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REPORTS OF ORIGINAL INVESTIGATIONS

Effect of superficial cervical plexus block on postoperative quality of recovery after anterior cervical discectomy and fusion: a randomized controlled trial

L'effet d'un bloc du plexus cervical superficiel sur la qualité de la récupération postopératoire après une discectomie cervicale antérieure et fusion: une étude randomisée contrôlée

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Abstract

Purpose *Spine surgeries are increasingly being performed as a day or short-stay surgery programs. Peripheral nerve block provide site-specific pain relief with few side effects, thereby reducing surgical stress and enhancing quality of recovery. The aim of our study was to determine the effect of a superficial cervical plexus block (SCPB) on postoperative quality of recovery and analgesia in patients undergoing elective anterior cervical discectomy and fusion (ACDF).*

Methods *After Research Ethics Board approval, we enrolled adults (> 18 yr) scheduled for elective single- or two-level ACDF in this randomized double-blind clinical trial. Participants were randomized to receive either a SCPB (0.25% bupivacaine, 10 mL) or No Block. The primary outcome measure was the quality of recovery at 24 hr, measured using the 40-item quality of recovery questionnaire (QoR-40). In addition, comparisons between groups were also made for postoperative opioid consumption and discharge times.*

Results *Forty-six patients were randomized to receive either a SCPB block (n = 23) or No Block (n = 23). Median [interquartile range] aggregated global QoR-40 scores at 24 hr were significantly greater in the SCPB group, indicating good quality of recovery compared with the No Block group (179 [116-195] vs 157 [97-196], respectively; median difference, 22; 95% confidence interval [CI], 7 to 34; P = 0.002]. There were no differences between the SCPB and the No Block group with regard to mean (standard deviation) postoperative opioid consumption at 24 hr [22.9 (13.6) mg vs 24.6 (9.5) mg, respectively; mean difference 1.7; 95% CI, −5.2 to 8.7; P = 0.620] and the number of patients discharged within 24 hr (15 vs 12, respectively; P = 0.550).*

Conclusion *We showed that preoperative SCPB is an effective strategy for improving the early quality of recovery in patients undergoing single- or two-level ACDF. Nevertheless, there was no impact on opioid consumption or discharge times. This trial was registered at www.clinicaltrials.gov (NCT01662219).*

Résumé

Objectif *Les chirurgies de la colonne sont de plus en plus souvent réalisées en ambulatoire ou dans le cadre de programmes chirurgicaux de courte durée. Les blocs des nerfs périphériques procurent un soulagement de la douleur localisé et entraînent peu d'effets secondaires,*

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réduisant ainsi le stress chirurgical et améliorant la qualité du rétablissement. L'objectif de notre étude était de déterminer l'effet d'un bloc du plexus cervical superficiel (BPCS) sur la qualité de la récupération postopératoire et de l'analgésie chez les patients subissant une discectomie cervicale antérieure et fusion (ACDF) non urgente.

Méthode *Après avoir obtenu l'accord du Comité d'éthique de la recherche, nous avons recruté des adultes (> 18 ans) devant subir une ACDF à un ou deux niveaux pour cette étude clinique randomisée à double insu. Les participants ont été aléatoirement répartis en deux groupes, soit le groupe BPCS (10 mL de 0,25 % bupivacaïne), et le groupe Sans bloc. Le critère d'évaluation principal était la qualité de la récupération à 24 h, mesurée à l'aide du questionnaire de qualité de récupération en 40 questions (QdR-40). Nous avons également comparé la consommation postopératoire d'opiacés et le moment de congé entre les deux groupes.*

