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Tentorial Venous Sinuses: A Cadaveric Study

Murat KOCAOGLU[1], Feridun ACAR[2]

[1]Hatay Research and Training Hospital, Department of Neurosurgery, Hatay, Turkey
[2]Odak Hospital, Department of Neurosurgery, Denizli, Turkey

Corresponding author: Murat KOCAOGLU ✉ drkocaoglu@yandex.com

ABSTRACT

AIM: To present the configuration of the tentorial venous sinuses, and to determine the optimal incision zone on the tentorium cerebelli.

MATERIAL and METHODS: This study has been completed with 24 autopsied cadavers. For every cadaver, firstly, supratentorial tissues were removed and tentorial measurements were noted, superior part of the tentorial sinuses was captured, and then infratentorial tissues were removed, and all the sinuses were checked and captured.

RESULTS: Average age of the studied 24 fresh cadavers was 50 years, wherein 4 were females and 20 were males. Tentorial sinus was presented in 87% of the cases, with 45% medial, 33% lateral, and 22% in the middle third of each tentorium half.

CONCLUSION: This study showed the pattern, incidence, location, and distribution of tentorial venous sinuses and tried to find the optimum incision zone by identifying sparse areas for the venous sinuses during transtentorial surgical approaches.

KEYWORDS: Tentorial venous sinuses, Tentorium cerebelli

INTRODUCTION

Besides being a structure that protects the brain, the tentorium cerebelli (TC) collects both infra and supratentorial venous circulation. Together with the major sinuses, the tentorial venous sinuses are located at this junction. Many anatomical or clinical studies were reported about the TC since it was first described by Winslow in 1732 (25). Especially, Rhoton revealed anatomical details of posterior fossa and the TC related structures (18,21). However, several studies have been conducted about the anatomy of the tentorial venous sinuses (19,20,22,27).

Neurosurgeons often choose transtentorial approaches to reach deep brain lesions (1,8,12,14,16,23,24). Sometimes, cutting the TC is a challenge since massive venous bleeding can make a big problem during surgery. Knowledge about the presence of the tentorial venous sinuses and their importance in surgical practice is very limited.

In this study, we tried to find the optimum incision zone, which would sacrifice minimum venous sinuses during transtentorial surgical approaches, by showing the pattern, dimensions, and distribution of the tentorial venous sinuses.

MATERIAL and METHODS

This study examined 24 fresh cadavers. None of the cadavers died from head injury or intracranial causes. All were in the adult age group.

During brain autopsy, firstly, the supratentorial structures of the brain were removed, then the TC was inspected macroscopically, and the following distances were measured: 1) tentorial width (TW), the distance between the transverse-sigmoid sinus junction and the sinus rectus, and 2) tentorial length (TL), the distance between the posterior edge of each half of the TC and the ipsilateral posterior clinoid (Figure 1). Then, the presence of venous sinuses was recorded by a photograph using Nikon D5100 (NIKON, Japan) camera with a 105 mm macro lens. Concurrently, the size and dimension of the TC and location of every venous sinus were noted. Afterward, the TC was incised bilaterally from the edges, infratentorial structures were removed, and the TC was inspected again inferiorly. Every tentorial sinus was opened and checked to confirm its presence.

When we look at the literature, Muthukumar et al. conducted a study very similar to ours and, reported one of the first

Murat KOCAOGLU : 0000-0002-4276-7897
Feridun ACAR : 0000-0002-6964-087X

publications to classify tentorial venous sinuses in detail at the end of the study (20).

RESULTS

Measurements of 24 cadavers revealed TL of average 7.1 ± 0.21 cm. The maximum TL value was 7.8 cm and the minimum value was 6.8 cm. The right TW was measured as an average of 5.19 ± 0.21 cm, with a maximum of 5.6 cm and a minimum of 4.8 cm. The left TW was measured as an average of 5.21 ± 0.2 cm, with a maximum of 5.5 cm and a minimum of 4.8 cm (Table I).

