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Original Article

Seasonal Variation of Acute Stroke - Hospital Based Study -

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Objectives: This study aimed to investigate the seasonal variation in stroke types, ischemic stroke subtypes, stroke risk factors and *Sasang* constitutions.
Methods: 226 patients with acute stroke within 14 days onset were included, who were admitted to Kyunghee Oriental Medical Center from November 2005 to October 2006. The year was subdivided into four parts: spring (March-May); summer (June-August); fall (September-November); and winter (December-February). Stroke types, ischemic stroke subtypes, stroke risk factors and *Sasang* constitutions in the four groups were examined.
Results: Ischemic stroke was most frequent in summer, whereas hemorrhagic stroke was most frequent in winter. There was no significant difference in seasonal variation of stroke.
The frequency of ischemic heart disease among stroke risk factors was significantly high in spring (p=0.031). The frequency of hypertension, diabetes mellitus, atrial fibrillation, and hyperlipidemia did not differ among seasons. There was no significant difference in *Sasang* constitution among seasons. Frequency of small vessel occlusion was highest in summer. Large artery atherosclerosis was frequent in spring and summer,but seasonal variation of ischemic stroke subtypes did not show statistical difference.
Conclusion: Acute stroke demonstrates seasonal characteristics according to stroke types, ischemic stroke subtypes, risk factors for stroke, and *Sasang* constitutions. These results have important clinical implications in stroke prevention.

Key Words : Stroke, seasonal variation, stroke type, *Sasang* constitution

Introduction

Seasonal variation in the incidence of stroke has been reported[1-9]. There is agreement among these reports that the incidence of onset of stroke peaksin the winter-spring and decreases in the summer-autumn. On the other hand, some reported that there was no seasonal variation[10]. However, there has not yet been data examined from oriental medical hospitals, although many Koreans with stroke prefer being treated by an oriental medical therapeutic method[11].

To investigate the possibility that stroke occurrence varies according to the seasons, we examined data from the Kyunghee stroke registry.

The aim of the present study was to examine whether there is a seasonal variation in stroke types, ischemic stroke subtypes, stroke risk factors and Sasang constitutions.

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Subjects and Methods

Current study was conducted at Kyunghee Oriental Medical Center from November 2005 to October 2006. 226 hospitalized patients with first ever stroke within 14 days of onset were registered in this study. The diagnosis of stroke was based on the clinical features and neuroradiologic images (brain computed tomography (CT) scan and/or magnetic resonance imaging (MRI)), which was confirmed by at least two neurologists. Clinical characteristics, including age, sex, stroke types, risk factors, ischemic stroke subtypes, and Sasang constitution were recorded.

Stroke type meant ischemic orhemorrhagic stroke based on brain image. Risk factors for stroke included hypertension (HTN), diabetes mellitus (DM), ischemic heart disease (IHD), and atrial fibrillation (AF). Ischemic stroke subtype classifications, based on the modified TOAST classification[12,13]: large-artery atherosclerosis (LAA), small-vessel occlusion (SVO), cardiac embolism (CE), stroke of other determined etiologies (SOD), and stroke of undetermined etiologies (SUE). *Sasang* constitutions (*Soyeumin, Soyangin, Taeyeumin,* and *Taeyangin,* were diagnosed using the Questionnaire for *Sasang* Constitution Classification Ⅱ(QSCC Ⅱ).

The months of the year was grouped into four seasons, which were spring (March, April, May), summer (June, July, August), autumn (September, October, November), and winter (December, January, February). Seasonal differences were analyzed in relation to the following clinical characteristic; age, sex, stroke types, risk factors, ischemic stroke subtypes, and *Sasang* constitution.

Windows SPSS package was used for statistical analysis. Independent t-test was used for the comparison of continuous variables. The Pearson chi-square test was used for analysis of noncontinuous variables. A p value less than 0.05 was considered statistically significant.

