REVIEW

Update on scalp nerve block for craniotomy

Anna Maria Bombardieri, Maxim Pochebyt and Mark A. Burbridge

Purpose of review
The purpose of this review is to outline the indications, technique, and ideal local anesthetics and adjuvants that can be administered for scalp nerve block (SNB) in adult patients undergoing craniotomy. SNBs are an effective means to provide patients with analgesia with lower opioid requirements.

Recent findings
Recent literature shows a wide range of neurosurgical procedures can benefit from the administration of scalp blocks. Scalp blocks remain a technically straightforward regional anesthesia technique; however, the literature is insufficient to firmly recommend any specific local anesthetic or adjuvant.

Summary
SNBs should be considered a low risk, technically easy to perform, and highly effective regional anesthesia technique in a wide range of neurosurgical procedures. A long-acting local anesthetic such as ropivacaine, bupivacaine, or levobupivacaine is recommended, and the addition of an adjuvant such as dexmedetomidine, clonidine, or dexamethasone has been shown to prolong the duration of the block. Ultrasound may be useful addition to improve block success.

Keywords
adjuvants, craniotomy, local anesthetics, postoperative pain, scalp block

INTRODUCTION

Scalp nerve block (SNB) is a regional anesthesia technique that provides analgesia for neurosurgical patients by anesthetizing the sensory nerves of the scalp. Advantages of SNB include reduced intraoperative opioid consumption, decreased postoperative opioid consumption and pain scores, less postoperative nausea and vomiting, and reduced sympathetic response to pain and other noxious stimulation, therefore achieving stable hemodynamics [1,2▪,3,4▪▪,5▪]. This technique is critical in awake craniotomy to facilitate awake testing to ensure a more cooperative and comfortable patient. Neurosurgical patients benefit particularly from opioid-sparing techniques because opioids can cause particularly troublesome complications such as surgical site bleeding and raised intracranial pressure due to postoperative nausea and vomiting [6].

INDICATIONS

Most studies conducted for SNB pertain to its use in craniotomy procedures, such as supratentorial brain tumors. However, this technique can be utilized for any surgical procedure involving an incision on the scalp. Brain lesions with locations in supratentorial, infratentorial, and high cervical (such as Chiari malformations), can utilize the SNB to achieve improved patient comfort, hemodynamic stability, and decreased opioid use postoperatively [1,2▪,3,4▪▪,5▪]. Patients undergoing deep brain stimulator insertion have shown significant benefits in terms of comfort, neurological examination participation and electrophysiological stability, and postoperative pain and opioid use from SNB [7▪,8▪]. Patients undergoing stereotactic brain biopsy were able to undergo this procedure under sedation with an SNB and dexmedetomidine infusion and had less postoperative pain [9▪]. One study showed that patients undergoing ventriculoatrial shunt insertion were able to tolerate the procedure under sedation with the use of SNB and to have decreased pain and pain medication use postoperatively [10]. Additionally, one study found that SNB reduced headaches during focused ultrasound therapy procedures [11▪]. Patients undergoing intracranial bolt removal with SNB had increased satisfaction with the procedure and reduced pain after the bolt was removed [12].

Department of Anesthesiology, Perioperative and Pain Medicine Stanford University School of Medicine, Stanford, California, USA

Correspondence to Mark A. Burbridge, MD, Department of Anesthesiology, Perioperative and Pain Medicine Stanford University School of Medicine, 300 Pasteur Drive, Room H3578, Stanford, CA 94025, USA
Tel: +1 650 353 8484; e-mail: markburb@stanford.edu

Curr Opin Anesthesiol XXX, XXX:XXXX–XXXX
DOI:10.1097/ACO.0000000000001546

KEY POINTS

- Scalp blocks are technically straightforward and safe to perform.
- A long-acting local anesthetic such as bupivacaine, ropivacaine, or levobupivacaine is recommended.
- The addition of an adjuvant such as dexamethasone, clonidine, or dexmedetomidine may prolong the duration of the block.
- Ultrasound may improve block success based on a small number of studies.
- The literature for scalp blocks is overall sparse and further high-quality research studies are required to determine the ideal local anesthetic as well as adjuvant.

ANATOMY AND TECHNIQUE

The nerve supply to the scalp consists of a network of sensory nerves that are effectively anesthetized based on surface anatomy and a meticulous injection technique. Figure 1 displays these sensory nerves. A brief description of the injection technique for SNB is described below. An excellent instructional video [13■■] is recommended to all readers to view in addition to the text below.

