Clinical Effect of Plastic Splint for Treatment of New type of Midshaft Clavicle Fracture: A Retrospective Study

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Research Article

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Clinical effect of plastic splint for treatment of new type of midshaft clavicle fracture: a retrospective study

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Abstract

Background: On the basis of conservative treatment of 81 midshaft clavicle fractures, a new type of midshaft clavicle fracture was proposed and the clinical effect of plastic splinting in the treatment of these fractures was observed.

Methods: Eighty-one patients with midshaft clavicle fractures treated with plastic splints from January 2018 to July 2020 were retrospectively analyzed. The fractures were divided into four types according to their displacement. All patients underwent plastic splint fixation for 4 weeks. The visual analog scale score, Constant–Murley shoulder joint score, patient satisfaction with the post-treatment appearance, nonunion rate, and malunion rate were examined at 1, 3, and 9 months after treatment.

Results: Seventeen patients had type I fractures, 18 had type II, 9 had type III, and 37 had type IV. For all four fracture types, the mean visual analog scale score and Constant–Murley score considerably improved from pretreatment to 9 months post-treatment. Seven patients were not satisfied with the post-treatment appearance. Five patients still had no obvious callus at 9 months after treatment, indicating non-healing; most of these patients had type III and IV fractures.

Conclusions: Use of the new type of midshaft clavicle fracture is more appropriate for evaluation of the clinical treatment effect because it has more guiding significance for the treatment and prognosis of midshaft clavicle fractures. A plastic splint can be used to treat midshaft clavicle fractures. The short-term clinical effect is safe, and fracture reduction is accurate. Although the

incidence of malunion after plastic splint treatment is high, most patients are still satisfied with the appearance after treatment. This technique can be popularized in clinical practice. The functional score and satisfaction with the post-treatment appearance were lower in patients with type III and IV fractures than in those with type I and II fractures, and the rate of nonunion and abnormal healing were relatively high. Other treatment methods should be considered as early as possible for such patients to achieve the best treatment effect.

Keywords: Midshaft clavicle fracture; New clinical classification; Plastic splint; Clinical effect

Background

Fractures of the clavicle account for 2.6% to 5.0% of all fractures[1]. They can occur at any age, and indirect trauma is the main cause. The middle third of the clavicle is the most prone to fracture, accounting for about 80% of all clavicle fractures[2]. It is generally accepted that non-operative treatment is optimal for most mid-clavicle fractures and is likely to be associated with a very low nonunion rate of <1%[3]. However, in most hospitals in China and abroad, surgical treatment is often preferred for midshaft clavicle fractures. Since the beginning of the 21st century, Suzhou Traditional Chinese Medicine Hospital has adopted a "one-size-fits-all" nonsurgical conservative treatment method using a plastic splint for closed midshaft clavicle fractures with satisfactory clinical results. However, accurate follow-up information and data collection regarding the clinical efficacy of conservative treatment are lacking in previous studies. We retrospectively analyzed 81 patients treated for midshaft clavicle fractures from January 2018 to July 2020. The new type of midshaft clavicle fracture proposed in this report can better reflect the variations in midshaft clavicle fractures and is closely related to the clinical effect of a plastic splint. It can also better guide the choice of clinical treatment.

Methods

Patients

In total, 81 patients who underwent treatment for middle clavicle fractures from January 2018 to July 2020 were analyzed in this study. The patients comprised 45 men and 36 women ranging in age from 18 to 82 years. All patients provided written informed consent before treatment, and the Suzhou Traditional Chinese Medicine Hospital Ethics Committee approved the study. All patients were treated with a plastic splint. Type I fractures were present in 17 patients, type II in 18, type III in 9, and type IV in 37.

Diagnostic criteria

We referred to the Chinese Medical Association's Clinical Diagnosis and Treatment Guide - Division of Orthopaedics Division for the diagnosis of midshaft clavicle fractures[4]. The diagnostic criteria were a clear history of trauma, occurrence in the middle one-third of the clavicle, obvious local tenderness and swelling at the fracture site, and rubbing of the two displaced bone fragments against each other. Combination of the physical examination and imaging examination findings allowed for determination of the displacement and fracture type.

