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Lateral transzygomatic middle fossa approach and its extensions: Surgical technique and 3D anatomy

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ABSTRACT

Background: Various approaches to lesions involving the middle fossa and cavernous sinus (CS), with and without posterior fossa extension have been described. In the present study, we describe the surgical technique for the extradural lateral tranzygomatic middle fossa approach and its extensions, highlight relevant 3D anatomy.
Methods: Simulations of the lateral transzygomatic middle fossa approach and its extensions were performed in four silicon-injected formalin fixed cadaveric heads. The step-by-step description and relevant anatomy was documented with 3D photographs.
Result: The lateral transzygomatic middle fossa approach is particularly useful for lesions involving the middle fossa with and without CS invasion, extending to the posterior fossa and involving the clinoidal region. This approach incorporates direct lateral positioning of patient, frontotemporal craniotomy with zygomatic arch osteotomy, extradural elevation of the temporal lobe, and delamination of the outer layer of the lateral CS wall. Extradural drilling of the sphenoid wing and anterior clinoid process allows entry into the CS through the superior wall and exposure of the clinoidal segment of the ICA. Posteriorly, drilling the petrous apex allows exposure of the ventral brainstem from trigeminal to facial nerve and can be extended to the interpeduncular fossa by division of the superior petrosal sinus.
Conclusion: The present study illustrates 3D anatomical relationships of the lateral transzygomatic middle fossa approach with its extensions. This approach allows wide access to different topographic areas (clinoidal region and clinoidal ICA, the entire CS, and the posterior fossa from the interpeduncular fossa to the facial nerve) via a lateral trajectory. Precise knowledge of technique and anatomy is necessary to properly execute this approach.

1. Introduction

There are multiple approaches to lesions involving the middle fossa, the cavernous sinus (CS), and the petrous apex. The middle fossa approach, an extradural subtemporal approach, was first used in the late 19th century to access the trigeminal ganglion [11]. In 1961, House was the first to report the middle fossa approach for removal of an acoustic neuroma [33] and in 1965, Pulec used this approach for complete facial nerve decompression [55]. Since then, numerous surgeons have utilized the middle fossa approach to access the cavernous sinus and treat various middle fossa based skull base lesions [16,25,31,35,37,40,46,53,61,65]. Numerous authors have utilized a zygomatic arch osteotomy to increase the inferior–superior trajectory while decreasing the need for temporal retraction [2,4,7,9,24,48,71]. In 1985, Kawase described a modification of the middle fossa approach via an extradural anterior petrosectomy to access low lying basilar apex aneurysms [41]. Later, this approach became utilized for accessing tumors along the ventral brainstem from the trigeminal nerve to the facial nerve.

Others have utilized anterolateral approaches to access the middle fossa, cavernous sinus and posterior fossa. Extra and intradural approaches based on frontotemporal craniotomies with several modifications have been described [10,23,35,37,44,57,59]. One such modification is the temporopolar approach described separately by Sano [59] and Dolenc [17], which combines the exposures of the pretemporal and pterional approaches. In 1980, Sano first described the intradural temporopolar approach for upper basilar apex aneurysms as a modification of the pterional approach based on posterior retraction of the temporal lobe [59]. Later he described

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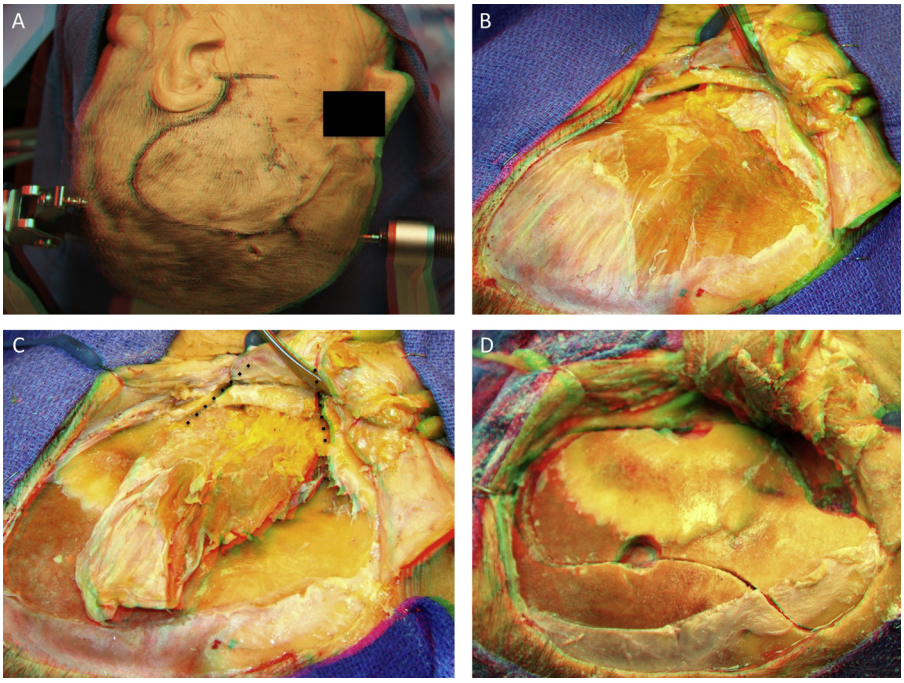

