SCALP NERVE BLOCKADE REDUCES PAIN AFTER HEADFRAME PLACEMENT IN RADIOSURGERY: A DOUBLE BLIND, RANDOMIZED CLINICAL TRIAL

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Abstract

Background: Patients undergoing stereotactic headframe placement for radiosurgery report that discomfort associated with the headframe often lasts for the duration of the treatment day (approximately 6 hours). We hypothesize that blockade of scalp nerves prior to headframe placement reduces the incidence of moderate to severe head pain during the entire treatment day. We describe a randomized, double-blind, placebo-controlled study of awake patients having radiosurgery for intracranial pathology that examines whether scalp nerve blockade and local anesthetic infiltration results in superior patient comfort versus infiltration alone.

Methods: Twenty seven adult patients undergoing stereotactic radiosurgery were randomized to receive a nerve block with placebo or bupivacaine 0.5% with epinephrine. Supraorbital and greater occipital nerve blocks using blinded syringes were performed by the anesthesiologist in addition to subcutaneous infiltration of pin sites with lidocaine 1% by the surgeon. Pain was reported using 10 cm visual analog scales (VAS) at pre-specified time points during the treatment day. The primary outcome measure was the presence of pain scores classified as "zero to mild pain (VAS <4)" or "moderate to severe pain (VAS ≥4)".

Results: 27 patients were randomized to placebo (n = 14) and nerve block (n = 13) groups. The proportion of moderate to severe pain measurements were significantly less in the nerve block group than the placebo group (4.9% vs. 24.1%; odds ratio, 0.166; 95% confidence interval 0.029-0.955; p = 0.044). There were no adverse events.

Conclusion: Scalp nerve block significantly decreased moderate to severe head pain in radiosurgery patients throughout the treatment day.

Keywords: randomized controlled trial; nerve block; stereotactic radiosurgery; regional anesthesia; bupivacaine

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Introduction

Stereotactic radiosurgery, first introduced by Lars Leksell at the Karolinska Institute in the 1960s, is widely used to treat intracranial tumors and arteriovenous malformations. This technique uses tightly focused , relatively high doses of radiation directed to the lesion. A stereotactic head frame, which is attached to the patient's skull with pins, is utilized to ensure accuracy of treatment setup and delivery[1]. This ambulatory treatment starts with placement of a stereotactic head frame, followed by diagnostic imaging, planning and delivery of radiation treatment. The team includes an anesthesiologist, neurosurgeons, and a radiation oncologist. Immediately prior to headframe placement, the anesthesiologist administers intravenous sedation and the neurosurgeon administers local anesthetic via infiltration of the skin at the intended pin sites. For the remainder of the 4-8 hour treatment day, the anesthesiologist is generally not in attendance. Placement of the frame causes considerable discomfort in patients[2]. In our experience, this discomfort continues during the entire treatment day. We hypothesize that bilateral blockade of the greater occipital and supraorbital nerves will reduce the incidence of moderate to severe head pain during the entire treatment day.

In 2001, Watson et al investigated the efficacy of scalp nerve blockade versus local infiltration in patients undergoing placement of a headframe for functional neurosurgery[2]. Each patient received supraorbital and greater occipital blocks on one side of the head, and subcutaneous infiltration at pin sites on the contralateral side. The study demonstrated that while scalp nerve blocks provided improved analgesia for the subsequent ipsilateral administration of subcutaneous local anesthetic, blocks were not superior for ameliorating the pain of pin placement, and not superior after the first hour. However, this study was not blinded, and the analysis incorrectly treated the Visual Analog Scale (VAS) scores of pain as parametric variables with a normal distribution.

In this trial, we seek to answer the question of whether scalp nerve blockade is superior to usual care (subcutaneous infiltration with lidocaine) throughout the radiosurgical treatment day, not just during pin placement. Our study design includes blinding through the use of placebo nerve blocks, and uses a non-parametric outcome for greater statistical accuracy.

Scalp blocks have previously been shown to be safe and effective in craniotomy patients[3]. Additionally, although patients requiring radiosurgery may have lower seizure thresholds than other patients, both levobupivacaine and ropivacaine have been found to have safe plasma levels after scalp block[4,5]. Prior clinical trials of scalp blocks for craniotomy patients have found that a block is superior to placebo[6] and provides similar postoperative pain relief to intravenous morphine[7], with less stress response to surgical stimulation as measured by ACTH, serum cortisol, and hemodynamic changes[8].

