

Corrugator Supercilii Muscle Resection and Migraine Headaches

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This study was conducted to determine whether there is an association between the removal of the corrugator supercilii muscle and the elimination or significant improvement of migraine headaches. Questionnaires were sent to 314 consecutive patients who had undergone corrugator supercilii muscle resection during endoscopic, transpalpebral, or open forehead rejuvenation procedures. The patients were queried as to whether they had a history of migraine headaches and, if so, whether the headaches significantly improved or disappeared after surgery. If the answer was affirmative, then the patients were further questioned about the duration of the improvement or cessation of the headaches and the relationship to the timing of the surgery. After an initial evaluation of the completed questionnaires, a telephone interview was conducted to confirm the initial answers and to obtain further information necessary to ensure that the patients had a proper diagnosis based on the International Headache Society criteria for migraine headaches. The charts of the patients who had migraine headaches were studied to ascertain and classify the type of surgery they had undergone. Patient demographics were reviewed, and the results were statistically analyzed.

Of the 314 patients, 265 (84.4 percent) either responded to the questionnaire, were interviewed, or both responded to the questionnaire and were interviewed. Of this group, 16 patients were excluded because of the provision of insufficient information to meet the International Headache Society criteria, the presence of organic problems, and other exclusions mandated by study design. Thirty-nine (15.7 percent) of the remaining 249 patients had migraine headaches that fulfilled the Society criteria. Thirty-one of the 39 (79.5 percent) with preoperative migraine noted elimination or improvement in migraine headaches immediately after surgery ($p < 0.0001$; McNemar), and the benefits lasted over a mean follow-up period of 47 months. When the respondents with a positive history of migraine headaches were further divided, 16 patients ($p < 0.0001$; McNemar) noticed improvement over a mean follow-up period of 47 months, and 15 ($p < 0.0001$; McNemar) experienced total elimination of their migraine headaches over a mean follow-up period of 46.5 months. When divided by migraine headache type, 29 patients (74 percent) had nonaura migraine headaches. Of these patients, the headaches disappeared

in 11 patients, improved in 13 patients, and did not change in five patients ($p < 0.0001$). Ten patients experienced aura-type headaches, which disappeared or improved in seven of the patients and did not change in three of the patients ($p < 0.0001$). This study proves for the first time that there is indeed a strong correlation between the removal of the corrugator supercilii muscle and the elimination or significant improvement of migraine headaches. (*Plast. Reconstr. Surg.* 106: 429, 2000.)

Migraine headaches afflict between 16 and 26 million Americans.^{1,2} Silberstein reported the prevalence of migraine headaches as occurring in 18 percent of women and 6 percent of men.³ The incidental discovery that botulinum toxin (Botox) injection^{4,5} is beneficial for treating headaches in some individuals, coupled with reports of similar experiences by our patients who had undergone removal of the corrugator supercilii muscle with elimination of their migraine headaches, prompted us to investigate the role of corrugator muscle resection in the elimination or improvement of migraine headaches. This report will elaborate on the details of that study.

METHOD

Consecutive patients who underwent forehead rejuvenation procedures encompassing resection of the corrugator supercilii muscle from 1989 to 1999 were included in this study. Questionnaires were sent to those patients who had undergone endoscopic, transpalpebral, or open-type resection, asking them whether they had experienced migraine headaches before surgery. Patients who had never had a migraine headache did not have to answer further questions. If the answer was affirmative, we asked

whether patients had observed the elimination or significant improvement of migraines following their forehead surgery. If indeed they had migraine headaches that improved or were eliminated following the surgical procedure, they were asked how long after the surgery they noted the change and how long it lasted. In a second phase of the study, a telephone interview was conducted to ask more elaborate questions pertaining to the presence of an aura and other migraine symptoms, which would aid in confirming the diagnosis and classifying the headache using criteria set forth by the International Headache Society.⁶ Patients were also asked about proximity of the last preoperative migraine attack to the surgery, how soon after surgery they noted improvement, time interval between diagnosis and surgery, specialty of the physician who made the diagnosis, headache laterality, family history of migraine headaches, medications that were beneficial, headache severity, relationship to menstrual cycles, and current status of corrugator supercilii muscle function. Those patients who reported a change in their migraine headaches that was remote from the surgery were eliminated from the study, as were those who did not have active migraine headaches shortly before the surgery.

The demographics of the respondents were obtained by chart review. The data were tabulated, then statistically analyzed using Statistica,⁷ a computer software statistics program, and reviewed by two biostatisticians. Various techniques of statistical analysis were used to test the above stated hypotheses, including McNemar's test for symmetry, the chi-square test with Yates correction, and (for small samples) Fisher's exact test. Unadjusted odds ratios were computed wherever appropriate. The observed frequencies were compared with hypothesized values using the chi-square and/or Fisher's exact test, when appropriate.

