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MRI venous architecture of insula

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ABSTRACT

Purpose: The purpose of this paper is to describe the venous anatomy of the insula using conventional MR brain imaging and confocal reconstructions in cases with glioma induced venous dilatation (venous gliography).
Methods: Routine clinical MRI brain scans that included thin cut (1.5–2 mm) post contrast T1 weighted imaging were retrospectively reviewed to assess the insular venous anatomy in 19 cases (11 males and 8 females) with insular gliomas. Reconstruction techniques (Anatom-e and Osirix) were used to improve understanding of the venous anatomy.
Results: We identified the following insular and peri-insular veins on MRI: the superficial middle cerebral vein (SMCV), peri-insular sulcus vein, vein of the anterior limiting sulcus, the precentral, central, and posterior sulcus veins of the insula, the communicating veins and deep MCV.
Conclusions: We concluded that venous anatomy of insula is complicated and is often overlooked by radiologists on MR brain imaging. Use of confocal imaging in different planes helped us to identify the superficial and deep middle cerebral veins and their relationship to the insula. The understanding of the insular venous architecture is also useful to distinguish these vessels from insular arteries. This knowledge may be helpful for presurgical planning prior to insular glioma resection.

1. Introduction

The insula is a challenging area to neurosurgeons due to its proximity to critical neural structures and also because of its complex vascular anatomy, particularly its juxtaposition to the middle cerebral artery (MCA) and to the middle cerebral vein (MCV). We and others have discussed the surgical challenges involved in insular surgeries including the need to dissect the M1 and M2 branches, to disconnect the tumor from the small perforators that arise from the M2 branches and that supply the tumor, and the requirement to avoid injury to the lenticulostriate perforators [1–3]. However, the venous anatomy has not been a significant topic of discussion. It has been noted that veins may need to be sacrificed during a transylvian-transinsular approach in insular surgeries [4]. Another study reported that the obliteration of the superficial or deep sylvian veins along the sphenoid ridge may cause seizures and a facial palsy plus aphasia, if the occlusion is on the left side [5]. Venous infarction or severe cerebral edema caused by venous congestion can result in neurological decline [6].

The existing literature on variations of superficial sylvian veins and insular veins is based on data derived from the anatomic dissection studies, angiographic studies [7–10] and operative studies [11]. However, to our knowledge there has been no study which has described the insular veins based on conventional MRI brain post contrast T1WI. Preoperatively, information about the venous anatomy will allow neuroradiologists to better distinguish insular arteries from insular veins. There may be a rich collateral venous system in a given patient and it may be difficult to foresee the neurological consequences of sacrificing veins, therefore knowledge of the venous anatomy prior to surgery for insular gliomas is important. The neuroradiologist can convey this information to the neurosurgeon who can decide whether a

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Table 1
Demographic, pathology and location of the insular gliomas in 19 patients.

NO	Gender	Age (years)	Tumor histology	Enhancing/non enhancing	Side of the tumor
1	F	58	AAIII	NE	L
2	M	56	Oligo II	NE	L
3	M	40	Oligo II	NE	L
4	F	32	GBM	Slight E	R
5	M	68	GBM	E	L
6	M	41	AAIII	NE	R
7	M	35	AAIII	NE	R
8	F	38	oligoastrocytoma	NE	B/L
9	F	58	GBM	E	L
10	F	52	Oligo II	Slight E	L
11	M	26	Oligo II	NE	L
12	M	39	AAIII	NE	R
13	M	59	ganglion cell tumor	Slight E	L
14	F	38	Oligo II	NE	L
15	M	32	Oligo II	NE	L
16	M	60	GBM	E	L
17	F	66	AAIII	Slight E	L
18	M	38	grade II	NE	R
19	F	24	grade II	NE	R

vein can be sacrificed without the consequence of possible venous infarction in that territory.

To bridge this gap, we undertook a radiological description of the insular veins using MR imaging techniques. In order to visualize the insular veins, we analyzed post-contrast T1 weighted imaging (T1WI) from patients with insular gliomas, in which the tumor produced congestion of the venous system, thereby opening up venous channels not easily visualized under normal circumstances. We have previously labeled this approach "venous gliography" because of the link between the presence of the tumor and the visualization of the veins [12].

2. Methods

2.1. Selection of the study group

Approval for this retrospective study was obtained from the Institutional Review Board, with a waiver of informed consent. We retrospectively studied cases involving the insula and/or the operculum between 2011 and 2015. Routine clinical MR Imaging studies which included thin cuts (1.5–2 mm) post-contrast T1-weighted imaging were reviewed to assess the venous anatomy in 19 such cases. Since 1/19 patients had bilateral insular glioma, we used number of tumors ($n = 20$) in this paper to describe venous anatomy. Reconstruction techniques (Anatom-e and Osirix) were used in difficult tumors where more than one view was required (10/20) for better understanding of the venous anatomy pattern. Images were correlated with literature descriptions of insular veins including anatomical features, location, course and variability from injected specimens and angiographic reports [8,9].