The sinus patterns of 24 cadavers did not detect the tentorial sinus in 4 cases (Figure 2). The rate of sinus detected cases was 83.4%. In 20 cadavers where the sinus was detected, 49 sinuses were independent, wherein 26 were observed in the left half of the tentorium and 23 in the right half. Sinuses existed bilaterally in 14 cadavers. Only 1 sinus was detected in 5 cases. In 15 cases, 2 or more sinuses were detected (Figure 3-5).

The sinuses are mostly located in the medial regions of both tentorium halves. According to the sinus density, the medial regions have 45%, the lateral regions have 33% and the middle regions have 22% sinus density (Figure 6). The rate of sinus detected cases was 86% in the study of Muthukumar et al. and they classified the sinuses into 3, as Type I (25%), Type II (25%), Type III (50%). But they included not only the location of the sinuses, but also the places where the sinuses drain (20).

The examination of sinus extensions on the TC revealed that the tentorial sinuses do not extend to the anterior of transverse sinus–superior petrosal sinus junction, except for one case (cadaver 20). Muthukumar et al. reported that any anterior sinus was not seen to this line in their series (20). Therefore, sinuses are generally located at 3 cm from the posterior border of the TC.

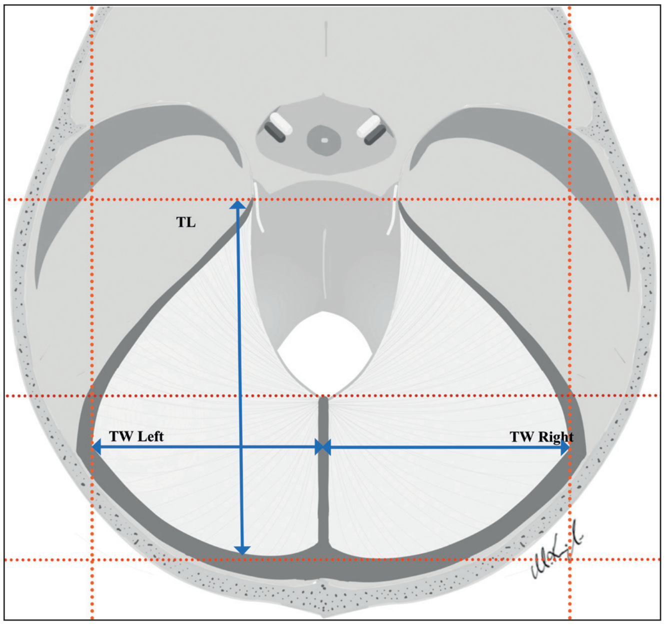

Figure 1: TL: Tentorial length, **TW:** Tentorial width.

The examination of the tentorial sinus distribution revealed that they are denser in the medial and lateral regions and are relatively less dense in the middle region. Therefore, incising at the midline at a distance of 3 cm from the posterior border on the TC will prevent the sacrification of sinuses that are not seen during surgery.

DISCUSSION

Especially neurosurgeons refer to paths and branches of major sinuses to determine their operation strategies and pay attention in planning their approaches in a way that does

Table I: Measurements of the Tentorium Cerebelli in Examined Cadavers

Case	Age, Sex	TL	TWR	TWL
1	39, M	7.2	5.1	5.2
2	30, M	7.3	5.3	5.3
3	80, F	7.0	5.0	5.1
4	60, F	7.1	5.1	5.0
5	50, M	7.4	5.2	5.2
6	23, M	7.5	5.3	5.3
7	55, M	7.0	5.2	5.2
8	85, M	7.1	5.0	5.0
9	35, M	7.1	5.1	5.1
10	34, M	7.2	5.4	5.4
11	55, M	7.0	5.1	5.2
12	59, M	7.2	5.0	5.0
13	48, M	7.1	5.4	5.3
14	51, M	7.5	5.2	5.3
15	18, M	7.4	5.3	5.5
16	63, F	7.0	5.0	4.9
17	60, M	7.2	5.5	5.4
18	74, M	7.2	5.5	5.5
19	66, M	6.8	5.0	5.5
20	57, M	7.8	5.6	5.4
21	52, M	7.0	5.5	5.5
22	58, M	7.2	4.8	4.8
23	30, F	7.1	5.0	5.0
24	18, M	7.3	5.0	5.0

