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# Pain, paresthesia, and the rotator cuff: the prevalence and magnitude of shoulder pain and hand numbness and tingling before and after rotator cuff repair



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## ARTICLE INFO

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**Level of evidence:** Level III; Cross-Sectional  
Design; Epidemiology Study

**Background:** Shoulder pain and loss of function are classically associated with rotator cuff tears, while paresthesia of the hand is not. We noted anecdotally that paresthesia of the arm was common in patients presenting with rotator cuff tears. The purpose of this study was to determine the prevalence and magnitude of hand paresthesia, its relationship to pain, and how surgery affected these symptoms.

**Methods:** This prospective cross-sectional study assessed the prevalence and magnitude of shoulder pain and hand numbness and tingling (as assessed by 2 questions from the modified Boston Carpal Tunnel Questionnaire) preoperatively and at 1 week, 6 weeks, 12 weeks, and 6 months postoperatively among 213 consecutive patients who presented for and underwent arthroscopic rotator cuff repair.

**Results:** The preoperative levels of prevalence and severity of shoulder pain during rest, overhead activities, and sleep improved by 52%, 22%, and 34%, respectively, compared with those by 6 months postoperatively ( $P < .05$ ). Seventy-five patients (33%) reported hand paresthesia before surgery. There was a 50% and 60% reduction in the severity of hand tingling and numbness, respectively, by 1 week after surgery ( $P < .05$ ). The preoperative level of hand numbness (Wald statistic;  $W = 20$ ) and whether the patient's shoulder problem was caused by a specific injury ( $W = 6$ ) were predictive of the presence of hand numbness at 6 months after surgery ( $P < .05$ ).

**Conclusion:** This study showed that many patients who undergo rotator cuff repairs present with hand paresthesia that is associated with their shoulder pain. The prevalence and severity of shoulder pain and hand numbness and tingling improved postoperatively.

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Rotator cuff tears are a common shoulder injury, with a prevalence of more than 20% in the general population.<sup>9,19</sup> The most typical sequelae of rotator cuff tears include shoulder pain with loss of strength and function.<sup>13</sup> However, we noted anecdotally that a large proportion of patients presenting with rotator cuff injuries complained of numbness and/or tingling in their ipsilateral arm and hand. Numbness and tingling of the hand have traditionally been associated with compression neuropathies of the upper limb, namely, carpal tunnel syndrome, cervical radiculopathy, and thoracic outlet syndrome.<sup>10</sup> We were only able to identify 1 study that has investigated the relationship between hand paresthesia

and shoulder conditions. Sivan et al<sup>15</sup> performed a clinical observation study on 100 consecutive patients undergoing surgery for subacromial impingement of the shoulder. They found that 54% of the patients reported paresthesia symptoms (tingling, pins and needles, burning, or woolly sensations) of the ipsilateral hand. However, it is undetermined whether patients with rotator cuff tears also experience hand paresthesia.

The aim of this study therefore was to determine the prevalence and magnitude of hand paresthesia pre/post rotator cuff repair (RCR), its association, if any, to shoulder pain, and the effect of surgery on hand paresthesia.

## Methods

### Study design

This study was a prospective analysis of the prevalence and magnitude of shoulder pain and hand numbness and tingling

IRB ethics approval was granted by the South-Eastern Sydney Local Health District Human Research Ethics Committee (HREC/11/STG/37) 2019/ETH14049.

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among patients who presented for arthroscopic RCR. This was part of a larger investigation of hand paresthesia among patients who presented to our clinic with a shoulder problem. Post hoc, we performed an analysis specifically on patients who underwent RCRs. The study was performed following ethics approval granted by the South-Eastern Sydney Local Health District Human Research Ethics Committee (HREC/11/STG/37). To be included, patients must have had undergone an arthroscopic RCR and completed a shoulder questionnaire prior to surgery. Patients underwent surgery at a single campus performed by a single surgeon (G.A.C.M.). Patients were excluded from the study if they had a previous surgery on the same shoulder.

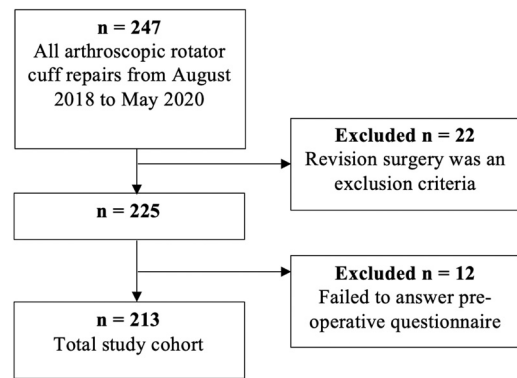
This study primarily assessed the prevalence and magnitude of shoulder pain and numbness and tingling of the hand in this population preoperatively and at 1 week, 6 weeks, 12 weeks, and 6 months postoperatively. As there were no shoulder scoring systems that include an assessment of hand numbness and tingling, we introduced a well-cited questionnaire (the Boston Carpal Tunnel Syndrome Questionnaire [BCTQ]), which has been validated in its use to assess symptom severity and functionality in patients with carpal tunnel syndrome,<sup>5</sup> to systematically assess hand numbness and tingling symptoms. Despite being used outside of its validated purpose, there are no shoulder scoring systems that include an assessment of hand numbness and tingling. Accordingly, we utilized the following 2 questions from the BCTQ in this study: “Do you have tingling sensations in your hand?” and “Do you have numbness (loss of sensation) in your hand?” Patient responses were assessed using a standard 5-point Likert scale of the BCTQ, which included “no,” “slight,” “medium,” “severe,” and “very serious.” Secondary outcomes included an evaluation of patient responses to the following questions of the L’Insalata Shoulder Questionnaire (Supplementary Appendix S1): “How often is your shoulder painful during activity, painful when you sleep, extremely painful?” “What is the level of your shoulder pain when you are resting, with activities above your head, when you sleep?” “How stiff is your shoulder?” “How much difficulty do you have with reaching behind your back, with activities above your head?” “How is your shoulder overall?” “What is your current level of activity at work?” and “What is your highest level of sport now?” In each case, the responses were also ranked using either a 4- or 5-point Likert scale depending on the question asked.

