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REPORTS OF ORIGINAL INVESTIGATIONS

Superficial cervical plexus block for transitional analgesia in infratentorial and occipital craniotomy: a randomized trial

Bloc du plexus cervical superficiel pour l'analgésie transitionnelle lors d'une craniotomie sous-tentorielle ou occipitale, une étude randomisée

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Abstract

Background *In this study, we compared the quality of transitional analgesia provided by bilateral superficial cervical plexus block (SCPB) or morphine following a remifentanil-based anesthesia for infratentorial or occipital craniotomy.*

Methods *In this randomized controlled and double-blind study, 30 patients scheduled for infratentorial or occipital craniotomy were divided randomly into two groups: group morphine (morphine 0.1 mg·kg^{-1} iv after dural closure and a SCPB performed with 20 mL of 0.9% saline at the end of the surgery) or group block (10 mL of 0.9% saline iv instead of morphine after dural closure and a SCPB performed with 20 mL of a 1:1 mixture of 0.5% bupivacaine and 2% lidocaine at the end of the surgery). Postoperative pain was assessed at one, two, four, eight, 12, 16, and 24 hr using an 11-point (0-10) numerical rating scale (NRS). Analgesia was provided with subcutaneous codeine.*

Results *Average NRS scores were similar between the two groups at each time interval over the study period. The average scores (with 95% confidence interval) were 3.9 (3.4-4.4) and 4.3 (3.8-4.9) for the block and morphine groups, respectively (P = 0.25). The delay before administration of the first dose of codeine was not statistically different between the two groups: 25 min (5-2,880) vs 21.5 min (5-90), median and range for the block and morphine groups, respectively. The incidence of nausea and vomiting was similar between the two groups.*

Conclusion *Bilateral superficial cervical plexus block provides transitional analgesia that is clinically equivalent to morphine following remifentanil-based anesthesia in patients undergoing occipital or infratentorial craniotomies.*

Résumé

Contexte *Dans le cadre de cette étude, nous avons comparé la qualité de l'analgésie transitionnelle produite par un bloc bilatéral du plexus cervical superficiel (SCPB) ou par la morphine à la suite d'une anesthésie au rémifentanil lors d'une craniotomie sous-tentorielle ou occipitale.*

Méthode *Dans cette étude randomisée et contrôlée en double aveugle, 30 patients ayant subi une craniotomie sous-tentorielle ou occipitale ont été divisés aléatoirement en deux groupes: le groupe morphine (morphine 0,1 mg·kg^{-1} intraveineuse après la fermeture de la dure-mère et un SCPB effectué avec 20 mL de solution salée à 0,9 % à la fin de la chirurgie) ou le groupe bloc (10 mL de solution salée à 0,9 % intraveineuse au lieu de la morphine après la fermeture de la dure-mère, et un SCPB effectué avec 20 mL d'un mélange 1:1 de bupivacaïne à 0,5 % et de lidocaïne à 2 % à la fin de la chirurgie). La douleur postopératoire a été mesurée à une, deux, quatre, huit, 12, 16 et 24 h à l'aide d'une échelle d'évaluation numérique*

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de 11 points (0 à 10). L'analgésie a été effectuée par injection sous-cutanée de codéine.

Résultats *Les scores moyens sur l'échelle d'évaluation numérique étaient semblables pour les deux groupes à chaque intervalle de temps pendant toute la durée de l'étude. Le score moyen (avec intervalle de confiance de 95 %) était de 3,9 (3,4 à 4,4) pour le groupe bloc et de 4,3 (3,8 à 4,9) pour le groupe morphine (P = 0,25). Le délai précédant l'administration de la première dose de codéine ne représentait pas un écart important sur le plan: médiane et extrêmes de 25 min. (5-2880) contre 21,5 min. (5-90) pour les groupes bloc et morphine, respectivement. L'incidence de nausées et de vomissements était semblable pour les deux groupes.*

Conclusion *Sur le plan clinique, le bloc bilatéral du plexus cervical superficiel produit une analgésie transitionnelle équivalente à la morphine à la suite d'une anesthésie au rémifentanil chez les patients subissant une craniotomie sous-tentorielle ou occipitale.*

The introduction of remifentanil in neuroanesthesia has contributed to faster emergence and recovery.[1-4] With the rapid metabolism of this agent, the patient may experience significant pain on awakening and a higher incidence of early postoperative hypertension.[3,4] Hence the need for a transitional method of analgesia in order to ensure a smooth and pain-free emergence from general anesthesia.

