Research Article

Shoulder Terrible Triad: Classification, Functional Results, and Prognostic Factors

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Abstract

Introduction: The shoulder terrible triad (STT) is a traumatic anterior shoulder dislocation, associated with rotator cuff (RC) tear and nerve injury from the brachial plexus. This study aimed to describe the functional results and prognostic factors of surgery in patients with STT.

Methods: Thirty consecutive patients with acute STT were included at the same institution. All patients were examined with x-rays, MRI, and electromyography. Surgical treatment in the acute setting was indicated to address an RC injury or a displaced greater tuberosity fracture. Variables registered on the day of surgery were preoperative Constant and Western Ontario Rotator Cuff (WORC) scores and injury pattern. At final discharge, Constant, American Shoulder and Elbow Surgeons (ASES), WORC, and subjective shoulder value scores were recorded by an independent evaluator.

Results: Twenty-seven patients underwent a complete follow-up. The dominant arm was affected in 50% of cases. The mean follow-up was 27 (12 to 43) months. The mean WORC and Constant scores improved from 1,543 to 1,093 ($P = 0.015$) and 31 to 54 ($P = 0.003$), respectively. The ASES and subjective shoulder value scores at the end of the follow-up were 60 and 56 points, respectively. RC tears and nerve injuries that did not involve the axillary or suprascapular nerves were associated to better results than greater tuberosity fractures and injuries to the axillary or suprascapular nerves, respectively, in WORC ($P = 0.028$), Constant ($P = 0.024$), and ASES scores ($P = 0.035$). Preoperative WORC and Constant scores were independent prognostic factors.

Conclusions: The most frequent patterns include complete RC tears, anterior capsular injuries, and an axillary nerve injury. Patients had improved functional scores at the end of follow-up after surgery. Better functional results were correlated to RC tears, injuries to nerves with innervation distal to the shoulder, and higher preoperative Constant and WORC scores.

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The "shoulder terrible triad" (STT) is defined as a traumatic shoulder dislocation associated with a rotator cuff (RC) tear and an injury to the brachial plexus branches.[1] It is a triple injury that compromises all functional structures of the shoulder. In 1991, it was described for the first time by Gonzalez et al[2] from two cases. Then, in 1994, Güven et al[3] reported one case and named it the "unhappy triad of the shoulder." The

term "shoulder terrible triad" was first used by Groh and Rockwood[1] in 1995. It has been described briefly in literature as case reports.[1-6] However, the patterns of injury have not been characterized, and surgical treatment results have not been described in larger series.

The main objective was to describe the functional results after surgical treatment in patients with an STT. The secondary objectives were to (1) characterize injury patterns in a cohort of patients with an STT and (2) describe prognostic factors of surgical treatment in patients with an STT.

Methods

Patient Selection

A retrospective cohort study was designed. An STT was defined as shoulder dislocation associated with a neurological injury involving the brachial plexus (root, trunk, cord, or terminal branch) and a complete RC tear or displaced greater tuberosity (GT) fracture. We decided to include displaced GT fractures associated to an anterior shoulder dislocation and a neurological injury involving the brachial plexus as a STT. Displaced GT fractures create a discontinuity of the load transfer between the RC and the proximal humerus, so they are a functionally similar injury to a complete posterosuperior RC tear in the setting of an STT. Therefore, RC injuries and displaced GT compromise the proximal humerus abductor complex and can be considered different types of STT.

Patients from our surgical database from 2014 to 2016 were reviewed. Inclusion criteria were as follows:

(1) A consecutive series of patients with an STT.

(2) Admitted for an arthroscopic repair of a complete RC tear or a GT fracture fixation.

(3) First anterior shoulder dislocation episode before surgery.

(4) Minimum follow-up of 1 year for functional assessment.

We excluded patients with irreparable RC tears who required another type of reconstructive surgery and those with nondisplaced GT fractures that did not need fixation. All study participants provided informed consent, and the study was authorized by the local scientific ethics committee.

Surgical Intervention and Follow-up

All patients were initially admitted to the emergency department due to a working accident, covered under the local working accidents insurance law. Shoulder radiographs were taken before and after shoulder reduction. All patients had their shoulder reduced under conscious sedation on the same day of the initial trauma. After this, all patients were referred to the shoulder surgery specialists.

