Defining the Caudal Limits and Predictors of the Endoscopic Endonasal Approach to the Craniovertebral Junction: A Cadaveric Study

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Introduction

- The endoscopic endonasal approach (EEA), has become the preferred alternative to traditional open and transoral approaches to the ventral craniovertebral junction (CVJ) region. However, preoperative prediction of the limitations of caudal reach remains challenging.
- This cadaveric study aimed to quantify the CVJ area of exposure and access afforded by the EEA, evaluate the accuracy of previously described radiographic anthropometric lines, and identify the lowest limit of the EEA corridor.

Methods

- Endoscopic endonasal dissections of the CVJ were completed in 35 cadaveric specimens. The area of exposure (AoE) and caudal-most reach were measured using a navigation system. Radiographic measurements included:

1. Distance of the odontoid process from the hard palate
2. Length of the hard palate
3. Distance of the lowest point reached from the hard palate level
4. Nasopalatine line (NPL) angle
5. Nasoaxial line (NAxL) angle
6. Nostril-hard palate line (NTL) angle
7. Rhinopalatine line (RPL) angle

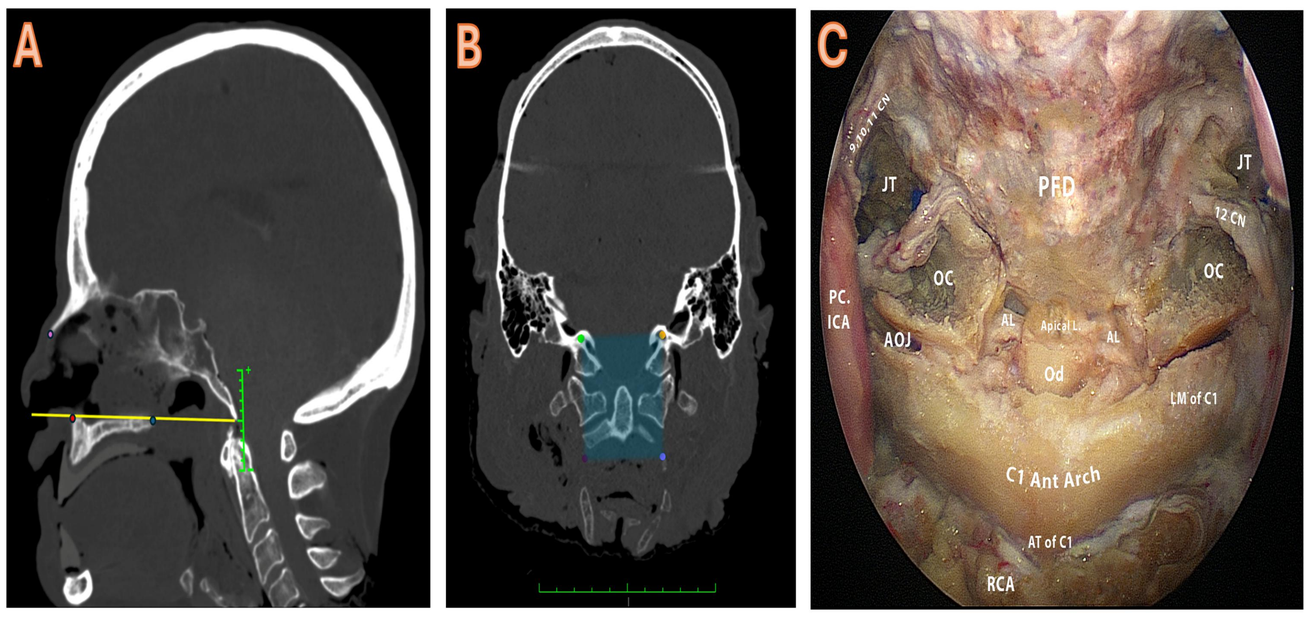

Figure 1. **A.** Sagittal midline view. The rhinion (pink point) marks the nasal bone tip. The hard palate is represented by a yellow line connecting the anterior (red point) and posterior (blue point) nasal spines. A green scale indicates positions relative to the hard palate, with negative values below and positive values above. **B.** Area of exposure measurement. Upper fixed points are centered on the jugular tubercles bilaterally. Lower variable points represent the maximum caudal reach of the navigation probe in the same sagittal plane as the jugular tubercles on each side. **C.** Endoscopic endonasal view of the craniovertebral junction post-dissection.

