



Original Article

Result from surgical treatment on the terrible triad of the elbow[☆]



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ABSTRACT

Objective: To evaluate the results from surgical treatment of the terrible triad of the elbow, with a minimum of six months of follow-up, taking elbow function into consideration.

Methods: The analyzed aspects of 20 patients, who underwent surgical treatment of the terrible triad of the elbow, were given as follows: Dash score (Disabilities of the Arm, Shoulder and Hand), Meps (Mayo Elbow Performance Score), pain according to VAS (visual analog scale), ROM (range of motion), patient satisfaction, degree of energy of the trauma, complications and radiographs.

Results: The mean length of follow-up among the patients was 38 months. There were statistically significant relationships between the following set of parameters: trauma mechanism and patient satisfaction; radiological outcome of "heterotopic ossification" and satisfaction; functional flexion-extension ROM and satisfaction; and between type of radial head fracture and presence of a radiological outcome.

Conclusion: The surgical treatment for the terrible triad of the elbow generally provided satisfactory results, when the functioning of this joint upon the return to activities was taken into consideration.

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Resultado do tratamento cirúrgico da tríade terrível do cotovelo

RESUMO

Objetivo: Avaliar os resultados do tratamento cirúrgico da tríade terrível do cotovelo, com no mínimo seis meses de seguimento, considerando a função do cotovelo.

Métodos: Foram analisados os seguintes aspectos de 20 pacientes submetidos a tratamento cirúrgico por tríade terrível do cotovelo: escores Dash (Disabilities of the Arm, Shoulder and Hand), Meps (Mayo Elbow Performance Score), dor pela EVA (Escala Visual Analógica), ADM (arco de movimento), satisfação do paciente, grau de energia do trauma, complicações e radiografias.

Palavras-chave:

Cotovelo

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Resultados: O tempo médio de seguimento dos pacientes foi de 38 meses. Houve relação estatisticamente significativa entre: mecanismo de trauma e satisfação dos pacientes; desfecho radiológico “ossificação heterotópica” e satisfação; ADM funcional de flexo-extensão e satisfação e entre o tipo de fratura da cabeça do rádio e a presença de desfecho radiológico. **Conclusão:** O tratamento cirúrgico da tríade terrível do cotovelo proporcionou, de forma geral, resultados satisfatórios, quando se considera a função dessa articulação no retorno às atividades.

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Introduction

Traumatic lesions in adult elbows can be very challenging to treat due to their complex anatomy and potential complications.¹

Hotchkiss¹ described an association pattern of lesions in this joint, the terrible triad of the elbow, which consists of posterior dislocation of the elbow associated with a coronoid fracture and with a radial head fracture, which presents great potential for joint instability. It is thus named due to its unfavorable prognosis.

The terrible triad is rare and generally occurs in young male patients, related to high-energy trauma. The most common mechanism consists of falling onto the outstretched hand, with the elbow under hyperextension, supination and valgus stress.²

The treatment for these lesions is eminently surgical because conservative treatment is risky and related to various complications.³ The latter treatment is considered to be the exception, indicated in well-selected cases in which there is good alignment of the elbow, without articular block, and in which the coronoid and radial head fractures are relatively small and only slightly deviated.⁴

Surgical treatment has the objectives of restoring joint stability and achieving anatomical reduction and early mobility during the postoperative period. This allows restoration of functional capacity and, therefore, reduces the risk of complications.⁵

Due to the seriousness and rarity of the lesion, few studies have evaluated the results from surgical treatment of the terrible triad of the elbow.^{6,7} Its prognosis remains uncertain, especially over the long term.⁶

The objective of the present study was to evaluate the results from surgical treatment of the terrible triad of the elbow, with at least six months of follow-up, considering the function of the elbow.

Material and methods

Patients with terrible triad of the elbow who were treated surgically between 1999 and 2012, at the Shoulder and Elbow Sector of the Discipline of Hand and Upper-limb Surgery of our service, were retrospectively evaluated.

All patients older than 18 years who agreed to participate in the study and signed the free and informed consent statement were included. The statement had previously been

accepted by the Research Ethics Committee under the number CEP 0032/11.

The exclusion criteria comprised associated lesions or diseases that could interfere in the evaluation of the outcomes, lack of information in the medical records due to absence or non-comprehension and failure to return for reevaluation.

The following epidemiological information was obtained: age, age on the date of the trauma, sex, dominance, elbow affected, trauma mechanism, associated lesions, surgery performed, duration of immobilization, complications during treatment, patient's degree of satisfaction and data from the last consultation.