The supraorbital and supratrochlear nerves are the terminal cutaneous branches of the frontal nerve, itself the largest division of the ophthalmic branch of the trigeminal nerve. The supraorbital nerve leaves the orbit along the supraorbital notch and divides almost immediately into medial and lateral branches, extending cephalad to supply sensation to most of the anterior forehead. The supratrochlear nerve travels roughly one centimeter medial the supraorbital nerve, supplying the upper medial eyelid and medial forehead. Both nerves can be blocked with a single skin puncture. Keeping the injection cephalad to the brow prevents spread into the eyelid where it can cause transient ptosis or extraocular weakness. Because the cutaneous fields of the left and right nerves overlap, the block is performed bilaterally for reliable coverage [14■].

The zygomaticotemporal nerve is a sensory branch of the zygomatic nerve, arising from the maxillary division of the trigeminal nerve. After running along the lateral orbital wall, it exits

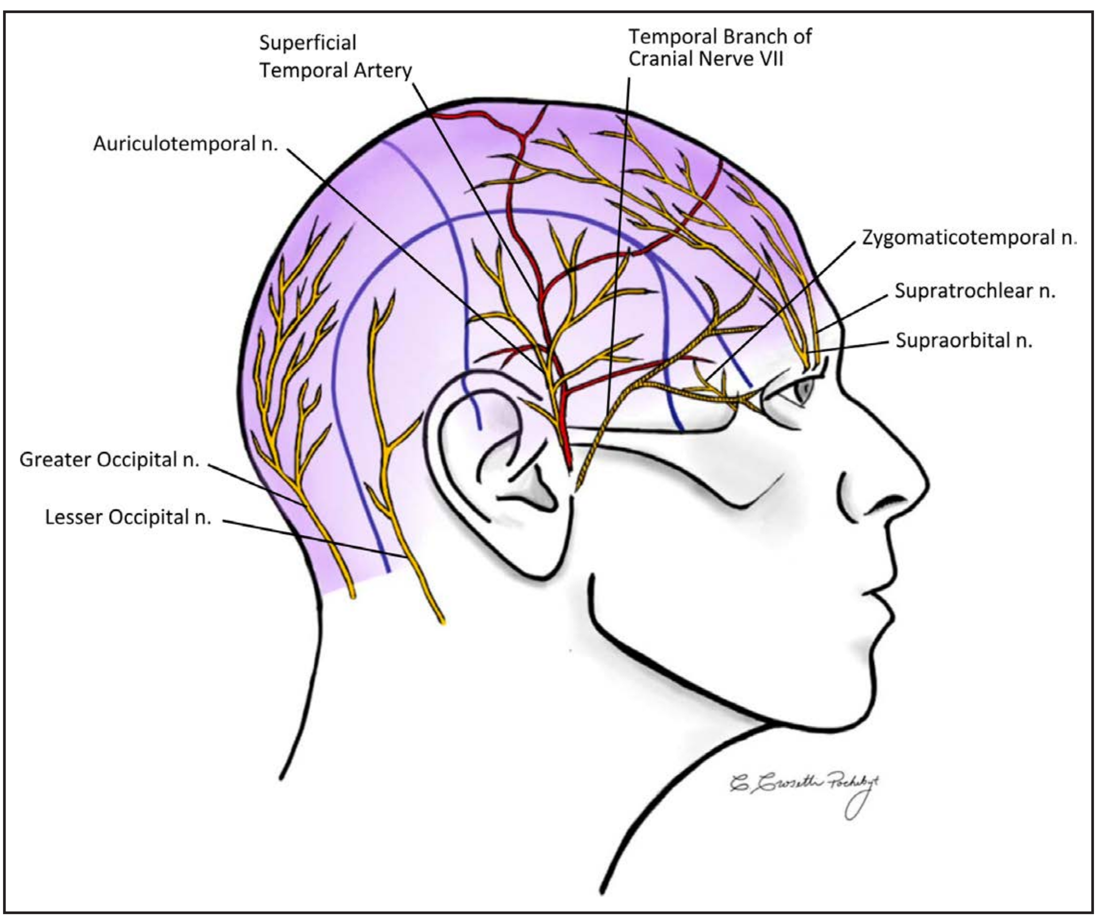

FIGURE 1. Sensory nerves of the scalp region.

through the zygomaticotemporal foramen just superior to the zygomatic arch and immediately pierces the deep layer of the temporalis fascia. It radiates cephalad to supply a teardrop-shaped patch of skin over the anterior temple and lateral forehead. Block failure rate tends to be highest with the zygomaticotemporal nerve because of high anatomic variability [15,16].

