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Intra- and extracranial atherosclerotic stenosis in China: epidemiology, diagnosis, treatment and risk factors

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Abstract. – OBJECTIVE: Data regarding the cerebral atherosclerotic stenosis (CAS) and incidence of stroke are conflicting. The number of stroke patients is more than three times that from coronary heart disease in China. The main aim of this report is to review the current status of intracranial and extracranial atherosclerotic stenosis including epidemiology, diagnosis, treatment and risk factors in China.

METHODS: Data was identified by searches of MEDLINE (January 1966 to December 2008), China Biological Medicine Database (CBM-disc 1979 to 2008), China National Knowledge Infrastructure (CNKI 1994 to December 2008).

RESULTS: The occurrence of intracranial artery stenosis was more frequent than that of extracranial artery in the Chinese population. TCD, Doppler ultrasound, CTA, MRA and DSA techniques are established to examine intracranial and extracranial atherosclerotic stenosis in China. Evidence-based treatments and CAS are more commonly applied in patients with cerebrovascular stenosis in China. However, the development of carotid endoarterectomy (CEA) is limited in Chinese communities. The risks of cerebral atherosclerotic stenosis include age, hypertension, diabetes mellitus, dyslipidemia, smoking and metabolic syndrome.

CONCLUSIONS: Further studies are needed to focus on the intracranial atherosclerotic stenosis.

Key Words:
Atherosclerotic stenosis, Carotid disease, Cardiovascular risk factors.

Introduction

Stroke is the second most common cause of death and leading cause of adult disability worldwide[1]. Over two thirds of stroke deaths worldwide are in developing countries[2]. Among developing countries, China has the largest population, the number of stroke patients is more than three times that from coronary heart disease. Ischemic stroke accounts for more than 80% of all strokes, cerebral large-artery occlusive disease represents an important cause of ischemic stroke worldwide. Over time, the proportion of elderly people in the population is likely increase as life expectancies will lengthen, and the influence of a westernized lifestyle might influence the number of cerebral atherosclerotic stenosis. The main aim of this report is to review the current status of intracranial and extracranial atherosclerotic stenosis including epidemiology, diagnosis, treatment and risk factors.

Methods

Data was identified by searches of MEDLINE (January 1966 to December 2008), China Biological Medicine Database (CBM-disc 1979 to 2008), China National Knowledge Infrastructure (CNKI 1994 to December 2008) with the terms "China", "Chinese", "epidemiology", "epidemiological", "incidence", "prevalence", "mortality", "morbidity", "fatality", "case fatality", "atherosclerosis", cerebrovascular accident", "isch(a)emic stroke", "intracranial", "extracranial", "primary prevention", "secondary prevention", "survey", "intervention", "management", "care", and "treatment". References in the relevant identified articles were manually searched. Studies were done in mainland China. Only papers published in English or Chinese were included. There was no time limit for the studies. We did not restrict inclusion criteria to a certain standard for comparable studies.

Results

Epidemiological Data

Symptomatic Population

Eight studies relevant to intracranial and extracranial atherosclerotic stenosis occurrence in

