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Functional reconstruction of the glenoid fossa utilizing a pedicled temporal osteomuscular flap

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A R T I C L E I N F O

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A B S T R A C T

Current techniques in management of end stage pathology of the temporomandibular joint (TMJ) include the use of alloplastic joint reconstruction. A polyethylene glenoid fossa prosthesis is a necessity of this treatment as it provides a stable platform for function of the metal alloy condylar head. Additionally, the fossa prosthesis limits superior and posterior movement of the reconstructed joint which prevents complications such as migration of the condylar prosthesis into the middle cranial fossa and ear, ankylosis, and pain.

When a pathologic process affects the glenoid fossa alone, alloplastic joint reconstruction becomes a less desirable treatment option. Lack of osseous structure along the temporal bone and zygomatic arch can impact the surgeon's ability to fixate a glenoid fossa prosthesis. Additionally, resection of an uninvolved condylar head in situations where there is no advanced pathology would provide a functional solution, but may be overly aggressive and potentially unnecessary.

The following is our experience with utilizing a pedicled temporal osteomuscular flap to reconstruct an acquired defect of the glenoid fossa in a 42-year-old male with a diffuse-type tenosynovial giant cell tumor. In this case the mandibular condyle was not affected by the pathology.

1. Introduction

Giant cell tumors (GCT's) of the skull are a rare entity. When diagnosed the temporal bone is the most common location [1,2]. GCT's of the skull present equally in men and women, with the average patient presenting in the 2nd or 3rd decade of life [1,2]. Various treatment options are reported in the literature which include surgical resection, curettage, subtotal resection with adjuvant radiation therapy, interferon alpha, denosumab, calcitonin, bisphosphonates and intralesional steroids [3–8]. The overall recurrence rate for treatment of GCT's is approximately 17.6%; segmental resection carries the lowest recurrence risk at roughly 4.3% [3]. Interferon, denosumab, calcitonin, and steroids are treatment options that may minimize morbidity but should be evaluated on a case-by-case basis as they may require some adjuvant surgical treatment for cure [4–7]. This patient presented with a GCT affecting the glenoid fossa without involvement of the adjacent condylar head. The goal of treatment was to create a reconstruction that would withstand the load of the mandibular condyle during function, provide a stopping position for the joint, allow for freedom of movement, maintain the patient's occlusion, minimize pain, and to provide a cosmetically acceptable result. Reconstructive options for this indication are limited but include autogenous bone grafting or custom alloplastic implants. This is our experience managing a

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post-ablative glenoid fossa defect utilizing a pedicled rotational temporal osteomuscular flap.

2. Case presentation

A 42-year-old male presented to the department of neurosurgery (NGY) with an indurated swelling of the left temporal region, left sided facial numbness, tinnitus, and intermittent headaches. The swelling had been progressing slowly for 5 years.

CT scans were obtained which demonstrated a mixed radiodense/radiolucent lesion with well-defined scalloped borders originating in the left temporal bone (Fig. 1A–D). A laboratory workup showed no evidence of hypercalcemia or hyperparathyroidism. Core needle biopsy of the lesion was completed which showed a giant cell rich neoplasm. NGY elected to proceed with subtotal excision of the lesion and Oral & Maxillofacial Surgery (OMS) was consulted for management of the planned ablative defect of the glenoid fossa.

2.1. Surgical plan

Surgical access to the lesion was obtained via a hemicoronal flap with a planned craniotomy for access to the left temporal bone and excision of the giant cell tumor (Fig. 2). This resection was to include complete removal of the glenoid fossa and approximately 50% of the ipsilateral zygomatic arch. The mandibular condyle was not involved by the primary tumor. OMS elected to reconstruct the glenoid fossa and zygomatic arch utilizing a pedicled temporal osteomuscular flap. This required both extension of the planned craniotomy superiorly to harvest the necessary bone and modification of the dissection approach to preserve a portion of the temporalis muscle to maintain flap vitality.

