



Original Article

Are diaphyseal clavicular fractures still treated traditionally in a non-surgical way?☆



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ABSTRACT

Objective: To evaluate the decision of orthopedics surgeons regarding which cases they would indicate surgery or non-surgical treatment.

Methods: 20 images of radiographs with fracture in the **middle third** of the collar bone (AO/OTA 15-B) in anteroposterior view were analyzed, and divided into four groups: group 1 – fracture type AO/OTA 15-B1 without displacement; group 2 – fracture type AO/OTA 15-B1 with displacement; group 3 – fracture type AO/OTA 15-B2; group 4 – fracture type AO/OTA 15-B3. The evaluator was requested to indicate the choice of treatment, surgical or non-surgical.

Results: There was no strong correlation between the amount of surgical indications and the working experience or age of the medical evaluator. It was observed that the average of surgical indications in the total sample was 52%. When indications were studied in different areas of Brazil, there was no significant difference among them. No pattern for the Brazilian regions studied was observed in the case analysis. Even within a group (cases of the same complexity), no specific pattern of surgical indication was observed.

Conclusion: No association between surgical indication and the length of professional experience was found. The Southern and Southeastern regions were those that most recommended surgeries in groups 2, 3, and 4. In no region the same level of surgical indication for cases of the same complexity rate was kept.

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Fraturas da diáfise da clavícula ainda são tratadas tradicionalmente, de forma não cirúrgica?

R E S U M O

Palavras-chave:

Fraturas ósseas/cirurgia
Fraturas ósseas/radiografia
Clavícula/cirurgia
Clavícula/radiografia
Placas ósseas

Objetivo: Avaliar a decisão de cirurgiões ortopédicos sobre em que casos indicariam a cirurgia ou tratariam não cirurgicamente.

Métodos: Foram analisadas 20 imagens de radiografias com fratura do terço médio da clavícula (AO/OTA 15-B) em incidência anteroposterior, que foram divididas em quatro grupos: 1 – fratura do tipo AO/OTA 15-B1 sem desvio; 2 – fratura do tipo AO/OTA 15-B1 com desvio; 3 – fratura do tipo AO/OTA 15-B2; 4 – fratura do tipo AO/OTA 15-B3. Ao avaliador, foi solicitado que indicasse o tipo de tratamento: cirúrgico ou não cirúrgico.

Resultados: Não houve correlação forte entre a quantidade de indicações cirúrgicas e o tempo de atuação do médico avaliador ou sua idade. Verificou-se que a média de indicação de cirurgias no total da amostra foi de 52%. Quando estudadas as indicações por diferentes regiões do Brasil, não houve diferença significativa. Não foi verificado qualquer padrão para as regiões brasileiras na análise por caso. Mesmo dentro de um grupo (casos de mesma complexidade), não foi verificado um padrão específico de indicação cirúrgica.

Conclusão: Não foi verificada associação entre a indicação cirúrgica e o tempo de atuação do profissional. As regiões Sul e Sudeste são as que mais recomendam a cirurgia dos grupos 2, 3 e 4. Verificou-se que em nenhuma região foi mantido o mesmo nível de indicação de cirurgias para casos do mesmo grau de complexidade.

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Introduction

Clavicle fractures are common injuries and occur in 2.6%–4% of adults. They account for 44% of shoulder girdle fractures,^{1–3} as this is the thinnest region of the clavicle and is not protected by muscle tissue. Conservative treatment has been recommended; it presents low rates of pseudoarthrosis (less than 1% of cases).^{4,5} However, recent literature has shown nonunion rates above 15% and unsatisfactory results between 23% and 31%.^{6–9} These results can be explained by changes in follow-up, improvement of diagnostic techniques, changes in results criteria, and the increasing severity of fractures.¹⁰

Surgical treatment is recommended in certain situations, such as in cases with a high degree of displacement or with more than 20 mm shortening.¹¹ With surgical treatment, pseudoarthrosis rates range from 2% to 3% with the use of plates and from 0% to 10% with intramedullary rods. Nonetheless, the rate of unsatisfactory results still ranges from 5% to 36%.^{12–14}

Several randomized trials compared results of conservative and surgical treatment.^{8,15–19} Xu et al.¹⁹ and McKee et al.²⁰ conducted a meta-analysis to determine the preferred treatment. These authors found high rates of pseudoarthrosis and malunion after conservative treatment.

