Ischemic Cerebrovascular Disease and Calcified Intracranial Vertebrobasilar Artery: A Case-Control Study by Using Cranial CT

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Objective: *To evaluate the association of intracranial vertebrobasilar (VB) artery calcification and ischemic cerebrovascular disease of the posterior circulation*

Material and Method: *A cross-sectional, retrospective, case-control study was performed in 198 patients with cranial CT. Presence of the posterior fossa infarction was disclosed in 104 patients of the case group. Absence of the posterior fossa infarction in 94 patients were defined as a control group. They were age and sex matched. Circumferential and thickness of calcification was graded for the intracranial vertebral and basilar arteries. Association between vascular wall calcification and posterior fossa infarction was analyzed.*

Results: *No statistically significant relationship between the presence of VB calcification and posterior fossa infarction was found (p = 0.08, OR = 1.75, 95% CI = 0.94-3.26). In subgroup analysis, by re-classifying occipital lobe and thalamus as areas supplied by VB system, there was a statistically significant relationship between the VB calcification and infarction (p = 0.02, OR = 2.08, 95% CI = 1.10-3.94). No relationship between degree of calcification and the area of infarction was observed.*

Conclusion: *The present study showed no significant relationship between the VB artery calcification and ischemic infarction of cerebellum and brainstem, but a significant relationship between VBA calcification and infarction in the end territory of VBA supply.*

Keywords: *Ischemia, Stroke, Posterior circulation, Calcification*

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On routine CT images, vascular wall calcification (VWC) is commonly found especially in adults. The significant relationship between VWC and end organs insult supplied by the vessel territories is still argued. Many studies have tried to demonstrate this relationship such as in coronary arteries, renal arteries and internal carotid arteries (ICA)[1-6]. The knowledge of VWC and its' significance to related organs has led to proposed guidelines of screening coronary calcium scoring for predicting future coronary heart disease and ischemic heart disease, or renal Doppler ultrasound for renal arterial stenosis, as well as CT angiography for cervical ICA stenosis and subsequent ischemic stroke. Not so many reports studied the significance of intracranial arterial calcification though CT has been used routinely for brain imaging. VWC is often found in vertebral arteries (VA), basilar artery (BA), and cavernous portion of ICA. A few studies reported relationship of intracranial ICA stenosis and ischemic stroke[7,8]. Other reports showed no significant relationship between brain infarction and calcification of intracranial ICA, nor middle cerebral artery (MCA)[9-11]. Based on our knowledge, there is no published study in posterior arterial territory in the English literatures.

The purposes of the present study was for identifying any significant relationship between intracranial vertebrobasilar arterial (VBA) calcification routinely found on brain CT and infarction of the posterior fossa parenchymal structure and the end territory of VBA system.

Material and Method

The present study was a cross-sectional retrospective case-control study in patients aged more than 18 years old with available brain CT between January 2008 and December 2009 in the PACS of the

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department of radiology in our institute. The authors hypothesized that patients with posterior fossa brain infarction had more VBA calcification than patients without the infarction. The sample size was calculated to be 110 cases for each in a study and a control groups. The patients in the study group were selected from those with reported cerebellar or brain stem infarction in the archive system. The control group was selected from patients with no reported infarction in these areas and having sex and age matched with the case group[11]. Exclusion criteria were history of brain surgery, brain tumor, intracranial hemorrhage, and infection.

All brain CTs were performed by 64 MDCT (Light Speed VCT 64 scanner, GE Healthcare USA; and Somatom Sensation 64, Siemens Medical Solutions, Germany) with continuous slice thickness of 1.25 or 1.5 mm and multi-formatted reconstruction. The Images were evaluated by a neuroradiologist (with more than 20 years' experience in neuroimaging) blinded from history of infarction. The window setting and level were chosen first for evaluating calcified VBA with wide soft tissue window (window width/level = 426/55 HU). Subsequently, brain infarction was identified by brain window (width/level = 150/50 HU). Visualized assessment of VWC was performed in each VA and BA. In cases with positive calcification, degree of calcification was estimated in thickness and extension modified from Babiaz LS et al[9,10]. Due to VA and BA are smaller size than ICA, the authors evaluated severity of luminal stenosis as the surrogate of calcification thickness. The most narrowing part of the artery was selected and measured for diameter of remaining lumen and outer diameter of the artery. The ratio of luminal diameter by outer diameter was used for grading score. The detail of scores is shown in Table 1.

