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Analysis of Variation of Orbital Soft Tissue by a Novel Method in Magnetic Resonance Imaging

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Summary: Accurate evaluation of the orbital soft tissue is essential when conducting surgery to remove excess lower eyelid fat. However, the eyelid puffiness decreases in the supine-position intraoperatively and when magnetic resonance imaging is performed preoperatively, compared with the standing/sitting-position in which patients are commonly examined. We investigated the orbital soft tissue difference between standing/sitting and supine positions. The study was conducted on six patients with an average age of 58.5 years. Anterior soft tissue and adipose tissue of eyeball axis, anterior adipose tissue in front of the infraorbital margin, total adipose tissue, and horizontal and vertical orbital positions were determined. Statistical examination by *t* test showed that soft tissue and adipose tissue, except for total adipose tissue, were significantly reduced in the supine-position compared with the standing/sitting-position. There was a significant difference in eye position only in the vertical direction. Anterior adipose tissue in front of the infraorbital margin, which is important during lower eyelid surgery, appeared 17.5% lower in the supine-position than in the standing/sitting-position. It is necessary to consider this postural discrepancy during the surgical management of lower eyelid fat. (*Plast Reconstr Surg Glob Open* 2022;10:e4015; doi: [10.1097/GOX.0000000000004015](https://doi.org/10.1097/GOX.0000000000004015); Published online 12 January 2022.)

Surgical intervention for lower eyelid sagging and bagginess is a common procedure.¹ To operate on the upper and lower eyelids, dissecting the soft tissue around the eye is essential for dermatological/plastic surgeons.¹ Patients typically complain of eyelid puffiness when standing or sitting. However, the eyelid puffiness is reduced in the supine-position, such as during the surgery, due to the postural variation exhibited by the anatomy of the orbital soft tissue. Some reports have recommended magnetic resonance imaging (MRI) for illustrating soft tissue in the orbital region.^{2,3} Nevertheless, even if pre-operative evaluation by ultrasound or MRI is performed, the droopy eyelids and the puffiness of soft tissue, which are apparent while the patient is standing or sitting, are masked during the surgery wherein the patient is in the supine-position.

In the present study, we aimed to investigate for the first time, to the best of our knowledge, the changes in the orbital soft tissue between the near-standing-position (60 degree head-up) and the supine-position by taking an MRI. (See **figure 1, Supplemental Digital Content 1**, which displays the two-microcoil method for magnetic resonance imaging. Two microcoils were used to sandwich the eyes in position with a 60 degree head-up state. <http://links.lww.com/PRSGO/B873>.)

METHODS

Participants

The study was performed on six patients with lower eyelid sagging (12 eyelids) who visited Kobe University Hospital between August 2019 and June 2021. The participants did not have specific diseases such as collagen disease and thyroidism, and consisted of two men and four women with an average age of 58.5 years (range, 51–65 years). The institutional review board approved the study design, and informed consent was obtained from the participants.

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Imaging

A 1.5-Tesla MRI was used (Achieva 1.5, Philips Medical Systems, Best, the Netherlands). The microcoil was positioned over the eyes of the supine patient. However, this produced a poor-quality image in the standing-position. Therefore, two microcoils with a diameter of 10 cm each were used on either side of the eyes, effectively sandwiching them, and the images were taken in near-standing-position while the head was rotated 60 degrees (**Supplemental Digital Content 1**, <http://links.lww.com/PRSGO/B873>). The T1-weighted images were taken using the following parameters: TR/TE: 146/13 ms, turbo factor: 7, the number of signals averaged 1 in sagittal planes. The orbital soft tissue was measured on the images using the AZE Virtual Place software (AZE Ltd., Tokyo, Japan).

Tissue quantification was performed according to the method described by Sean Darcy et al,⁴ wherein, anterior soft tissue and adipose tissue of the eyeball axis, anterior adipose tissue in front of the infraorbital margin, total adipose tissue, and horizontal and vertical positions of the orbit were determined. (See figure 2, **Supplemental Digital Content 2**, which displays the magnetic resonance imaging (MRI) of six patients with 12 eyelids. MRI using a two-microcoil method of six cases was done. The red line represents the infraorbital margin. The yellow frames shown on the slide represent the anterior adipose tissue in front of the infraorbital margin. *Detailed conditions*: T1-weighted images; TR/TE: 146/13 ms; turbo factor: 7; and the number of signals averaged one in sagittal planes. The soft tissue was measured on images using the AZE Virtual Place software (AZE Ltd., Tokyo, Japan). *Abbreviations*: R, Right; L, Left; Supine, Supine-position; Up, Near-standing-position (60 degree head-up). <http://links.lww.com/PRSGO/B874>.)

Individual differences are present in terms of the shape and size of the eyeball. Therefore, the sagittal section of the eye was determined based on the optic nerve, and the rate of fat change, not the amount, was calculated.

Statistical Analysis

Two-sided *t* test was used for statistical analyses, and statistical significance was considered at a *P* value less than 0.05.