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patients with symptomatic ischemic cerebrovascular diseases were included (Table I). The first study that mentioned the distribution of intracranial and extracranial atherosclerotic stenosis in the Chinese population was published in 1975[3]. In an earlier study from the New England Medical Center, 43% of 24 Chinese patients with transient ischemia attack (TIA) or stroke had middle cerebral artery(MCA) stem stenosis, whereas only 9% of the patients had severe stenosis of the extracrania artery[4]. A later study from Taiwan evaluating the 108 symptomatic patients with cerebrovascular steno-occlusive diseases showed 25.9% had only intracranial -tributary stenosis, 24.1% of patients had only extracranial carotid disease, and 17.6% of them had both extracranial and intracranial carotid artery tributaries[5]. A study of 96 patients with TIAs from the Peking Union Medical College Hospital showed that 51% had intracranial vascular stenosis or occlusion, and 19% had extracranial disease, the MCA was the most frequent site (66%) in the intracranial lesion[6]. Based on these findings, investigators at the Chinese University of Hong Kong reported similar results in 66 patients with acute stroke, the final data showed 22 (33%) patients with intracranial occlusive diseases (11 patients with MCA stenosis, 3 patients with terminal internal carotid stenosis and 8 patients with MCA occlusion) and 3 (6%) had extracranial carotid stenosis[7]. After two years, they use TCD to predict the number of occlusive arteries in the 705 patients, the results showed 258 patients (37%) had intracranial lesions only, 16 (2.3%) had extracranial lesions only, and 71 (10%) had both extracranial and intracranial lesions; MCA, vertebrobasilar artery, and anteriorcerebral artery were the 3 most commonly involved vessels[8]. Furthermore, two studies from Tiantan hospital and Xuanwu hospital in Beijing used digital subtraction angiography (DSA) to investigate distribution of cerebral artery stenosis in Chinese patients, these two researches reported different results (70.4% vs 49.8% intracranial arterial stenosis respectively, 49% vs 33.2% extracranial arterial stenosis respectively) [9,10]. The reason for this disparity may be due to the different diagnositic criteria of stenosis. These study populations were clinic based rather than community based, so that generalization may be limited.

Asymptomatic Population

In an early autopsy study from Hong Kong, investigators found that among the 114 consecutive patients who died from a variety of causes, 31.4% of the subjects had at least one of the nine intracranial main cerebral arteries affected by severe atherosclerosis, 18% of the subjects had extracranial carotid arteries stenosis and 2% had complete carotid arteries occlusion. In 70% of these cases, the sites of maximum narrowing occurred in the carotid sinus and the origin of the internal carotid artery. The distal branches of the intracranial vessels were also commonly involved[11]. Four reports used similar methods to investigate distribution of intracranial or extracranial atherosclerotic stenosis in various populations (Table I). The work of Wong et al[12] was the first published report of a door-to-door study of intracranial atherosclerostic stenosis. They observed 590 asymptomatic villagers in Liangbei County in central rural China and found 41 subjects (prevalence 6.9%) with intracranial atherosclerosis: 29 subjects (12 bilateral involvement) had MCA stenosis, 20 (9 bilateral) had anterior cerebral artery stenosis, 7 had vertebrobasilar stenosis, 4 had posterior cerebral artery, and 4 had intracranial carotid stenosis. Then they used transcranial Doppler sonography (TCD) to screen 3,057 asymptomatic high-risk Hong Kong patients and found the prevalence of diseased MCA was 12.6% (385 patients) in this cross-sectional study[13]. Huang et al[14] assessed 1,068 asymptomatic subjects in a local residential community in the Guangdong Province and found 63 subjects (prevalence 5.9%) had MCA stenosis. Compared with prevalence from Liangbei population, the prevlance of MCA stenosis is higher in the Guangdong population. Furthermore, the First Affiliated Hospital of Beijing university and Fuwai Hospital investigated the prevalence of cerebral arterial stenosis in the two villages and two communities in the rural area of Beijing, of all the 2711 participants 101 (3.7 %) had intracranial arterial stenosis only, 41 (1.5%) had extracranial arterial stenosis only and 19 (0.7%) had both intracranial and extracranial arterial stenosis[15].

In conclusion, both the epidemiological survey of asymptomatic populations and the inspection in patients with ischemic stroke have confirmed that the occurrence of intracranial artery stenosis was more frequent than that of extracranial artery in the Chinese population.

Racial Differences in the Distribution of Cerebral Atherosclerostic Stenosis

There are striking differences in the distribution of atherosclerotic stenosis in the cerebral vasculature among different populations. Asian,

Table I.