Additional imaging studies included shoulder magnetic resonance for suspected RC injuries and CT scans to evaluate GT fractures before surgery. Neurological lesions were suspected during physical examination if any sensory or motor deficits of the musculocutaneous, radial, medium, or ulnar nerves were observed. Sensory examination of the terminal branch of the axillary nerve was done to find changes that were suggestive of axillary nerve damage. Deltoid muscle strength was not initially considered suggestive of axillary nerve damage as it may be difficult to test after a recent traumatic episode and a concomitant GT fracture or RC tear.[4] The STT was diagnosed by the shoulder specialist after clinical and imaging evaluations and surgery were indicated. All patients were examined using electromyography (EMG) to confirm the presence and extension of nerve injuries. For changes in EMG to manifest Wallerian degeneration, the EMG was done between the fourth and sixth week after the initial injury.[5] All patients underwent at least a second EMG during the follow-up.

On the day of surgery, a Western Ontario Rotator Cuff (WORC) and a Constant score were assigned to all patients scheduled for an arthroscopic RC repair.[6,7] At the end of the surgery, the following variables were recorded in the surgical database: sex, age, type of abductor injury, and type of anterior glenoid injury according to the arthroscopic findings. According to the International Society of Arthroscopy, Knee Surgery, and Orthopaedic Sports Medicine consensus,[8] RC injuries were classified based on size according to Snyder[9] and retraction according to Patte.[10] Fatty degeneration was classified according to Goutallier et al[11] as Fuchs et al[12] demonstrated that a grading system of fatty degeneration is reproducible as well on CT scans as on MRI scans. Subscapular injuries were classified according to Lafosse et al[13] and GT fractures according to Mutch et al.[14] Nerve injuries were described and classified according to Seddon[15] based on the initial EMG findings.

All surgeries were done by a team of five shoulder surgeons at a single trauma center. RC tears were repaired arthroscopically with suture anchors. Suture anchor repair technique was decided by each surgeon; 70% of the RC repairs were done with a single row technique and 30% with a double-row transosseous equivalent repair. The average number of anchors used was 2.7 (range, 1 to 5). Fifty-two percent underwent an acromioplasty. No capsulolabral or bony Bankart repair was done as an associated procedure. Split GT fractures were fixed with plate and screws, and avulsion fractures were fixed with open surgery and suture anchors. Examples of RC repairs and GT fixations can be seen in Supplemental Digital Content 1 (Figure 1, A, http://links.lww.com/JAAOS/A438); Supplemental Digital Content 2 (Figure 1, B, http://links.lww.com/JAAOS/A439); Supplemental Digital

Table 1

Summary of Anatomic Injury Findings in Patients With Shoulder Terrible Triad

Injury	Incidence (%) (N)
Abductor complex injury	
RC	83.3 (25)
Greater tuberosity	16.7 (5)
Anterior glenoid injury	
Capsular	63 (19)
Bankart	17 (5)
Bony Bankart	20 (6)
Neurologic injury	
Axillary nerve	70 (21)
Suprascapular nerve	13 (4)
Axillary and suprascapular nerves	7 (2)
Nerves distal to the shoulder	10 (3)

RC = rotator cuff

Content 3 (Figure 2, A, http://links.lww.com/JAAOS/A440); and Supplemental Digital Content 4 (Figure 2, B, http://links.lww.com/JAAOS/A441).

All patients were put in a shoulder immobilization device for the first 3 weeks, only allowing them hand and elbow exercises alone. Between the third and sixth weeks, passive assisted mobilization was initiated. After 6 weeks onward, the shoulder immobilization device was not used anymore, and scapular balance exercises were initiated. From week 12 onward, strength exercises were added.

During follow-up, GT fractures were followed with x-rays until bone union was observed. Patients who underwent RC repair also underwent an MRI during follow-up if after 6 months persisted with pain at 90° of elevation, there was a positive Jobe sign, belly press sign, lag signs, pseudoparesia, or pseudoparalisis.[16,17]

All patients with at least 1-year follow-up were called back at the same time for a functional evaluation which was done by an independent surgeon. Constant, WORC, American Shoulder and Elbow Surgeons (ASES), and subjective shoulder value (SSV) functional scores were done.

Statistical Analysis

Patients were grouped by their abductor complex injury, anterior glenoid injury, and brachial plexus injury, and a descriptive analysis was done. Abductor complex injuries were grouped as an RC or GT injury. Anterior glenoid injuries were grouped as a capsular, labral, or bony Bankart injury. In the absence of labral or bony Bankart injuries, we classified the injury as anterior capsular injury because there must be at least some capsular stretching after an anterior shoulder dislocation. Brachial plexus injuries were grouped based on anatomic patterns and by Seddon[15] classification.

