



# Postoperative Functional Evaluation in Patients Undergoing Surgical Treatment of the Terrible Triad Injury of the Elbow

## *Avaliação funcional pós-operatória em pacientes submetidos a tratamento cirúrgico da tríade terrível do cotovelo*

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### Abstract

**Objective** To evaluate the functional results of patients submitted to a surgical approach for the treatment of the terrible triad of the elbow, analyzing the treatment methods used and associated epidemiological variables.

**Methods** Patients who underwent surgical treatment for the terrible triad of the elbow from February 2018 to June 2020 at our service were evaluated. The identified sample consisted of 17 patients, but of these, only 13 completed all stages of the study and, therefore, were considered as the universe to be considered. Epidemiological information of interest was collected: age, sex, hand of dominance, affected side, characteristics and classification of injuries, trauma mechanism, time to surgery, type of procedure performed and range of motion. The Mason classification was used for radial head fractures and the Regan and Morrey classification for the coronoid process. In order to perform a functional analysis, the DASH and BRUCE questionnaires were applied.

**Results** About 77% of the patients were male, 92% of the fracture mechanisms were due to high-energy trauma. Contrary to this, the predominance of the non-dominant side was observed as the most affected. Evaluating the results according to the time to start the treatment, the patients operated within 14 days had statistically better functional results.

**Conclusion** Surgical treatment of TTIE generates acceptable functional results in most cases. The success of the treatment is related to the time interval between the trauma and the first surgery, in addition to the severity of the injuries.

### Keywords

- ▶ coronoid fracture
- ▶ elbow dislocation
- ▶ radial head fracture
- ▶ terrible triad injury of elbow
- ▶ elbow joint

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## Resumo

**Objetivo** Avaliar os resultados funcionais dos pacientes submetidos a abordagem cirúrgica para o tratamento da tríade terrível do cotovelo, analisando os métodos de tratamento utilizados e variáveis epidemiológicas associadas.

**Métodos** Foram avaliados pacientes submetidos ao tratamento cirúrgico de tríade terrível do cotovelo de fevereiro de 2018 a junho de 2020 em nosso serviço. A amostra identificada foi de 17 pacientes, mas destes apenas 13 concluíram todas as etapas das pesquisas e por isso foram considerados como o universo a ser levado em consideração. Coletou-se informações epidemiológicas de interesse: idade, sexo, dominância, lado acometido, características e classificações das lesões, mecanismo do trauma, tempo para cirurgia, tipo de procedimento realizado e o arco de movimento. Foi utilizada a classificação de Mason para a fratura de cabeça do rádio e a de Regan e Morrey, para o processo coronoide. A fim de realizar uma análise funcional, aplicou-se os questionários de DASH e BRUCE.

**Resultados** Cerca de 77% dos pacientes foram do sexo masculino, 92% dos mecanismos de fratura foram por trauma de alta energia. Contrariamente a esta, observou-se a predominância do lado não dominante como o mais afetado. Avaliando os resultados de acordo com o tempo para início do tratamento, os pacientes operados em até 14 dias obtiveram resultados funcionais estatisticamente melhores.

**Conclusão** O tratamento cirúrgico da TTC gera resultados funcionais aceitáveis na maioria dos casos. O sucesso do tratamento está relacionado ao intervalo de tempo entre o trauma e a primeira cirurgia, além de se relacionar com a gravidade das lesões.

## Palavras-chave

- ▶ fratura do coronoide
- ▶ luxação de cotovelo
- ▶ fratura de cabeça do rádio
- ▶ tríade terrível do cotovelo
- ▶ articulação do cotovelo

## Introduction

Elbow dislocation associated with radial head and coronoid fractures is called the terrible triad injury of the elbow (TTIE). This type of injury is usually related to ligament and capsular involvement of the joint, in addition to the involvement of flexor and extensor tendons.<sup>1</sup> The great structural involvement causes the instability of this joint, often resulting in limitation of range of motion, early arthrosis and joint stiffness.<sup>2</sup>

Determined by Hotchkiss (1996), the term terrible triad injury of the elbow started to be used due to the difficulties in managing the injury and which historically presents an unsatisfactory outcome if there is no immediate diagnosis and adequate treatment. The anatomical and biomechanical understanding of the elbow associated with the understanding of the fracture-dislocation mechanism, as well as the development of new implants, have allowed a systematic approach to the treatment of this injury, enabling better functional results.<sup>1-3</sup>

Regarding epidemiology, this is a rare pathology that usually affects young men. It typically arises from high-energy mechanisms, with one notable scenario being a fall involving an outstretched hand, hyperextended elbow, supination, and valgus stress.<sup>4,5</sup>

In view of the scientific relevance of the best approach for treating the terrible triad injury of the elbow, the objective of this study is to evaluate the functional results of patients undergoing surgical intervention for this type of injury,

analyzing the treatment methods used and associated epidemiological variables.