To accurately predict the bone necessary for reconstruction, OMS utilized virtual surgical planning (VSP). The VSP allowed prediction of a harvest site outside tumor margins, a reproducible resection position of the zygomatic arch, and created a surgical guide for the internal surface of the skull to accurately shape a bone flap which would correspond to the planned ablative defect.

2.2. Surgery

After a hemicoronal flap was elevated, intraoperative navigation was utilized to determine the tumor position under the temporalis muscle. A temporal craniotomy was preformed superior to this taking into account the additional bone for glenoid fossa

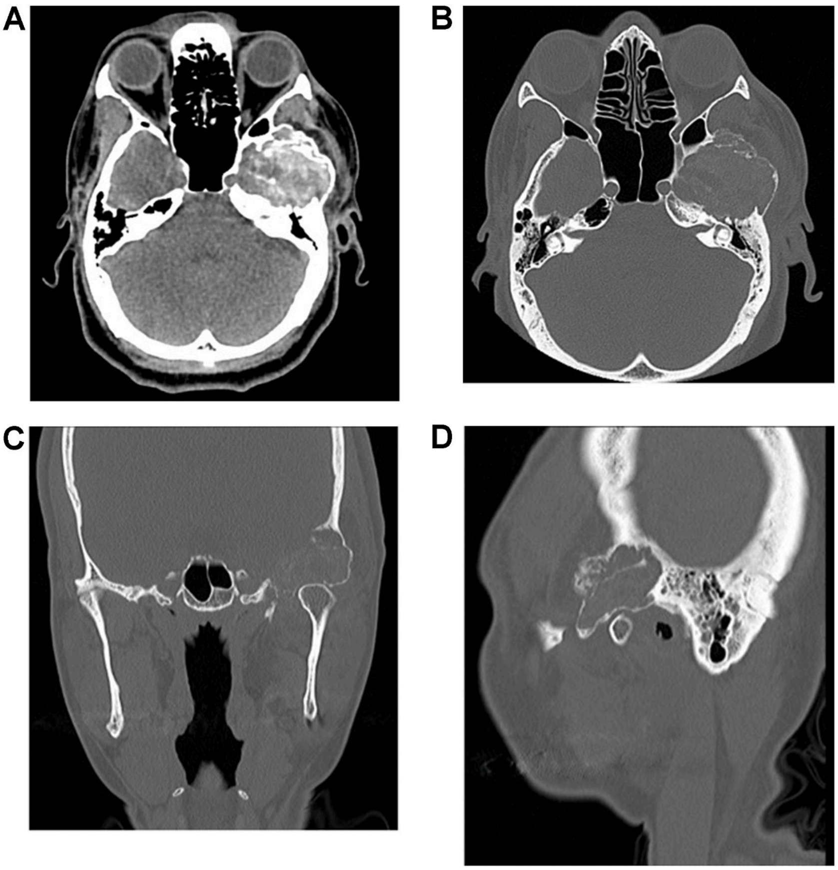

Fig. 1. CT images showing lesion originating in the left temporal bone with extension through the glenoid fossa. Mandibular condyle is not involved. (A) Axial view, post-contrast, soft tissue window. (B) Axial view. (C) Coronal view. (D) Sagittal view. (Would crop image A to correspond to height of image B. Would also crop image D to corrwespond to height of image C. You would not loose any critical information with this edit.)