This study aimed to evaluate the decision among orthopedic surgeons regarding which cases they would perform surgery or treat conservatively. The hypotheses were:

Hypothesis 1. To evaluate whether less experienced surgeons indicate surgeries more frequently.

Hypothesis 2. To evaluate whether there is a difference in treatment indication in different regions of Brazil.

Hypothesis 3. To evaluate whether different types of fracture influence treatment indication.

Material and methods

A computer program was developed; it contained 20 radiographs of fractures of the middle third of the clavicle (AO/OTA 15-B). All the images were of acute fractures in anteroposterior view, and were divided into four groups: 1 – AO/OTA 15-B1 fractures without deviation; 2 – AO/OTA 15-B1 fractures with deviation; 3 – AO/OTA 15-B2 fractures; and 4 – AO/OTA 15-B3 fractures. Each group contained five randomly distributed images. The evaluator was asked to indicate a type of treatment, whether conservative or surgical. The software included only images of fractures of the middle third of the clavicle in patients aged between 18 and 60 years. Images of patients with previous, exposed, or pathological fractures were excluded, as well as those of patients with previous morbidity affecting the upper limb (including the scapular girdle and the presence of neurovascular involvement). This study classified physicians as experienced when they had ≥ 20 years of practice, and as new those with < 20 years of practice.

As the study aimed to analyze the evaluator's conduct; age, gender, and cause of the accident were not mentioned so that the evaluator would indicate treatment based on radiographic criteria alone.

Table 1 – Number of participants, mean age, mean time of professional activity, and general percentage of surgical indications, by region of Brazil.

Region	Number of participants	Mean age (years)	Mean time of professional activity (years)	Overall percentage of surgery indications
Brazil	193	43	17.5	52
Mid-West	7	44	13	46
Northeast	19	46	21	48
North	6	41	14	43
Southeast	130	50	23	52
South	31	43	18	55

Source: AO trauma courses, Brazil, 2014.

Table 2 – Percentage of professionals who indicate the surgery, stratified by time of professional activity.

Group	Case	Time of professional activity				
		Up to 2 years	3-6 years	7-10 years	11-20 years	Over 20 years
1	1	9.1	0.0	4.5	1.7	6.0
	2	0.0	4.5	0.0	1.7	1.5
	3	13.6	0.0	4.5	15.0	7.5
	4	18.2	0.0	4.5	18.3	13.4
	5	9.1	13.6	4.5	8.3	9.0
2	1	40.9	50.0	50.0	63.3	59.7
	2	90.9	100	95.5	100	95.5
	3	68.2	63.6	77.3	66.7	80.6
	4	86.4	54.5	86.4	65.0	76.1
	5	100	90.9	95.5	93.3	97.0
3	1	77.3	68.2	68.2	73.3	82.1
	2	27.3	9.1	4.5	23.3	23.9
	3	4.5	4.5	0.0	1.7	0.0
	4	95.5	95.5	90.9	96.7	95.5
	5	36.4	27.3	27.3	31.7	37.3
4	1	86.4	95.5	90.9	90.0	92.5
	2	68.2	40.9	45.5	58.3	56.7
	3	86.4	90.9	86.4	83.3	88.1
	4	77.3	59.1	77.3	78.3	86.6
	5	86.4	54.5	63.6	61.7	71.6

Source: Courses AO trauma Brazil 2014.

Tables 1-3 show the description of the 193 evaluators, mean age, mean time of professional activity, and overall percentage of surgical indications by region of Brazil.