## Materials and methods

This study was a cross-sectional study evaluating patients with the terrible triad of the elbow who underwent surgical treatment from February 2018 to June 2020 in our service, with a minimum postoperative follow-up of 12 months. The identified sample consisted of 17 patients, but of these only 13 completed all stages of the study and therefore were considered as the universe to be taken into account.

The epidemiological information of interest was collected: age, sex, side of dominance, affected side, characteristics and classifications of injuries, trauma mechanism, time to surgery, type of procedure performed and range of motion. The Mason classification was used for radial head fractures and the Regan and Morrey classification for the coronoid process. In order to perform a functional analysis, the DASH and BRUCE questionnaires were applied at 1, 3, 6, 9 and 12 months after the surgical approach.

The DASH score assesses everyday functional and work capabilities, ranging from no difficulty to totally incapable. It is composed of simple and direct questions answered by the patients themselves.

Among the criteria evaluated by the BRUCE score are the range of motion and cosmetic appearance, evaluation performed by the physician, and the presence of residual pain



**Fig. 1** A-B AP and lateral radiographs, respectively, demonstrating fracture of the radial head, coronoid fracture, and subluxated elbow after closed reduction of the terrible triad injury of the elbow.

and impact on activities of daily living, which are considered based on the patients' responses.

Inclusion criteria were patients aged between 16 and 80 years and diagnosed with radial head fracture associated with coronoid fracture and elbow dislocation (terrible triad injury of the elbow). With regard to the exclusion criteria are the existence of other associated fractures in the same limb, active infection, clinical comorbidities that contraindicate surgery and patients younger than 16 years old.

### Results

Among the 13 patients studied, 77% were male and only 23% were female. (► Fig. 1A-B). Different ages were recorded, with a minimum of 27 years old and a maximum of 76 years old. With regard to the injured limb, 77% were in the left elbow and only 23% in the right, of these, 23% of the patients were left-handed and 77% were right-handed. Regarding the motivations for the trauma, although different situations were found, 92% were with a high-energy mechanism (► Table 1).

Regarding the interval between the date of the trauma and the first surgical intervention, of the 13 cases evaluated,

**Table 1** Epidemiological data of the terrible triad injury of the elbow

Male	10 (77%)
Female	3 (23%)
Average Age	45 years
Dominant side affected	23%
Average time to surgery	12 days

only 4 were operated on in less than 14 days. When analyzing the results obtained according to the time to start treatment, patients operated within 14 days had statistically better functional results than those operated on over 14 days. This longer interval until the surgery is performed among the patients studied may be decisive in the functional results found. In situations of this complexity, the ideal is for hospitalization to take place within 24-48 hours, and among the cases evaluated, the average time was 12 days.

In the present study, Mason's classification was used for fractures of the radial head, with 61% of the cases being type III, another 30% type II and 9% type I. of the coronoid process, the parameters of Regan and Morrey were used, with 38.5% of the cases as type I, 38.5% as type II and only 23% cases as type III. These epidemiological data obtained corroborate with those described in the literature. Conversely, a predominance of the non-dominant side as the most affected (77%) was observed. (► Table 2).

Initially, the patients underwent closed reduction of the dislocation and immobilization with an axillary plaster splint, until the surgical treatment was performed. Regarding the surgical techniques, radial head arthroplasty (60%), resection (30%) and osteosynthesis (10%) were used in the radial head were. As for the coronoid fracture, coronoid-plasty (80%), anchor fixation (20%) and conservative (7.7%) were used. (► Figs. 2 and 3).

Of the 13 patients followed up, 7 (54%) underwent a second surgery. Of these, 4 were performed to remove the external fixator placed at the time of the first surgery, 1 to replace the radial head prosthesis that was subluxated in the immediate postoperative period, 1 patient underwent joint manipulation due to elbow stiffness and 1 for external fixator placement. This last patient underwent a third procedure to

