



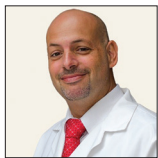
Technical Notes

A novel temporary cranial fixation device for awake cranial surgery: Technical report of 14 cases

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ABSTRACT

Background: Awake craniotomy has become the gold standard in various cranial procedures. As part of the awake technique, three-point pin fixation of the patient's head is important. One of the issues we encountered is the problem of matching the scalp infiltration site with the final pin position. To overcome this problem, we developed a flat plunger type fixator that adapts to the Mayfield holder.

Methods: Our fixator has a 2.5 cm metallic shaft that articulates in a ball and socket joint to allow its concave surfaces to adapt to the patient's scalp. After placing the patient in the desired position, the head is fixed with the three plungers, circles are drawn around each plunger, and they are then removed for the circles to be infiltrated with bupivacaine. Standard fixation pins are then placed in the Mayfield holder and aimed at the center of the circles.

Results: So far, we have operated on 14 patients with this technique. No patient experienced pain during temporary fixation, and the drawn circles ensured that there were no mismatches between the local anesthetic and pin locations. The technique was particularly useful on hairy scalps, where infiltration sites were hidden. We also used only 22.5 mg bupivacaine at the pin sites, freeing a dose for the field block around the scalp incision.

Conclusion: The temporary plunger type fixator provided a simple method to economize on local anesthetic use, check the patient's head position before final fixation, and ensure that the Mayfield pins matched with the anesthetized area.

Keywords: Craniotomy, Infiltration, Local anesthesia, Technique, Tumor

INTRODUCTION

Awake craniotomy has become gold standard in various cranial procedures, especially in the surgical management of gliomas. The use of awake mapping has improved neurological outcomes and has increased the potential extent of resection.^[3,4,11] Three-point pin fixation of the patient's head is important for the awake technique, but the pin fixation sites must be thoroughly infiltrated with local anesthetics before the placement of a Mayfield head holder to avoid pain. However, an issue we have encountered during positioning in nonshaved patients is that it can be difficult to match the scalp infiltration sites with the final pin positions. The usual method in awake craniotomies is for the Mayfield pins to be placed close to the scalp while an assistant infiltrates the pin placement sites; however, this has several drawbacks. It can be uncomfortable for patients

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with hairy scalps if they do not consent to scalp shaving. In addition, with three-point fixation systems, the pin on the other side of the scalp may not be visible to the surgical team. To overcome these issues, we developed a temporary fixation system that can adapt to the Mayfield head holder to allow perfect matching of the scalp infiltration sites with the final pin positions. Here, we describe the technique and outline our experiences with in across five cases.

CLINICAL PRESENTATION

We developed a flat plunger type fixator called ARTFIX (Temporary Fixation System) that adapts to the Mayfield head holder [Figure 1]. This temporary fixator has a 2.5 cm metallic shaft that articulates in a ball and socket-type joint with the plunger, allowing the concave surfaces to adapt perfectly to the patient's scalp. The patient is first placed in the desired position and the three plungers are temporarily fixed to the head [Figure 2a], around which we draw three circles with a marking pen [Figure 2b]. The plungers are then removed, and the three circles are fully infiltrated with bupivacaine and epinephrine [Figure 2c]. The plungers are then replaced with standard fixation pins that are aimed at the center of each of the three circles before tightening the holder [Figure 2d].

This technique required the assistants to hold the patient's head and draw the circles, while the surgeon presented the head holder loaded with the plungers. In this way, the patient's head could be oriented in the desired position by temporary fixation, allowing for perfect matching of the Mayfield pin sites to the areas treated with a local anesthetic. On postoperative day 1, patients were asked whether they had felt pain related either to the ARTFIX or to pin positioning.



Figure 1: The ARTFIX system. The flat plunger type fixators articulate with the main metallic shaft in a ball and socket-type joint.

They were shown a visual analog scale (VAS) to describe this step of the procedure.

To date, we have used our novel technique for 13 awake craniotomies and one awake C1-C2 fusion [Table 1]. This study was approved by the HPR Ethics Committee (approval #1/0065). All patients signed an informed consent form before each procedure. Six patients were operated on for primary brain tumors, one patient had a brain metastasis, three had arteriovenous malformations, two had brain cavernomas, another had a brain aneurysm, and the last one received awake C1-C2 fusion [Table 1]. We used cases 4 and 5 as representative cases to illustrate our findings [Figure 3]. Local anesthesia was obtained with 0.25% bupivacaine and 1:400,000 epinephrine (34 mL) and was administered after using dexmedetomidine and remifentanyl to induce conscious sedation. All three pin sites in each patient required only 3 mL of the local anesthetic solution (using 22.5 mg bupivacaine per patient), leaving 31 mL (77.5 mg bupivacaine) to perform the field block around the scalp incision.