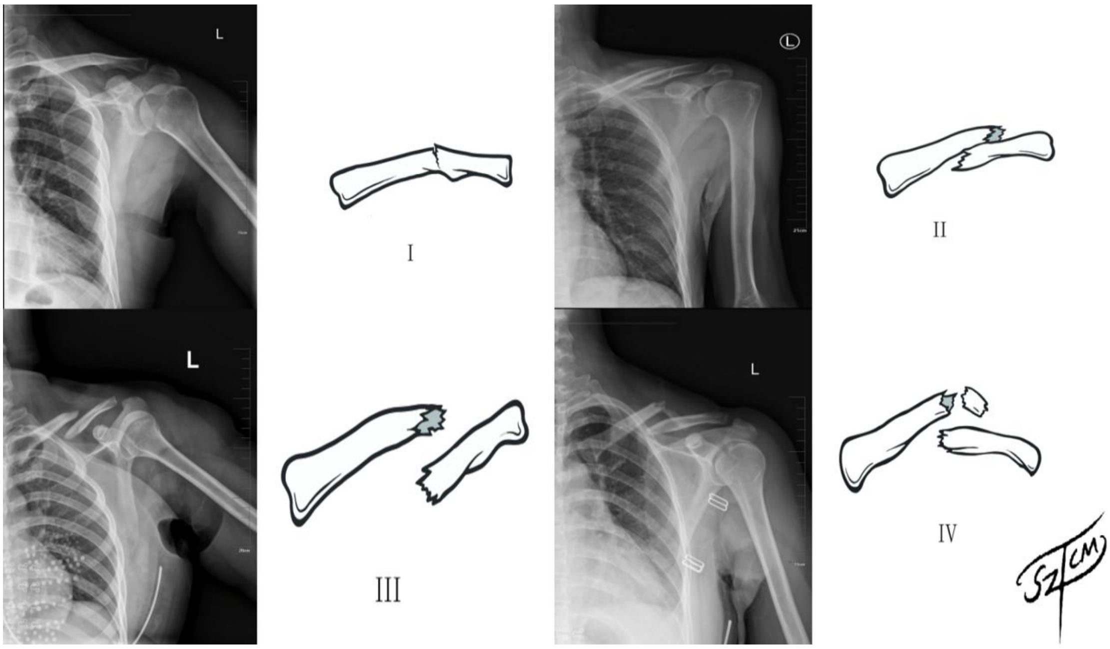
Inclusion and exclusion criteria

The inclusion criteria for this study were satisfaction of the diagnostic criteria for midshaft clavicle fractures, the presence of a fresh fracture with no other treatment, complete imaging findings, good patient compliance, age of >16 years, provision of informed consent, and treatment with a plastic splint. The exclusion criteria were distal or proximal clavicle fractures, open fractures, pathological fractures, multiple ipsilateral upper limb fractures, vascular nerve injury, poor patient compliance, inability to undergo follow-up, and refusal of conservative treatment.

New classification standards

We proposed a new type of midshaft clavicle fracture according to the fracture displacement during conservative treatment: type I, good alignment with no obvious displacement of the fracture ends; type II, overlapping displacement of and contact between the distal and proximal fracture ends; type III, separation (no contact) of the distal and proximal fracture ends; and type IV, separation of the fracture ends with at least one free bone mass between them. The fracture types are illustrated in Figure 1.

