Association Between Abnormal Course of Carotid Artery and Cerebrovascular Disease

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Abstract-

Purpose: Abnormal course of the carotid artery (ABCA) is commonly identified during carotid sonography studies. Whether ABCA is related to the risk of stroke and stroke risk factors remains unclear. The purpose of the study is to investigate the prevalence of ABCA and the relationship with stroke and the risk factors of stroke.

Methods: Color duplex ultrasound scanning of carotid arteries was performed on 615 subjects (between January 1, 2012 and March 31, 2012). ABCA and intimal thickness were recorded. Risk factors of stroke such as hypertension, diabetes mellitus, dyslipidemia, atherosclerosis, stroke history, and heart disease were recorded. The prevalence of ABCA was analyzed and its relationship with stroke and stroke risk factors was evaluated.

Results: ABCA was found in 4.1% (25/615) patients, 6.29% (19/302) in women, and 1.91% (6/313) in men. ABCA in 1 vessel was noted in 18 patients, 2 vessels in 3 patients, 3 vessels in 3 patients, and 4 vessels in 1 patient. The frequency of ABCA was significantly higher in women than in men (6.3% vs 1.9%, $p = 0.01$). There was no difference in the prevalence of ABCA between stroke patients and non-stroke subjects ($p = 0.60$). ABCA was more frequent in patients older than 65 years. (5.91% (22/372) vs. 1.23% (3/243) $p = 0.01$). Logistic regression analysis did not reveal associations between ABCA and stroke risk factors (hypertension, diabetes mellitus, dyslipidemia, stroke history, heart disease and atherosclerosis). During 1 year follow-up, 2.88% (17/590) of non-ABCA patients and 4.0% (1/25) of ABCA patients had event of stroke or transient ischemic attack (TIA) (p =0.08).

Conclusion: The prevalence of ABCA in the present study is significantly lower than that in previous studies (Togay-Isikay et al., 24.6%, Del Corso et al., 58%). ABCA is more frequent in women and older patients. ABCA is not related to stroke and stroke risk factors. From our results, we suggest that patients with ABCA be placed under observation unless they exhibit neurological symptoms.

Key Words: Carotid artery, Cerebrovascular disease, Stroke, Tortuosity, Ultrasound

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INTRODUCTION

Abnormalities of the carotid artery (ABCA) were first reported a century ago[1]. Abnormalities of the carotid artery include tortuosity, kinking, and coiling of the artery[2], and the etiology and clinical roles of ABCA are still controversial. ABCA is found in 4-45% patients undergoing angiography[2]. The etiology of ABCA can be either congenital or acquired. Congenital ABCA is observed in both youth and children. Acquired ABCA could be due to atheroma, aging, and/or hypertension[3,4].

The clinical significance of ABCA is not well known. Some authors consider it a benign angiopathy[5]. However, it is recognized to be associated with cerebrovascular insufficiency and stroke[6]. In patients undergoing internal carotid artery stenting, a tortuous artery may increase the risk of vessel spasm[7]. Quattlebaum et al. suggested re-sectioning of tortuous carotid arteries in patients with history of a TIA to prevent stroke[6]. However, stroke and TIA have many risk factors, and whether re-sectioning of a tortuous carotid artery can prevent stroke requires further investigation.

Carotid duplex ultrasound was introduced to evaluate carotid and intracranial arteries 20 years ago[2]. It allowed noninvasive evaluation of the morphology and blood flow of extracranial arteries[8].

ABCA is not uncommon in clinical practice. However, there is no information on the prevalence of carotid artery abnormalities in Taiwan and whether these abnormalities increase the risk of stroke. In the present study, we investigated the prevalence of carotid artery abnormalities and whether it is associated with stroke.