Table 1. Modified grading scale of calcification[9,10]

Circumferential extension of calcification
Grade 0 = No calcification
1 = Dot of calcification
2 = Crescent area of calcification <90°
3 = Calcification from >90-<270°
4 = Calcification from >270-360°
Thickness grade as degree of luminal stenosis
Grade 0 = No calcification
1 = 1-25% stenosis
2 = 26-50% stenosis
3 = 51-75% stenosis
4 = >75% stenosis

Areas of infarction were evaluated as hypodense lesions and classified as supratentorial or infratentorial lesion. The supratentorial infarction was further classified into superficial and deep group whereas the infratentorial group was classified as brain stem, cerebellar hemisphere, and vermis groups.

Descriptive analysis of the findings was performed at the appropriate place. The relationship of VWC and evidence of infarction was analyzed by using Chi-square test with predetermined significant p-value of less than 0.05. Odds ratio with 95% confidence interval (95% CI) were presented.

Results

Six patients in the study group (2 intracranial hemorrhage, 4 previous surgery) and 16 patients in the control group (3 hemorrhage, 5 post-surgery, 8 infarction in posterior fossa brain) were excluded after this step.

Finally, there were 104 patients in the study group (61 males and 43 females, aged between 29 and 97 years old, mean 69.4±13.9) and 94 patients in the control group (55 males and 39 females, aged between 34 and 94 years old, mean 68.3±12.6). The numbers of patients in each age group were demonstrated in Fig. 1.

One hundred ninety eight patients were enrolled into the present study with 104 in the study group and 94 in the control group. Vetebrobasillar artery calcification was found in 72 cases (69%) in the study group and 53 cases (56%) in the control group. No statistically significant relationship between VBA calcification and infratentorial infarction was found (p = 0.08, OR = 1.75, 95% CI = 0.94-3.26). When reclassified occipital and thalamic infarction as end territory of VBA system, 11 cases in the control group were excluded. In this new control group, 46 cases (52%) with VBA calcification were identified. Then, statistical significance of the relationship between VBA calcification and infarction in the end territory of VBA system was reached (p = 0.02, OR = 2.08, 95% CI = 1.1-3.94). However, there was no relationship between severity of calcification and areas of infarction. The VWC was found more in older age group in both study and control groups (Fig. 2).

Though no relationship between gender and VWC was found, there was a tendency of higher incidence of VWC in female than male (70% vs. 59%).

VWC was mostly found at left VA, followed by right VA and BA respectively in both study and control groups. Most of the infarction was found in

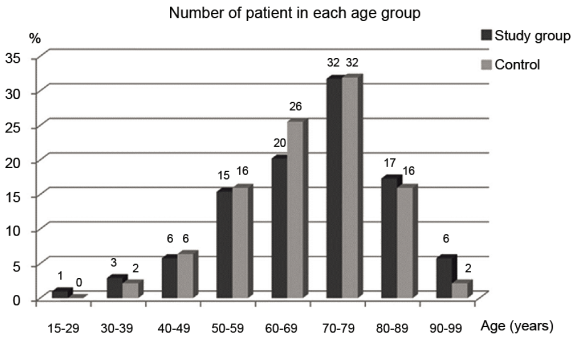


Fig. 1 Number of patient in each age group.

