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Technical note: Orbitozygomatic craniotomy using an ultrasonic osteotome for precise osteotomies

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ABSTRACT

Background: The orbitozygomatic craniotomy is a fundamental procedure in neurosurgery, allowing access to orbital and skull base pathology.
Objective: Determine the feasibility of using an ultrasonic osteotome to safely perform orbitozygomatic osteotomies in patients with intracranial pathology.
Methods: The medical records of patients undergoing orbitozygomatic craniotomy using an ultrasonic osteotome (Aesculap BoneScalpel™) for tumor resection at Johns Hopkins Hospital between November 2009 and March 2013 were retrospectively reviewed.
Results: Six patients underwent orbitozygomatic craniotomy for tumor resection using an ultrasonic osteotome at the Johns Hopkins Hospital during the study period. All patients were female and the average age was 53.2 years. Patients were followed for an average of 375 days. There were two cases of transient diplopia. There were no cases of periorbital violation, orbital injury, enophthalmos, or orbital hematoma. Post-operative imaging showed the cuts were well opposed and no cosmetic issues were encountered.
Conclusion: Use of an ultrasonic osteotome allows for precise cuts under direct visualization with minimal risk to critical adjacent structures in our cohort of patients undergoing a two-piece orbitozygomatic craniotomy. This appears to be a safe instrument for osteotomy creation in skull base approaches.

1. Introduction

Neurosurgical tools have significantly evolved since the development of trephines that were used for craniotomies described as early as 8000–5000 BC [1]. The orbitozygomatic approach and its modifications allow for increased exposure of orbital, suprasellar, parasellar, and middle fossa pathology while minimizing brain retraction [2–4]. The orbitozygomatic craniotomy is classically created by making a series of cuts in the orbital rim and zygoma in conjunction with a frontotemporal craniotomy. These osteotomies can be performed in a controlled fashion by instruments such as osteotomes, reciprocating saws, or craniotomes [4,5]. While these devices have been widely used with proven safety, the width of the osteotomies can result in large bony defects with associated cosmetic deformities or inadvertent injury to neural or orbital structures.

Ultrasonic osteotomes are able to make precise osteomies, as thin as 0.5 mm, while protecting soft tissues deep to the cutting surface. This is achieved via high frequency (22,500 Hz) oscillations over a small surface area (35–300 μ). Underlying soft tissues, such as dura and periorbita are theoretically spared due to their ability to deform, increasing the surface area in which energy is applied and dampening the energy transferred upon contact with the device [6].

While Parker et al. reported that an ultrasonic osteotome was safe and efficacious for use in laminectomies, no published study has reported its use in cranio-orbital applications [7]. We report our initial experience using an ultrasonic osteotome in two-piece orbitozygomatic craniotomies for tumor resection and comment on surgical outcome and complications as a result of its use.

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2. Methods

2.1. Subjects

The electronic medical records of patients undergoing first-time craniotomy for tumor resection with the BoneScalpel™ (Aesculap Inc., Center Valley, PA, USA), an ultrasonic osteotome, at the Johns Hopkins Hospital between November 2009 and March 2013 were retrospectively reviewed from a prospectively accrued, IRB-approved database. Electronic medical records were queried for demographic data, surgical approach, radiologic studies, and intra-operative and post-operative complications including orbital violation, periorbital ecchymosis, diplopia, disconjugate gaze, and cosmesis.

2.2. Surgical technique

All patients underwent an orbitozygomatic approach for tumor resection. The technique for performing a two-piece orbitozygomatic craniotomy used in our institution has been previously reported [5]. In brief, patients are placed in a supine position on the operating room table followed by standard anesthesia and head fixation in a three-pin Mayfield frame. After fixation, the head is translated, extended and rotated according to the target pathology. Following skin incision, the two layers of the superficial temporalis fascia are incised and a subfascial flap is elevated with the skin flap with careful attention to spare the frontal branch of the facial nerve. The temporalis muscle is then subperiostially elevated by blunt dissection of the deep temporal fascia. After creation of a tailored frontosphenotemporal craniotomy, dura is elevated off of the skull base and attention is then directed to the orbitozygomatic osteotomies.