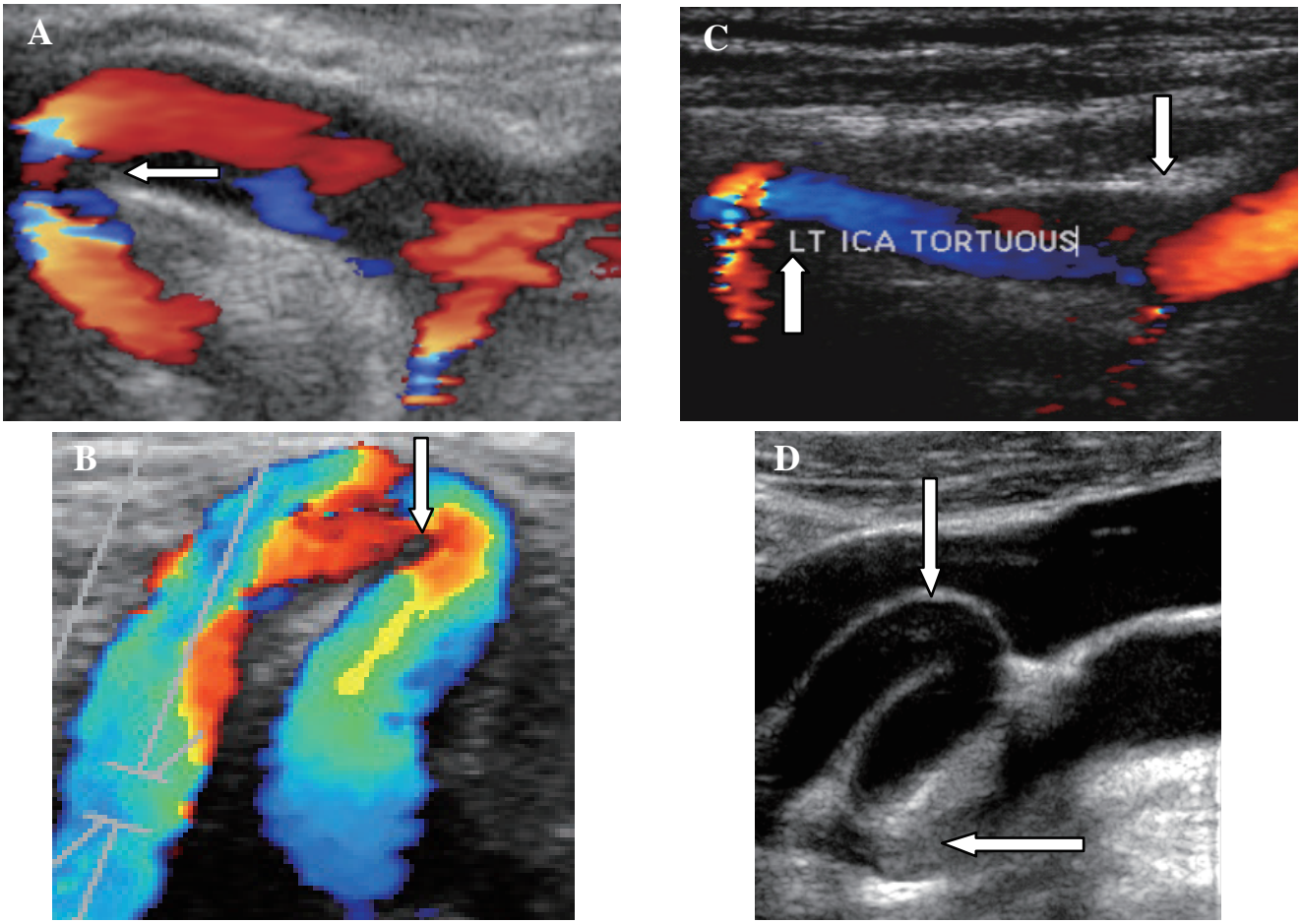

Figure 1. (A) C-shape tortuosity; (B) C-shape kinking (acute angulation, arrow); (C) S-shape tortuosity; (D) S-shape Coiling (exaggerated S-shape curve, arrow)

