



Radiological Study of the Carotid-Clival Window and Its Application in Endoscopic Endonasal Expanded Approaches

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■ **BACKGROUND:** The surgical approach to the petrous apex (PA) and petroclival junction (PCJ) remains a challenge. The carotid-clival window (CCW) represents the widest window available to approach the PCJ from a mediolateral endoscopic route. Here we define the CCW radiologically in nonpathological conditions, to establish the anatomic variability of the PCJ, relate this variability to pneumatization patterns, and evaluate some technical concerns conditioned by the CCW.

■ **METHODS:** This was an analytical study of 10 multislice computed tomography scans from patients without SB pathology. Bilateral measures were taken at the roof and floor levels of the lacerum canal (LC) and its posterior projection over the PCJ (segments DE and QR). All measures were compared across different pneumatization patterns.

■ **RESULTS:** The DE and QR lengths were found to be the most important measures affecting the width of the CCW. Wide variability was observed, with a mean DE length of 8.52 mm (range, 2.4–12.8 mm) at the LC floor level and a mean QR length of 9.11 mm (range, 4.3–13.1 mm) at the LC roof level. The presence of retrocarotid pneumatization was statistically significantly associated with longer DE and QR segments. No differences were found among other pneumatization patterns.

■ **CONCLUSIONS:** The CCW varies widely among individuals. The presence of pneumatization behind the paraclival carotid represents an advantageous characteristic when planning an endoscopic approach to the PCJ.

INTRODUCTION

Approaching the petrous apex (PA)¹ and the petro-clival junction (PCJ)² remains challenging for skull base (SB) surgeons.³ That challenge is compounded by the anatomic structures involved in this region, specially the internal carotid artery (ICA)³ (Figure 1).

The approach to these regions, especially the retrocarotid space, corresponding to the petrous bone, is difficult to define endoscopically.⁴ The carotid-clival window (CCW), defined previously,⁵ represents the widest window available to approach the PA from a mediolateral endoscopic route (Figure 2). In many cases, when an endoscopic approach to this region is planned, there is an existing pathology that has modified the characteristics of the CCW. This condition may facilitate the approach. In other words, the tumor creates the pathway by itself. However, in some cases these advantageous conditions are not present, and thus gaining access to the retrocarotid space can be difficult (Figure 3). The ability to predict the size of the CCW would be important in planning and performing surgical maneuvers. Considering that these are lateral regions that are approached through a medial corridor, the use of a 30° or 45° endoscope could seem appropriate; however, the view provided by these endoscopes is less intuitive for the surgeon and can hinder bimanual dissection. In the present study, we aimed to establish the CCW in nonpathological conditions from a radiologic standpoint, to analyze the anatomic variability of the PCJ in healthy individuals, and to relate that variability to different pneumatization patterns. Moreover, we analyzed, from theoretical and geometrical standpoints, whether given a specific anatomic configuration, we could endoscopically visualize the entire width of the retrocarotid space under the view provided by a 0° endoscope.

Key words

- Carotid-clival window
- Endonasal approach
- Endoscopic approach
- Petroclival junction
- Petrous apex
- Retrocarotid space

