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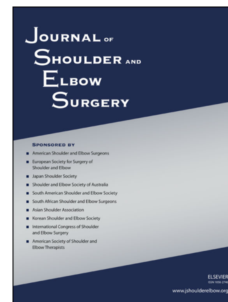

Suprascapular nerve injury after reverse total shoulder arthroplasty. Correlation with screw out of vault penetration and functional situation. Prospective study

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Suprascapular nerve injury after reverse total shoulder arthroplasty. Correlation with screw out of vault penetration and functional situation. Prospective study

Run Title: Suprascapular nerve injury during reverse shoulder arthroplasty

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1 **Suprascapular nerve injury after reverse total shoulder arthroplasty. Correlation with screw**
2 **out of vault penetration and functional situation. Prospective study**
3

4 Abstract
5 Introduction: Baseplate screws have been suggested as a possible cause of suprascapular neuropathy
6 after reverse total shoulder arthroplasty (RTSA). This study aims to investigate the association
7 between screw penetration out of the vault, electromyographic study and the clinical outcomes.
8 Methods: 31 patients who underwent RTSA for cuff tear arthropathy were prospectively enrolled.
9 They were followed up for a minimum of 24 months. All underwent computed tomography 6 months
10 postoperatively in order to determine the extraosseous position of the screws (perforation of the
11 second bone cortex and protrusion into the supra or infraspinatus fossa). Electrodiagnostic evaluation
12 was performed preoperatively and postoperatively to stablish any relation between cortex perforation
13 of the screw and SSN injury. Clinical outcomes pre and postoperatively (Constant score, ranges of
14 motion, and VAS) of patients with and without documented injury were recorded.
15 Results: 14 patients (45.2%) had abnormal preoperative SSN electrodiagnostic study (chronic or
16 disuse injuries) and 6 patients (19.4%) abnormal postoperative study (acute injury. Of these last 6
17 patients: 2 cases appeared over the pre-existing lesion and 4 appeared over an intact preoperative
18 nerve, all of them affecting the infraspinatus branch of the SSN. Perforation of the second cortex was
19 detected for 60% of superior screws and 40% of posterior screws. The mean lengths of the superior
20 and posterior screws were 30 and 18.2 mm, respectively. Patients with screw perforation of the second
21 cortex were assessed as having a high risk of nerve injury (40% vs. 9.5%).
22 Conclusions: Preoperative SSN injuries do not have a significant clinical impact and do not
23 predispose to an acute postoperative SSN lesion. The Constant Score and VAS scale for patients with
24 acute SSN injuries were not statistically different than those without SSN injury.
25 Extraosseous position of the screw increases the probability of a SSN injury to 31%. This risk is
26 higher with the posterior screw, which leads us to question whether it is really necessary to use it.

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27

28 Keywords: Baseplate screw penetration; suprascapular neuropathy; reverse total shoulder
29 arthroplasty; clinical outcome; suprascapular electromyographic.

30

31 Level of evidence: Level I; Prospective Cohort Design; Prognosis Study

32

33

34 Reverse shoulder arthroplasty (RSA) is an effective treatment option for patients with rotator cuff
35 tear arthropathy (RCTA). It has been reported to produce early satisfactory clinical outcomes,
36 however some of the complications reported with the RSA are specifically related to the design and
37 biomechanical behavior of this implant. Neurologic injury to the suprascapular nerve is one of these
38 complications.

39 Early issues of loosening of the baseplate in reverse total shoulder arthroplasty (RTSA) were diminish
40 by the introduction of the glenoid component screw fixation. However, screw insertion into a small
41 glenoid vault, can causes screw penetration out of the vault and consequently nerve structures injuries.

42 The suprascapular nerve is a mixed nerve that runs parallel to the superior border of the scapula and
43 passes through the suprascapular notch below the superior transverse scapular ligament. Its main
44 function is to provide motor supply for the Supraspinatus muscle and Infraspinatus muscle. On its
45 course, the nerve gives off a sensory branch that provides sensory innervation for two joints:
46 Glenohumeral and Acromioclavicular joint. It can be affected by excessively long screws employed
47 to fix the baseplate penetrating the contralateral cortex [6,19]. Furthermore, preoperative traction injury
48 to the SSN from a massive rotator cuff tear (RCT) has also been described [1,5,16] although the actual
49 incidence and prevalence of this association remains largely unknown.