The auriculotemporal nerve originates from the posterior division of the mandibular nerve. It ascends with the superficial temporal artery anterior to the tragus, branching to innervate the lateral scalp, anterior and superior to the ear. Injection below the zygoma can cause facial nerve blockade and should be avoided [14▪].

The greater occipital nerve originates from the dorsal ramus of C2. It ascends medial to the occipital artery and arborizes to innervate the posterior medial scalp. The greater occipital nerve can be blocked by injection one-third of the distance away from the occipital protuberance along a line connecting the occipital protuberance and mastoid. The greater occipital nerve typically runs just medial to the occipital artery, two centimeters lateral to the occipital protuberance. When the occipital artery is difficult to palpate, Doppler or ultrasound guidance allows accurate deposition with as little as 2 ml of local anesthesia [17▪▪].

The lesser occipital nerve arises from the cervical spinal roots, and supplies sensation to the lateral posterior scalp. The lesser occipital nerve can be blocked with the injection of local anesthesia along roughly two centimeters along nuchal ridge, from the posterior base of the pinna extending medially and in the direction of the occipital protuberance [18▪].

Recently, several reports of utilizing ultrasound guidance for SNB have emerged. Tsan *et al.* [19] published a case report of a patient undergoing awake craniotomy with excellent pain control both intraoperatively and postoperatively. A randomized prospective controlled trial by Ibrahim *et al.* [20] compared the analgesic efficacy of ultrasound use compared to the traditional landmark method. Patients who received ultrasound guided SNB experienced significantly lower pain scores postoperatively, with less opioid consumption in the first 24 h after surgery. An extensive review on the technical aspects of SNB under ultrasound guidance is provided by Zetlaoui *et al.* [21].

LOCAL ANESTHETICS

There is currently no consensus on the optimal local anesthetic or concentration for SNB. Recent randomized controlled trials have evaluated long-acting agents such as ropivacaine, bupivacaine, and levobupivacaine at various concentrations, with or without epinephrine. Most studies compared a single local anesthetic to a sham saline injection. Only one study assessed different concentrations of the same local anesthetic, and none directly compared different long-acting agents. These findings are summarized in Table 1.

Yang *et al.* [22▪▪] conducted a randomized, double-blind, placebo-controlled trial in 85 patients undergoing craniotomy under general anesthesia. Patients received a preincision SNB with 8 ml of either 0.2, 0.33, or 0.5% ropivacaine or saline as the control. All three ropivacaine concentrations significantly reduced postoperative pain for up to 2 h ($P = 0.01$, 0.02, and 0.01, respectively), with 0.5% extending analgesia to 4 h ($P = 0.02$). Compared to control, all concentrations significantly blunted increases in mean arterial pressure (MAP) during incision, drilling, and sawing ($P < 0.05$), while heart rate (HR) was significantly lower in the 0.2 and 0.5% groups. Intraoperative sufentanil use was significantly reduced across all ropivacaine concentrations ($P < 0.001$). These findings support the use of 0.5% ropivacaine for superior early analgesia and intraoperative hemodynamic control.

Rigamonti *et al.* [23▪] randomized 89 patients undergoing craniotomy to bilateral SNB using 20 ml of 0.5% bupivacaine with epinephrine or sham saline with epinephrine at the end of surgery. No significant differences were observed in 24-h visual analogue scale scores, opioid consumption, or discharge times. However, pain modeling revealed a significant treatment-by-time interaction ($P < 0.001$), indicating lower pain in the SNB group during the first 12 h, suggesting a potential role for SNB in settings such as awake craniotomy.

Carella *et al.* [24▪] evaluated a SNB using 30 ml of 0.33% levobupivacaine vs. a sham saline injection in a randomized, double-blind, placebo-controlled trial. The block was performed after induction and at least 20 min before skull pinning. Compared to controls, the SNB group showed significantly attenuated responses to skull pinning, incision, and craniotomy (MAP differences: 6.1–20.5 mmHg, $P < 0.001$; HR differences: 3.1–7.6 bpm, $P < 0.05$). Intraoperative propofol and remifentanil requirements were significantly lower ($P < 0.001$), as were postoperative pain scores (1–48 h, $P < 0.0001$) and 48-h morphine consumption ($P < 0.001$).

Kulikov *et al.* [25▪] randomized 56 patients undergoing craniotomy to preincision or postskin-closure SNB, both using 0.75% ropivacaine, in addition to incision line and skull pin infiltration.

