Analysis of Jugular Foramen Exposure in the Fallopian Bridge Technique

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ABSTRACT

Objective: To analyze the exposure of the jugular foramen afforded by the fallopian bridge technique. **Method:** The jugular foramen exposure was obtained using the jugular foramen approach combined with the fallopian bridge technique. We applied this technique using 10 temporal bone specimens at a tertiary referral center. The exposure was assessed by means of depth of the dissection field and two separate dissection spaces that were created anteriorly and posteriorly to the facial nerve. Anteroposterior and superoinferior dimensions of the anterior dissection space were 4.4 ± 1.03 mm and 6.3 ± 2.49 mm, respectively. The superoinferior and anteroposterior dimensions of the posterior dissection space were 11.7 ± 2.08 mm and 8.0 ± 2.95 mm, respectively. The depth of the first dissection field was 8.2 ± 2.11 mm. After perforating the jugular bulb, the depth of the second dissection field was 16.0 ± 1.60 mm. **Results:** The anterior dissection space serves only as an additional visualization space for anatomical orientation to the jugular bulb. Tumor dissection is to be accomplished mainly through the posterior dissection space. **Conclusion:** The fallopian bridge technique should be added to surgical armamentarium for the jugular foramen tumors confined only to the jugular fossa or tumors with middle ear extension.

KEYWORDS: Jugular foramen, fallopian bridge technique, facial nerve, infratemporal fossa approach, infralabyrinthine tumors

The infratemporal fossa approach without facial nerve transposition was originally described by Martin and Prades¹ for selected infralabyrinthine tumors. As originally described, the approach used either an intact canal wall technique or canal wall

down mastoidectomy.¹ Maniglia et al² described the same operation but called it the inferior mastoidectomy-hypotympanic approach. Later, Pensak and Jackler³ used the term *fallopian bridge technique* for selected jugular foramen tumors. The aim of all

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these authors was to preserve the facial nerve function by leaving it in the fallopian canal while removing a tumor in the jugular fossa. The essence of the technique described by all these authors is an infratemporal fossa approach in which the facial nerve is skeletonized from the second genu to the stylomastoid foramen.^{3,4}

With this technique, good facial nerve outcomes have been reported in patients with jugular foramen lesions.^{1,3} However, because the mastoid segment of the facial nerve occupies the center of the operative field, most accept that it obstructs the surgical view to some extent and, as a consequence, makes tumor dissection difficult. The aim of this study was to analyze the surgical exposure of the jugular foramen afforded by the fallopian bridge technique.

MATERIALS AND METHODS

The jugular foramen approach combined with the fallopian bridge technique was performed on 10 formaldehyde-preserved temporal bone specimens. A wide postauricular incision was used to pass through the postauricular soft tissue. The cartilaginous canal skin was incised, and the pinna was pulled anteriorly. The mastoid cortex was exposed. A complete mastoidectomy was undertaken, and both the sigmoid sinus and facial nerve were skeletonized. Using an extended facial recess approach, the mastoid segment of the facial nerve was skeletonized from the second genu to the stylomastoid foramen. Care was taken to ensure that a thin layer of bone remained over the nerve. The rest of the bone anterior and posterior to the mastoid segment of the nerve was then removed. Thus, two spaces were created. The first (anterior dissection space) was between the mastoid segment and the posterior canal wall. The second (posterior dissection space) was posterior to the mastoid segment of the facial nerve and between the ampulla of the posterior semicircular canal (PSCC) and the

stylomastoid foramen, a space that corresponded to the infralabyrinthine cells. To define a reference point for the measurements, the ampulla of the PSCC was opened. The mastoid tip was amputated. Complete removal of the infralabyrinthine cells in the anterior dissection space exposed the dome of the jugular bulb. The bulb was then perforated to identify the jugular foramen and the inferior petrosal sinus (IPS). The IPS was identified as one or more openings. The internal carotid artery (ICA) was also skeletonized up to the genu.

