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Original article

Evaluation of the results from surgical treatment of fractures of the lateral extremity of the clavicle, using the double ligature technique☆

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ABSTRACT

Objective: To evaluate the incidence of consolidation in surgical treatment of fractures of the lateral extremity of the clavicle using the double subcoracoid ligature technique, with nonabsorbable No. 5 thread.

Methods: Between May 1993 and June 2013, the Shoulder and Elbow Group of our service surgically treated 116 patients (116 shoulders) with fractures of the lateral extremity of the clavicle. Among these, we were able to reassess 65 cases. The surgical technique used consisted of double subcoracoid ligature with two nonabsorbable threads. In two patients classified as type III, we had to combine this technique with use of an interfragmentary screw for fixation of the intra-articular portion of the acromioclavicular joint.

Results: We achieved fracture consolidation in 90%. Fourteen cases (21%) evolved with major complications: four cases of pseudarthrosis, five of adhesive capsulitis, two of delayed consolidation and three of loss of reduction. Two cases (3%) evolved with minor complications of skin granuloma.

Conclusion: The double ligature technique for fractures of the lateral extremity of the clavicle promotes the stabilization needed for consolidation to take place, without the need for synthesis using metal components. It avoids reoperation for the synthesis material to be removed. Moreover, it is a low-cost procedure with good reproducibility and preservation of the acromioclavicular joint.

☆ Work developed in the Shoulder and Elbow Group, Department of Orthopedics and Traumatology, Faculdade de Ciências Médicas da Santa Casa de São Paulo (FCMSCSP), Pavilhão Fernandinho Simonsen, São Paulo, SP, Brazil.

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Avaliação dos resultados do tratamento cirúrgico das fraturas da extremidade lateral da clavícula pela técnica do amarrilho duplo

Palavras-chave:
Fraturas ósseas
Clavícula
Articulação acromioclavicular

RESUMO

Objetivo: Avaliar a incidência de consolidação do tratamento cirúrgico nas fraturas da extremidade lateral da clavícula pela técnica do duplo amarrilho subcoracóideo com o uso de fio inabsorvível número 5.

Métodos: Entre maio de 1993 e junho de 2013, o Grupo de Ombro e Cotovelo do nosso serviço tratou cirurgicamente 116 pacientes (116 ombros) com fratura da extremidade lateral da clavícula. Desses, conseguimos reavaliar 65. A técnica cirúrgica usada foi o amarrilho duplo subcoracóideo com dois fios inabsorvíveis. Em dois pacientes classificados como tipo III tivemos de associar um parafuso interfragmentário para fixação da porção intra-articular da AC.

Resultados: Tivemos 90% de consolidação da fratura; 14 casos (21%) evoluíram com complicações maiores: quatro pseudoartroses, cinco capsulites adesivas, dois retardos de consolidação e três perdas de redução; e dois casos (3%) evoluíram com complicação menor: granuloma de pele.

Conclusão: A técnica do amarrilho duplo para as fraturas da extremidade lateral da clavícula promove a estabilização necessária para que haja consolidação sem necessidade de síntese metálica; evita reoperações para retirada do material de síntese; além de ser um procedimento de baixo custo, com boa reprodutibilidade e preservação da articulação acromioclavicular.

Introduction

Allman divided fractures of the clavicle into three groups based on anatomy and injury mechanisms.[1] Fractures located in the middle third (group I) are the most frequent type, account for around 80% of the cases and especially among young adults. Fractures located at the lateral extremity of the clavicle (group II) account for around 15–25%, while only around 5% occur in the proximal third (group III).[2–4] Fractures of the lateral extremity of the clavicle are classified based on whether the coracoclavicular ligaments are intact and on the impairment of the acromioclavicular joint. This classification was first described by Neer and was subsequently complemented by Craig.[5,6]