Table 1. Summary of Local Anesthetic Use for Scalp Nerve Blocks in Recent Randomized Controlled Trials

First Author, year	Local Anesthetic	Volume and Concentration	Timing of Scalp Nerve Blocks	Comparator	Key Findings
Yang *et al.* (2020) [22■■]	Ropivacaine	8 ml of 0.2, 0.33, or 0.5%	Preincision	Saline	All doses reduced pain for 2 h; 0.5% extended analgesia to 4 h. All doses blunted MAP during incision, drilling, and sawing and reduced intraoperative opioid use. HR was lower with 0.2 and 0.5%
Rigamonti *et al.* (2020) [23■]	Bupivacaine + epinephrine	20 ml of 0.5%	End of surgery	Saline + Epi	No difference in 24 h visual analog scale or opioids; early pain modeling favored scalp nerve block group
Carella *et al.* (2021) [24■]	Levobupivacaine	30 ml of 0.33%	Postinduction	Saline	Improved MAP/HR control; lower intraop anesthetic use and 48 h pain/opioid scores
Kulikov *et al.* (2021) [25■]	Ropivacaine	0.75% (volume not reported)	Preincision vs. postop	No sham	Lower intraop fentanyl use with preincision scalp nerve block
Lee *et al.* (2023) [26■]	Ropivacaine	21–25 ml of 0.5%	Preoperative	No block	Lower pain scores at 6–24 h; reduced peak and cumulative pain burden
Moharari *et al.* (2024) [1■]	Bupivacaine + epinephrine	3–5 ml of 0.35%	Preincision	No block	Higher analgesia nociception index scores; lower remifentanil use; no MAP/HR differences

HR, heart rate; MAP, mean arterial pressure.

No sham control was used. While 24-h pain scores were similar, the preoperative SNB group had significantly lower intraoperative fentanyl use ($P = 0.01$).

Lee *et al.* [26■] randomized 74 patients undergoing microvascular decompression to receive either preoperative SNB with 0.5% ropivacaine (21–25 ml) or no block. While cumulative 24-h opioid use was similar, the SNB group had significantly lower pain scores at 6, 12, and 24 h ($P = 0.005$, 0.007, and 0.015), and reduced peak numeric rating scale scores and area-under-the-curve pain burden.

Moharari *et al.* [1■] conducted a randomized, single-blind trial in 28 patients comparing standard general anesthesia to general anesthesia with preincision SNB using 0.35% bupivacaine with epinephrine. The SNB group had significantly higher analgesia nociception index scores at all surgical stages (e.g. 62.6 ± 12.6 vs. 38.7 ± 6.5 during pinning, $P = 0.001$) and lower remifentanil use ($P = 0.008$). No significant hemodynamic differences were observed.

Due to the heterogeneity in block timing, local anesthetic agents, and concentrations across studies, formulating a standardized recommendation remains challenging. Nonetheless, findings from randomized controlled trials published over the past 5 years support 0.5% ropivacaine as the most effective and durable option for SNB, offering superior postoperative analgesia and intraoperative hemodynamic control compared to lower concentrations or other long-acting agents. Although ropivacaine has a slower onset compared to shorter-acting agents, this is generally offset by the time required for patient positioning and surgical preparation prior to skull pinning. In clinical practice, some providers mix ropivacaine with a short-acting local anesthetic (e.g. mepivacaine) to accelerate onset. However, a recent meta-analysis found no significant benefit of such combinations on sensory or motor block onset in ultrasound-guided peripheral nerve blocks [27]. Importantly, this analysis did not include any studies of SNB, and its findings may not fully translate to the SNB setting.

Based on the current evidence, we recommend prioritizing a longer duration of action over a faster onset when selecting local anesthetics for SNB in neurosurgical procedures.

ADJUVANTS

An adjuvant is a medication that is used to enhance the effects as well as prolong the duration of action of the local anesthetic. Such medications are widely used in regional anesthesia techniques in anatomical sites all over the body for example in joint arthroplasty surgery. Several medications have been studied recently in the context of SNB with varying success and are reviewed below. These findings are summarized in Table 2.

Dexamethasone

Jia and colleagues [28■■] conducted a study comparing SNB in patients undergoing craniotomy and were randomly assigned to receive SNB with 0.5% bupivacaine alone in a control group, or with 0.5% bupivacaine with 4 mg dexamethasone. The primary outcome was the duration of analgesia, and secondary outcome was postoperative opioid consumption, pain scores, and patient satisfaction. The mean analgesia duration was significantly prolonged in the dexamethasone group compared with the control group 660 min compared to 420 min ($P < 0.001$). The postoperative opioid consumption was also lower in the dexamethasone group compared with the control group at 12 h ($P < 0.001$), 24 h ($P = 0.014$), and 48 h ($P = 0.049$). This study showed that the addition of dexamethasone to 0.5% bupivacaine for SNB significantly prolonged the duration of the block, lowered postoperative pain scores, lowered postoperative opioid consumption, and lead to higher patient satisfaction scores.