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50 The incidence of peripheral nerve complications of reverse shoulder arthroplasty ranges within 0.6–
51 3.6%[4]. However, some injuries especially suprascapular nerve lesions, cause nonspecific
52 symptomatology not being clinically recognized (posterior and/or superior shoulder pain). Patients
53 and surgeons may believe that this pain is the normal postoperative pain which can lead to
54 misdiagnosis[12]. In addition to posterior shoulder pain, injury to the SSN may have an impact on
55 postoperative shoulder function, specifically external rotation. The preservation of external rotation
56 is essential for the success of RTSA, hence the importance of preserving the function of the
57 infraspinatus is key in the surgical technique. Additionally, the use of RTSA in pathologies in which
58 the postero-superior cuff is intact, such as primary glenohumeral osteoarthritis with poor bone stock
59 or significant glenoid retroversion and also in fractures, makes the preservation of the SSN even more
60 critical[18].

61 Several studies analyze suprascapular nerve (SSN) anatomical relationships in cadavers [13,14,18],
62 however in the current literature we cannot find any studies analyzing these injuries pre and
63 postoperatively by electrodiagnostic and imaging techniques.
64 The purpose of the present study is to analyze the incidence and functional impact of electrodiagnostic
65 disorders of the SSN and to correlate these injuries with screw penetration out of the vault.
66

67 **Methods**

68

69 After obtaining approval from our Institution Review Board (protocol code C.P.-C.I.14/512-E), patients
70 who met the inclusion criteria were prospectively included in the study. The inclusion criteria were
71 patients with RCTA Hamada grades II III, IV, or V who underwent a RTSA, and who were able to
72 understand the information and provide written informed consent. We excluded patients who did not
73 accept or did not understand the informed consent, who could not undergo surgery because of an
74 associated comorbidity (American Society of Anesthesiologists), RCTA on the contralateral

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75 shoulder, any comorbidity that might result in neuropathy (e.g., diabetes mellitus, alcoholism, or
76 demyelinating disorders), and previous surgery on the affected or contralateral shoulder.
77 Pre and postoperative functional outcomes (at 1, 3, 6, 12 months, and 24 months) were measured with
78 the Constant scale (CS)[2] relative CS (rCS) based on the normalized values of the CS[3], range of
79 movement (ROM) and Visual Analog Scale (VAS). Clinical evaluation was performed by 2
80 independent surgeons who were not involved in the original surgery.
81 Standard serial radiographs (anteroposterior and axillary) of the affected shoulder were obtained
82 during the follow-up (first postoperative visit at 1 week, 1 month, 3 months, 6 months, 12 months,
83 and 24 months). Six months after surgery a CT scan was performed with .625mm multiplanar layer
84 reconstructions based on a standardized protocol provided by the investigators to determine a causal
85 relationship between the length and penetration of the screw out of the vault ("extraosseous position")
86 with the presence of SSN injuries. The extraosseous position was defined as the perforation of the
87 second bone cortex and consequently the penetration of the screw in the supra or infraspinatus fossa.
88 The distance of the tip of the screw to the suprascapular notch was measured and, in those cases,
89 where the screw penetrated the second cortex the distance that exceeded the second cortex was
90 measured. The DICOM data generated were imported into the AGFA Impax 6, Windows-based PC
91 software (Agfa- Gevaert N.V) reconstructing three planes[9] coronal, axial, and sagittal. The posterior
92 3D reconstruction and image processing was performed by a radiologist expert in musculoskeletal
93 pathology (MM) with the Advantage Workstation Server 3.2. system (General Electric) with
94 multiplanar reconstruction and Volume Rendering (VR). All studies were evaluated by 2 independent
95 and blinded investigators (an orthopedic surgeon and a radiologist with expertise in musculoskeletal
96 pathology), both fully involved in shoulder-related scientific research, who were specifically trained
97 to perform the radiographic evaluation. Each of the investigators performed the radiological
98 assessment twice, with a minimum interval of 4 weeks between them, and the average of these
99 measurements was used. Interobserver reliability for the radiological evaluation was calculated with

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100 the Cohen k coefficient, showing a high degree of consistency between the two observers that ranged
101 from .88 to .93.
102 In order to establish if there is any relationship between functional outcome, radiographic findings,
103 and neurologic lesion, an electrodiagnostic evaluation was performed preoperatively and between 3-
104 4 months postoperatively by a single neurologist (S.M.A.) with expertise in EMG of the upper arm
105 who was blinded to clinical information about each patient. This study includes electromyography
106 and nerve conduction velocity. The examination consisted of a motor study of each branch of the
107 SSN following the previously described protocol[15] This procedure classified the presence of abnormal
108 electrodiagnostic findings into 3 types of injuries: acute, chronic, and disuse.
109
110 Surgical technique
111 All surgeries were performed by 1 of the 3 senior shoulder surgeons (Y.L., C.G.-F., F.M.), and 2 of the
112 3 surgeons were present at every surgery as described previously[15] Delta Xtend reverse shoulder
113 arthroplasty (54.8%) (DePuy-Johnson & Johnson, Warsaw, IN, USA) and Lima SMR (45.2%) (Lima
114 LTO, San Daniele del Friuli, Italy) were employed. The baseplate was positioned in line with the
115 inferior border of the glenoid and rotated such that the superior hole was aligned with the base of the
116 coracoid. Glenoid baseplates were uncemented and fixed in place with 4 (Delta Xtend) or 2 (Lima
117 SMR) peripheral locking screws. The mean lengths of the screws were 21.37 mm for the anterior
118 screw, 30.06 mm for the superior, and 18.2 mm for the posterior. Postoperatively, patients were
119 immobilized in slings and started on passive range of motion exercises at 24 to 48 hours after surgery.
120 They progressed gradually to increased function by 4 to 6 weeks and strengthening at 6 weeks.
121
122 Statistical analysis
123 Qualitative variables are presented with their frequency distribution and percentages. The mean, SDs,
124 and ranges are reported for the continuous variables. Continuous variables that showed a skewed
125 distribution are summarized with median and interquartile ranges (IQRs). We used the Mann-

