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ORIGINAL ARTICLE
Hand

Incidence of Chronic Postsurgical Pain after Upper Extremity Surgery and its Correlation with Preoperative Pain

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Background: The incidence of chronic postsurgical pain (CPSP) after upper extremity surgery is not known. The goal was to study CPSP at 5 years postoperative and to investigate patient, surgical, and anesthetic risk factors.
Methods: Patients scheduled for elective upper extremity surgery were included, and numeric rating scale (NRS) score for pain was obtained preoperatively and at 5 years postoperatively. According to the International Association for the Study of Pain definition, CPSP was defined as an increase in NRS compared with preoperatively.
Results: A total 168 patients were contacted at 5 years postoperatively. Incidence of CPSP was 22%, and 35% had an NRS score of 4 or more. The number of patients with an NRS score of 0 and with an NRS score of 4 or more preoperatively was higher in the no-CPSP group, with *P* values of 0.019 and 0.008, respectively. Of the patients with no preoperative pain, 34% developed CPSP. Regional anesthesia was associated with a lower CPSP incidence ($P = 0.001$) and was more frequently applied in surgery on bony structures and in patients with a preoperative NRS score of 4 or more.
Conclusions: The incidence CPSP was 22%. Patients with no pain or an NRS score of 4 or more preoperatively were less likely to develop CPSP, but individual susceptibility to pain and success of the surgery may be of influence. One-third of the patients with no preoperative pain developed CPSP. More studies are needed to reveal the exact relation between brachial plexus anesthesia and CPSP. *(Plast Reconstr Surg Glob Open 2023; 11:e4922; doi: 10.1097/GOX.0000000000004922; Published online 13 April 2023.)*

INTRODUCTION

Chronic postsurgical pain (CPSP) is an unfortunate but common problem of surgery, that can severely impair a patient's quality of life.[1–6] Also, the ongoing worldwide opioid crisis makes CPSP of public interest, as CPSP may result in prolonged opioid use, including opioid-related side-effects and addiction.[7–9]

The International Association for the Study of Pain defines CPSP as pain localized to the surgical field, developing or increasing in intensity after a surgical procedure, persisting for at least 3 months after surgery, and not resulting from any other causes or a preexisting pain problem.[4] The exact incidence of CPSP is not well known, and numbers ranging from 0% up to 85% are reported.[1,10] Studies on upper extremity CPSP are rare. We aimed to assess the incidence of CPSP at 5 years after different elective surgical procedures of the upper extremity and to investigate the association between patient, surgical, and anesthesia factors and the long-term postoperative pain intensity, to be able to identify patients at risk for developing CPSP.

MATERIALS AND METHODS

This study was carried out by the departments of anesthesiology and plastic surgery of two hospitals, a large

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Received for publication October 21, 2022; accepted February 16, 2023.

DOI: 10.1097/GOX.0000000000004922

Disclosure statements are at the end of this article, following the correspondence information.

Related Digital Media are available in the full-text version of the article on www.PRSGlobalOpen.com.

university hospital, and a midsize teaching hospital. Data were derived from a prospective observational study on postoperative nerve injury after regional anesthesia for hand and wrist surgery.[11] The local medical ethics committee of both hospitals reviewed and approved this study (October 2012 and July 2017, number 2012-327), and the study adheres to the applicable EQUATOR guidelines.

Patients scheduled for elective upper extremity surgery between October 2012 and October 2013 were consecutively invited to be enrolled. All patients included in this study gave written informed consent and met the following inclusion criteria: 18 years and older, scheduled for elective ambulatory plastic hand surgery of the distal upper extremity, and under general or single shot brachial plexus block. All surgery was below the elbow, except for the ulnar nerve transposition at the level of the elbow.

Preoperatively, a numeric rating scale (NRS) score for pain was obtained for all patients. The NRS is a verbally administered 11-point numeric scale, on which a patient can report pain intensity score, ranging from 0 ("no pain") to 10 ("worst pain imaginable").[12]

Data on patient and surgical characteristics, and anesthesia technique were collected using the computerized hospital information system. The treating physicians were free to determine the treatment strategies for their patient with regard to the surgical technique and type of anesthesia. The preferred type of regional anesthesia was the single-shot axillary brachial plexus block, using ropivacaine 0.75% with volumes ranging from 20 to 40 mL. Final block testing was done just before surgery by the hand surgeon using the pinprick test.

