The Anatomical basis of venographic filling defects of the transverse sinus

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Introduction

Idiopathic intracranial hypertension (IIH) has many possible aetiological factors with grave symptoms and severe morbidity. Elevated intracranial dural sinus venous pressure is a common observation in IIH and is associated with cerebral venous flow restriction at various sites. There are indications that the anatomy of the transverse sinus may play a crucial role in the development of IIH.

The dural venous sinuses are endothelial-lined spaces between the endosteal and meningeal layers of the dura; and form where the dural folds attach[(1)]. These sinuses drain blood from the large veins on the surface of the brain. Ultimately, almost all the blood from the brain will drain through the dural venous sinuses into the internal jugular veins [(1)]. In this study we focused mainly on the anatomical basis of the transverse sinuses which pass laterally from the confluence of sinuses, grooving the occipital bones and the posteroinferior angles of the parietal bones[(1;2)].

A venographic hidden stenosis at the junction of middle and lateral third of the transverse sinus has been observed by Subramaniam et al. (2004) in patients suffering from idiopathic intracranial hypertension[(3)]. They conducted a pilot study in 10 human cadavers where 20 transverse sinuses were explored to resolve the anatomical basis of this stenosis[(3)]. Subramaniam et al. (2004) observed the presence of septa of varying sizes. They concluded that the presence of a large septum is one of the possible aetiological factors in venographic cryptic stenosis that might be involved in idiopathic intracranial hypertension[(3)]. According to Subramaniam et al. (2004), elevated intracranial dural sinus venous pressure is a common observation in IIH and is associated with cerebral venous flow restriction at various sites[(3)]. King et al. (1995) have shown that there is bilateral outflow restriction at the junction of middle and lateral third of the transverse dural sinus in patients suffering from IIH[(4)]. Tumour compression on venous sinuses has also been documented to cause cerebral venous outflow restriction[(5)].

Aim

The aim of this study was to identify the structures which may show signs of potential venographic filling defect qualities, which ultimately may lead to increased intracranial dural sinus venous pressure.

Materials and Methods

Sample

After obtaining ethical clearance (S185/2007), 39 human cadavers of both sexes were dissected in the dissecting rooms of the Department of Anatomy, School of Medicine, University of Pretoria. In addition to the dissections, post contrast CT scans of sixty three (n=63) patients were obtained retrospectively with permission from the Pretoria Academic Hospital. Information that was obtained from the patient file included: Age, sex, and digital CT with contrast medium(Figure 1). All data were kept strictly confidential.

Methodology

In the cadavers, the revealed transverse sinus septae and stenotic walls were observed in terms of number and position. The presence of all potential venographic filling defects within the transverse sinuses, such as trabeculae/septa, arachnoid granulations or stenotic walls were documented in both the cadavers and patients' post-contrast CT scans.

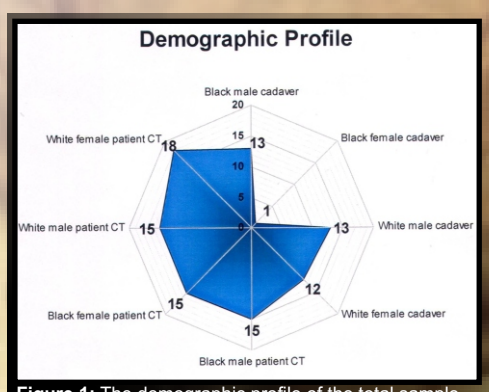

Figure 1: The demographic profile of the total sample

Results

A significant 53% of subjects presented with obstructive luminal structures, including trabeculae/septa, arachnoid granulations, or stenotic walls.

Trabeculae/Septa and Arachnoid Granulations

Trabeculae/septa were found in 29.4% of the subjects (cadavers and patients) (Figure 2). A total of 50 trabeculae/septae were found in 30 subjects. These trabeculae/septa were predominant distributed in the central (30%) and lateral (22%) thirds of the right transverse sinuses. The central third of the left transverse sinuses had the lowest incidence of all (8%) (Figure 3).