	Duration of data collection	Sample population	Age range (years)	Diagnostic method	Case ascertainment	Examining segment	Distribution /Prevalence
Brust1975[3]	1968-1972	296 (16 Chinese)	42-73	DSA	Retrospective study	Intra- and extra-cranial	6.3% intra 31.3%extra
Feldmann 1990[4]	1990	24 symptomatic patients	Unclear	DSA	Retrospective study first and then	Intra- and extra-cranial	43% intra(MCA)
Leung 1993[11]	1988	114 died patients	8 - 90	Autopsy	Retrospective study	Intra- and extra-cranial	9% extra 31.4% intra 20% extra
Liu1996[5]	1994-1995	108 symptomatic patients	44 - 85	MRA	Prospective study	Intra- and extra-cranial	25.9% intra 24.1%extra 17.6% both
Huang1997[6]	1996	96 patients with TIAs	12-81	TCD and Duplex ultrasound	Prospective study	Intra- and extra-cranial	51% intra 19%extra
Wong1998[7]	1996	66 acute stroke patients	42-84	TCD and MRA	Prospective study	Intra- and extra-cranial	33% intra 6% extra
Wong 2000[8]	1997-1998	705 acute stroke patients	Mean age 67.7	TCD	Prospective study	Intra- and extra-cranial	37% intra 2.3% extra 10% both
Wang 2003[9]	2001-2002	196 patients with cerebrovascular disease	23-83	DSA	Cross-sectional study	Intra- and extra-cranial	70.4% intra 49% extra
Shi 2005[10]	2002-2005	1000 with cerebrovascular disease	3-86	DSA	Retrospective study	Intra- and extra-cranial	49.8% intra 33.2% extra 17.0% both
Wong 2007[12]	1999	590 asymptomatic villagers	≥ 40	TCD	Retrospective door-to-door survey	Intracranial	6.9% intra
Wong2007[13]	Unclear	3057 high-risk patients	≥ 45	TCD	Cross-sectional study	Intracranial	12.6% intra
Huang 2007[14]	unclear	1068 healthy residents	50 - 103	TCD	Cross-sectional study	Intracranial	5.9% intra
Fan2007[15]	2002-2005	2711 rural community residents	≥ 40	TCD	Cross-sectional study	Intra- and extra-cranial	3.7% intra 1.5% extra 0.7% both

MRA: magnetic resonance angiography

Hispanic, and African are more prone to intracranial large artery stenosis (ICS) while Caucasian individuals are more prone to extracranial carotid stenosis[16-18]. Feldmann et al[4] first specifically compared the angiographic features between the Chinese and Caucasian populations in the distribution of symptomatic occlusive cerebrovascular diseases. They found that the Chinese population had more severe intracranial atherosclerotic stenosis (IAS) while Caucasians had more severe extracranial carotid diseases and suggested that the preponderance of intracranial vascular stenosis in Chinese patients was similar to that seen in African and Japanese patients. But their investigation had a selection bias. Autopsy studies of the distribution of cerebral atherosclerosis in the general population have shown similar racial differences. African and Japanese populations have more intracranial atherosclerosis, whereas Caucasians have more extracranial disease[19-22]. A recent autopsy work involving 114 Hong Kong Chinese suggested atherosclerotic narrowing of intracranial atherosclerosis is much more severe in Hong Kong Chinese compared with figures from Caucasian and Japanese populations, whereas the extent of the extracranial atherosclerosis is less severe in Hong Kong Chinese than in Caucasians[11].

Diagnosis

TCD

In 1982, the Transcranial Doppler (TCD) technique was first applied to detect cerebrovascular occlusive disease in the clinic by Aaslid et al[23]. After ten years, a TCD center was also established to examine intracranial and extracranial atherosclerotic stenosis in the Chinese Peking Union Medical College Hospital and the Chinese University of Hong Kong.

The Hong Kong prince of Wales Hospital gives the criteria for occlusive arteries by blood flow velocity as follows: 140 cm/s for the MCA, 120 cm/s for the anterior cerebral artery (ACA), 100 cm/s for the posterior cerebral artery (PCA) and vertebrobasilar artery (VBA), and 120 cm/s for the siphon internal carotid artery (ICA)[12]. The criteria for intracranial arterial occlusion was diagnosed if all basal arteries except the artery in question were detectable or if there was -21% compared with the contralateral vessel, and stenosis or occlusion of the extracranial carotid artery was suggested by low ipsilateral MCA or siphon velocity; evidence of intracranial collateral circulation, systolic ratio of 1.8 and peak systolic velocity of 120 cm/s. Compared to the above criteria, Beijing Union Medical College hospital diagnosed intracranial artery stenosis only as the mean blood velocity 120 cm/s[6], but did not define the criteria for the main stem of intracranial artery, respectively.