Abbreviations and Acronyms

CCW: Carotid-clival window
ICA: Internal carotid artery

LC: Lacerum canal

SB: Skull base

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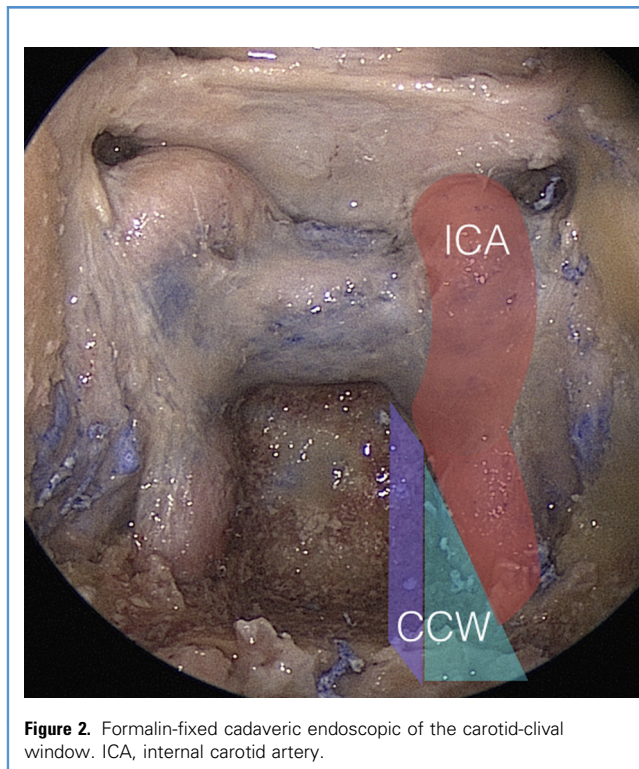
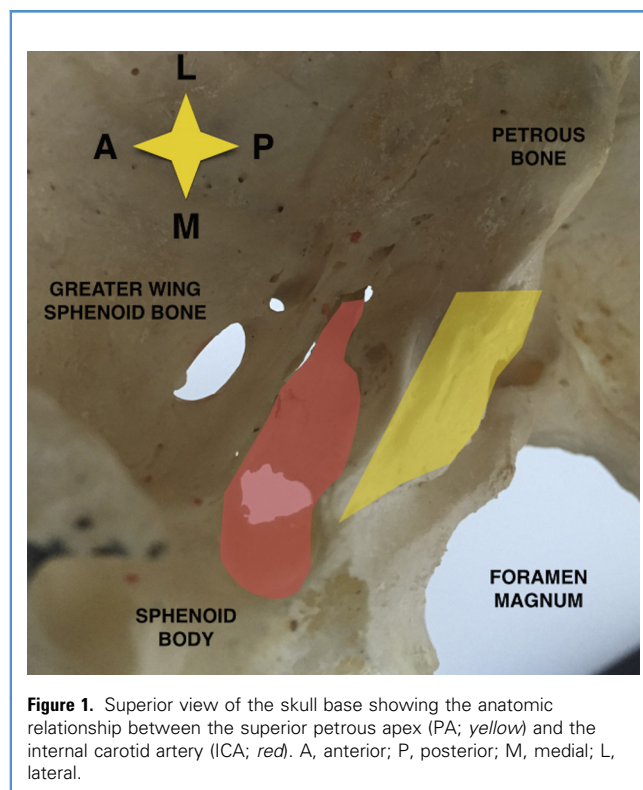
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MATERIALS AND METHODS

An analytic study was carried out on 10 multislice computed tomography scans from patients without skull base pathology. All scans were all performed following the infraorbitomeatal plane, so the measures obtained were not influenced by differences in head positioning. Equally, scans that presented an asynclitic degree $>1^\circ$ were discarded. Measures were obtained bilaterally at the roof and floor of the lacerum canal (LC) and its posterior projection over the PCJ.

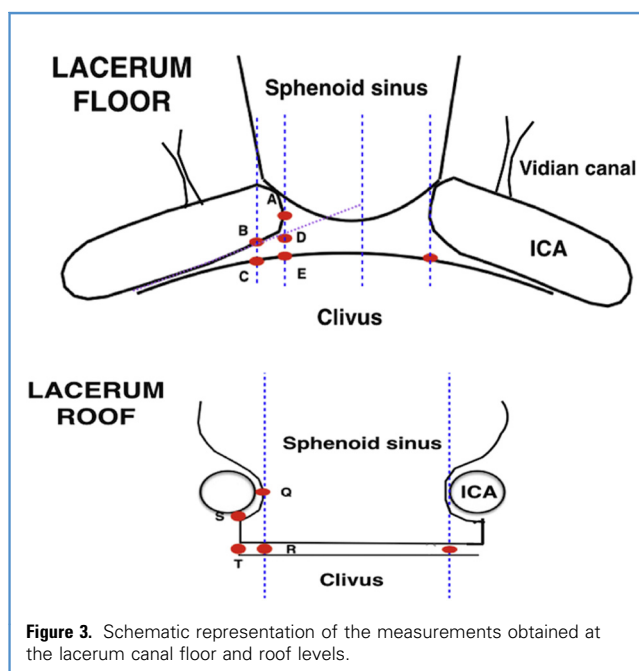
Endoscopic dissection images of formalin-fixed and latex injected cadaveric specimens were used to better illustrate the CCW (Figure 2). Radiologically, the CCW (at the LC floor and roof) was defined as the hypotenuse of the rectangular triangle defined by the intercarotid length and the distance from ICA to the clival posterior cortical (DE and QR segments, respectively) (Figure 3). At the floor of LC, the plane of which was established at the level of the superior cortical of the vidian canal, the following reference points were used:

- A, point over the orthogonal to the medial edge of the carotid
- B, last point of contact of the carotid in relation with a line drawn over the cortical of the posterior lacerum
- C, point over the orthogonal across B, at the level of the cortical of the posterior clivus
- D, intersection points of the line drawn along A and the cortical of the posterior lacerum
- E, point resulting from the orthogonal over A and D at the level of the clivus posterior cortical.



At the roof of the LC, the following reference points were used:

- Q, point over the orthogonal to the medial edge of the carotid.
- S, point over the posteromedial edge of the carotid.



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