The primary outcome used was the DASH score,⁸ as validated for the Portuguese language.

The secondary clinical functional outcome was the Mayo Elbow Performance Score (MEPS).⁹ In addition, pain was evaluated using a visual analog scale (VAS)¹⁰ and the patients' range of motion (ROM) was analyzed dichotomously, considering the functional ROM according to Morrey (30–130° of flexion–extension of the elbow and 50–50° of pronation and supination).⁹

Complications were recorded according to their severity and the date of occurrence; for instance: infection, renewed dislocation and reoperation.

Lesions were evaluated radiographically and classified as follows:

- Radial head fracture, with description of the type of fracture according to Mason. Classified^{11,12} according to their severity and divided into type I: fractures without deviation, type II: fractures with deviation, and type III: comminuted fractures.
- Coronoid process fracture. Classified according to the system described by Regan and Morrey¹³ and divided into type I: apex avulsion, type II: impairment of up to 50% of its height and type III: involving over 50% of its height.

In addition, postoperative radiographs were produced in frontal and lateral views and the following characteristics were evaluated: presence of osteoarthritis, presence of ligament calcification, pseudarthrosis, skewed consolidation (malunion) and heterotopic ossification. The responses were dichotomous.

All the evaluations were made by three independent evaluators who were experts on shoulder and elbow surgery and did not have connections with the study.

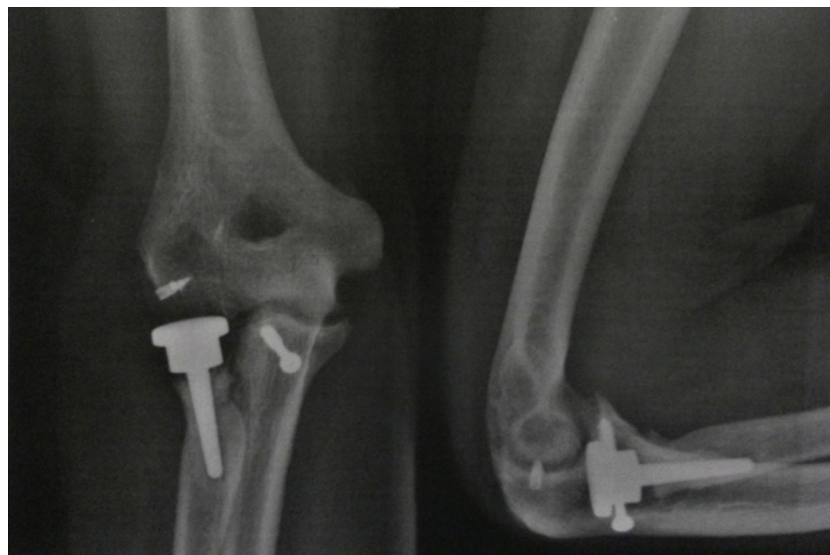


Fig. 1 – Front and lateral-view radiographs of the elbow demonstrating the results from the surgical treatment, with lateral ligament repair using an anchor, radial head prosthesis and osteosynthesis of the coronoid using a screw.

For the statistical analysis, the test of equality of two proportions was used in order to characterize the relative frequencies of sex, trauma mechanism, dominance, MEPS classification and complications.

The chi-square test was used for comparing the qualitative variables with the MEPS classification.

The Mann-Whitney test was used for comparing variables relating to the type of fracture, such as trauma mechanism, classification of the radial head fracture and classification of the coronoid fracture, and variables relating to radiographic complications such as osteoarthritis, ligament calcification, heterotopic ossification and malunion, with the factors of functional range of motion, elbow function, pain and satisfaction.

Lastly, the Spearman correlation was used for measuring the degree of relationship between the duration of immobilization and the findings from the physical examination and questionnaires.

The following software was used for performing the statistical analysis: SPSS V17, Minitab 16 and Excel Office 2010.

All the patients included underwent the same surgical procedure protocol. After administration of brachial plexus block in association with general anesthesia, the patients were placed in the horizontal dorsal decubitus position and asepsis was performed using chlorhexidene and alcohol. The procedure always began through the lateral access route described by Kocher, between the extensor carpi ulnaris and the anconeus muscles. The radial head fracture was first dealt. In cases of an indication of arthroplasty, the condition of the coronoid process was verified through the same access route and the fracture was dealt with whenever possible. In all cases, the lateral ulnar collateral ligament was also repaired. In patients treated with osteosynthesis of the radial head and in cases of persistence of elbow instability, an additional medial access route was created in order to perform osteosynthesis of the coronoid or repair of the anterior capsule and, when necessary, repair or reconstruction of the medial

collateral ligament. After repairing all these structures, if there was any remaining instability, a dynamic external fixator was used (Fig. 1).