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126 Whitney U test to compare scores between normal continuous variables and dichotomic variables.
127 We evaluated the association between qualitative variables with the $\chi2$ test or Fisher's exact test. A
128 comparison of continuous variables with qualitative variables with >2 categories was performed by
129 analysis of variance. A Kruskal-Wallis nonparametric test was used for variables with skewed
130 distribution. Clinical parameters of interest were compared with the 2-tailed Wilcoxon test or the $\chi2$
131 test, when appropriate. Level of significance was set at $p < .05$.
132

133 **Results**

134

135 During the period of the study Forty patients met the inclusion criteria and accept to participate in the
136 study being the preoperative electrodiagnostic evaluation performed. After their enrolment six
137 patients eventually decided not to undergo surgery and another two patients were excluded from the
138 study because they did not consent to the postoperative electrodiagnostic study, one patient died in
139 the postoperative course due to causes unrelated to the surgery. Therefore, the final study was
140 conducted with 31 patients, with a mean follow-up of 28.4 ± 4,4 months (range, 24-36 months).
141 Figure 1 summarizes the study flowchart.
142

143 Demographic data

144 Twenty-nine cases (85%) were women, with a mean age of 78 ± 5.4 years (range 67-86 years). The
145 indications for surgery were RCTA Hamada grade II in 21 cases (67.8%), grade III and IV in 4 cases
146 (12.9%), and V in 2 cases (6.4%). Demographic and functional preoperative data are summarized in
147 Table I.
148

149 Electrodiagnostic study results

150 Fourteen patients (45.2%) had an abnormal preoperative SSN electrodiagnostic study (chronic or
151 disuse injuries). The supraspinatus branch was affected in 9 patients (29%) and the infraspinatus

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152 branch was affected in 8 patients (25.8%). The mean age of the patients with preoperative injury was
153 different to those without preoperative injury (77.4 vs. 78.4; p .624).
154 Regarding the evolution of the preoperative SSN injury in the postoperative electrodiagnostic study
155 of the 9 injuries affecting the supraspinatus branch, 3 cases had complete resolution, 3 cases
156 improved, and 3 cases persist. No acute lesions were found affecting this branch. Of the 8 preoperative
157 injuries affecting the infraspinatus branch, 2 cases improved (25%), 4 cases did not (50%), and 2
158 cases had an acute injury over the pre-existing lesion. Additionally, 4 acute injuries (13%) appeared
159 over an intact preoperative nerve. Results are summarized in Table 2.
160 No correlation between the presence of a preoperative lesion and an acute lesion on the postoperative
161 electrodiagnostic study was found (p=1).
162

163 Correlation between preoperative electromyographic finding and clinical situation (Table 3).
164 Regarding preoperative electromyographic findings, there were no differences in the Constant score,
165 and ROM (forward flexion, abduction, and external rotation) between normal, chronic, or disuse
166 preoperative nerve injuries in any of the affected branches. Table 3 summarizes functional outcomes
167 according to preoperative electrodiagnostic situation (Normal, chronic or disuse) and functional pre
168 and postoperative (24 months) functional situation.
169 Mean preoperative VAS of the complete series was 8.1 and a mean postoperative VAS 2.1 ($p <$
170 0.001). All the preoperative abnormal electrodiagnostic findings (disuse, chronic) in both branches
171 of the SSN improve after surgery (supraspinatus branch p .463; infraspinatus branch p.736).
172

173 Postoperative acute injuries
174 There were 6 patients (19.4%) with acute postoperative injuries in the postoperative electrodiagnostic
175 study, all of them affecting the infraspinatus branch. These patients did not have statistically
176 significant differences in the constant score when compared to those without acute injuries (76.4±16.6
177 vs. 81.5±19.4; p .559). We also did not find significant differences in functional outcomes between