Résultats *Quarante-six patients ont été randomisés à recevoir soit un bloc BPCS (n = 23) ou aucun bloc (Sans bloc, n = 23). Les scores globaux agrégés médians [écart interquartile] sur le QdR-40 à 24 h étaient significativement plus élevés dans le groupe BPCS, indiquant une bonne qualité de récupération par rapport au groupe Sans bloc (179 [116-195] vs 157 [97-196], respectivement; différence médiane, 22; intervalle de confiance [IC] 95 %, 7 à 34; P = 0,002]. Aucune différence n'a été observée entre les groupes BPCS et Sans bloc quant à la consommation postopératoire moyenne d'opiacés (écart type) à 24 h [22,9 (13,6) mg vs 24,6 (9,5) mg, respectivement; différence 1,7; IC 95 %, −5,2 à 8,7; P = 0,620] et au nombre de patients ayant reçu leur congé au cours des premières 24 h (15 vs 12, respectivement; P = 0,550).*

Conclusion *Notre étude démontre qu'un BPCS préopératoire constitue une stratégie efficace pour améliorer la qualité de récupération précoce chez les patients subissant un ACDF à un ou deux niveaux. Cependant, ce type de bloc n'a eu aucun impact sur la consommation d'opiacés ou les moments de congé. Cette étude a été enregistrée au www.clinicaltrials.gov (NCT01662219).*

Spine surgeries are increasingly being performed as day or short-stay surgical procedures, and anterior cervical decompression and fusion (ACDF) is one such procedure.[1,2] Postoperative pain is the leading cause of delayed discharge or unplanned readmissions following day surgery.[3] Pain and discomfort after ACDF is difficult to quantify as these patients often experience painful swallowing, dysphagia, and position-related occipito-nuchal pain in addition to incisional pain.[4-6] Postoperative incisional pain has been reported as moderate in severity usually needing oral opioid analgesics. Nevertheless, opioid-related side effects, including nausea, vomiting, and respiratory depression, are undesirable in these patients who are at risk for airway complications due to airway edema secondary to surgical retraction or wound hematoma.[7-9]

Peripheral nerve block, as a part of a multimodal analgesic technique, provide site-specific pain relief with few side effects and have been shown to be effective for improving the quality of recovery.[10,11] Superficial cervical plexus block (SCPB) is a safe and simple technique that has been shown to provide good pain relief for both incisional pain and the occipito-nuchal pain after thyroid and carotid surgeries.[6]

Postoperative pain is an important component of quality of recovery after surgery; however, assessment of only pain outcomes after surgery does not completely describe the full dimensions of the quality of recovery. Among the multiple tools available to access the quality of recovery after anesthesia and surgery, the 40-item quality of recovery questionnaire (QoR-40) is one of the validated multidimensional tools that has been shown to be suitable to assess the effect of interventions in anesthesia that are aimed at improving the quality of recovery and improving patient satisfaction.[12] The questionnaire measures various dimensions of recovery, including pain, nausea and vomiting, physical independence, physical comfort, emotional state, and psychological support.[12]

The main objective of this study was to determine the effect of SCPB on postoperative quality of recovery and analgesia in patients undergoing elective anterior cervical discectomy and fusion. We hypothesized that the SCPB would reduce postoperative pain and discomfort and thus improve the quality of recovery at 24 hr as measured by the QoR-40 questionnaire in patients undergoing elective ACDF.

Methods

Our Institutional Research Ethics Board approved (May 2012) the study protocol for this single-centre prospective randomized double-blind clinical trial. Written informed consent was obtained from all study participants. All adult patients aged 18-80 yr with American Society of Anesthesiologists physical status I-III who underwent elective, single- or two-level ACDF from June 2012 to December 2013 were enrolled in this study. Our exclusion criteria included patients with a history of allergy to local anesthetics, pregnancy, and patients with known psychiatric or neurological conditions that would affect the completion of the QoR-40 questionnaire.

Using a computer-generated set of randomized numbers, patients were randomized to receive either unilateral SCPB

with 0.25% bupivacaine 10 mL (SCPB) or No Block. Group assignments were sealed in sequentially numbered opaque envelopes that were opened by research personnel not involved in patient care or data collection. The assessors who were evaluating the postoperative patient outcomes were blinded to group allocation, but both the anesthesiologist and the surgeon were not blinded.