The analysis of variance test was used to compare the means of functional scores before surgery and at the end of the follow-up. A Student *t*-test was done to compare the means of independent variables. A bivariate correlation analysis between numerical variables was done. A multiple linear regression was done to study the relationship between known identified independent variables and functional results.

A regression was done for each functional score, using a backward stepwise method to choose the subset of independent variables. From the analysis of variance tests, significant models were chosen ($P \leq 0.05$). Among them, the determination coefficients (R^2) were used to identify known variables that most influenced the functional results. All statistical analyses were conducted with SPSS (SPSS).

Results

Overall, data for 100 consecutive patients with shoulder anterior dislocations and abductor complex injuries were found in our surgical database during the study period. Of them, 30 had a nerve injury involving the brachial plexus (30%), and STT was diagnosed.

The average age of patients was 56 (range, 36 to 74; SD = 7.4) years, and 73% were men. The dominant arm was affected in 50% of cases. The average length of time from the injury to surgery was 2.9 months (SD = 1.05) for RC tears and 0.81 months (SD = 0.66) for GT fractures.

Injury Description

The most frequent abductor complex injury was the RC tear (83.3%). The most frequent anterior glenoid injury was a pure capsular lesion (63%). All bony Bankart injuries were less than 20% of the glenoid surface area. According to EMG findings, the axillary nerve was the most frequent nerve involved (70%), followed by the suprascapular nerve. According to the Seddon[15] classification, 46% of cases had neuropraxias and 53% axonotmesis. All neurological injuries were postganglionic and were managed without surgery. Table 1 demonstrates the summary of the findings.

Regarding RC injuries, 60% were complete tears of the posterosuperior cuff and 92% had a Goutallier score ≤2. The posterosuperior cuff injuries had a C3 and C4 extension in

56.5% of the cases and a Patte 3 retraction in 30.4%.[9,10] Subscapular tendon tears were Lafosse type 2 in 80% of the cases and Patte 2 in 57%. A descriptive analysis of RC injuries can be found in Table 2. Of GT fractures, four were split fractures and one was an avulsion type fracture.[14]

Functional Results

The median follow-up period was 27 (12 to 43) months, and 27 of the 30 patients admitted had an on-site functional assessment. The results are summarized in Table 3. Preoperative Constant and WORC scores of patients who had an RC repair improved at the end of the follow-up (Table 4).

The rate of RC retears diagnosed by MRI was 24% (6/25). Of these, five required another surgery. Confirmed RC retears had a significantly worse Constant score than patients who did not require an MRI during follow-up (33.7 versus 60.4; $P = 0.003$). The mean WORC ($P = 0.332$), ASES ($P = 0.342$), and SSV ($P = 0.830$) scores were worse for confirmed retears.

The mean time from initial trauma to surgery in patients who had a retear was 2.4 months (SD = 0.48), and the mean age was 57 (SD = 4.88) years. Initially, all had a complete posterosuperior RC tear, and three had an associated subscapular Lafosse type 2 tendon tear.[13] The posterosuperior extension was C4[9] in five patients, and retraction was Patte 3 in four patients.[10] Three were reoperated with a reverse prosthesis and two with a new RC repair. One (1/5) GT fracture was loosened and required a revision surgery.

No patient suffered a recurrent dislocation after surgery. All nerve injuries showed at least partial recovery in EMG findings and clinical evidence of a reinnervation process during their follow-up without the need for nerve surgery. No difference was found between neuropraxias and axonotmesis in the final follow-up Constant ($P = 0.345$), WORC ($P = 0.781$), ASES ($P = 0.986$), and SSV ($P = 0.378$).