No patient in this series experienced pain during the placement of the temporary cranial fixation device, which was well tolerated in all cases [Figure 3a]. The postoperative VAS mean score was 1/10. It was notable that drawing the circles around the plungers [Figure 3b] helped us to place the pins exactly where the local anesthetic had been injected [Figure 3c]. We found the technique to be especially useful for hairy scalps in which the infiltration sites could be hidden [Figure 3d and e]. Finally, the technique meant that we could infiltrate all pin sites using only 30% of the initial dosage (100 mg of bupivacaine), allowing us to save another 50 mg to address wound or pin-related pain that might have developed during the procedure.

DISCUSSION

Awake craniotomy has become a versatile tool in the treatment of brain tumors. Its use permits maximal tumor resection with a reduction in the risk of postoperative speech and motor deficits.^[8,12] In a recent meta-analysis, Hamer *et al.*^[5] showed that resection in adult patients with supratentorial infiltrative gliomas had double the number of late severe neurologic deficits when intraoperative stimulation mapping was not used compared with when mapping was used.

Maintaining patients' comfort during the procedure is essential to ensure adequate brain mapping and optimal tumor resection. However, headache is a common complaint when using fixation devices, and Keifer *et al.*^[6] reported that supplemental local anesthesia and analgesia were required to treat intraoperative headaches in 16% of cases. Local anesthetics used in the procedure, including bupivacaine, also

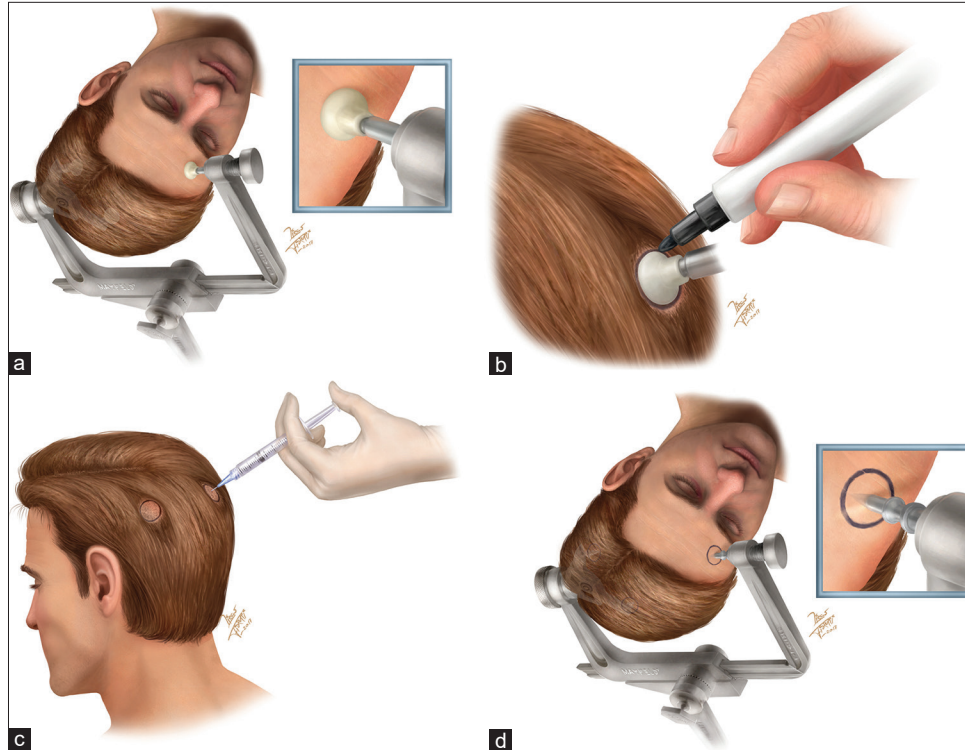


Figure 2: (a) Artistic rendering of the technique used with the ARTFIX system patient being secured using the ARTFIX system, (b) drawing a circle around a plunger, (c) infiltration with local anesthetic at the center of the circles, (d) final head position.



Figure 3: Representative images of intraoperative positioning for awake craniotomy using ARTFIX Images for Cases 4 (a-c) and 5 (d and e) are shown. (a) Initial fixation of the patient's head with ARTFIX, (b) a circle is marked on the frontal scalp, (c) final pin placement inside the marked circle, (d) a marked circle on the occipital scalp, (e) final position before craniotomy.

Table 1: Patient characteristics of the study cohort.

