Clinical Evaluation of the Surgical Treatment of Midshaft Clavicle Fractures at a Hospital in the South of Santa Catarina*

Avaliação clínica do tratamento cirúrgico das fraturas do terço médio da clavícula em um hospital do sul de Santa Catarina

Fernando H.S. Hehn[1] Paola S.G. Bonavides[1] Aloir N. Oliveira Júnior[1] Helena C.G. Silva[1,2] Martins Back Neto[2] Willian N. Stipp[2]

[1] Faculdade de Medicina, Universidade do Sul de Santa Catarina (Unisul), Tubarão, SC, Brazil
[2] Department of Orthopedics and Traumatology, Hospital Nossa Senhora da Conceição, Tubarão, SC, Brazil

Address for correspondence Fernando H.S. Hehn, MD, Rua Simeão Esmeraldino de Menezes 138, apto. 202/2, Dehon, Tubarão, SC, Brasil, CEP: 88704-090 (e-mail: sauerh@gmail.com).

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Abstract

Objective To evaluate the results of the surgical treatment of fractures of the middle third of the clavicle.

Methods A retrospective cross-sectional study, in which 36 patients who suffered fractures of the middle third of the clavicle and who were surgically treated from January 2012 to February 2017 were evaluated. They were evaluated for types of fracture, age, smoking, osteosynthesis material, and Constant-Murley and Modified-University of California at Los Angeles Shoulder Rating Scale (UCLA-M) scores.

Results The mean Constant-Murley and UCLA-M scores were 91.59 and 31.29 respectively. The mean age was 37.62 years, and it was statistically related to the type of osteosynthesis ($p < 0.05$), but the osteosynthesis material did not show significance with the improvement in the rates of the functional scores.

Conclusion The surgical treatment provides good functional results after diaphyseal fractures of the clavicle, regardless of the line of the fracture, with a low rate of pseudarthrosis.

Keywords
- clavicle/surgery
- treatment outcome
- fractures, bone

Resumo

Objetivo Avaliar o resultado do tratamento cirúrgico de fraturas do terço médio da clavícula.

Métodos Estudo tranversal retrospectivo, em que foram avaliados 36 pacientes que sofreram fratura do terço médio da clavícula, que foram tratados cirurgicamente no período de janeiro de 2012 a fevereiro de 2017. Eles foram avaliados quanto aos tipos

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de fratura, idade, tabagismo, material de síntese, e escores de Constant-Murley e Modified-University of California at Los Angeles Shoulder Rating Scale (UCLA-M).

Resultados As médias dos escores de Constant-Murley e UCLA-M foram de 91,59 e 31,29, respectivamente. A idade média foi de 37,62 anos, e apresentou relação estatística com o tipo de síntese ($p < 0,05$), mas o material de síntese não apresentou significância com a melhora de pontuação dos escores funcionais.

Conclusão O tratamento cirúrgico ocasiona bons resultados funcionais após a fratura diafisária de clavícula, independente do traço da fratura, com baixa taxa de pseudoartrose.

Palavras-chave
- clavícula/cirurgia
- resultado do tratamento
- fraturas ósseas

Introduction

Clavicle fractures account for 2.6 to 10% of all adult fractures, and for up to 44% of shoulder girdle fractures, with the most common location being the middle third.[1,2] They are 3 times more common in men and have 2 peaks: in men under the age of 25 and in women over the age of 60.[3,4] The main causes are direct trauma, falls from standing height and car accidents, the latter being the most common.[5]

Historically, fractures have been treated conservatively, with a sling or figure-of-eight bandages, regardless of their deviation. This approach was guided by two studies from the 1960s that stated that, this way, the rate of pseudarthrosis was lower than 1%. Surgical treatment was considered only if the fracture was exposed and there was an imminent risk of skin damage caused by the bone fragment, floating shoulder or neurovascular injury.[6,7]

However, recent evidence casts doubt over whether most of these fractures should be treated conservatively, as new data show that the non-surgical option causes more complications than previously reported. In addition, the conservative treatment may result in a non-esthetic appearance due to the possibility of shortening of the clavicle and of the formation of an exuberant bone callus, situations that surgery can prevent.[8]

The surgical treatment results in better short-term functional outcomes, shorter consolidation time and faster return to work.[2,9] There are three main options for the surgical management: plate with screws, intramedullary fixation, and external fixation, but plate fixation is the standard technique for this approach.[10] There are several synthesis options using plates, such as the dynamic compression plate (DCP), the reconstruction plate, and locked plates.[11] However, this method is not devoid of complications, such as surgical wound infection, hypertrophic scar, prominence of the synthesis material, and the need for reoperation to remove the material.[8,12]

Therefore, due not only to the high incidence of clavicle fractures, and to the impact caused by the removal from social and work activities, but also mainly due to the lack of unanimity as to the best treatment, the present study has the goal of performing an evaluation of the outcome of the surgical treatment of clavicle shaft fractures in order to add information to the existing literature.

