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Anatomical pre-contoured locking plate versus reconstruction plate in the management of displaced midshaft clavicular fractures

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Abstract
Background: Various plates are available for mid shaft displaced clavicle fractures, each with its own set of benefits and drawbacks. Although reconstruction plates are inexpensive and easily bendable, their stability and strength have been called into doubt. In comparison to the reconstruction plate, the anatomical pre-contoured locking plates give great stability and strength.
Methods: To compare the results, a study [prospective] was done with 30 patients with displaced mid shaft clavicle fractures who were treated with a pre-contoured anatomical locking plate (15 patients) and a recon plate (15 patients) at our hospital between Jan and Dec 2020. Patients were followed up for 6months and clinical radiological results between the pre-contoured locking plate and reconstruction plate were compared individually using the quick DASH score and plain x rays.
Results: The group with reconstruction plates had a mean-16 weeks for bone union and for the locking plate [pre contoured] group was 13weeks. The mean quick dash score for the reconstruction group is 30.5 and for the anatomical pre-contoured plate group is 25.8. We had entanglements, for example, hypertrophic scar, plate prominence, agonizing shoulder, implant failure were noted uniquely in the recon plate group, which required implant exit while the anatomical locking plate group they didn't have those complications. The implant removal was done for 2 subjects in the reconstruction cohort while zero patients in the locking plate category required one. None of the patients in both groups had a non-union.
Conclusion: When compared to reconstructive plating, surgical therapy of fractures in middle third clavicle with pre-contoured locking plates provided stable fixation, faster union, and superior functional success. Anatomical plates have the advantage of requiring less soft tissue stripping and requiring less lag screw fixation for fracture stability because the pre-contoured plate provides a stiff build.

Keywords: Clavicle fracture, ORIF, anatomical plate, DASH score

Introduction
The S shape clavicle is the first long to begin ossification and final long bone to finish ossification. Fractures of the clavicle are most frequent above 18 years of age [1]. Previously nonsurgical treatments were provided for mid shaft clavicle fractures, which according to neer showed low nonunion rates [2, 3] Midshaft are the most common fractures among clavicle fractures [4]. Patients treated conservatively developed symptoms like pain, malunion, non-union [5]. However, current evidence suggests that operational therapy for displaced, comminuted fractures occurring from accidents, such as car accidents, commercial accidents, and sports injuries, is becoming more popular. This is done to avoid shortening or angular deformities, both of which can be painful [6]. There are a variety of surgical options for treating clavicle midshaft fractures, including K-wires, Steinman pins, and ORIF with PO [7, 8]. All the patients in this study had the clinical outcome measure using DASH score [9]. Plain x-rays were taken for all the patients and their radiological outcomes were documented.

Materials and Methods
After receiving, institutional ethical committee approval, a study [prospective] was done. Surgery done for midshaft clavicle fractures above 18 years of age by ORIF WITH PO from Jan 2020 to Dec 2022 and patients who were treated surgically with recon plates were selected along with those fixed with anatomical pre-contoured clavicle locking plates.

All of the operations were carried out by orthopaedic surgeons. Fractures with a displacement or shortening of 20 mm, comminuted fractures, irreducible fractures due to suspected soft tissue interposition, open fractures, multiple fractures, and fractures with a neurovascular injury and associated fractures were all considered operative indications. The surgeons had no bearing on the plate selection decision. Adults with un-displaced fractures of the clavicle and children were excluded from this study. The surgery was done by surgeons in our institute. Surgery done under regional anesthesia. Patient in beach chair position, skin incision made over the clavicle and minimal periosteal stripping done. Fracture reduction was done and fixed with a bone holding clamp. In the reconstruction plate group the plate was contoured and placed and fixed with screws. In anatomical pre contoured locking plate group, the plate was chosen which fits to the clavicle and fixed with screws. If fracture reduction could not achieved or in cases of comminuted fracture lag screws were used. Bone graft was used if there is severe comminution present to avoid nonunion. The implant was placed over the upper border of the clavicle, screw length was measured to avoid neovascular injury and prominence of screw. Postoperatively patient was advised broad arm sling support for 2weeks and pendulum exercises for 2weeeks and active exercises started from 2 to 4 weeks. Strengthening exercises started from 6th week. The patients were seen six weeks following surgery, as well as at three, six, and twelve months. Anteroposterior x rays were taken at each visit and checked for any complications. Complete cortical bridging across the fracture site was defined as radiographic union. The DASH score, as recommended by the American Academy of Orthopaedic Surgeons, were used to assess functional ability. SPSS Version 25.0 (SPSS Inc., Chicago, Illinois, USA) was used for statistical analysis. We utilised an independent t-test and an x2 test. A p value of less than 0.05 was deemed significant.

Results

The demographic profile (fig 1) and side involvement of the patients were comparable (fig 2).