In addition, patients underwent a standardized examination of their shoulder preoperatively and at 6 weeks, 12 weeks, and 6 months postoperatively. Examiners visually measured the patient shoulder range of motion in passive forward flexion, abduction, external rotation, and internal rotation according to a validated protocol.<sup>12</sup> Examiners also measured patient shoulder strength in internal rotation, external rotation, abduction in the scapular plane (supraspinatus), liftoff, and adduction using a handheld dynamometer according to validated protocols.<sup>2</sup>

**Surgical technique**

All procedures included in this study were performed by a single shoulder surgeon. Patients received a regional interscalene block using ropivacaine 0.75% and lignocaine 2% with adrenaline (1:100,000) and were placed in the beach-chair position.

A posterior portal was created approximately 2 cm inferomedially to the posterolateral acromion. The 30° arthroscope was inserted, and diagnostic glenohumeral arthroscopy was performed. A lateral portal was created with an outside-in technique after localization with a spinal needle. If a partial thickness tear was present, the tear was sutured by the surgeon. The greater tuberosity at the site of the rotator cuff tear was debrided from the lateral



**Figure 1** Patient selection flow chart.

**Table I** Study cohort demographics.

Study group demographics	
Patients, n	213
Sex, male:female, n	131:82
Age at surgery, yr*	60 ± 0.74 (34-86)
Time of surgery from symptom onset, mo*	17 ± 2.51 (0-241)
Affected shoulder, left:right, n	86:127
Related to specific injury, yes:no, n	141:67
Work related, yes:no, n	68:137

SEM, standard error of mean.  
\*Mean ± SEM (range).

**Table II** Operative details.

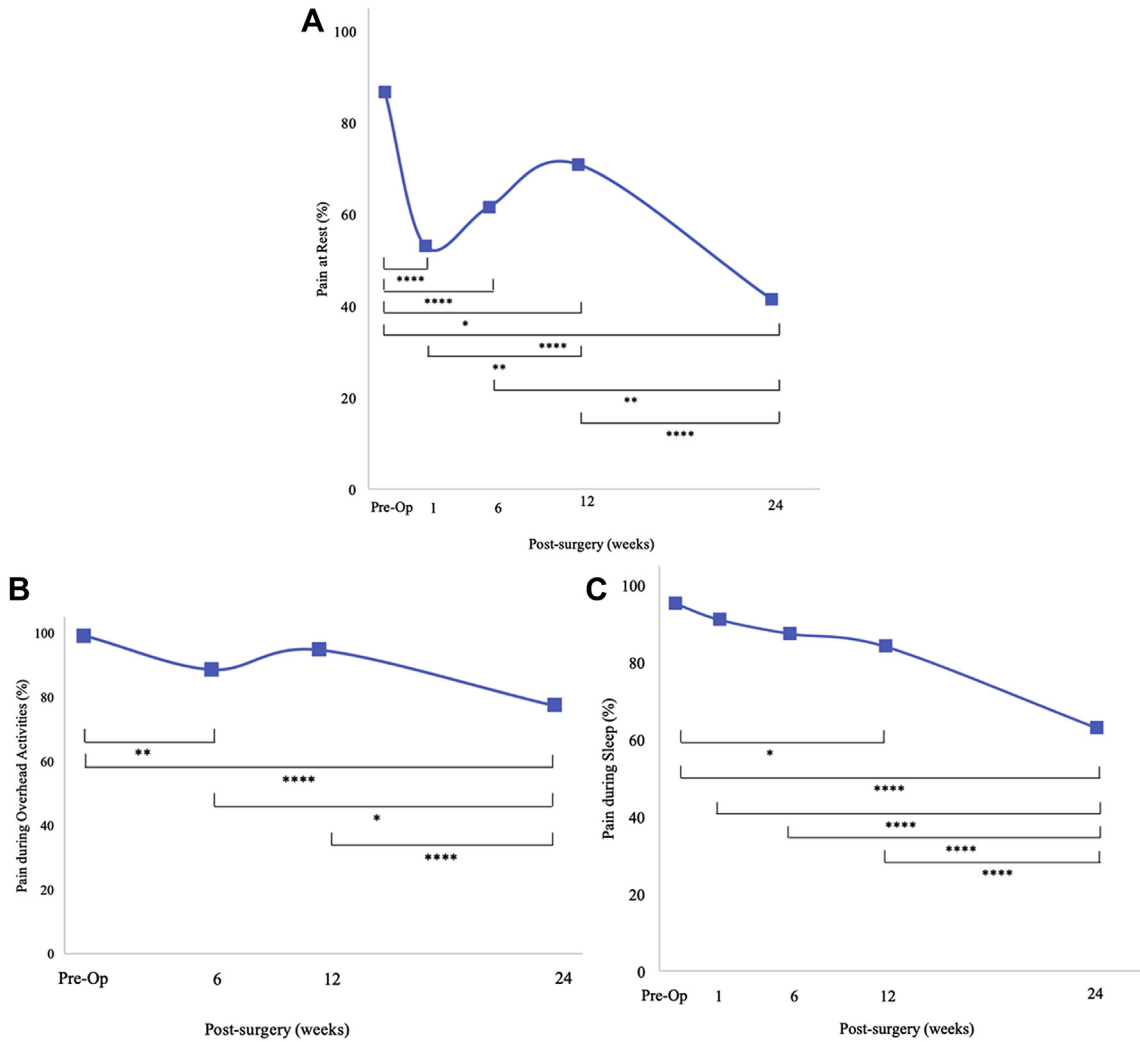
Study operative details	
Tear size area, mm <sup>2</sup>	352 ± 24.0 (2-1750)
Anchors used, n*	2.2 ± 0.10 (1-7)
Operative time, min*	20.5 ± 1.12 (5-95)

