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Endoscopic Submandibular Retropharyngeal Approach to the Craniocervical Junction and Clivus: an Anatomic Study

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■ INTRODUCTION: **Surgery of the craniocervical junction (CCJ) and clivus is technically demanding. For many years, we have used the submandibular retropharyngeal approach for surgery of the upper cervical spine, especially hangman fracture. We hypothesized that submandibular gland resection could offer a significant cranial enlargement of the operative field, up to the clivus. Our aim in this work was to assess the feasibility of an endoscope-assisted retropharyngeal approach to the CCJ and clivus.**

■ METHODS: **Eight anatomic specimens were used, including 4 silicon-injected specimens. We performed a submandibular retropharyngeal approach with gland resection, and then we exposed the CCJ and clivus. We drilled the C2 vertebral body, odontoid process, C1 anterior arch, and the clivus. We noted 8 anatomic landmarks that were easily identified on each anatomic specimen. These measurements were designed to quantify the exposure of the clivus and CCJ after bone resection.**

■ RESULTS: **A submandibular approach was feasible in all specimens. The main dimensions of the area of dural exposure after bone drilling were as follows: mean width between C1 lateral masses, 19 mm (range, 17—20 mm); at the tip of the clival window, 18 mm (range, 16—20 mm); distance between the C3 vertebra and the tip of the window within the clivus, 57 mm (range, 55—60 mm).**

■ CONCLUSIONS: **An endoscopic submandibular retropharyngeal approach provides a simple and straightforward access to the CCJ. It also conveniently exposes the clivus. This technique could be added to the techniques used for this difficult surgery.**

INTRODUCTION

Surgery of the craniocervical junction (CCJ) is challenging for neurosurgeons because it is a relatively rare condition and because its approach is technically demanding. A standard Smith-Robinson anterior cervical approach is not convenient because the access is too lateral and too tangential to the upper cervical spine. Its upper limit is approximately the lateral horn of the hyoid bone. It does not allow an orthogonal access to the cervical spine above C4.

Transoral surgery, initially described by Fang and Ong,[1] provides an orthogonal and direct access to C1 and C2, but the lateral exposure is limited, and the rate of complications, especially infectious, is significant. Extended transoral approaches have been proposed to enlarge the exposure caudally,[2] but glossotomy and mandibulotomy are fraught with risks and technical difficulties.

For this reason, a retropharyngeal approach could be an interesting alternative. Southwick and Robinson[3] gave the first description of this technique. Their followers, in line with McAfee et al.,[4] mainly used this approach to access the upper cervical spine. Our own experience with a retropharyngeal approach was based on C2-C3 fusion procedures for hangman fracture with C2-C3 instability. Nevertheless, several investigators[5-8] in the past had reported limited but relevant experience with surgery of the clivus using a retropharyngeal approach.

Key words
- Chordoma
- Clivus
- Craniocervical junction
- Endoscopic surgery
- Retropharyngeal approach
- Skull base
- Upper cervical spine

Abbreviations and Acronyms
CCJ: Craniocervical junction
ENT: Ear, nose, and throat
VA: Vertebral artery

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In our experience, we had observed that submandibular gland resection could offer a significant cranial enlargement of the operative field, as recently suggested by Skaf et al.[9] Moreover, the use of an endoscope could also make the procedure more convenient and improve visualization in the depth of the surgical field. Based on these considerations, we proposed assessing in a cadaveric study the feasibility and reliability of a retropharyngeal approach to the CCJ under endoscopic control and to quantify the surgical exposure that could be reached in practice.

METHODS

Dissections

Eight anatomic specimens (5 women, 3 men) without obvious cervical disease, including 4 injected specimens, were dissected. The surgical procedure was conducted using an endoscope (Karl Storz GmbH, Tuttlingen, Germany), and standard microneurosurgical instruments. Bone drilling was performed using a Midas Rex Legend high-speed drill (Medtronic Inc., Minneapolis, Minnesota, USA).

Surgical Procedure

The head was positioned in slight extension and rotated toward the left by approximately 15°–30°. We performed a U-shaped incision arching 4–5 cm below the mandible (Figure 1), to avoid injury to the marginal mandibular branch of the facial nerve (Figure 2). The platysma muscle was incised, and then, the muscle flap was rolled superiorly. The carotid artery was exposed. The superior thyroid and lingual arteries were dissected and ligated if necessary.