Table 2

Descriptive Analysis of RC Injuries

RC Injury (25 Cases)	Incidence (%) (N)
Tendons	
Posterosuperior	60 (15)
Anterior	8 (2)
Posterosuperior + anterior	32 (8)
Fatty degeneration	
Goutallier 0	32 (8)
Goutallier 1	36 (9)
Goutallier 2	24 (6)
Goutallier 3	8 (2)
Posterosuperior extension (23 cases)	
C1	9 (2)
C2	35 (8)
C3	13 (3)
C4	43 (10)
Posterosuperior retraction	
Patte 1	26 (6)
Patte 2	44 (10)
Patte 3	30 (7)
Anterior injury extension (10 cases)	
Lafosse 1	10 (1)
Lafosse 2	80 (8)
Lafosse 3	10 (1)
Anterior retraction	
Patte 1	40 (4)
Patte 2	60 (6)
Patte 3	0

RC = rotator cuff

Table 3

Functional Scores at Final Follow-up

Score	Min.	Max.	Mean	SD
Constant	17	100	50	26.8
WORC	5	1,935	1,172	583.1
ASES	13	100	59	25.5
SSV	0	100	57	24.2

ASES = American Shoulder and Elbow Surgeons, SSV = subjective shoulder value, WORC = Western Ontario Rotator Cuff

Prognostic Factors

Independent variables from the different injury patterns identified were included in the multiple linear regression (Table 5).

Of all patients, those with RC tears and injuries to nerves with innervation distal to the shoulder correlated with better Constant, WORC, and ASES

Table 4

Preoperative and Final Follow-up Constant and WORC Scores of Patients Who Had a Rotator Cuff Repair

Score	Preop (Mean ± SD)	Postop (Mean ± SD)	*P* Value
Constant	31 ± 15	54 ± 26	0.003
WORC	1,544 ± 346	1,092 ± 596	0.015

WORC = Western Ontario Rotator Cuff.

Table 5

Independent Variables Included in the Analysis to Study the Relationship With Functional Results

- Abductor complex injury
  - RC tear
  - GT fracture
- Anterior glenoid injury
  - Capsular
  - Bankart
  - Bony Bankart
- Brachial plexus injury
  - Distal to shoulder nerves
  - 1 nerve to the shoulder (axillary or suprascapular)
  - 2 nerves to the shoulder (axillary and suprascapular)
  - Neurapraxia
  - Axonotmesis
- Preoperative functional scores (RC injuries)
  - WORC
  - Constant
- RC healing status
  - Healed
  - Retear

GT = greater tuberosity, RC = rotator cuff, WORC = Western Ontario Rotator Cuff

scores ($P \leq 0.05$, $R^2 = 0.22$ to 0.33) (Table 6).

In the RC tear subgroup, better preoperative WORC and Constant scores were correlated with better functional results in Constant, WORC, ASES, and SSV scores at the end of the follow-up ($P \leq 0.05$, $R^2 = 0.33$ to 0.66) (Table 7). Anterior glenoid injuries, RC healing status, type of nerve injury according to Seddon,[15] or amount of nerves innervating the shoulder involved did not correlate to functional scores ($P \geq 0.05$).

Age did not have a significant correlation with the Constant score ($P = 0.83$), WORC ($P = 0.44$), ASES ($P = 0.72$), and SSV ($P = 0.63$).

Discussion

The objectives of this study were to describe injury patterns, functional results, and prognostic factors of surgical treatment in a cohort of patients with an STT. To date, this is the largest study in this group of patients. There were different injury patterns under the same definition of STT that have not been described in detail previously and surgical treatment had improved functional results.

Regarding abductor complex injuries, RC tears were the most frequent type of injury, with an isolated posterosuperior cuff tear as the most frequent pattern. Most of them had a Goutallier score ≥1; hence, we can assume that these were probably acute over chronic tendon injuries or chronic injuries. The incidence of a complete RC tear associated with a shoulder dislocation increases with age, reaching 100% in patients older than 70 years.[18]

Three injury patterns were identified in the anterior glenoid rim: capsular injuries, Bankart injuries, and bony Bankart lesions. Pure capsular lesions, in which no labral or anterior glenoid lesion was observed under arthroscopic vision, were the most frequent. This agrees with what has been described previously. Older patients have less incidence of Bankart injuries after an anterior shoulder dislocation.[18]

In patients with an RC tear associated with the first episode of shoulder dislocation, the surgical technique implemented by our team did not involve Bankart repair. This is because we have observed a greater tendency of stiffness than instability in these patients after surgery. The same is true for GT fractures associated with a shoulder dislocation, where fixation of the proximal humerus is traditionally the only planned surgery. In patients with their first episode of a shoulder dislocation and RC tear, we only repair bony Bankart lesions with critical glenoid bone loss (>20%). In this cohort of STTs, no patient with these characteristics was seen, but it has been previously described within STT in the literature.[19]

Three different anatomical patterns of nerve injuries of the brachial plexus were identified. The most frequent one was an isolated injury of a terminal branch that innervates the shoulder, being an isolated axillary nerve injury. Then, a similar incidence was found between brachial plexus injuries that involved innervation distal to the shoulder, isolated suprascapular nerve injuries, or injuries to both terminal branches to the shoulder. According to the Seddon[15] classification, almost half of our cases had a neurapraxia and the other half an axonotmesis. No patient had a neurotmesis.

