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An epidemiological survey of moyamoya disease, unilateral moyamoya disease and quasi-moyamoya disease in Japan

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ABSTRACT

Objectives: Moyamoya disease (MMD) is a unique occlusive disease of the bilateral internal carotid arteries in which, compensation for occlusion results in an enrichment of collateral arteries at the base of the brain. However, the epidemiology of unilateral MMD (typical angiographic evidence of MMD unilaterally with equivocal contralateral findings), and quasi-MMD (MMD present with inherited or acquired disorders) is poorly known. Here, a nationwide epidemiological survey was conducted to estimate the total numbers of patients, the annual incidence rates and prevalences of MMD, unilateral MMD and quasi-MMD in Japan.
Patients and methods: The neurosurgery, neurology and pediatrics departments that were listed in Japanese resident training programs were recruited to participate in this survey. Questionnaires were directly mailed to 2998 departments in February 2006.
Results: A total of 1183 departments replied to the questionnaire (39.5% response rate). It was estimated that there were 6670.9 MMD patients, 840.5 unilateral MMD patients and 430.4 quasi-MMD patients in Japan. The annual incidence rates of MMD, unilateral MMD and quasi-MMD are 1.13, 0.23 and 0.11/100,000, respectively, and the prevalences are 5.22, 0.66 and 0.34/100,000, respectively. These patients were mainly treated by neurosurgeons. An estimated total of 929.1 surgical interventions are performed in Japan annually.
Conclusion: This nationwide study reports the current epidemiologic status of MMD, unilateral MMD and quasi-MMD in Japan.

1. Introduction

Moyamoya disease (MMD) is characterized by idiopathic stenoocclusion at the terminal portion of the internal carotid artery and concomitant abnormal vascular networks [1]. Whether a unilateral lesion, confirmed by typical angiographic evidence of MMD unilaterally and normal or equivocal contralateral findings, is an early form of definite (bilateral) MMD remains controversial [2–5]. Several inherited or acquired disorders and other disease conditions may be present in conjunction with MMD, a condition known as quasi-MMD [6]. Although there are several published epidemiological studies on MMD, however, the current status of unilateral MMD or quasi-MMD has not been evaluated. Here, we report our findings of the annual incidence rate and the prevalence of MMD, unilateral MMD and quasi-MMD in Japan.

2. Materials and methods

The clinical diagnosis of MMD was based on the criteria prepared by the Research Committee on Moyamoya disease (Spontaneous Occlusion of the Circle of Willis) of Japan. In 2005, there were 2426 Departments of Neurosurgery, 1637 Departments of Neurology, and 3154 Departments of Pediatrics in Japan. We sent questionnaires to the resident training sites, 1221 neurosurgery units designated by the Japan Neurosurgical Society, 760 neurology units designated by the Societas Neurologica Japonica, and 1017 pediatrics units designated by the Japan Pediatric Society. Thus, the 2998 of 7217 departments (41.5%) were included in this study. The survey mailing, which was sent out to the hospitals in February 2006, included letters of request for participation, survey slips and a request for reports of the numbers of patients with MMD, unilateral MMD and quasi-MMD treated between January 1, 2005 and December 31, 2005. A diagnostic algorithm to verify the appropriate diagnosis of each disease was provided (Fig. 1). For the diagnosis of quasi-MMD, disorders that were previously reported to be associated with MMD were listed as follows: atherosclerosis, autoimmune disease (systemic lupus erythematosus, antiphospholipid antibody syndrome, arteritis nodosa, Kawasaki disease and Sjögren syndrome), meningitis, von Recklinghausen disease,

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Table 1
Aggregated total of questionnaire on moyamoya disease, unilateral moyamoya disease and quasi-moyamoya disease.

	Institute	MMD		Unilateral MMD		Quasi-MMD	
		First visit	Revisit	First visit	Revisit	First visit	Revisit
Neurosurgery	428	518	1912	113	194	40	85
Neurology	305	18	98	3	15	5	16
Pediatrics	450	35	54	2	5	8	16
Total	1183	571	2064	118	214	53	117

MMD, moyamoya disease.