Results

In this study, 226 patients with first ever stroke were enrolled at the Kyunghee Oriental

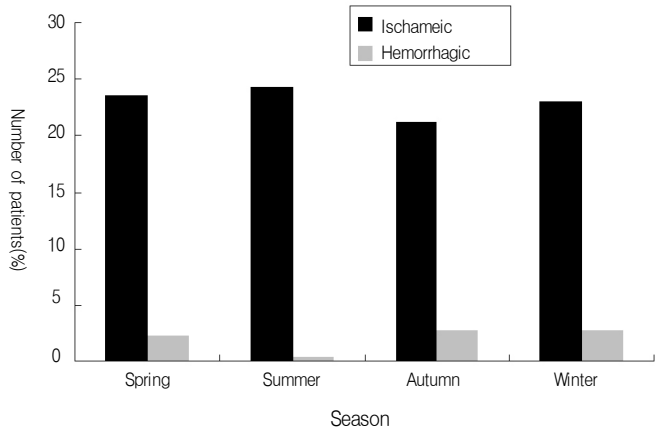

Fig. 1. Seasonal variation of ischemic and hemorrhagic stroke onset

Table 1. Clinical Characteristics of Stroke Patients in Each Season

	Season Group, n (%)			
	Spring (n=58)	Summer (n= 56)	Autumn (n=54)	Winter (58)
Age, mean ± standard deviation	65.97 ± 10.77	62.71 ± 11.34	58.78 ± 11.10	66.05 ± 11.36
Men	32 (55.2)	33 (58.9)	30 (55.6)	32 (55.2)
Women	26 (44.8)	23 (41.1)	24 (44.4)	26 (44.8)
Risk factors				
Hypertension	29 (50)	33 (58.9)	22 (40.7)	29 (50)
Diabetes mellitus	22 (37.9)	14 (25.0)	13 (24.1)	14 (24.1)
Atrial fibrillation	1 (1.7)	0 (0)	1 (1.9)	0 (0)
Hyperlipidemia	1 (1.7)	4 (7.1)	2 (3.7)	1 (1.7)
Ischemic heart disease	7 (12.1)	2 (3.6)	3 (5.6)	0 (0)

Medical Center over 1 year (mean age, 63.46 ±11.36 years; 127 men and 99 women). The age and sex distribution was not significantly different among the four groups.

208 patients (92.0 %) were diagnosed with ischemic stroke and 18 patients (8.0 %) had hemorrhagic stroke. The seasonal variation of ischemic and hemorrhagic stroke onset among the 226 patients is depicted in Fig.1. Among all subjects, 53 patients (23.5 %) developed ischemic stroke in spring, 55 (24.3 %) in summer, 48 (21.2 %) in autumn, and 52 (23.0 %) in winter. There was no significant difference in seasonal variation of stroke.

Table 1 shows the distribution of stroke among 4 seasons according to the general char- acteristics. HTN was most common (50%; n=113) among risk factors, followed by DM (27.9 %; n=63), IHD (5.3 %; n=12), hyperlip- idemia (3.5 %; n=8), and AF (0.9 %; n=2). The frequency of IHD was significantly high in spring (p=0.031). The frequency of HTN, DM, AF, and hyperlipidemia did not differ among seasons.

As analyzed according to *Sasang* constitution, 15 patients could not get a QSCC Ⅱ test and 78 patients were not identified with a *Sasang* constitution because they were mixed among the 4 constitutions. Thus, the remaining 133 patients were analyzed. Table 2 indicated the distribution of *Sasang* constitution in each season. *Soyeumin* and *Soyangin* were most

Table 2. Sasang Constitution in Each Season

	Season Group, n (%)			
	Spring (n=39)	Summer (n=34)	Autumn (n=28)	Winter (n=32)
Soyeumin	10 (25.6)	5 (14.7)	7 (25.0)	3 (9.4)
Taeyeumin	10 (25.6)	11 (32.4)	9 (32.1)	11 (34.4)
Soyangin	19 (48.7)	18 (52.9)	11 (39.3)	18 (56.3)
Taeyangin	0 (0)	0 (0)	1 (3.6)	0 (0)