The incidence of an axillary nerve injury in shoulder dislocations has been estimated to be between 9% and 18%.[19] An injury to the axillary nerve may be caused by either a direct compression mechanism of the humeral head or by a traction

mechanism of the nerve in the posterior axillary gap.[20] Suprascapular nerve injuries are supposed to be a result of a traction mechanism in line with a complete posterosuperior RC tear; meanwhile, combined injuries of the suprascapular and axillary nerves may be a combination of both mechanisms or an injury located at the superior trunk.[20]

The mean functional results achieved at the end of the follow-up were only regular. The scores in all functional scales ranged from 50% to 60%, with a wide dispersion. However, patients with an RC repair showed notable statistical and clinical improvement with respect to their preoperative scores.[21] RC retears had worse Constant score at final follow-up.

To date, only clinical and functional results have been described in a series of patients with STT. Simonich and Wright described a series of six patients with an average age of 57 and 5.6 years of follow-up. Total Shoulder Pain and Disability Index postoperative scores revealed good or excellent results in four patients. Clinically, five patients achieved nerve injury recovery.[22] These results were better than ours; however, comparison between studies becomes difficult because RC injuries were not described in detail and different scores were used. In addition, it should be considered that all patients in our series were under a workers' compensation insurance law, which has been described as a prognostic factor for poorer results in RC repairs.[23]

Among the different structures injured in an STT, we identified some prognostic factors in the different patterns. Between the two types of abductor complex injuries, repaired RC correlated with better results than GT fixation. The number of reoperations in each group was 20% because of an RC retear or GT loosening. This finding may be influenced by the small number of patients in the GT fixation group. Nothing has been described about this difference and must be studied in future in larger series.

Table 6

Variables Associated With Better Functional Scores

Score[a]	Variables	*P* Value	R	R^2
WORC	RC + distal nerves	0.028	0.51	0.26
Constant	RC + distal nerves	0.024	0.58	0.33
ASES	RC + distal nerves	0.035	0.41	0.17

ASES = American Shoulder and Elbow Surgeons, RC = rotator cuff, WORC = Western Ontario Rotator Cuff
[a] There was no correlation found between known variables and subjective shoulder value.

Table 7

Rotator Cuff Repair Subgroup Variables Associated With Better Functional Score

Score	Variables	*P* Value	R	R^2
WORC	Preop. WORC + distal nerves	0.006	0.65	0.42
Constant	Preop. Constant + distal nerves	0.001	0.81	0.66
ASES	Preop WORC + distal nerves	0.021	0.58	0.33
SSV	Preop WORC + distal nerves	0.009	0.68	0.46

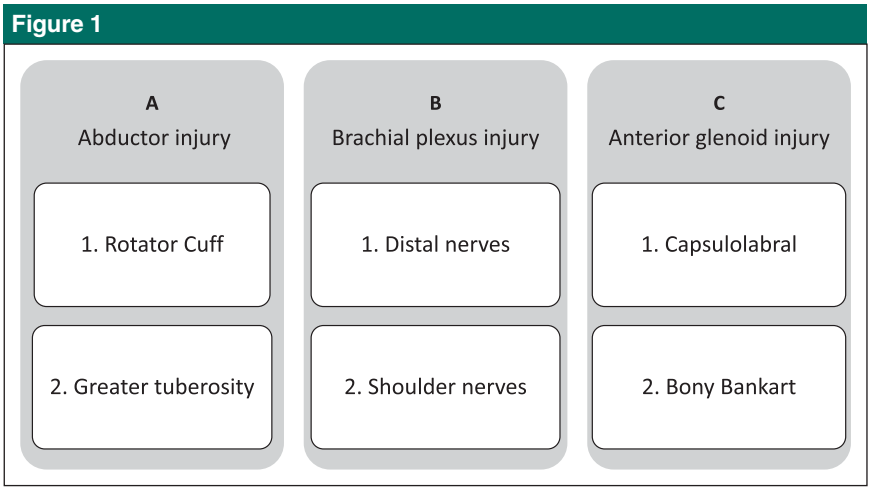
ASES = American Shoulder and Elbow Surgeons, SSV = subjective shoulder value, WORC = Western Ontario Rotator Cuff