RESULTS

Of the 314 patients, 49 (15.6 percent) were excluded because they could not be contacted. Sixteen other patients, most of whom had observed improvement or elimination of headaches, were excluded because of insufficient information for meeting the International Headache Society criteria, the presence of organic problems, or other exclusions mandated by study design. The remaining 249 patients (15 men and 234 women) were available for the study. Data were collected by questionnaire only from 117 patients (47 percent), by telephone interview only from 93 patients (37 percent), and by a combination of questionnaire and phone interview from 39 patients (16 percent). The authors interviewed all of the patients who suffered from migraine headaches, in addition to their completion of the questionnaires.

Migraine Group

Thirty-nine (15.7 percent; 38 women and one man) out of 249 patients fulfilled the International Headache Society criteria for migraine headaches. Twenty-nine patients (74.4 percent; all women) experienced migraine without aura, whereas 10 patients (25.6 percent; 1 man and 9 women) had migraine with aura. Thirty-one patients (79.5 percent) experienced either elimination or improvement of the migraine headaches immediately after surgery, which was statistically significant ($p < 0.0001$; McNemar). The follow-up period averaged 47 months, ranging from 5 to 122 months. Of the patients who experienced a change in their migraines, 15 (38.5 percent; $p < 0.0001$; McNemar) had a total elimination of the headaches with a mean follow-up of 46.5 months. In 16 patients (41 percent; $p < 0.0001$; McNemar), the headaches improved with an average follow-up period of 47 months (Table I). The difference in the response rate between

TABLE I
Migraine Patient Data

Migraine Patients	Aura Group (%)	Nonaura Group (%)	Total Group (%)	Average Follow-Up (months)	<i>p</i> Values
Disappeared	4 (40)	11 (38)	15 (38.5)	46.5	<0.0001
Improved	3 (30)	13 (45)	16 (41)	47	<0.0001
No change	3 (30)	5 (17)	8 (20.5)	48	
TOTAL	10 (100)	29 (100)	39 (100)		

these two groups was not statistically significant.

Migraine Type (Aura and Nonaura)

When divided by migraine type, 29 patients (74.4 percent) had nonaura-type headaches (Table I). Of these patients, 11 (37.9 percent) had migraines eliminated, 13 (44.8 percent) experienced improvement ($p < 0.0001$), and five (17.2 percent) did not notice any change in their headaches. Ten patients (25.6 percent) were classified as having migraines with aura (Table II). An elimination of the headaches with aura occurred in four patients. Three patients experienced an improvement ($p < 0.0001$), and three patients reported no change.

Family History

Nineteen of the 39 patients with preoperative migraine (49 percent) had a positive family history of migraine headaches. Of this group, 14 (74 percent) had an elimination or improvement and 5 (26 percent) failed to experience any change. There was no statistically significant difference between those who had a

family history of migraine headaches and those who did not.

Age

The mean age of the patients for whom migraines improved or were eliminated was 56.1 years (range: 32 to 70 years). The mean age of the patients for whom migraines did not change was 52 years (range: 46 to 64 years). This age difference was not statistically significant.

Menstrual Cycle

Eight patients had migraine headaches that were related to their menstrual cycles. The migraines disappeared in four of these patients, improved in one, and remained unchanged in three. Of the two patients who had menopause-related migraines, the headaches disappeared in one and improved in the other.

Surgical Approach

Of the 39 patients with migraine headaches, 9 (23.1 percent) underwent an open forehead rejuvenation procedure, and 23 (59.0 percent) were subjected to an endoscopic forehead

TABLE II
Aura Group

Patient	A	B1	B2	B3	B4	C	Response interval
	At least two attacks that fulfill three or more categories from B1 through B4	One or more aura symptoms	At least one aura symptom develops gradually over >4 minutes	All aura symptoms last less than 60 minutes	Headache follows aura with a free interval <60 minutes	Evidence of organic disease	
Headache disappeared							
R.M.	+	Flashing lights: scintillations	Not sure	+	+	-	Immediate
E.W.	+	Flashing lights: scintillations	Rapid onset	+	+	-	Immediate
M.M.	+	Flashing lights: scintillations	+	+	+	-	Immediate
M.Z.	+	Visual: bright spots, positive scotomata	+	+	+	-	Immediate
Headache improved							
H.B.	+	Visual: wavy lines, fortification spectra	+	+	+	-	Immediate
L.G.	+	Visual: dark spots, negative scotomata	+	+	+	-	Immediate
J.M.	+	Visual: bright spots, positive scotomata	+	+	+	-	Immediate
No change							
P.D.	+	Visual: wavy lines, fortification spectra	+	+	+	-	
B.S.	+	Visual: dark spots, negative scotomata	+	+	+	-	
L.A.	+	Visual: wavy lines, fortification spectra	+	+	+	-	

technique. In seven patients (17.9 percent), the corrugator supercilii muscle was removed through a transpalpebral approach (Table III). There were no statistically significant differences in response rate among the three groups.