**Table 2** Clinical data of patients undergoing surgical treatment of the terrible triad injury of the elbow

	Interval between trauma and hospitalization	Interval between date of trauma and 1st surgical procedure	Mason score	Regan and Morrey classification	Radio Head Technique	Technique for coronoid
1	8 days	27 days	III	II	Radial head arthroplasty	Coronoideplasty
2	17 days	23 days	II	II	Osteosynthesis	anchor fixation
3	10 days	22 days	I	I	Radial head arthroplasty	Coronoideplasty
4	9 days	22 days	II	II	Radial head arthroplasty	Coronoideplasty
5	10 days	13 days	III	I	Radial head resection	Coronoideplasty
6	12 days	12 days	II	II	Radial head arthroplasty	Coronoideplasty
7	22 days	34 days	III	III	Radial head arthroplasty	Fixation with Ethibond + External Fixator
8	22 days	24 days	III	III	Radial head arthroplasty	Coronoideplasty + Complex fixation Lateral ligament with anchors
9	16 days	52 days	II	I	Partial radial head resection	Coronoideplasty
10	15 days	44 days	III	I	Radial head resection	Coronoideplasty
11	4 days	11 days	III	I	Radial head arthroplasty	Conservative
12	14 days	26 days	III	II	Radial head arthroplasty	Coronoideplasty
13	2 days	10 days	III	III	Radial head resection	Coronoideplasty



**Fig. 2** Intraoperative photograph demonstrating lateral access used for coronoid repair, radial head repair/replacement, and common extensor/LCL repair.

remove this fixator. The need to place an external fixator was due to the identification of joint instability during passive movement. Half of the of patients included in this study returned to their professional activities.

Regarding the DASH score, in which the highest values indicate worse clinical conditions, only 2 patients had a high score. With regard to BRUCE, as expected, a greater number of patients had a high score, ranging from 13 to 78 (– **Table 3**).



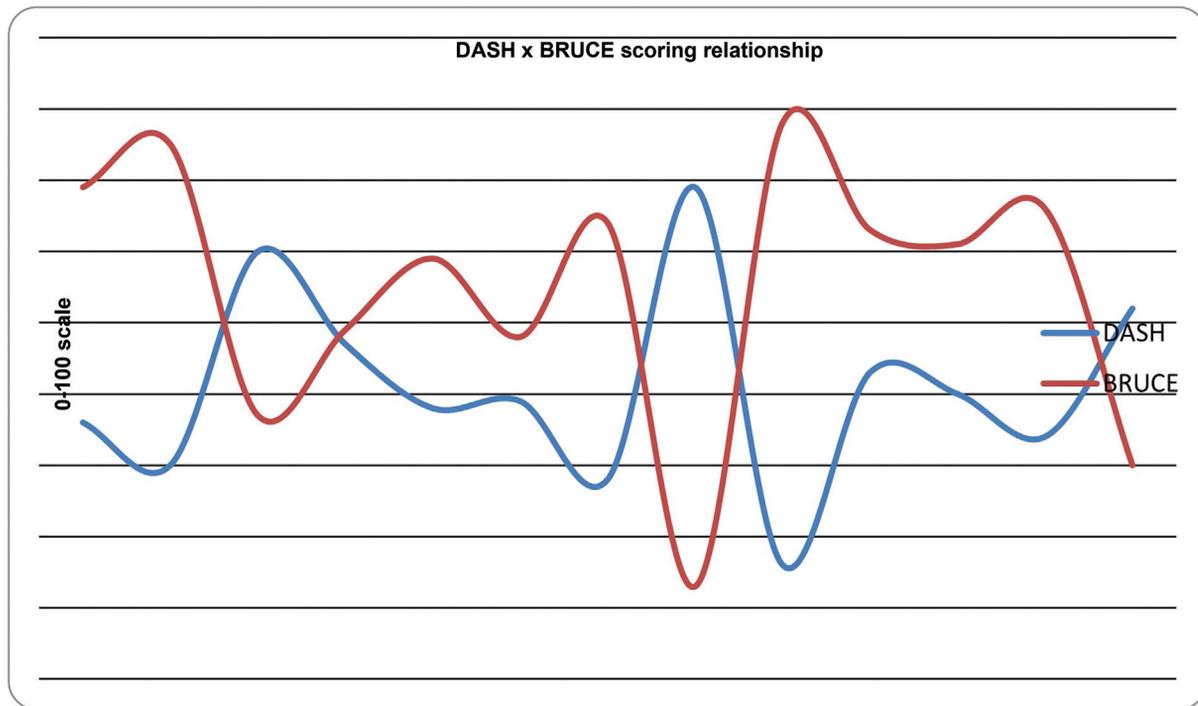
**Fig. 3** Intraoperative photography. Bone fragment of the head of the radius resected during a surgical approach.