Fig. 1. (a) Positioning: head is turned 90° lateral. A question-mark incision is marked from the zygoma just anterior to the tragus and extended to the posterior auricular line and curved superiorly above the pterion (marked with an 'X') and anteriorly toward to the hairline. (b) Exposure: an interfascial dissection is performed to fully expose the zygoma. (c) Zygomatic osteotomy: an osteotome or drill is used to perform a zygomatic osteotomy (dotted lines indicate osteotomy lines). The posterior cut is angled as pictured to avoid injuring the temporomandibular joint. The zygoma may be plated prior to the cuts to ease reconstruction. (d) Craniotomy: for access to the posterior cavernous sinus and petrous apex, a craniotomy is placed about 1/3 posterior to the external auditory canal and 2/3 anterior. For access to the anterior cavernous sinus, the craniotomy should extend anteriorly to the sphenoid wing. For access to the anterior clinoid process, the craniotomy is extended superior to the pterion. In all of these craniotomies, the superior limit of the craniotomy should extend just beyond the squamosal suture.

a modification of this approach using a zygomatic arch osteotomy [60]. Dolenc described the extradural frontotemporal (FT) approach to Meckel's cave and lateral cavernous sinus (CS) lesions [17].

The lateral transzygomatic middle fossa approach can be used to access the entire middle fossa floor, cavernous sinus, and posterior fossa. Multiple extensions of this approach exist to expand access to include (a) the carotid cave and clinoidal and supraclinoidal segments of the ICA via an anterior clinoidectomy, (b) the posterior fossa from trigeminal nerve to facial nerve via an anterior petrosectomy, and (c) the interpeduncular fossa via a transtentorial extension. Detailed knowledge of the topographic anatomical relationships is critical to execute these approaches and to avoid complications. Yet there are few reports detailing the surgical anatomy of these middle fossa based lateral approaches. In the present study, we describe, in detail using cadaveric models, the surgical technique for the extradural lateral tranzygomatic middle fossa approach and its extensions, highlight relevant 3D anatomy.

2. Methods

The lateral transzygomatic middle fossa approach and its extensions were performed in four silicone-injected, formalin fixed cadaveric heads. The step-by step description and relevant anatomy was documented with 3D photographs. Please note, 3D illustrations require use of red-cyan 3D glasses.

3. Surgical technique and 3D anatomy

3.1. Positioning

The specimen is positioned supine with the head turned to the opposite side so as to attain a direct lateral position. A question mark incision is marked from the zygoma, extending posteriorly along the temporal floor just behind the auricle, and then extending superiorly just above the level of the superior temporal line and carried anteriorly to the hairline (Fig. 1a).

3.2. Exposure

After skin incision and separation of the galea from the temporalis fascia to the level of the frontotemporal fat pad, an interfascial dissection is performed to fully expose the zygoma (Fig. 1b). An osteotome or oscillating saw is then used to perform an isolated zygomatic osteotomy with care to avoid the temporomandibular joint on the posterior cut (Fig. 1c). A superior cut is made in the temporalis muscle preserving a cuff and the temporalis muscle is dissected in a caudal–rostral fashion to preserve neurovascular supply [39]. The temporalis muscle is mobilized out of the temporal fossa and retracted inferiorly using low-profile hooks.

3.3. Craniotomy

The craniotomy is tailored to the pathology. For access to the posterior cavernous sinus, and petrous apex, the craniotomy is placed about 1/3 posterior and 2/3 anterior to the external auditory canal [39]. For access to the anterior cavernous sinus, the craniotomy should extend anteriorly to the sphenoid wing. Finally, for access to the anterior clinoid, the craniotomy is extended superiorly above the pterion (Fig. 1d). The superior limit of the temporal portion of the craniotomy should be just above the squaomosal suture. Care must be taken to adequately strip the dura off the bone. A durotomy in the temporal dura must be repaired prior to extradural dissection to prevent temporal lobe herniation during retraction. In clinical cases a lumbar drain is inserted before positioning and CSF is drained at this stage of the operation, prior to temporal lobe elevation. The inferior temporal bone is drilled with