SEM, standard error of mean.  
\*Mean ± SEM (range).

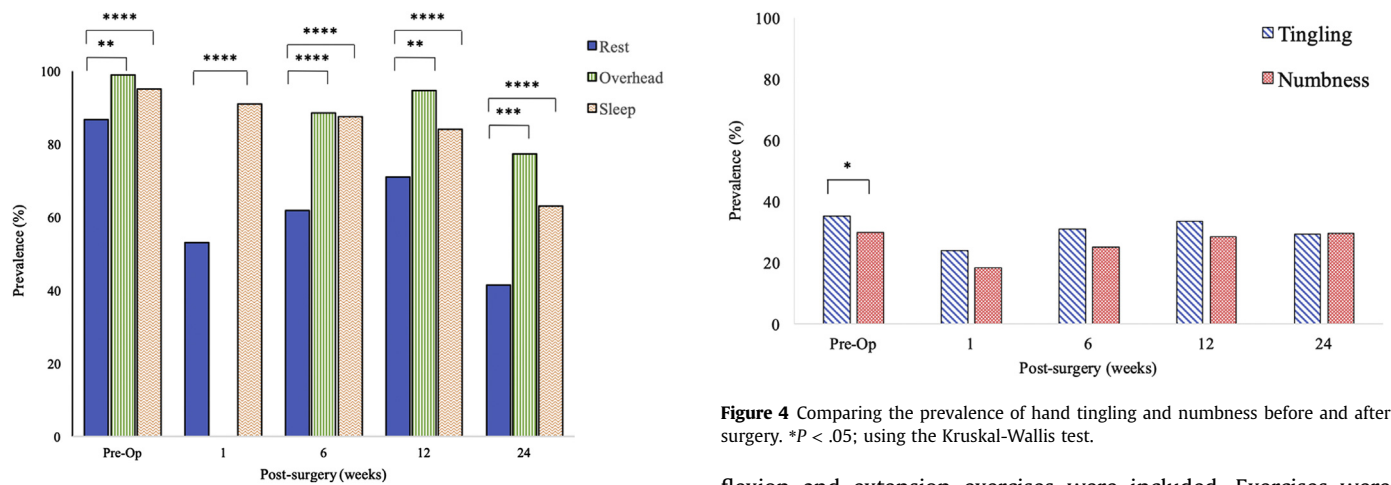
portal to ensure adequate decortications of the bony surface for tendon healing. The torn rotator cuff tendon was repaired using the knotless suture technique (Opus Magnum; ArthroCare Corporation, Sydney, NSW, Australia). The torn rotator cuff was grasped with the Opus Smart-Stitch Suture Device (ArthroCare Corp), which delivers a Number 2 polyester mattress suture into the cuff through the lateral portal. A hole was punched on the landing site at the desired position through the lateral portal. Both limbs of the suture were passed through the Opus Magnum Knotless Implant, which was inserted into the bone hole and deployed. The suture was wound through the anchor, reducing the tendon to the bone before locking the suture in the anchor.<sup>7,17</sup>

**Postoperative rehabilitation protocol**

All patients who underwent RCR underwent a standardized 3-phase rehabilitation protocol postoperatively. In the first phase (0-6 weeks), the patients immobilized the operated shoulder in a sling with a small abduction pillow (UltraSling; DJO, Normanhurst, NSW, Australia) during the day. Mobilization exercises were commenced at day 1 postoperatively, which included elbow range of motion, improving grip, periscapular strengthening, and internal and external rotation. From the second week onward, shoulder