Optimal analgesia after craniotomy should have minimal interaction with neurological recovery. In this setting, scalp nerve block has been shown to be a good alternative to opioids.[5-12] The focus of these studies was on the evaluation of pain in supratentorial surgery, whereas patients undergoing infratentorial or occipital neurosurgery report more severe pain with increased opioid consumption.[13-16] The superficial cervical plexus block (SCPB) blocks the branches of the occipital nerves and may be a good alternative to opioid analgesia in this patient population.[17]

We designed this randomized controlled double-blind study to compare the quality of transitional analgesia provided by SCPB with that provided by intravenous morphine following general anesthesia consisting of remifentanil and sevoflurane for infratentorial or occipital craniotomy. We hypothesized that the use of SCPB would result in lower pain scores, fewer side effects associated with opioids (confusion, nausea and vomiting), as well as a reduction in total opioid requirements in the first 24 hr following surgery.

Methods

After ethical and scientific committee approval and written informed consent, 30 patients were enrolled in this study. The patients were American Society of Anesthesiologists' (ASA) physical status I–III, aged 18-70 yr, and scheduled for an elective infratentorial or occipital craniotomy at Montreal University Medical Centre, a tertiary care setting. The exclusion criteria included the inability to understand a numerical rating scale (NRS), proven or suspected allergy to local anesthetics or morphine, and a craniotomy incision extending beyond the field covered by the SCPB. We also excluded patients who were chronically treated with opioid medications (> two weeks), those presenting with a history of alcohol abuse, and those with active psychiatric disorders.

Anesthetic management

Anesthesia was standardized for all patients; patients were premedicated with midazolam 2 mg *iv* in the operating room, and anesthesia induction consisted of propofol 1.0-3.0 $mg \cdot kg^{-1}$ and remifentanil 1.0 $\mu g \cdot kg^{-1}$. Tracheal intubation was facilitated with rocuronium 0.9-1.2 $mg \cdot kg^{-1}$ or cisatracurium 0.15-0.20 $mg \cdot kg^{-1}$. An infusion of remifentanil was started immediately after induction at a rate of 0.1 $\mu g \cdot kg^{-1} \cdot min^{-1}$. The remifentanil infusion rate was adjusted from 0.1 to 0.5 $\mu g \cdot kg^{-1} \cdot min^{-1}$ by increments or decrements of 0.1 $\mu g \cdot kg^{-1} \cdot min^{-1}$ to maintain mean arterial blood pressure of 60-80 mmHg and heart rate within 20% of the baseline value. Along with the remifentanil infusion, anesthesia was maintained with sevoflurane 0.5-1.0 monitored anesthesia care (MAC) in oxygen and air (F_iO_2 0.40). The attending anesthesiologist was asked to make adjustments with the remifentanil infusion first and then to increase the sevoflurane concentration as necessary. To prevent hemodynamic reaction, remifentanil 1.0-1.5 $\mu g \cdot kg^{-1}$ was given one minute before the application of the Mayfield's head holder. There was no infiltration of the scalp by the surgeon. Muscle relaxants were used as needed to maintain a single twitch on train-of-four stimulation.

Patients were divided randomly into two groups using a computer-generated random list, and allocation concealment was ensured by placing each patient's group allocation in a sequentially numbered sealed envelope. Patient enrolment was completed by a trained research assistant. Patients in the *morphine* group received a bolus of morphine 0.1 $mg \cdot kg^{-1}$ *iv* diluted to a total of 10 mL with normal saline after dural closure and a SCPB (cf block section below) was performed with 0.9% normal saline (placebo) instead of the local anesthetic mixture at the end of surgery. For patients in the *block* group, 10 mL of 0.9% normal saline (placebo) was given intravenously after dural closure instead of morphine, and a SCPB with 20 mL of local anesthetic was performed at the end of the procedure. The syringes for the morphine/placebo and the local anesthetic/placebo were prepared and labelled as "study drug" by an anesthesiologist not involved in the study or care of the patients.

