



Original article

Displaced midshaft clavicle fracture in athletes – should we operate?☆



Neydson André Solposto Marques de Souza*, Paulo Santoro Belangero, Eduardo Antônio de Figueiredo, Alberto de Casto Pochini, Carlos Vicente Andreoli, Benno Ejnisman

Centro de Traumatologia do Esporte, Departamento de Ortopedia e Traumatologia, Universidade Federal de São Paulo, São Paulo, SP, Brazil

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ABSTRACT

Objective: To assess the results of the treatment of fractures of the middle third of the clavicle with a pre-contoured plate in athletes.

Methods: The authors performed 26 osteosyntheses in 25 patients with fractures of the middle third of the clavicle. The fractures were classified according to Robinson as 16 type B1 and ten type B2. The mean age was 37 years, ranging from 15 to 63 years, 20 patients were male and five were female, and all play sports in an amateur or professional manner. All patients were operated on in the acute phase of fracture within five days after trauma. Patients were treated with open reduction and internal fixation using pre-contoured plates. The technique and the implant used were the same, but the time of immobilization and rehabilitation protocol were individualized for each patient according to physical activity. Mean follow-up was 16.8 months (6–48 months), with return to sport activities in 45.6 days. **Results:** Functional assessment was performed using the University of California at Los Angeles (UCLA) score. The results averaged 34.07 of 35 points. No cases presented nonunion. Only one complication was observed (thrombosis of the subclavian vein with good response to conservative treatment); two patients required implant removal.

Conclusion: The surgical treatment of clavicle fractures in athletes presented satisfactory functional outcome and early return sport.

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☆ Study conducted at Centro de Traumatologia do Esporte, Departamento de Ortopedia e Traumatologia, Universidade Federal de São Paulo, São Paulo, SP, Brazil.

* Corresponding author.

E-mail: dr.nasouza@gmail.com (N.A. Souza).

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Fratura do terço médio da clavícula em atletas – Devemos operar?

R E S U M O

Palavras-chave:
Fraturas ósseas
Clavícula
Placas ósseas
Atletas

Objetivo: Avaliar os resultados do tratamento de fraturas do terço médio da clavícula com placas pré-contornadas em atletas.

Métodos: Os autores fizeram 26 osteossínteses em 25 pacientes com fratura do terço médio da clavícula. As fraturas foram classificadas de acordo com Robinson como tipo 2B1 (16) e tipo 2B2 (dez). A média de idade foi de 37,6 anos, entre 15 e 63; 20 pacientes eram do sexo masculino e cinco do feminino, todos praticantes de alguma atividade esportiva de forma amadora ou profissional. Todos os pacientes foram tratados com redução aberta e fixação interna com placas pré-contornadas na fase aguda da fratura, dentro de, no máximo, cinco dias após o trauma. A técnica usada e o implante foram os mesmos para todos os pacientes, mas o tempo de imobilização e o protocolo de reabilitação foram individualizados para cada paciente, de acordo com a atividade física. A média do seguimento foi de 16,8 meses (6-48), com liberação para atividade esportiva com média de 45,6 dias.

Resultados: A avaliação funcional foi feita através do escore da Universidade da Califórnia em Los Angeles (UCLA). Os resultados tiveram como mediana 34,07 de 35 pontos. Nenhum caso apresentou pseudartrose. Apenas uma complicação (trombose da veia subclávia com boa resposta ao tratamento conservador) foi observada; dois pacientes necessitaram remoção do implante.

Conclusão: O tratamento cirúrgico das fraturas da clavícula em atletas apresentou resultado funcional satisfatório e retorno precoce ao esporte.

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Introduction

The clavicle is the tenth most common fracture site, accounting for 2.6–5% of all fractures.¹⁻³ The estimated incidence of clavicle fractures in the United States is 24.4 per 100,000 person-years. The main causal factor is sports activity, accounting for 45% of all clavicle fractures.⁴

The substantial increase in the number of athletes in the last decades, associated with the great diversity of sports activities and the intensity at which these are practiced, has generated an increase in the incidence of this type of fracture.^{4,5} Court-Brown and Caesar³ indicated that 12.8% of all fractures, regardless of location, were associated with sports trauma.

