

Transclival Venous Circulation: Anatomic Study

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■ **INTRODUCTION:** The clivus is a small, central area of the basal cranium with limited surgical access and high morbidity associated with pathologies of its surrounding structures. Therefore thorough knowledge and understanding of the anatomy in this region are crucial for the success of treatments and interpretation of imaging. As to our knowledge, there is no extant cadaveric examination of the transclival veins, so the present study was performed.

■ **METHODS:** Fifteen lightly embalmed adult heads underwent blue latex injection of the left and right internal jugular veins. Special attention was given to the presence or absence of transclival vessels. When transclival veins were identified, their intracranial source, point of penetration of the clivus and anterior connections were documented.

■ **RESULTS:** Ten (66.7%) specimens were found to have transclival veins. These connected the basilar venous plexus to the retropharyngeal venous plexus on all specimens. Eight of the 10 specimens had multiple transclival veins, and 2 had only 1 vessel. The majority of the transclival veins were found penetrating the clivus at its lower one third. However, 2 specimens also had transclival veins that pierced the clivus at its upper one third.

■ **CONCLUSIONS:** An improved understanding of the skull base and its venous drainage can assist clinicians and surgeons in better understanding normal, pathologic, and variant anatomy in this region.

INTRODUCTION

The clivus is the site of various pathologies including tumors and retroclival hematomas.¹⁻³ Due to the location of the clivus, thorough knowledge of its anatomy is crucial for avoiding surgical complications.¹ For example, during extended transsphenoidal surgery—involving the drilling of the clivus—or clivectomies, bleeding is a known complication with the source often originating from the cavernous sinus or basilar venous plexus.^{4,5} When local vasculature is disrupted, retroclival epidural hematomas can form, which can cause brainstem compression.³ As neurosurgeons approach the clival region, structures including the transclival veins require consideration and examination for pathologic findings. For instance, Lang⁶ reported the association of transclival veins and venous hemorrhage. Unfortunately, these structures are rarely mentioned in anatomic textbooks.⁷

The transclival vein, an emissary vein, is described as connecting the basilar venous plexus with the veins located at the inferior aspect of the skull base⁸ and inferior surface of the clivus adjacent the pharynx.^{4,9} Specifically, it is said to connect the basilar plexus with the venous plexus of the vertebral canal and inferior petrosal sinuses.¹⁰⁻¹² The transclival vein is one of many emissary veins that travel via the canals located in the occipital portion of the clivus,^{13,14} where the basiocciput and basisphenoid fuse.^{6,15}

The basilar canal, found at the basal segment of the occipital bone, may carry previous basivertebral veins originating from the upper vertebral region and which have been integrated into the skull base. These are found in approximately 8% of the population; however, the median basilar canal,¹⁶ which emerges from the midline of the basiocciput, has a prevalence of 20% in newborns and is rarely seen (1%) in adults.¹⁷ To better elucidate the veins that traverse the clivus, we examined them via intracranial and extracranial cadaveric dissection.

Key words

- Anatomy
- Clival diploic veins
- Clivus
- Emissary veins
- Transclival veins

Abbreviations and Acronyms

CDV: Clival diploic vein

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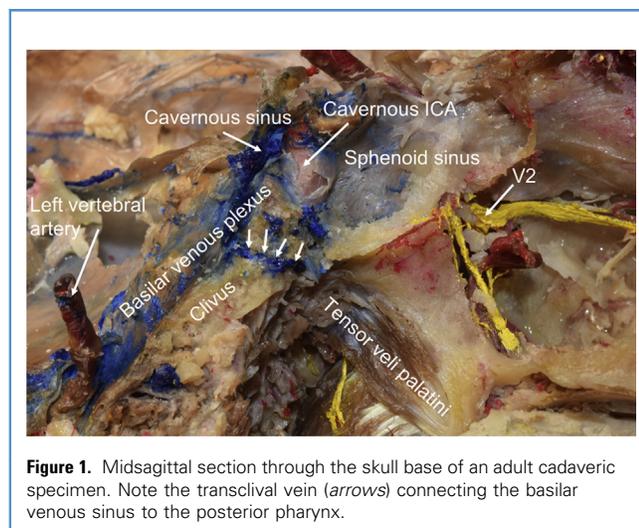


Figure 1. Midsagittal section through the skull base of an adult cadaveric specimen. Note the transclival vein (arrows) connecting the basilar venous sinus to the posterior pharynx.