During the postoperative period, the patients underwent the same rehabilitation protocol and were encouraged to do early assisted exercises in accordance with their tolerance of pain, in order to avoid elbow stiffness due to joint immobilization.

Results

This study presented an initial sample of 20 cases, from which three were excluded due to lack of essential data in their records and two abandoned the follow-up before the conclusion of the study. Thus, 15 patients remained for the final analysis. The epidemiological characteristics, the clinical data of the sample, the radiological outcome and the functional outcome were reported through the observed DASH score, MEPS, VAS and patient's satisfaction, as described in Table 1.

The cases evaluated presented a mean time interval between trauma and surgery of 7 ± 2.6 days and mean length of follow-up of 38.6 ± 23.3 months. The mean of duration of immobilization was 2.8 ± 0.8 weeks.

The analysis on the range of motion of elbow flexion-extension during the postoperative period revealed that 10 cases (66.7%) presented a ROM that was considered functional, while the remaining five (33.3%) presented a non-functional elbow from this perspective. The analysis on pronosupination of the forearm revealed that 12 patients (80%) presented acceptable function.

Comparing the functional results from the DASH, MEPS, VAS and satisfaction measurements with the severity of the lesion as determined through the energy of the trauma, with the radiological outcomes and with the functional results relating to the physical examination, a correlation between the trauma mechanism and satisfaction was observed. All the patients who stated that they were "not satisfied" had

Table 1 – Epidemiological characteristics and clinical data of the sample.

Male (%)	5 (33.3)
Female (%)	10 (66.7)
Mean age (SD)	43.8 (13.4)
Dominance – left upper limb (%)	1 (6.7)
Dominance – right upper limb (%)	14 (93.3)
Characteristics of the fracture	
Side affected – left (%)	9 (60)
Side affected – right (%)	6 (40)
High-energy trauma (%)	7 (46.7)
Low-energy trauma (%)	8 (53.3)
Radial head fracture n (%)	
Type 1	0 (0)
Type 2	5 (33.3)
Type 3	10 (66.7)
Coronoid fracture n (%)	
Type 1	10 (66.7)
Type 2	2 (13.3)
Type 3	3 (20)
Functional outcomes	
DASH	Mean (SD) 28.7 (13.7)
MEPS	84.7 (16.7)
VAS	2.0 (2.3)
MEPS	
Excellent	n (%) 8 (53.3%)
Good	3 (20%)
Fair	3 (20%)
Poor	1 (6.7%)
Satisfaction	
Yes	n (%) 12 (80)
No	3 (20)
Radiological outcomes	
Ligament calcification	n (%) 7 (46.7)
Malunion	2 (13.3)
Heterotopic ossification	3 (20)
Osteoarthritis	5 (33.3)
Pseudarthrosis	1 (6.7)

SD, standard deviation; n, number; DASH, Disabilities of the Arm, Shoulder and Hand; MEPS, Mayo Elbow Performance Score; VAS, visual analog scale.

experienced high-energy trauma. There were also correlations between the radiological outcome of “heterotopic ossification” and satisfaction and between functional flexion–extension ROM and satisfaction (Table 2). In addition, there was also a tendency toward an association between the radiological outcome of “heterotopic ossification” and the visual analog scale (Table 3).

From correlating the types of fracture with the functional outcomes determined by scores and with the functional range of movement, tendencies toward an association between the type of coronoid fracture and functional ROM of pronosupination and between the type of coronoid fracture and the MEPS score were observed (Table 4).

When the data regarding the classification of fractures were correlated with the presence of a radiological outcome, a significant association was observed for the type of radial head fracture (Table 5).

Table 2 – Satisfaction versus trauma mechanism versus outcomes.

Satisfaction	Trauma mechanism		Heterotopic ossification		Flexion–extension functional ROM		Pronation–supination functional ROM		Heterotopic ossification	
	Low energy	High energy	No	Yes	No	Yes	No	Yes	No	Yes
No	0	3 (20%)	1 (6.7%)	2 (13.3%)	3 (20%)	0	1 (6.7%)	2 (13.3%)	2 (13.3%)	
Yes	8 (53.3%)	4 (26.7%)	11 (73.3%)	1 (6.7%)	2 (13.3%)	10 (66.7%)	2 (13.3%)	10 (66.7%)	2 (13.3%)	p > 0.05
Total	8 (53.3%)	7 (46.7%)	12 (80%)	3 (20%)	5 (33.3%)	10 (66.7%)	3 (20%)	12 (80%)	3 (20%)	p = 0.00

ROM, range of motion; FE, flexion–extension; PS, pronation–supination.

