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Prevalence of Intracranial Aneurysms Found on Computed Tomography Angiogram in Patients Presented with Traumatic Subarachnoid Haemorrhage

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Abstract

Introduction: In the setting of trauma, the cause of intracranial haemorrhage is frequently attributed to the physical, traumatic event. The actual incidence of underlying aneurysms in patients with SAH after a head trauma is not well clear or studied previously. The role for immediate Computed Tomography Angiography (CTA) still remains controversial to evaluate for non-traumatic causes.

Methods: This study reviewed a total of 797 CT angiograms of the brain conducted in the 2 major hospitals over period 48 months, between February 2013 and February 2017. 170 CTAs were performed on patient with classical thunderclap headache (spontaneous group) while 58 CTAs were performed on patient with head trauma (trauma group).

Results: This study found that 16 plain CT Brains with positive SAH for the Spontaneous group and Traumatic group. Meanwhile, 16 CTAs in Spontaneous group had positive findings intracranial aneurysms compared to 4 from the Traumatic group. Overall incidence of intracranial aneurysms in spontaneous group is 9.4% compared 6.8% in traumatic group (p=0.590) and has no statistically significant difference when comparing the groups.

In regards to primary outcome, 9 patients in Spontaneous group with SAH found to have intracranial aneurysms on CTA compared to 2 patients in Traumatic group (p=0.065). This comparison did not show statistically significant difference.

The study also shown that 7 patients in Spontaneous group with positive SAH on plain CT brain had no aneurysms on CTAs as compared to 12 in Traumatic group. In terms of incidental findings of pre-existing aneurysms, 7 patients from Spontaneous group found to have aneurysms without SAH compared to 2 from Traumatic group.

Conclusion: Prevalence of pre-existing aneurysms in patients with traumatic subarachnoid haemorrhage is comparable with spontaneous type and may had been underestimated and therefore performing CT cerebral angiogram is recommended to evaluate non-traumatic cause of SAH.

Keywords: Traumatic Subarachnoid Haemorrhage (tSAH); Spontaneous Subarachnoid Haemorrhage (SAH); Intracranial aneurysm; CT cerebral angiogram

Introduction

Subarachnoid Haemorrhage (SAH) is a medical condition where bleeding occurs in subarachnoid space. It is an emergency condition that accounts for 5-10% of all cerebrovascular accidents and has a high mortality rate, estimated to be between 40% and 50% [1]. By far the most common cause of SAH, apart from trauma, is ruptured intracranial aneurysm which accounts for 85% of non-traumatic causes [2]. Traumatic SAH (tSAH) commonly refers to brain injury sustained in an accident or a fall while Spontaneous SAH (sSAH) occur with little or no warning and are frequently caused by rupture of aneurysms or arteriovenous malformation in the brain [3].

These 2 major types of SAH are believed to have 2 different mechanisms of pathology. Whilst spontaneous SAH is commonly related to rupture intracranial aneurysms, the exact aetiology of tSAH is remained unspecified. There are several possible mechanisms proposed, which include rotational acceleration causing short-lasting oscillatory movements of the brain, vertebrobasilar artery stretch due to hyperextension, sudden rise of intra-arterial pressure from a blow to the cervical carotid artery or tearing of the bridging veins or pial vessels [4]. However sometimes, no cause can be found [5].

In the setting of trauma, the cause of intracranial haemorrhage is frequently attributed to the physical, traumatic event. The actual incidence of underlying aneurysms in patients with SAH after a head trauma had never been assessed. The role for immediate Computed Tomography Angiography (CTA) remains controversial to evaluate for non-traumatic causes [6]. Therefore, it will important to investigate the

actual prevalence of aneurysms in this subgroup of patients and provide a good foundation for future study of aetiology and nature history of this medical condition.

Aim

This study was conducted to investigate the incidence rate of intracranial aneurysms found CT Angiogram (CTA) of brain conducted in patients with clinical suspicious of spontaneous and traumatic SAH.

Design

This study retrospectively reviewed all Computed Tomography Angiography (CTA) of patients presented clinical presentation suspicious of SAH to 2 major hospitals in metropolitan Sydney, Australia. The 2 hospitals were St George Hospital, a tertiary referral hospital located in Kogarah, a southern suburb of Sydney and Sutherland Hospital which is located in Sutherland Shire in southeast Sydney. All CTAs dated from February 2013 to February 2017 were reviewed in this study.