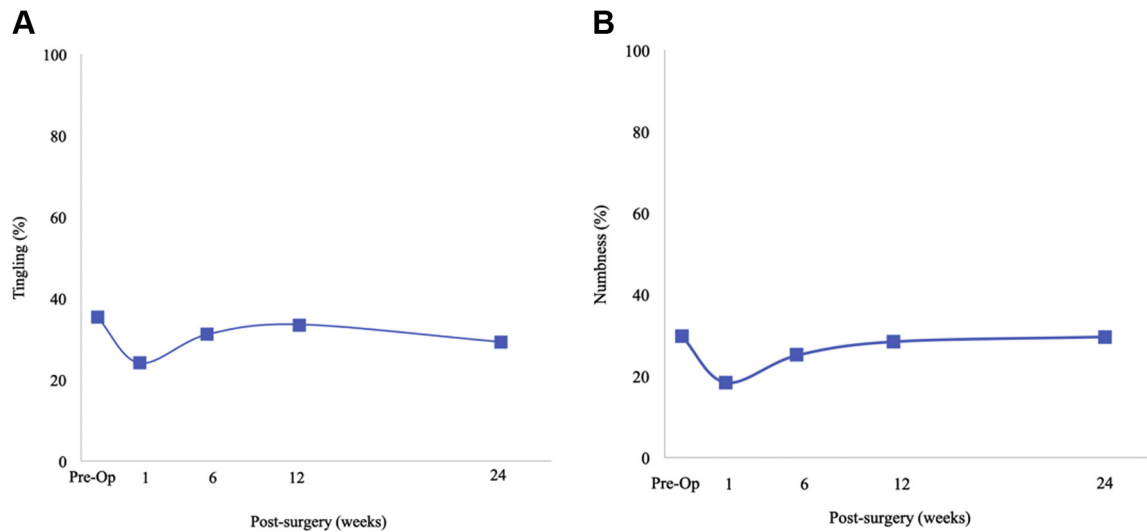
**Figure 2** Temporal outcomes in the prevalence of shoulder pain during (A) rest, (B) overhead activities<sup>†</sup>, and (C) sleep in patients who underwent RCR. \* $P < .05$ , \*\* $P < .01$ , \*\*\*\* $P < .0001$ ; using the Kruskal-Wallis test. <sup>†</sup>Patients were not asked about pain with overhead activities at 1 week. RCR, rotator cuff repair.



**Figure 3** Comparing the prevalence of pain modalities before and after surgery. \*\* $P < .01$ , \*\*\* $P < .001$ , \*\*\*\* $P < .0001$ ; using the Kruskal-Wallis test.

**Figure 4** Comparing the prevalence of hand tingling and numbness before and after surgery. \* $P < .05$ ; using the Kruskal-Wallis test.

flexion and extension exercises were included. Exercises were performed thrice daily. Phase 2 (6 weeks-3 months) exercises were done once a day and comprised isometric strengthening exercises.



**Figure 5** Temporal outcomes in the prevalence of (A) hand tingling and (B) numbness in patients who underwent RCR. RCR, rotator cuff repair.

Phase 3 exercises (3–6 months) were performed twice a day and consisted of strengthening exercises using a yellow TheraBand.<sup>16</sup>

*Statistical analysis*

The Kruskal-Wallis test was used to compare the prevalence and severity of each measured outcome across all time points (preoperatively and at 1 week, 6 weeks, 12 weeks, and 6 months after surgery). The Wilcoxon matched-pairs signed-rank test was used to compare the hand numbness with tingling across all time points. Multivariate analysis with logistic regression was conducted to identify preoperative factors that make significant contribution to the presence of hand numbness and tingling at 6 months postoperatively. Spearman correlation coefficient was conducted to determine the relationship between different variables taken from data at 6 months after surgery.

**Results**

*Study group*

A total of 247 arthroscopic RCRs were performed by a single surgeon during the study period (August 2018–May 2020). Of these, 22 were excluded for being revision surgeries and 12 patients were excluded for failing to answer the preoperative questions. This resulted in 213 patients who underwent arthroscopic RCR and formed the study cohort (Fig. 1).

*Study demographics*

The study cohort was made up of 131 male and 82 female patients, with a mean age of 60 years ± 0.74 (standard error of mean [SEM]). The majority of patients (n = 141) presented due to a specific injury, and 68 patients reported their injury was work related (Table I).

*Operative details*

The size of rotator cuff tear was determined intraoperatively. The mean tear size was 352 mm<sup>2</sup> ± 24.0 (SEM), and an average of 2.2 ± 0.10 (SEM) anchors were used to repair the tears (Table II).

*Temporal outcomes in the prevalence of shoulder pain and hand paresthesia*

*Pain during rest*

Ninety percent of the patients who underwent RCRs reported shoulder pain at rest before surgery. At 1 week after surgery, there was a 50% reduction in the reported prevalence of shoulder pain during rest (P < .0001). The prevalence of resting shoulder pain increased to 70% by 12 weeks after surgery and reduced to 40% by 6 months postoperatively (P < .05) (Fig. 2A).

