3D Endoscope-Assisted Anatomy of the Foramen Magnum and Cranio-Vertebral Junction Through a Far Lateral Approach – A Technical Note

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Introduction

The far lateral approach is commonly used in neurosurgical practice for the removal of lesions localized at the the cranio-vertebral junction (CCJ). There remains a lack of available endoscopic anatomical data. The anatomy, as seen through an endoscope, takes on a different perspective, and needs to be studied in detail in order to achieve familiarization with this different surgical perspective.

Table 1. Anatomic Compartmentalization of the Exposed Intradural Structures.

ANATOMIC COMPARTMENTALIZATION OF THE EXPOSED INTRADURAL STRUCTURES

	ANTERIOR-MEDIAL		MIDDLE		POSTERIOR-LATERAL
CRANIAL COMPARTMENT	NERVOUS: CN VI VASCULAR: LATERAL SIDE OF THE BA, MEDIAL POSTOMEDULLARY PORTION OF THE AICA	POSTERIOR WALL OF THE IAC	NERVOUS: CN VII-VIII COMPLEX VASCULAR: POSTO-MEDULLARY PORTION OF THE AICA, SUBARCUATE ARTERY, LABYRITHINE ARTERY, VEIN OF POSTO-MEDULLARY SULCUS	ANTERIOR WALL OF THE IAC	BASAL CISTERN
	UPPER MARGIN OF THE JUGULAR FORAMEN				
	NERVOUS: CN XII VASCULAR: ORIGIN OF THE PICA, VA-BA UNION	POSTERIOR WALL OF THE JUGULAR FORAMEN?	NERVOUS: CN IX, X AND XI. VASCULAR: TONSILLO-MEDULLARY SEGMENT OF THE PICA	POSTERIOR WALL OF THE CN XII FORAMEN	BASAL CISTERN
	UPPER MARGIN OF THE FORAMEN MAGNUM				
	ANTERIOR-MEDIAL				POSTERIOR-LATERAL
SPINAL COMPARTMENT	VASCULAR: UPPER COURSE OF VA, ANTERIOR SPINAL ARTERY AND ITS BRANCHES	ANTERIOR-MEDIAL LIMIT OF THE OCCIPITAL CONDYLE			NERVOUS: ROOTLETS OF CN XI, ROOTLETS OF THE C1 AND C2 SPINAL NERVES VASCULAR: ENTRANCE OF THE VA THROUGH THE FORAMEN MAGNUM, ORIGIN OF THE POSTERIOR SPINAL ARTERY. OTHER: DENTATE LIGAMENT

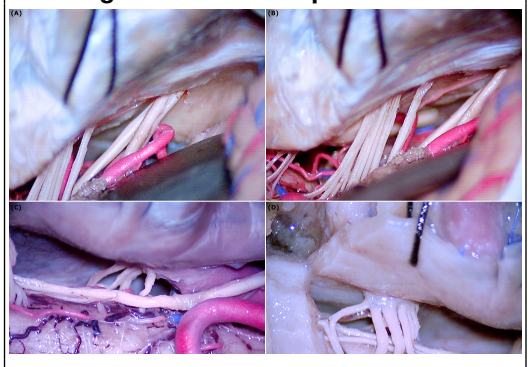
Methods

A conventional far lateral approach was performed on 6 preserved cadaveric heads (12 sides. On six sides a partial condylectomy was performed, and on six sides the approach was completed with resection of the jugular tubercle. In order to properly assess the exposure of specific major anatomic and neurovascular structures, as seen with the aid of the 3D endoscope, the intradural anatomy of the exposed CCJ was divided in eight compartments (Table 1): three superior cranial compartments (anterior-medial, middle and posterior-lateral), three inferior cranial compartments (anterior-medial, middle and posterior-lateral), and two spinal compartments (anterior-medial and posterior-lateral).

Results

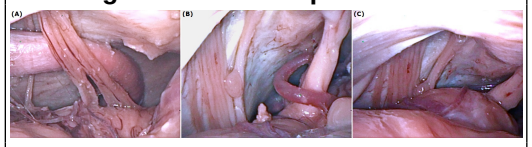
Our study provided a detailed description of the endoscopic anatomy of the cranio-vertebral junction. The anterior-medial compartments towards the midline were difficult to explore using the microscope alone (Figure 1) and required the aid of the endoscope. The 3D endoscope (Figure 2) provided general circumferential visualization of the anatomical structures, as well as visualization of the more lateral compartments (Table 1). In addition, use of the 3D endoscope allowed for better perception of the depth of the field as compared to the conventional 2D endoscope. Our study also identified optimal and safe surgical corridors for insertion of the endoscopic probe. These corridors provide a safe entry point for proper visualization of deeper structures, however these corridors are too narrow to permit surgical maneuvers.

Figure 1. Microscopic Photos.



(A,B) CN VII-X, CN XII (B), the anterior inferior cerebellar artery, and the choroid plexus are visible. (C,D) The spinal component of CN XI, rootlets of C1 (C), the rootlets of C2 (D), and the posterior inferior cerebellar artery (C) are visible.

Figure 2. Endoscopic Photos.



(A) The vertebral artery and CN XII rootlets are visible. (B,C) The anterior inferior cerebellar artery is seen wrapped around CN VII-VIII. CN IX-XI and the flocculus are also visible.

Table 2. Structural Visualization by Compartment.

Anatomic Compartmentalization	Microscope Visualization	Endoscopic Visualization
Cranial		
Antero-Medial Compartment		
CN VI	+*	+
CN XII	+*	+
Lateral Side of BA	+	+
Medial Pontomedullary Portion of AICA	±	+
Origin of PICA	±	+
VA-BA Union	±	+
Middle Compartment		
CN VII-VIII Complex	+*	+
CN IX	+*	+
CN X	+*	+
CN XI	+*	+
Pontomedullary Portion of AICA	±	+
Subarcuatre Artery	±	+
Labyrithine Artery	±	+
Vein of Ponotmedullary Sulcus	±	+
Tonsillo-Medullary Segment of PICA	±	+
Postero-Lateral Compartment		
Basal Cistern	+	+**
Spinal		
Anterior-Medial Compartment		
Upper Course of VA	+	+
Anterior Spinal Artery	±	+
Posterior-Lateral Compartment		
Rootlets of CN XI	+	+**
Rootlets of C1 and C2	+	+**
VA in Foramen Magnum	+	+**
Origin of Posterior Spinal Artery	+	+**
Dentate Ligament	+	+**

+, positively visualized; –, not visualized: ±, partially or occasionally visualized.
*Visualized mainly in the lateral aspect;
**Technically possible although adequately visualized by the microscope alone.

Conclusions

The use of a 3D endoscope allows for better visualization of the surgical compartments towards the midline and for better in-depth surgical exploration of each intradural compartment. Despite these promising results, the 3D probe is still too large and restricts surgical maneuvers. Further development of this tool is required to obtain complete data about its use through a far lateral approach.

Learning Objectives

By the conclusion of this session, participants should be able to (1) describe the anatomy of the foramen magnum and cranio-vertebral junction and (2) discuss the use of the of the 3D endoscope with a far lateral approach.

References

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