Clavicle fractures can be divided according to the region affected as middle third, medial third, and lateral third. The middle third accounts for 69–82% of all clavicle fractures.^{1,5}

In general, the treatment of middle third clavicle fractures is conservative, with satisfactory results.⁶⁻⁸ The main indications for surgical treatment during the acute phase are: deviation or shortening greater than 1.5–2.0 cm between the bone fragments; exposed fractures or at-risk of exposure; neurovascular injury; floating shoulder; and polytraumatized patients.⁶

The main advantages of surgical treatment are the significantly lower rate of malunion and pseudoarthrosis, as well as earlier functional return when compared with conservative treatment.^{6,7}

This study is aimed at presenting the results of the surgical treatment of clavicle fractures with pre-contoured plates in professional or amateur athletes.

Material and methods

Between March 2010 and October 2013, the authors performed 26 osteosyntheses in 25 patients with fractures of the middle third of the clavicle (two were performed in the same patient, but in different events, on different shoulders).

The inclusion criteria were closed fractures of the middle third of the clavicle, without neurovascular deficit, with deviation between the fragments or angulation without bone contact, in professional or amateur athletes who aimed an early return to their sport activities. The minimum follow-up time was six months. All patients underwent surgery in less than five days after trauma.

For diagnostic verification and surgical programming, radiographs in anteroposterior (AP) and lateral views were performed, as well as a AP cephalic 20° angulation view, when deemed necessary (Fig. 1).

By the Robinson classification, 16 fractures were type 2B1 and ten, type 2B2. Only seven fractures (26.9%) were simple fractures; nine were with wedge comminution (34.6%), and ten had at least three fragments (38.4). The mean age was 37 years (range: 15–63); 20 patients were male and five were female (Table 1).

The technique used was open reduction with internal fixation with an Acumed pre-contoured plate (Hillsboro, OR, USA). The plates were positioned on the superior aspect of the clavicle. Fixation was performed with at least three medial screws and three lateral screws. At least two cortical screws were used; the first screw proximal to the fracture and the second, lateral. The fixation was completed, preferably, with locking screws. In eight cases, anchor fixation was



Fig. 1 – Radiograph of left clavicle after a cycling accident.

Table 1 – Patient gender and fracture laterality.

Type of fracture	n (%)
2B1	16 (61.5)
2B2	10 (38.5)
Gender	
Male	21 (80.7)
Female	5 (19.3)
Laterality	
Right	13 (50)
Left	13 (50)

done with unabsorbable high-resistance polyethylene fiberwire (FiberWire[®], Arthrex Inc., Naples, FL, USA) after plaque fixation (Figs. 2 and 3).

Patients were reassessed one week postoperatively, and thereafter every two weeks until medical discharge. All shoulders were immobilized in a simple sling immediately after surgery; patients underwent supervised rehabilitation three times a week with passive mobilization during the first week

and active mobilization after the 15th postoperative day. A single rehabilitation protocol was used in the first 21 days; after that period, the rehabilitation was individualized and intensified according to the patients' tolerance, aiming for a faster return to sports activity. This return did not depend on radiographic consolidation, but rather was allowed after the patient was able to perform a complete range of motion without pain and the force test presented a result similar to that of the contralateral shoulder through the use of a manual dynamometer.

A significant difference was observed regarding time to return to sports activity, with a mean of 45.6 days. Two athletes returned to sports even without medical clearance, at 17 and 20 days, respectively (Table 2).

The mean follow-up was 16.8 months (6–48).

Results

The three-month radiographic control showed no loss in fracture reduction, signs of pseudoarthrosis, or implant failures in any of the osteosyntheses.



Fig. 2 – Transoperative image of the left shoulder after osteosynthesis with locking plate and suture with high-resistance fiberwires.

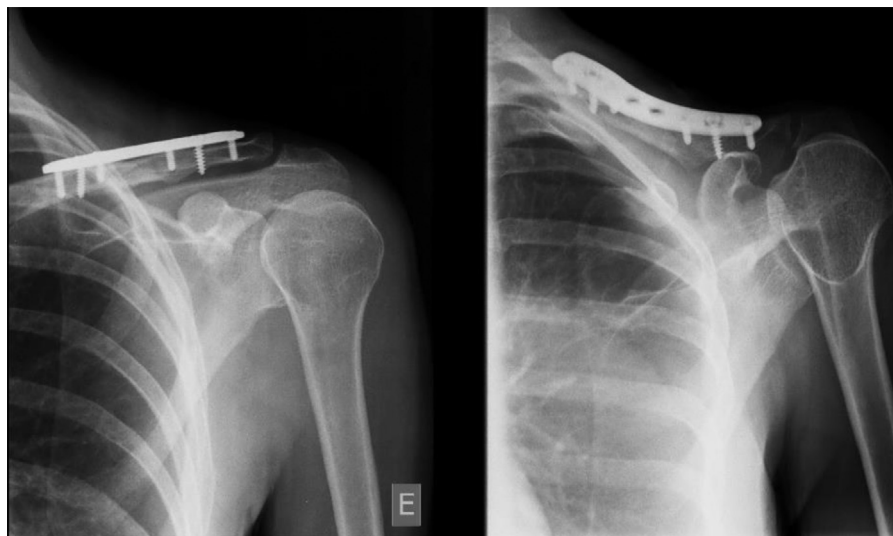


Fig. 3 – Postoperative radiograph of the left clavicle.