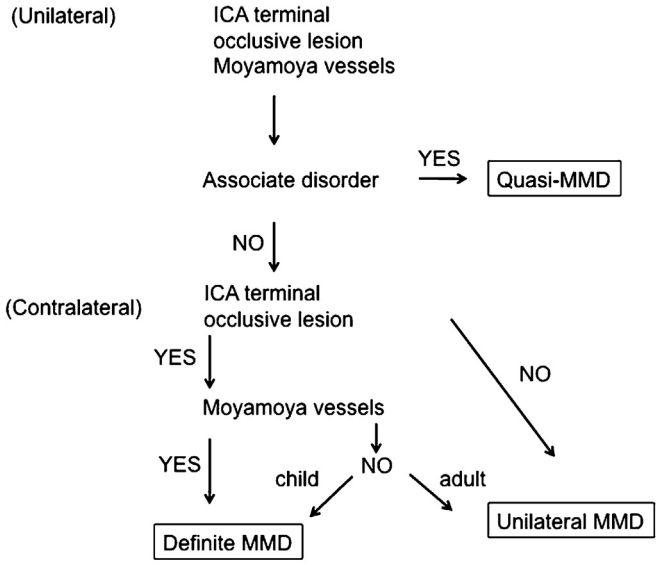

Fig. 1. A diagnostic algorithm for moyamoya disease, unilateral moyamoya disease and quasi-moyamoya disease. ICA, internal carotid artery. MMD, moyamoya disease.

brain tumor, Down syndrome, head injury, irradiation, Turner syndrome, Allagille syndrome, Williams syndrome, Noonan syndrome, Marfan syndrome, nodular sclerosis, Ito nevus, incontinence of pigment, Hirschsprung disease, diabetes mellitus-type IA, Prader-Willi syndrome, Wilms tumor, primary oxalosis, sickle cell anemia, Fanconi anemia, spherocytosis, eosinophilic granuloma, plasminogen abnormality II, leptospirosis, EB virus infection, protein S deficiency, pyruvate kinase deficiency, fibrous dysplasia, polycystic kidney, retinitis pigmentosa and oral contraceptive use. The annual incidence rate and the prevalence of MMD were calculated using the population of Japan in 2005 (n = 127,756,815). The population-based numbers were generated as follows:

$$\text{Estimated patient number} = \frac{\text{identified patient number}}{\text{response rate}}$$

$$\text{Incidence rate} = \frac{\text{estimated first visit patients} \times 100,000}{\text{total population}}$$

$$\text{Prevalence} = \frac{(\text{estimated first visit patients} + \text{estimated revisit patients}) \times 100,000}{\text{total population}}$$

Statistical analysis was performed using the chi-square test. No personal information was retained with the data used in this study.

3. Results

Among 2998 departments, 1183 departments replied, for a response rate of 39.5% (neurosurgery = 428, neurology = 305, and pediatrics = 420), and a total of 3137 patients were identified. Among the 3137 patients reported, the numbers of MMD, unilateral MMD and quasi-MMD cases were 2635 (84%), 332 (10.5%), and 170 (5.4%), respectively. The numbers of annual first visit patients with MMD, unilateral MMD and quasi-MMD were 571, 118, and 53, respectively. Thus, the numbers of annual revisit patients with MMD, unilateral MMD and quasi-MMD were 2064, 214, and 117, respectively (Table 1). The large majority of the patients (MMD = 92.2% and unilateral MMD = 92.5%) were treated in the neurosurgery departments (Fig. 2). Interestingly, a significant greater population of quasi-MMD patients were managed in neurology and pediatrics; only 73.5% of quasi-MMD patients received neurosurgery care, while 12.4% were managed in neurology and 14.1% were managed in pediatrics.

Table 2
Estimated patient number and epidemiological analysis on moyamoya disease, unilateral moyamoya disease and quasi-moyamoya disease.

	MMD	Unilateral MMD	Quasi-MMD
Estimated first visit Pt.	1445.6	298.3	134.2
Estimated revisit Pt.	5225.3	541.8	296.2
Estimated total Pt. number	6670.9	840.5	430.4
Incidence rate/100,000/year	1.13	0.23	0.11
Prevalence/100,000	5.22	0.66	0.34

MMD, moyamoya disease; Pt., patient.

Table 3
Total operation number and estimated operation number of moyamoya disease, unilateral moyamoya disease and quasi-moyamoya disease.

	MMD	Unilateral MMD	Quasi-MMD
OP no.	319	37	11
Estimated OP no.	807.6	93.7	27.8

OP, operation; no., number.

It is estimated that there are 6670.9 MMD patients, 840.5 unilateral MMD patients and 430.4 quasi-MMD patients exist in Japan. The incidence rates of MMD, unilateral MMD and quasi-MMD are found to be 1.13, 0.23 and 0.11/100,000, respectively, and the prevalences are 5.22, 0.66 and 0.34/100,000, respectively (Table 2). Vascular reconstruction surgery was performed in 319 cases of MMD, 37 cases of unilateral MMD, and 11 cases of quasi-MMD (Table 3). It is estimated that a total of 929.1 MMD surgical interventions are performed in Japan annually.

4. Discussion

4.1. Moyamoya disease in Japan

The Ministry of Health, Labor and Welfare of Japan has promoted scientific research on many intractable diseases, and nationwide epidemiological surveys have been conducted in Japan with the