*Pain with overhead activity*

All patients reported shoulder pain during overhead activities before RCR surgery. The prevalence reduced to 90% by 1 week after surgery (P < .01) and 60% by 6 months (P < .0001) postoperatively (Fig. 2B).

*Pain during sleep*

Ninety-five percent of patients reported shoulder pain during sleep prior to surgery. The prevalence decreased to 85% at 12 weeks after surgery (P < .05) and to 60% at 6 months after surgery (P < .0001) (Fig. 2C). The prevalence of pain during sleep was greater than resting pain both before and after surgery (P < .0001) (Fig. 3).

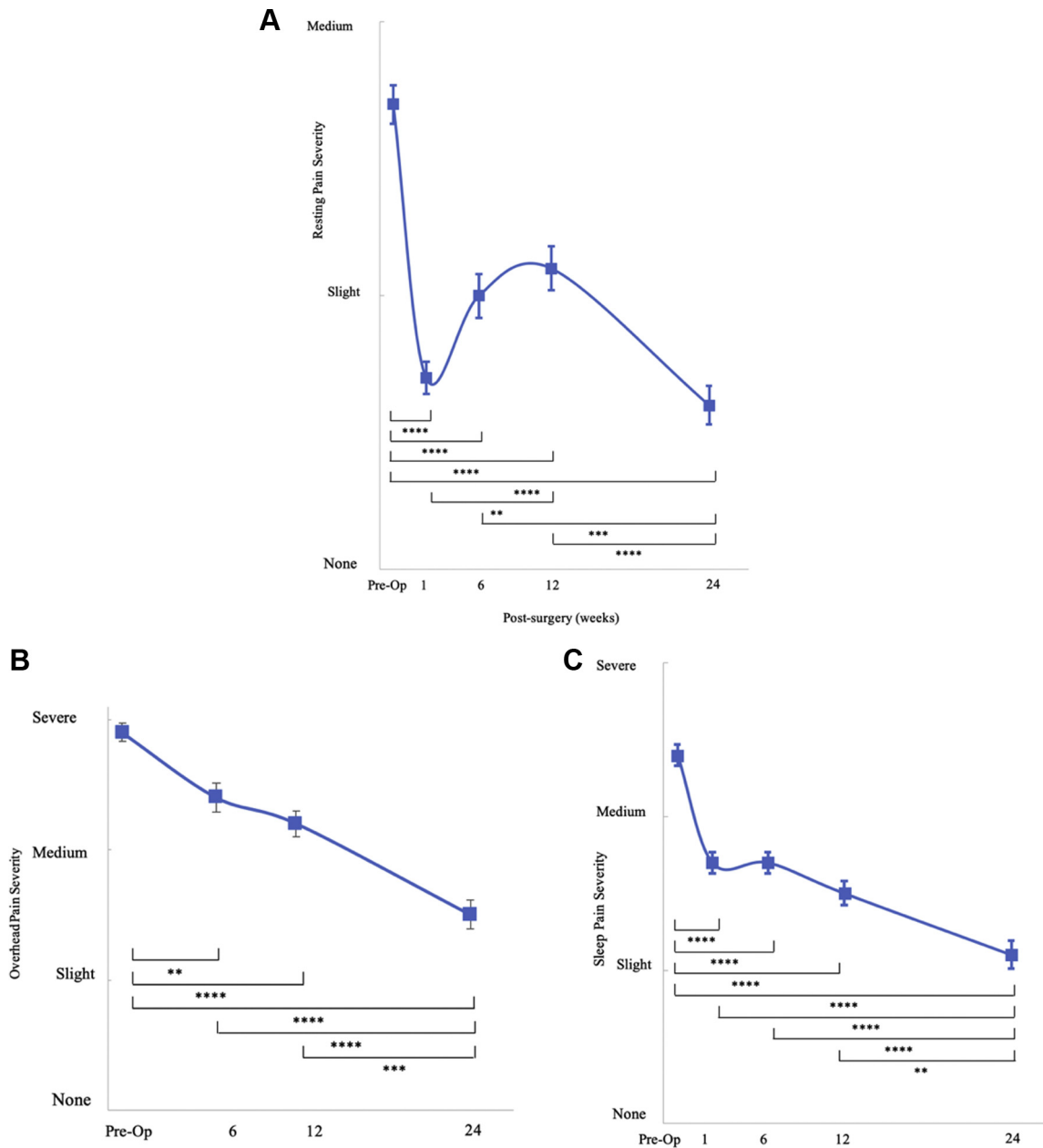
*Hand paresthesia*

Prior to surgery, a slightly larger proportion of patients reported hand tingling (35%, n = 75) than numbness (30%, n = 61) (P < .05). There was no difference between the prevalence of hand numbness and tingling across all other time points (Fig. 4). There were no statistically significant changes in the prevalence of hand numbness or tingling following surgery (Fig. 5).

