

ORIGINAL ARTICLE

Prevalence and associated characteristics of aponeurotic ptosis among a general population in Japan

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Abstract

Background: Ptosis is caused mainly by age-related degeneration of the aponeurosis caused by lifestyle-related diseases. Some patients with ptosis complain of stiff shoulders and headaches. There have been few actual epidemiological investigations of aponeurotic ptosis and these symptoms. We aimed to find their prevalence and associated characteristics of ptosis in Japanese general population.

Methods: The target population consisted of 1004 volunteers who took part in the 2016 Iwaki Health Promotion Project. We administered a questionnaire, took blood samples, took physical measurements, and measured marginal reflex distance (MRD-1) in each participant. The relationship between survey items (age, gender, difficulty in raising eyelids, headache, stiff shoulders, hypertension, diabetes, dyslipidemia, and body mass index [BMI]) and eyelid droop was examined statistically.

Results: The prevalence of ptosis in this study was 15.4%. Ptosis prevalence correlated with elderly people 65 years or older (odds ratio. 3.07, 95% CI: 2.02–4.66), male sex (odds ratio. 0.29, 95% CI: 0.20–0.43), hypertension (odds ratio. 1.68, 95% CI: 1.11–2.54) and dyslipidemia (odds ratio. 1.51, 95% CI: 1.02–2.23).

Conclusions: The present results suggested that hypertension, dyslipidemia and male sex were thought to be the risk factors of aponeurotic ptosis in Japanese general population.

Hirosaki Med. J. 71 : 131–137, 2021

Key words: Aponeurotic ptosis; Lifestyle; risk factors; general population; logistic regression.

Introduction

The most common form of acquired ptosis is aponeurotic ptosis. Aponeurotic ptosis has various causes; in general, it is degeneration of the aponeurosis with age¹⁾. Fat infiltration has been seen in the aponeurosis during the intraoperative findings of ptosis surgery²⁾. In cases of aponeurosis with fewer fatty deposits, the levator aponeurosis does not need to be surgically advanced very far, and more favorable surgical results are achieved³⁾. Some authors have pointed out that microcirculatory distur-

bances that result from lifestyle-related diseases such as hypertension, dyslipidemia, and diabetes can cause fatty degeneration of tissues, which worsens levator muscle function and can lead to ptosis⁴⁾. Ptosis may be accompanied by tension headache because, in order to maintain field of vision, the occipitofrontalis muscle are constantly contracting⁵⁾. In addition, maintaining lateral flexion of the neck in order to see can cause stiff shoulders.

As described above, several authors have described the causal relationship between ptosis and its causes and symptoms. However, few

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Received for publication, December 2, 2020

Accepted for publication, December 18, 2020

studies of the aponeurotic ptosis have focused on the Japanese general population. In this study, we examined the prevalence and associated characteristics of aponeurotic ptosis among a general population in Japan.

Patients and Methods

Of the 1148 residents of the Iwaki area, Hirosaki City, Aomori Prefecture, Japan, who participated in the 2016 Iwaki Health Promotion Project, 1004 ([397 men and 607 women, aged 20–92 years) participated in this study. We excluded those who had cataracts, retinal detachment, facial nerve paralysis, and a history of eyelid ptosis surgery, as well as those using steroids. A questionnaire was administered on the day of the medical examination to collect data on age, gender, medical history, and symptoms. Blood was collected early in the morning on an empty stomach, and levels of hemoglobin A1c, blood glucose, low-density lipoprotein (LDL)-cholesterol, high-density lipoprotein (HDL)-cholesterol, and triglycerides were measured. Marginal reflex distance 1 (MRD-1) was measured by five physicians in the Department of Plastic and Reconstructive Surgery, Hirosaki University Graduate School of Medicine, Hirosaki, Japan, who were qualified as plastic surgery specialists by the Japan Society of Plastic and Reconstructive Surgery. MRD-1 was defined as the distance from the upper eyelid margin to the corneal light reflex in the primary position, regardless of the effect of dermatochalasis or brow ptosis. In participants who had skin laxity, we lifted flaccid skin manually and measured.