Routine preparation of the patients was carried out as per our institutional standards for all patients undergoing ACDF. Patients received standardized monitoring and an anesthetic regimen consisting of intravenous fentanyl 2-3 $\mu g \cdot kg^{-1}$ and propofol 2-3 $mg \cdot kg^{-1}$, with rocuronium 0.6 $mg \cdot kg^{-1}$ to facilitate endotracheal intubation. Anesthesia was maintained with oxygen, air, and sevoflurane (approximately 1 MAC). After induction of anesthesia and positioning the patient, a unilateral SCPB was performed on the side of surgical incision in patients randomized to block. A line that extended from the mastoid process to the clavicular head of the sternocleidomastoid muscle was marked, and the block needle was inserted at the midpoint of this line. After aseptic preparation of the injection area, the SCPB was performed using a 25G 38-mm long needle and 0.25% bupivacaine 10 mL at the midpoint between the anterior and posterior border of the sternocleidomastoid muscle. Using a fan-shaped technique, the local anesthetic was injected at and 2-3 cm below and above the needle insertion site with 3 mL in each direction.

Intraoperatively, all patients received dexamethasone 4 mg *iv* (before surgical incision) and ondansetron 4 mg *iv* (during closure) for postoperative nausea and vomiting (PONV) prophylaxis. Additional analgesia was provided with incremental intravenous boluses of fentanyl 25 μg as indicated. At the end of the surgery, sevoflurane was turned off and the neuromuscular blockade was reversed with neostigmine (50 $\mu g \cdot kg^{-1}$ *iv*) and glycopyrrolate (10 $\mu g \cdot kg^{-1}$). In the postanesthetic care unit (PACU), the general care of the patients was as per our standard practice in terms of monitoring and assessment of neurological status, pain, PONV, and level of sedation.

Patients were asked to rate their pain upon arrival and at regular intervals using an 11-point visual analogue scale (VAS; 0 = no pain, 10 = the worst pain imaginable). Nausea and vomiting were assessed using a dichotomous yes or no scale. The level of sedation was recorded using the Ramsay sedation scale (1-6), with a score of 1-3 indicating an awake state and 4-6 indicating a sleep state. To maintain a VAS of < 4, fentanyl 25 μg *iv* was administered every five minutes for pain to the maximum of 200 μg. Morphine 1-2 mg *iv* or hydromorphone 0.2-0.4 mg *iv* were administered every five minutes as needed for additional analgesia. Difficulty with postoperative nausea and vomiting was treated with dimenhydrinate 25-50 mg *iv* and/or additional intravenous ondansetron 4 mg. Patients were discharged from the PACU after four hours to either the day surgery unit or the inpatient surgical ward. The time of discharge from the hospital was determined by the surgeon.

After discharge from the PACU, patients received either oral codeine 30 mg with acetaminophen 300 mg or oxycodone 5 mg with acetaminophen 325 mg for postoperative analgesia. If they could not tolerate oral medications, intravenous morphine or hydromorphone was used. An investigator who was unaware of the study group allocation carried out individual patient follow-up for 24 hr following the procedure (by inpatient visit or telephone). The QoR-40 questionnaire was administered at 24 hr after surgery. The questionnaire consists of 40 questions that examine five domains of patient recovery using a five-point Likert scale as follows: none of the time, some of the time, usually, most of the time, and all the time. The five domains assessed included physical comfort, pain, physical independence, emotions, and support. Global QoR-40 scores range from 40-200 representing very poor to outstanding quality of recovery.

The other data recorded included patient demographics, anesthesia and surgical data, postoperative pain, sedation, nausea and vomiting scores, incidence of sore throat, dysphagia, and the total analgesic consumption in the first 24 hr. In addition, we collected three-month postoperative outcome data in both groups. The Neck Disability Index questionnaire measures the severity of disability after cervical spine surgery, and these data were used to compare the severity of the disability between the groups.[13]

The primary outcome measure was the global QoR-40 aggregate score at 24 hr after surgery. The secondary outcome measures were total opioid consumption, side effects, and hospital discharge times.