Table 3. Clinical Ischemic Stroke Subtypes in Each Season

	Season Group, n (%)			
	Spring (n=53)	Summer (n=55)	Autumn (n=48)	Winter (n=52)
Large artery atherosclerosis	11 (20.8)	11 (20.0)	6 (12.5)	6 (11.5)
Cardioembolism	0 (0)	0 (0)	0 (0)	1 (1.9)
Small vessel occlusion	39 (73.6)	43 (78.2)	42 (87.5)	41 (78.8)
Stroke of other determined etiology	1 (1.9)	0 (0)	0 (0)	0 (0)
Stroke of undetermined etiology	2 (3.8)	1 (1.8)	0 (0)	4 (7.7)

common in spring (25.6 %; n=10 and 48.7 %; n=19, respectively). *Taeyeumin* was frequent in summer and winter. There was no significant difference in *Sasang* constitution among seasons.

Table 3 demonstrates the distribution of ischemic stroke subtypes in each season.

Frequency of SVO was highest in summer (78.2 %; n=43). LAA was frequent in spring and summer. Seasonal variation of ischemic stroke subtypes did not show statistical difference.

Discussion

Many cardiovascular diseases have seasonal variations. These include myocardial infarction, cardiac death, and stroke. The existence of a seasonal variation in the occurrence of stroke remains controversial. This study aimed to investigate whether there is seasonal variation of stroke. In traditional Korean medicine, it has been reported that different physiological conditions and management of lifestyle exist according to the four seasons[14]. Thus, it is very important to consider seasonal variation to prevent stroke.

This study showed that ischemic stroke rate was highest in summer. The biological reasons for the higher occurrence of strokes during summer are not known, but several possible mechanisms may be suggested, such as heat stress. Seasonal variations in other factors such as air pollution, exposure to sunlight, incidence of influenza, and diet have also been suggested to play a role, but variation in temperature has been considered the most likely reason[15]. On the other hand, the occurrence of hemorrhagic stroke was higher in autumn and winter and lowest in summer. These results were similar to other reports[16]. Factors that might contribute to an increased risk during the winter are uncertain. However, cardiovascular stresses occur during the winter, particularly in climates with extremes of seasonal climate, which may result in fluctuations in blood pressure, blood coagulability, and cardiovascular performance. These stresses include deconditioning, stress of physical activity in temperature extremes, types of activity required in a cold climate, and more specific effects of abrupt temperature changes and temperature extremes on blood pressure and the vascular system. Inflammatory factors such as cytokine levels and cortisol levels fluctuate with circadian and circannual rhythmicity. These factors may play a role in priming the vasculature to respond in a manner predisposing the endothelium to rupture[16-20].

In the analysis of *Sasang* constitution, various seasonal patterns were observed. *Soyeumin* and

Soyangin were most common in spring. *Taeyeumin* was frequent in summer and winter. There was no clear reason for these distributions. These results might be simply because the cases were few owing to increasing case losses by the mixture of *Sasang* constitution and short study period.

This study demonstrated that the occurrence of LAA and SVO was more frequent in summer. These results might be explained by the fact that dehydration increases as temperature rises in summer as a result, hyperviscosity and platelet aggregation is enhanced[21-25]. LAA was higher in spring. This may also be that the average temperature of spring was higher owing to global warming.

Several investigators have shown a seasonal variation in the incidence of the onset of IHD with a peak in the winter months[26-28]. This study showed that IHD was most frequent in the spring months. This result might be because ischemic stroke, having the same pathophysiologic mechanism of IHD, did not display seasonal variations and cases were too few and study period too short.

There were several limitations in this study. This study was hospital-based rather than population-based. The study period was short and only a small number of patients were included. Further, larger population-based study will be required.

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