***TL:** Tentorial Length, **TWR:** Tentorial Width Right, **TWL:** Tentorial Width Left.*

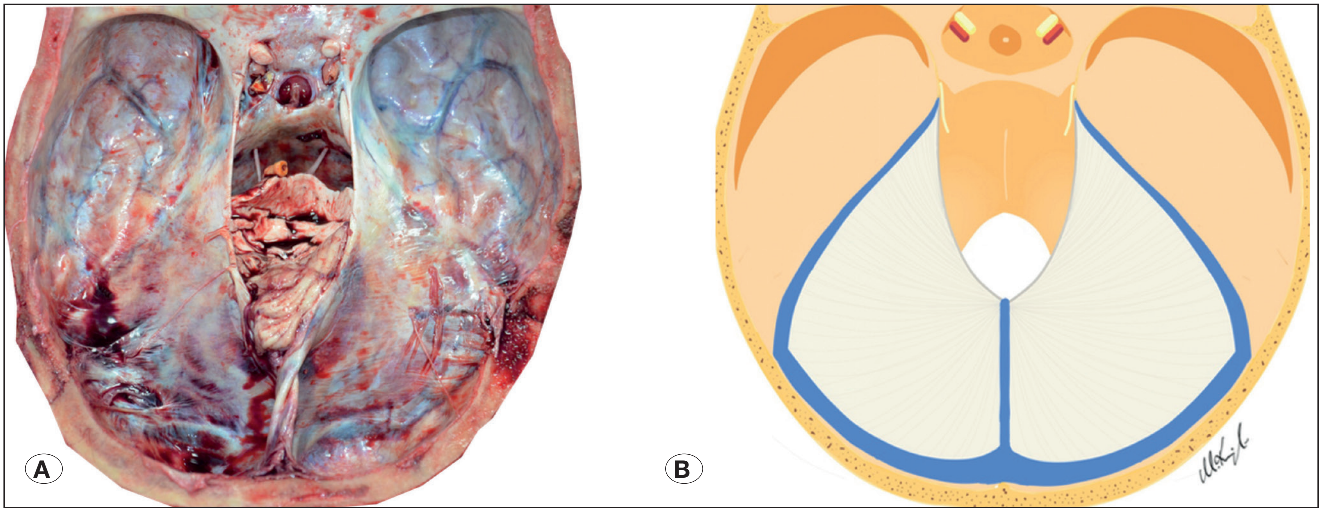

Figure 2: Dissection photo of cadaver 4 **(A)**, and its illustration **(B)** showing no tentorial sinuses.

