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Research Paper:

Cerebral Angiographic Findings in Non-Traumatic Intracranial Hemorrhage: A Single Center Experience in the West of Iran

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ABSTRACT

Background and Aim: This study aimed at analyzing the demographic characteristics of the patients with non-traumatic intracranial hemorrhage, their angiographic results and the correlation between computed tomography (CT) scan and angiography findings.

Methods and Materials/Patients: In a descriptive study, we retrospectively reviewed the records of the patients with non-traumatic intracranial hemorrhage based on their brain CT or lumbar puncture findings from 2011 to 2017. For all patients, four vessel catheter angiography via the femoral approach was performed in the Medical Imaging Center of Kermanshah University of Medical Sciences, Iran.

Results: We investigated 143 cases with non-traumatic intracranial hemorrhage which was indicated in CT findings (91.61%) or lumbar puncture (8.39%). Of 143 patients, 64 (44.8%) were men and 79 (55.2%) women (mean age 53.7±12.1 years old). Moreover, 104(72.7%) patients had Subarachnoid Hemorrhage (SAH), 19(13.3%) of them had Intracranial Hemorrhage (ICH), 8(5.6%) ones had Intraventricular Hemorrhage (IVH) and 12(8.4%) patients had normal brain CT. There were 100 cases of aneurysm (69.93%), 13 cases of Arteriovenous Malformations (AVM) (9.09%), 28 cases with negative angiograms (19.58%), and 2 cases with other pathologies (1.4%). Seven (4.89%) cases of multiple aneurysms were also recorded. Of 13 patients with AVM, 8(61.5%) patients had AVM in parieto-occipital region, 2(15.4%) in temporal, 1(7.7%) in frontal region and 2(15.4%) had deep AVM. Two (1.4%) patients with SAH had dural AVF. Twenty-eight (19.6%) patients had negative angiogram, 22 cases of them had second angiography after one to two weeks. The most common positive finding in the second angiogram was Acom aneurysm (18.18%).

Conclusion: Aneurysms and AVMs are the most common causes of non-traumatic intracranial hemorrhage. The most common site of intracranial aneurysms is the circle of Willis. A second angiogram after one to two weeks is necessary in most patients with negative results in first angiography after non-traumatic intracranial hemorrhage.

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1. Introduction

Spontaneous intracranial hemorrhages occur in the absence of trauma [1, 2]. Aneurysm, arteriovenous malformation and cavernous malformation are the most common causes of non-traumatic intracranial hemorrhages [3-5]. Conventional catheter angiography is the gold standard for diagnosis of vascular abnormality; however; other imaging modalities such as CTA and MRA can help to find out about vascular abnormalities [6-8]. Intracranial aneurysms are the most common causes of non-traumatic intracranial hemorrhage, occurring in 60%-85% of cases [9, 10]. The most common place of intracranial aneurysms is the circle of Willis and its immediate branches [11-13]. The location and the size of the aneurysms are the important factors influencing management and prognosis of patients [14, 15]. The main aim of our study was to evaluate the demographic characteristics of 143 patients with non-traumatic intracranial hemorrhage, their angiographic results and correlation of CT scan findings and angiography of patients, investigating the etiologies and their angiographic presentations and discerning the anatomical distribution of cerebral aneurysms and areriovenous malformations in the Kermanshah.

2. Methods & Materials/Patients

Patients

This is a retrospective study in which the records of 143 patients with non-traumatic intracranial hemorrhage based on their brain Computed Tomography (CT) scan images or lumbar puncture findings were reviewed. The study population included the patients with non-traumatic intracranial hemorrhage (which was proven through CT scan or lumbar puncture), referring to Imam Reza Hospital, Kermanshah University of Medical Sciences in Kermanshah city (western Iran). The sample was selected via census method during five years from April 2011 to April 2017. For data collection, a permission was obtained from Kermanshah University of Medical Sciences and the researcher was referred to Imam Reza Hospital.

Inclusion criteria

Documented non-traumatic intracranial hemorrhage finding and age between 10 to 70 years old were the inclusion criteria of this study.

Exclusion criteria

We excluded the patients with severe coagulopathy that accounted for the hemorrhage and those with hemorrhage into the tumor which was diagnosed by brain CT scan or MRI.

Procedure

We used a checklist for data gathering that included demographic features of patients such as age and sex, patients' brain CT scan findings and results of the first and second angiography. For all patients, four vessel catheter angiography via the femoral approach was performed in the Medical Imaging Center of Kermanshah University of Medical Sciences. Image acquisition was done by Digital Subtraction Angiography (DSA). A positive angiography was defined by the identification of a vascular abnormality accounting for the hemorrhage. The angiogram was repeated after 1 to 2 weeks of primary negative angiogram except in patients with SAH in perimesencephalic cisterns. SPSS (version 20) was used for the data analysis. The statistical error type I and confidence interval were 5% and 95%, respectively.

