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Angiographic assessment of variants of basal vein of Rosenthal in idiopathic subarachnoid hemorrhage

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ABSTRACT

Previous studies have reported the possible contribution of a primitive variant of the basal vein of Rosenthal (BVR) in the cause of idiopathic subarachnoid hemorrhage (ISAH). The purpose of this study was to assess the drainage patterns of the BVR among ISAH patients. The venous phase at cerebral angiography was retrospectively analyzed in 19 patients with ISAH and then compared with patients with unruptured aneurysms as controls. A relationship was found between ISAH and the presence of a primitive variant. However, the venous configuration effect on bleeding is still unknown.

1. Introduction

Non-traumatic subarachnoid hemorrhage (SAH) generally occurs as a result of aneurysm rupture. In approximately 15% of cases, neither aneurysm nor other vascular malformation can be identified by cerebral angiography; in this case it is defined as idiopathic SAH (ISAH) [1,2]. ISAH have a benign clinical course and a much better outcome than patients with aneurysmal SAH [1,3]. In the literature, studies have suggested a possible contribution by primitive variants of Basal vein of Rosenthal (BVR) in the pathogenesis of ISAH [2,4,5]. The way in which this venous configuration might influence bleeding is still unknown. In this paper we retrospectively studied the prevalence of angiographic variants of BVR to determine whether there were differences between patients with ISAH and those with unruptured aneurysms.

2. Materials and methods

During the period of 2012–2014 a retrospective evaluation of patients with SAH was carried out. Patients were selected if SAH was seen on a cranial computed tomography (CT) image and a negative digital subtraction angiography (DSA).

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Inclusion criteria for this study were repeating radiological imaging (either DSA or MRA) after 2–4 weeks which again proved negative. Exclusion criteria for the study was SAH secondary to head trauma, the presence of an aneurysm or other intracranial vascular malformations and blood dyscrasis. As a control group we evaluated the patients having an incidental unruptured aneurysm. These patients were selected at random, independently of the site of aneurysm. The initial admission cranial CT pattern was defined according to the Nayak CT-based classification system for non-aneurysmal SAH. Type 1a; blood in basal cisterns only. Type 1b; type 1a with extension into the sylvian fissures. Type 2; type 1 (including 1a&1b) with extension of blood into cortical sulci $\pm$ ventricles. Type 3; SAH without blood in basal cisterns. Type 4; any type of SAH with subarachnoid blood in the posterior fossa/cerebellar vermis [6]. Clinical grades were determined using the Hunt and Hess grade [7].

2.1. DSA technique

The preprocedural 6 h fasting was provided. Written informed consent was obtained from the patients. Complete blood count, blood biochemistry and coagulation parameters were obtained and confirmed to be within normal ranges. Both groins were prepared and drapped. The common femoral artery (usually right femoral artery) was palpated. Lidocain (% 1) was injected into the skin and a skin incision was made. A single wall puncture technique with retrograde manner and 18 G angiographic needle was used to introduce 6 Fr 11 cm vascular sheath (Medtronic, Minneapolis, Minnesota, USA) into the common femoral artery.

Catheters used for selective cerebral angiography were Headhunter, vertebral and simmons 2 (Boston Scientific, Natick, MA). Bilateral selective internal carotid artery catheterization was performed under the roadmapping technique. Standard anteroposterior (AP), lateral views and the late venous phase were obtained. The images of all patients were loaded in the picture archiving and communications system (PACS). The venous phases of angiography were reviewed independently by one neurosurgeon and one neuroradiologist, each blind to the patient features. After this first examination the results were compared and discussed. The results were classified according to the Watanabe classification (type A, B and C) [5]. Type A; normal pattern; the vein drains mainly into the vein of Galen. Type B; normal discontinuous pattern; the vein drains anteriorly (uncal vein) and posteriorly (into the Galenic system). Type C; primitive pattern; the veins drain into the cavernous or sphenoparietal sinus, into the superior petrosal sinus via perimesencephalic veins, or into the transverse/straight sinus directly, other than the galenic system.

2.2. Statistical analysis

Chi-square tests were applied to assess the independency of variables, such as a comparison of the study-control groups in terms of other variables. Additionally, the proportions of the study and control groups at the level of other variables were compared using Z tests. Descriptive information as counts and percentages were also reported in cross tabulation tables.