*Temporal outcomes in the severity of shoulder pain and hand paresthesia*

*Pain during rest*

Prior to surgery, the average (±SEM) severity of shoulder pain during rest was reported between “medium” and “slight” (1.7 ± 0.07). Patients reported an improvement in the severity of this pain which was between “slight” and “none” (0.7 ± 0.06) by 1



**Figure 6** Temporal outcomes in the severity (mean ± SEM) of shoulder pain during (A) rest, (B) overhead activity, and (C) sleep in patients who underwent RCR. \*\* $P < .01$ , \*\*\* $P < .01$ , \*\*\*\* $P < .0001$ ; using the Kruskal-Wallis test. RCR, rotator cuff repair; SEM, standard error of mean.

week after surgery ( $P < .0001$ ). By 12 weeks after surgery, patients reported more severe pain than that at 1 week postoperatively ( $P < .0001$ ). By 6 months postoperatively, average severity reduced to between “slight” and “none” ( $0.6 \pm 0.07$ ) ( $P < .0001$ ) (Fig. 6A).

**Pain with overhead activity**

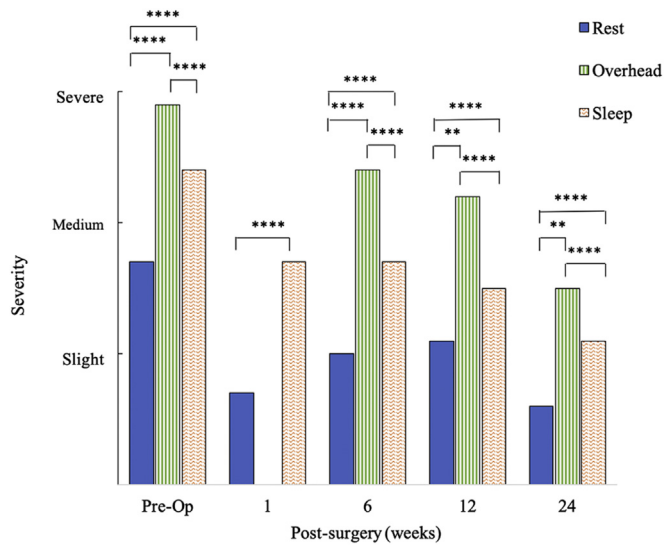
Shoulder pain during overhead activities was the most severe modality of pain reported ( $P < .0001$ ) and was ranked between “severe” and “moderate” prior to surgery ( $2.9 \pm 0.07$ ). After surgery, patients reported consistent improvement in the severity of this pain across all time points ( $P < .01$ ). Compared to preoperative levels, the average severity reduced by 50% to between “medium” and “slight” ( $1.5 \pm 0.11$ ) by 6 months after surgery ( $P < .0001$ ) (Fig. 6B). Patients reported overhead shoulder pain as the most severe modality of pain across all time points ( $P < .01$ ) (Fig. 7).

**Pain during sleep**

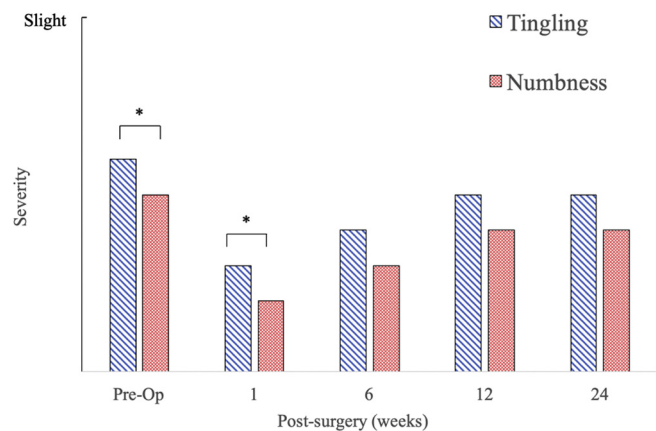
Patients presenting for RCRs reported an average severity of shoulder pain during sleep between “severe” and “moderate” ( $2.4 \pm 0.07$ ). Patients reported improvements in the severity of their shoulder pain during sleep to between “slight” and “moderate” ( $1.7 \pm 0.07$ ) by 1 week after surgery ( $P < .0001$ ). By 6 months after surgery, patients continued to report more dramatic reductions in the severity of this pain to “slight” ( $1.0 \pm 0.09$ ,  $P < .0001$ ).

**Hand paresthesia**

Patients reported more severe hand tingling than numbness both before surgery ( $P < .05$ ) and 1 week postoperatively ( $P < .05$ ) (Fig. 8). The average severity of hand tingling ( $0.6 \pm 0.06$ ) and numbness ( $0.5 \pm 0.06$ ) was reported between “slight” and “none” prior to surgery. Patients reported significantly less severe hand



**Figure 7** Comparing the severity (mean ± SEM) of pain modalities before and after surgery. \*\**P* < .01, \*\*\*\**P* < .0001; using the Kruskal-Wallis test. SEM, standard error of mean.



**Figure 8** Comparing the severity of hand tingling and numbness before and after surgery (\**P* < .05).

tingling ( $0.3 \pm 0.04$ ) and numbness ( $0.2 \pm 0.03$ ) by 1 week after surgery (*P* < .05) (Fig. 9).