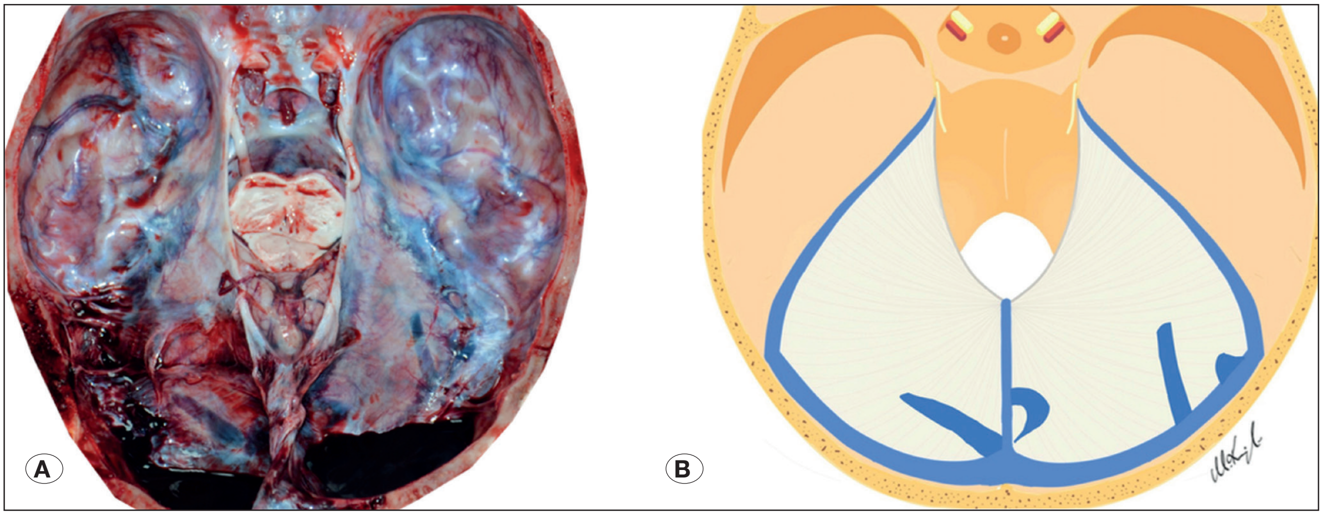

Figure 3: Dissection photo of cadaver 3 **(A)**, and its illustration **(B)** showing a medial tentorial sinus on the left side and both medial and lateral tentorial sinuses on the right side.

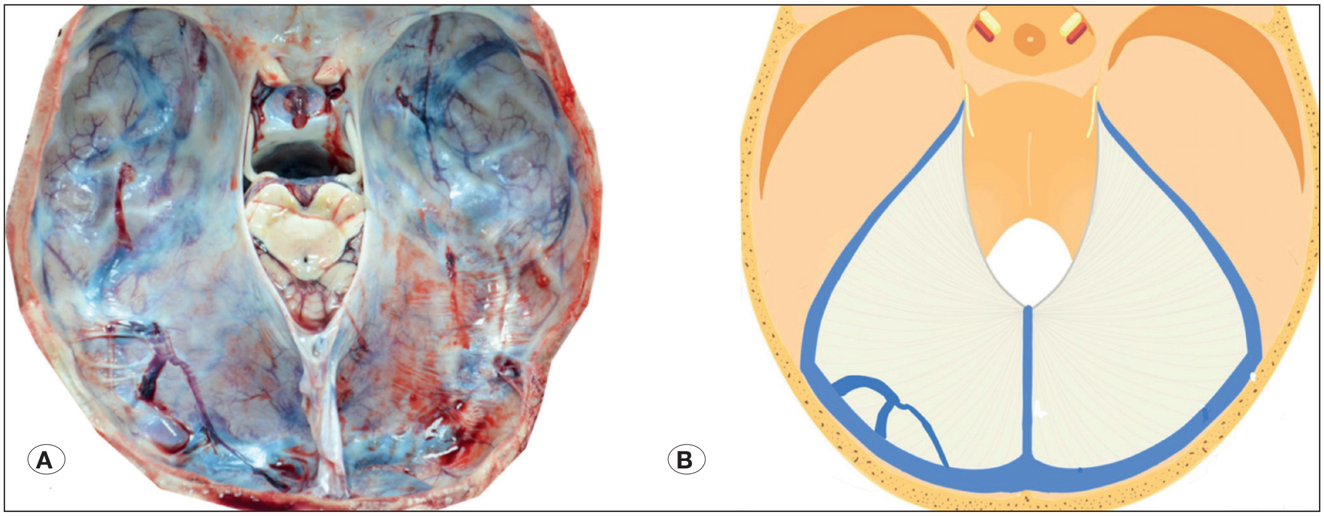

Figure 4: Dissection photo of cadaver 24 **(A)**, and its illustration **(B)** showing a middle-lateral tentorial sinus on the left side.