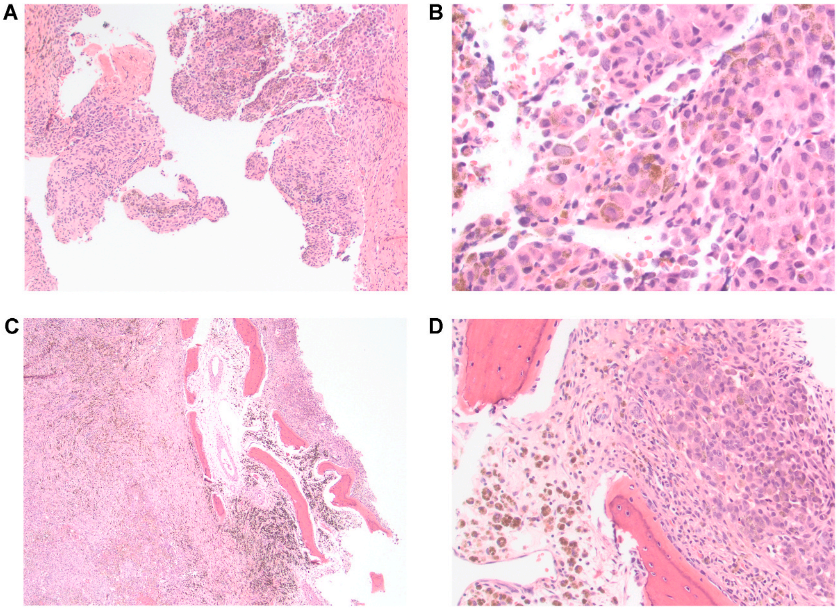

Fig. 2. The microscopic sections of the tumor show areas of a focal villous architecture often seen in diffuse type giant cell tumor (A). Higher power examination shows both extracellular and intracellular hemosiderin deposition (B). The tumor infiltrates into the bone (C) in which the tumor cells are intimately associated with bony trabeculae (D).

reconstruction.

Once the bone flap was released from the dura, dissection proceeded through the temporalis muscle protecting a portion anteriorly to provide vascular supply. The muscular pedicle was then dissected medially from the skull which allowed for access to the tumor and free movement and rotation of the flap (Fig. 3A). The blood supply was maintained by evidence of bleeding of the bony flap margins.

NGY then completed the resection of approximately 98% of the giant cell tumor. Utilizing a prefabricated cutting guide, OMS then resected the zygomatic arch. Next, a surgical guide was adapted to the internal surface of the cranial flap. The periphery of the guide was marked and used to outline the planned cranial bone harvest. Osteotomies were completed following the markings utilizing a reciprocating saw and copious sterile saline irrigation. Once complete the pedicled flap was rotated into position with the bone abutting the zygomatic arch (Fig. 3B) and the posterior aspect was adjusted with a pineapple bur to correspond to the extent of the temporal bone resection. The flap was then secured into position with a prebent reconstruction plate (Figs. 3C & 4A-D). Opening, closing, and lateral excursive movements of the mandible were free and unimpeded. The temporomandibular disk remained uninjured during the resection and was found to be attached to the condylar head without displacement or perforation. The disk was left in place and periumbilical fat was harvested and inset around the site prior to closure.

2.3. Post-operative course

The patient was discharged with a non-chew diet for 8 weeks. His first OMS clinic visit was at 17 days post-surgery. At that time, he was found to be pain free and biting repeatably into a class III relationship consistent with his presurgical bite. He was found to have a maximum incisal opening (MIO) of 40mm, with 10mm and 5mm of right and left lateral excursive movements respectively.

At his 2nd follow-up, 2 months post-surgery, the patient developed trismus with a MIO of 15mm. He reported no problems with

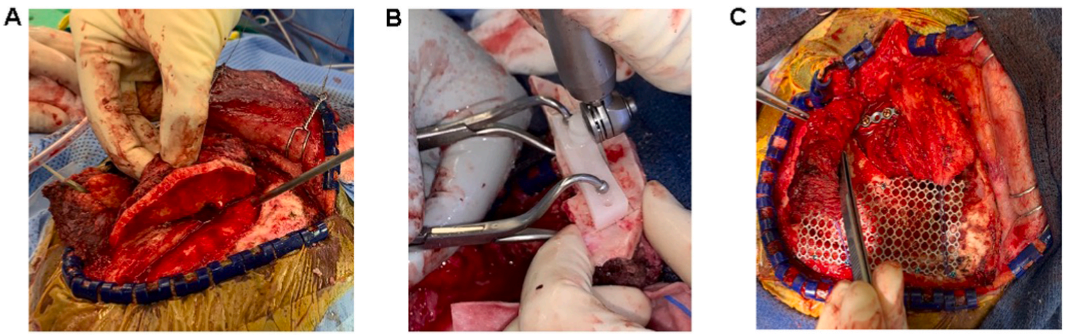

Fig. 3. (A) Mobilization of the osteomuscular flap with a pedicle of temporalis muscle. (B) Osteotomy being completed with surgical guide in place. (C) Reconstruction bar securing the osteomuscular flap.