Superficial cervical plexus block

The SCPB was carried out bilaterally at the end of surgery while the patient remained under general anesthesia and before removal of the head holder. The block was performed by a blinded investigator. The anesthetic solution consisted of a mixture of 2% lidocaine 10 mL and 0.5% bupivacaine 10 mL (group *block*) or 0.9% saline 20 mL (group *morphine*).

The superficial cervical plexus supplies innervation to the skin of the neck through the anterior primary rami of C2 through C4.[17] The site of needle insertion was marked at the midpoint of the line connecting the mastoid process with Chassaignac's tubercle of the C6 transverse process. The local anesthetic was injected alongside the posterior border of the sternocleidomastoid muscle and 2-3 cm below and above the needle insertion site where the four distinct branches of the superficial cervical plexus emerge.

Patients were awakened and their tracheas were extubated after block completion and as soon as standard extubation criteria were met.

Postoperative pain

Patients were asked to rate their pain using an 11-point NRS (0 was defined as no pain at all and 10 the worst imaginable pain) at one, two, four, eight, 12, 16, and 24 hr postoperatively. Cumulative doses of codeine and the incidence of nausea and vomiting were noted. Only NRS data obtained from patients who were fully oriented and with a Glasgow coma score of $\geq$ 14 were considered for statistical analysis. Codeine phosphate 30-60 mg was given subcutaneously to treat pain as needed every four hours. Acetaminophen was given only in case of fever. Non-steroidal anti-inflammatory drugs were not allowed during the study period. We recorded the delay before the first analgesic request in the postoperative period. Patients who did not request analgesic for the entire study period (48 hr) were arbitrarily attributed a value of 2,880 min. There were no modifications of the study protocol or pre-defined outcomes after trial commencement.

Statistical analyses

Differences in NRS scoring between groups and over time were evaluated using a repeated measure analysis of variance. Post hoc analyses were completed with the Tukey-Kramer multiple comparisons test. The difference between the two groups regarding the interval of time between the end of surgery and the first administration of codeine was analyzed using unpaired Student's t test. The Mann-Whitney test was used if the data failed the Kolmogorov and Smironov test for normality. A P value < 0.05 was considered significant throughout. Based on the data of Gottschalk *et al.*[14] wherein a pain score at rest of 4.9 $\pm$ 2.2 was reported for patients who underwent an infratentorial craniotomy, a priori power analysis revealed that two groups of 15 patients would allow us to detect a difference of two points on the 11-point pain scale (NRS) with a power of 80% and an alpha of 0.05. A clinically significant difference was defined as a difference of three points on the NRS, which represents a category size when the NRS is dichotomized into mild (1-3), moderate (4-6), or severe ($\geq$ 7) pain. Statistical analyses were performed with GraphPad InStat version 3.06 32-bit (GraphPad Software, San Diego California USA, www.graphpad.com).

Results

Fifty-seven consecutive patients satisfying inclusion criteria were screened for this study, and 27 of this number were excluded for the following reasons: chronic pain or chronic use of opiates (16 patients), alcohol abuse or active psychiatric disorder (seven patients), surgery extending beyond the field of the SCPB (2 patients), and allergy to morphine (two patients). The remaining 30 patients were recruited for this study. No patient was excluded from the study after randomization, and no patient was lost at follow-up.