TCD is a noninvasive, safe, and accepted method to diagnose intracranial occlusive disease and has been validated for grading MCA stenosis[24,25]. The TCD criteria used in the study of the Hong Kong prince of Wales Hospital had a sensitivity of 91.4% and a specificity of 82.7% for diagnosing 50% MCA stenosis compared with MRA[25]. Beijing Union Medical College Hospital validated their TCD technique in their local population with DSA, the results showed the sensitivity and specificity of the TCD examination for arterial stenosis to be 86% and 98%, respectively[26]. Regardless of known and accepted TCD criteria for cerebral artery stenotic disease, TCD grading of stenosis is largely operator dependent. TCD may not as accurate as angiography, but it is well suited for screening a large number of subjects[12-14], especially in the clinic. Furthermore, TCD has a low cost and is accessible to most hospitals, especially important for rural hospitals in China.

Doppler Ultrasound

Previously, few works reported the Doppler ultrasound findings of the extracranial carotid arteries in Chinese people[27,28]. Now Doppler ultrasound has been available for routine noninvasive examination of the extracranial arteries for detection and evaluation of stenosis[29], characterization of atherosclerotic plaques[30], diagnosis and follow up of vascular diseases[31], and for assessment of the indication for carotid artery operation in China[32]. In a 5 years period (2004-2008), there were about 30,000 research reports on the application of Ultrasound B in the clinical research of extracranial atherosclerotic stenosis.

CTA and MRA

In 1990s, many city-level or above hospitals introduced computed tomography angiography (CTA) and magnetic resonance angiography (MRA) techniques to evaluate intracranial and extracranial atherosclerotic disease[5,33-35]. During the past decade, the CTA technology has dramatically evolved from 4 slice to 128 slice spiral CT and the MRA examination has evolved from the

3D TOF, 3D PC and 3D CE MRA to 4D CE MRA. Now almost all the big or middle-size city-level or county-level hospitals in China have CTA or MRA, the two techniques have been widely accepted as powerful and noninvasive tools in the evaluation of cerebrovascular atherosclerotic disease[36-38].

DSA

Digital subtraction angiography (DSA) is regarded as the standard method to evaluate carotid artery stenosis and to indicate endarterectomy. During the past decade, DSA technology has evolved from the 2D DSA and 3D DSA to DSA virtual endoscopy. However, the method is an invasive procedure and is associated with relatively high risk of complications in patients with atherosclerosis[39]. Many institutions published diagnostic studies in which MRA, CTA and/or duplex ultrasound were compared with DSA, and the results suggest that the combination of noninvasive examinations might be preferable over DSA for preoperative evaluation in most patients[40-43]. Therefore, presently in China DSA is mainly used in local intra-arterial thrombolysis[44] or evaluation of carotid stenosis severity, carotid tortuosity, intracranial circulation stenosis and collateral circulation before angioplasty and stenting[45,46].

Treatment of Intra- and Extracranial Atherosclerotic Stenosis

Drug Therapy

Antiplatelet drug therapy and aggressive correction of risk factors are the main stays of medical therapy for intracranial and extracranial atherosclerotic stenosis. At present, evidence-based treatments such as aspirin, clopidogrel, statins and antihypertensive are more commonly applied in patients with cerebrovascular stenosis. In addition, phytoteraphy was also used in patients with atherosclerotic stenosis[47,48].

Surgical Treatment

The first successful extracranial carotid endarterectomy (CEA) was performed in 1953, and it was established as the standard treatment for symptomatic severe carotid stenosis by two landmark trials (NASCET, ECST) in the 1990s[49,50]. Since that time the number of CEA procedures has been increasing in the West, and now CEA is the most common vascular procedure performed in the United States with over 117 000 cases done annually[51]. The first endarterectomy for carotid stenosis was performed in 1989 in China[52]. However, the development of CEA is limited in Chinese communities, only large-size hospitals in China perform the operation (Table II) [52-63]. This limitation may be due to Chinese patients who could not accept the neck incision because of the invasiveness and the risk of CEA, which may increase the occurrence of stroke or death[64].