178 patients without and with acute SSN injury regarding anterior flexion (133º±5 vs 125º±40; p .862),
179 abduction (120±35º vs 115º±35º; p .653), and external rotation (14º±9 vs 11º±11; p. 432). The final
180 VAS score at 24 months of the patients with acute postoperative injuries was 3.3±1.5 vs 1.7± 2,3 in
181 patients without SSN electrodiagnostic injury (p. 114). There were no cases of acute supraspinatus
182 branch injuries.
183 Analyzing the relationship between the prosthesis model employed and the presence of neurological
184 injury, a positive correlation was found between the presence of SSN injury, and the prosthesis model
185 employed, with the Delta Xtent having 5 (29.4%) cases and the Lima SMR 1(7.1%) (p .185).
186
187 Radiographic evaluation
188 The extraosseous position (perforation of the second cortex by the screws according to CT) was
189 recorded in 32.3% (10 cases/31 total). In 6 of the 10 cases (60%), the superior screw pierced the
190 second cortex and the tip of the screw in the supraspinatus fossa was outside the second cortex by a
191 mean distance of 2.4 mm, and in 4 cases (40%) it was the posterior screw (mean distance 3.1 mm)
192 (Figure 2).
193
194 With respect to the electrodiagnostic correlation of the perforation of the second cortex, the
195 extraosseous position comprised 40% acute injuries of the SSN vs. 9.5% of acute injuries if the screw
196 did not perforate the second cortex (p .067). All the four cases where the posterior screw was outside
197 the cortex had an acute infraspinatus branch injury on the electrodiagnostic study.
198
199 **Discussion**
200
201 Implantation of the glenoid component during reverse total shoulder arthroplasty requires placing the
202 screws into the glenoid vault to achieve proper fixation. Various design modifications and innovations
203 have occurred to improve glenoid baseplate fixation (bicortical central screw fixation,

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204 multidirectional cortical and locking peripheral screws, multiple screws..)[18] SSN injury in RTSA has
205 been specifically related to the length and position of the screws employed to fix the baseplate. There
206 are several anatomical studies that have assessed these parameters and their relationship to the
207 suprascapular nerve. However, there are very few clinical studies analyzing SSN injuries in patients
208 after RTSA, and the few existing studies are case reports [11, 19] or do not cover the possibility of the
209 preoperative presence of this lesion.
210 The most accepted theory about the preoperative origin of SSN injuries is that muscle retraction, as
211 a result of a rotator cuff tear, or a massive rotator cuff tear, as occurs in RCTA, cause excessive
212 traction on the nerve, with the consequent pain and associated weakness, [16,20] the anatomical variants
213 of the first motor branch (proximal or distal to the notch) as described by Albritton et al [1], being the
214 explanation for the absence of preoperative electromyographic lesions in some of the patients.
215 The present study correlates the main three aspects of these injuries: electrodiagnostic study, imaging
216 analysis with CT scan, and clinical impact, considering the preoperative nerve situation and the
217 postoperative evolution of the lesions. Additionally, a specific study of each branch of the nerve was
218 performed to establish the etiopathogenesis of the injury.
219 Jang et al investigate the association between screw penetration on three-dimensional CT scan and
220 the clinical outcomes in a retrospective clinical study without electrodiagnostic confirmation and
221 preoperative evaluation[10]. They found that 12% of patients who received RSA were assessed to be at
222 high risk of iatrogenic suprascapular neuropathy by baseplate screw penetration. However, the
223 clinical outcomes of RSA at a minimum follow-up of 1 year were similar in the high- and lower-risk
224 groups.
225 In the present series, both branches were equally affected preoperatively (infraspinatus and
226 supraspinatus), while only the infraspinatus branch of the nerve was affected postoperatively. This
227 difference is possibly related to the anatomical location of the injury. The preoperative involvement
228 of both branches suggests that the level of compression of the nerve is located in the suprascapular
229 notch since the nerve is compressed before its division. This would be consistent with the anatomical

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230 study performed by Albritton of the effects on the SSN of a retraction of the supraspinatus muscle
231 after a massive tear [1]. They hypothesized that medial retraction of the supraspinatus tendon drastically
232 changes the course of the suprascapular nerve through the scapular notch, creating increased tension
233 on the nerve (Figure 3). However, nerve injury at the level of the spinoglenoid notch affects only the
234 infraspinatus branch, which would be more in line with a neurological injury during the placement of
235 the baseplate screws.

236 There are several studies analyzing the relationship of the screws employed to fix the baseplate in
237 RSA with the suprascapular nerve, pointing mainly to the superior and posterior screws as the cause
238 of these injuries. Wang et al[19] identified scar tissue due to the prominence of two centimeters from
239 the upper screw as a cause of compression of the suprascapular nerve. Similarly, the anatomical
240 studies carried out by Molony et al of the suprascapular nerve have shown that if the superior or
241 posterior screw perforate the second cortex, there is a 40% more chance of contact with any branch
242 of the nerve[17].