MATERIALS AND METHODS

Fifteen lightly embalmed adult cadaveric heads aged 59–83 (mean 75 years) at death underwent blue latex injection of the left and right internal jugular veins. The basilar plexus was also latex injected and retracted while maintaining all transclival connections. Of the specimens, 8 were male and 7 were female. In the supine position, the calvaria was removed with an oscillating bone saw and the dura mater was opened with dissecting scissors. Next, the brain was removed and the dura mater covering the clivus was carefully elevated. Special attention was given to the presence or absence of transclival veins. When transclival veins were identified, their intracranial source was documented. The clivus was carefully chipped away with a mallet and osteotome, and the transclival vessels were traced to their anterior connection.

RESULTS

Ten (66.7%) specimens were found to have transclival veins, which connected the basilar venous plexus to the retropharyngeal venous plexus on all sides (Figure 1). A midline connection between the basilar venous plexus and retropharyngeal veins were found in all 10 specimens with 8 of the 10 specimens having multiple (2–4; mean 2.5) transclival veins (Figures 2 and 3) and 2 having only 1 vessel (Figure 4). The majority of the transclival veins were found penetrating the clivus at its lower one third. However, 2 specimens also had transclival veins that pierced the clivus at the junction of its middle and upper thirds (see Figures 4 and 5). None was found to traverse the middle one third of the clivus. No specimen was found to have intracranial pathology or grossly visible anatomic variants. No gross differences between male and female specimens were noted.

DISCUSSION

Our study found transclival veins in the majority of specimens with most being multiple. Most previous studies have only examined the bony clival canals of the clivus. It has been speculated by some

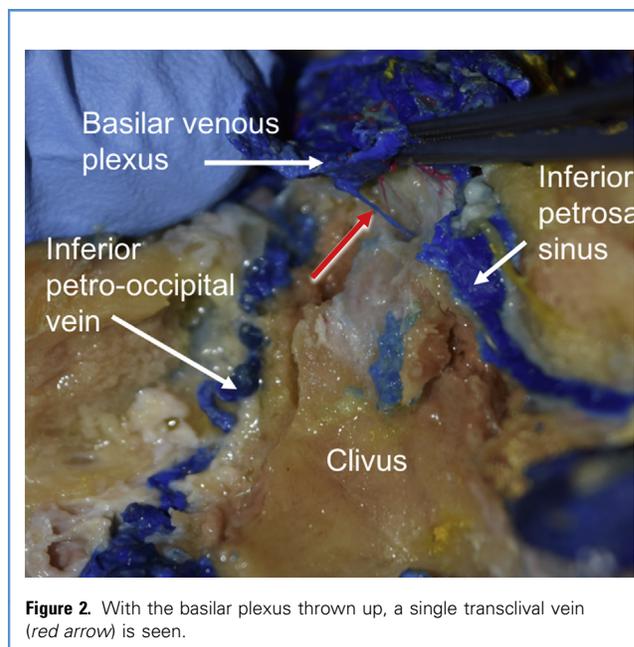


Figure 2. With the basilar plexus thrown up, a single transclival vein (red arrow) is seen.

authors that during early development, clival canals are formed by the notochord or Rathke pouch.^{10,11} However, Tubbs et al¹⁸ noted that the contents of the clival canals they studied exhibited neither pituitary nor notochordal tissues. A study conducted by Inal et al¹¹ examined the clival canal using multidetector computed tomography (MDCT) in 186 patients and identified this structure in 33.3% (n = 62) of patients. By the 11th and 12th weeks of gestation, the basiocciput undergoes ossification with final ossification occurring between the 13th and 16th weeks of fetal life with the formation of the basisphenoid.^{4,11,18–22}

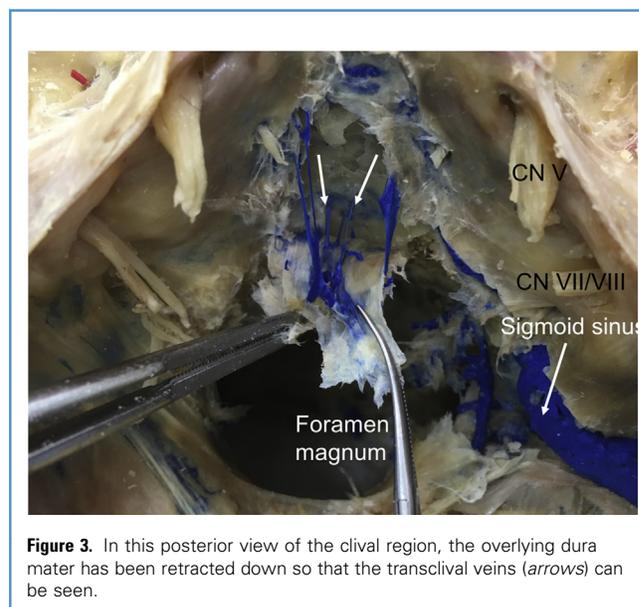


Figure 3. In this posterior view of the clival region, the overlying dura mater has been retracted down so that the transclival veins (arrows) can be seen.