Endovascular Treatment

The first balloon angioplasty for carotid stenosis was performed in 1979, and case series were published in the 1980s[65,66]. In the last decade, this procedure with and without stent placement has gained popularity as a minimally invasive and effective alternative to CEA for the treatment of carotid stenosis, although it still intensely controversial.

The earliest endovascular treatments for carotid stenosis were performed in the1990s in China[67,68]. Compared with the CEA, carotid artery angioplasty and stenting (CAS) are more increasingly popular and widely used. It may be due to the minimally invasive nature of the procedure and the shorter length of hospitalization which is accepted by Chinese patients. At present, almost all the large or mid-size city-level or county-level hospitals could perform the procedure and the number of cases published has increased as experience with the technique has grown[69-71].

Intracranial atherosclerostic stenosis is an important cause of ischemic stroke among Asian populations[72]. Despite medical treatment, the risk of stroke in patients with intracranial stenosis remains high. The poor outcome of medical therapy has prompted the study of endovascular interventions for IAS. In the past few years, many case studies and single center trials on intracranial angioplasty and stenting have been published (Table III), reflecting the increased enthusiasm for the application of this interventional technique. In a total of 816 patients (80.6% men; mean age 54.3 years ± 8.9) in Table III, 845 arteries had been treated. The mean severity of stenosis before treatment ranged from 63% to 85% (mean ± SD: 74.7±7.7) and from 4% to 23% (11.6 ± 6.4) after treatment, respectively. Over half of these stenoses (63.3%) were located in the anterior circulation (intracranial portion of the ICA [n = 77], MCA [n = 457] and ACA [n = 1]), whereas 36.7% involved the posterior circulation (distal segment of the vertebral artery (VA) [n =154], basilar artery (BA) [n=155] and poste-

Table II.

	Duration of data collection	Case numbers	Age range or mean age(years)	Method	30-day vascular event and death (%)	Hospital
Zhou 1999[52]	1989-1999	20	42-72	sCEA	10	Chinese PLA General Hospital Beijing
Guo 2002[53]	1993-2000	20	47-76	sCEA	10	Zhongshan Hospital of Fudan University, Shanghai
Ting 2002[54]	1994-1999	59	52-86	sCEA	3.4	Queen Mary Hospital Hong Kong
Lu 2002[55]	2000-2001	43	51-78	sCEA	2.4	First People's Hospital Shanghai Shanghai
Chen 2004[56]	1999-2003	59	56-79	sCEA	1.7	Friendship Hospital Beijing
Zhao 2004[57]	1999-2003	42	53-81	eCEA	0	Changhai Hospital Shanghai
Liu 2004[58]	2002-2003	82	48-84	sCEA	2.6	The First Affiliated Hospital of Xi'an Jiaotong University Xi'an
Liu 2005[59]	2002-2003	24	52-78	eCEA	0	Gulou Hospital Nanjing
Zhang2006[60]	2004-2005	32	56-78	sCEA	0	First Affiliated Hospital of Nanjing Medical University Nanjing Huashan
Yu 2006[61]	2001-2005	45	55-71	sCEA	4.4	Hospital of Fudan University Shanghai
Ye 2007[62]	1998-2006	95	51-86	sCEA	0	China-Japan Friendship Hospital Beijing
Liu 2008[63]	2003-2005	87	41-72	sCEA	21.8	The First Affiliated Hospital of Xi'an Jiaotong University Xi'an

sCEA: stand carotid endarterectomy, eCEA: eversion carotid endarterectomy

rior inferior cerebellar artery (PICA) [n = 1]).The technical success rates varied from 64.3% to 100% across all studies. In 1.4% (n = 12) of the procedures percutaneous transluminal angioplasty (PTA) were used[45,73], and in 98.6% (n = 833) of all procedures stent-assisted angioplasty[46,69,74-81] (SAA) had been used. The 30-day vascular event and death rates ranged from 0% to 21.4%, and the clinical follow-up time reached a maximum mean follow-up time of 32 months in one study[81], with a mean follow-up time across all studies of 17.2 months.