For postoperative analgesia, some patients under general anesthesia received additional individual distal nerve blocks by the surgeon at the end of the surgery, using a long-acting local anesthetic drug. In all patients, postdischarge medication included acetaminophen plus a nonsteroidal antiinflammatory drug and/or opioids (tramadol or oxycodone). All blocks were single-shot, and no catheters were placed for postoperative analgesia. Patients were discharged home if NRS score was less than 4.

Postoperative NRS scores were obtained at day 1, and at 5 years postoperatively. On the first postoperative day, postoperative pain was assessed telephonically by an investigator, who was blinded for both surgical and anesthesia details. At 5 years after surgery, all participating patients received an invitation by email to rate their pain on a specially designed webtool. Patients were asked to give an NRS score for their overall pain during the past week, localized to the surgical field, and not resulting from any other causes for pain. Patients who did not respond to three email invitations were contacted by telephone by an investigator. Again, this investigator was blinded for surgical and anesthesia details.

Outcome

The primary outcome parameter in this study was CPSP. The International Association for the Study of Pain defines CPSP as pain localized to the surgical field, developing or increasing in intensity after a surgical procedure, persisting for at least 3 months after surgery, and not resulting from any other causes or a preexisting pain problem.[4] According to this International Association for the Study of Pain definition, the current study defines CPSP as an increase of in pain score at 5 years after surgery compared with preoperatively (thus, postoperative NRS > preoperative NRS). In addition, the pain should be localized in the surgical field, and is not the result of any other causes or a preexisting pain problem.

As a secondary outcome parameter, we used an NRS score of 4 or higher at 5 years after surgery, as in numerous studies on acute postoperative pain, and in daily clinical practice, an NRS score of 4 or more is considered abnormal.[13]

Takeaways

Question: What is the incidence of 5-year upper extremity chronic postsurgical pain (CPSP) and its correlation with preoperative pain?

Findings: Incidence of 5-year CPSP is 22%. CPSP is seen in 34% of the patients with no preoperative pain (numeric rating scale = 0) and in 14% of the patients with a preoperative numeric rating scale score of 4 more. Individual susceptibility to pain and success of the surgery may be of influence.

Meaning: One-fifth of the patients developed CPSP after upper extremity surgery and patients with no pain or a numeric rating scale score of 4 or more preoperatively were less likely to develop CPSP.

Statistical Analysis

Statistical analysis was performed using SPSS 25.0 (IBM Corporation, Armonk, N.Y.). Variables were tested for normality of the distribution, and were presented as mean (±SD) or as median (+IQR). For continuous variables, an unpaired *t* test and Mann Whitney U test was applied if appropriate. For categorical variables, chi-square test was used. A *P* value of 0.05 or less was considered to be statistically significant.

RESULTS

A total of 227 patients agreed to participate in this study, and a total of 168 patients could be contacted successfully at 5 years after surgery. Patient, surgery and anesthesia details of the 168 included patients are shown in Table 1 and Supplemental Digital Content 1. (**See table, Supplemental Digital Content 1,** which displays the patient, surgery, and anesthesia details of patients with an NRS score greater than or equal to 4 at 5 years after surgery. **http://links.lww.com/PRSGO/C493**.)

A total of 37 patients (22%) had higher 5-year pain scores compared with preoperatively and, as per current definition, were labeled as CPSP patients (Table 1). At 5 years postoperatively, a total of 131 patients (78%) had an equal [N = 43 (26%)] or lower [N = 88 (52%)] pain score compared with that of preoperative and were labeled as "no CPSP" patients (Table 1). In Figure 1, pre- and postoperative NRS scores are presented for all 169 patients, with lines depicting increase, decrease, or equal NRS scores.