3. Results

In this study, 143 cases of non-traumatic intracranial hemorrhage proven by CT (n=121, 91.61%) or lumbar puncture (n=12, 8.39%) were evaluated. Of 143 patients studied, 64(44.8%) were men and 79(55.2%) women. The mean±SD of patients' age was 53.7±12.1 years old (Tables 1 and 4). Brain CT findings revealed that 104(72.7%) patients had subarachnoid hemorrhage, 19(13.3%) ones had ICH, 8(5.6%) ones had IVH and 12(8.4%) patients had normal brain CT scan (Tables 1 and 5). Furthermore, the results of the first angiogram showed that 100 cases had aneurysm (69.93%), 13 cases had AVM (9.09%). The angiogram of 28 cases were negative (19.58%), 2 cases had other pathologies (1.4%) and 7(4.89%) cases had multiple aneurysms (all of them had two aneurysms) (Table 2).

In patients with intracranial aneurysms, eighty-two (82%) aneurysms were in anterior circulation and 18(18%) of them were in posterior circulation. The most common aneurysms were anterior communicating artery (Acom) (43%), middle cerebral artery (MCA) (16%) and internal carotid artery (ICA) (15%), respectively. Moreover, 27(27%) aneurysms had a size less than 5 mm, 67(67%) ones between 5 to 25 mm and 6(6%) ones were giant (size more than 25 mm) (Table 3). We concluded that 13 patients had arteriovenous malfor-

Table 1. Frequency of variables of sex, CT results and age groups of 143 patients with non-traumatic intracranial hemorrhage proved in their brain CT or lumbar puncture findings

Variables		Frequency (N)	Percent
Sex	Male	64	44.8
	Female	79	55.2
CT scan	Subarachnoid hemorrhage	104	72.7
	Intracranial hemorrhage	19	13.3
	Intraventricular hemorrhage	8	5.6
	Normal	12	8.4
Age group (year)	<30	13	9.1
	30<x<40	24	16.8
	40<x<50	32	22.4
	50<x<60	37	25.9
	>60	37	25.9
	Total	143	100

Table 2. Results of first and second angiography of all patients of 143 patients with non-traumatic intracranial hemorrhage proved in their brain CT or lumbar puncture findings

Results	First Angiogram Results		Second Angiogram Results	
	Frequency	Percent	Frequency	Percent
Anterior communicating artery	43	30.06	4	18.18
Anterior cerebral artery	3	2.1	1	4.54
Middle cerebral artery	16	11.18	1	4.54
Internal cerebral artery	15	10.4	0	0.0
Basilar artery	3	2.1	0	0.0
Vertebral artery	2	1.4	0	0.0
Posterior cerebral artery	4	2.8	0	0.0
Posterior communicating artery	4	2.8	1	4.54
Arteriovenous malformation	13	9.1	0	0.0
Posterior inferior cerebellar artery	3	2.1	0	0.0
Other	2	1.4	0	0.0
Multiple aneurysm	7	4.89	0	0.0
Negative	28	19.6	15	68.1
Total	143	100	22	100

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Table 3. The frequency of angiography results based on sex variable in 143 patients with non-traumatic intracranial hemorrhage proved in their brain CT or lumbar puncture findings

Variable		Sex		Total N(%)
		Male N(%)	Female N(%)	
Angiography results	Anterior communicating artery	19(29.7)	24(30.4)	43(30.1)
	Anterior cerebral artery	0(0)	3(3.8)	3(2.1)
	Middle cerebral artery	7(10.9)	9(11.4)	16(11.2)
	Internal cerebral artery	5(8)	10(12.5)	15(10.4)
	Basilar	3(4.7)	0(0)	3(2.1)
	Vertebral	0(0)	2(2.5)	2(1.4)
	Posterior cerebral artery	1(1.6)	3(3.8)	4(2.8)
	Posterior communicating artery	3(4.7)	1(1.3)	4(2.8)
	Arteriovenous malformation	6(9.4)	7(8.9)	13(9.1)
	Posterior inferior cerebellar artery	1(1.6)	2(2.5)	3(2.1)
	Other	1(1.6)	1(1.3)	2(1.4)
	Multiple aneurysm	3(4.7)	4(5)	7(4.89)
	Negative	15(23.4)	13(16.5)	28(19.6)
Total		64(100)	79(100)	143(100)

mation, 8(61.5%) of them located in parieto-occipital region, 2(15.4%) in temporal, 1(7.7%) in frontal region and 2(15.4%) had deep AVM. Two patients with AVM had aneurysms synchronously, one had intranidal aneurysm and one had proximal aneurysms at the ipsilateral side of AVM. Two (1.4%) patients with SAH had dural arteriovenous fistula in their angiogram. Twenty-eight (19.6%) patients had negative angiogram. Besides, 22 cases underwent second angiography after one to two