Clonidine

Bagle *et al.* [29■] investigated the impact of adding clonidine at a dose of 1 μg/kg to SNB performed with 0.5% ropivacaine for supratentorial craniotomy compared to a group of patients who received a SNB of 0.5% ropivacaine plus 1 ml of normal saline. The duration of analgesia was significantly prolonged, and the amount of rescue opioid medication postoperatively was lower, in patients receiving ropivacaine with clonidine. MAP analysis also yielded significantly more stable readings in the clonidine group.

Dexamethasone vs. clonidine

Maharani *et al.* [30■] performed a head-to-head analysis of clonidine vs. dexamethasone in 0.25% bupivacaine for SNB. A total of 40 participants were randomly divided into two groups. Group one received bupivacaine 0.25% and clonidine 2 μg/kg, and group two received bupivacaine 0.25% and dexamethasone 8 mg. The results of this study showed that patients in the bupivacaine and clonidine group experienced significantly lower pain scores postoperatively up to 24 h, as well as lower cortisol levels, indicating a blunted stress response to surgery.

Table 2. Summary of Adjuvants for Scalp Nerve Block in Recent Clinical Literature

Author	Adjuvant	Dosage	Local Anesthetic	Effect of Adjuvant vs. Local Anesthetic Alone
Jia *et al.* (2025) [28■■]	Dexamethasone	4 mg	Bupivacaine 0.5%	Dexamethasone prolonged duration of block, lower postoperative pain scores, and increased patient satisfaction
Bagle *et al.* (2024) [29■]	Clonidine	1 mcg/kg	Ropivacaine 0.5%	Clonidine prolongs duration of analgesia, reduced rescue analgesia, more stable hemodynamics
Maharani *et al.* (2023) [30■	Clonidine Dexamethasone	2 mcg/kg 8 mg	Bupivacaine 0.25%	Clonidine was superior to dexamethasone with lower postoperative pain scores, and lower cortisol levels
Sheethal *et al.* (2025) [31■]	Dexmedetomidine	1 mcg/kg	Bupivacaine 0.5%	Dexmedetomidine lowers postoperative opioid consumption, pain scores, and more stable hemodynamics
Stachtari *et al.* (2023) [32■]	Dexmedetomidine	1 mcg/kg	Ropivacaine 0.5%	Dexmedetomidine results in superior hemodynamics and lower opioid consumption
Sahana *et al.* (2023) [33■]	Dexmedetomidine	1 mcg/kg	Ropivacaine 0.5%	No difference in hemodynamics with the addition of dexmedetomidine
Kaushal *et al.* (2024) [34■]	Ketamine	2 mg/kg	Bupivacaine 0.5%	Ketamine reduced opioid consumption and more stable hemodynamics

Dexmedetomidine

Sheethal *et al.* [31▪] evaluated the efficacy of scalp block with 0.5% bupivacaine and 1 mcg/kg dexmedetomidine compared to local anesthesia wound infiltration. In this small prospective, double-blind, randomized controlled trial, 34 adult patients undergoing elective posterior fossa surgeries were equally assigned to either posterior scalp block or skin infiltration groups. Patients in the SNB group exhibited significantly lower postoperative opioid consumption, pain scores, and superior hemodynamic stability.

In a larger, higher quality study, Stachtari *et al.* [32▪] enrolled 105 patients undergoing elective craniotomy for tumor resection and were randomly divided into three groups to receive scalp block as an adjuvant to general anesthesia: with either 40 ml ropivacaine 0.5%, 40 ml ropivacaine 0.5% plus dexmedetomidine 1 μg/kg, or 40 ml saline as a placebo. Patients who received SNB with ropivacaine and dexmedetomidine demonstrated significantly better hemodynamic stability in response to pin fixation and skin incision compared with other groups, lower intraoperative remifentanil consumption, postoperative opioid consumption, but postoperative pain scores were no significantly between the three groups.

Sahana *et al.* [33▪] conducted a study on sixty patients who were randomly allocated to receive scalp block with 25 ml of 0.5% ropivacaine added with either normal saline as a control group, or dexmedetomidine (1 μg/kg). This study examined only hemodynamic variables including HR and blood pressure measurements made at baseline, 1, 3, 5, 10, and 15 min following skull pin placement. There was no significant effect on HR, systolic, diastolic, and mean blood pressure with addition of dexmedetomidine to ropivacaine.