The following measurements were then made to evaluate the exposure of the jugular foramen afforded by this technique (Figs. 1 and 2):

1. Distance between the ampulla of the PSCC and the stylomastoid foramen (superoinferior dimension of the posterior dissection space)
2. Distance between the mastoid segment of the facial nerve and the dural surface of the sigmoid sinus (anteroposterior dimension of the posterior dissection space)
3. Distance between the lower boundary of extended facial recess approach and lower boundary of the anterior dissection space (superoinferior dimension of the anterior dissection space)
4. Distance between the posterior canal wall and the mastoid segment of the facial nerve (anteroposterior dimension of the anterior dissection space)
5. Distance between the mastoid segment of the facial nerve and the dome of the jugular bulb (first depth of the dissection field)
6. Distance between the mastoid segment and the IPS (second depth of the dissection field)

The posterior canal wall was then taken down and the middle ear completely exposed. Measurements were then made from:

1. The promontory to the inferior wall of the jugular bulb
2. The ICA to the mastoid segment of the facial nerve

Figure 1 Right ear in surgical position. Anterior and posterior dissection spaces, preserved posterior canal wall, mastoid, and intraparotid segments of the facial nerve and the sigmoid sinus are seen. Note that the inferior ring of the tympanic bone (inferior curvature of the posterior canal wall) limits the anterior dissection space. Arrow 1: distance between the ampulla of the posterior semicircular canal and the stylomastoid foramen. Arrow 2: distance between the mastoid segment of the facial nerve and dural surface of the sigmoid sinus. Arrow 3: distance between the lower boundary of extended facial recess approach and lower boundary of the anterior dissection space. Arrow 4: distance between the posterior canal wall and the mastoid segment of the facial nerve. PCW, posterior canal wall; FN, facial nerve; *, jugular bulb.

All measurements were made using a caliper with 0.1-mm gradations. A Zeiss surgical microscope (OPMI 1-FR model; Oberkochen, Germany) was used for microsurgical dissection.

RESULTS

Table 1 lists the measurements made from reference points. With the posterior canal wall intact, the anteroposterior and superoinferior dimensions of the anterior dissection space were 4.4 ± 1.03 mm and 6.3 ± 2.49 mm, respectively. The former was the smallest of the dimensions of overall exposure.

When viewing the jugular foramen from the posterior dissection space, the entrance to the dissection field was determined by the curvature of the PSSC superiorly, the stylomastoid foramen inferiorly, the mastoid segment of the facial nerve ante-

riorly, and the sigmoid sinus posteriorly. The superoinferior dimension of this entrance was 11.7 ± 2.01 mm, and the anteroposterior dimension was 8.0 ± 2.95 mm. Before perforating the jugular bulb, the depth of the first dissection field was determined by the measurement of the dimension between the mastoid segment and the dome of the jugular bulb, which was 8.2 ± 2.11 mm. After perforating the jugular bulb, the depth of the second dissection field was determined by the measurement of the dimension between the mastoid segment and the IPS, which was 16.0 ± 1.60 mm.

When the posterior canal wall was taken down, the exposure improved significantly. The superiority of this exposure was achieved by decreasing the depth of the dissection field by 8.2 mm. When looking at the jugular foramen from above, the field was bordered by the round window, the inferior wall of the jugular bulb, the ICA, and the mastoid segment of the facial nerve. The

Figure 2 Right ear in surgical position. The exposure and measurements after a canal wall down procedure and skeletonization of the internal carotid artery (ICA) and internal jugular vein (IJV) are seen. An Adson forceps indicates (**) the jugular foramen. The inferior petrosal sinus (IPS) (*) is also visible. Arrow 1: distance between the promontory and the inferior wall of the jugular bulb. Arrow 2: distance between the ICA and the mastoid segment of the facial nerve.

superoinferior dimension between the RW and the inferior wall of the jugular bulb was 13.2 ± 6.12 mm, and the anteroposterior dimension between the ICA and mastoid segment of the facial nerve was 12.2 ± 2.69 mm.

DISCUSSION

Management of jugular foramen tumors requires thorough anatomical knowledge of the region. The degree of temporal bone pneumatization determines the anatomical relationship of the vascular, neural, and bony structures. It is helpful to have some idea of the precise dimensions of this exposure

and its variations before attempting a resection because there can be limitations.