According to Edwards et al.[7] and Anderson,[8] surgical treatment is indicated in situations of displaced fractures of the lateral extremity of the clavicle because of the high risk of non-consolidation, which may affect around 30% of these patients. This morbidity is attributed partly to the shearing forces between the fragments, which contributes toward non-consolidation of the fracture.[9]

There is no standardized method for surgical treatment of fractures of the lateral extremity f the clavicle.[10] Several techniques have been described in the literature, consisting of using a screw,[11] fixation with metal wires,[12,13] fixation with a hook plate,[14] fixation with a specific locking Plate[15] or use of cerclage.[10,16] According to Neer,[16] the cerclage technique with double binding between the clavicle and the coracoid process indirectly promotes reduction and stabilization of the fracture, with minimal periosteal injury. Once consolidation has been achieved, the acromioclavicular ligaments (especially the upper one) are sufficient for maintaining the suspensor mechanism of the shoulder.[11,16,17]

The present study had the aim of evaluating the incidence of consolidation following surgical treatment by means of the subcoracoid double-binding technique, using nonabsorbable No. 5 thread, in cases of fractures of the lateral extremity of the clavicle.

Sample and methods

Between May 1993 and June 2013, 116 patients (116 shoulders) with fractures of the lateral extremity of the clavicle were treated surgically by the shoulder and elbow group of our service. Among these patients, 93 underwent the double-binding technique. We were able to reassess 65 of these patients from their medical files and radiographic images (Table 1).

The inclusion criterion was that all the patients needed to have presented fractures of the lateral extremity of the clavicle and needed to have undergone surgical treatment by means of the double-binding technique, with postoperative follow-up for a minimum of six months.

Patients presenting the following were excluded: fractures of the middle or proximal thirds of the clavicle; fractures in diseased bones; previous injuries or factures of the shoulder or the ipsilateral upper limb; associated neurovascular injuries; or follow-up shorter than what was established.

The patients were followed up as outpatients for a mean period of 11.64 months (range: 6–180). The mean length of time between the dates of the trauma and the surgery was 7.6 days, with a range from one to 21 days (Table 1).

Table 1 – General data on the patients with fractures of the lateral extremity of the clavicle who underwent the double-binding technique.

Sex	Age	Dom.	Class	ΔT	TM	Cons.	FU	Surgery
M = 50 (77%)	14–83 mn = 37.7	D = 37 (57%)	II = 42 (65%)	1–19 mn = 7.6	HE = 48 (74%)	C = 59 (90.7%)	3–180 mn = 11.6	Cerclage alone = 63 (97%) IFS = 2 (3%)
F = 15 (23%)		ND = 28 (43%)	III = 06 (9%) IV = 01 (1.5%) V = 16 (24.5%)		LE = 17 (26%)	NC = 06 (9.3%)		

M, male; F, female; age, in years; mn, mean; Dom., dominance; D, dominant; ND, non-dominant; Class, classification; ΔT, time interval between trauma and surgery in days; TM, trauma mechanism: HE, high energy; LE, low energy; Cons., consolidation; C, consolidated; NC, non-consolidated; FU, length of follow-up in months; IFS, association with interfragmentary screw.

The patients' ages ranged from 14 to 83 years (mean of 37.7). There were 50 male patients (77%) and 15 female patients (23%). The dominant limb was affected in 37 cases (57%) (Table 1).

In relation to the trauma mechanism, 74% (48 cases) were due to high-energy trauma and 26% (17 cases) to low-energy trauma (Table 1).

Using the Craig classification, the patients were grouped as follows: 42 cases of type II (65%), six of type III (9%), one of type IV (1%) and 16 of type V (25%) (Table 1).