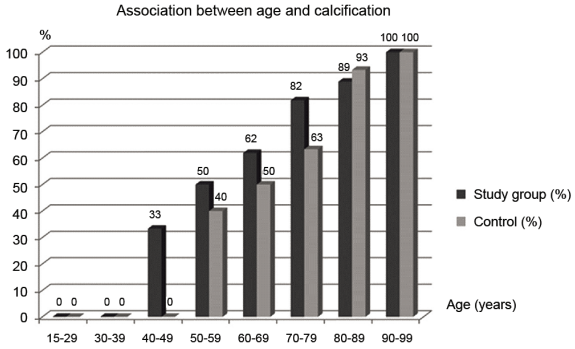
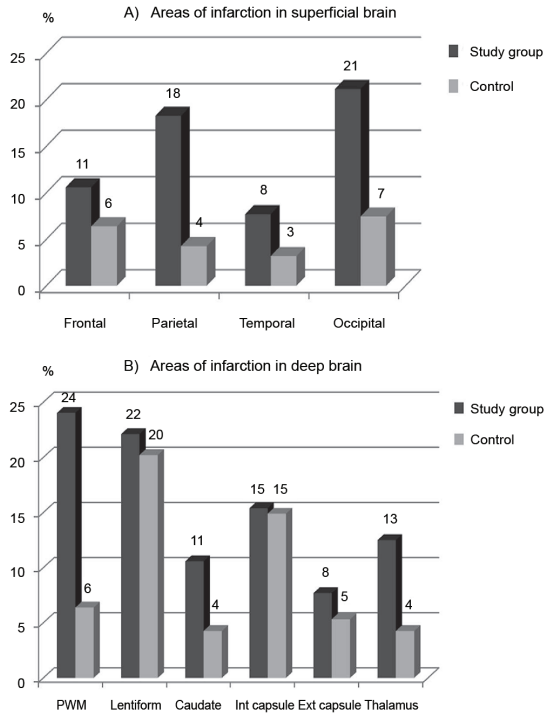


Fig. 2 Number and percentage of patients with vascular calcification in each age group in both case and control groups.



PWM = periventricular white matter, Int capsule = internal capsule, Ext cap = external capsule

Fig. 3 Supratentorial infarction areas in the study and control group before reclassification.

cerebellar hemisphere (57 cases in left side and 54 cases in right side), followed by pons (25 cases), mid brain (10 cases), vermis (8 cases), and medullar oblongata (3 cases) respectively. Surprisingly, infarction of supratentorial location was found more in the study group than in the control group (81 vs. 44 cases) (Fig. 3).

Discussion

The etiology of ischemic stroke may be divided into atherosclerotic large vessel disease, lacunar-small vessel disease, cardio embolic stroke, stroke from other known causes, and idiopathic stroke[2,13]. Nandular KR, et al demonstrated relationship between atherosclerotic cervical ICA and ischemic stroke[1]. The finding could be used as a predictor for future stroke. Chen X et al reported overall intracranial vessel calcification as a new risk factor for ischemic stroke[8]. Their study had no information of regional brain that was related to the involved arterial territories in the study. Other studies showed no relationship between infarction and VWC[9-11]. Up to the authors' knowledge, no study about the relationship between calcification of VBA and infarction of posterior circulation was reported in the English literatures. The important factor is the complexity of blood supply in this area and variation of VBA system and circle of Willis.

In the present study, the relationship between VBA calcification and infratentorial infarction was not found either. However, significant relationship was demonstrated when including occipital and thalamic infarction into the study group. Considering the complexity and variation of occipital and thalamic blood supply made the authors not include those areas into the study group at first. Notwithstanding limitation of lesion detection in the posterior fossa, the authors intended to generalize the result by studying on routine brain CT in identifying infarction.

Next to the top end of VBA is the right and left posterior cerebral artery (PCA), a part of circle of Willis, whereby the posteromedial and frontolateral groups of ganglionic and perforating branches directly come off and straightforward to supply the thalamus. The occipital lobes are the end areas territories of the terminal branches of these PCAs. When the arterial

pressure is reduced by a certain degree of stenosis in the VBA system, ischemic infarction will take place in the remote areas such as occipital lobes and thalamus first and before the adjacent or nearby ones.