3. Results

A total of 19 patients' 38 BVR were examined, within which the mean age was 53 years (range 18–77); 13 patients were female while six were male. A total 35 patients' 70 BVR were evaluated as a control group. The mean age of patients with unruptured aneurysm was 56 years (range 32–83); 25 were female while 10 were male. At the time of diagnosis 3 patients were classified as Hunt and Hess grade I, 11 as grade II, and 5 as grade III. The amount of blood in the CT was evaluated by Nayak classification; 6 patients were presented as type 1a, 5 as type 1b, 5 as type 2, and 3 as type 3. Eleven patients had previously experienced hypertension. No patients had hydrocephalus. Four showed radiologically vasospasm on DSA but only 2 patients were clinically effected by this. All patients were treated only conservatively and recovered completely. A total of 38 studies of BVR patients were evaluated, including 19 who were both sides cases (Figs. 1–3). Type A, 24 (63.1%), B, 1 (2.7%) and C 13 (34.2%) were noted in ISAH patients, while type A, 51 (72.9%), B, 12 (17.1%) and C 7 (10%) were noted in control group patients (Table 1). In ISAH patients, normal drainage (AA) pattern in 10 (52.6%), normal variants (AB, or BB) in 1 (5.3%) and primitive pattern (CA, CB, CC) in 8 (42.1%) patients were observed. In control groups with unruptured aneurysm, 19 (54.3%) patients normal, 10 (28.6%) patients normal variant, 6 (17.1%) patients primitive pattern were found. The primitive pattern was statistically more significant in the study group ($p < 0.05$). The normal variant pattern was statistically more significant in the control group ($p < 0.05$) while the normal pattern was found not to be significant. The analysis of ISAH with regard to CT findings did not reveal any significant difference in variations of the BVR.

4. Discussion

Spontaneous SAH is generally caused by rupture of an aneurysm, although DSA could not locate the cause of bleeding in about 15% of patients with spontaneous SAH [2,3,8]. In a subtype of DSA negative SAH patients the blood is placed in the cisterns around the mid-brain and the center of bleeding is anterior to the mid-brain in 21–68% of the ISAH cases known to have perimesencephalic SAH (PMSAH) [9–11]. The etiology of ISAH has not yet been determined. Several risk factors of PMSAH have been suggested, such as smoking, female gender, and youth, although hypertension is the only risk factor consistently present across studies [12–14]. The clinical features of PMSAH include the slower onset of headaches, infrequent loss of consciousness, the limited extension of hemorrhage. Benign clinical courses show that the cause is likely to be a local leakage of venous or capillary bleeding rather than a high pressure arterial source [2,4,15]. Although the etiology of PMSAH has not yet been determined, the ventriculostriate or thalamoperforating arteries, anterior longitudinal pontine or interpeduncular and posterior communicating veins, cryptic brain stem arteriovenous malformations, primary intramural hematoma of the basilar artery have each been proposed as sources of hemorrhage [16–19]. Work on the categorization of the venous system in normal

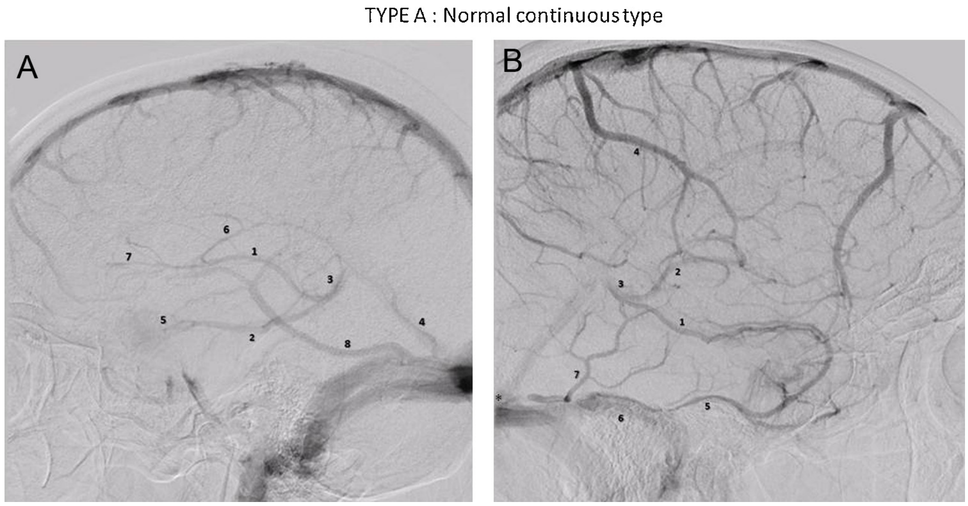

Fig. 1 – (A) Lateral venous phase of DSA showing the venous drainage of type A: Anterior cerebral vein (7) and Talamostriate vein (6) are continuous with the internal cerebral vein (1) and drains mainly into the vein of Galen (3). Uncal vein (5) is continuous with the Basal vein of Rosenthal (BVR) (2) and drains mainly into the vein of Galen. Straight sinus (4). İnferior anastomotic vein (Labbe) (8). (B) Type A venous drainage: İnternal cerebral vein (2), Basal vein of Rosenthal (1) Vein of Galen (3), superior anastomotic vein (Trolard) (4), superior petrosal sinüs (5), transvers sinus (6). Inferior anastomotic vein (Labbe) (7) is mainly drains confluens sinus (*).