Materials e Methods

The present study was conducted at the Orthopedics Outpatient Clinic of Hospital Nossa Senhora da Conceição (HNSC), in the city of Tubarão, in the State of Santa Catarina, Southern Brazil, after approval by the Ethics in Research Committee of Universidade do Sul de Santa Catarina (UNISUL), following the guidelines and regulatory standards of scientific research, under resolution CNS 466/12, approved under registration CAAE 62460816.3.0000.5369.

The present is an observational cross-sectional study that included patients who suffered fractures of the middle third of the clavicle, who were surgically treated at the same department and by the same surgeon from January 2012 to February 2017, and who signed a free and informed consent form (ICF). Patients who did not return to the clinic and who already had any previous diseases, neurological sequelae or surgery on the affected limb were excluded from the study. The total study population consisted of 55 patients.

The patients underwent three questionnaires: the Constant-Murley (CM) score and the Modified-University of California at Los Angeles Shoulder Rating Scale (UCLA-M), both validated for the Brazilian reality,[13,14] and a questionnaire asking general information such as age, gender, trauma mechanism, fracture side, fracture type, type of synthesis, fracture time, complications and smoking.

Data were entered into Excel (Microsoft, Redmond, WA, US), version 14.0.0, spreadsheets and processed and analyzed using the Statistical Package for the Social Sciences (SPSS, IBM Corp., Armonk, NY, US) software, version 20.0. Descriptive analysis – mean and standard deviation –, numeric variables and frequency were used for the categorical variables. Statistical tests: Chi-squared for the categorical variables, and Student *t*-test and analysis of variance (ANOVA) for the numerical variables, as needed. The significance level adopted was of 5%.

Results

The population consisted of 36 of the 55 projected patients who suffered fractures of the middle third of the clavicle at the HNSC. Out of the 36 patients who returned for clinical evaluation, 2 cases were excluded from the study because they were initially treated conservatively, but evolved with

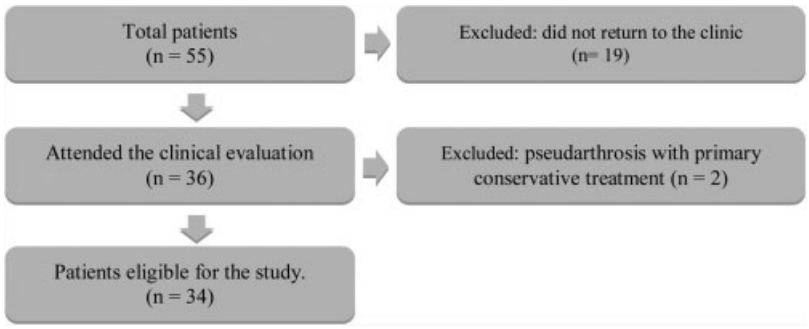

Figure 1 Flowchart of the sample relationship of the patients, from the recruitment to the evaluation for the study.

pseudarthrosis and were surgically approached due to this complication. The other 19 patients were lost to outpatient follow-up, and could not be contacted to have their return requested. Such information is described in ►**Figure 1**.

There was a predominance of males, with age ranging from 21 to 30 years old, mostly non-smokers, whose fracture type was comminuted, and the osteosynthesis was performed with the DCP plus screws. The mean age of the patients was 37.62 ± 13.49 years old, with a minimum age of 18 years and a maximum age of 63 years. Additional data on the profile of the patients who suffered fractures of the middle third of the clavicle in the city of Tubarão are described in ►**Table 1**.

In ►**Table 2**, the mean, maximum and minimum values of the CM and UCLA-M scores are described. It is noteworthy that when the Spearman correlation test was applied, a strong correlation was observed ($p = 0.000$; 95% confidence interval [95%CI]: -0.875–-0.468), in other words, the tests are in accordance.