No relationship between intracranial ICA and infarction was found in previous studies[9-11]. The negative result may confound from atherosclerotic cervical ICA[11]. On the other hand, atherosclerosis of cervical VA is less found. This may explain a trend to find significant relationship between vascular wall calcification and posterior circulation infarction in the present study.

More cases of supratentorial infarction found in the study group in this series possibly implied more severe atherosclerotic process of the intracranial arteries. The calcification of VBA may not represent only insult to the posterior circulation brain but indicate severity of the process to the whole brain parenchyma. The present study could not demonstrate the relationship between posterior fossa infarction and degree of vascular wall calcification even with variable grading methods. Too small sample size in each subgroup of calcification grade or inappropriate grading score may be the cause of this limitation. The second limitation of the present study is needed to be improved by a deep review of the end territory of VBA system. Finally, the present study did not evaluate clinical information of the patients. Cohort study of VBA calcification on the clinical impact in prospective way is needed.

Conclusion

There was no statistical significance of relationship between vascular wall calcification and the infarction of posterior fossa anatomical structure per se-brainstem and cerebellum, but a significant relationship between VBA calcification and infarction in the end territory of VBA-the thalamus and occipital lobes.

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การศึกษาความสัมพันธ์ระหว่างหินปูนเกาะหลอดเลือดเลี้ยงสมองส่วนหลังกับการเกิดเนื้อสมองตายด้วยภาพซีที

อรสา ชวาลภาฤทธิ์, สุรพงษ์ ชาลีวิทย์

วัตถุประสงค์: *เพื่อศึกษาความสัมพันธ์ของการเกิดเนื้อสมองตายกับการเกิดหินปูนอุดตันหลอดเลือดเลี้ยงสมองส่วนหลัง*

วัสดุและวิธีการ: *ศึกษาย้อนหลังจากภาพซีทีสมองของผู้ป่วยที่มาตรวจในโรงพยาบาลศิริราชจำนวน 198 ราย ที่มีข้อมูลในระบบฐานข้อมูลภาพ โดยการคัดเลือกจากผู้ป่วยที่พบเนื้อสมองตายจากการขาดเลือดในก้านสมองและสมองน้อยจำนวน 104 ราย ผู้ป่วยที่มีอายุและเพศตรงกับผู้ป่วยกลุ่มโรค 94 ราย แต่ไม่มีเนื้อสมองส่วนก้านสมองและสมองน้อยตาย ถูกคัดเลือกเป็นกลุ่มควบคุม ผู้นิพนธ์ได้บันทึกการพบหินปูนเกาะผนังหลอดเลือดที่เลี้ยงสมองส่วนหลัง (vertebrobasilar system) และวัดส่วนที่หนาที่สุดและสัดส่วนของหินปูนที่เกาะเพื่อให้ระดับความรุนแรงของการอุดตันหลอดเลือด*

ผลการศึกษา: *จากการวิเคราะห์ทางสถิติไม่พบความสัมพันธ์อย่างมีนัยสำคัญ ระหว่างการเกิดเนื้อสมองตายกับการมีหินปูนเกาะผนังหลอดเลือด เมื่อจัดกลุ่มที่มีเนื้อสมองตายในบริเวณ occipital lobe และ thalamus เข้าเป็นกลุ่มโรค พบว่ากลุ่มที่มีเนื้อสมองตายพบหินปูนเกาะผนังหลอดเลือดมากกว่ากลุ่มควบคุมอย่างมีนัยสำคัญทางสถิติ แต่ไม่พบความสัมพันธ์ระหว่างความรุนแรงของหินปูนที่เกาะหลอดเลือดกับบริเวณของเนื้อสมองตาย*

สรุป: *จากการศึกษานี้พบแนวโน้มของความสัมพันธ์ของการเกิดหินปูนที่ผนังหลอดเลือดกับการเกิดเนื้อสมองตายจากการขาดเลือดในสมองส่วนที่เลี้ยงด้วยหลอดเลือดระบบ vertebrobasilar*