Orthop Relat Res* 2011;469:3344-50.
 5. Kabak S, Halici M, Tuncel M, Avsarogullari L, Karaoglu S. Treatment of midclavicular nonunion: comparison of dynamic compression plating and low-contact dynamic compression plating techniques. *J Shoulder Elbow Surg* 2004;13:396-403.
 6. Collinge C, Devinney S, Herscovici D, DiPasquale T, Sanders R. Anterior-inferior plate fixation of middle-third fractures and nonunions of the clavicle. *J Orthop Trauma* 2006;20:680-6.
 7. Coupe BD, Wimhurst JA, Indar R, Calder DA, Patel AD. A new approach for plate fixation of midshaft clavicular fractures. *Injury* 2005;36:1166-71.
 8. Hulsmans MH, van Heijl M, Houwert RM, Hammacher ER, Meylaerts SA, Verhofstad MH, Dijkgraaf MG, Verleisdonk EJ. High irritation and removal rates after plate or nail fixation in patients with displaced midshaft clavicle fractures. *Clin Orthop Relat Res* 2017;475:532-9.
 9. Fontana AD, Hoyen HA, Blauth M, Galm A, Schweizer M, Raas C, Jaeger M, Jiang C, Nijs S, Lambert S. The variance of clavicular surface morphology is predictable: an analysis of dependent and independent metadata variables. *JSES Int* 2020;4:413-21.
 10. Malhas AM, Skarparis YG, Sripada S, Soames RW, Jariwala AC. How well do contoured superior midshaft clavicle plates fit the clavicle? A cadaveric study. *J Shoulder Elbow Surg* 2016;25:954-9.
 11. 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.
 12. Fang CX, Liu R, Yee DKH, Chau J, Lau TW, Chan R, Woo SB, Wong TM, Fang E, Leung F. Comparison of radiological and clinical outcomes, complications, and implant removals in anatomically pre-contoured clavicle plates versus reconstruction plates - a propensity score matched retrospective cohort study of 106 patients. *BMC Musculoskelet Disord* 2020;21:413.
 13. Zhao B, Zhao W, Assan I, Bi R. Conoid tubercle angle: attention should be paid to supraclavicular plate fixation. *J Orthop Surg Res* 2022;17:105.