Ketamine

A single study examined ketamine as an adjuvant to 0.5% bupivacaine in adult patients undergoing craniotomy. Kaushal *et al.* [34▪] enrolled sixty patients and randomized them into two groups. They were given SNB either with 12 ml 0.5% bupivacaine and 3 ml saline or bupivacaine 12 ml and 2 mg/kg ketamine. The ketamine plus bupivacaine group demonstrated superior hemodynamic stability, as well as a mean postoperative opioid reduction of 50%. The addition of ketamine as an adjuvant to bupivacaine for SNB not only provides significant hemodynamic stability but also reduces both intra- and postoperative analgesic consumption.

CONCLUSION

SNB are a technically straightforward, efficacious regional anesthesia technique for patients undergoing a wide variety of neurosurgical procedures. Despite their widespread use, high quality clinical trials for the ideal local anesthetic and adjuvant for SNB are lacking and no combination can be recommended based on the available recent research. A long-acting local anesthetic with or without an adjuvant, of which clonidine may be superior based on the limited evidence, can be recommended for routine use. The use of ultrasound guidance may also increase the success and efficacy of SNB. Future research should focus on randomized, double blind, randomized trials to delineate the ideal combination of medications to fully exploit the benefits of this technique.

Acknowledgements

We sincerely thank Christina Crosetti Pochebyt for creating Fig. 1.

Financial support and sponsorship

None.

Conflicts of interest

None.

REFERENCES AND RECOMMENDED READING

Papers of particular interest, published within the annual period of review, have been highlighted as:
▪ of special interest
▪▪ of outstanding interest

1. ▪ Moharari RS, Emami P, Neishaboury M, *et al.* Scalp nerve block for enhanced pain control and analgesic optimization in elective craniotomy: a randomized controlled trial with analgesia nociception index monitoring. World Neurosurg 2024; 189:e55–e60.

This randomized controlled trial concludes that SNB is effective in reducing postoperative pain control and opioid use, while producing greater hemodynamic stability in adult patients undergoing craniotomy.

2. ▪ Stieger A, Romero CS, Andereggen L, *et al.* Nerve blocks for craniotomy. Curr Pain Headache Rep 2024; 28:307–313.

This review article reviews recent literature that SNB reduces postoperative pain, complications, pain medication consumption, and nausea and vomiting.

3. Chen Y, Ni J, Li X, *et al.* Scalp block for postoperative pain after craniotomy: a meta-analysis of randomized control trials. Front Surg 2022; 9:1018511.
4. ▪▪ Fu PH, Teng IC, Liu WC, *et al.* Association of scalp block with intraoperative hemodynamic profiles and postoperative pain outcomes at 24-48 hours following craniotomy: an updated systematic review and meta-analysis of randomized controlled studies. Pain Pract 2023; 23:136–144.

This meta-analysis demonstrates that SNB provides superior hemodynamic stability, lower pain scores, and reduced opioid consumption postoperatively. It provides the most recent and extensive analysis of its kind.

5. ▪ Luo M, Zhao X, Deng M, *et al.* Scalp nerve block, local anesthetic infiltration, and postoperative pain after craniotomy: a systematic review and network meta-analysis of randomized trials. J Neurosurg Anesthesiol 2023; 35:361–374.

This meta-analysis concludes that SNB with ropivacaine is superior to surgical site infiltration of local anesthesia for reducing postoperative pain and opioid consumption.

6. McCullough IL, Shteamer JW, Erwood AM, *et al.* Opioid-free anesthesia for craniotomy. J Neurosurg Anesthesiol 2023; 35:80–85.

7. ▪ Xie S, Liu Y, Yang A, *et al*. Scalp block improves electrophysiological stability and patient cooperation during deep brain stimulation surgery. Sci Rep 2025; 15:12596.

This study showed that in patients who underwent deep brain stimulation surgery, SNB improves patient comfort, better performance during neurological testing, and more stable hemodynamics.

8. ▪ Lu W, Chang X, Wu W, *et al*. The scalp nerve block combined with intercostal nerve block improves recovery after deep brain stimulation in patients with Parkinson's disease: a prospective, randomized controlled trial. Clin Interv Aging 2024; 19:1881–1889.

This study combined SNB with intercostal nerve block in patients undergoing deep brain stimulator surgery, and found that this technique resulted in superior postoperative pain control, and reduced pain and postoperative nausea and vomiting.

9. ▪ Singh M, Ahamed TPW, Maurya VP, *et al*. Stereotactic biopsy for brain lesions: doing more with less. J Neurosci Rural Pract 2024; 15:95–102.

This case series consisted of 22 patients successfully undergoing stereotactic brain biopsy with scalp block and dexmedetomidine infusion.