With the exception of age, there were no differences between groups in terms of demographics and pre and intraoperative data (Table 1). The NRS scores with 95% confidence interval (CI) for each time interval are provided

Table 1 Demographic data, preoperative and intraoperative

	Group Block (n =15)	Group Morphine (n =15)
Male : Female	7:8	6:9
Age (yr)	55 $\pm$ 13	45 $\pm$ 11 (P = 0.034)
Weight (kg)	78 $\pm$ 19	72 $\pm$ 16
Corticosteroids	8	10
Acetaminophen	1	2
Preoperative diagnosis		
Tumour	10	11
Neurovascular	1	0
Chiari malformation	1	1
Meningioma	3	3
Remifentanil (total, mg)	7.2 $\pm$ 3.7	6.5 $\pm$ 4.5
Duration of surgery (hr)	6 $\pm$ 2.2	7.5 $\pm$ 3.3
Types of surgery		
Occipital or suboccipital	10	9
Posterior fossa	5	6

Mean $\pm$ standard deviation

Table 2 Mean pain scores

	Group Block (n = 15)	Group Morphine (n = 15)
1 hr	6 (3.9-6.9)	7 (4.6-8.3)
2 hr	4 (3.1-5.9)	5 (2.9-5.9)
4 hr	5 (2.7-5.8)	4 (1.9-4.9)
8 hr	2 (1.5-4.1)	4 (2.7-5.4)
12 hr	2 (1.9-4.5)	5 (3.2-6.1)
16 hr	4 (2.0-4.9)	3 (1.6-5.1)
24 hr	4 (2.2-5.2)	5 (2.9-6.2)

Numerical rating scale (0 was defined as no pain and 10 as the worst possible pain)

Median (95% confidence interval)

in Table 2. There was no difference in the NRS scores between the two groups over the 24-hr period (group *block*: 4, 95% CI 3.4-4.4 *vs* group *morphine*: 5, 95% CI 3.7-4.9; $P = 0.25$).

The cumulative doses of codeine as well as the delay before the administration of the first dose of codeine were similar between the two groups (Table 3). One patient in the *block* group did not require additional analgesia over the study period.

Nausea and vomiting occurred with similar frequencies in the two groups. Six patients received antiemetic prophylaxis in the *morphine* group *vs* two patients in the *block* group.

In the postanesthesia care unit (PACU), systolic blood pressure values were significantly higher in the *block* group up to one hour postoperatively. Five patients received antihypertensive medication in the *block* group *vs* four patients in the *morphine* group (Table 3).

Discussion

In this study, contrary to our primary hypothesis, we showed that superficial cervical block was equivalent to morphine for transitional analgesia after remifentanil infusion for infratentorial or occipital craniotomy. The two groups did not differ in terms of pain scores and total dose of analgesics required for the first 24 postoperative hours.

Equivalence between the two groups was assumed in this study because 1) with its 95% CI (treatment effect), the average difference between the NRS values of the two groups was 0.43 (-0.32-1.18); and 2) the difference fell completely within the zone of clinical indifference set *a priori* at a three-point difference.

Table 3 Postoperative data

	Group Block (n = 15)	Group Morphine (n = 15)
Delay before administration of codeine in minutes, median and (range)	25 (5-2,880)	21.5 (5-90)
Cumulative dose of codeine (mg)		
4 hr	110 ± 63.7	94 ± 45.8
12 hr	174.3 ± 97	175 ± 115.3
24 hr	341.4 ± 235.2	306 ± 199
48 hr	561.8 ± 447	544 ± 399
Percentage of patients with nausea and/or vomiting, cumulative n (%)		
1 hr	4 (27)	5 (33)
4 hr	5 (33)	8 (53.3)
12 hr	5 (33)	8 (53.3)
24 hr	7 (46.7)	10 (66.7) ($P = 0.26$)
Postoperative hemodynamic variables		
PACU arrival		
SBP	152 ± 15	130 ± 25 ($P = 0.006$)
HR	90 ± 20	96 ± 23
1 hr postoperative		
SBP (mmHg)	153 ± 18	134 ± 21 ($P = 0.012$)
HR	80 ± 19	85 ± 22
2 hr postoperative		
SBP (mmHg)	144 ± 16	131 ± 29
HR	73 ± 14	85 ± 18 ($P = 0.05$)