2.2. Reconstruction techniques used to analyze examples for this series

In all cases, the middle cerebral veins (superficial and deep) and the insular veins were assessed using serial post-contrast MR T1WI in three standard imaging planes. Images were obtained on 1.5 Tesla (in 7/19 cases) or 3.0 Tesla (in 12/19 cases) GE MRI scanners (Excite HDxt MR scanners and one 3 Tesla GEMR750 scanner; GE Healthcare, Waukesha, Wisconsin) by using 8 or 16-channel phased-array head coil. The following parameters were used for 1.5 Tesla MR T1-weighted post-contrast scans (TR = 500–600 ms, TE 102 ms) of 1 number of excitations, matrix of 256 × 192, field of view of 22 cm and for 3 Tesla MR T1-weighted post-contrast scans (TR = 4950–6050 ms, TE = 100 ms) of 1 number of excitations, matrix of 384 × 256, field of view of 22 cm.

In 10/20 tumors a full display of the curved pathways of the veins was evaluated using Anatom-e, Information Systems (Houston, TX) and OsiriX 32-bit format (OsiriX@, Pixmeo SARL, Bernex, Switzerland) for a better understanding of the venous patterns. Using these reconstruction techniques in variable section thickness, the authors created Multiplanar Maximum Intensity Projections (MIP) and were able to visualize the venous structures, and their interconnections [13]. Good quality thin section (1.5 mm) MR scans was the prerequisite for these techniques followed by knowledgeable manipulation of the scans for producing images that distilled the important venous features.

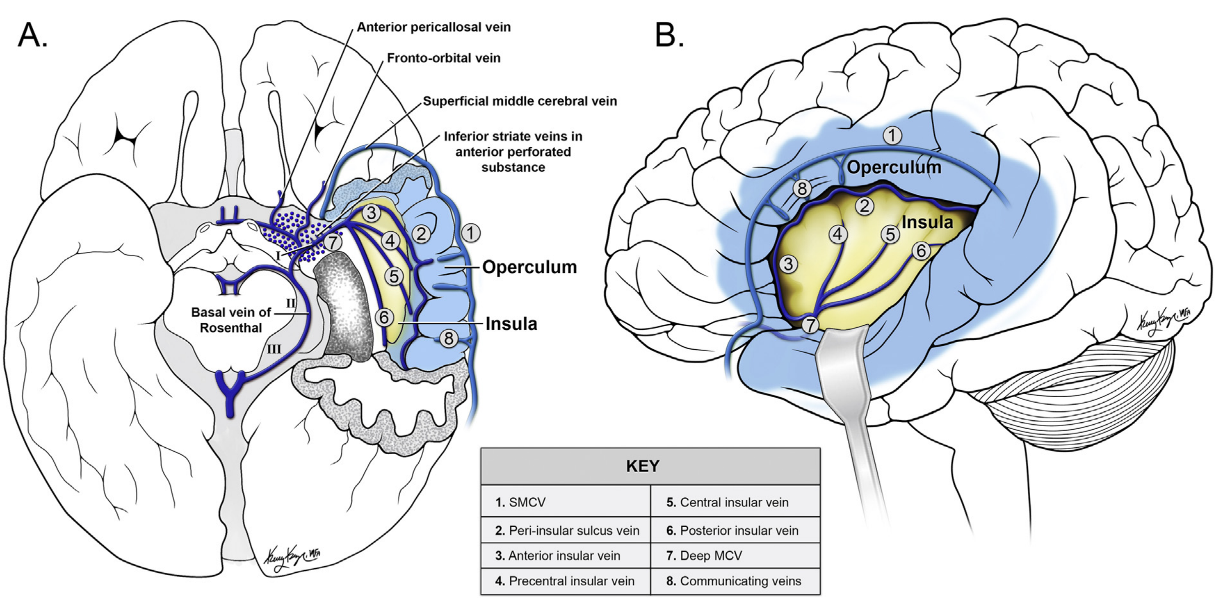

Fig. 1. A & B. Schematic illustrations showing two networks of insular venous drainage in caudal view (A) and lateral view (B). Note, light blue represents the superficial MCV (#1) and dark blue illustrates the deep MCV and its tributaries. Also note, the insular veins (#3,4,5,6) join to form the deep MCV (#7). The anterior insular vein (#3) can be contiguous with the peri-insular sulcus vein (#2). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)