According to the guidelines of plastic surgery medical treatment, MRD-1 less than 2 mm was defined as ptosis⁶. According to the World Health Organization (WHO) standards, people aged 65 years or older were defined as elderly persons. A systolic blood pressure of 140 mm Hg

or more or a diastolic blood pressure of 90 mmHg or more was defined as hypertension according to the 2014 Hypertension Treatment Guidelines⁷, and persons with a history of use of antihypertensive agents or of other hypertension treatment were considered to have hypertension. Blood glucose levels of 200 mg/dL or higher and hemoglobin A1c levels of 6.5% or higher were considered to represent diabetes, in accordance with the 2018–2019 Diabetes Practice Guideline⁸, and persons who had used oral glycemic medications or received other treatment for diabetes were considered diabetic. LDL-cholesterol levels higher than 140 mg/dL, HDL-cholesterol levels lower than 40 mg/dL, and triglyceride levels of 150 mg/dL or more were considered to represent dyslipidemia, according to the 2017 Atherosclerosis Disease Prevention Guideline⁹; patients with a history of medication or other treatment for dyslipidemia were considered to have this condition. Body mass index (BMI) was calculated as weight (in kilograms) divided by height (in meters) squared. According to the WHO standards, a BMI of less than 18.5 was defined as low BMI, and that of 25 or more was defined as high BMI.

In this cross-sectional study, the population of participants was divided into ptosis and nonptosis groups according to the definitions just described. Characteristics of the two groups such as age, gender, difficulty in raising eyelids, BMI, and the presence or absence of headache, hypertension, diabetes, and dyslipidemia were compared in multiple logistic regression analysis. SPSS ver. 24 (SPSS IBM Inc., Armonk, NY, USA) was used for data input and analysis, and a *p* value of less than 0.05 was considered significant.

This study was approved by the Ethics Committee of Hirosaki University Graduate School of Medicine.

Table 1. Characteristics of participants list involved with the result of analysis

		Overall	Ptosis group	Non ptosis group
		N = 1004	n = 155(15.4%)	n = 849(84.6%)
Value of MRD-1		2.92 ± 1.08	1.21 ± 0.75	3.24 ± 0.80
Age		53.3 ± 15.5	65.5 ± 15.5	51.7 ± 15.5
	≥65years	284(28.3%)	84(54.2%)	200(23.6%)
	<65years	720 (71.7%)	71(45.8%)	649(76.4%)
Sex	Male	397(39.5%)	95(61.3%)	302(35.6%)
	Female	607(60.5%)	60(38.7%)	547(64.4%)
Visual field constriction (Yes)		76(7.6%)	17(11.0%)	59(7.00%)
Headache (Yes)		561(55.9%)	64(41.3%)	497(58.5%)
Shoulder discomfort (Yes)		773(77.0%)	115(74.2%)	658(77.5%)
Hypertension (Yes)		403(40.1%)	96(61.9%)	307(36.2%)
Diabetes mellitus (Yes)		73(7.3%)	24(15.5%)	49(5.8%)
Dyslipidemia (Yes)		444(44.2%)	91(58.7%)	353(41.6%)
BMI		22.9 ± 3.4	23.3 ± 3.4	22.8 ± 3.4
	Low	72(7.2%)	4(2.6%)	68(8.0%)
	Middle	685(68.2%)	114(73.6%)	571(67.3%)
	High	247(24.6%)	37(23.9%)	210(24.7%)

Data for continuous variables(MRD-1, Age, BMI)are listed as means ± standard deviations, and data of categorical variables are listed as frequencies and percentages. BMI, body mass index; MRD-1, marginal reflex distance

Table 2. result of the multiple logistic regression model on the associations of ptosis

		Odds ratio(95% confidence interval)	p-Value
Age(≥65years/<65years)		3.07(2.02-4.66)	<0.001
Sex(female/male)		0.29(0.20-0.43)	<0.001
Visual field constriction(yes/no)		1.77(0.94-3.34)	0.078
Headache(yes/no)		0.79(0.53-1.17)	0.237
Shoulder discomfort(yes/no)		1.20(0.77-1.87)	0.429
Hypertension(yes/no)		1.68(1.11-2.54)	0.014
Diabetes mellitus(yes/no)		1.57(0.86-2.85)	0.140
Dyslipidemia(yes/no)		1.51(1.02-2.23)	0.039
BMI	Low(low/middle)	0.59(0.20-1.75)	0.344
	High (high/middle)	0.61(0.39-0.96)	0.033

Results

The prevalence of ptosis in this study was 15.4%. The ptosis group consisted of 155 people (95 men, 60 women), and the mean MRD-1 on both sides was 1.21 mm (standard deviation, 0.75mm). The nonptosis group consisted of 849 people (302 men, 547 women), and the mean

MRD-1 on both sides was 3.24 mm (standard deviation, 0.80 mm). Characteristics of participants are listed in Table 1. The data in Table 2 are the results of multiple logistic regression analysis.