PACU = postanesthesia care unit; SBP = systolic blood pressure; HR = heart rate

Most patients undergoing elective major intracranial surgery experience episodes of moderate to severe pain (NRS $\geq$ 4) for the first two days after surgery.[5,13-16] In a previous retrospective study, we found that 76% of craniotomy patients experience moderate to severe pain during this time period.[13] In concordance with other studies, we also showed that infratentorial surgery was associated with the greatest opioid consumption.[14,15] In the present study, we did not obtain higher NRS scores compared with our similarly designed previous study in the supratentorial population.[6] However, the need for analgesia in the postoperative period was much greater in the present study than in our previous study (553 mg $\pm$ 400 *vs* 332 mg $\pm$ 230, respectively; $P = 0.009$). In a prospective study, Gottschalk *et al.*[14] evaluated the incidence, severity, and treatment of postoperative pain in 187 patients who underwent intracranial surgery (129 supratentorial and 58 infratentorial procedures). They reported that those who underwent infratentorial procedures had more severe pain and received greater quantities of opioid and non-opioid analgesics than those who underwent supratentorial procedures. In contrast, in their study in 2003, Irefin *et al.*[6] found median pain scores of 2 in supratentorial craniotomy and spine patients *vs* median pain scores of 5 in patients with infratentorial craniotomy, but the results did not reach statistical significance ($P = 0.06$). This difference in the amount of pain might be due more to the extent of muscle damage in the operative approach than due to the craniotomy site per se.

In our study, the average NRS scores did not differ between the *block* and *morphine* groups. Two studies examined the potential benefits of regional anesthesia in patients undergoing intracranial procedures with a remifentanil-based anesthesia.[6,12] Both studies showed that scalp nerve block was equivalent to morphine for transitional analgesia after supratentorial procedures. Infratentorial procedures were not included in these studies. Bilateral SCPB provides anesthesia of the anterolateral and posterior parts of the neck.[17] It therefore appears to be a good alternative to morphine for transitional analgesia in infratentorial or occipital procedures. In a retrospective study with unmatched historical controls, Niijima *et al.*[10] showed that SCPB seemed to decrease the incidence and severity of cervicocephalic pain after both supra and infratentorial craniotomy. Despite obvious design limitations, the authors reported a twofold reduction in the incidence of pain (from 56% in the historical control group to 27% in the regional technique group) at a non-specified postoperative time. For a number of reasons, it is difficult to compare these results with those of our study: the patients did not receive any other form of analgesia and, most importantly, the authors specifically evaluated cervicocephalic pain and did not evaluate pain at the surgical incision, which was the main outcome of our study. In our study, we found no difference in the requirements for postoperative analgesics. The total codeine consumption and median duration of time before the first dose of codeine was administered were similar in the two groups.

Postoperative nausea and vomiting is common after intracranial surgery due to manipulation of intracranial structures. In some studies, the incidence was even greater for infratentorial procedures.[13,19] In a retrospective study of intracranial surgery, Fabling *et al.*[19] found that 50% of patients reported nausea and 39% experienced emesis. They showed that patients who underwent infratentorial procedures had an increased incidence of nausea and vomiting. In this study, we did not observe such a difference from our previous study involving supratentorial surgery (66.7% infratentorial *vs* 62% supratentorial).[6] In accordance with previous studies, there was no difference between the *block* and *morphine* groups in the incidence of nausea and vomiting during the first 24 hr postoperatively.[6,12] A possible explanation may be the absence of a difference in opioid consumption between the two groups.

Arterial blood pressure was higher in the *block* group at PACU arrival and at one hour postoperatively. This result contrasted with the results we obtained in our previous study with supratentorial craniotomy.[6] Guy *et al.*[3] were the first to publish a study comparing remifentanil and fentanyl for intracranial surgery, and they found that systolic blood pressure (SBP) was greater in the remifentanil group than in the fentanyl group in the postoperative period, but transitional analgesia was not used in the remifentanil group. In our study, five patients in the *block* group received antihypertensive drugs, but only in the PACU; whereas in the *morphine* group, two patients received antihypertensive drugs in the operating room and four in the PACU. This may partially explain the observed difference.

In conclusion, and contrary to our a priori hypothesis, SCPB is equivalent to morphine for transitional analgesia in patients undergoing infratentorial or occipital surgery, with possibly improved postoperative control of the hemodynamic profile in patients who receive morphine.

Conflicts of interests None declared.

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