Statistical analysis

The mean (SD) QoR-40 score at 24 hr after major spine surgery has been reported to be 160 (17).[14] Previous studies are lacking on QoR-40 scores after short-stay or outpatient spine surgery; however, the median [interquartile range; IQR] QoR-40 scores at 24 hr after outpatient surgery have been reported as 157 [127-193] and 146 [130-169].[15,16] A ten-point difference represents a 15% relative improvement in quality of recovery based on previously reported values of the QoR-40 score in patients after surgery and anesthesia.[17] To show a difference of ten points in the QoR-40, we calculated that 23 patients per group would be needed to detect a significant difference between groups with an alpha of 5% and power of 80% and assuming a baseline mean (SD) QoR-40 of 160 (17).[14]

Continuous data are reported as mean (SD), while non-continuous data are reported as median [IQR]. The data

were tested for normal distribution using Shapiro-Wilk and Kolmogorov-Smirnov tests. The primary outcome and other continuous data were compared between groups using a Mann-Whitney U test or an unpaired Student's *t* test. Categorical data were compared using a Chi square test. All reported *P* values are two sided. The statistical analyses were performed using SPSS® (version 16) and GraphPad Prism® 6 (La Jolla, CA, USA).

Results

Forty-six patients were recruited and randomized to receive either a SCPB ($n = 23$) or No Block ($n = 23$). All patients' data were taken for final analysis as none of the patients were excluded or lost to follow-up after enrolment. The details of the conduct of the study are shown in Fig. 1. There were no differences between the groups with regard to patient demographics and surgical and anesthetic data (Table 1).

Median [IQR] aggregated global QoR-40 scores at 24 hr were significantly greater in the SCPB group, indicating good quality of recovery compared with the No Block group (179 [116-195] *vs* 157 [97-196], respectively; median difference, 22; 95% CI, 7 to 34; $P = 0.0023$). The dimensions of the QoR-40 questionnaire are shown in Table 2. Patients in the SCPB group had better median scores in the dimensions of pain, physical comfort, emotional status, and support when compared with the No Block group, but there was no difference in physical independence.

There were no differences between the SCPB and the No Block group with regard to mean (SD) postoperative opioid consumption at 24 hr [22.9 (13.6) mg *vs* 24.6 (9.5) mg, respectively; mean difference, 1.7; 95% CI, −5.2 to 8.7; $P = 0.620$] (Table 3). The VAS scores (up to 12 hr) were also similar between the groups (Table 4) The incidence of nausea, vomiting, dysphagia, and hoarseness were similar between the two groups at two hours after surgery (Table 5), but the incidence of nausea, vomiting and dysphagia were significantly less in patients who received SCPB at 24 hr after surgery (Fig. 2).

Twenty-seven patients (15 in the SCPB group and 12 in the No Block group) were discharged within 24 hr after surgery ($P = 0.550$), with 18 patients (ten in the SCPB group and eight in the No Block group) discharged within 12 hr after surgery ($P = 0.763$). There were no adverse events or complications reported in either group. In addition, at three months postoperatively, the mean (SD) Neck Disability Index scores were similar in both groups [SCPB group, 16.2 (11.4) *vs* No Block group, 15.5 (10); mean difference, 0.094: 95% CI, −7.1 to 7.1; $P = 0.979$].