Patients and methods

From January 1, 2012 to March 31, 2012, 618 consecutive patients were examined at the neuroultrasound laboratory of Chia Yi Christian Hospital. Of the 618 patients, 3 patients were excluded from the study because of high bifurcation, short conformation of the neck, and inability to complete the evaluation. In the remaining 615 patients, the most common reason of ultrasound studies were ischemic stroke or TIA (277), followed by atherosclerotic carotid artery disease follow-up (150), vertigo (63), dizziness and suspected atherosclerosis (37), syncope (13), dementia (13), physical examination (13), preoperative investigation (6), and other neurological conditions (8). In addition, 35 patients were examined due to a history of ischemic heart disease. Two ultrasonographers performed the carotid ultrasound examination. They routinely scanned the arteries from the proximal common carotid artery, proceeding superiorly to the distal internal carotid artery and external carotid artery[8]. The internal carotid artery abnormality may be found 6cm above the bifurcation of the common carotid artery[1]. Abnormal course of the carotid artery includes tortuosity, kinking, or coiling of the artery. Tortuosity has been defined as any elongation, C-shape (Fig. 1A), or S-shape (Fig. 1C) curve of the vessel. Kinking (C-shape 1B) was defined as an acute angulation of the vessel associated with functional or organic narrowing. Coiling was defined as elongation of the vessel with an exaggerated S-shape curve (1D) or circulation configuration[8,9]. In the present study, ABCA was defined as the presence any one of tortuosity, kinking, or coiling. Atherosclerosis of the carotid artery was defined as stenosis of more than 50%. The clinical features of the patients included age, sex, and risk factors of vascular disease (hypertension, diabetes mellitus, hyperlipidemia, heart disease, and stroke history). Abnormal courses of the common carotid artery, internal carotid artery, and external carotid artery were recorded. We monitored the patients in the outpatient clinics for 1 year, and we obtained information from medical records. We obtained information by telephone interviews for patients who did not have regular follow-up and had no medical records at our hospital.

Statistical analysis of ABCA and non-ABCA groups was performed using the Chi-square test for categorical variables. Logistic regression analysis was used to investigate the risk factors of stroke. $p < 0.05$ was considered significant. MedCalc for Windows, version 12.3 (MedCalc Software, Ostend, Belgium) was used for data analyses. The study has been approved by the Ethics Committee of the hospital.

RESULTS

Of the 615 patients, 302 were women and 313 were men, and their mean age 68.99 ± 11.96 years (Table 1). ABCA was present in 25 (4.06%) of patients in a total of 37 vessels-1 abnormal vessel in 18 patients (5 men, 13 women), 2 in 3 patients (1 man, 2 women), 3 in 3 patients (3 women), and 4 in 1 patient (1 woman). The 37 abnormal vessels included 21 internal carotid arteries (4 men, 17 women), 15 common carotid arteries (3 men, 12 women), and 1 external carotid artery (1 woman). The prevalence of ABCA is higher in patients older than 65 years old. (1.23% vs 5.91%, $p = 0.01$). The mean age of patients with ABCA were older than those patients without ABCA (75.00 ± 10.36 vs. 68.94 ± 11.88; $p = 0.01$). The prevalence of ABCA is higher in women than in men

Table 1. Characteristics of patients (N=615)

	ABCA (25)	non-ABCA (590)	Total (615)	*p*
Men	24% (6/25)	52.0% (307/590)	50.9% (313/615)	0.01
Age >65	88% (22/25)	59.3% (350/590)	60.5% (372/615)	0.01
Hypertension	80% (20/25)	65.4% (386/590)	66.0% (406/615)	0.19
Diabetes mellitus	32% (8/25)	27.3% (161/590)	27.5% (169/615)	0.65
Hyperlipidemia	44% (11/25)	31.0% (183/590)	31.5% (194/615)	0.19
Stroke	52% (13/25)	44.7% (264/590)	45.0% (277/615)	0.54
Heart disease	20% (5/25)	17.5% (103/590)	17.5% (108/615)	0.95

ABCA: abnormal course of carotid artery

Table 2. Age distribution and abnormal course of carotid artery.