Table 4. The crosstab of the age and angiography results of 143 patients with non-traumatic intracranial hemorrhage proved in their brain CT or lumbar puncture findings

Variable		Age					Total N(%)
		<30	30-40	41-50	51-60	>60	
Angiography results	Anterior communicating artery	2(15.4)	6(25)	13(40.6)	13(35.1)	9(24.3)	43(30.1)
	Anterior cerebral artery	0(0.0)	1(4.2)	1(3.1)	0(0.0)	1(2.7)	3(2.1)
	Middle cerebral artery	1(7.7)	1(4.2)	4(12.5)	6(16.2)	4(10.8)	16(11.2)
	Internal cerebral artery	3(23.1)	2(8.3)	2(6.3)	5(13.5)	3(8.1)	15(10.4)
	Basilar	0(0.0)	1(4.2)	0(0.0)	2(5.4)	0(0.0)	3(2.1)
	Vertebral	0(0.0)	0(0.0)	0(0.0)	1(2.7)	1(2.7)	2(1.4)
	Posterior cerebral artery	1(7.7)	1(4.2)	0(0.0)	1(2.7)	1(2.7)	4(2.8)
	Posterior communicating artery	0(0.0)	2(8.3)	1(3.1)	0(0.0)	1(2.7)	4(2.8)
	Arteriovenous malformation	5(38.5)	3(12.5)	4(12.5)	1(2.7)	0(0.0)	13(9.1)
	Posterior inferior cerebellar artery	0(0.0)	0(0.0)	1(3.1)	1(2.7)	1(2.7)	3(2.1)
	Other	0(0.0)	0(0.0)	0(0.0)	0(0.0)	2(5.4)	2(1.4)
	Multiple aneurysms	0(0.0)	0(0.0)	0(0.0)	3(8.1)	4(10.8)	7(4.9)
	Negative	1(7.7)	7(29.2)	6(18.8)	4(10.8)	10(27)	28(19.6)
Total		13(100)	24(100)	32(100)	37(100)	37(100)	143(100)

Table 5. The crosstab of the CT scan findings and angiography results of 143 patients with non-traumatic intracranial hemorrhage proved in their brain CT or lumbar puncture findings

Variable		CT Scan Findings				
		SAH N(%)	ICH N(%)	IVH N(%)	Normal N(%)	Total N(%)
Angiography results	Anterior communicating artery	31(29.8)	6(31.6)	3(37.5)	3(25)	43(30.1)
	Anterior cerebral artery	2(1.9)	1(5.3)	0(0.0)	0(0.0)	3(2.1)
	Middle cerebral artery	8(7.7)	4(21.1)	1(12.5)	3(25)	16(11.2)
	Internal cerebral artery	5(4.9)	5(26.3)	4(50)	1(8.3)	15(10.4)
	Basilar	3(2.9)	0(0.0)	0(0.0)	0(0.0)	3(2.1)
	Vertebral	1(1)	0(0.0)	0(0.0)	1(8.3)	2(1.4)
	Posterior cerebral artery	4(3.8)	0(0.0)	0(0.0)	0(0.0)	4(2.8)
	Posterior communicating artery	4(3.8)	0(0.0)	0(0.0)	0(0.0)	4(2.8)
	Arteriovenous malformation	10(9.6)	2(10.5)	0(0.0)	1(8.3)	13(9.1)
	Posterior inferior cerebellar artery	2(1.9)	1(5.3)	0(0.0)	0(0.0)	3(2.1)
	Other	2(1.9)	0(0.0)	0(0.0)	0(0.0)	2(1.4)
	Multiple aneurysms	7(6.8)	0(0.0)	0(0.0)	0(0.0)	7(4.9)
	Negative	25(24)	0(0.0)	0(0.0)	3(25)	28(19.6)
Total		104(100)	19(100)	8(100)	19(100)	143(100)

weeks. The most common positive finding in the second angiogram was Acom aneurysms (18.18%) (Table 2).