Discussion

In our study, we found that the postoperative quality of recovery after ACDF was better in patients who received preoperative SCPB. There was a 22-point improvement in the QoR-40 score in the SCPB group when compared with the score in the No Block group ($P = 0.002$). There were no differences between the groups with regard to total opioid consumption and discharge times. Besides this improvement in the QoR-40 score, patients in the SCPB group reported

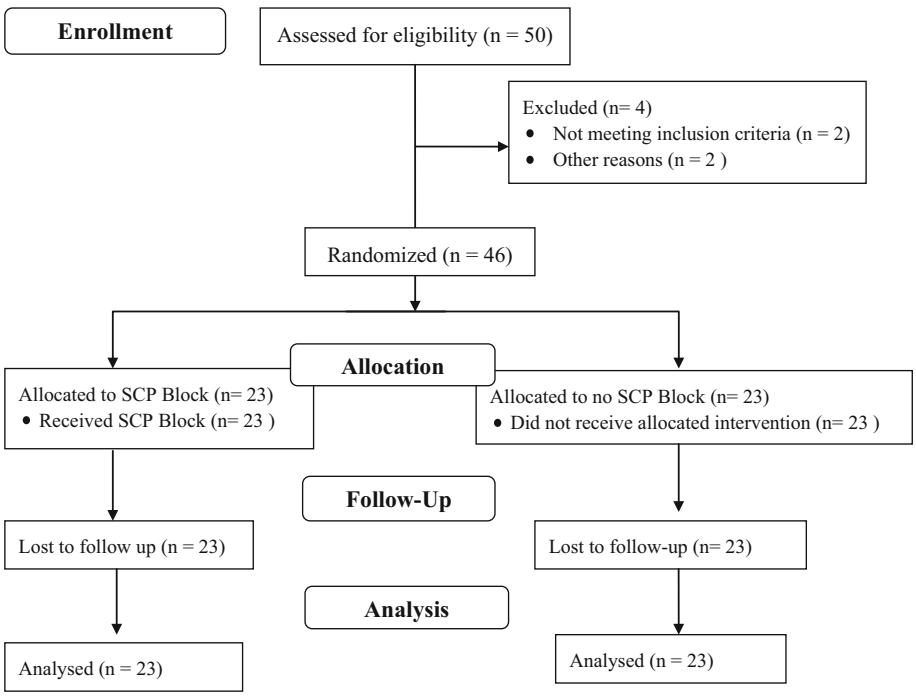

Fig. 1 Consort diagram

Table 1 Patient characteristic and intraoperative data

	SCPB group ($n = 23$)	No Block group ($n = 23$)
Age (yr)	48.2 (9.3)	52.2 (11.9)
Sex: Male	13 (56%)	16 (70%)
BMI	31.3 (6.4)	28.3 (4.1)
Co-existing disease		
Hypertension	8 (34%)	9 (39%)
Diabetes Mellitus	2 (9%)	5 (21%)
IHD	3 (13%)	5 (21%)
OSA	1 (4%)	1 (4%)
Smoking history	17 (73%)	13 (56%)
Preoperative opioid use	12 (52%)	12 (52%)
Surgical levels One/Two level	10/13	10/13
Fentanyl dose (μg)	308 (145)	283 (114)
Propofol dose (mg)	289 (26)	263 (17)
Rocuronium dose (mg)	53 (2)	54 (2)
Intravenous fluids (mL)	1,343 (75)	1,378 (119)
Surgical duration (min)	254 (16)	232 (12)

Data are shown as numbers *n* (%) and mean (SD);
BMI = body mass index;
IHD = ischemic heart disease;
OSA = obstructive sleep apnea;
SCP = superficial cervical plexus

Table 2 Quality of Recovery score (QoR-40) at 24 hr after surgery

Parameters	SCPB Group ($n = 23$)	No Block Group ($n = 23$)	Difference (95% CI)	*P* Value
Physical comfort	53 [47-56]	46 [39-53]	7 (0 to 13)	0.012
Emotional state	41 [37-44]	35 [28-39]	6 (0 to 11)	0.004
Physical dependence	33 [29-35]	32 [28-34]	1 (1 to 4)	0.141
Patient support	20 [19-23]	16 [14-20]	4 (0 to 8)	0.003
Pain	32 [27-34]	28 [25-32]	4 (0 to 7)	0.014
Total score	179 [116-195]	157 [97-196]	22 (7 to 34)	0.002