**Factors correlated with hand paresthesia**

Bivariate correlation analysis was performed to determine the factors associated with hand tingling and numbness at 6 months after surgery. Patients who reported a shoulder injury related to work, higher level of work prior to surgery, higher frequency and level of shoulder pain, shoulder stiffness, difficulty of movement, and lower overall shoulder rating reported higher levels of hand paresthesia 6 months postoperatively (Table III). Patients with a lower range of motion in forward flexion, abduction, and external/internal rotation and patients with weaker internal/external rotation, supraspinatus liftoff, and abduction also reported higher levels of hand paresthesia by 6 months after surgery (Table IV).

**Predictive factors of hand paresthesia**

Multiple logistic regression was performed to determine the preoperative factors that independently were associated with the presence or absence of hand paresthesia at 6 months after surgery.

**Hand tingling**

Regression analysis revealed that patients who reported a specific injury on presentation (Wald statistic; *W* = 5.80) and higher levels of hand numbness before surgery (*W* = 20.49) were more likely to have tingling in their hand at 6 months after surgery (Table V).

**Hand numbness**

Patients who reported a specific injury on presentation (*W* = 3.56) and had higher levels of hand tingling before surgery (*W* = 7.81) were more likely to have numbness in their hand at 6 months after surgery (Table VI).

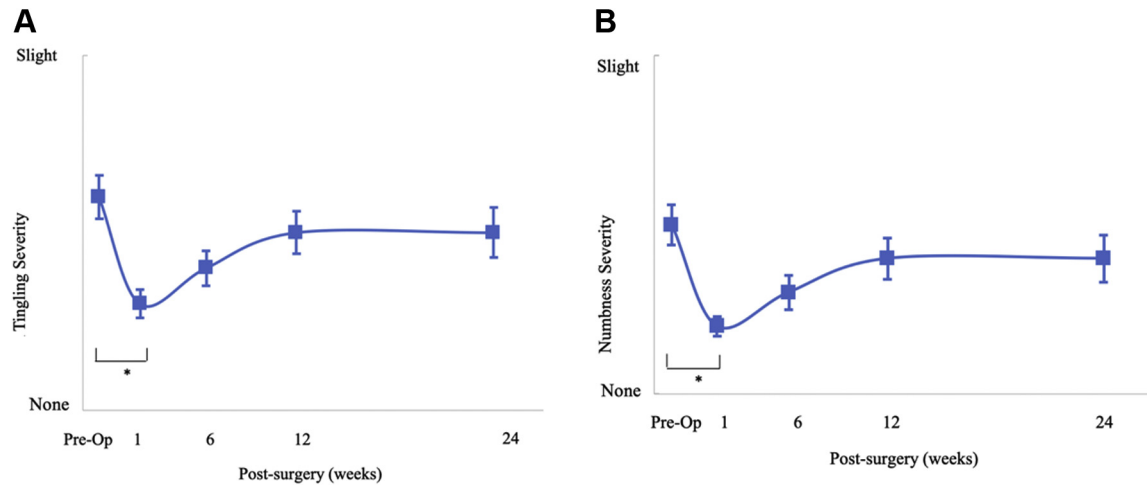
**Discussion**

This study showed that a large proportion (one-third) of patients who underwent RCRs reported hand paresthesia both before and after surgery. Patients did not report improvements in their symptoms after surgery. Hand numbness and tingling were associated with the level and frequency of shoulder pain during rest, overhead activity, sleep, shoulder stiffness, and weakness at 6 months after surgery. The presence of preoperative hand numbness and whether the patient’s shoulder problem was caused by a specific injury were predictive of hand tingling at 6 months postoperatively.

We found that the prevalence and severity of shoulder pain during rest, overhead activities, and sleep significantly improved compared to preoperative levels by 6 months after surgery. These findings are consistent with those of a number of previous studies, which have identified improvements in shoulder pain and function following RCR.<sup>6,8,11</sup> We found that shoulder pain during rest was less prevalent than pain during overhead activities and sleep and that overhead pain was ranked most severe compared with shoulder pain during rest and sleep both before and after surgery.

To our knowledge, this is the first study to investigate the prevalence and magnitude of hand paresthesia among patients undergoing RCRs. This study confirmed our anecdotal observation that many patients presenting for RCR complained of hand numbness and tingling in addition to their shoulder pain. Only 1 other study has previously identified hand paresthesia in patients presenting with shoulder pathologies. Sivan et al<sup>15</sup> reported a high prevalence (54%) of hand paresthesia in patients undergoing subacromial decompression surgery. Nerve conduction tests were randomly performed on 13% of patients with positive symptoms and revealed no significant attributable entrapment neuropathy.