Age	ABCA	non- ABCA	% of ABCA	total
≤40	0	10	0	10
41-50	1 (M 1)	36	2.7%	37
51-60	1 (F 1)	93	1.0%	94
61-70	5 (M 2; F 3)	149	3.2%	154
71-80	11 (M 3, F 8)	219	4.8%	230
>80	7 (F 7)	83	7.8%	90

ABCA: abnormal course of carotid artery, M: men; F: female

Table 3. Logistic regression about factors related to ABCA

	Odds ratio	Confidence interval	P
Sex (W/M)	3.28	1.24- 8.68	0.01
Age> 65 years (Yes/no)	4.19	1.21-14.50	0.02
Hypertension (Yes/no)	1.41	0.49- 4.10	0.51
Diabetes mellitus (Yes/no)	1.06	0.42- 2.62	0.89
Hyperlipidemia (Yes/no)	1.52	0.62- 3.70	0.35
Stroke (Yes/no)	1.33	0.56- 3.15	0.50
Atherosclerosis (yes/no)	1.44	0.48- 4.30	0.50
Heart disease	1.27	0.44- 3.70	0.64

ABCA: abnormal course of carotid artery, W: women; M: men

(1.91% vs. 6.29% $p = 0.01$). The prevalence of risk factors for stroke included diabetes mellitus, hypertension, heart disease, hyperlipidemia, and atherosclerosis; there were no significant differences between ABCA and non-ABCA groups. The history of stroke was not different between the two groups ($p = 0.5$). The prevalence of ABCA increases with age, from 2.7% at age 41–50 years to 7.8% in patients older than 80 years (Table 2). Multivariate logistic regression analysis revealed an association between ABCA, and, women or old age (Table 3). In the study, most of the ABCA were an incidental finding in ultrasound examination and there were asymptomatic. During one year follow-up, 2.88% (17/590) of non-ABCA patients and 4.0% (1/25) of ABCA patients had event of stroke or TIA (p=0.08).

DISCUSSION

The prevalence of ABCA in previous studies using carotid duplex ultrasound was from 26%-58%[2,9,10]. In the present study, carotid artery abnormalities were found in 6.68% of the subjects, which is lower than that reported in previous studies. This difference may be related to patient selection. In a resident population-based study, the prevalence of ABCA was 1.3%[11]. Whether the difference between the present and previous studies is related to ethnic differences requires further investigation.

The pathophysiology of carotid artery abnormalities is still unclear. Ricardo et al. found that carotid artery abnormalities were not related to age, cardiovascular risk factors, or presence of atheromatous plaques, and that kinking and coiling of the carotid artery are a result of alterations in embryological development and not due to aging and/or atherosclerosis[12]. However, some studies found that ABCA was associated with stroke risk factors. Pancera et al. reported a high prevalence of tortuosity of carotid arteries in hypertension patients and hypothesized that high endoluminal pressure may be a factor contributing to tortuosity of the carotid artery[4]. Corso et al. found that carotid abnormalities were associated with hypertension, hyperlipidemia, chronic cigarette smoking, and ischemic heart disease[2]. Our study shows that the prevalence of carotid artery abnormality was not related to cerebrovascular disease risk factors or stroke history but was associated with women and older patients. The result is the same as that of Sacco et al.[8].

Tortuosity of the carotid artery has been reported to correlate with TIA and stroke, and surgical intervention to relieve the kinking has been suggested to prevent stroke[5,13-15]. However, some authors suggest that tortuosity of the carotid artery does not imply any additive risk for stroke and recommend only observation[16]. In the study, most of the ABCA were an incidental finding during ultrasound examination and were asymptomatic. Our study showed that ABCA was not correlated to cardiovascular risk factors and stroke history and was not increase the risk of stroke. According to these results, we suggest that patients with abnormal morphology of the carotid artery be placed with observation unless they exhibit neurological symptom. There are some limitations in the present study. First, the study is a clinical study and not a randomized control study, and hence, there may have been bias in patient selection. Second, we did not record the abnormal morphology of the carotid artery. Third, because the study is a retrospective study, we could not obtain complete information on the risk factors of stroke.

In conclusion, ABCA is common during neurovascular examinations and most of the ABCA are asymptomatic. It is usually seen in aged individuals and women and is not related to stroke and not related to the risk factors of stroke. It also does not increase the risk of stroke. From our results, we suggest that patients with ABCA be placed under observation unless they exhibit neurological symptoms. However, a larger, prospective study to clarify this point is necessary.

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