Results

Verification of hypotheses

The authors investigated the possibility of a relationship between evaluators' responses and their age, and between evaluators' response and their professional experience. The research was based on two methodologies: (1) analysis of the Spearman correlation between the number of surgical indications from an evaluator and his/her age and between the number of surgical indications from an evaluator and his/her time of professional experience; and (2) chi-squared test to evaluate the significant association between the age group and the response to each question. Table 4 shows the result of the correlation analysis; no strong correlation was observed between the number of surgical indications and the

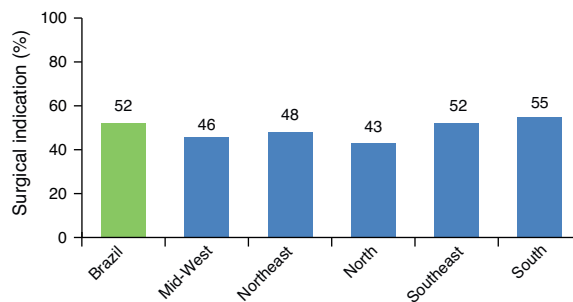


Fig. 1 – Overall percentage of surgical indications by region of Brazil.

Source: AO trauma Brazil courses, 2014.

evaluators' experience or age. The chi-squared test also did not present significant associations between the responses and age group in the 20 assessments.

Fig. 1 shows the results of the evaluators. It was observed that the mean indication of surgery in the total sample was

Table 3 – Percentage of professionals who indicate the surgery in each age bracket of evaluators.

Group	Case	Age range of the evaluators				
		Up to 29 years	30–39 years	40–49 years	50–59 years	Over 60 years old
1	1	5.0	4.5	0.0	3.2	13.0
	2	5.0	1.5	0.0	3.2	0.0
	3	10.0	9.1	15.1	3.2	4.3
	4	10.0	12.1	17.0	6.5	17.4
	5	5.0	9.1	7.5	12.9	8.7
2	1	35.0	59.1	54.7	61.3	65.2
	2	90.0	98.5	98.1	93.5	100
	3	75.0	72.7	64.2	74.2	87.0
	4	80.0	74.2	64.2	71.0	82.6
	5	100	95.5	94.3	90.3	100
3	1	65.0	77.3	71.7	80.6	82.6
	2	15.0	16.7	28.3	22.6	13.0
	3	5.0	1.5	1.9	0.0	0.0
	4	90.0	97.0	96.2	90.3	100
	5	25.0	33.3	35.8	35.5	30.4
4	1	85.0	92.4	86.8	93.5	100
	2	60.0	53.0	58.5	58.1	47.8
	3	90.0	86.4	83.0	83.9	95.7
	4	65.0	77.3	77.4	83.9	91.3
	5	60.0	72.7	58.5	71.0	73.9

Source: Courses AO trauma Brazil 2014.

Table 4 – Spearman correlation index between number of surgical indications and duration of surgery, as well as between the number of surgical indications and age.

	Time of operation	Age
Number of indications for group 1 cases	-0.01	0.01
Number of indications for group 2 cases	0.08	0.08
Number of indications for group 3 cases	0.03	0.11
Number of indications for group 4 cases	0.04	0.09
Number of indications in total cases	0.05	0.10

Source: Courses AO trauma Brazil 2014.

52%. No significant differences were observed when surgical indications were stratified by different regions of Brazil.

Figs. 2–5 show the incidence of surgery indication for the different fracture groups.

Fig. 6 shows that for both global and regional analyses, the proportion of surgical recommendation was much lower in group 1, as expected. Cases from group 2 received more surgical indications than those of group 3 in all regions of Brazil; only in the Mid-West and North regions they did not surpass the percentage of surgical indications of group 4 (higher complexity).

Fig. 7 shows that, in an overall analysis, higher percentages of surgical indication were observed from physicians from the South and Southeast regions for all the radiographs of groups 2, 3, and 4.

In the case analysis, no pattern could be identified for the Brazilian regions. Even within a group (cases of the same complexity), no specific pattern of indication was verified in the regions of Brazil.

Discussion

In this study, the authors aimed to answer the question: are diaphyseal clavicular fractures still treated traditionally in a non-surgical way?

Through three hypotheses, the authors demonstrated that surgical indication was uniform for both the less experienced and the more experienced evaluators. Despite the large socioeconomic differences, the different regions of the country presented a pattern for surgical indication. Through the radiographic characteristics of the fracture, it was not possible to establish how deviation size, angulation, and severity can define treatment.