With regard to age, the proportion of elderly people was significantly higher in the ptosis group (odds ratio [OR], 3.07; 95% confidence

interval [CI], 2.02–4.66; $p < 0.001$). Moreover, the proportion of patients with hypertension, dyslipidemia, and standard BMI (vs. high BMI) were significantly more prevalent in the ptosis group (ORs: 1.68, 1.51, and 0.61; 95% CIs: 1.11–2.54, 1.02–2.23, and 0.39–0.96; $p = 0.014$, 0.039, and 0.033, respectively). The ptosis group also contained significantly more men than women (OR, 0.29; 95% CI, 0.20–0.43; $p < 0.001$). We found no significant difference between the two groups with regard to prevalence of diabetes, low BMI, difficulty in raising the eyelid, prevalence of headache, or prevalence of stiff shoulder.

Discussion

Few studies have focused on the prevalence of aponeurotic ptosis in healthy individuals, and no studies have been conducted on Japanese subjects^{4,10}. According to Kim *et al.*, the estimated prevalence of degenerative ptosis in Koreans was 13.5% (MRD-1 of less than 2 mm was defined as ptosis)⁴. In a British study of 400 randomly selected, age-stratified subjects older than 50 years of age, 11.5% had ptosis¹⁰. The prevalence of ptosis in this study was 15.4%, and was slightly high level more than the above-mentioned previous researches.

In this study, rates of hypertension and dyslipidemia were significantly different between participants with and without ptosis^{4,11,12}. It has been said that steatosis of the aponeurosis as a result of aging, microcirculation disorders resulting from hypertension, atherosclerotic microcirculation disorders resulting from dyslipidemia, and tissue degeneration cause eyelid drooping⁴. However, no actual research had been conducted previously in such a large number of healthy people in Japan.

Niimi described circulatory disturbances caused by hypertension¹³: for example, hypertrophy of vessel walls, rarefaction of blood cells, and abnormalities in blood flow. These cause changes

in the microcirculation. In addition, they may play an important role in microcirculatory disorders caused by high blood pressure because they disrupt oxygen supply to organ tissue, gas exchange, and water flow¹³. The degeneration of the aponeurosis as a result of microcirculation disorders may cause ptosis.

Shirado studied Japanese patients who had clinical signs of eyelid drooping, skin flaccidity, or eyebrow drooping or had a history of ptosis or blepharoplasty¹². He statistically compared plasma lipid data for patients with and without age-related ptosis and found that levels of total cholesterol and HDL-cholesterol were significantly and independently associated with age-related ptosis.

Decreased HDL-cholesterol is known to be an independent risk factor for coronary artery disease and is one of the diagnostic criteria for dyslipidemia⁹. LDL-cholesterol, a component of total cholesterol, is the first management target value in the guidelines of the Japanese Society of Atherosclerosis for preventing atherosclerotic disease⁹. Dyslipidemia is commonly associated with decreased levels of HDL-cholesterol and elevated levels of LDL-cholesterol and may be one of the causes of age-related ptosis¹². Therefore, the results of this study were consistent with those of the studies mentioned previously. Although the reasons for the significant relationship between dyslipidemia and age-related ptosis have not been specified, a significant relationship between retinal microcirculatory disturbance and dyslipidemia has been described and may be the reason why circulatory disorders may be causing ptosis^{14,15}.

Matsuda evaluated the length of the anterior layer of the levator aponeurosis that had no fatty deposits during transcutaneous aponeurotic repair³. If the eyelids contained more fatty deposits during levator shortening operation, more levator aponeurosis shortening was needed, but surgical correction tended to be inadequate

at later.

As stated previously, this study also showed that dyslipidemia and hypertension were significantly related to ptosis and therefore might be among the risk factors for ptosis.

No significant difference was found in rates of diabetes in this study. Several reports have described the relationship between diabetes and ptosis^{4, 11, 14, 16, 17}. In these researches, odds ratio of diabetes for ptosis was reported as 1.32 (95%CI: 1.09-1.58) by Kim et al.⁴ and 1.53 (95%CI: 1.16-2.02) by Hashemi et al.¹¹ According to these reports, ptosis may occur with microvascular dysfunction (caused by lipid deposition and oxidative stress on vascular walls) and neuropathy (caused by oculomotor paralysis and Horner syndrome) that result from diabetes^{11, 17}. But no significant relationship between diabetes and ptosis was observed in this study. A further detailed investigation about relationship diabetes and ptosis is required.