243 The preoperative clinical situation of the patients with or without SSN injury was similar. This fact
244 only translates as the clinical difficulty in the differential diagnosis between rotator cuff tears,
245 neurological injury, or the presence of both. In the present series, 88.9% of supraspinatus branch
246 chronic lesions improved, however 25% of the chronic infraspinatus injuries did not, and even in two
247 cases they worsened with the presence of two acute injuries over the previous chronic injuries. This
248 fact could be related to the aforementioned etiology of the baseplate screw position.

249 Although the suprascapular nerve was historically considered primarily a motor nerve, so its injury
250 may affect postoperative shoulder function, specifically external rotation, recent data suggested it
251 would provide up to 70% of the sensitivity of shoulder, participating in the innervation of the
252 coracohumeral and coracoclavicular ligaments, the subacromial bursa, and the posterior capsule. The
253 results of the present study do not detect differences in external rotation between the presence or not
254 of acute SSN injuries in the electrodiagnostic study. Probably the employment of a medialized COR
255 prosthesis, which have been related with lower external rotation have a role in this aspect[7].

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256

257 Regarding the prosthesis model, the authors hypothesized that the higher incidence of SSN with the
258 Delta Xtend is due to the employment by this model of four screws (anterior, posterior, superior, and
259 inferior) instead of only two (superior and inferior), as with the Lima SMR model, to fix the baseplate.
260 Molony et al employing the Delta Xtend model (as in the present study) found that in 90% of cases
261 the posterior screw (despite having the shortest length at 26.2 mm) perforated the bone, being less
262 than 5mm from the SSN and having a 40% chance of contacting any of the branches[17]. The screw
263 affected the motor branch of the infraspinatus in two cases, the glenohumeral articular branch in
264 another case, and through the main trunk in four cases. Vance et al also in cadaveric study found that
265 the average distance from the exiting hole in the scapula to the SSN was 9.2 ±6.3 mm for the superior
266 screw and 8.9 ± 3.8 mm for the posterior screw[18].
267 In the present study, 10 screws (32%) perforated the second cortex leaving its intraosseous position.
268 Of these, 4 cases were posterior screws (40%) and 6 superior screws (60%). All the posterior screws
269 which perforated the second cortex had an electrodiagnostic study of acute infraspinatus branch
270 injury. There were two acute postoperative nerve injuries not related with the perforation of the
271 second cortex by the screw, one explanation could be the employment of a drill that perforates the
272 second cortex followed by use of a screw that does not penetrate the second cortex.
273 A balance must be achieved between the maximum screw length that allows stable fixation and the
274 risk of cortex perforation in critical anatomical areas for the nerve (superior and posterior screws).
275 The resulting mean length of our series for the anterior screw was 21.37 mm, for the superior screw
276 30.06 mm, and for the posterior screw 18.2 mm. The anterior screw usually does not compromise the
277 SSN when the cortex is perforated because of the protection provided by the subscapularis muscle.
278 The literature shows between 20%-40% of cases in which the upper screw perforates the second
279 cortex of the scapula causing it injury [6,17,8]. In the present study, perforation of the second cortex of
280 the bone by the posterior screw seems to be more likely to injure the SSN than a superior screw when
281 it is out of the vault. With current locking screw technology and prosthesis models where the central

282 peg plays an essential role in baseplate fixation we do not recommend the employment of bicortical
283 screws in order to avoid these injuries.
284
285
286 Study strengths and limitations
287 The present study has important strengths. First, the homogeneity of the sample. Most studies include
288 different pathologies to analyze the incidence of neurological injuries after RSA which can introduce
289 important bias, especially with the inclusion of traumatic pathology or revision surgeries. This study
290 focused exclusively on rotator cuff arthropathy. Second, all electrodiagnostic studies were performed
291 by only one neurophysiologist expert in musculoskeletal pathology, always using the same method
292 and protocol, which is essential to avoid interobserver variability. Finally, its prospective design is
293 another important strength. However, the study also has important limitations: 1) although
294 postoperative nerve injuries after interscalene block as part of the anesthetic regime is not common,
295 this technique might have introduced a bias 2) because 95% of the patients evaluated were women
296 and because women are generally of smaller stature, it is possible that the incidence of SSN injuries
297 due to perforation of the second cortex by the screw would be higher because of the smaller glenoid
298 vault 3) the absence of baseplate tilt measurement in x-rays and the determination of a possible
299 relation with the risk of nerve injury by the superior screw. 4) and finally, this is a relatively small
300 sample of patients and as such we may not have had adequate statistical power to show significant
301 differences in the Constant Score or the VAS scale.
302
303 **Conclusions**
304
305 Preoperative SSN injuries do not have a significant clinical impact and do not predispose to an acute
306 postoperative SSN lesion. Patients with acute SSN injuries do not have statistically significant
307 differences in the Constant Score of the VAS when compared to patients without a SSN lesion.