At this stage, the submandibular gland was exposed. The facial vein, which is located at the upper and outer part of the submandibular gland, was ligated. Then, we removed the submandibular gland. Mobilization and upward reflection of the gland exposed the hypoglossal nerve medial to the tendon of the digastric muscle. The posterior border of the mylohyoid muscle was identified and retracted anteriorly. This mobilization exposed the Wharton duct, which was ligated. The lingual nerve was exposed and mobilized upward after section of the fibers entering the submandibular gland. This procedure allowed the complete mobilization and removal of the submandibular gland (Figure 3).

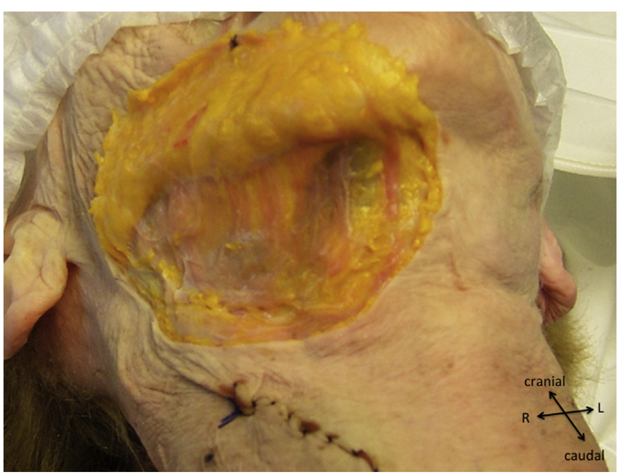

Figure 1. U-shaped skin incision. Skin flap is rolled upward. L, left; R, right.

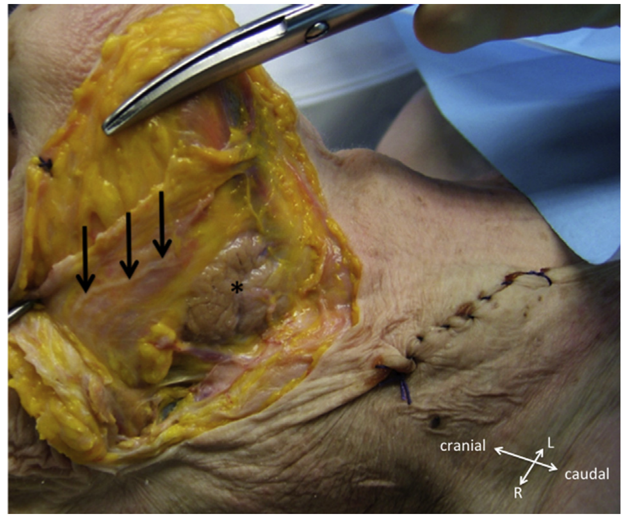

Figure 2. Muscle flap is rolled upward. See the mandibular branch of the facial nerve (*arrows*) and the submandibular gland (*). L, left; R, right.

At this stage, we observed the submandibular triangle formed by the lower edge of the mandible and the anterior and the posterior belly of the digastric muscle joined at their apex by digastric tendon. The hypoglossal nerve was identified. The mylohyoid muscle was retracted anteriorly to give direct access to the retropharyngeal space. The retropharyngeal space was gently dissected. A retractor was introduced under the lower edge of the mandible, and then a rigid 30° endoscope (Figure 4). We identified the anterior tubercle of C1 (Figure 5), indicating the midline. The longus colli muscles were detached from the vertebrae, and the C2-C3 intervertebral disc was exposed. At this stage, the working area extended to the anterior arch of C1. The longus colli muscles were detached and reflected laterally, thus exposing C2 (Figure 6) and C1 (Figure 7). The mucosa was detached to the spheno-occipital synchondrosis and base of the vomer. A surgical swab was tailored and introduced to protect the mucosa. Under endoscopic control, the C2-C3 intervertebral disc was removed.

The C2 vertebral body was carefully hollowed out until only a transparent posterior cortical rim remained (Figure 8). The dura was then exposed using a small rongeur (Figure 9). The anterior arch of C1 was drilled (Figure 10) as far as the lateral masses and the C0-C1 and C1-C2 joints. The alar and apical odontoid ligaments were resected, and the odontoid process was removed en bloc. The transverse atlantal ligament was removed using a small rongeur. The dura was thus exposed between the C2-C3 intervertebral disc and the foramen magnum (Figure 11). The anterior aspect of the foramen magnum was opened, and the clivus was carefully drilled (Figure 12).