General literature suggests that all clavicular fractures have good results with conservative treatment.^{4,5} Reports prior to Hippocrates had already observed that “when the clavicle fracture is simple and transverse, treatment is easier; in turn, when it is oblique, the treatment becomes more difficult.”²¹ Recent studies have shown that surgical treatment is preferred in specific cases (especially displaced fractures).^{6,9} The current literature, when comparing treatments, has reported that surgical treatment reduces nonunion rates and symptomatic malunion, leading to better functional outcomes and early return to activity.^{17,20,22} Pieske et al.²³ published the results of treatment preferences for middle third of the clavicle fractures in a study including 142 patients in Germany, and observed a mean of 26% of surgically treated fractures per year. Unfortunately, the authors did not classify the type of fracture. Heuer

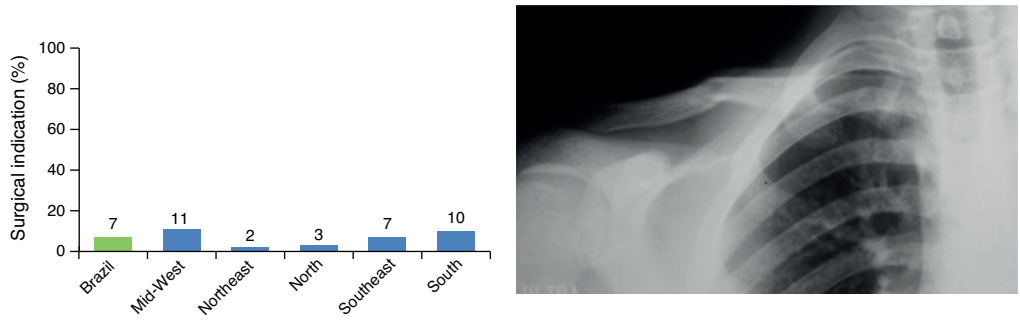


Fig. 2 – Overall percentage of surgical indications for group 1 – AO/OTA 15-B1 fracture without deviation, by region of Brazil. Representative radiograph of the group.

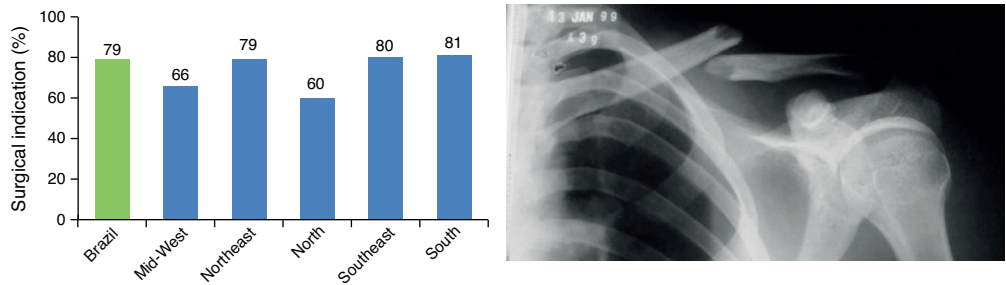


Fig. 3 – Overall percentage of surgical indications for group 2 – AO/OTA 15-B1 fracture with deviation, by region of Brazil. Representative radiograph of the group.

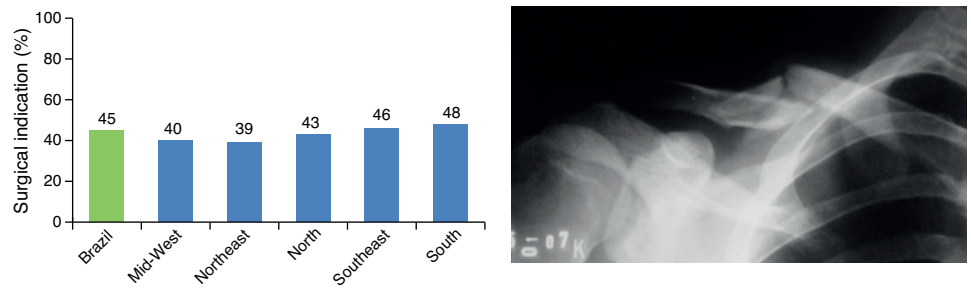


Fig. 4 – Overall percentage of surgical indications for group 3 – AO/OTA 15-B2 fracture, by region of Brazil. Representative radiograph of the group.

et al.¹⁰ showed that surgical treatment was recommended in 56% of cases and selected in 60%, probably due their case selection, with a large proportion of displaced fractures. However, the study has shown a strong tendency for surgical treatment to become more widely used.

