Reviewer's report

Title: An anatomy-based lumped parameter model of cerebrospinal venous circulation: can an extracranial anatomical change impact intracranial hemodynamics?

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Reviewer: Clive Beggs

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Reviewer's Comments on:
An anatomy-based lumped parameter model of cerebrospinal venous circulation: can an extracranial anatomical change impact intracranial hemodynamics?
Stefania Marcotti, et al.

General Comments

This paper presents an interesting model, which although limited in some respects, has enabled the authors to make a prediction, which if true is of major importance; namely that constriction of the internal jugular veins (IJVs) can lead to greatly increased pressure at the confluence of Rosenthal vein and the vein of Galen. In my opinion, this finding is important because it provides a plausible explanation for the reported link between periventricular white matter changes and extracranial venous anomalies. This reported link remains highly contentious and any findings that help to clarify the situation are, in my opinion, of great importance.

The authors rightly consider the cerebral venous drainage network as a system, rather than a series of isolated vessels – an important fact, which sadly, too many researchers have ignored. As such, I believe that the model makes a timely contribution to the knowledge base regarding cerebral venous drainage anomalies.

Having said this, although I believe that the paper makes a valuable contribution to the scientific debate, I do have some reservations, which I feel the authors should address. These are as follows:

Major Compulsory Revisions

1. It is not stated whether the model applies to subjects in the supine or upright position. I presume from the fact that the volume flow rate through the IJVs is much greater than that through the vertebral veins (VVs), that the model refers to subjects in the supine position. The authors should clarify this and explain that the venous drainage pathways can differ greatly when the subjects are upright.
2. The major limitation of the model is that it is only steady-state and that it takes no account of the thoracic pump, which is periodic and has a major influence on cerebral venous drainage. Having said this, although limited the steady-state model is still valid. However, the authors should discuss in more detail the limitations of their model in the text.

3. The authors have not made enough of their findings. If the pressure at the confluence of Rosenthal vein and the vein of Galen can be so greatly increased simply through constriction of the IVJs, then it adds considerable weight to the findings of many researchers, including:


who have postulated that venous reflux can lead to increased pressure in the vein of Galen and rupture of the delicate periventricular veins. While simulated results should always be treated with caution, the fact that the model predicts the same thing as these other researchers postulated, should be commented on by the authors. Also, the author’s finding that venous constriction can result in reversed flow is an issue of importance that should be discussed in more detail. In particular, the authors should explain from a fluid mechanics point of view why reverse flow occurs. At the moment the paper appears to be a little vague on this issue.

4. Following on from point 4 above, if the pressure in the vein of Galen can be greatly increased by extracranial venous constriction, then the laws of fluid mechanics tell us that the hypertension is likely to occur in the superior sagittal sinus, something which would tend to inhibit CSF absorption. As such, it adds weight to the observations of a number of researchers who have found CSF flow in the Aqueduct of Sylvius to be linked with impaired venous drainage. The authors should comment on this in the discussion section.

Minor Essential Revisions

5. The written English is a little clumsy in places making it difficult for the readers follow the arguments.

6. Perhaps the authors could use the term 'retrograde' rather than 'reverted'.

7. In Figure 4, sub-plots B and C do not match the caption. Have they been mixed-up?
Level of interest: An article of importance in its field

Quality of written English: Needs some language corrections before being published

Statistical review: No, the manuscript does not need to be seen by a statistician.

Declaration of competing interests:

I am currently collaborating with Marcella Lagana on a separate project.