4. Discussion

In this study, we evaluated 143 cases suffering non-traumatic intracranial hemorrhage which was confirmed through CT analysis or lumbar puncture. Angiographic detectable causes for non-traumatic intracranial hemorrhage was obtained in 81.4% and 85.31% of cases after the first and second angiography, respectively. Similar to most of the studies, in our study the most common diagnosis with negative angiography was missed aneurysms [16, 17]. The Acom aneurysms had most false negativity in angiography in agreement with other studies [18, 19]. Causes suggested for inducing false negative angiography may include technical errors such as incomplete angiographic views, presence of vasospasm (especially on the 3rd to 14th day of hemorrhage), presence of hematoma mass-effect, existence of thrombosis in the neck of aneurysms and injection of hyperosmolar contrast [20-27]. According to most reports by other researchers, the maximum number of cases with non-traumatic intracranial hemorrhage were detected in age range of 50-59 years old [11, 14, 15, 19, 28]. Increased age has been recognized as a risk factor of hemorrhage; however, extreme old age is protective, decreasing the risk of hemorrhage [12, 16, 19, 22, 29]. In the present work, women at their sixth decade of life consisted most of the patients as in some other studies [9, 11, 25, 30]. The majority of studies have reported a female-to-male ratio of about 1.09-1.42 [23, 31, 32]. Some experts proposed the role of female hormones in female preference for non-traumatic intracranial hemorrhage but there is a controversy about this [33, 34]. The results of this study were compatible with most other studies.

The common causes of non-traumatic intracranial hemorrhage are aneurysms and Arteriovenous Malformations (AVM) [3-5, 35, 36]. Intracranial hemorrhage secondary to AVM occurs in the younger patients relative to aneurysms (before 30 years of age versus after 50 years of age) [37, 38]. In our study, the mean age of patients with AVM were lesser than the mean age of patients with aneurysm.

The risk of bleeding of an aneurysm elevates with increased size of it but aneurysms can present with bleeding at any size [39, 40]. According to the literature, aneurysms with size less than 5 mm are less prone to bleeding while larger aneurysms are more susceptible to bleeding [40, 41]. Age less than 50 years old, aneurysm diameter greater than 4.0 mm, hypertension, and aneurysm multiplicity were found to be predictors of rupture of small aneurysms [39-42].

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The possibility of missed smaller aneurysm in angiography is higher than larger ones [35, 37, 43]. In our study, most of the aneurysms had a size between 5 to 15 mm and most of the missed aneurysms in first angiography had a size lesser than 5 mm.

We found 82(82%) aneurysms in anterior circulation and 18(18%) of them in posterior circulation. The most common aneurysms were Acom (43%), MCA (16%) and ICA (15%), respectively. This is compatible with most of other studies [7, 12, 15, 17, 25, 30, 36]. The rate of multiple aneurysms have been reported 10-15% in prior literature but the amount of less than 5% to more than 30% have been reported, too [20, 31, 43]. The rate of multiple aneurysms in this study was 4.89% that is less than other reported ones. According to most studies, multiple aneurysms have a higher risk of hemorrhage, but there is no consistency in the existing data [20, 31, 35, 37].

In our study, AVM was found in 13 (9.1%) of the patients. Eight (61.5%) patients had AVM in parieto-occipital region, 2(15.4%) in temporal, 1(7.7%) in frontal region and 2(15.4%) had deep AVM. The most common presentation of AVM are bleeding, seizure and focal neurological deficits [9, 15]. Intraparenchymal hemorrhage, intraventricular hemorrhage and subarachnoid hemorrhage are the most common types of bleeding in patients with AVM [15, 32, 40]. Subarachnoid hemorrhage is more common when an AVM is located cortically [32, 40]. Interestingly, in our study the most common type of bleeding in these patients was SAH. It may be due to the overall higher number of patients with SAH than ICH and cortical location in most of our AVMs. As a limitation, we can mention the retrospective data collection and the high chance of missing ones.

5. Conclusion

Aneurysms and arteriovenous malformation are the most common causes of non-traumatic intracranial hemorrhage. The most common place of intracranial aneurysms is the circle of Willis. A second angiogram after 1 to 2 weeks is necessary in most patients with negative outcomes in first angiography after non-traumatic intracranial hemorrhage.

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Conflict of Interest

The authors declare that they have no conflicts of interest. Authors' Contribution is as follows: Conception and design: Mohammad Gharib-Salehi, Ehsan Alimohammadi; Data Collection: Meisam Akbari, Mozhgan Nargesi, Zahra Abbasi, Ameneh Khani, Akram Amiri; Drafting the article: Ehsan Alimohammadi, Seyed-Reza Bagheri, Meisam Akbari, Mozhgan Nargesi, Zahra Abbasi, Ameneh Khani, Akram Amiri; Critically revising the article: Hamidreza Saeidi-Brojeni, Alireza Abdi; Reviewing submitted version of manuscript: Alireza Abdi; and Approving the final version of the manuscript: All authors.

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