The hypothesis raised was whether experienced evaluators would indicate conservative treatment more often than those less experienced, as there was a consensus in both textbooks and articles about the notion that “clavicle fractures are traditionally treated non-surgically.” Moreover, less experienced

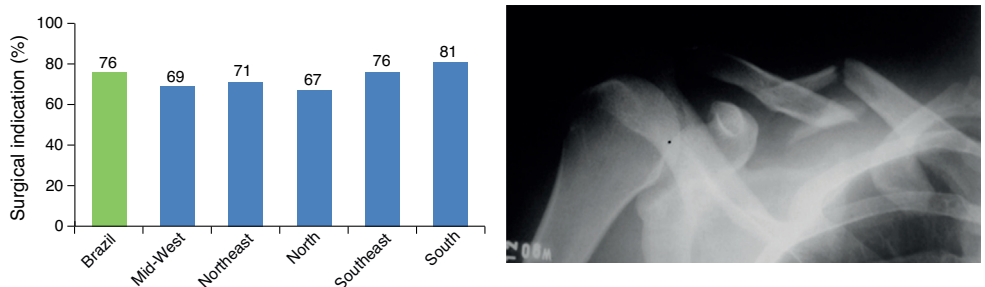


Fig. 5 – Overall percentage of surgical indications for group 4 – AO/OTA 15-B3 fracture, by region of Brazil. Representative radiograph of the group.

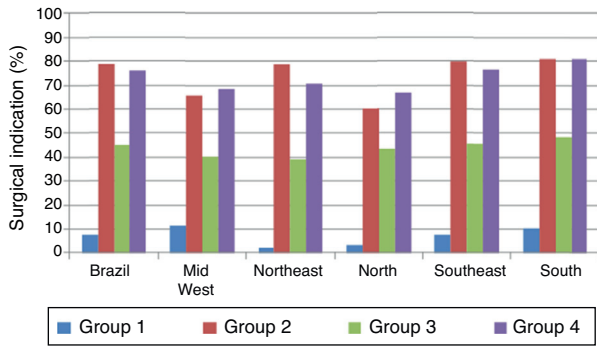


Fig. 6 – Percentage of surgeons who would indicate surgery in Brazil for each group of images, defined according to the complexity in Brazil and by region of Brazil.
 Source: AO trauma courses, Brazil, 2014.

evaluators would, in theory, indicate surgeries more often, due to the development of new technologies, among other causes. In this study, the hypotheses of a relationship between the evaluators' responses and their age as well as between the evaluators' response and their professional experience were rejected. As shown in the results, no significant trend or association was observed between the most experienced and the youngest (in relation to age) or less experienced (relative to time in practice). The indication for surgical treatment in this study was 52%, which is in agreement with Heuer et al.¹⁰ The percentage of professionals who indicate surgery, the evaluators' time of professional experience, and the age group of evaluators are shown in Tables 2 and 3.

Another hypothesis raised was whether in certain regions of the country, with more socioeconomic difficulties, indication for surgery could vary. This hypothesis was also rejected. In the global analysis, even within the same group (cases of the same complexity), no specific pattern of indication was verified in the regions of Brazil. Evaluators from the South and Southeast regions stood out for indicating more surgeries. However, for the cases of simple fracture, the Mid-West

region presented the highest percentage of surgical indications (11%), while the Northeast and North regions presented percentages of 3% and 2%, respectively. The Mid-West, North, and Northeast regions presented percentages of surgical indications below the global proportion, except in group 1 cases, where Mid-West evaluators indicated surgery more frequently than the global proportion (11% vs. 7%, respectively). A relevant observation was the lack of a standard for the Brazilian regions in the analysis of cases of the same complexity. Each regional group of evaluators was expected to present percentages of surgical indications without much variability within a single group, since the images from the same group presented the same degree of complexity. However, a high variability in surgical indications was observed within the same complexity group.