Data are shown as median [interquartile range].
CI = confidence interval;
SCP = superficial cervical plexus

Table 3 Postoperative opioid consumption at 2, 6, 12, 24 hr

Cumulative opioid consumption (mg)*	SCPB Group ($n = 23$)	No Block Group ($n = 23$)	Difference (95% CI)	*P* Value
2 hr	11.1 (7.3)	10 (6.6)	−1.0 (−5.1 to 3.1)	0.621
6 hr	13.7 (8.7)	14.6 (8.4)	0.9 (−4.0 to 5.9)	0.702
12 hr	18.6 (10.2)	18.4 (8.6)	−0.2 (−5.8 to 5.3)	0.936
24 hr	22.9 (13.6)	24.6 (9.5)	1.7 (−5.2 to 8.7)	0.620

Data represented as mean (SD); CI = confidence interval; SCP = superficial cervical plexus

*Opioid consumption is in morphine equivalents (mg)

better scores in the physical comfort, emotional state, and pain subcomponents of the QoR-40 questionnaire (Table 2). These findings are important in the setting of day or short-stay surgical populations where an optimal quality of recovery is needed in order to ensure the possibility of early discharge. With the recent advances in anesthetic and surgical techniques, the focus of healthcare has moved towards improving the quality of recovery in patients undergoing surgery.

Myles *et al.* developed the QoR-40 scoring system,[17] which is a valid, reliable, and responsive tool for assessment of the quality of recovery after surgery and anesthesia. A recent quantitative systematic review and meta-analysis by Gornall *et al*. has shown that the QoR-40 scale is a good-quality measurement tool for assessing the quality of recovery.[12] This scoring system has been validated for many surgical facilities, including neurosurgery.[17]

Table 4 VAS pain scores up to 12 hr after surgery

VAS scores at various intervals	SCPB group ($n = 23$)	No Block Group ($n = 23$)	Difference (95% CI)	P value
5 min	5 [3-8]	5 [2-7]	0 (−2 to 2)	0.830
30 min	6 [4-7]	6 [5-8]	0 (−1 to 2)	0.679
60 min	6 [4-7]	5 [3-6]	−1 (−2 to 1)	0.409
90 min	4 [2-5]	4 [2-5]	0 (−1 to 1)	0.856
2 hr	4 [2-5]	4 [2-5]	0 (−1 to 1)	0.559
4 hr	4 [2-5]	4 [2-5]	0 (−1 to 1)	0.856
6 hr	4 [2-7]	6 [4-7]	−2 (−3 to 0)	0.073
12 hr	5 [3-6]	4 [2-5]	1 (0 to 2)	0.066

Data are presented as median [interquartile range]; CI = confidence interval; SCP = superficial cervical plexus; VAS = visual analogue scale

Table 5 Incidence of adverse effects in the PACU (first 2 hr after surgery)

Postoperative adverse effects	SCPB group ($n = 23$)	No Block Group ($n = 23$)	P Value
Nausea	11 (47%)	10 (43%)	0.767
Vomiting	11 (47%)	10 (43%)	0.767
Hoarseness	2 (9%)	3 (13%)	0.636
Dysphagia	2 (9%)	4 (17%)	0.381

PACU = postanesthesia care unit; SCP = superficial cervical plexus

All data are presented as number (%)

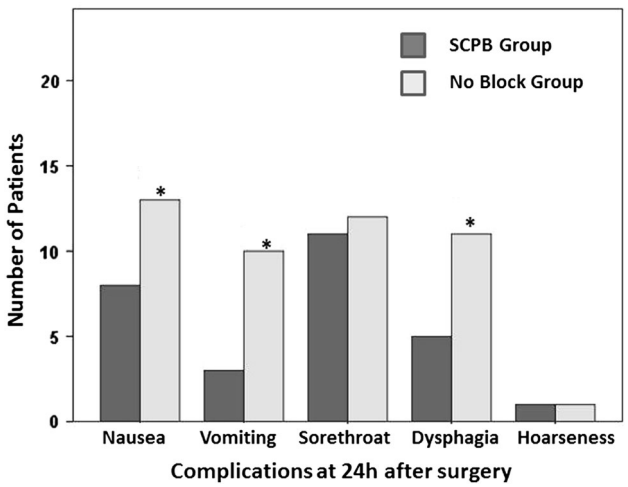

Fig. 2 Incidence of adverse events at 24 hr after surgery. At 24 hr after surgery, there was significantly less incidence of nausea, vomiting, and dysphagia in the superficial cervical plexus block (SCPB) group than in the No Block group