Methods

This was a single-center, double-blind, placebo-controlled randomized trial conducted at a tertiary care hospital. Following institutional review board approval and written informed consent, patients over the age of 18 were recruited who presented for elective radiosurgery of an intracerebral lesion requiring headframe placement. Patients were excluded if they were unable to give informed consent, understand the Visual Analog Scale (VAS), had an allergy to local anesthetic, an incompletely healed craniotomy scar, or a known coagulopathy.

Assuming a 75% incidence of moderate to severe pain among controls and 15% among patients receiving treatment, a sample size of 26 patients is required to detect a difference in postoperative pain scores between placebo and control groups with a Type I error probability of 0.05 and a Type II error probability of 0.8. 27 patients were enrolled; 14 males and 13 females, with a mean age of 57 ± 14.8 years.

Prior to attachment of the headframe, and following sedation by the anesthesiologist, the neurosurgeon infiltrated 5 mL of 1% lidocaine subcutaneously at the pin sites using a 25 gauge needle. After the headframe was secured, the anesthesiologist (S.D. or I.O.) performed bilateral supraorbital and greater occipital nerve blocks using a syringe containing either normal saline or 0.5% bupivacaine with epinephrine.

Table 1
Demographic Data

	Saline placebo	Bupivacaine 0.5% with epinephrine	P-value
Number of patients	13	14	
Age (yr)	60.8 ± 12.8	53.4 ± 16.1	0.197
Male: Female (*n*)	4:9	10:4	0.057
ASA status			0.338
II	1	3	
III	10	11	
IV	2	0	
Diagnosis			0.222
Tumor	13	11	
AVM	0	3	
Duration in Study (hrs)	5.1 ± 1.3	4.7 ± 1.3	0.474

Data are presented as mean ± standard deviation or n. AVM = Arteriovenous malformation. P-value for age and duration in study computed using two-sample t-test; p-values for Gender, ASA, and Diagnosis computed using Fisher's exact test.

For the supraorbital nerve block, the supraorbital notch was identified by palpation. A syringe with a 25 gauge needle was inserted 1 cm medial to the supraorbital foramen, and 2 mL of study drug was injected. For the greater occipital nerve block, the occipital artery was identified and the needle was inserted medial to the artery. After negative aspiration, 3 mL of study drug was injected. The technique followed that described in the recent review article by Osborn[9].

Patients were assigned to the placebo or treatment group using a computer-generated randomized list with a block size of 3. Blinding was maintained by a research pharmacist who recorded the actual contents of each syringe in a secure location. Patients and investigators were both blinded to treatment assignment.

The patient recorded their head pain on a Visual Analog Scale (VAS) administered by a trained research assistant at 30 minutes, 1 hour, 2, hours, 4 hours, 6 hours, and 8 hours after headframe placement or until the headframe was removed. Patients were able to request supplementary analgesia in the form of lidocaine gel, lidocaine injections, or oral pain medication (acetaminophen, ibuprofen, or oxycodone/acetaminophen) as needed.

The primary outcome measure was the proportion of patients reporting a VAS score greater than or equal to 4, signifying "moderate to severe head pain". The primary outcome variable was analyzed with clustering by patient using the generalized estimating equations method. A secondary outcome measure was the median pain score within each group.

Inter-group differences in patient age and study duration were analyzed using a two-sample t-test. Differences in gender, ASA status, and diagnosis were computed using Fisher's exact test. P values less than 0.05 were considered to indicate statistical significance. Statistical analysis was performed with the geepack library and R statistical software, version 2.13.1[10,11]. Data visualization was performed with the ggplot2 R package[12].