The next hypothesis was whether different types of fractures would present different treatment indications (whether the degree of complexity guides the type of treatment); that is, whether the more complex the fracture, the higher the surgical indication index.

Both in the overall sample and in the Brazilian regions studied, the hypothesis was not confirmed, as in the global analysis and in the regions studied, the proportion of surgical recommendation was much lower, as expected in group 1. The cases of group 2 (simple deviated fractures) received more surgical indications than the cases of group 3 in all regions, and only did not surpass the percentage of surgical indications of group 4 (greater complexity) in the Mid-West and North regions.

This study has some limitations, among them the selection of evaluators. The authors analyzed information from general orthopedic surgeons, not those specialized in trauma or in shoulder surgery. Another limitation was the lack of information about gender, age, and cause of the fracture, which might have influenced the indication. However, this lack of information was intentional, since the purpose of the study was to evaluate the treatment indications based on radiographic criteria. Another important point that needs to be taken into account is the low number of evaluators from the Mid-West and North regions of the country.

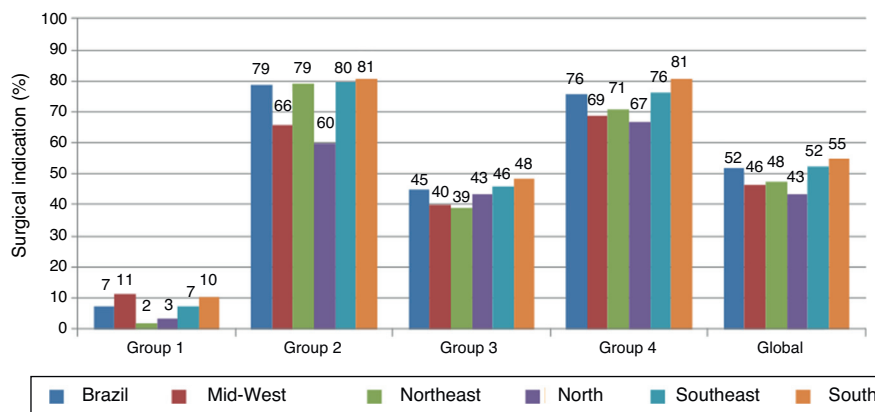


Fig. 7 – Percentage of surgeons who indicate surgery for each group of images, defined according to the complexity in Brazil and by region of Brazil.
 Source: AO trauma courses, Brazil, 2014.

Conclusion

There was no association between surgical indication and time of professional practice.

The South and Southeast regions were those that most recommend surgery for groups 2, 3, and 4. For group 1, the evaluators from the Mid-West region were those who most recommend surgery. Furthermore, no characteristic pattern for the Brazilian regions was verified in the case analysis.

Even within groups (cases of the same complexity), no specific pattern of indication was verified per region of Brazil.

It was observed that no region maintained the same level of surgical indication for cases with the same degree of complexity.

The authors believe that fractures of the middle third of the clavicle should be treated according to clinical and radiographic criteria to achieve best results, contrary to the recommendation from most articles and textbooks that fractures of the middle third of the clavicle are traditionally treated non-surgically.

Conflicts of interest

The authors declare no conflicts of interest.