Table 1. Patient, Surgery, and Anesthesia Details of Patients with CPSP versus no CPSP at 5 years after Surgery

	Total (n = 168)	CPSP (n = 37)	No CPSP (n = 131)	*P*
Patient details				
Gender				0.747
Women	96 (100%)	22 (23%)	74 (77%)	
Men	72 (100%)	15 (21%)	57 (79%)	
Age (y)*				0.928
Median (IQR)	53 (38–62)	51 (41–63)	54 (41–63)	
BMI*				0.346
Median (IQR)	25 (23–27)	26 (23–30)	25 (23–27)	
ASA classification †				0.881
ASA 1	75 (100%)	17 (23%)	58 (77%)	
ASA 2	86 (100%)	18 (21%)	68 (79%)	
ASA 3	7 (100%)	2 (29%)	5 (71%)	
NRS scores preoperatively*				
Median NRS score (IQR)	4 (0–7)	2 (0–4)	5 (1–7)	<0.001
No pain (NRS = 0)	47 (100%)	16 (34%)	31 (66%)	0.019
NRS 1–3	28 (100%)	9 (32%)	19 (68%)	0.210
NRS ≥ 4	87 (100%)	12 (14%)	75 (86%)	0.008
NRS scores at day 1*				
Median NRS score (IQR)	3 (1–6)	3.5 (1–6.75)	3 (1–6)	0.533
No pain (NRS = 0)	3 (100%)	0	3 (100%)	0.350
NRS 1–3	84 (100%)	16 (19%)	66 (81%)	0.851
NRS ≥ 4	75 (100%)	17 (23%)	58 (77%)	0.613
NRS scores at 5 years*				
Median NRS score (IQR)	1 (0–5)	5 (3–7)	0 (0–4)	<0.001
NRS = 0	68 (100%)	0	68 (100%)	<0.001
NRS 1–3	41 (100%)	12 (29%)	29 (71%)	0.201
NRS ≥ 4	59 (100%)	25 (42%)	34 (58%)	<0.001
Type of surgery‡				
Surgery on bony structures (icl. wrist)	49 (100%)	10 (27%)	39 (30%)	0.693
Ligament and tendon surgery	71 (100%)	15 (41%)	56 (43%)	
Nerve-related surgery	26 (100%)	5 (13%)	21 (16%)	
Miscellaneous	22 (100%)	7 (19%)	15 (11%)	
Anesthesia details				
Regional anesthesia	93 (100%)	12 (32%)	81 (62%)	0.001
General anesthesia	75 (100%)	25 (68%)	50 (38%)	
General anesthesia				0.736
With additional nerve block	28 (37%)	15 (60%)	32 (64%)	
Without additional nerve block	47 (63%)	10 (40%)	18 (36%)	

*Age, BMI, and NRS scores are not normally distributed, and therefore presented as "median (IQR)." All other data are presented as number and "valid percentage."

†ASA classification (class 1–6), according to ASA physical status classification system.

‡Type of surgery: Surgery on bony structures (icl. wrist): arthrodesis/arthroplasty (25); finger-joint replacement (1); placement of osteosynthesis material (3); proximal row carpectomy (2); removal of osteosynthesis material (4); wrist arthroscopy (14). Ligament and tendon surgery: Dupuytren contracture (39); ganglion cyst removal (5); ligament repair surgery (14); Quervain release surgery (2); tendon repair surgery (7); tenolysis (4). Nerve-related surgery: carpal tunnel syndrome (6); cubital tunnel syndrome (2); neuroma excision (6); neurolysis (4); ulnar nerve transposition (8).

In the 71 patients (30%) who were lost to follow-up, preoperative and day-1 postoperative pain scores were comparable to the pain scores of the 168 patients who were contacted successfully, with *P* values of 0.62 and 0.71, respectively.

Patient characteristics (gender, age, BMI, and ASA classification) were not found to be of influence on CPSP (Table 1). However, there were statistically significantly more women with an NRS score of 4 or more at 5 years after surgery ($P = 0.006$; Supplemental Digital Content 1, **http://links.lww.com/PRSGO/C493**).

Median preoperative pain score was significantly lower for CPSP patients compared with no-CPSP patients, with a median NRS score of 2 (IQR 0–4) and 5 (IQR 1–7), respectively ($P < 0.001$; Table 1). These patients without CPSP had either no pain [N = 31 (24%)] or an NRS score of 7 or more [N = 47 (36%)], and this resulted in a low median pain score. **(See figure, Supplemental Digital Content 2,** which displays the preoperative pain scores (NRS) for patients with and without CPSP. **http://links.lww.com/PRSGO/C494**.)