Results

Recruitment occurred from July 2009 to February 2011, terminating once the desired sample size was reached. Of the 28 patients who were assessed, 27 were enrolled and one declined to participate. Of the 27 patients enrolled, 14 were randomized to placebo and 13 received local anesthetic for their nerve blocks. The demographics and diagnoses for the patients are described in Table 1. The placebo group had similar

Table 2
Results

	Saline placebo	Bupivacaine 0.5% with epinephrine	P-value
Median Pain Score (all times)	1.4 (3.8)	0.6 (1.9)	0.183
30 minutes after block	0.1 (1.3)	0.1 (0.8)	0.722
60 minutes	2.8 (3.7)	1.2 (2.1)	0.250
120 minutes	1.7 (4.6)	0.6 (1.1)	0.379
240 minutes	2.4 (3.8)	1.3 (2.3)	0.355
360 minutes	1.4 (2.7)	1.8 (1.3)	0.748
Percentage of pain scores ≥4 (all times)	24%	4.9%	0.003
30 minutes after block	7.7%	0%	0.481
60 minutes	23%	0%	0.098
120 minutes	31%	7.1%	0.165
240 minutes	38%	7.7%	0.160
360 minutes	17%	17%	1.000
Number of patients receiving first adjunct analgesia at any time point	5	7	0.704
60 minutes after block	4	3	0.678
120 minutes	1	0	0.481
240 minutes	0	2	0.481
360 minutes	0	2	0.481

Data are presented as median pain score (interquartile range), percentage of observations, or n. P-value for median pain scores computed using Mann-Whitney-Wilcoxon test; p-values for percentages with VAS ≥ 4 and patients receiving adjunct analgesia computed using Fisher's exact test.

age, gender ratio, and ASA scores compared to the treatment group ($p > 0.05$ for each category.) As only one procedure lasted more than 6 hours, pain scores after 6 hours were not included in the analysis. All patients received the assigned treatment, and all patients were included in the final analysis.

Patients from both groups requested supplementary analgesia, 5 from the placebo group and 7 from the treatment group. Four of the 7 patients in the treatment group asked for the first analgesic supplement at 4 hours after the nerve block, while four of the 5 patients in the placebo group asked for the first analgesic supplement at 1 hour after the nerve block. Two patients each in the placebo group asked for more than one dose of supplementary medication, versus no patients in the treatment group.

Only twelve patients out of the original 27 were still wearing the headframe at six hours, split evenly between placebo and treatment groups. No complications as a result of the nerve blocks were observed.

A total of 119 pain scores were collected, 58 in the placebo group and 61 in the treatment group. Table 2 shows the percentage of scores ≥4 and the median pain scores across all times and at individual time points. Fig. 1 displays the number of moderate to severe pain scores (VAS ≥4) within each group for each time period. The treatment group had fewer moderate to severe pain scores at every time point prior to 6 hours. The odds ratio of experiencing moderate to severe pain is less in the nerve block group than the placebo group, when clustered by patient (4.9% vs. 24.1%; odds ratio, 0.166; 95% confidence interval 0.029-0.955; $p = 0.044$).

Fig. 1

Moderate to Severe Pain Scores at Each Time Interval; Placebo vs. Treatment. Bars indicate number of moderate to severe pain scores at each time period for treatment versus placebo. Percentages represent the number of moderate to severe pain scores out of all pain scores within each time period and each group

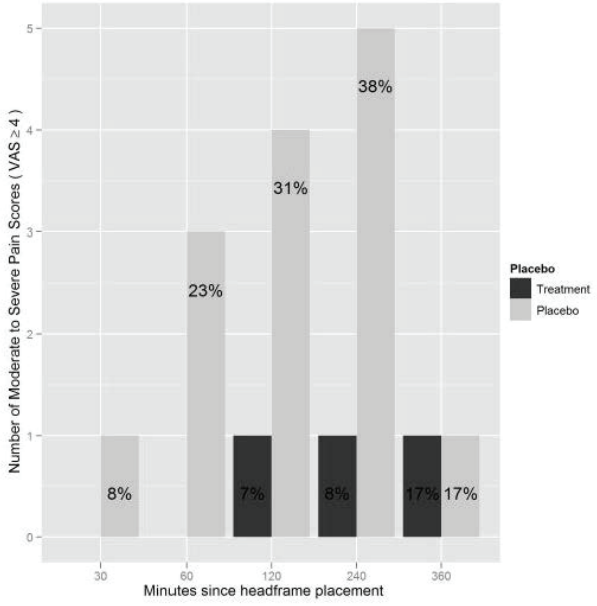

Fig. 2

Pain Scores; Placebo vs. Treatment. Box plot of VAS pain scores at all time points for treatment versus placebo. Whiskers extend to 1.5 times interquartile range