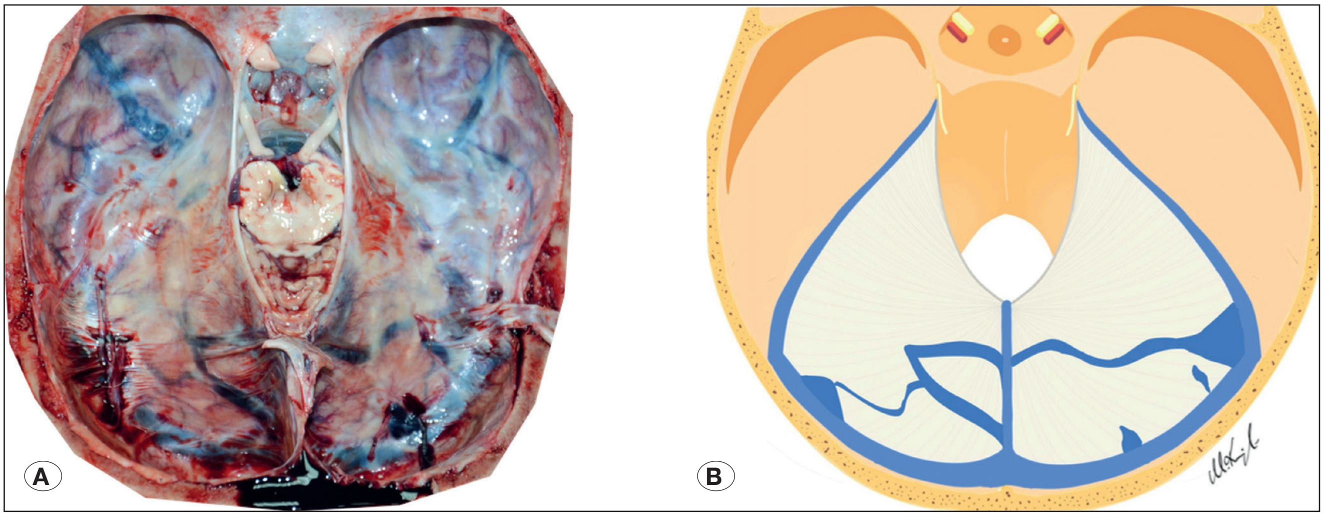

Figure 5: Dissection photo of cadaver 14 **(A)**, and its illustration **(B)** showing a ring-shaped tentorial sinus in all tentorial areas.

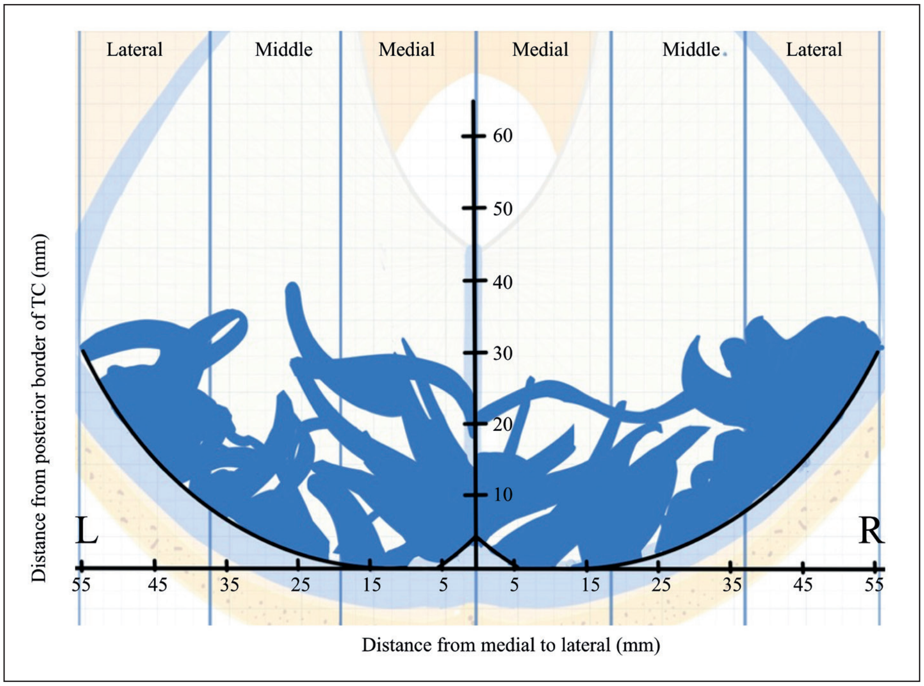

Figure 6: Graphic illustration is showing the location density of all tentorial sinuses on 48 sides. Tentorial sinuses are denser in the medial and lateral regions and relatively less dense in the middle region.

not damage these sinuses. Knowing the variations of dural venous sinuses is important to distinguish normal variations from pathological processes (27). Therefore, tentorial sinus anatomy and its variations attract more attention in the literature day by day. Particularly, the preferred transtentorial approaches to protect the cerebral cortex and the search for a safe surgical corridor make the anatomy of this region a focus of attention. These studies have intensified in recent years. For example, in 2019, Ye et al. described an endoscopic approach extending from the supratentorial to the infratentorial space (26).