In ►**Table 3**, it is possible to observe the evaluation of both scores according to Boehm.[15] The percentages presented in the table are regarding the total of individuals pertinent to each category analyzed. It can be observed that most individuals had excellent results in both scores. When the Student *t*-test was applied and the mean CM score between the sexes was compared, there was no statistical significance; however, the male patients had higher scores, with a mean CM score of 92.15, and, for females, the mean score was of 89.43 ($p = 0.525$; 95%CI: -9.1–14.5).

Regarding age and type of synthesis, when the Student *t*-test is applied, there is a tendency to use the DCP, considering the absolute number; in other words, out of the 34 patients, 23 used the DCP, with a mean age of 34.04 years, and the reconstruction plate had a mean CM score of 45.09 years. This age difference between the types of synthesis was not significant given the limitation in the number of research subjects ($p = 0.116$; 95%CI: -20.4–-1.6).

The type of synthesis was not related to the scores, considering the sample size. The CM score had a mean, with the DCP, of 91.91, and with the reconstruction plate, it was of 90.91 ($p = 0.483$; 95%CI: -9.2–11.2). With the UCLA-M score, the average was of 31.22 and 31.45, with the DCP and the reconstruction plates respectively ($p = 0.502$; 95%CI: -4.1–3.6). The statistical significance analysis of the study variables is described in ►**Table 4**.

We also observed that there was no statistical difference when comparing the type of line of the fracture, smoking, complications, and the CM and UCLA-M scores.

Discussion

The best approach to the treatment of middle third clavicle fractures is still under discussion in the literature. The aim is to improve the patient's prognosis, so that he/she can fully return to the functions performed before the fracture. Recently, studies have published results that favor the surgical option because it reduces the incidence of pseudarthrosis, of vicious consolidation, and improves shoulder function. The most commonly used osteosynthesis is plate fixation plus screws superiorly to the clavicle. Therefore, the main complications of this technique are related to the surgical material.[1,2,10,16]

The study by Asadollahi et al,[17] which is in line with the present research, reported a prevalence of male patients when compared to females, and a mean age of 39.1 years. Napora et al[3] and Devji et al[18] reported a mean age between 26.5 and 44.2 years, as well as a higher predominance of men, ranging from 53 to 91% of the study cases.

Traffic accidents (TAs) corresponded to the main mechanism of trauma (91.2%), followed by fall from standing height (5.9%). This predominance of TAs is higher than the data found in the literature. Kihlström et al[19] classified the causes of 2,422 diaphyseal fractures: falls generally corresponded to 49% of them, and TAs consisted of 41.5%. Conversely, Napora et al[3] found 58% of cases due to TAs, and 34% due to falls in general. Therefore, the causes of fractures may vary according to the type of population studied.

In the present study, there was no association between smoking and worse functional outcome or greater complications. According to Napora et al[3] and Robinson et al,[20] smoking leads to worse functional shoulder scores, as this habit is related to worse bone consolidation; however, in these patients there was no clinical difference between the surgical or conservative treatments. Murray et al[21] and Ban et al[22] described that the risk of developing pseudarthrosis is four times higher among smokers. They even specify smoking cessation as part of the treatment, whether surgical or conservative.

Regarding the type of fracture line, there was a predominance of the comminuted type (52.9%). Robinson et al[20] also found a higher incidence of this type of fracture (68%), and

Table 1 Profile of the patients who suffered fractures of the middle third of the clavicle in the city of Tubarão, and who were surgically treated at Hospital Nossa Senhora da Conceição during the study period

Variable	N	%
Sex		
Male	27	79.4
Female	7	20.6
Age group		
$\leq$ 20 years old	2	5.9
From 21 to 30 years old	12	35.3
From 31 to 40 years old	6	17.6
From 41 to 50 years old	6	17.6
From 51 to 60 years old	5	14.7
Older than 60 years old	3	8.8
Smoking		
Yes	10	29.6
No	24	70.6
Time since fracture		
Until 12 months	7	20.5
From 12 to 24 months	12	35.2
From 24 to 36 months	3	8.7
From 36 to 48 months	6	17.4
More than 48 months	4	11.7
Type of fracture		
Simple	16	47.1
Comminuted	18	52.9
Affected side		
Right	21	61.8
Left	13	38.2
Type of synthesis		
Dynamic compression plate	23	67.6
Reconstruction plate	11	32.4
Trauma mechanism		
Fall from standing height	2	5.9
Traffic accident	31	91.2
Other (sports)	1	2.9
Acidente Automobilístico	31	91,2
Complications		
Pseudarthrosis	1	2.9
Prominent plate	15	44.1
Peri-scar paresthesia	7	20.6
No complication	11	32.4