The fallopian bridge technique is a trade-off between surgical exposure and facial nerve function. By leaving the mastoid segment of the facial nerve in situ, the dissection field is divided into two almost equal parts. When the posterior canal wall is retained intact, there are two entrances to the jugular fossa, anterior and posterior, with the anterior space being significantly smaller. Anteroposterior and superoinferior dimensions of this space were 6.3 mm and 4.4 mm, respectively. Enlargement of the dimensions of the anterior space could only be achieved by violating the posterior canal wall. The position of the inferior ring of the tympanic bone has an influence on the dimensions of the space. However, anteroposterior and superoinferior dimensions of the posterior dissection space were 8 mm and 11.7 mm, respectively. Before perforating the jugular bulb, the depth of the first dissection field was 8.2 mm. If the facial nerve had been mobilized anteriorly, the superoinferior dimension would have remained the same, but the new anteroposterior dimension would have been enlarged to 14 mm.

The posterior canal wall was the only other structure that limited the dissection field when the facial nerve was in situ. Some authors have stated that even if the facial nerve is mobilized anteriorly, the exposure is still limited.⁵ An intact canal wall procedure is not recommended for tumors with significant anterior extension. In this study, removal of the posterior canal wall improved the exposure considerably. It facilitated dissection anterior to the facial nerve. The anteroposterior dimension of this field was 12 mm, and the superoinferior dimension was 13 mm. These measurements show that preservation of the posterior canal wall hinders the exposure.

Similar measurements were performed in a study that investigated the differences in three anterior facial nerve rerouting techniques. In that study, the distance between the mastoid segment and the sigmoid sinus was 7 ± 1.78 mm, and the distance from the mastoid segment to the jugular bulb (depth of the dissection field) was 6.7 ± 1.72 mm. The distance between the facial

Table 1 Distances Between Anatomic Boundaries

Anatomic Boundaries	Distance	
	Mean $\pm$ Standard Deviation (mm)	Minimum-Maximum (mm)
PSCC to stylomastoid foramen (superoinferior dimension of the posterior dissection space)	11.7 $\pm$ 2.08	7.5–14.1
Mastoid segment to sigmoid sinus (anteroposterior dimension of the posterior dissection space)	8.0 $\pm$ 2.95	3.5–11.7
Lower boundary of extended facial recess approach to lower boundary of anterior dissection space (superoinferior dimension of the anterior dissection space)	6.3 $\pm$ 2.49	3.6–10.5
Posterior canal wall to mastoid segment (anteroposterior dimension of the anterior dissection space)	4.4 $\pm$ 1.03	3.2–5.8
Mastoid segment to dome of jugular bulb (first depth of the dissection field)	8.2 $\pm$ 2.11	3.4–12.7
Mastoid segment to IPS (second depth of the dissection field)	16.0 $\pm$ 1.60	13.6–18.5
Promontory to inferior wall of the jugular bulb	13.2 $\pm$ 6.12	7.5–22.2
ICA to mastoid segment	12.2 $\pm$ 2.69	7.4–16

PSCC, posterior semicircular canal; IPS, inferior petrosal sinus; ICA, internal carotid artery.

nerve and the carotid genu was 8.05 ± 2.27 mm.⁵ In another study, the distance between the facial nerve and the jugular bulb was 5.18 ± 1.69 (range, 2 to 7.5 mm). The distance of the sigmoid sinus from the facial nerve was 6.1 ± 2.29 mm (range, 3 to 10 mm).² All these results were similar to those recorded in this study.

The findings of this study imply that tumor dissection is better accomplished through the posterior dissection space rather than the anterior space. In other words, the surgeon must accomplish the resection through a space that measures just 11 mm $\times$ 8 mm. These dimensions might be reduced to 7.5 mm $\times$ 3.5 mm if the temporal bone is poorly pneumatized. The anterior dissection space serves only to improve visualization and orientation of the jugular bulb. This space measures 4.4 mm $\times$ 6.3 mm and is neither large enough for tumor dissection nor instrumentation. The depth, 8 to 16 mm, should not be ignored either; especially with the posterior ear canal in place, middle ear exposure is very limited. Overall, the authors consider that the fallopian bridge technique is a useful addition to the surgical armamentarium for jugular foramen tumors but should be confined to jugular fossa tumors with limited middle

ear extension and certainly not to those involving the ICA.

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