Risk Factors of Intra- and Extracranial Atherosclerosis

Age

Age is the most important risk factor for cerebrovascular stenosis in China. An asymptomatic Chinese population study analyzed prevalence and risk factors of for MCA stenosis in 1,068 people. The results showed that advancing age was significant risk factor for MCA stenosis (OR = 1.04, $p < 0.01$) [14]. The investigation of the risk factors for occlusive lesions of intracranial and extracranial arteries observed that the age was the independent risk factors for extracranial atherosclerostic stenosis (EAS), and the patients with EAS were significantly elderly compared with those with IAS[82].

Hypertension

The prevalence of hypertension (systolic blood pressure ≥ 140 mm Hg, diastolic blood pressure ≥ 90 mm Hg or under antihypertensive treatment) of the general population (age ≥ 35 years old) was 37.1% in 1987[83]. Results of a study in 2000-01[84] indicated that the prevalence of hypertension of the adult population (aged 35-74 years) was 27.2%, suggesting that 130 million persons are hypertensive in China.

Hypertension is an important risk factor for the development of atherosclerosis and athero-

Table III.

	Duration of data collection	Case number	Age range or mean (years)	Male (%)	Menthod	No of intracranial procedures	Technical success rate (%)	30-day vascular event and death rate (%)	Mean clinical follow-up time (months)
Miao 2002[45]	1997-2001	14	32-52	85.7	PTA (n=9) SAA(n=5)	14 (all MCA)	64.3	21.4	12.5
Jiang 2002[73]	2001-2002	19	23-69	73.7	PTA (n=3)	SAA (n=16) 19 (11 MCA, 1 ACA , 1 ICA, 5 VA, 1BA)	100	5.3	3.7
Jiang 2003[74]	2001-2003	42	16-74	83.3	SAA	42(27 MCA, 4 ICA, 7 VA, 4 BA)	95.2	9.5	8
Huang 2003[75]	2000-2002	39	46-78	64.1	SAA	39 (8 MCA, 12 ICA, 5 VA, 14 BA)	100	0	9.9
Jiang 2004[76]	2002-2003	40	16-67	77.5	SAA	42 (all MCA)	97.6	10	10
Liu 2004[77]	2000-2002	46	46-78	63.0	SAA	50(9MCA,13ICA, 16 BA, 12VA)	98	0	8.5
Jiang 2005[78]	2001-2004	155	50.9	85.2	SAA	170 (93 MCA, 19 ICA, 29 BA, 28 VA, 1 PICA)	92.4	6.5	14.8
Jiang 2007[79]	2001-2005	79	58.5	84.8	SAA	79(38 BA, 41 VA)	94	6.3	27.1
Jiang 2007[46]	2001-2005	213	20-79	82.6	SAA	220 (120 MCA, 20 ICA, 39 BA, 41 VA)	92.3	4.9	26.8
Jiang 2007[80]	2003-2004	46	38-74	89.1	SAA	48 (20 MCA, 8 ICA, 11BA, 9 VA)	91.7	8.7	23.9
Miao 2009[69]	2001 -2006	113	25-79	77.0	SAA	113 (all MCA)	96.5	4.4	29
Du 2009[81]	2001-2007	10	49-79	90.0	SAA	9 (6 VA, 3 BA)	90.0	0	32

PTA: percutaneous transluminal angioplasty, SAA: stent-assisted angioplasty

sclerotic cerebrovascular disease. Several surveys suggest that hypertension was associated with intracranial atherosclerosis as a significant risk factor ($p < 0.01$) [11-13]. Furthermore, a community-based study in Taiwan indicate that hypertension strongly influences extracranial carotid atherosclerosis, hypertension was the evident determinant of carotid stenosis ≥ 50% after adjustment for other covariates[85]. These data indicated that hypertension is a greater risk factor for intracranial and extracranial atherosclerostic stenosis in Chinese people.