The number of patients with no preoperative pain (NRS = 0) and with a preoperative NRS of 4 or more were higher in the no-CPSP group compared with the CPSP group (Table 1; Supplemental Digital Content 2, **http://links.lww.com/PRSGO/C494**). Of the 47 patients with no preoperative pain, a total of 16 patients (34%) developed CPSP, of which seven patients (15%) had an NRS score of 4 or more

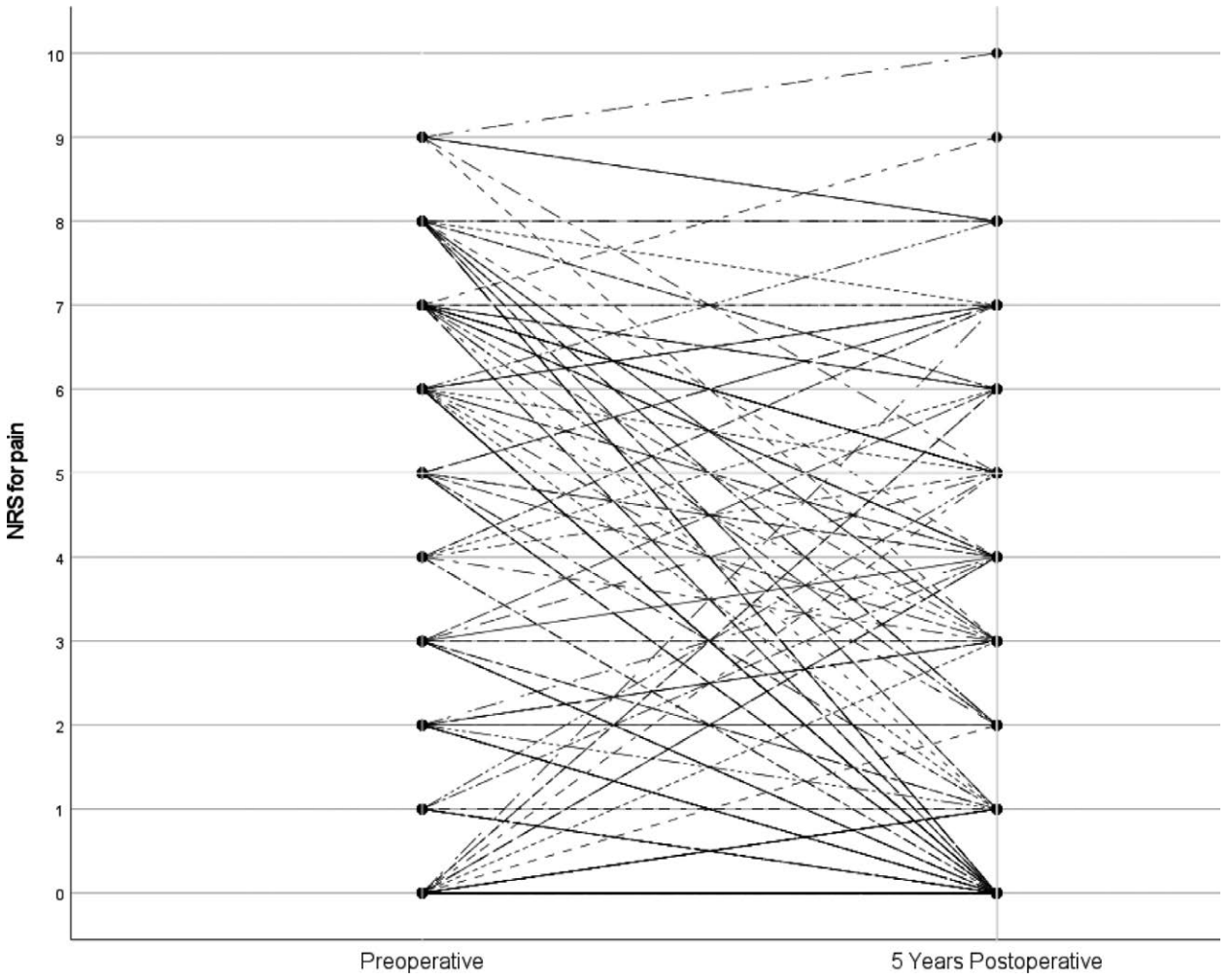

Fig. 1. Pre- and postoperative pain in all 169 patients, with lines for increase, decrease, or comparable NRS scores.

at 5 years postoperatively (Table 1). Of the 87 patients with a preoperative NRS score of 4 or more, in a total of 41 patients (47%), NRS score decreased below 4, and 21 patients (28%) had an NRS score of 0 at 5 years postoperatively.