In this study, high BMI was significantly less prevalent among people with ptosis than was standard BMI. According to some reports, BMI and ptosis are significantly related; according to others, they are not^{4, 12, 16-19}. In this study, the numbers of people with low and high BMI were lower than the number of people with standard BMI. In addition, the average BMI in this study was slightly lower than the average BMI in subjects in past studies in which BMI and ptosis were significantly related. It is possible that our results differ from those in reports in which BMI and ptosis were significantly related.

The prevalence of men with ptosis was significantly higher than that of women with ptosis. We found few reports in which gender differences in ptosis were described. Surveys in Tehran also revealed that men with ptosis were significantly more numerous than women with ptosis²⁰. Although this study concerned aponeurotic ptosis, there are reports that aging has more significant effects on cutaneous ptosis in

men than in women^{19, 21, 22}. Surveys of Dutch and British people also demonstrated that men with cutaneous ptosis were more numerous than women with cutaneous ptosis¹⁹. The skin in the orbital region consists of the dermis, thin facial muscles, and a thin subcutaneous fat layer and is not attached to the bone. The orbital area is larger in men than in women, and men are more susceptible to age-related sagging²¹.

In addition, in a comparison of the deep muscle tendons involved in finger flexion in men and women, women reported less time-dependent elongation than did men; that is, women's tendons were stiffer²³. The sites of elongation may have differed in men and women, but elongation may be common in tendons that undergo repeated loading. To determine whether male sex is a risk factor for ptosis, further research is needed.

This is the first study to investigate ptosis and subjective symptoms in the general population. According to some reports, headache is a functional indication for ptosis surgery²⁴, and headaches have been resolved with ptosis surgery. Although subjects with and without ptosis have exhibited generally significant differences in difficulty in raising the eyelids, headache, and stiff shoulders in other studies, we found no significant differences in this study. Eighty nine % of the ptosis group were unaware of visual field constriction despite the presence of ptosis. It was suggested that early ptosis may be asymptomatic due to compensation by Müller's muscle contraction, occipitofrontalis muscle contraction and lateral flexion of the neck. Patients with ptosis are less likely to visit a hospital care if they do not have symptoms. Thus, a large number of ptosis patients are potentially present in the general population. Viewed from the opposite side, patients visiting a hospital were subjective and had significantly more advanced symptoms, suggesting that they may have symptoms of headache and stiffness.

Our study had several limitations. We used logistic regression analysis to analyze the data, and bias may have been present in our sample. The Iwaki project is based on statistics from volunteers from the Iwaki area, Hirosaki City, and data may differ from those of other Japanese populations.

This study was conducted on a large number of volunteers, and our findings may support a causal relationship between dyslipidemia/hypertension and ptosis. It has also been suggested that ptosis may contribute to sympathicotonia diseases such as hypertension. Early detection and treatment of potential ptosis patients by screening for ptosis may be helpful in the treatment of ptosis and associated symptoms.

Conclusions

In this study, we investigated the association between aponeurotic ptosis and its causes and the association between ptosis and symptoms. The present study provides the first representative data on aponeurotic ptosis among a large-scale survey of the general population of a city in Japan. An association between ptosis and older age, male sex, hypertension, and dyslipidemia was suggested. A significant relationship between dyslipidemia/hypertension and ptosis demonstrated in previous reports was found. In view of findings of previous studies and ours, we suggest that dyslipidemia, hypertension, and male sex may be included among the risk factors for aponeurotic ptosis in Japanese general population. It may be useful to educate people with the risk factors identified in this study about the risk of developing ptosis and to teach them to reduce eyelid irritation to prevent ptosis.

Financial Disclosure Statement

This work was supported by JST COI Grant Number JPMJCE1302.

Conflict of Interests

All authors have no conflicts of interest directly to the content of this article.

Acknowledgements

We thank Dr.Matsuzaka (Department of Medical Informatics, Hirosaki University Hospital), and Professor Ihara (Department of Social Medicine, Hirosaki University Graduate School of Medicine)for their valuable comments, and ENAGO (www.enago.jp)for the English language review.

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