REFERENCES

- Robinson CM. Fractures of the clavicle in the adult. Epidemiology and classification. *J Bone Joint Surg Br.* 1998;80(3):476-84.
- Nordqvist A, Petersson C. The incidence of fractures of the clavicle. *Clin Orthop Relat Res.* 1994;(300):127-32.
- Postacchini F, Gumina S, De Santis P, Albo F. Epidemiology of clavicle fractures. *J Shoulder Elbow Surg.* 2002;11(5):452-6.
- Neer CS 2nd. Nonunion of the clavicle. *J Am Med Assoc.* 1960;172:1006-11.
- Rowe CR. An atlas of anatomy and treatment of midclavicular fractures. *Clin Orthop Relat Res.* 1968;58:29-42.
- 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.
- Hill JM, McGuire MH, Crosby LA. Closed treatment of displaced middle-third fractures of the clavicle gives poor results. *J Bone Joint Surg Br.* 1997;79(4):537-9.
- McKee MD, Pedersen EM, Jones C, Stephen DJ, Kreder HJ, Schemitsch EH, et al. Deficits following nonoperative treatment of displaced midshaft clavicular fractures. *J Bone Joint Surg Am.* 2006;88(1):35-40.
- Zlowodzki M, Zelle BA, Cole PA, Jeray K, McKee MD, Evidence-Based Orthopaedic Trauma Working Group. Treatment of acute midshaft clavicle fractures: systematic review of 2144 fractures: on behalf of the Evidence-Based Orthopaedic Trauma Working Group. *J Orthop Trauma.* 2005;19(7):504-7.
- Heuer HJ, Boykin RE, Petit CJ, Hardt J, Millett PJ. Decision-making in the treatment of diaphyseal clavicle fractures: is there agreement among surgeons? Results of a survey on surgeons' treatment preferences. *J Shoulder Elbow Surg.* 2014;23(2):e23-33.
- McKee MD. Clavicle fractures in 2010: sling/swathe or open reduction and internal fixation? *Orthop Clin North Am.* 2010;41(2):225-31.
- Kettler M, Schieker M, Braunstein V, König M, Mutschler W. Flexible intramedullary nailing for stabilization of displaced midshaft clavicle fractures: technique and results in 87 patients. *Acta Orthop.* 2007;78(3):424-9.
- Millett PJ, Hurst JM, Horan MP, Hawkins RJ. Complications of clavicle fractures treated with intramedullary fixation. *J Shoulder Elbow Surg.* 2011;20(1):86-91.
- Mueller M, Rangger C, Striepens N, Burger C. Minimally invasive intramedullary nailing of midshaft clavicular fractures using titanium elastic nails. *J Trauma.* 2008;64(6):1528-34.
- Nowak J, Holgersson M, Larsson S. Sequelae from clavicular fractures are common: a prospective study of 222 patients. *Acta Orthop.* 2005;76(4):496-502.
- Rehn CH, Kirkegaard M, Viberg B, Larsen MS. Operative versus nonoperative treatment of displaced midshaft clavicle fractures in adults: a systematic review. *Eur J Orthop Surg Traumatol.* 2014;24(7):1047-53.
- Robinson CM, Goudie EB, Murray IR, Jenkins PJ, Ahktar MA, Read EO, 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.
- Virtanen KJ, Remes V, Pajarinen J, Savolainen V, Björkenheim JM, Paavola M. Sling compared with plate osteosynthesis for treatment of displaced midshaft clavicular fractures: a randomized clinical trial. *J Bone Joint Surg Am.* 2012;94(17):1546-53.
- Xu CP, Li X, Cui Z, Diao XC, Yu B. Should displaced midshaft clavicular fractures be treated surgically? A meta-analysis based on current evidence. *Eur J Orthop Surg Traumatol.* 2013;23(6):621-9.
- McKee RC, Whelan DB, Schemitsch EH, McKee MD. Operative versus nonoperative care of displaced midshaft clavicular fractures: a meta-analysis of randomized clinical trials. *J Bone Joint Surg Am.* 2012;94(8):675-84.
- Hippocrates on the articulations. 400 B.C.E. *Open Orthop J.* 2013;7 Suppl. 3 M6:329-33. Available at: <http://classics.mit.edu/Hippocrates/artic.14.14.html>.
- Sohn HS, Kim WJ, Shon MS. Comparison between open plating versus minimally invasive plate osteosynthesis for acute displaced clavicular shaft fractures. *Injury.* 2015;46(8):1577-84.
- Pieske O, Dang M, Zaspel J, Beyer B, Löffler T, Piltz S. Midshaft clavicle fractures – classification and therapy. Results of a survey at German trauma departments. *Unfallchirurg.* 2008;111(6):387-94.