Table 2 – Sport practiced, time of return to sports, and number of practitioners.

Sport practiced	No. of practitioners	Time of return to sports
Motorcycle racing	8 (30.7%)	17–89 (46)
Triathlon	4 (15.3%)	30–50 (42.5)
Cycling	3 (11.5%)	25–62 (48.6)
Mountain biking	3 (11.5%)	25–90 (50)
Running	3 (11.5%)	40–91 (64)
Soccer	1 (3.9%)	25
Basketball	1 (3.9%)	45
Gymnastics	1 (3.9%)	30
Golf	1 (3.9%)	25
Skiing	1 (3.9%)	60
Total	26	–45.6

There were no superficial or deep infections, and no healing problems were observed during clinical follow-up. The loss of sensation observed in one case was minimized by careful dissection of the cutaneous branches of the supraclavicular nerve. Only two patients (7.7%) underwent implant removal; one patient presented skin discomfort and another patient had an esthetic complaint and expressed the desire to remove the implant.

Only one (3.8%) complication was observed: thrombosis of the left subclavian vein, which presented good response to conservative treatment. The patient returned to the sport (motorcycle racing) 70 days after the fixation, without functional restriction.

Most patients (19; 73%) were authorized to return to sports activity after 21–60 days.

Functional assessment was performed using the University of California at Los Angeles (UCLA) score, applied from the third week onwards, with successive evaluations every two weeks during rehabilitation. The mean and standard deviation of the UCLA score were, respectively, 34.07 and 0.61. The score obtained by the patient was classified as follows: 34–35 points, excellent results, and 28–33 points, good; no poor results were observed.

Immediately after the medical discharge, 24 (92.3%) patients presented excellent and two (7.7%), good results; no poor results were found.

Discussion

The indication for surgical treatment in cases of fractures of the middle third of the clavicle should be individualized for athlete patients. In 2007, a multicenter article from the Canadian Society of Orthopedic Trauma compared functional outcomes and complications between conservative and surgical fracture treatment in 138 patients (not necessarily athletes), confirming the superiority of osteosynthesis over conservative management in patients presenting deviated fractures, with less time of radiographic consolidation, a lower rate of pseudarthrosis, and better DASH and Constant scores.⁹

The authors chose to use pre-contoured plates, because biomechanical studies have demonstrated their superiority in comparison with traditional reconstruction plates and dynamic compression plates (DCP) regarding initial rigidity, load of rupture, torsion, and flexion with support in three

points in repeated cycles.^{10–12} The choice of the superior positioning of the implant was based on biomechanical superiority when compared with the anteroinferior position, because the support surface is in the tension area and has a greater resistance momentum, due to the greater distance from the lower cortex; moreover, it allows the use of larger implants and screws.^{11–13} On the other hand, the anteroinferior position presents a lower rate of reoperation due to skin irritation and lower risk of iatrogenic injury.^{14,15}

Özler et al. reported good results in a series of 16 patients with a minimum follow-up of one year and use of locking plates, but who only returned to their activities six weeks after osteosynthesis.¹⁶ Patients were not necessarily athletes; the authors aimed at reporting the good results obtained, with a low rate of skin irritation and pseudarthrosis even with early mobilization.

In a study in semiprofessional athletes, surgical wound infection was the most frequent complication (18% of cases), and the refractive index was 5%. In 90% of cases, radiographic consolidation was observed in 12 weeks.¹⁷ In the present study, even with early release for sports activity, no patients presented surgical wound infection, pseudarthrosis, delayed bone union, or refracture. The radiographic evaluation at 12 weeks demonstrated bone healing in all patients.

Meisterling et al. analyzed 29 athletes who underwent osteosynthesis of the middle third of the clavicle with a locking plate and obtained results similar to those presented in this study.¹⁸ However, they considered return to sports as the return to any previous activity practiced by the athlete, not necessarily his main activity.