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308 Extraosseous position of the screw increases the probability of a SSN injury to 31%. This risk is
309 higher with the posterior screw, which leads us to question whether it is really necessary to use it.
310

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382 **Figure Legend**

383

384 Figure 1. Study flowchart

385

386 Table 1: Demographic data. M: male. F: female. mo: months. *According to Hamada classification.
387 Side: Right/left. ASA American Society of Anesthesiologists. Data are presented as “mean ±
388 standard deviation” or “percentage (total number)”.

389

390 Table 2: Results of the preoperative electrodiagnostic study and its evolution according to type of
391 injury and location. Electromyographic study. SSN: Suprascapularis nerve, Supra: Supraspinatus
392 branch, Infra: Infraspinatus branch. *Improvement/resolution (n/n). Referring to percentage over nerve injuries.
393 ** No improvement. Referring to percentage over nerve injuries ***Acute lesion over preoperative lesion (disuse or
394 chronic) and acute lesion over an intact preoperative nerve. Referring to percentage over the total n.

395

396 Table 3: Functional results according to preoperative electrodiagnostic study and its 24 months
397 postoperative follow-up. *Statistical significance for the intra-group analysis (follow-up difference between
398 preoperative and postoperative variable status). **Statistical significance for the analysis of the inter-group follow-up of
399 the variable related to the nerve branch (different evolutive pattern between the study groups)

400

401 Figure 2: Clinical case of a patient with second cortex perforation of the superior screw. Yellow
402 arrow points to the suprascapular notch.

403

404 Figure 3: Anatomical location of nerve injuries. A,B) Preoperative nerve injuries. Medial retraction
405 of the supraspinatus tendon tensioning the nerve at the suprascapular notch. C,D) Postoperative nerve
406 injuries. Proximity of the posterior screw to the infraspinatus branch of the SSN.

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Table 1. Demographic data

	Total
N	31
Age, *years*	77.89± 5.4
Sex, *M/F*	15/85 (2/29)
Hamada*	
II	67.8 (21)
III	12.9 (4)
IV	12.9 (4)
V	6.4 (2)
Side (R/L)	77/23 (24/7)
Implant Type	
Delta Xtent	54.8 %
Lima SMR	45.2%
ASA	
1	16 (5)
2	68 (21)
3	16 (5)
Preop. Constant score	26.6±8.4
Preop. Relative Constant score	39.4±10.2
VAS preop.	8 ± 1.1
Follow-up, *mo*	28.4 ± 4.4

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M: male. F: female. mo: months.

*According to Hamada classification

Side: Rigth/left

ASA American Society of Anesthesiologists
Data are presented as “mean ± standard deviation” or “percentage (total number)”.

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Table II. Results of the preoperative electrodiagnostic study and its evolution according to type of injury and location								
		PREOPERATIVE EMG			POSTOPERATIVE 3 M EMG STUDY			
n:31	Branch	NORMAL (n)	CHRONIC (n)	DISUSE (n)	IMPROVEMENT/ RESOLUTION (n)*	NO IMPROVEMENT (n)**	ACUTE OVER PREOP*** LESION	ACUTE OVER AN INTACT NERVE
SSN	Supra	71 % (22)	16,1 % (5)	12,9 % (4)	67 % (3/3)	33 % (3)	-	-
	Infra	74,2 % (23)	9,7% (3)	16,1% (5)	25 % (2/0)	50% (4)	6,4 % (2)	13% (4)

Table 2. Results of the preoperative electrodiagnostic study and its evolution according to type of injury and location. Electromyographic study. SSN: Suprascapular nerve, Supra: Supraspinatus branch, Infra: Infraspinatus branch. *Improvement/resolution (n/n). Referred to Percentage over nerve injuries. ** No improvement. Referred to percentage over nerve injuries ***Acute lesion over preoperative lesion (disuse or chronic) and acute lesion over an intact preoperative nerve. Referred in percentage over the n total.

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Table 3. Functional results according to preoperative electrodiagnostic study and its 24 months postoperative clinical situation