The ultrasonic osteotome is then used to complete the orbital and zygomatic osteotomies (Fig. 1). A more in depth review of the modified orbitozygomatic craniotomy is reviewed elsewhere but in brief, the first osteotomy involves an oblique cut of the inferior, posterior edge of the zygomatic arch. Next, the frontal process of the zygoma is released from the body with care not to invade the periorbita. To release the temporal process of the zygoma, an osteotomy is made along the inferior edge of the temporal process of the zygoma toward the previous osteotomy. To remove the roof of the orbit, the osteotomy begins lateral to the supraorbital notch and continues in the direction of the superior orbital fissure and then directed laterally down the wall of the orbit. The adjacent periorbita and dura are protected under direct visualization by the assistant surgeon. To release the lateral wall of the orbit, osteotomy begins in the inferior orbital fissure and is continued to join the previous osteotomy [5]. The bone flap is pre-plated to provide optimal alignment when complete (Fig. 2).

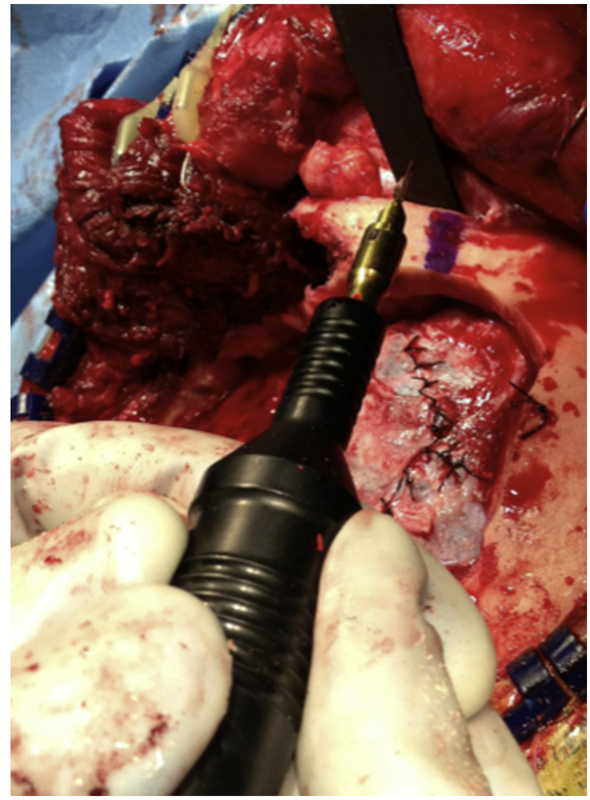

Fig. 1. Intraoperative photograph showing the orbital rim prior to osteotomy with the ultrasonic osteotome.

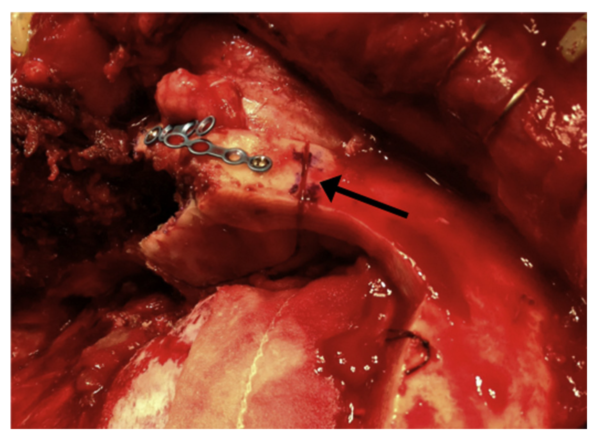

Fig. 2. Intraoperative photograph showing alignment of the bone flap following osteotomy with the ultrasonic osteotome. To improve alignment, the bone flap was pre-plated.

3. Results

The mean age of the six patients was 53.2 years (range: 40–77 years). All patients were female. The primary pathologies included meningioma ($n = 5$) and craniopharyngioma ($n = 1$). Patients were followed for an average of 375 days (range: 52–1293 days). During the post-operative and follow-up period, complications included transient diplopia ($n = 2$) and temporary restriction of ocular movements ($n = 3$). A single patient required a tissue rearrangement surgery as a result of eye pain and diplopia. No cosmetic complications were noted on last follow up (Table 1). Two patients required a second operation as a result of tumor progression. A representative post-operative CT scan of the first operation for a patient presenting with a craniopharyngioma is shown in Fig. 3.

4. Discussion

The orbitozygomatic approach allows for removal of the lateral wall of the orbit and zygoma providing access to the orbital contents, orbital apex, lateral sphenoid wing, cavernous sinus, clivus, frontal fossa, and temporal fossa. Furthermore, addition of a fronto-spheno-temporal craniotomy improves visualization and enhances the surgical corridor while minimizing brain retraction, potentially decreasing patient morbidity as a result of the procedure [5].

Description of the orbitozygomatic approach was first reported in 1982, when Jane et al. reported a modification of the frontal