The study specified the term CTA of "neck and circle of Willis" during the search and review of the CTA database. Only CTAs conducted with aim to investigate patients with clinical suspicion of SAH were included in study. The reviewed CTAs would then be divided into 2 groups, spontaneous and traumatic, based on the clinical presentation of the patients. Patients with presenting complaints of "headache", "Thunderclap headache" were included in the spontaneous group. Meanwhile, patients presenting after head trauma or injury will be reviewed and included in the traumatic group.

This study had also reviewed plain CT brain of all the patients included in both groups. All patients suspected with SAH would routinely undergo plain CT brain as part of the investigation in both hospitals. Therefore, both plain CT brain and CTA of each patient in the study were reviewed as part of the study. All 3 types of aneurysms, saccular, fusiform and microaneurysms were included in review but pseudoaneurysms found in CTAs were excluded.

Overall incidence of SAH and aneurysms of patients in both traumatic and spontaneous groups will be recorded. Incidence rate of aneurysms of both group were compared using a Chi-square test. The primary focus of the study was to compare incidence rate of positive intracranial aneurysms in patients with 2 different types of SAHs.

Results

This study reviewed a total of 797 CT angiograms of the brain conducted in the 2 major hospitals over period 48 months, between February 2013 and February 2017. A total of 228 CT angiography were performed for investigation of SAH and included in this study. 170 CTAs were performed on patient with classical thunderclap headache (spontaneous group) while 58 CTAs were performed on patient with head trauma (trauma group). Same numbers of plain CT brain were conducted as part of the investigation for SAH. Plain CT brain routinely preformed as the first investigation for suspected SAH and followed by CTA.

This study found that 16 plain CT Brains with positive SAH for the Spontaneous group and Traumatic group. Meanwhile, 16 CTAs in Spontaneous group had positive findings intracranial aneurysms compared to 4 from the Traumatic group. Overall incidence of intracranial aneurysms in spontaneous group is 9.4% compared 6.8% in traumatic group (p=0.590) and has no statistically significant difference when comparing the groups.

In regards to primary outcome, 9 patients in Spontaneous group with SAH found to have intracranial aneurysms on CTA compared to 2 patients in Traumatic group (p=0.065). This comparison did not show statistically significant difference.

The study also shown that 7 patients in Spontaneous group with positive SAH on plain CT brain had no aneurysms on CTAs as compared to 12 in Traumatic group. In terms of incidental findings of pre-existing aneurysms, 7 patients from Spontaneous group found to have aneurysms without SAH compared to 2 from Traumatic group (Tables 1-3).

	SAH	Aneurysm	Marginal Row Totals
Spontaneous	16 (18.6) [0.36]	9 (6.4) [1.06]	25
Traumatic	16 (13.4) [0.51]	2 (4.6) [1.47]	18
Marginal Column Totals	32	11	43 (Grand Total)
The chi-square statistic is 3.4053. The p-value is 0.064989. This result is not significant at p<0.05			

Table 1: Incidence of aneurysms in positive SAH.

	Total number of CTA's	Incidence of Aneurysms	Marginal Row Totals
Spontaneous	170 (171) [0.01]	16 (15) [0.07]	186
Traumatic	58 (57) [0.02]	4 (5) [0.2]	162
Marginal Column Totals	228	20	248 (Grand Total)
The chi-square statistic is 0.2901. The p-value is 0.590183. This result is not significant at p<0.05			

Table 2: Overall incidence of aneurysms.

Discussion

CTAs reviewed in the study were conducted on patients who either presented classical "Thunderclap" headache or known history of traumatic head injury with clinical suspicion of SAH. The results showed an incidence rate of aneurysms found on CTAs about 9.4% and 6.8% for spontaneous and traumatic group respectively. The incidence rates of both groups were much higher than expected. Previous autopsy study indicates the prevalence of intracranial aneurysms in the adult population is between 1-5% [7]. Meanwhile, prevalence of intracranial aneurysms among adults undergoing

cerebral angiography is between 0.5% and 1% [8]. However when comparing the incidence rate between 2 groups, this study found no statistically significant differences. Authors of the study attributed the high prevalence of aneurysms to the fact that by presenting with the clinical features of SAH, the studied cohort had increased risk of pre-existing aneurysms.

	Spontaneous	Traumatic
Total CTA	170	58
Plain CT with SAH	16	16
CTA with Aneurysm	16	4
SAH with Aneurysm	9	2
SAH without Aneurysm	6	2

Table 3: Overall spontaneous and traumatic results.