Figure 1. Midshaft clavicle fracture types



Surgical technique

After admission, all patients were treated with plastic splinting using the following technique. First, a plastic splint was created. The length of the splint was equivalent to the distance from the neck edge to the acromion, and the width was twice the distance from the sternoclavicular joint of the affected side to the highest point of the shoulder. The neck end was cut into a semicircle at the center of the midpoint to ensure the ability to maximally cover the splint and neck with clothing. The shoulder end was also cut into a concave shape toward the middle. To expose the acromion, the front of the splint was cut into an oblique shape according to the direction of the clavicle. The excess was trimmed from the edges to achieve better comfort. Second, the operator used digital palpation to determine whether the fracture ends were displaced. The patient sat on a bench with his or her head up, chest up, hands on the hips, and elbows turned outward. The assistant stood behind the patient with his or her knee to the center of the patient's back. The assistant held the outside of the patient's shoulders in both hands and performed slow back traction so that the patient's shoulder was fully stretched, thereby restoring or improving any overlapping fracture displacement. Third, after manual resetting of the fracture, the patient kept his or her hands on the hips with elbows turned outward and with the chest and head up, and the surgeon placed a cotton pad above the proximal end of the fracture. The splint was placed on the cotton pad, and a large cotton pad was then placed in the bilateral armpits. From this starting point, a gauze bandage was wrapped 8 to 12 times over the fracture end, bypassing the axilla, extending around the back to the healthy shoulder, wrapping in front of the shoulder and around the axilla, and finally extending from the back to the starting point. The affected limb was then fixed in the neutral position with a triangular towel (Figure 2). Fourth, after resetting, the X-line was rechecked to determine whether the reset was satisfactory. If the fracture ends were unsatisfactorily positioned, a secondary reset was considered to ensure that the fracture ends came into the greatest contact possible. However, the surgeon did not blindly pursue a perfect outcome by repeated and violent reduction. Thus, improper reduction and damage to peripheral blood vessels and nerves was avoided. After resetting, close observation during restricted activities was performed for 4 weeks, and the X-line was regularly checked. After 4 weeks, active motion of the shoulder joint was carried out without external fixation, and the range of motion was gradually increased according to the patient's tolerance. Patients did not perform strenuous exercise for 3 months after fracture.

Figure 2. Images of plastic splint fixation

Evaluation of efficacy

After treatment, the following parameters were recorded to evaluate the clinical efficacy of plastic splinting in patients with different types of midshaft clavicle fractures: the visual analog scale (VAS) score[5], the Constant–Murley shoulder joint score[6], patient satisfaction with the post-treatment appearance, and the nonunion rate.

Statistical methods

Statistical analysis was carried out using SPSS 26.0 (IBM Corp., Armonk, NY, USA). Measurement data are expressed as mean ± standard deviation. According to the homogeneity of data variance, either the paired-samples t test or Mann–Whitney rank sum test was used for group comparisons. Count data are expressed as frequency and percentage. A P value of <0.05 indicated a statistically significant difference.

Results

VAS and Constant–Murley scores

All 81 patients were followed up, and the VAS score and Constant–Murley shoulder joint score were significantly improved after treatment. The scores before and after treatment (1, 3, and 9 months) are shown in Tables 1 and 2.

Table 1. Changes in VAS score before and after treatment

Time \ Classification	I type	II type	III type	IV type
Pre-treatment	2.85±0.83	3.71±0.80	5.85±0.85	6.92±0.70
1 month	1.40±0.44	1.92±0.44	2.89±0.49	3.42±0.37
3 months	0.86±0.28	1.19±0.33	1.67±0.25	1.97±0.25
9 months	0.52±0.20	0.75±0.25	1.04±0.21	1.15±0.20

Table 2. Changes in Constant–Murley score before and after treatment

Time \ Classification	Type I	Type II	Type III	Type IV
Pre-treatment	65.95±2.02	63.48±2.15	54.26±2.44	47.85±2.82
1 month	76.64±1.70	73.35±2.20	62.15±2.42	55.69±2.76
3 months	81.90±1.73	78.31±2.16	67.44±2.33	61.95±2.69
9 months	88.54±2.05	85.06±2.18	73.78±2.24	71.58±2.41

The mean pretreatment to 9-month post-treatment VAS score of all 81 patients decreased from 2.85±0.83 to 0.52±0.20 for type I fractures, from 3.71±0.80 to 0.75±0.25 for type II fractures, from 5.00±0.85 to 1.04±0.21 for type III fractures, and from 6.92±0.70 to 1.15±0.20 for type IV fractures. The mean pretreatment to 9-month post-treatment Constant–Murley shoulder joint score increased from 65.95±2.02 to 88.54±2.05 for type I fractures, from 63.48±2.15 to 85.06±2.18 for type II fractures, from 54.26±2.44 to 73.78±2.24 for type III fractures, and from 47.85±2.82 to 71.58±2.41 for type IV fractures. All differences were statistically significant ($P<0.05$).