Case #	Age (years)	Disease	Lesion location	Time of awake surgery	Dose of local anesthesia for each pin site	Visual analog score	Complications
1	47	Metastatic tumor (breast)	Left temporal lobe	390 min	Lidocaine 1%–epinephrine 1:200,000+bupivacaine 0.25/2.5 ml	1/10	No
2	61	GBM	Left temporal lobe	450 min	Lidocaine 1%–epinephrine 1:200,000+bupivacaine 0.25/2.5 ml	1/10	No
3	60	Cavernous malformation	Left inferior parietal lobe	240 min	Lidocaine 1%–epinephrine 1:200,000+bupivacaine 0.25/2.5 ml	0/10	No
4	27	Anaplastic ependymoma	Right premotor frontal lobe	480 min	Lidocaine 1%–epinephrine 1:200,000+bupivacaine 0.25/2.5 ml	1/10	No
5	58	Anaplastic oligodendroglioma	Left premotor frontal lobe	480 min	Lidocaine 1%–epinephrine 1:200,000+bupivacaine 0.25/2.5 ml	2/10	No
6	40	GBM	Left temporal lobe	390 min	Lidocaine 1%–epinephrine 1:200,000+bupivacaine 0.25/2.5 ml	1/10	No
7	49	AVM	Left inferior parietal lobe	450 min	Lidocaine 1%–epinephrine 1:200,000+bupivacaine 0.25/2.5 ml	0/10	Wound infection
8	45	AVM	Right SMA frontal lobe	420 min	Lidocaine 1%–epinephrine 1:200,000+bupivacaine 0.25/2.5 ml	0/10	No
9	66	AVM	Left inferior parietal lobe	720 min	Lidocaine 1%–epinephrine 1:200,000+bupivacaine 0.25/2.5 ml	2/10	Cerebral edema
10	38	Cerebral aneurysm	Middle cerebral artery	360 min	Lidocaine 1%–epinephrine 1:200,000+bupivacaine 0.25/2.5 ml	1/10	No
11	55	Cavernous malformation	Left temporal lobe	180 min	Lidocaine 1% –epinephrine 1:200,000+bupivacaine 0.25/2.5 ml	2/10	No
12	49	GBM	Left temporal lobe	420 min	Lidocaine 1% – epinephrine 1:200,000+bupivacaine 0.25/2.5 ml	1/10	No
13	25	Anaplastic oligodendroglioma	Left SMA frontal lobe	420 min	Lidocaine 1% – epinephrine 1:200,000+bupivacaine 0.25/2.5 ml	1/10	Cerebral edema
14	76	Odontoid fracture	C2	176 min	Lidocaine 1% – epinephrine 1:200,000+bupivacaine 0.25/2.5 ml	1/10	No

GBM: Glioblastoma

have a maximal dose that must be taken into consideration, requiring that their use be rational and efficient throughout. Our device provided a simple method to ensure anesthetic delivery at the optimal site.

Another important issue that patients must be comfortable during the “awake” part of the procedure, and the surgeon, anesthesiologist, and neurologist/speech therapist must agree

on the final position. By fixing the head temporarily, the team can double-check and agree on the patient’s final head position before the pins are placed.

It is not always easy to match the infiltration and pin sites with the standard technique, especially on hairy scalps. Although a wider infiltration field could accomplish this task, the potential toxicity of local anesthetics needs to be considered

(e.g., dysrhythmias, hypotension, and depressed cardiac output), with surgeons only having a fixed amount of local anesthetic to use for the entire procedure.^[2,10] Although doses may be repeated every 3 h, most experience to date is with single doses of <175 mg. Excessive anesthesia to scalp sites that are not going to be pinned is wasteful, unnecessary, potentially dangerous, and can restrict more appropriate use later in the procedure. The technique we used mitigates this issue.

Scalp infiltration with local anesthetics can protect against potentially dangerous increases in arterial pressure when the Mayfield holder is used.^[1,7] Using the temporary fixation plungers described in this report could also help during standard craniotomies performed under general anesthesia (especially in vascular surgery). Furthermore, the devices could be used as a teaching tool, especially for fellows and residents, before committing to pin insertion and the attendant risk of complications.^[9,13] Although we only used a small case series, precluding drawing any definitive conclusions, we believe that the technique described has the potential to be of great use in awake craniotomy procedures. However, to determine whether this technique helps to reduce local anesthetic use, studies should compare the doses required to infiltrate pin sites adequately when using and not using the temporary fixation device.

The main drawback we found using this new device, is the need for two assistants (one to hold and rotate the patient's head as required, and the other one to draw the circles with a marking pen). Furthermore, for patients with dense hair, it is sometimes needed to shave a circle about the size of the plungers to draw the circles.

CONCLUSION

Patient comfort during intraoperative stimulation mapping surgery is crucial to improving outcomes. The temporary fixation device reported in this study provides a simple method that can economize on local anesthetic use at the cranial fixation site and allow the patient's head position to be checked by all team members before final rigid fixation.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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