The mechanisms underlying hand paresthesia in this situation are poorly understood. Tham et al<sup>16</sup> found that bursal thickness, tendon vascularity, and capsule thickness increased by 1 week after surgery and then decreased by 6 months postoperatively. The temporal outcomes of these factors parallel the magnitude of shoulder pain recorded in our study. Xu et al<sup>18</sup> obtained arthroscopic biopsies of the shoulder capsule in patients undergoing capsular release. The samples revealed increased expression of nerve growth factor receptors, neoinnervation, neoangiogenesis, subsynovial hypercellularity, and fibroplastic proliferation compared to controls. Gwilym et al<sup>3</sup> reported that a large proportion of patients awaiting subacromial decompression experienced referred pain radiating down the arm and showed hyperalgesia to punctate stimulus of the skin compared to controls, and these patients reported poorer functional outcomes by 3 months after surgery. This study by Gwilym et al<sup>3</sup> provides evidence of central pain sensitization following shoulder injury.<sup>14</sup> We hypothesize that a healing process involving new nerve formation in the glenohumeral joint capsule may accompany capsular inflammation or “capsulitis” following rotator cuff injury and repair, and this may



**Figure 9** Temporal outcomes in the severity (mean ± SEM) of (A) hand tingling and (B) numbness in patients who underwent RCR. \* $P < .05$ ; using the Kruskal-Wallis test. RCR, rotator cuff repair; SEM, standard error of mean.

**Table III** Patient reported factors correlated with hand paresthesia at 6 months after surgery.

Variable	Tingling (r)	Numbness (r)
Work-related shoulder injury	0.25	0.17
Level of work prior to surgery	0.17	0.21
Frequency of shoulder pain during activity	0.40	0.41
Frequency of shoulder pain during sleep	0.41	0.41
Frequency of extreme shoulder pain	0.29	0.31
Level of shoulder pain during rest	0.36	0.44
Level of shoulder pain during overhead activity	0.37	0.40
Level of shoulder pain during sleep	0.42	0.38
Level of shoulder stiffness	0.24	0.26
Level of difficulty of behind the back activity	0.25	0.36
Level of difficulty of overhead activity	0.25	0.36
Level of overall shoulder rating	-0.33	-0.46

All values  $P < .05$ .

**Table IV** Examiner measured factors associated with hand paresthesia at 6 months after surgery.

Variable	Tingling (r)	Numbness (r)
Forward flexion ROM	-0.30	-0.27
Abduction ROM	-0.24	-0.32
External rotation ROM	-0.30	-0.21
Internal rotation ROM	-0.19	-0.39
Strength of internal rotation	-0.35	-0.29
Strength of external rotation	-0.36	-0.25
Strength of supraspinatus	-0.25	-0.29
Strength of liftoff	-0.23	-0.21
Strength of abduction	-0.31	-0.26

ROM, range of motion.

All values  $P < .05$ .

contribute to the manifestation of peripheral upper limb paresthesia due to interactions with the central nociceptive pathways and pain sensitization.

The strengths of this study were the prospective nature of data collection and the clear inclusion and exclusion criteria of hand numbness and tingling among a large sample size. Furthermore, rather than simple yes/no, the data were collected on a scale, which allows more accurate patient reporting. The study also has high internal validity, with all shoulder pathologies being diagnosed and repaired by the same shoulder surgeon using the same devices,

**Table V** Predictive factors of the presence or absence of hand tingling 6 months after surgery.

Variable	Coefficient (B)	Wald statistic	P value
Shoulder problem caused by specific injury (yes/no)	1.334	5.80	.016
Preoperative hand numbness (level)	1.139	20.49	<.0001

**Table VI** Predictive factors of the presence or absence of hand tingling 6 months after surgery.

Variable	Coefficient (B)	Wald statistic	P value
Shoulder problem caused by specific injury (yes/no)	1.543	3.56	.059
Preoperative hand tingling (level)	0.896	7.81	.005

with an extensive experience in shoulder surgery at a single campus. However, these factors (same surgeon, same campus) may limit the applicability of the findings to other surgeons and centers.

There are several limitations to this study which should be considered. We did not formally perform nerve conduction studies or magnetic resonance imaging to rule out cervical radiculopathy, carpal tunnel syndrome, and cubital tunnel syndrome, which are known causes of hand paresthesia.<sup>1</sup> Koulidis et al<sup>4</sup> recently performed a systematic review evaluating the diagnostic accuracy of neurodynamic tests for the assessment of neuropathic pain and found that nerve conduction studies alone were not useful in the diagnosis of upper limb neuropathies, including carpal tunnel syndrome and cervical radiculopathy. We did not record the dermatomal distribution of patients' hand numbness and tingling. The study was also limited to a 6-month follow-up.

**Conclusion**

This study has shown that hand tingling and numbness are prevalent among patients who undergo RCRs. We hypothesize that hand numbness and tingling are very much related to shoulder pain and both are related to the healing process and capsulitis of the shoulder joint, which occurs with rotator cuff injury and following repair.

**Disclaimers:**

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**Conflicts of interest:** George A C Murrell reports that he is a paid consultant; has received research funding from Smith and Nephew (Smith and Nephew products are used in this study); is a financial stakeholder with the facility (Kogarah Private Hospital) where the majority of the procedures was performed; and is on the Editorial and /or governing board of the Journal of Shoulder and Elbow Surgery and Shoulder and Elbow (UK). The other authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

**Supplementary Data**

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jseint.2022.04.010>.

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