Patient satisfaction

Seven of the 81 patients were not satisfied with the post-treatment appearance, mainly because of the high uplift of the fracture end; the remaining patients were satisfied (Table 3). Comprehensive analysis showed that the overall satisfaction rate was 91.36%.

Table 3. Patient satisfaction

	Type I	Type II	Type III	Type IV
Satisfactory	17	17	7	33
Not satisfied	0	1	2	4

Nonunion rate

Five of the 81 patients still had no obvious callus 9 months after treatment, indicating non-healing; the overall non-healing rate was 6.17% (Table 4). Patients with fracture nonunion were treated by open reduction and internal fixation or other methods according to their own conditions and wishes.

Table 4. Nonunion

	Type I	Type II	Type III	Type IV
Healing	17	17	7	35
Non-healing	0	1	2	2

Malunion rate

Of the 81 patients, 32 had malunion; the rate of malunion was 39.50% in combination with imaging findings (Table 5).

Table 5. Malunion

	Type I	Type II	Type III	Type IV
Normal healing	17	16	5	11
Deformity healing	0	2	4	26

Discussion

Fracture classification is an important basis for treatment selection and outcome prediction. Clavicle fractures are generally classified according to their anatomical location[7]. The Craig, Allman, Neer, Edinburgh (later developed into Robinson), and OTA/AO classification systems are commonly used[8-11]. Among them, the Robinson classification system is the most appropriate for midshaft clavicle fractures[12]. However, this classification only divides midshaft clavicle fractures into two types: non-displacement and displacement fractures[13]. The classification makes no mention of common clinical overlapping displacement and comminuted fractures. At present, there is no specific and detailed classification system for midshaft clavicle fractures.

The main clavicle fracture classification systems are the Robinson, Craig, Allman, and Neer systems. The treatment choices and prognosis of midshaft clavicle fractures are not uniform, mainly because the classification is not comprehensive or perfect. We found that there are still many defects and deficiencies in the Robinson classification in the course of clinical treatment of midshaft clavicle fractures, resulting in some difficulties and obstacles in the treatment of these fractures. Therefore, we further supplemented and perfected the Robinson classification system and developed a new type of midshaft clavicle fracture classification.

The incidence of malunion in patients with midshaft clavicle fractures treated with plastic splints is high. However, because of the scar caused by surgical treatment, most patients still choose plastic splint treatment, which only causes slight fracture end uplift. This technique is thus becoming popularized in the clinical setting.

In the present study, all patients' VAS scores and Constant–Murley shoulder scores were better after than before treatment. However, patients with type III and IV midshaft clavicle fractures were less satisfied with the post-treatment appearance than were patients with type I and II fractures, and satisfactory results were not obtained in three cases of fracture nonunion. This may have been related to the integrity of the fracture block and whether the fracture ends were in close contact. Related studies have shown that patients' evaluation of the level of joint participation in decision-making is the main factor influencing overall satisfaction[14]. Therefore, we should objectively inform patients of the potential complications and sequelae of different treatment methods when deciding on the treatment plan so patients can participate in the decision-making process and we can meet their treatment expectations[15].

A plastic splint is effective in the treatment of most midshaft clavicle fractures and can obtain satisfactory clinical results. However, patients should be surgically treated as soon as possible when they have indications for surgery such as open fractures, nerve or vascular injuries, extensive displacement, comminuted fractures[16], and high-energy trauma such as floating shoulder, shoulder impaction, and multiple trauma[17]. In addition, among patients with type III fractures with severe end separation and type IV comminuted midshaft clavicle fractures, we suggest that those who have no contraindications be given priority for surgical treatment, facilitating greater clinical efficacy and a lower incidence of complications. For type I and II midshaft clavicle fractures, conservative splinting is recommended because it is a simple operation with less pain, satisfactory clinical efficacy, and a low incidence of complications. Because of the limited sample size in the present study, the clinical efficacy and complication rate of plastic splinting in the treatment of midshaft clavicle fractures requires further confirmation and discussion.

Declarations

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Consent for publication

The informed consent for publication was obtained form all participants for identifying information/images in an online open-access publication.