Table 3 – Radiological outcomes versus scores.

	DASH		MEPS		VAS	
	Median	p value	Median	p value	Median	p value
Osteoarthritis						
Yes	26.67		85		2	
No	15	0.4	95	0.45	1	0.6
Ligament calcification	Median	p value	Median	p value	Median	p value
Yes	26.67		85		2	
No	15	0.64	97	0.4	1	0.62
Malunion	Median	p value	Median	p value	Median	p value
Yes	47.1		77.5		3	
No	20	0.31	95	0.43	0	0.27
Heterotopic calcification	Median	p value	Median	p value	Median	p value
Yes	35.22		60		4	
No	21.97	0.11	95	0.14	0	0.07

ROM, range of motion; n, number; DASH, Disabilities of the Arm, Shoulder and Hand; MEPS, Mayo Elbow Performance Score; VAS, visual analog scale.

Table 4 – Range of motion versus types of fracture.

	Flexion–extension functional ROM			Pronation–supination functional ROM		
	Yes n (%)	No n (%)	p value	Yes n (%)	No n (%)	p value
Coronoid fracture						
Type 1	7 (70)	3 (30)		9	1	
Type 2	2 (100)	0		2	0	
Type 3	1 (33)	2 (67)		1	2	
Total	10 (66.7)	5 (33.3)	0.27	12 (80)	3 (20)	0.07
Radial head fracture	Yes n (%)	No	p value	Yes n (%)	No	p value
Type 2	4 (80)	1 (20)		4	1	
Type 3	6 (60)	4 (40)		8	2	
Total	10 (66.7)	5 (33.3)	0.43	12 (80)	3 (20)	0.99
	Scores versus type of fracture					
	DASH		MEPS		VAS	
Coronoid fracture	Median	p value	Median	p value	Median	p value
Type 1	10		97.5		0	
Type 2	26.67	0.15	72.5	0.07	3	0.11
Type 3	77.5		60		4	
Radial head fracture	Median	p value	Median	p value	Median	p value
Type 2	14.16	0.58	95	0.62	2	0.7
Type 3	26.67		90		0	

ROM, range of motion; n, number; DASH, Disabilities of the Arm, Shoulder and Hand; MEPS, Mayo Elbow Performance Score; VAS, visual analog scale.

Discussion

The terrible triad of the elbow is characterized by great potential for joint instability and an unfavorable prognosis.^{1,5} Surgical treatment is the therapy of choice in the vast majority of cases, with the aims of restoration of the anatomy and early mobility. This objective remains a challenge for surgeons due to the complexity of the lesion.⁵

In most cases in the present study, the lesion was due to low-energy trauma. Considering the radial head fractures, type 3 of the Mason classification was the most common one. Considering the coronoid fractures, the distribution was het-

erogeneous. Type 1 of the Regan-Morrey classification was the one most observed. These data corroborated the epidemiology described in the literature.^{6,14}

Unlike some studies,^{14,15} the sample of the present study presented greater prevalence of the female sex (66.7%), which can be explained by population aging and by the predominance of women in this age group. There was also predominance of the non-dominant side as the side most affected (53.3%), i.e. the left limb.

Regarding the function of the limb, 10 patients (66.7%) presented a functional range of motion of flexion–extension and 12 (80%) presented acceptable function in relation to the range

Table 5 – Radiological outcome versus type of fracture.

Radiological outcome			
<i>Coronoid fracture</i>	No	Yes	<i>p</i> value
Type 1	4	6	
Type 2	2	0	0.08
Type 3	0	3	
<i>Radial head fracture</i>	No	Yes	<i>p</i> value
Type 2	4	1	0.02
Type 3	2	8	

of motion of pronosupination. Thus, the majority of the sample presented a functional elbow joint for daily activities after surgery, which was concordant with the results from other studies that evaluated range of motion.^{7,15,16}

Although one study¹⁶ did not obtain good functional results through the Bruce score,¹⁶ the results from the present study showed good functional results. This difference can be explained by the score used, since other validated scores were used in the present study.

As expected, relationships between satisfaction and range of motion of flexion–extension and between satisfaction and the trauma mechanism were observed. This was because all the patients who stated that they were not satisfied presented a non-functional range of motion and had been involved in events with a high-energy trauma mechanism.

In addition, satisfaction presented a great association with the presence of heterotopic ossification in the radiographic evaluation. Those who did not present such outcomes reported being satisfied. These correlations allow the inference that these variables are prognostic factors for evaluation of the satisfaction of patients with surgical treatment.