The primary outcome of the study is prevalence of pre-existing intracranial aneurysms in both spontaneous and traumatic Subarachnoid Haemorrhage (SAH). The study showed no statistically differences when comparing positive findings of aneurysms CTAs of patients with confirmed SAH on plain CT from both groups. This finding is intriguing as the 2 type of SAHs, spontaneous and traumatic, are previous shown to have very different aetiologies and mechanisms.

In general, terms, SAH can be divided into Traumatic SAH (tSAH) and Spontaneous or non-traumatic SAH (sSAH) 2 main types. These 2 main types were believed to have different aetiology. TSAH has higher incidence rate than sSAH but better prognosis when compared to sSAH [9,10]. sSAH or non-traumatic SAH has long recognised to be related with pre-existing intracranial aneurysms [11]. About 80% of non-traumatic SAH are due to ruptured intracranial saccular aneurysms [12]. Other aetiology of sSAH including Arteriovenous (AV) malformation, arterial dissections, use of anticoagulants and other rare conditions [13]. In rare cases, two or more aneurysms that have bled within a few minutes or few hours of one another. Dubois and Major [14] reported a very rare case where a patient who presented with subarachnoid haemorrhage from two ruptured aneurysms.

In contrary, tSAH is due to head trauma or injury. tSAH is most commonly seen in the cerebral sulci than in the Sylvian fissure and basal CSF cisterns [15]. Multiple aetiology had been proposed, which included contusion bleeding into the subarachnoid space, intraventricular bleeding due to tearing of the tela choroidea, or other rare causes such as rupture of the posterior inferior cerebellar artery, intracranial or extracranial vertebral artery, internal carotid artery and carotid-cavernous fistula [16,17].

Morioka et al. [18] reported a case of blunt head injury caused a rupture of the pre-existing giant saccular aneurysm in middle cerebral artery. Several other case reports had also reported similar presentation of ruptured underlying intracranial aneurysms following blunt head trauma [19,20]. Authors of this study speculate that ruptured pre-existing aneurysm might be a rare mechanism of SAH following head trauma which was concurrent by Park et al. [21]. There was no previous study available in literature assessing the prevalence of pre-existing aneurysms in SAH cohort or the relationship between aneurysmal rupture and head trauma.

Plain CT scan of brain is commonly used as first line investigation for clinical suspected SAH. When it is performed during the first 24 h, it has a sensitivity of 95% but depends mostly on the extent of the SAH and also on haemoglobin concentration and falls with the time between the initial headache and time when the scan is performed [22,23]. After 7 days, plain CT is positive in only 50% of cases in SAH. Literature had been reporting that CTA processed a sensitivity ranges between 67% to 100% and specificity between 50% to 100% in diagnosing intracranial haemorrhage [24-26]. However, lumbar puncture should be performed in any patient with suspected SAH and negative or equivocal results on plain CT head [27].

Digital Subtraction Angiography (DSA) is considered the gold standard in diagnosis and pre-operative assessment for intracranial aneurysms [28]. However, there is evidence supporting CTA, which is more easily available, as an alternative tool. CTA of the circle of Willis has a sensitivity of 98% to detect intracranial aneurysms, particularly because of its excellent spatial resolution, which is less than 1 mm [29]. Plain CT and CTA of neck and Circle of Willis were used as standardised protocol for assessment of SAH and intracranial aneurysms. Each patient reviewed in the study had both plain CT and CTAs as investigation modalities. This can be an easily reproducible clinical protocol for evaluation and investigation of traumatic SAH in major trauma hospitals.

The use of immediate CTA in head trauma, after a positive SAH on plain CT, to evaluate for non-traumatic causes still remains controversial. Cases of SAH following blunt head trauma later found to have bleeding intracranial aneurysms had been reported. Son et al. [30] had reported a case of a patient with delayed re-bleeding of a cerebral aneurysm in right middle cerebral artery bifurcation following a closed head trauma. Another similar case had also been reported by Hsieh et al. [31]. All 2 cases in this study, intracranial aneurysms were found to be source of SAH at time of CTA following head trauma. It is therefore important to consider the possibility of bleeding in the subarachnoid space from pre-existing aneurysms following a closed head trauma. However, there is limited literature available at the moment. It is something which will require more focus research in the future.

Conclusion

Prevalence of pre-existing aneurysms in patients with traumatic subarachnoid haemorrhage is comparable with spontaneous type. It may have been underestimated. The push for CT angiography after initial plain CT brain is essential to evaluate non-traumatic cause of bleeding.

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