The beneficial effects of SCPB have been reported after other neck operations.[18-24] Several studies have shown that the SCPB not only improves pain control after thyroidectomy and carotid endarterectomy,[18-24] but it also decreases PONV after thyroidectomy.[18] Nevertheless, we did not find any differences in postoperative opioid consumption between the two groups. This may be because the postoperative incisional pain following ACDF may be only moderate in severity. Results of a previous study by Niijima *et al.* showed that a SCPB combined with a greater occipital nerve block reduced occipito-nuchal pain associated with positioning after craniotomy.[6] Hence, the greater scores in the pain and patient comfort components of the QoR-40 in patients with a SCPB might be due to reduced discomfort related to positioning. There was also a significant reduction in the incidence of vomiting, dysphagia, and sore throat in the SCPB group, which might be another reason for the improved QoR-40 scores. These factors may have resulted in SCPB patients feeling better despite requiring similar amounts of analgesia. Our study did not show any differences between the two groups in the physical dependence component of the QoR score, which may be due to assessing the components of physical dependence (e.g., normal speech, activities of daily living, writing, and ability to return to work) too soon (at 24 hr) after surgery.

There are several limitations to our study. First, the attending anesthesiologists were not blinded to the study intervention as the No Block group did not even receive a skin wheal. This could have caused some bias while the hemodynamic responses to pain were treated during the intraoperative period. Ideally, the control group should have received a placebo (i.e., saline) infiltration in their block, but we could not obtain Institutional Research Ethics Board

approval for this approach. Second, our study was adequately powered to show a difference of ten points in the quality of recovery, but it was not adequately powered to show any differences in postoperative opioid consumption and adverse effects. Third, we could not record the VAS scores after the patients were discharged from the hospital. Most patients were taking the opioid analgesics every three to four hours as per their postoperative instructions. The ability to record VAS scores before and after the patients received their medication would have provided more information on the duration of the block and its analgesic effect. Since we could not show the difference in opioid consumption, recording the VAS score before the analgesics were taken could have helped compare the pain severity between the two groups. Fourth, we used only unilateral and not bilateral SCPB as the surgical incision reached midline; thus, we cannot comment on whether pain relief from a bilateral block would have been superior to that from a unilateral block. Previous studies addressing this topic are lacking. Furthermore, we followed the patients for only the first 24 hr; hence, some of the complications of block and readmission would have been missed. Longer follow-up would have been appropriate to determine if the SCPB block improves the physical dependence component of the QoR-40 score.

The QoR-40 score does measure pain, and in this cohort, the SCPB group reported significantly greater comfort with respect to pain. Although the No Block group reported worse pain, there was no significant difference between the groups in total opioid consumption at 24 hr after surgery. There are several possible reasons for this discrepancy. The intensity of pain following ACDF surgery has been quoted as moderate in severity, and a superficial cervical plexus block might be responsible for pain relief only in the immediate postoperative period which is unlikely to extend beyond 24 hr. In our study, the oral analgesia given to our patients every three to four hours was not titrated to pain scores. For example, patients may have received the same analgesic dose at a pain score of 4, while another patient might have received a similar dose at a pain score of 8.

In conclusion, we showed that preoperative SCPB improves the quality of recovery after single- or two-level ACDF, making it a low-cost and effective strategy for improving the quality of recovery in patients undergoing anterior neck surgeries.

Conflict of interest None declared.

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