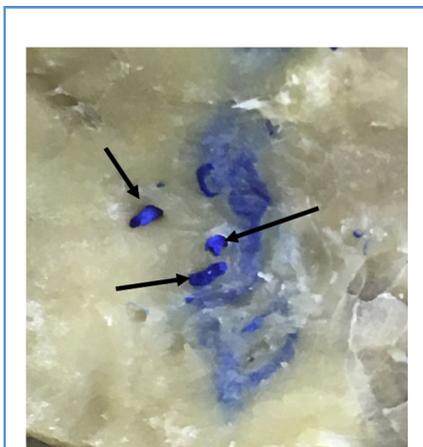


Figure 4. Another specimen following removal of the overlying dura and noting multiple transclival veins that have been transected (arrows).

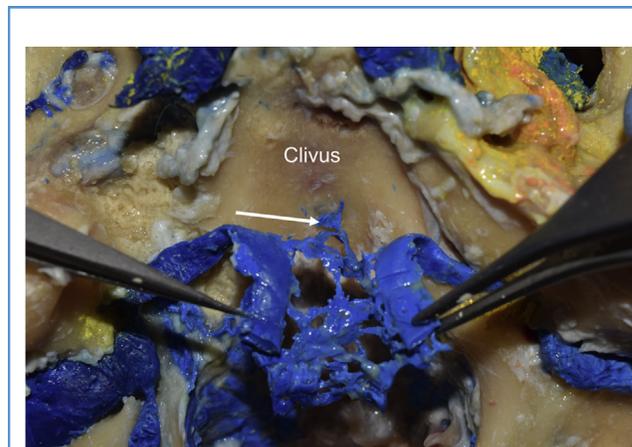


Figure 5. Posterior view of the clivus and overlying basilar plexus that has been pulled down to expose a clival vein (arrow).

Other vascular elements within the clivus include the clival diploic veins (CDVs), which necessitate differentiation from the transclival emissary veins. CDV, a longitudinal vein, connects veins such as the intracavernous sinus with the inferior petro-occipital vein.⁴ An investigation by Mizutani et al⁴ analyzed the venous channel within the clivus using MDCT digital subtraction venography of 50 unruptured aneurysms in order to provide detailed accounts of clival venous anatomy. The study found the emissary veins to be more common compared with the CDV. Half of the emissary veins were identified in the middle clivus with 9 of them connecting the inferior petrosal sinus to the inferior petro-occipital vein. Five emissary veins were located in the lower clivus, and 3 cases were in the upper clivus. Mizutani et al⁴ studied the CDV and found it in 14% of cases. The rostral end was tracked to the posterior intercavernous sinus in 2 cases and to the superior aspect of the basilar plexus in 5 cases. In 3 cases, the vein split into 2 in the middle clivus and coursed to the lower clivus inferolaterally. The CDV connected with the inferior petro-occipital vein, marginal sinus, and anterior condylar confluence and vein. Although distinct from emissary veins, understanding the collaterals of the CDV alongside emissary veins within the clivus is important during surgical procedures of the skull base.⁴

From the 15 cadavers in our present study, ten (66.7%) specimens were found to have transclival veins forming a midline and more or less sagittal connection between the basilar venous plexus and retropharyngeal venous plexus. Compared to Mizutani et al,⁴ our study found multiple transclival veins in a majority of specimens with 8/10 cases with multiple (2–4) transclival veins and 2 specimens with only 1. Mizutani et al⁴ found 2 transclival emissary veins seen on CT in 4 cases with none having multiple veins. Lastly, these authors⁴ reported that the majority of the transclival veins penetrated the middle clivus. However, our study found that these emissary veins most commonly penetrated the lower clivus. Although there were few anatomic variations noted in our study, it is imperative to take note of variations during surgical procedures in this region.

CONCLUSIONS

An improved understanding of the skull base and its venous drainage such as examined herein can assist clinicians and surgeons in better understanding normal, pathologic, and variant anatomy in this region. On the basis of our study, the transclival veins should be considered normal structures of the skull base.

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