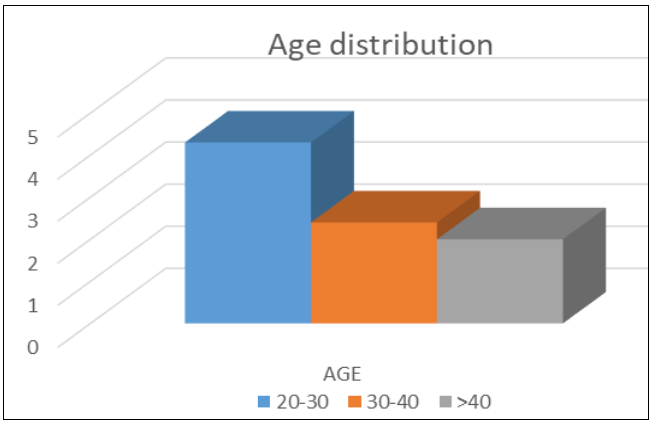

Fig 1: Age distribution

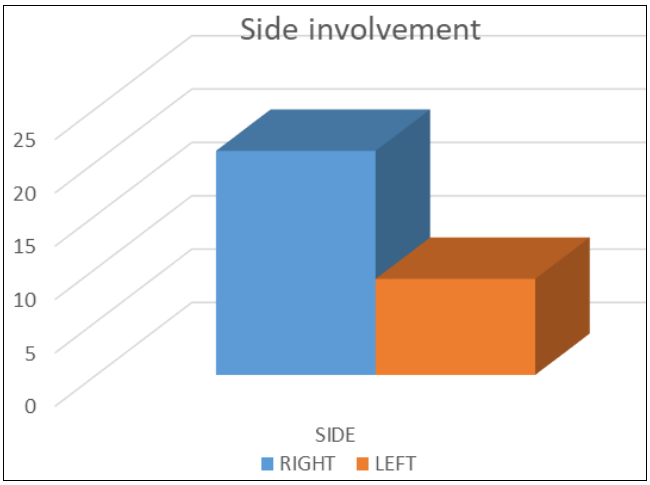

Fig 2: Side involvement

In this study 30 patients who were diagnosed to have displaced midshaft clavicle fracture were treated with ORIF WITH PO. In that for 15 patients we used anatomical locking plate {group 1}. And for another 15 patients we used a reconstruction plate {group 2}. The mean operation time in the reconstruction group was 85 minutes while it was 59 minutes in the anatomical locking group. We discovered a substantial difference in the number of fractures that required reduction by lag screws. The lag screws were mostly used in reconstruction plate to achieve reduction. The pre-contoured plate group took less time since there was less need for plate contouring, whereas the reconstruction plate group spent the majority of their time contouring the plate to fit the original bone curvature. Bony union was achieved at 13 weeks in anatomical locking plate group and 16 weeks in the reconstruction plate group. Which shows a significant [P-value- 0.05] difference between two groups. Quick DASH score of 31.45 in group 2 and 28.12 in group 1 were recorded. (Figure 3).

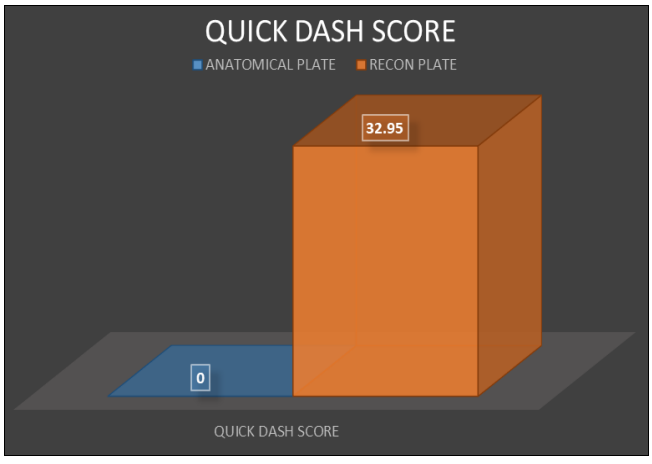

Fig 3: Quick DASH score

Both groups experienced postoperative problems. Plate prominence was present in all of the patients in both groups, although it did not appear to cause significant mental distress. We employed plates that gave us with 3 different types of pre-contoured plates, each with a different size that mainly matched the patients' natural contour. In spite of this some patients had a modest offset of 2-3 mm might be accepted, which is the primary cause of the implant prominence problem. Hypertrophic scar without pain was found in three patients, screw cut out in one cases, and plate failure in one patient in the reconstruction plate. Hypertrophic scar was seen in one patient in the anatomical locking group, but no screw loosening or plate failure was seen in this group. Both groups were free of infection and non-union. (Table 1&2).

Discussion

Clavicle fractures are mostly treated conservatively. Neer in 1960 conducted a study and he reported non-union occurred only in 3 patients out of 2235 patients whom were treated nonsurgically for midshaft clavicle fractures. [10] Rowe in 1968 reported that conservatively treated clavicle fractures shows non-union only in 4 patients out of 556 clavicle fractures and the patients treated surgically developed more complications and non-union [11]. Zlowodzki *et al*, reported that non-union occurred in only 6% of the patients who are treated conservatively out of 1145 midshaft clavicle fractures cases and only 2% of the patient developed non-union who undergone surgical treatment [12]. For midshaft clavicle fractures, operative treatment was performed in most of the cases due to severe displacement and comminuted fractures caused by road traffic accidents [13]. Shen *et al*, reported that outcomes were better in the cases who underwent open reduction and internal fixation [14].