None of the different anterior glenoid injuries correlated with functional scores at the end of the follow-up. No patient had a residual instability despite the absence of an anterior glenoid injury repair. These findings suggest that in most cases, anterior glenoid injuries do not need any surgery to prevent a new shoulder dislocation. However, we still do not know whether a Bankart or bony Bankart repair influences functional scores as they restore normal articular anatomy. These findings must be compared with those of patients who have undergone anterior glenoid repair.

All patients in this series showed evidence of partial or full nerve recovery at their last EMG during follow-up and clinical evidence of a reinnervation process. None of them had a clinical deficit that required surgery. Irreversible nerve injuries associated with acute shoulder dislocations are rare. Most of the nerve injuries recover partially or completely after a post-traumatic interval between 3 to 24 months[22,24] with reported rates in the literature ranging from 87.5% to 100% of cases.[5,25] Although some authors recommend surgery for nerve injuries if there is no improvement in terms of the clinical and/or electrophysiological recovery status within 3 to 4 months after the injury, we think that nerve injuries associated to shoulder dislocations can be observed longer because most of them will show enough reinnervation and muscle function during follow-up.[26,27]

Injuries to the brachial plexus which involved nerves with innervation distal to the shoulder correlated with better shoulder functional results than injuries to the axillary nerve and/or suprascapular nerve. This may be explained because only shoulder functional scores were done at the final follow-up. As shoulder innervation was not injured, it may not compromise shoulder scores. Other functional evaluations, such as the

Figure 1



Shoulder terrible triad classification.

Disabilities of the Arm, Shoulder, and Hand score, should be used to have a wider view of the functional effect of distal brachial plexus injuries.[28] Functional results were not influenced by having one or two injured nerves innervating the shoulder.

Neuropraxias and axonotmesis had similar functional results at the final follow-up, and none of them influenced the final results as prognostic factors. We think this may be explained because axonotmesis nerve injuries recovered as well as neuropraxias at the final follow-up. However, a standardized clinical and electrophysiological follow-up is necessary to determine the speed and the final degree of recovery of both types of lesions.

We propose the following working classification for STT based on the findings of this study regarding anatomic patterns, prognostic factors, and surgical indications (Figure 1): (A) abductor complex injury—(1) RC and (2) GT; (B) brachial plexus injury—(1) distal nerves and (2) shoulder nerves; and (C) anterior glenoid injury—(1) capsulolabral and (2) bony Bankart.

Surgery is indicated for injuries in group A. Repairable complete tears of the RC and displaced GT fractures should be repaired early. For injuries in group B, observation is initially advised if there is no evidence of being preganglionic. Most will not require subsequent surgical treatment. Shoulder function may be influenced by the extension of the brachial plexus injury. Most of the injuries in group C do not require surgery without causing residual instability. However, surgery should be considered for critical glenoid defects (>20%), especially when associated with other risk factors of shoulder dislocation in this group of combined instability and RC tears.[20]

The sample size and retrospective design are considered the limitations of this study. This is due to a low frequency combination of injuries to the shoulder. Other limitations include its transverse final evaluation, only 1-year follow up, a lack of nonsurgical control group, a heterogeneous sample of patients, and multiple surgeons involved in the treatment of these patients. Neurological lesions were not followed in a standardized manner, so there is an absence of the exact degree of recovery and time to recover. A future, larger series should evaluate functional and prognostic results of this behavior within the different patterns of injuries described.

Conclusions

Patients with STT have different injury patterns. The most frequent patterns include complete RC tears, anterior capsular lesions, and an axillary nerve injury. Although patients undergoing surgical treatment had improved functional results, these were only regular at the final follow-up. RC tears and injuries to nerves with innervation distal to the shoulder correlated with better functional results. In patients undergoing RC repair, preoperative functional scores (Constant and WORC) correlated positively with final results at the end of follow-up. The revision surgery rate was high due to complications in the abductor complex injury and none due to residual instability. A working classification for STT based on the findings of this study regarding anatomic patterns, prognostic factors, and surgical indications could be helpful in guiding treatment and future studies in these patients.

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