The present experience of fixation with pre-contoured plates in athletes presented convincing results. The authors believe that the sequential and individualized assessment helped in the earlier return to sports activity. Although all patients returned to the sports activity before bone healing, no cases of loss of fracture reduction or osteosynthesis failure were observed. The low complication rate and the early return to sports (mean: 45.6 days) were promising. Early fixation of the fracture in athletes results in good indexes by the UCLA score, and osteosynthesis results in less pain, which generates more comfort and confidence for patients in relation to conservative treatment.⁹

The main limitations of the study are the following: relatively small number of patients analyzed, lack of a control group, and lack of accurate information on the athletes' performance in the first postoperative competition, especially in the case of professional athletes.

Conclusion

Surgical treatment of clavicle fractures in athletes is an efficient and safe technique, allowing an early return to sports; it is the authors' first treatment option in this group of patients.

Conflicts of interest

The authors declare no conflicts of interest.

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REFERENCES

1. Postacchini F, Gumina S, De Santis P, Albo F. Epidemiology of clavicle fractures. *J Shoulder Elbow Surg.* 2002;11(5):452-6.
2. Nordqvist A, Petersson C. The incidence of fractures of the clavicle. *Clin Orthop Relat Res.* 1994;(300):127-32.
3. Court-Brown CM, Caesar B. Epidemiology of adult fractures: a review. *Injury.* 2006;37(8):691-7.
4. Van Tassel D, Owens BD, Pointer L, Moriatis Wolf J. Incidence of clavicle fractures in sports: analysis of the NEISS Database. *Int J Sports Med.* 2014;35(1):83-6.
5. Robinson CM. Fractures of the clavicle in the adult. Epidemiology and classification. *J Bone Joint Surg Br.* 1998;80(3):476-84.
6. van der Meijden OA, Gaskill TR, Millett PJ. Treatment of clavicle fractures: current concepts review. *J Shoulder Elbow Surg.* 2012;21(3):423-9.
7. Khan LA, Bradnock TJ, Scott C, Robinson CM. Fractures of the clavicle. *J Bone Joint Surg Am.* 2009;91(2):447-60.
8. Sirvent-Díaz E, Calmet-García J, Capdevila-Baulenes J. Fracturas de clavícula tratadas conservadoramente tras 22 años de seguimiento: resultados funcionales y estéticos. *Rev Esp Cir Ortop Traumatol.* 2014;58(2):108-13.
9. Canadian Orthopaedic Trauma Society. Nonoperative treatment compared with plate fixation of displaced midshaft clavicular fractures. A multicenter, randomized clinical trial. *J Bone Joint Surg Am.* 2007;89(1):1-10.
10. Eden L, Doht S, Frey SP, Ziegler D, Stoyhe J, Fehske K, et al. Biomechanical comparison of the Locking Compression superior anterior clavicle plate with seven and ten hole reconstruction plates in midshaft clavicle fracture stabilisation. *Int Orthop.* 2012;36(12):2537-43.
11. Demirhan M, Bilsel K, Atalar AC, Bozdog E, Sunbuloglu E, Kale A. Biomechanical comparison of fixation techniques in midshaft clavicular fractures. *J Orthop Trauma.* 2011;25(5):272-8.
12. Celestre P, Roberston C, Mahar A, Oka R, Meunier M, Schwartz A. Biomechanical evaluation of clavicle fracture plating techniques: does a locking plate provide improved stability? *J Orthop Trauma.* 2008;22(4):241-7.
13. 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(5):457-62.
14. Formaini N, Taylor BC, Backes J, Bramwell TJ. Superior versus anteroinferior plating of clavicle fractures. *Orthopedics.* 2013;36(7):e898-904.
15. 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(10):680-6.
16. Ozler T, Güven M, Kocadal AO, Uluçay C, Beyzadeolu T, Altýntaş F. Locked anatomic plate fixation in displaced clavicular fractures. *Acta Orthop Traumatol Turc.* 2012;46(4):237-42.
17. Verborgt O, Pittoors K, Van Glabbeek F, Declercq G, Nuyts R, Somville J. Plate fixation of middle-third fractures of the clavicle in the semi-professional athlete. *Acta Orthop Belg.* 2005;71(1):17-21.
18. Meisterling SW, Cain EL, Fleisig GS, Hartzell JL, Dugas JR. Return to athletic activity after plate fixation of displaced midshaft clavicle fractures. *Am J Sports Med.* 2013;41(11):2632-6.