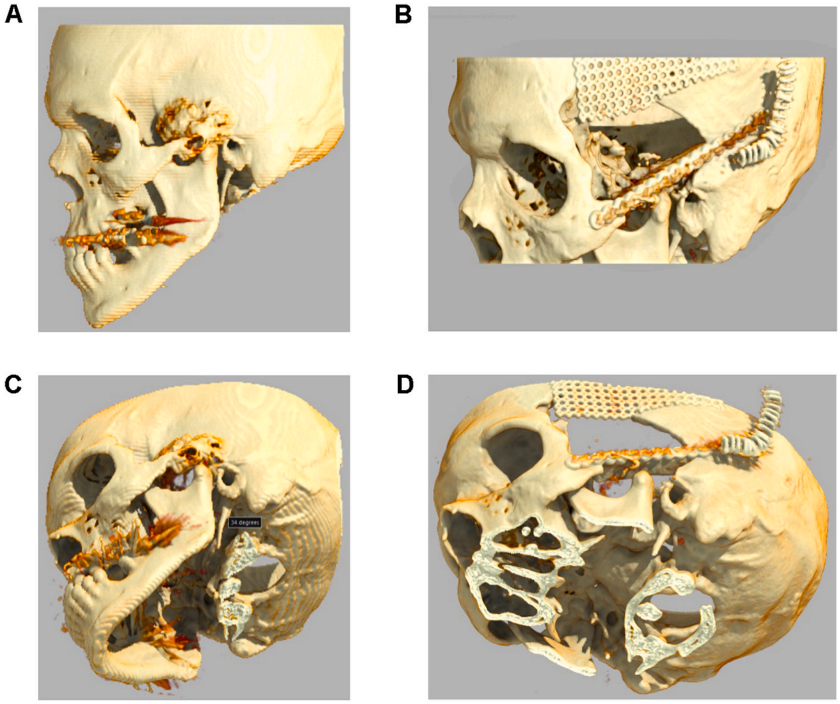

Fig. 4. 3D reconstruction of preoperative (A & C) and post-operative (B & D) CT's showing the ablative defect at the skull base and reconstructed glenoid fossa.

chewing, locking, pain, or malocclusion. A Therabite (Atos, New Berlin, WI) was prescribed for daily use and the patient was encouraged to follow-up with a jaw physical therapist. The patient returned again at 8 months post-surgery with an improved MIO to 40mm. He remained pain free and was able to tolerate a normal diet with no restrictions (Fig. 5A and B).

3. Discussion

Failure to reconstruct the glenoid fossa will result in poor occlusion and limited function with no stopping position for the mandibular condyle. Treatment options for glenoid fossa reconstruction fall into two categories, alloplastic materials and autografts. Alloplastic TMJ reconstruction is a predictable technique to treat advanced temporomandibular joint disease including inflammatory arthritis, osteoarthritis, tumors, and trauma [9]. In clinical situations where the glenoid fossa and zygomatic arch are not available, custom TMJ condylar prosthetics can be developed to attach to distant cranial positions, however, this treatment option requires resection of the mandibular condyle and prosthetic replacement to provide predictable function [10]. Techniques utilizing biomaterials such as high-density porous polyethylene (Medpor), polyether ether ketone (PEEK) or polymethyl methacrylate (PMMA) for long term function on the load bearing surface of the temporomandibular joint are not currently supported. While these options would allow for anatomic reconstruction of the glenoid fossa, Medpor is not indicated in load bearing applications and PMMA is found to fragment when used as an intraarticular spacers in two stage joint reconstructions [11,12]. PEEK is being studied extensively for use in orthopedics and spine surgery applications. While the material is strong and has a high Young's modulus, when used in articulations PEEK containing polymers demonstration fragmentation and create wear particles which can be found in the articular tissues [13–15]. The clinical significance of this is still under investigation. There is insufficient data to suggest these biomaterials would provide equal or superior functional outcomes compared to joint replacement or bone autografts for reconstruction.