Authors' Contributions

Authors XT Z, YT S, and JT L designed the study. Authors XT Z,YT S, YX D，S L,YF S, andZJ M collected the clinical data and conducted the statistical analysis. Author XT Z wrote the manuscript. Authors JT Land H J revised the manuscript; all authors seriously and critically read the manuscript to improve intellectual content. All authors read and approved the final manuscript.

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Availability of data and materials

Raw data and materials of this study is deposited in the local server of Suzhou Hospital of traditional Chinese Medicine Affiliated to Nanjing University of traditional Chinese Medicine for safety and confidentiality purpose. Our data are available upon reasonable request from the corresponding author.Please contact the corresponding author at okdoctor@163.com for more information.

Ehtics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki (WMA) and the International Ethical Guidelines for Biomedical Research involving human subjects (CIOMS).This research was approved by the ethics committee of the Suzhou Hospital of traditional Chinese Medicine Affiliated to Nanjing University of traditional Chinese Medicine. All patients or their families signed the informed consent and provided the consent to publish and report individual clinical data.

Competing interests

The authors have no conflicts of interest, including specific financial interests and relationships and affiliations, relevant to the subject of this manuscript.

References

1.Postacchini F, Gumina S, De Santis P, Albo F: Epidemiology of clavicle fractures. Journal of shoulder and elbow surgery 2002, 11(5):452-456.

2.van der Meijden OA, Gaskill TR, Millett PJ: Treatment of clavicle fractures: current concepts review. Journal of shoulder and elbow surgery 2012, 21(3):423-429.

3.Stanley D, Trowbridge EA, Norris SH: The mechanism of clavicular fracture. A clinical and biomechanical analysis. The Journal of bone and joint surgery British volume 1988, 70(3):461-464.

4.Chinese Medical Association. Guidelines for clinical diagnosis and treatment: Orthopedics volume. Beijing: People's Health Publishing House, 2009:94.

5.McCaffery M: Using the 0-to-10 pain rating scale. The American journal of nursing 2001, 101(10):81-82.

6.Constant CR, Murley AH: A clinical method of functional assessment of the shoulder. Clinical orthopaedics and related research 1987(214):160-164.

7.Burnham JM, Kim DC, Kamineni S: Midshaft Clavicle Fractures: A Critical Review. Orthopedics 2016, 39(5):e814-821.

8.Neer CS, 2nd: Nonunion of the clavicle. Journal of the American Medical Association 1960, 172:1006-1011.

9.Allman FL, Jr.: Fractures and ligamentous injuries of the clavicle and its articulation. The Journal of bone and joint surgery American volume 1967, 49(4):774-784.

10.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 musculoskeletal disorders 2017, 18(1):82.

11.Van Tongel A, Toussaint A, Herregods S, Van Damme S, Marrannes J, De Wilde L: Anatomically based classification of medial clavicle fractures. Acta orthopaedica Belgica 2018, 84(1):62-67.

12.Robinson CM: Fractures of the clavicle in the adult. Epidemiology and classification. The Journal of bone and joint surgery British volume 1998, 80(3):476-484.

13.O'Neill BJ, Hirpara KM, O'Briain D, McGarr C, Kaar TK: Clavicle fractures: a comparison of five classification systems and their relationship to treatment outcomes. International orthopaedics 2011, 35(6):909-914.

14.Tutuhatunewa ED, Stevens M, Diercks RL: Clinical outcomes and predictors of patient satisfaction in displaced midshaft clavicle fractures in adults: Results from a retrospective multicentre study. Injury 2017, 48(12):2788-2792.

15.Carry PM, Koonce R, Pan Z, Polousky JD: A survey of physician opinion: adolescent midshaft clavicle fracture treatment preferences among POSNA members. Journal of pediatric orthopedics 2011, 31(1):44-49.

16. Robinson CM, Goudie EB, Murray IR, et al. Open reduction and plate fixation versus nonoperative treatment for displaced midshaft clavicular fractures: a multicenter, randomized, controlled trial. J Bone Joint Surg Am. 2013, 95(17):1576-84.

17.Ropars M, Thomazeau H, Huten D: Clavicle fractures. Orthopaedics & traumatology, surgery & research : OTSR 2017, 103(1s):S53-s59.