The surgical procedure was performed with the patient in the deckchair position. We used a saber-cut incision located medially to the fracture line. We opened the deltotrapezial fascia to expose the focus of the fracture and the coracoid process, without viewing the acromioclavicular joint. We made a central orifice in the clavicle, 2 cm medially to the fracture. We passed two nonabsorbable no. 5 threads under the coracoid process and through this orifice. We reduced the fracture by means of a maneuver to lower the proximal portion of the clavicle and the suspension of the lateral extremity of the clavicle, with compression of the ipsilateral elbow, and then tied the threads separately to the clavicle (Fig. 1). The knots were directed toward the coracoid process so as to avoid bulges under the skin. In two patients who were classified as type III, we had to use an interfragmentary screw in association with this procedure, to achieve fixation of the intra-articular portion of the acromioclavicular joint (Fig. 2).

During the postoperative period, the patients were immobilized until fracture consolidation had been achieved (approximately six to eight weeks). During this period, the only movements allowed were lateral rotation of the shoulder and flexion-extension of the elbow with the arm alongside the trunk. After consolidation had been confirmed radiographically, the patients were allowed to make movements in all planes and to gradually return to their usual activities. All the patients were evaluated radiographically during the postoperative period.

Descriptive analysis was performed by constructing frequency tables and graphs showing the data. Since the sample resulted in groups for each variable of interest that were of very small size, only nonparametric hypothesis tests were used, with a significance level of 5%. Thus, hypotheses for which the tests presented a descriptive level (p-value) lower than 0.05 were rejected.

To test the independence between pairs of random variables, the Fisher test was used, based on hypergeometric distribution. To test whether there was any difference between the means of pairs of groups, the Mann–Whitney test was used. To test the equality between more than three means, Kruskal–Wallis analysis was used. The analysis was done with the aid of the Minitab® statistical software, version 16.

This study was approved by our institution's research ethics committee, under no. 14312013.0.0000.5479.

Results

We found that consolidation of the lateral extremity of the clavicle occurred in 59 of the 65 cases (90%).

Because of the small number of patients in whom consolidation of the fracture did not occur, distributed between the different subgroups of the classification, it was not possible to performed independence tests between the consolidation and classification variables. However, in observing the proportions of this occurrence, we noted that among all the fractures that did not consolidate, 67% (11) were of type II and 33% (four) were of type V. Among those that consolidated, 64% (31) were of type II and 24% (12) were of type V (Table 1).

The total number of complications was 16 (24%). We divided the complications into major and minor types. They were considered to be major if they influenced the functional result. There were 14 cases (21%) of major complications: four with pseudarthrosis, five with adhesive capsulitis, two with delayed consolidation and three with loss of reduction. There were also two cases (3%) of minor complications, consisting of skin granuloma (Table 2).

In the statistical analysis, we were unable to detect any relationship between the trauma mechanism and consolidation ($p = 0.648$) or between sex and consolidation ($p = 1.000$). There were also no statistically significant differences between the means for the time interval between

Table 2 – Description of the complications.

Adhesive capsulitis	5 (31.2%)
Granuloma	2 (12.5%)
Delayed consolidation	2 (12.5%)
Loss of reduction	3 (18.8%)
Pseudarthrosis	4 (25%)
Total	16