The Canadian orthopedic society compared between operative and nonoperative treatment for midshaft displaced clavicle fractures, in that open reduction and internal fixation with plates and screws groups shows rapid union, good functional outcome, and less complication compared to the nonoperative group [15]. The reconstruction plate can contour to the fracture pattern to obtain good fixation, and it is very thin compared to the locking plates. [16, 17]. Penetration of the opposite cortex while screw fixation may lead to damage to subclavian vessels, in osteoporotic patients it is difficult to maintain firm fixation but pre-contoured plate screw hold will be good in osteoporotic patients [18, 19].

In our study the reconstruction plates did not cause any complications like brachial plexus injury and subclavian vessel but pain and restriction of movement was present in follow up. Non-union were not present in any of the cases, anatomical pre-contoured locking plate used as an alternative for reconstruction plate to decrease the complications.

Anatomical pre-contoured locking plates are used mostly because it causes strong fixation between plate and screws and it preserve the blood supply due to less contact between plate and bone [20, 21]. Screws are fixed with both cortices but in locking plate, the screw heads are fixed with plate thread which prevents screw loosening. Plate are not compressed with the cortical bone thus preserving the blood supply [22]. Minimal periosteal striping increases union rates.

Ali khan and Lucus reported that patient developed hypertrophic scars after surgical treatment with plates for clavicle fractures [23]. Four of our patients developed hypertrophic scars after surgical treatment but none of them developed pain. Implant removal done 2 of the patients in the reconstruction group, where one of them for plate failure and one for screw failure, but none in anatomical pre-contoured locking plate group. Non-union and malunion was not present in both group.

Table 1: Out come analysis of anatomical locking plate group

Age	Sex	Side	Cause of injury	Lag screw usage	Surgery time[min]	Quick dash score	Bone union period(weeks)	Complications				
								PP	HS	IR	SF	PF
45	M	R	RTA	-	58	25.44	13	+	-	-	-	-
28	M	R	RTA	-	60	22.34	14	+	-	-	-	-
56	M	R	ASSAULT	-	63	26.97	16	+	-	-	-	-
30	F	L	RTA	-	57	25.88	15	+	-	-	-	-
39	M	L	RTA	-	58	23.87	16	+	-	-	-	-
41	M	R	RTA	-	62	25.87	18	+	-	-	-	-
35	M	L	RTA	-	57	26.12	14	+	-	-	-	-
39	F	R	RTA	+	60	22.89	16	+	-	-	-	-
51	M	R	RTA	-	59	23.78	15	+	-	-	-	-
32	M	R	RTA	-	55	26.76	14	+	-	-	-	-
28	M	R	RTA	+	62	25.12	12	+	-	-	-	-
26	M	L	RTA	-	65	22.78	12	+	-	-	-	-
46	M	L	ASSASULT	-	58	26.75	17	+	+	-	-	-
43	F	R	RTA	-	61	25.97	16	+	-	-	-	-
31	M	R	RTA	-	59	27.64	15	+	-	-	-	-

PP- Plate prominence, HS- Hypertrophic scar, IR- Implant removal, SF- Screw failure, PF- Plate failure

Table 2: Out come analysis of reconstruction plate group

Age	Sex	Side	Cause of injury	Lag screw usage	Surgery time [mins]	Quick dash score	Bone union period (weeks)	Complications				
								PP	HS	IR	SF	PF
37	M	R	RTA	+	85	32.65	16	+	-	-	-	-
34	M	R	RTA	+	88	33.76	18	+	-	-	+	-
28	M	R	RTA	+	79	32.78	15	+	-	-	-	-
25	M	L	RTA	+	81	35.12	19	+	-	-	-	-
41	M	R	RTA	+	80	31.65	20	+	-	-	-	-
45	F	R	ASSASULT	+	84	33.54	18	+	-	-	-	-
39	M	R	RTA	+	85	32.12	19	+	+	-	+	-

26	M	R	RTA	-	79	31.29	16	+	-	+	-	-
31	M	L	ASSASULT	-	87	33.18	22	+	-	-	-	+
33	M	L	RTA	+	82	34.03	20	+	-	-	-	-
38	M	R	RTA	-	84	32.08	21	+	+	-	-	-
27	F	R	RTA	-	77	34.27	23	+	-	+	-	-
29	M	R	RTA	+	78	32.22	19	+	-	-	-	-
30	M	L	RTA	+	85	32.46	17	+	+	-	-	-
41	M	R	RTA	-	86	33.12	19	+	-	-	-	-

Conclusion

When compared to reconstruction plating, the operative care of middle third clavicle fractures with locking plate [precontoured] provided stable fixation, faster callus formation, fewer implant related comorbidities, and a great outcome. The fundamental benefit of operational intervention with a pre-contoured locking plate is that it restores natural anatomical form and length of the clavicle, allowing for normal shoulder girdle biomechanics and quicker mobilisation.

Conflict of Interest

Not available

Financial Support

Not available

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