Table 2 Mean, maximum, and minimum Constant-Murley and Modified-University of California at Los Angeles Shoulder Rating Scale (UCLA-M) functional scores of study sample

Scores	Mean	Maximum	Minimum
Constant-Murley	91.59	100	48
Modified-University of California at Los Angeles Shoulder Rating Scale (UCLA-M)	31.29	35	14
Acidente Automobilístico		31	91,2

Table 3 Stratification of the results of the Constant-Murley and Modified-University of California at Los Angeles Shoulder Rating Scale (UCLA-M) functional scores of the study sample

Score evaluation	N	%
Constant-Murley		
Excellent	23	67.65
Good	6	17.65
Satisfatory	2	5.88
Adequate	1	2.94
Poor	2	5.88
Modified-University of California at Los Angeles Shoulder Rating Scale (UCLA-M)		
Excellent	16	47.1
Good	11	32.4
Fair	5	14.7
Bad	2	5.9

Table 4 Statistical significance analysis of the study variables

Variable	*p*	95% confidence interval
Constant-Murley (CM) score x Modified-University of California at Los Angeles Shoulder Rating Scale (UCLA-M) score*	0.000[1]	−0.875−−0.468
Sex x CM** score	0.525[2]	−9.1–14.5
Age x type of synthesis**	0.116[2]	−20.4−−1.6
CM score x type of synthesis for male ** patients	0.483[2]	−9.2–11.2
CM score x type of synthesis for female** patients	0.502[2]	−4.1–3.6

Notes: *Spearman correlation test. **Student *t*-test. [1]Statistically significant. [2]No statistical significance.

the high percentage of TAs may explain this situation, since in these cases there is a relationship with the high energy of the trauma, according to Stegeman et al.[23] In another study,[24] this characteristic was identified as a risk factor for pseudarthrosis, and was even associated with worse functional scores. In the present study, however, there was no significant difference in the comparison between the types of fracture line and the functional scores.

The biggest criticism regarding the surgical treatment is due to the prominence of the synthesis material, since the clavicle has a subcutaneous localization. A similar fact was found in our study, in which most of the patients' complaints were that the plaque was protruding (44.1%), which endorses the surgical technique and the findings in other studies. Wang et al[25] found 40% of complications related to prominent plates or screws, as well as Nourian et al,[10] who described that the superior approach results in a high rate of plate problems, as well as in the need for further surgery for implant removal.

In the context of shoulder functionality, Naveen et al,[8] at the end of the follow-up, found a CM score of 94 in surgically-treated patients, and similar results were found in the present study. The mean MC and UCLA-M scores in our study were of 91.59 and 31.29 respectively. The meta-analyses performed by Woltz et al[16] and Smeeing et al[2] compared the surgical treatment with the conservative treatment, and they found better results that favor the former; however, the difference is not clinically relevant, given that a difference of at least 15 points is required to have some functional impact on the CM score.

Furthermore, van der Ven Denise et al[26] and Naveen et al[8] found that the benefits of the surgical treatment come faster than those of the conservative treatment, such as immediate stabilization, analgesia, early mobilization and, therefore, a quicker return to work. However, when analyzing shoulder function, the two groups only show a significant difference in the initial treatment period, up to six weeks in general. At about 24 weeks, the variation between the scores loses clinical significance, and the scores are matched over the long term with both treatments.

However, the main advantage of the surgical treatment is that it facilitates the reduction of the fracture and the decrease in the number of pseudarthrosis. This is the complication that worsens quality of life and decreases shoulder functionality. Asadollahi et al[17] analyzed the complications related to plaque fixation; in their study, pseudarthrosis occurred in 2.7% of the cases, and a similar rate was found in the present study (2.9%). These numbers are well below those found in the current literature regarding the non-surgical option, and according to George et al,[27] this situation can affect 15 to 26% of adults.

There are some limitations to the present study. First, the limited number of patients, due to the difficulty in contacting them, otherwise this study could show better results. Second, the patients were not examined at the same point of the development of their fractures, considering that this study was retrospective, and this may have improved the functional scores.

Conclusion

We conclude that the surgical treatment results in good functional outcomes after a diaphyseal clavicle fracture, regardless of the type of fracture line, with a low rate of pseudarthrosis. The complication most associated with the treatment was related to the prominence of the synthesis material. Therefore, these results can be added to the available literature, so that the treatment of clavicle fractures is optimized.

Conflict of Interests
The authors have no conflict of interests to declare.

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