Some studies were conducted about tentorial venous sinuses in the historical process. Gibbs was the first to mention the existence of venous sinus structures in the TC in 1934 (10). Later, Bisaria mentioned the presence of venous sinuses in the TC in his study, where he investigated venous sinus variations in the torcular herophile region (2). Browder et al. examined the tentorial venous sinuses with vinylite-acetone mixture injection and revealed that venous ducts were common in the TC and emphasized that, especially, the middle part of the tentorium had less dense venous sinuses (4). Braun et al. investigated the tentorial sinuses in detail anatomically and angiographically, which paved the way for the basic classification of tentorial sinuses. Braun et al. divided these sinuses into 2, medial and lateral sinuses (3).

Two studies are getting attention among all prior studies. One of these studies was reported by Matsushima et al., which examined 13 cerebellar tentoria in cadavers under a surgical microscope and classified these sinuses into 4 groups according to sinus drainage. Group 1 sinuses receive blood from the cerebrum; Group 2 sinuses drain the cerebellum; Group 3 sinuses originate in the TC itself; and Group 4 sinuses originate from a vein bridging to the tentorial free edge (19). Another study by Muthukumar et al. studied 80 fresh cadavers, where they inspected the TC for the presence of venous sinuses. Finally, they classified tentorial venous sinuses into 3 groups. Type 1 sinuses are located in the medial 1/3 of the TC and drain into the straight sinus and torcular herofili. Type 2 sinuses are located in the lateral 1/3 of the TC and drain into the transverse sinus and superior petrosal sinus. Type 3 sinuses are also located in the medial 1/3 of the TC and drain into the straight sinus, torcular herofili, and medial 1/3 of the transverse sinus, and are different from Type 1 since they are smaller and have no branching pattern (20).

The presence of tentorial sinuses has been also demonstrated in many angiographic studies (11,16,17). However, compared to anatomical studies, the presence of sinuses is significantly less common in radiological imaging since dural venous sinuses receive drainage from several different foci, but due to opaque substance that is administered to a single artery during angiography, blood flow without opaque substance from other arterial sources reduces the visibility of the tentorial sinus (9). However, advances in magnetic resonance imaging venography and computed tomography venography allow a more detailed assessment of tentorial venous sinuses than conventional angiography (6,7,12).

Sectioning the TC is a common practice to reach deep-seated lesions (10,12,15,20). Therefore, the tentorial sinuses may bleed massively or become sacrificed. In many cases, occlusion of the venous sinuses does not create a clinic due to collateral pathways. However, when major venous ducts are blocked by pathological processes, the venous sinuses in the tentorium play an important role in venous outflow; thus, sacrificing the venous sinuses can cause cerebral edema or infarction. Many cases that reveal this situation have been reported in the literature. Especially, the first examples in the literature that support the hypothesis that emphasize the importance of venous pathways in the sinus rectus obliteration were presented by Browder and Kaplan (5,13).

Our study results generally reveal a high degree of agreement with the results of other studies in the literature. However, some limitations should be noted. First, there was no any data on ethnic origins of cadavers. Second, we were able to study 24 cadavers in one year. Third, we could only work in the adult age group. Studies to be conducted on cadavers from multiple centers, different age groups and ethnic origins can reveal the sinus structures of the TC in more details.

CONCLUSION

The measurements that were obtained by measuring the distances between the reference points of the TC were used to determine the location, size, and configuration of the tentorial sinuses. The tentorial venous sinuses are relatively less dense in the middle region after 3 cm from the posterior border of the TC. Considering the distribution of the sinuses and the points where the sinuses are found will help us to avoid possible complications when deciding on the incision on the TC for lesions involving or transiting the TC.

AUTHORSHIP CONTRIBUTION

Study conception and design: FA, MK
Data collection: MK
Analysis and interpretation of results: MK
Draft manuscript preparation: MK
Critical revision of the article: FA, MK
Other (study supervision, fundings, materials, etc...): FA, MK
All authors (FA, MK) reviewed the results and approved the final version of the manuscript.

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