The severity of the coronoid fracture, as determined through its classification, is another factor that can anticipate the prognosis in relation to the clinical result. In comparing this variable with the MEPS score, a tendency toward an association was observed, in which fractures of greater severity obtained scores that were considered worse. The same happened when this variable was correlated with the function of the elbow, measured through pronosupination. This importance of the type of coronoid fracture was observed by Gomide et al.¹⁵ On the other hand, the radial head fracture did not present any similar association, from this point of view.

However, the majority of the radial head fractures that were considered to be of greater severity presented at least one radiographic outcome, which denotes that the severity of this fracture is a risk factor for the presence of some type of radiological outcome. In contrast, no such relationship was found when the coronoid fracture was considered.

Due to the rarity of the lesion^{6,7} and the difficulty of following up our surgically treated patients, the sample evaluated presented a small number of cases, which may have influenced the final results found in the present study.

Conclusion

Despite the limitation of the range of motion and a certain degree of residual pain, the surgical treatment of the

terrible triad of the elbow generally provided satisfactory results with regard to joint function in the patients' return to activities.

Conflicts of interest

The authors declare no conflicts of interest.

REFERENCES

- Hotchkiss RN. Fractures and dislocations of the elbow. In: Rockwood CA, Green DP, Bucholz RW, Heckman JD, editors. *Rockwood and Green's fractures in adults*. 4th ed. Philadelphia: Lippincott-Raven; 1996. p. 929–1024.
- Rodriguez-Martin J, Pretell-Mazzini J, Andres-Esteban EM, Larrainzar-Garijo R. Outcomes after terrible triads of the elbow treated with the current surgical protocols: a review. *Int Orthop*. 2011;35(6):851–60.
- Chan K, MacDermid JC, Faber KJ, King GJ, Athwal GS. Can we treat select terrible triad injuries nonoperatively? *Clin Orthop Relat Res*. 2014;472(7):2092–9.
- Guitton TG, Ring D. Nonsurgically treated terrible triad injuries of the elbow: report of four cases. *J Hand Surg Am*. 2010;35(3):464–7.
- Mathew PK, Athwal GS, King GJ. Terrible triad injury of the elbow: current concepts. *J Am Acad Orthop Surg*. 2009;17(3):137–51.
- Seijas R, Ares-Rodriguez O, Orellana A, Albareda D, Collado D, Llusca M. Terrible triad of the elbow. *J Orthop Surg (Hong Kong)*. 2009;17(3):335–9.
- Wang YX, Huang LX, Ma SH. Surgical treatment of "terrible triad of the elbow": technique and outcome. *Orthop Surg*. 2010;2(2):141–8.
- Orfale AG, Araújo PM, Ferraz MB, Nataour J. Translation into Brazilian Portuguese, cultural adaptation, and evaluation of the reliability of the Disabilities of the Arm, Shoulder and Hand Questionnaire. *Braz J Med Biol Res*. 2005;38(2):293–302.
- Morrey BF, An KN, Chao EYS. Functional evaluation of the elbow. In: Morrey BF, editor. *The elbow and its disorders*. 2nd ed. Philadelphia: Saunders; 1993. p. 86–9.
- Summers S. Evidence-based practice part 2: reliability and validity of selected acute pain instruments. *J Perianesth Nurs*. 2001;16(1):35–40.
- Mason ML. Some observations on fractures of the head of the radius with a review of one hundred cases. *Br J Surg*. 1954;42(172):123–32.
- Johnston GW. A follow-up of 100 cases of fracture of the head of the radius with review of the literature. *Ulster Med J*. 1962;31:51–6.
- Regan W, Morrey B. Fractures of the coronoid process of the ulna. *J Bone Joint Surg Am*. 1989;71(9):1348–54.
- Ring D, Jupiter JB, Zilberfarb J. Posterior dislocation of the elbow with fractures of the radial head and coronoid. *J Bone Joint Surg Am*. 2002;84(4):547–51.
- Gomide LC, Campos DO, Sá JMR, Sousa MRP, Carmo TC, Andrada FB. Triade terrível do cotovelo: avaliação do tratamento cirúrgico. *Rev Bras Ortop*. 2011;46(4):374–9.
- Miyazaki AN, Checchia CS, Fagotti L, Fregoneze M, Santos PD, Silva LA, et al. Avaliação dos resultados do tratamento cirúrgico da tríade terrível do cotovelo. *Rev Bras Ortop*. 2014;49(3):271–8.