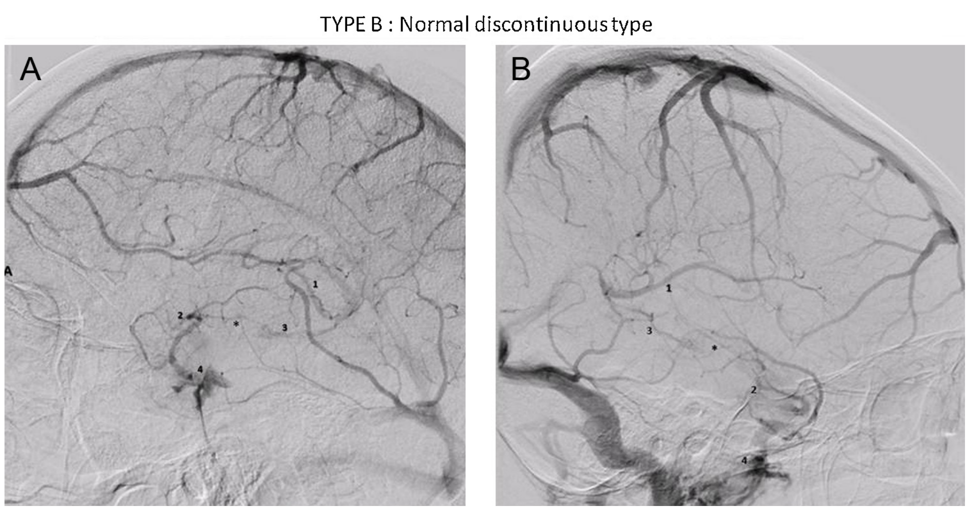

Fig. 2 – Type B or normal discontinuous venous drainages: There are discontinuous dual drainage, anterior to the uncal veins (2) and posterior to the vein of Galen (3). The middle segment of the BVR is not appear (*). İnternal cerebral vein (1) directly drains into the vein of Galen. Uncal veins drain into the cavernous sinus (4).

continuous (type A), normal discontinous (type B), and primitive variant (type C) has been published based on the embryological development of the venous system [5]. The BVR is formed by longitudinal anastomoses of three primitive veins during development, which are the telencephalic, diencephalic, and mesencephalic veins [20]. These primitive veins drain into the tentorial sinus in the early embryonic stage. During development these draining veins are usually obliterated and drainage becomes mainly into the Galenic system. Drainage of the BVR into the tentorial or another dural sinus was defined as primitive type C variant. Because failure of anastomosis is most frequent between the first and second segment, type B is a common variant of type A [11]. The mechanism suggested is that the veins might be torn by way of the direct connection of perimesencephalic veins with the dural sinuses with intracranial venous congestion, or sudden swelling of the tributaries of the BVR among patients with anomalous venous drainage [3,4].

Song et al. reviewed 57 patients with ISAH, normal drainage (AA) 28.1% patients, 22.8% patients with normal variants (AB, or BB) and 49.1% patients with a primitive pattern (CA, CB, CC) found. In control groups with aneurysmal SAH, 59.6% patients normal, 21.1% patients normal variant and 19.3% patients with primitive a pattern were noted. Also noted was that the primitive pattern of BVR had more of a relationship with ISAH compared to aneurysmal SAH [2].