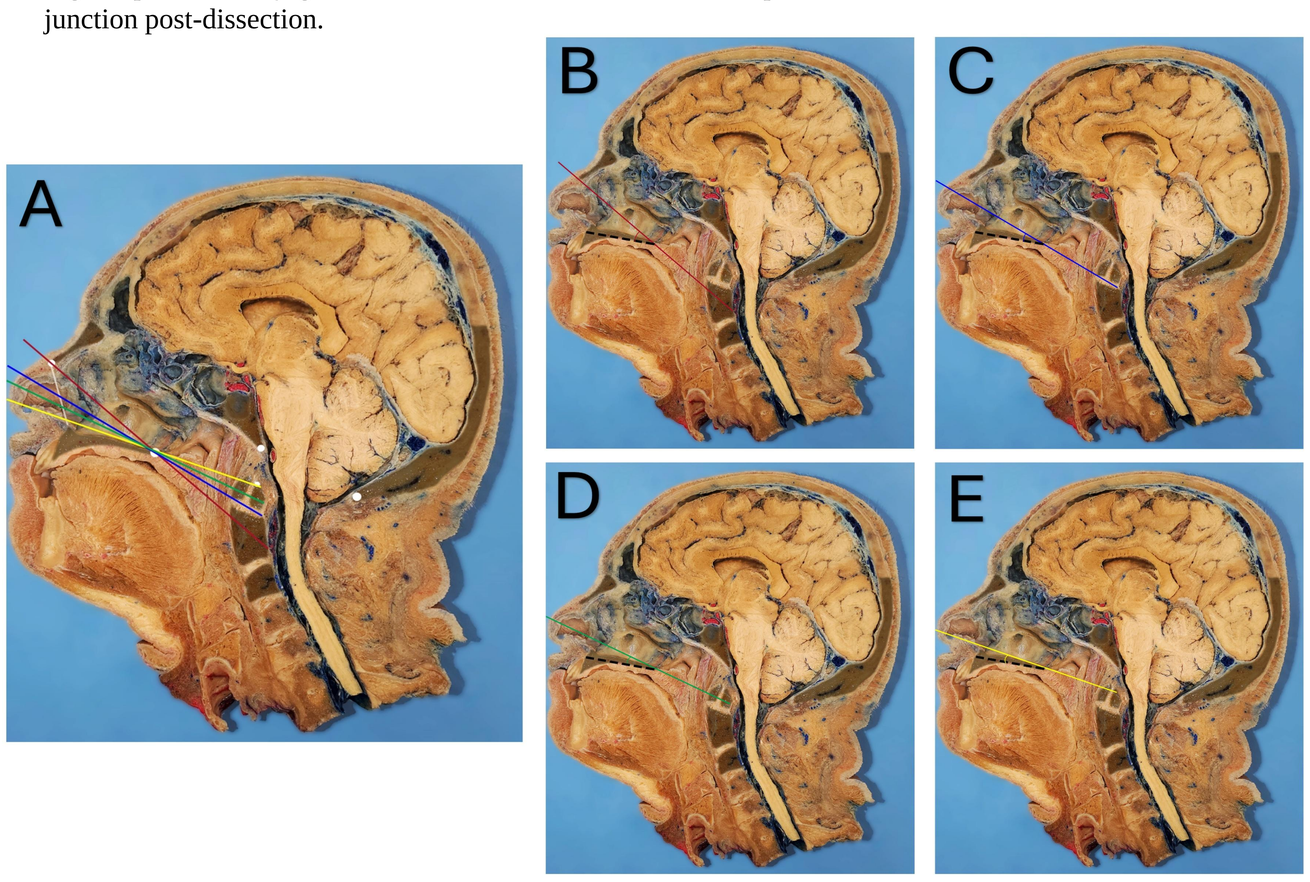

Figure 2. Radiographic caudal predictive lines and associated angles. **A.** Illustration of all radiographic caudal predictive lines described in the literature, showing their start points and relationships. Lines: NasoPalatine (red), NasoAxial (blue), RhinoPalatine (green), and Nostril (yellow). **B, C, D, E.** Calculated angles at the posterior nasal spine level relative to the hard palate line (dashed black line).

Results

Table 1. Quantitative Measurements Obtained from CT Scan Images and Navigation System

Measurements	Mean (SD)
Distance of Odontoid Process from Hard Palate Level (mm)	-5.67 (6.42)
Distance from Posterior Nasal Spine to C1 Arch (mm)	32.53 (3.84)
Hard Palate Length (mm)	49 (4.78)
NPL Angle (degree)	29 (4.52)
NAxL Angle (degree)	17.47 (3.48)
NTL Angle (degree)	14.43 (3.81)
RPL Angle (degree)	12.55 (2.65)
CVJ Area of Exposure (mm²)	931.22 (79.36)
Distance of Lowest Point Reached from the Hard Palate Level (mm)	(1.24)9.47

Table 2. Quantitative Measurements Obtained from CT Scan Images and Navigation System

	Pearson's r	95% CI		p-value
		Lower	Upper	
NPL Angle	-0.521	-0.728	-0.221	**0.001**
NAxL Angle	-0.538	-0.739	-0.249	**0.001**
NTL Angle	-0.241	-0.532	0.100	0.162
RPL Angle	-0.500	-0.714	-0.201	**0.002**

Table 3. Simple Linear Regression Analysis of Factors Influencing the Craniovertebral Junction Area of Exposure.

	Pearson's r	95% CI		p-value
		Lower	Upper	
Distance from Posterior Nasal Spine to C1 Arch	-0.110	-0.427	0.232	0.531
Hard Palate Length	-0.416	-0.658	-0.079	**0.013**
NPL Angle	0.155	-0.187	0.465	0.372
NAxL Angle	0.068	-0.272	0.392	0.699
NTL Angle	-0.019	-0.350	0.316	0.914
RPL Angle	0.042	-0.295	0.370	0.810
Naso-Odontoid-Palatine Angle	-0.129	-0.444	0.213	0.459
Naso-Basion-Palatine Angle	-0.113	-0.430	0.228	0.517
Naso-Opisthion-Palatine Angle	-0.123	-0.439	0.219	0.480

Conclusion

- This anatomic study highlights the variability in CVJ anatomy and the limitations of using previously defined radiographic anthropometric lines for predicting the caudal limits of the EEA.
- Hard palate length emerged as the only reliable predictor of the surgical area of exposure via the endonasal corridor.
- Clinical studies are warranted to validate these findings and define the potential need for adjunctive surgical routes in managing complex CVJ pathologies.