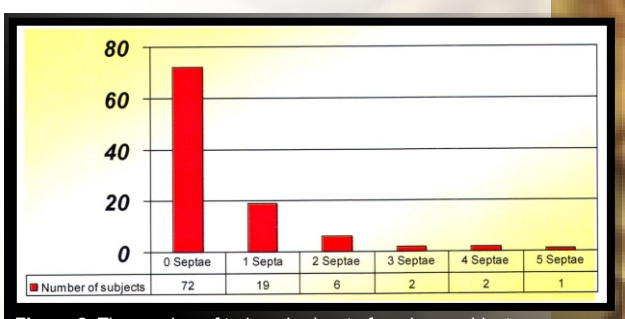

Figure 2. The number of trabeculae/septa found per subject

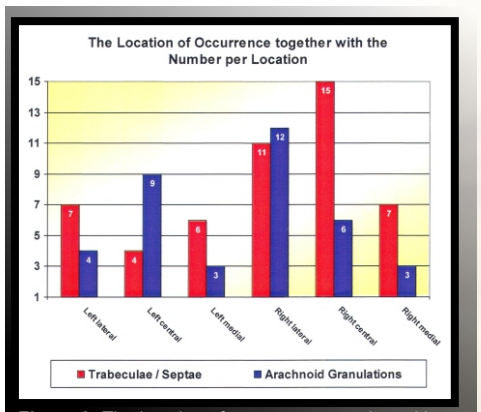

Figure 3: The location of occurrence together with the number of trabeculae/septa and arachnoid granulations found per designated location (number indicated on applicable bar)

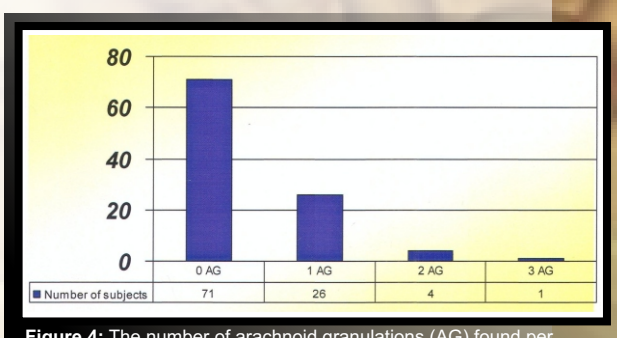

Figure 4: The number of arachnoid granulations (AG) found per subject

The right transverse sinus, as a whole, is more significantly dominant (chi-square; $p<0.01$) in trabecular/septal occurrence than the left transverse sinus.

Arachnoid granulations were found in 30.4% of subjects (cadavers and patients) (Figure 4). A total of 37 arachnoid granulations were found in 31 subjects. It was found that arachnoid granulations may co-exist with the trabeculae/septa in the same subject. The granulations were mostly dominant in the lateral (32.4%) third of the right transverse sinuses and in the central (24.3%) third of the left transverse sinuses (Figure 3). It is interesting that the left and right medial thirds of the transverse sinuses were equally the least (8.1%) dominant occurring sites of all. In general, the right transverse sinus is significantly (chi-square; $p<0.05$) more dominant in arachnoid granulations occurrence when compared to the left transverse sinus.

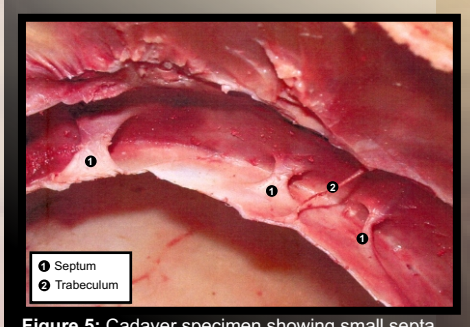

Figure 5: Cadaver specimen showing small septa together with a sting-like trabecula.

When considering both of these venographic fillings defects collectively, statistical evidence shows that the right transverse sinus is at higher risk for demonstrating potential venographic filling defects. These venographic filling defects shows good correlation between sexes (Pearson coefficient = 0.880), however, these filling defects appear not to be significantly different (chi-square, $p>0.05$) when compared between sexes.

Morphologically, the cadaver study revealed the trabeculae as thin string-like structures, yet solid and strong. The implantation sites of these trabeculae appear a little broader and thicker (Figure 5). Septa of variable sizes were observed, from small "pillar"-like structures to large broad structures (Figures 5 and 6). Like the trabeculae, the implantation sites of the smaller septa appear to be broader and thicker and bear a resemblance to "pedestals" for these "pillar"-like structures. Radiologically, the postcontrast CT scans revealed typical filling defects in septal or granular shapes, relevant to the specific structure (Figure 7).