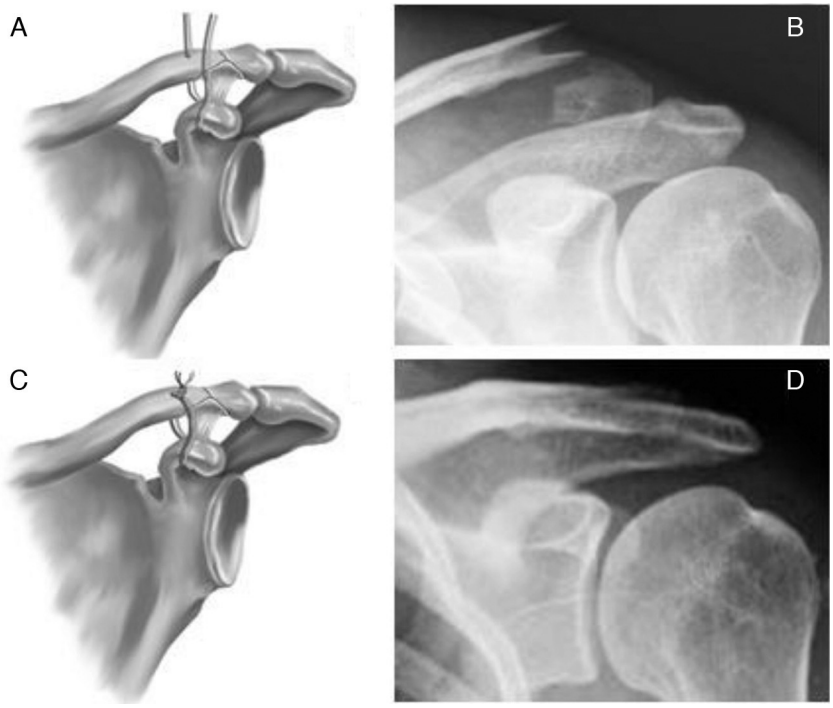

Fig. 1 – (A) Illustration demonstrating fracture of the lateral extremity of the clavicle; (B) radiographic image of the left shoulder, in Zanca view, showing fracture of the lateral extremity of the clavicle; (C) illustration of the surgical technique of double binding; (D) radiographic image of the left shoulder, in Zanca view, showing consolidation of the fracture after binding.

trauma and surgery, for any of the following pairs of groups: with and without consolidation (with consolidation, 7.8 days, versus without consolidation, 5.3 days; $p = 0.351$); or with and without complications (with complications, 6.2 days, versus without complications, 8.1 days; $p = 0.313$).

There were statistically significant differences between the means for ages, for the following pairs of groups: with and without consolidation (with consolidation, 36.3 years, versus without consolidation, 51.3 years; $p = 0.048$); and with and without complications (with complications, 45.7 years, versus without complications, 35.1 years; $p = 0.011$). The ages were greater when there was no consolidation and when there were complications.

Discussion

Reconstruction of the suspensor mechanism of the shoulder can be done directly, by means of osteosynthesis between the bone fragments,[5,14,15,18–20] or indirectly, by means of synthesis between the clavicle and the coracoid process, either using a screw[11] or using cerclage.[10,16] There are also different techniques in relation to the access route, which can be for either open or arthroscopic procedures.[21,22] These techniques bring together the bone fragments and enable fracture consolidation. After this has been achieved, the acromioclavicular ligaments (especially the upper one) are

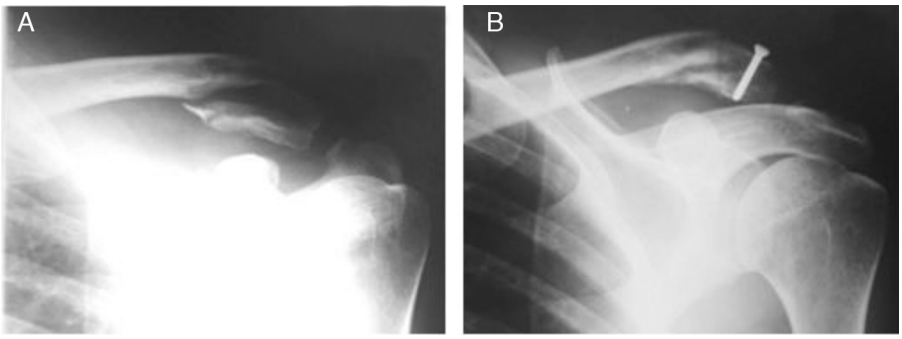

Fig. 2 – Radiographic images of the left shoulder, in Zanca view. (A) Fracture of the lateral extremity of the clavicle, type III; (B) image showing use of interfragmentary screw (in association with the double-binding technique) for intra-articular fixation of the fracture.