Autogenous bone grafting does have drawbacks including additional surgical sites and difficulties with graft incorporation and resorption [15]. Also, in cases where free tissue transfer is utilized, the surgeon must contend with small vessel caliber, limited vessel availability, increased length of surgery, increased donor site morbidity, overall flap bulk, poor cosmesis, and appropriate flap selection to provide adequate bony support for a functional joint reconstruction [16].

Using a pedicled temporal osteomuscular flap for reconstruction of a glenoid fossa defect allowed our patient to resume normal function post-operatively. Additionally, the blood supply was easily maintained, the flap was thin and easily positioned, and the use of bone and the planned resection margin created no additional morbidity as it was from the existing surgical site. The reconstruction is free of implanted biomaterials on the articular surface. The major complication of the procedure was trismus, which resolved with the use of a Therabite (Atos, New Berlin, WI) and jaw physical therapy.

Pedicled temporal osteomuscluar flaps have been utilized for cosmetic reconstruction of malar hypoplasia [17,18]. However, use of this technique for immediate functional reconstruction of the glenoid fossa is not well described. This technique resulted in minimal morbidity, excellent immediate and prolonged joint function, and maintenance of the patient's uninvolved mandibular condyle.

Reconstruction of the glenoid fossa, with or without the mandibular condyle is challenging. The use of cranial bone grafting has

A

B

Fig. 5. 8 months following glenoid fossa reconstruction with maximum incisal opening of 40mm. (A) In occlusion (B) Maximum opening.

been utilized for TMJ and maxillofacial defects, however this is largely with devascularized split thickness autografts [19]. Maintaining a vascularized pedicle improves flap viability and osteosynthesis. This has the potential to limit graft resorption, graft failure, and complications secondary to immediate function [20].

Alternatively, alloplastic reconstruction of the glenoid fossa with maintenance of the native condyle has been described by Tawfillis et al. [21] In this paper, a custom alloplastic Christensen prosthesis was used to reconstruct the glenoid fossa opposing the patients' native condyle. This case was complicated by recurrent cerebral spinal fluid otorrhea and chronic abscess of the temporal bone requiring mastoidectomy. The patient in the report established a 28mm MIO post-operatively and was able to resume oral feeding. The paper goes on to discuss relapse and limited opening despite physical therapy. While these authors were able to establish a reconstruction with a bone to prosthesis articulation, this case demonstrated complications that were likely multifactorial. In our experience, we were able to reestablish an articulation between the native condyle and the rotated osteomuscular flap which afforded our patient excellent opening and immediate function.

The use of implantable alloplastic materials caries infection risk [22]. The pedicled flap did require a reconstruction bar for stabilization, but after osseous healing this hardware can be removed without an anticipated functional deficit. Conversely, an infection involving an alloplastic implant could lead to significant morbidity including pain, swelling, loss of function, need for maxillomandibular fixation, infection, and further surgical needs including staged reconstruction/gap arthroplasty [22,23].

Overall, the use of a pedicled temporal osteomuscular flap can be easily accomplished. With VSP and medical modeling this technique provided a reproducible reconstructive plan. This patient experienced a return to normal function with a stable occlusion and no prolonged pain. This technique should be considered when there is a need for glenoid fossa reconstruction when the native mandibular condyle is preserved.

Credit author statement

Vincent M. Aquino, D.D.S., M.D.: Investigation, Writing – Original Draft, Visualization. **Jack P. Rock, M.D.:** Investigation. **Kyle D. Perry, M.D.:** Investigation**. Benjamin T. Barbetta, D.M.D., M.D.:** Conceptualization, Methodology, Investigation, Writing – Review & Editing, Visualization, Supervision, Project Administration.

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