It is possible to relate the functional results obtained by the scores and by the physical examination with the severity of the injury. It was also observed that among the results obtained in the flexion/extension and prone/supination analysis, and the DASH and BRUCE scores achieved, it can be seen that the patient who presents a good range of motion is the same one who had satisfying DASH and BRUCE's results. Likewise, patients with poor scores were those who had more compromised Flexo/Extension and Prone/Supination results (– **Fig. 4**).

In addition, when relating the DASH and BRUCE scores of each patient, we observed that those with the lowest DASH scores were also the ones with the highest BRUCE scores. Since these two scores are opposites, while high BRUCE scores are desired, DASH is expected to be low. Thus, the

**Table 3** Classification of the terrible triad injury of the elbow according to the DASH and BRUCE scores

	FLEX/EXTENSION	PRONE/SUPINATION	DASH	BRUCE
1	15 - 140	60 / 10	36	69
2	20 - 140	50 / 50	20	75
3	70 - 110	20 / 10	60	37
4	30 - 70	45 / 45	47	49
5	60 - 120	50 / 50	38	59
6	10 - 130	60 / 40	39	48
7	30 - 120	50 / 40	28	64
8	20 - 30	10 / 10	69	13
9	20 - 130	70 / 70	16	78
10	30 - 110	60 / 30	43	63
11	30 - 110	50 / 40	40	61
12	20 - 120	45 / 45	34	66
13	30 - 70	40 / 40	52	30



**Fig. 4** DASH and BRUCE scoring relationship. Relação DASH x BRUCE = DASH x BRUCE scoring relationship, Escala 0 a 100 = 0-100 scale

result found in the studied sample is in accordance with the indicators of the area.

**Discussion**

The terrible triad injury of the elbow is a complex injury with an unfavorable prognosis due to recurrent functional limitations.<sup>6</sup> The main rotatory mechanisms of injury are posterolateral and posteromedial, the displacement force involves supination of the forearm and of the valgus. In cases where rotation is sufficient for the coronoid process and the

head of the radius to project below the distal humerus, the dislocation is considered simple. On the other hand, in insufficient rotation, the distal humerus fractures the coronoid process and the radial head, configuring the terrible triad injury of the elbow. The first ligament affected is the lateral collateral (LCL), followed by the medial collateral (LCM).<sup>4,5</sup>

The diagnosis is made through standard anteroposterior and lateral radiographs; however, this type of fracture may not be visualized in conventional radiological exams. Thus, it is important that patients who are victims of the

aforementioned traumatic mechanism, who have reduced limb mobility, edema, pain on passive and active movement, undergo computed tomography to rule out possible injuries.<sup>7</sup>

In the vast majority of cases, surgical treatment is the most indicated since it offers better outcomes.<sup>2,3</sup> Some variants are relevant in obtaining the results of these patients, such as the trauma mechanism, patient age, fracture severity, and time to start treatment. However, even if adequate treatment is used, some complications can be expected, such as range of motion limitation, ligament instability, arthrosis and ulnar neuropathy.<sup>6,8,9</sup>

Surgical treatment comprises, in general, reduction and fixation of the coronoid process, repair of fractures of the radial head and of the lateral ligament complex. The medial collateral ligament approach is performed in specific cases of maintenance of residual instability.<sup>10,11</sup>

When analyzing the results obtained by Gonçalves et al.,<sup>12</sup> in which the DASH score was used to assess treated patients, it is possible to see that they obtained an average score of 12, a result much lower than those achieved in this study, in which the average score was 40 points. This difference in results may be due to the long waiting time for the start of treatment and the severity of these cases of the patients surveyed.

However, in a study by Miyazaki et al.,<sup>13</sup> where the BRUCE was used as a parameter for evaluating the results, the scores obtained were much higher than those achieved in this study. Even though most of them were not considered excellent by the researchers, they indicated greater success in the techniques used.

In addition, surgical performance by different professionals may, to some extent, have interfered with the results. Even knowing that all are qualified surgeons, in a study it is important that the sample is submitted to the same parameters for greater reliability and possibility of comparison between cases and results achieved. In a situation where this group of patients went through different parameters in care, it is possible that there are also differences in the results.

## Conclusions

Surgical treatment of the terrible triad injury of the elbow generates acceptable functional results in most cases, regardless of the method used. It is also noteworthy that the success of the treatment is related to the time interval between the trauma and the first surgery, in addition to the severity of the injuries. Therefore, the longer this interval and the greater the severity of the injury, the greater the

patient's difficulty in restoring elbow functions. Furthermore, due to the reduced sample size, we suggest new studies in order to prove such outcomes.

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### Conflict of interests

The authors declare no conflict of interest.

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