TYPE C : Primitive type

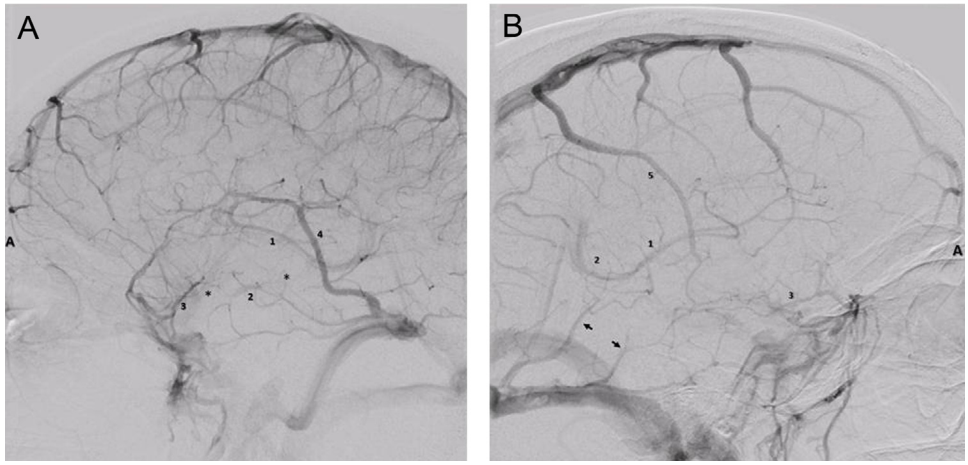

Fig. 3 – (A) Venous phase showing anterior and posterior agenesis of BVR (*). Central of the BVR is mainly drains into the transvers sinus (2). Uncal vein (3) and inferior anastomotic vein (Labbe) (4). (B) Complete agenesis of BVR. Region of BVR's venous drainage, posterior to the confluens sinus (arrows). Internal cerebral vein (1) and vein of the Galen (2) are normal. Superior anastomotic vein (Trolard) (5). Uncal vein (3).

Watanabe et al. assessed a total 12 BVR in 6 patients with PMSAH. They discovered 3 type A (25%), 2 type B (17%), and 7 type C (58%). They studied 102 patients with aneurysmal SAH and discovered 41% type A, 37% type B and 22% type C. They noted that type C was more prevalent among patients with PMSAH than in those with aneurysmal SAH [5].

Yamakawa et al. studied a total 35 BVR in 18 patients with PMSAH. The number of type A detected was 28.6%, those of type B 20% and type C 51.4%. In the aneurysmal SAH group they noted type A was 56.9%, type B 31.3% and type C 11.8%. Type C was observed as being significantly more prevalent among patients in the PMSAH group [11].

Alen et al. reviewed 100 patients with ISAH. Types A, B and C drainage were present in 23.8%, 43.9% and 32.3%, respectively of patients, compared with 58.7%, 25.9% and 15.4% respectively in the aneurysmal SAH group and 57.5%, 37.5% and 5% respectively in the non hemorrhagic incidental aneurysm group. Type C was present in at least one side in 41.8% patients compared with 21.4% in the aneurysmal SAH and 8% in the non hemorrhagic group. No differences were detected between both control groups [1].

Table 1 – The distribution of the type of Basal vein of Rosenthal (BVR) in groups.

Type of venous drainage	Group	
	Study (ISAH) BVR (38), Patients (19)	Control (unruptured aneurysm) BVR (70), Patients (35)
Type A	**24 (63.1%)**	**51 (72.9%)**
Unilateral right	2	10
left	2	3
Bilateral	10	19
Type B	**1 (2.7%)**	**12 (17.1%)**
Unilateral right	1	2
left		8
Bilateral		1
Type C	**13 (34.2%)**	**7 (10%)**
Unilateral right	1	2
left	2	3
Bilateral	5	1

Unlike most of the above studies, Daenekindt et al. concluded that there was no association between PMSAH and the presence of a primitive variant. They studied 59 patients with PMSAH. Type C was present among 28 patients with PMSAH (47%) and in 21 with aneurysmal SAH (36%) in at least one hemisphere [15].

Sabatino et al. examined 40 patients with ISAH and found no significant differences between type C drainage among the groups. However, they recognized a significant prevalence of BVR type B variants in ISAH compared with the unruptured aneurysm group. Type A was prominent in control groups. They concluded that variant B might be involved in the pathogenesis of venous ISAH [3].

In the present study the primitive variant of BVR observed was 34.2% in ISAH and 10% in the unruptured aneurysm group in at least one side. The primitive variant of BVR was found significantly more in ISAH patients. In the literature different results have been published concerning the prevalence of the variant of BVR which could be related to differences in study groups, number of samples, both sided assessment, and evaluation of DSA. In addition, PMSAH definition is insufficient to describe all ISAH cases in which bleeding is extended to carotid cisterns, sylvian fissure, interhemispheric fissure and cortical sulci. In this study results indicate the primitive pattern of BVR is important in ISAH.

5. Conclusion

In conclusion, the primitive variant of BVR should be considered as one of the possible reasons for patients with

ISAH, however the actual etiology as well as risk factors involved have yet to be identified.

Conflict of interest

The authors declare that they have no conflict of interest.

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Ethics

The work described in this article has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans; Uniform Requirements for manuscripts submitted to Biomedical journals.

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