Branch	EMG study	Preop Constant	Postop Constant (24m)	p value*	p value **	Preop ABD	Postop ABD (24 m)	p value*	p value **	Preop ER	Postop ER (24 m)	P value*	p value **	Preop Forward Flexion	Postop Forward flexion (24m)	P value*	P value **
Supra	Normal	37±9	86±21	p<0,001	0.868	67±23º	116±33º	p<0.001	0.274	13±12º	13±10º	0.939	0.698	77±28	127±34	p<0.001	0.438
	Chronic	39±8	83±11	p<0,001		80±12º	100±36º	0.27		18±7º	12±6º	0.343		79±37	110±28	0.091	
	Disuse	53±14	92±0	p<0,001		85±10	145±17º	0.006		20±20º	17±9º	0.722		90±16	155±13	0.003	
Infra	Normal	38±9	86±21	p<0,001	0.988	70±22º	120±36º	p<0.001	0.496	15±13º	14±10º	0.714	0.962	77±30	131±34	p<0.001	0.545
	Chronic	41±8	89±10	0.002		83±5º	103±15º	0.407		15±15º	13±6º	0.839		86±6	120±35	0.159	
	Disuse	46±17	92±7	p<0,001		71±25º	114±27º	0.027		12±13º	9±10º	0.637		81±24	118±30	0.048	

Table 3. Functional results according to preoperative electrodiagnostic study and its 24 months postoperative follow-up

*Statistical significance for the intra-group analysis (follow-up difference between preoperative and postoperative variable status)

**Statistical significance for the analysis of the inter-group follow-up of the variable related to the nerve branch (different evolutive pattern between the study groups)

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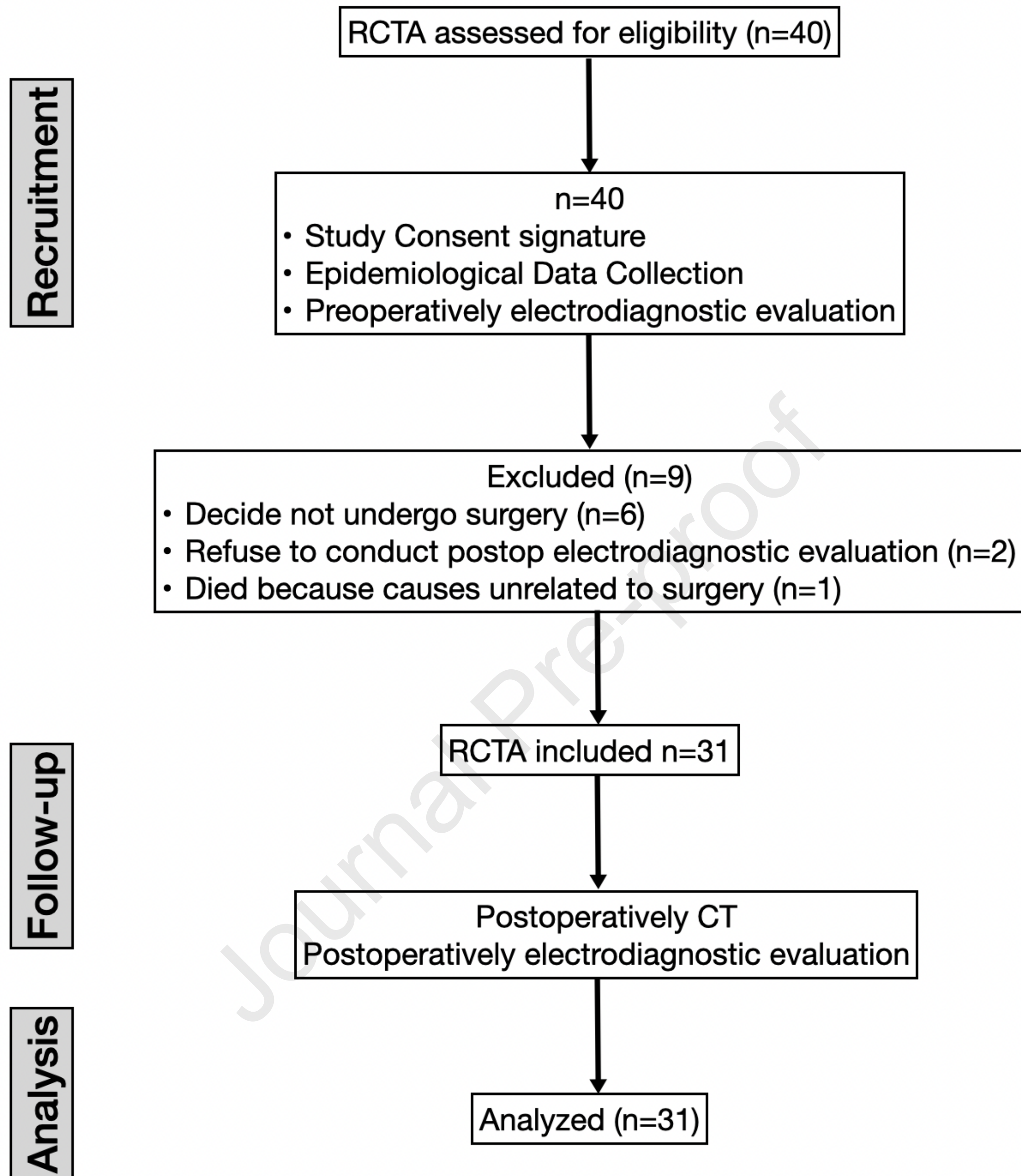