Diabetes Mellitus

The prevalence of diabetes mellitus in the general population (aged ≥ 25 years old) of China was 2.51% in 1994[86]. Result of a survey on diabetes prevalence in urban China in 2002 reported that 6.13% of population aged over 20 years in large cities and 3.78% in medium small cities had diabetes[87]. Moreover, the Beijing Eye Study 2006 including 3251 subjects (aged ≥ 45 years old) indicated that the prevalence of diabetes was 12.87%, suggesting that more than 30 million individuals are diabetic in China. Among diabetic group 64.6% subjects were on diabetic diet or on additional anti-diabetic therapy, 53.8% subjects took oral anti-diabetic drugs, and 11.5% subjects were on insulin therapy[88]. Compared with previous studies, it suggests an increasing prevalence of diabetes.

Diabetes is another risk factor for intracranial and extracranial atherosclerotic stenosis. Compared to those without diabetes, diabetic patients frequently have significant IAS. An investigation of risk of IAS observed that the risk ratios of diabetes mellitus were 6.5 in South China, 5.7 in North China and 16.9 when combining South and North[89]. Based on this result, an investigation of communities in Rongqi County, Southern China reported similar result, diabetes mellitus emerged as independent risk factor of MCA stenosis (OR = 5.9, $p < 0.001$). Furthermore, an cross-sectional study of asymptomatic intracranial atherosclerosis patients in Hong Kong also showed that diabetes mellitus was significant risk factor for MCA stenosis (OR = 1.53 $p < 0.04$) [13].

Dyslipidemia

A study in 2002 reported that 18.6% of the Chinese adult population 18 and over years had dyslipidemia. The age-specific prevalence of dyslipidemia was 17.0%, 22.9% and 23.4% in the groups of 18-44, 45-59 and over 60 years old, respectively, and 21.0% and 17.7% in urban and rural areas, respectively. This data indicates that dyslipidemia has become one of important risk factors threatening health of people[90]. Dyslipidemia is a risk factor for atherosclerotic events. In a study, which included 583 Chinese patients with ischemic cerebrovascular disease, hyperlipidemia was identified as an independent risk factor for both EAD and IAD[82]. There was also a trend towards an increased risk of IAS with high level LDL cholesterol[91]. Moreover, a recent study showed that hyperlipidemia was the significant associate factor for MCA stenosis (OR = 1.78, $p < 0.01$) [13].

Smoking

The investigator of the chronic diseases reported that more than 300 million men smoke cigarettes in China, less than 3% of women are currently smokers[92]. A report of cerebral atherosclerosis indicated that smoking was associated with narrowing of the extracranial vessels only ($p = 0.0054$) [11]. Furthermore a study in 2002-04, which included 93 young adults with ischemic stroke suggested that long-term smoking may be an independent risk for cerebral artery atherosclerostic stenosis, but this needs to be conducted by a larger sample size (OR = 4.367, $p = 0.046$)[93].

Metabolic Syndrome

A cross-sectional survey in 2000 of 15,540 Chinese adults (aged 35-74 years old) indicated that the age-standardized prevalence of metabolic syndrome (MS) was 9.8% (95% CI 9.0-10.6) in men and 17.8% (95% CI 16.6-19.0) in women, suggesting that a large proportion of Chinese adults have MS[94]. It has recently been suggested that metabolic syndrome, is associated with increased risk of cerebrovascular stenosis[95-97]. Based on these results, a study of patients with ischemic stroke reported similar results, MS was associated with intracranial atherosclerotic stenosis (OR = 1. 716, $p = 0.0046$), but not associated with extracranial atherosclerotic stenosis (OR = 1.466, $p = 0.2233$) [98].

Conclusions

The occurrence of intracranial artery stenosis was more frequent than that of extracranial artery in the Chinese population. Further studies are needed to focus on the intracranial atherosclerotic stenosis.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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