Fig. 3 – Radiographic images of the left shoulder. (A) Fracture of the lateral extremity of the clavicle; (B) non-consolidation after initial surgical treatment using double binding; (C) consolidation of the fracture after second procedure using locking plate.

sufficient for maintaining the suspensor mechanism of the shoulder.[11,16,17]

The various surgical techniques for treating fractures of the lateral extremity of the clavicle are not free from post-surgical complications. Leppilahti and Jalovaara reported that the technique that uses fixation with metal wires is associated with migration of the wire and infection of the pin pathway.[12] Shin et al.[13] reported that the clavicle underwent erosion caused by the suturing material, during the reconstruction of the coracoclavicular ligaments in 11% of the cases. These complications were not observed in our sample.

Klein et al.[14] observed that with the hook plate technique, despite positive results regarding bone consolidation (94.7%) and patient rehabilitation, complications occurred in 15.8% of the cases and comprised infections, fracturing around the implant and failure of the synthesis material. This made it necessary to perform a second procedure to remove the implants, so that the subacromial impact and risk of fracturing the acromion would be reduced.

Andersen et al.[15] retrospectively evaluated 16 patients who had undergone fixation by means of a locking place for the lateral extremity of the clavicle and found that the consolidation rate was 94%. They reported that there were two cases of complications: one of infected pseudarthrosis and one of fracturing around the implant.

With regard to other fixation methods described previously, we did not see any reason to use them, given that the double-binding technique is simpler and cheaper, has fewer complications and does not require a second procedure to remove the synthesis material.

Yang et al.[10] conducted a retrospective study in which the technique applied was similar to that used among our patients, but with bands of nonabsorbable material and without performing ligament repair or using implants. They showed a consolidation rate of 100% (29 patients). However, some cases of complications were observed: adhesive capsulitis (one case) and discomfort on the skin caused by bulging of the suturing knot (one case). We had complications similar to those of Yang et al.[10] Five patients presented adhesive capsulitis and underwent conservative treatment by means of serial blocks of the suprascapular nerve.[23] These patients evolved with consolidation of the fracture. Another two patients evolved with superficial granuloma and were treated satisfactorily by means of cleaning, debridement and removal of the suturing thread from the skin.

The two patients who evolved with delayed consolidation did not require any other surgical procedure. They evolved to fracture consolidation within 10 months and reached a normal range of motion, in relation to their contralateral side.

In the three cases in which there was loss of reduction, one of them consolidated satisfactorily, despite skewed consolidation of the fragments, while the other two had to undergo a second procedure, 15 days and one month after the first surgery. These cases required new binding, performed in association with fixation by means of Kirschner wires. They evolved with consolidation of the fracture and good range of motion.

In our sample, 10% of the cases did not attain fracture consolidation (four patients). One of these patients presented clinical asymptomatic pseudarthrosis and it was decided to simply monitor the patient: a good functional result was seen. Three patients underwent a second surgical procedure. One of them received a locking plate for the lateral extremity of the clavicle, in association with a bone graft. Another case only received a locking plate for the lateral extremity of the clavicle (Fig. 3). The third case was treated using a combination of a Kirschner wire and a bone graft. These reoperated patients achieved fracture consolidation, with good functional results. Out of the 19 patients evaluated by Shin et al.,[13] only one (5%) evolved with symptomatic pseudarthrosis. This patient subsequently underwent resection of the distal fragment of the fracture.

We observed that the younger patients had fewer complications and that their fractures consolidated better, in comparison with the older patients. This result may have been due to the bone quality and better formation of bone callus.

Conclusion

We achieved a consolidation rate of 90% through using the double-binding technique for cases of fractures of the lateral extremity of the clavicle.

Age was the only statistically significant variable in relation to the consolidation results from these cases of fractures of the lateral extremity of the clavicle that underwent the

double-binding technique, with greater mean age in the cases without consolidation (51.3 years).

Conflicts of interest

The authors declare no conflicts of interest.

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