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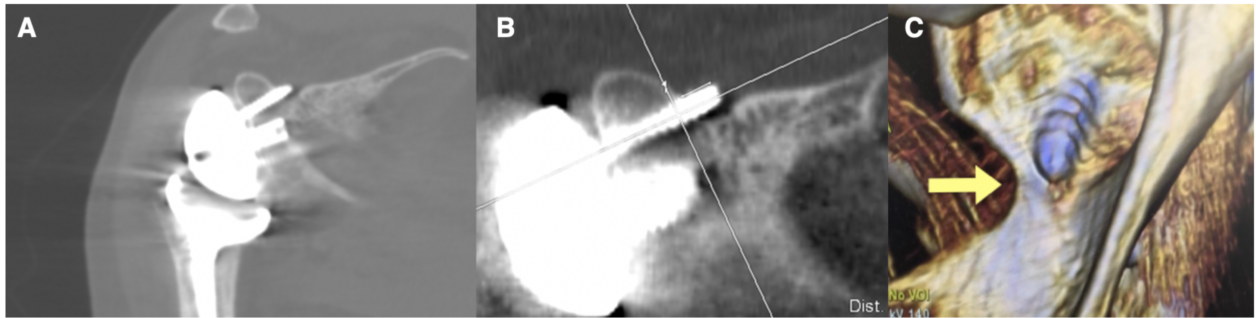

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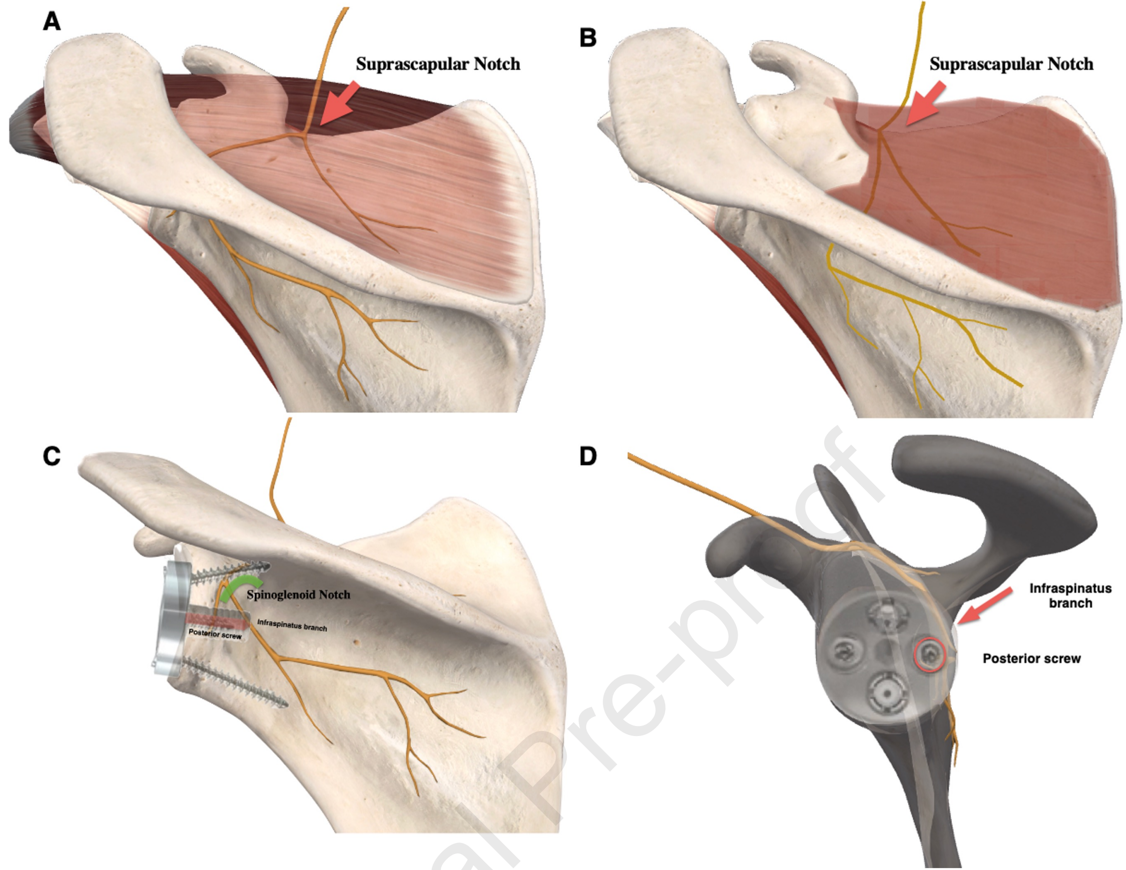

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