Median 5-year postoperative pain score was significantly higher for CPSP patients compared with no-CPSP patients, with a median NRS score of 5 (IQR 3–7) and 0 (IQR 0–4) respectively ($P < 0.001$) (Table 1). **(See figure, Supplemental Digital Content 3,** which displays the 5-year postoperative pain scores (NRS) for patients with and without CPSP. **http://links.lww.com/PRSGO/C495**.) Patients with an NRS score of 4 or more at 5 years after surgery had higher median preoperative pain scores, and were more likely to have a preoperative NRS score of 4 or more (Supplemental Digital Content 1, **http://links.lww.com/PRSGO/C493**).

Patients in the no-CPSP group were statistically significantly more frequently operated on under regional than general anesthesia ($P = 0.001$; Table 1). Yet, there was no difference in the number of patients with a 5-year NRS score of 4 or more between patients operated on under regional or general anesthesia (Supplemental Digital Content 1, **http://links.lww.com/PRSGO/C493**). Noteworthy, regional anesthesia was more frequently applied in patients undergoing surgery on bony structures ($P = 0.027$) and in patients with a preoperative NRS score of 4 or more ($P = 0.070$). There was no association between type of anesthesia and gender, age, BMI, or ASA classification.

Type of upper extremity surgery was not of influence on CPSP incidence (Table 1), though surgery on bony structures and nerve surgery resulted in a statistically significantly higher number of patients with an NRS score of 4 or more compared with the other types of surgery ($P = 0.018$) (Supplemental Digital Content 1, **http://links.lww.com/PRSGO/C493**). Other surgical and anesthesia characteristics (tourniquet time, tourniquet inflation pressure, type of brachial plexus block, local anesthetic drug used, volume of local anesthetic, use of nerve stimulator or ultrasound, sedation or paraesthesia during block placement, and additional nerve blocks in patients under general anesthesia) were not found to be of influence on both CPSP incidence and 5-year postoperative pain scores (Table 1; Supplemental Digital Content 1, **http://links.lww.com/PRSGO/C493**).

DISCUSSION

This prospective observational study shows a CPSP incidence of 22%, and 35% of patients had an NRS score of 4 or more at 5 years after elective distal upper extremity surgery. CPSP patients had statistically significantly lower median pain scores preoperatively, but the majority of these patients had either no pain or a high pain score preoperatively. The number of patients with no preoperative pain and with an NRS score of 4 or more preoperatively was higher in the no-CPSP group. There was a lower incidence of CPSP patients after regional anesthesia. Regional anesthesia was more frequently applied in patients with surgery on bony structures and in patients with a preoperative NRS of 4 or more.

The exact incidence of CPSP is not well known, and a considerable variability has been reported.[1,10] This variability is mostly due to methodological differences, such as variable definitions of CPSP, the time frame applied for measurement of postoperative pain, and the use of diverse pain measurement tools.[10] When reviewing findings of several studies on CPSP after various surgical interventions, incidence numbers range from 0% up to 85%.[10] Although incidence numbers vary, it clearly shows that CPSP is a common problem.[10] Our study identifies an incidence of 22%, which is well in range with findings reported by others.[10]

The transition from acute to chronic postsurgical pain is a complex and multifactorial process, in which both biological, genetic, psychosocial, surgical, and environmental mechanisms can be involved.[1,2,6,14] Documented risk factors of CPSP are younger age, woman, preexisting preoperative pain, type of surgery, and (severe) postoperative pain.[2,3,6,10,14] This study could not identify an association between the development of CPSP and age, gender, and type of upper extremity surgery, although there was a higher number of women with an NRS score of 4 or more at 5 years after surgery.