10. Aspide R, Migliorino E, Pirina A, *et al*. Ventriculoatrial shunt under locoregional anesthesia: a technical note. World Neurosurg 2022; 166:135–140.

11. ▪ Kadowaki M, Sugiyama K, Nozaki T, *et al*. Scalp nerve block alleviates headaches associated with sonication during transcranial magnetic resonance-guided focused ultrasound. Neurosurgery 2024; 95:447–455.

This study shows that SNB reduces headache during focused ultrasound therapy procedures.

12. Goel A, Asif H, Craven C, *et al*. Regional scalp blockade for painless removal of intracranial pressure bolts: technical note and patient-reported outcomes. World Neurosurg 2022; 162:43–46.

13. ▪▪ Velázquez A, Pereira SM, Rigamonti A, *et al*. Scalp block: video in clinical anesthesia. A A Pract 2025; 19:e01938.

This instructional video provides a thorough stepwise technique to successfully performing scalp blocks. It also provides succinct instruction on how to avoid common complications that can arise during injection.

14. ▪ Pochebyt M, Herron SM, Pan SJ, *et al*. Regional anesthesia for head and neck neurosurgical procedures: a narrative review in adult and pediatric patients. Int Anesthesiol Clin 2024; 62:10–20.

This comprehensive review provides an overview of regional anesthesia techniques for neurosurgery, as well as head and neck surgery in adult and pediatric patients. It also explores the technique of regional anesthesia after subarachnoid hemorrhage to reduce cerebral vasospasm.

15. Sato T, Nishiwaki K. Accuracy of landmark scalp blocks performed during asleep-awake-asleep awake craniotomy: a retrospective study. JA Clin Rep 2021; 7:8.

16. Totonchi A, Pashmini N, Guyuron B. The zygomaticotemporal branch of the trigeminal nerve: an anatomical study. Plast Reconstr Surg 2005; 115:273–277.

17. ▪▪ Gürsoy G, Tuna HA. Comparison of two methods of greater occipital nerve block in patients with chronic migraine: ultrasound-guided and landmark-based techniques. BMC Neurol 2024; 24:311.

This study shows that an ultrasound guided, landmark guided technique to nerve block were both efficient techniques, and that ultrasound guided blocks resulted in lower pain scores, shorter duration of pain, and lower analgesic consumption.

18. ▪ Ma K, Uejima JL, Bebawy JF. Regional anesthesia techniques in modern neuroanesthesia practice: a narrative review of the clinical evidence. J Neurosurg Anesthesiol 2024; 36:109–118.

This review article provides an overview of regional anesthesia techniques in neuroanesthesia practice and presents the evidence for such techniques.

19. Tsan SEH, Goh CH, Tan PCS. Ultrasound-guided scalp blocks for an awake craniotomy: a case report. A A Pract 2022; 16:e01618.

20. Ibrahim SF, Labeb HA, Aboelnile DBM, *et al*. Analgesic efficacy and safety of ultrasound guided scalp nerve blocks in supratentorial craniotomies: a randomized controlled trial. QJM ***2024***; 117:hcae175.080.

21. Zetlaoui PJ, Gauthier E, Benhamou D. Ultrasound-guided scalp nerve blocks for neurosurgery: a narrative review. Anaesth Crit Care Pain Med 2020; 39:876–882.

22. ▪▪ Yang Y, Ou M, Zhou H, *et al*. Effect of scalp nerve block with ropivacaine on postoperative pain in patients undergoing craniotomy: a randomized, double blinded study. Sci Rep 2020; 10:2529.

This is the only randomized controlled trial to compare three different concentrations of ropivacaine (0.2, 0.33, and 0.5%) for scalp nerve block in craniotomy patients. The study demonstrated that 0.5% ropivacaine provided the most prolonged postoperative analgesia (up to 4 h) an superior control of intraoperative hemodynamic responses compared to lower concentrations.

23. ▪ Rigamonti A, Garavaglia MM, Ma K, *et al*. Effect of bilateral scalp nerve blocks on postoperative pain and discharge times in patients undergoing supratentorial craniotomy and general anesthesia: a randomized-controlled trial. Can J Anaesth 2020; 67:452–461.

This randomized, placebo-controlled trial compared scalp block with 0.5% bupivacaine plus epinephrine to sham saline injection and found no significant difference 24-h pain scores of opioid use, though modeling suggested reduced pain the first 12 h postoperatively.

24. ▪ Carella M, Tran G, Bonhomme VL, Franssen C. Influence of levobupivacaine regional scalp block on hemodynamic stability, intra- and postoperative opioid consumption in supratentorial craniotomies: a randomized controlled trial. Anesth Analg 2021; 132:500–511.