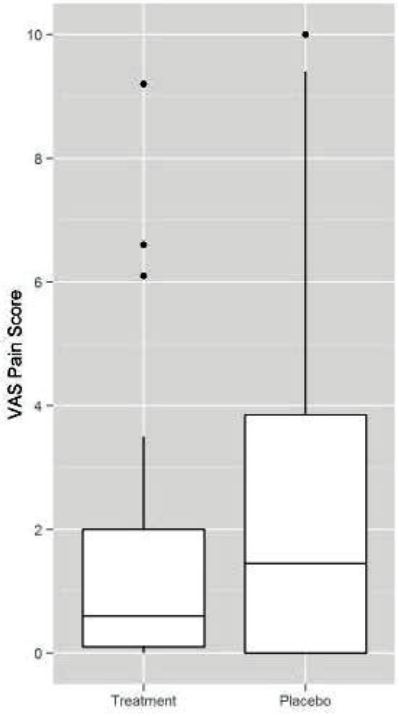

Fig. 2 shows a boxplot of the collected pain scores. The percentage of scores ≥ 4 across all times was 24% in the placebo group and 4.9% in the treatment group (p=0.003 using Fisher's exact test.) There was no significant difference in the median pain score between groups overall (1.4 in placebo group versus 0.6 in treatment group, p=0.183) or at any time point.

Discussion

Scalp nerve blocks significantly decrease moderate to severe pain in radiosurgery patients versus subcutaneous pin site infiltration alone for at least 4 to 6 hours after administration. While one could speculate that our study compared local anesthetics and not infiltration vs. nerve block, we observed a difference between pain scores at the earliest time point, suggesting an additional benefit of nerve blockade even when short acting local anesthetic is given via infiltration. As seen in fig. 2, the treatment group had fewer moderate to severe pain scores at every time point prior to 6 hours. There was no difference at the 6 hour mark, possibly due to the nerve block effect wearing off or the small number of patients that were still wearing the frame at the 6 hour point.

There is some precedent for our findings. Nguyen et al. examined the use of nerve block for craniotomy using a similar classification of moderate to severe pain vs. none. They found that 70% of placebo patients reported moderate to severe pain (defined as VAS >3), versus 20% in the treatment group[3]. In our study 62% of placebo patients and 14% of treatment patients reported a pain score greater than 3 at any time point. However, the Nguyen study used parametric statistics in parts of their analysis which limits its applicability to our results.

No patients in the treatment group requested more than one dose of supplementary analgesia. Most of the treatment group patients who did require supplementary analgesia first requested it at four hours after the block, while most placebo group patients

asked for supplementary analgesia within the first hour. While these results are not statistically significant, they support our hypothesis that scalp nerve blocks prolong the period of time that the radiosurgery patient does not require additional pain relief.

A limitation of this study is that all patients received subcutaneous injections of 1% lidocaine at the pin sites. It is not clear whether the block added longevity due to the local effect of bupivacaine or the scalp block technique. However, the fact that at time points prior to 6 hours the treatment group was less likely to have moderate or severe pain suggests that the technique has merit. This was a small pilot study, therefore the differences in pain scores are only statistically significant when clustered. Our pilot study suggests that a larger sample size would be required to demonstrate significance at individual time points. It is not clear if treatment group outliers who reported significant pain were due to block failure. Testing for nerve block success was not possible, as a successful test would have revealed that the patient was in the treatment group.

An important role of the anesthesiologist is to treat current and future pain in patients who arrive for prolonged outpatient procedures. As the anesthesiologist cannot remain at the patient's side the entire day, methods for long-lasting analgesia must be employed. Future studies can find if patient satisfaction improves with different nerve block agents and concentrations. Scalp nerve blocks can be studied in conjunction with patient controlled intravenous analgesia to identify its potential role in improving patient analgesia.

To the best of our knowledge, this is the first double-blind, randomized, controlled trial of nerve block versus placebo for stereotactic headframe pain. We believe our results demonstrate that the scalp nerves are a major contributor to the pain caused by the pins themselves and the overall weight of the headframe. Scalp nerve blocks significantly decrease moderate to severe pain in radiosurgery patients who are not under the continuous care of an anesthesiologist. Nerve blocks are an important tool to provide radiosurgery patients with pain relief throughout the course of the treatment day.

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