RESULTS

The two-microcoil method achieved a high resolution, which enabled the quantification and comparison of the soft tissue and adipose tissue around the eyes (**Supplemental Digital Content 2**, <http://links.lww.com/PRSGO/B874>). The yellow frame shown on the slide is anterior adipose tissue in front of the infraorbital margin (**Supplemental Digital Content 2**, <http://links.lww.com/PRSGO/B874>). Based on the *t* test, soft tissue and adipose tissue, except for total adipose tissue, were significantly reduced in the supine-position compared with the standing/sitting-position (**Table 1**). There was a significant difference in the orbital position only in the vertical direction (**Table 1**). The changes between the near-standing-position (60 degree head-up) and supine-position are shown in **Table 1** and **Supplemental Digital Content 2** (<http://links.lww.com/PRSGO/B874>). The mean value of anterior soft tissue of the lower eyeball axis decreased from 178.0 ± 32.94 to 163.75 ± 33.07 mm² (change = -14.25, change rate = 92.0%, *P* < 0.01). The mean value of anterior adipose tissue of the eyeball axis decreased from 81.17 ± 18.68 to 71.25 ± 15.96 mm² (change = -9.92, change rate = 87.8%, *P* < 0.01). The mean value of anterior adipose tissue in front of the infraorbital margin, which requires treatment during lower eyelid sagging surgery, decreased from 62.5 ± 16.06 to 51.58 ± 14.32 mm² (change = -10.92, change rate = 82.5%, *P* < 0.01). The mean value of total adipose tissue decreased from 532.6 ± 63.14 to 518.5 ± 64.09 mm² (change = -14.1, change rate = 97.4%, not significant). The mean value of horizontal positions of the orbit changed from 8.67 ± 1.42 to 8.83 ± 1.33 mm (change = 0.16, change rate = 101.8%, not significant). The mean value of

Table 1. Statistical Analyses of Each Item between Supine-position (at the Time of Surgery) and Near-standing-position (60 Degree Head-up) (at the Time of Examination) Using Student *t* Test

		Anterior Soft Tissue of the Eyeball Axis (mm ²)		Anterior Adipose Tissue of the Eyeball Axis (mm ²)		Anterior Adipose Tissue in Front of the Infraorbital Margin (mm ²)		Total Adipose Tissue (mm ²)		Horizontal Positions of the Orbit (mm)		Vertical Positions of the Orbit (mm)	
		Supine	Up	Supine	Up	Supine	Up	Supine	Up	Supine	Up	Supine	Up
Case 1	R	190	220	81	92	71	76	566	564	9.3	9.0	6.8	5.1
	L	165	189	65	70	63	67	544	604	10.7	10.6	6.7	6.0
Case 2	R	197	197	85	88	68	73	419	572	8.0	8.6	5.7	6.0
	L	188	186	72	79	62	69	501	509	9.8	9.7	6.1	5.9
Case 3	R	125	134	46	51	30	42	558	544	11.1	10.0	8.8	7.4
	L	121	150	45	63	36	49	575	607	10.2	10.8	6.9	6.8
Case 4	R	197	228	98	117	63	87	643	542	7.9	6.5	6.5	6.3
	L	219	219	83	107	60	85	539	613	8.1	8.7	7.8	7.8
Case 5	R	146	157	79	85	44	48	464	451	7.2	6.9	6.3	6.2
	L	138	139	61	70	39	43	439	433	8.1	7.2	6.7	6.2
Case 6	R	141	158	62	67	37	49	479	461	7.4	7.7	7.4	6.3
	L	138	159	78	85	46	62	495	491	8.1	8.3	7.4	6.2
Mean Value		163.75	178	71.25	81.17	51.58	62.5	518.5	532.6	8.83	8.67	6.93	6.35
SD		33.07	32.94	15.96	18.68	14.32	16.06	64.09	63.14	1.33	1.42	0.83	0.71
<i>t</i> test		<i>P</i> < 0.01		<i>P</i> < 0.01		<i>P</i> < 0.01		NS		NS		<i>P</i> < 0.01	

R, right; L, left; Supine, supine-position; Up, near-standing-position (60 degree head-up); NS, not significant.

vertical positions of the orbit changed from 6.35 ± 0.71 to 6.93 ± 0.83 mm (change = 0.58, change rate = 109.1%, $P < 0.01$).

DISCUSSION

This study emphasized two critical lessons by quantifying the soft tissue and adipose tissue around the eye in near-standing-position (60degree head-up) and in supine-position.

First, the two-microcoil method, with a 60degree head-up position, provided high-quality resolution images with MRI.

Second, anterior adipose tissue in front of the infra-orbital margin, which is essential during lower eyelid surgery, appeared 17.5% lower supine-position (at the time of surgery) than near-standing-position (60degree head-up) (at the time of examination).

It is important to note that this study was limited by a small sample size. Therefore, it is necessary to conduct the next survey in each gender as well as in each age group because of the reported increase of lower eyelid fat with aging.⁴ Further long-term studies are also needed.

CONCLUSIONS

Some surgeons may obtain good clinical results by removing slightly more fat than expected during surgery and completing the surgery with a concave shape instead of a flattened shape. This study presents supportive data

that suggests consideration of the discrepancy between the positions is necessary to manage the lower eyelid fat surgically.

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