This randomized, placebo-controlled trial compared 0.33% levobupivacaine scalp block to sham saline injection and showed significantly reduced hemodynamic responses, intraoperative anesthetic requirements, and postoperative opioid use in patients undergoing supratentorial craniotomy.

25. ▪ Kulikov A, Tere V, Sergi PG, *et al*. Preoperative versus postoperative scalp block combined with incision line infiltration for pain control after supratentorial craniotomy. Clin J Pain 2021; 37:194–198.

This randomized trial compared the timing of scalp nerve block with ropivacaine and found no difference in 24-h postoperative pain scores, though preoperative block was associated with lower intraoperative fentanyl use.

26. ▪ Lee EK, Lee S, Kwon JH, *et al*. The efficacy of scalp nerve block in postoperative pain management after microvascular decompression: a randomized clinical trial. J Clin Med 2023; 12:4242.

This randomized trial compared preoperative scalp nerve block with 0.5% ropivacaine to no block in patients undergoing microvascular decompression. It found significantly lower postoperative pain scores at 6, 12, and 24 h in the block group, although opioid consumption over 24 h was similar between groups.

27. Pietroski Dos Santos N, Silva VP, Oliveira GSDS, *et al*. Efficacy of long-acting local anesthetics versus their mixture with shorter-acting local anesthetics for peripheral nerve blocks guided by ultrasound: a systematic review with meta-analysis of randomized controlled trials. Reg Anesth Pain Med 2025:rapm-2024-106104 [Epub ahead of print].

28. ▪▪ Jia Z, Shrestha N, Wang S, *et al*. Efficacy of dexamethasone as an adjuvant for scalp nerve blocks to prolong analgesia: a prospective, double-blind, randomized controlled study. J Pain Res 2025; 18:217–227.

This is a high quality study showing that dexamethasone added to bupivacaine improves postoperative analgesia and patient satisfaction without introducing any complications to the patient.

29. ▪ Bagle A, Raj A, Kale A. Comparison of the effect of scalp block with ropivacaine vs. ropivacaine and clonidine on postoperative pain in patients undergoing craniotomy surgery under general anesthesia. Cureus 2024; 16:e67342.

This study found that the addition of clonidine to ropivacaine for SNB significantly prolongs the duration of analgesia and maintains stable hemodynamics.

30. ▪ Maharani ND, Fuadi A, Halimi RA. Comparison of the effect of scalp block analgesia bupivacaine 0.25% and clonidine 2 μg/kg with bupivacaine 0.25% and dexamethasone 8 mg on cortisol levels and Numeric Rating Scale in craniotomy tumour. Med J Malaysia 2023; 78:808–814.

This study concludes that SNB with clonidine plus bupivacaine is more effective in reducing postoperative pain scores compared to bupivacaine and dexamethasone.

31. ▪ Sheethal N, Pai VA, Kateel R, *et al*. Posterior scalp block with bupivacaine and dexmedetomidine for pain management in posterior fossa surgeries: a prospective, double blind randomized controlled trial. Pain Manag 2025; 15:131–140.

This trial shows that SNB for posterior fossa surgery with bupivacaine and dexmedetomidine improves postoperative pain, reduces opioid consumption, and provides better hemodynamics.

32. ▪ Stachtari C, Stergiouda Z, Koraki E, *et al*. Dexmedetomidine as an adjuvant to scalp block in patients undergoing elective craniotomy: a prospective randomized controlled trial. Clin Neurol Neurosurg 2023; 227:107669.

This study shows the addition of dexmedetomidine to ropivacaine for SNB results in superior hemodynamic stability, and reduced opioid consumption.

33. ▪ Sahana BN, Radhapuram SD, Samantaray A, *et al*. Comparison of effects of dexmedetomidine added to ropivacaine versus ropivacaine alone infiltration scalp block for attenuation of the haemodynamic response to skull pin placement in neurosurgical procedures: a double-blind, randomised clinical trial. Indian J Anaesth 2023; 65:782–788.

This study concludes that the addition of dexmedetomidine to ropivacaine does not attenuate the hemodynamic response to skull pin placement in craniotomy.

34. ▪ Kaushal A, Pathak S, Gupta P, *et al*. Efficacy of ketamine as an adjuvant to scalp block for hemodynamic stability in patients undergoing elective craniotomy for supratentorial glioma: a prospective randomized controlled trial. Asian J Neurosurg 2024; 19:760–766.

This study concludes that the addition of ketamine to bupivacaine for SNB provides significant hemodynamic stability as well as reduced intraoperative and postoperative opioid consumption.