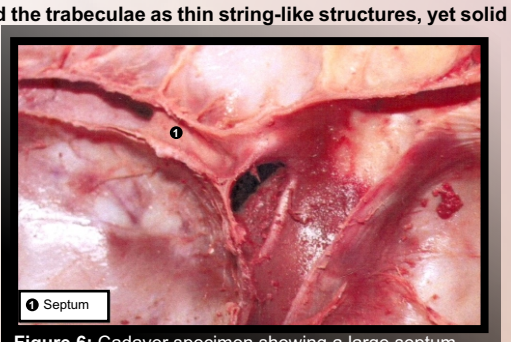

Figure 6: Cadaver specimen showing a large septum

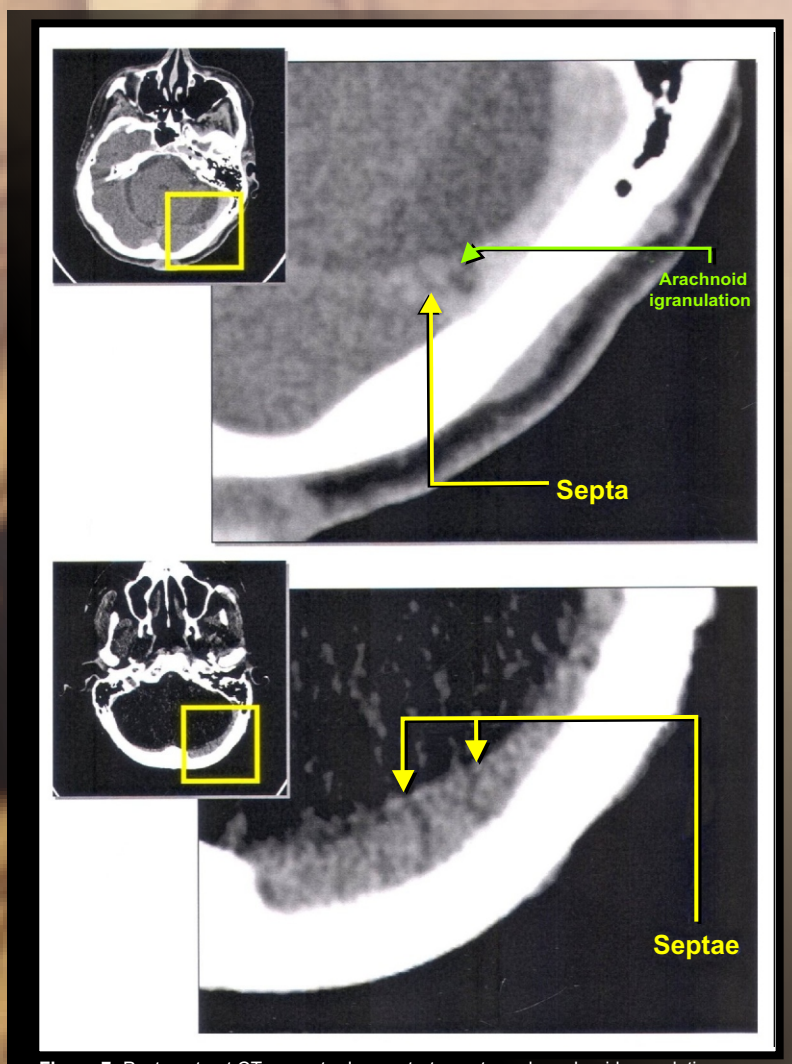

Figure 7: Post contrast CT scans to demonstrate septa and arachnoid granulations within the transverse sinus

Discussion

The study showed right-sided dominance in the trabeculae/septa and arachnoid granulations. A possible explanation for this phenomenon may be the fact that the right transverse sinus is usually found to be larger[(2)]. With its larger surface, it makes sense that more arachnoid granulations would be allowed to project into the sinus.

In a study conducted by Subramaniam et al. (2004)[(3)], trabeculae/septa found in 20 transverse sinuses were classified, according to their pattern, into 3 types[(3)]: T1: One/two small, thin trabeculae; T2: Many (>5), thin small trabeculae; T3: Large thick septum, obstructing 25% of the lumen. When comparing the above classification with the results of this study, similarities seem to exist, but are unfortunately not identical. The trabeculae/septa patterns observed in this study allow for the introduction of new categories in addition to the proposed classification of Subramaniam et al. (2004)[(3)]. The limited sample size of only 10 cadavers used in their study, compared with the much larger sample used in this study (39 cadavers and 63 patients), could be the reason for this difference .

The role of the trabecula/septa (also described as fibrous bands[(2)]), which was observed during this study, is unclear. It is postulated that these fibrous bands or septa may act as wall reinforcements to keep the walls from dilating or collapsing. For the same reason, a larger right sided transverse sinus will need more "reinforcements" to overcome the higher wall tension generated by a larger volume of blood found in the sinus. Should one or more of these septa tear, by whatever means, it may act as a valve in an area where no valves are normally found[(2)]. This may theoretically obstruct normal cerebral venous drainage, which may eventually result in a raise in intracranial dural venous pressure.

Conclusion

It was found that 53% of the subjects presented with structures in their transverse sinuses that could be potential venous filling defects. Arachnoid granulations and trabeculae/septae were found to be more dominant in the right transverse sinus. It is clear from the results that the right transverse sinus is at the highest risk for demonstrating potential venographic filling defects.

References

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