The presence of moderate-to-severe pain before and acute pain after surgery is considered to be the most important and independent predictor of the development of CPSP.[3,6,10,14,15] In this study, however, no such distinct pattern between preoperative pain and CPSP could be detected. Patients with either no preoperative pain (NRS = 0) or a preoperative NRS score of 4 or more were less likely to develop CPSP. Individual susceptibility to pain and the response to analgesics can partly explain this finding.[6] Moreover, in patients with a preoperative NRS score of 4 or more, surgery is often performed on the basis of a painful condition (eg, fractures, arthrosis), and the postoperative pain intensity may therefore be affected by success of the surgical intervention.

Although the risk of developing CPSP is lower in patients with no preoperative pain, it is certainly not zero risk. In this cohort, we found that if a patient had no preoperative pain (NRS = 0), there was a 34% chance of an increase in pain, and notably, a 15% chance of an NRS score more than 4 at 5 years. In contrast, if a patient had a preoperative NRS score of 4 or more, there was a 79% chance of a decreased pain score at 5 years after surgery, and even a decrease to an NRS score of 0 in 28% of the patients. These numbers are small, and the findings should be interpreted with care. However, we believe these findings highlight the importance of an individualized multimodal perioperative analgesic regimen, to aggressively treat acute postoperative pain.[6,16]

Regional anesthesia techniques have a track record in treating acute postoperative pain, and have several beneficial effects over other nonregional analgesic regimens.[7,17–21] Firstly, local anesthetic drugs diffuse into the nerve itself and inactivate the sodium channels, resulting in a total blockade of nociceptive input to the central nervous system. Blockage of pain impulses prevents the sensitization of the central nervous system and may reduce the risk of developing CPSP.[1,16] Secondly, regional anesthesia techniques provide complete muscle paralysis of the forearm, possibly facilitating the approach to the operative site, minimizing tissue damage and lowering nociceptive input to the spinal cord.[21] Thirdly, local anesthetic drugs used usually have an analgesic effect well beyond the duration of surgery, preventing onset of pain in the initial postoperative period.[22] Although regional anesthesia techniques are able to provide good analgesia in the early postoperative period, mixed results are reported on chronic postoperative pain[7,16–21] The current study demonstrates a lower CPSP incidence in regional anesthesia patients, suggesting a protective effect against the development of CPSP. However, in our study population, regional anesthesia is more frequently applied in patients with a preoperative NRS score of 4 or more, and in surgery on bony structure. Therefore, more studies are needed to reveal the exact correlation between regional anesthesia and CPSP.

The strength of the current study lies in the evaluation of pain at 5 years after surgery. We are not aware of any similar study measuring pain intensity at 5 years postoperatively. However, the long follow-up period can also be a potential limitation. During this follow-up period, patients might have another painful event at the surgical site, such as trauma or other surgery, or progression of the initial disease (eg, arthrosis). Unfortunately, we do not have any information on pain scores between day 1 and 5 years postoperatively. This is due to the fact that the current study is derived from a prospective observational study on postoperative nerve injury after regional anesthesia.[11]

Another limitation is due to the definition of CPSP used in the current study. CPSP is defined as any increase in pain compared with preoperatively and this gives patients who start with an NRS score of 0 a "relative" high risk of developing CPSP, as an NRS score of 0 cannot decrease. Furthermore, deciding on how to diagnose CPSP is challenging. Does an increase of 1 NRS point classify as having CPSP, or should we define a cut-off for minimal increase in NRS score?

CONCLUSIONS

Incidence of 5-year CPSP after elective upper extremity surgery is 22%, and 35% had an NRS score of 4 or more at 5 years after elective distal upper extremity surgery. Patients with no pain or an NRS score of 4 or more preoperatively were less likely to develop CPSP, but individual

susceptibility to pain treatment and success of the surgical intervention may be of influence. However, zero pain preoperatively is no guarantee for zero pain at 5 years, as one-third of the patients with no preoperative pain developed CPSP. In patients operated on under regional anesthesia, CPSP incidence was lower. More studies are needed to reveal the exact association between brachial plexus anesthesia and CPSP after upper extremity surgery.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

ACKNOWLEDGMENTS

The authors thank Sanne Hoeks and Sander Frankema for their useful comments on the article. The authors would also like to thank Klaas Hoek, Nils de Rooij, and Stefan van Adrichem (medical students from the Erasmus University Rotterdam, the Netherlands) for providing logistical assistance.

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