Migraine Prophylaxis

None of the patients received prophylactic treatment for migraine headaches postoperatively.

DISCUSSION

Based on reports of the disappearance of migraine headaches after the injection of Botox^{4,5} and statements by patients who, after undergoing forehead rejuvenation, no longer experienced the migraine headaches, the authors were encouraged to investigate a large patient population that had undergone corrugator supercilii muscle resection. It was intriguing to discover that so many of these patients noted either a significant improvement or an elimination of their migraines.

Migraine headaches are seen in approximately 6 percent of Americans between 18 and 64 years old.² According to Silberstein,³ migraines occur in 18 percent of women. Therefore, millions of sufferers could possibly experience either an enduring improvement or a total abolition of their headaches after corrugator supercilii muscle resection. There is currently no lasting medical treatment for migraine headaches, although the symptoms can be effectively palliated using pharmaceutical agents. On occasion, the frequency and intensity of migraines can be reduced using prophylactic medications.^{3,8,9} Interestingly, many patients who suffer from the headaches are in the patient group that would benefit from the aesthetic improvement achieved through removal of the corrugator supercilii muscle. According to the National Institutes of Health, 5.8 percent of people aged 45 to 64 years suffer from chronic migraine headaches.² The percentage of patients in this study who reported having migraine headaches is ostensibly higher than the national level for several reasons. The ratio of women to men favors women significantly (38 to one) compared with the normal population. Considering that migraine headaches are more common in women (occurring in 18 percent of women as opposed to 6 percent of men),³ the preponderance of women in the patient sample is one reason for the higher-

than-average incidence of migraines in this patient population. Another reason is that only the patients who had experienced migraines chose to answer the questionnaires, a conclusion reached by interviewing the 93 patients who did not return the questionnaires. These patients uniformly felt that, because they did not have migraine headaches, they did not have to return the questionnaires.

In 1994, when the lead author of this report (B.G.) introduced the use of Botox in the aesthetic surgery field for the first time,¹⁰ there was no expectation of a functional improvement. In fact, the fervent enthusiasm with which many physicians from different disciplines have embraced this modality has been gratifying. Learning that botulinum eliminates headaches was an even greater surprise. Until a better patient selection criteria is outlined, we are currently using Botox as a prognostic indicator.

Because headaches can be caused by so many conditions, we specifically and deliberately limited the questionnaire to migraine headaches. Our follow-up confirmation telephone interviews assured us that, in all but five of the patients who experienced a change after surgery, the migraine diagnosis was made by a neurologist or by a physician. However, the remaining five patients do fit unquestionably in the migraine patient group as determined by the International Headache Society criteria.⁶ Furthermore, to obviate ambiguity, we focused the questions on either the elimination or the significant improvement of migraine headaches. In other words, to ensure a valid outcome, slight or even moderate improvement was not considered in this study.

Resection of the corrugator supercilii muscle is an integral part of forehead rejuvenation. To gain a more successful, amaranthine outcome, we advocate a thorough resection of this muscle.¹¹⁻¹⁶ The isolated corrugator supercilii muscle resection can be performed either through an endoscopic or using a transpalpebral approach, as first reported by the senior author^{11,16} and by Knize.¹⁷

Although no statistically significant difference was noted with respect to the surgical approach, the odds of improving or eliminating a migraine headache were higher for endoscopic corrugator supercilii muscle resection than for the other techniques.

Analysis indicated that resection of the corrugator muscle positively influenced the outcome of migraine headaches ($p < 0.0001$; Mc-

TABLE III
Surgical Approach Data

Group	Procedure	No. of Patients	Disappeared or Improved (%)	No Change (%)	Odds Ratio	p Value
A	EFL	23	20 (87)	3 (13)	A vs. B = 3.3	0.3
B	OFL	9	6	3	A vs. C = 2.7	0.6
C	TP	7	5	2	C vs. B = 1.3	1
TOTAL		39	31 (79.5)	8 (20.5)		

EFL, endoscopic forehead lift; OFL, open forehead lift; TP, transpalpebral corrugator muscle resection.

Nemar). Migraines were either improved or eliminated in 31 of 39 patients with preoperative headaches. The primary null hypothesis was that migraine headaches neither improved nor were eliminated by corrugator muscle resection. This hypothesis was tested against actual outcomes of treatment and rejected ($p < 0.0001$). Having established a positive effect of surgery on migraine headaches, the question

arose as to whether there was a statistically significant difference between the observed outcomes in this study and the expected attrition of migraines that may occur as a result of the natural history of the disease in the age group of patients included in this study. However, this was not a possibility because only the patients who had experienced immediate elimination or improvement of headaches after sur-

TABLE IV
Nonaura Group

Patient	A	B	C	C1	C2	C3	C4	D1	D2	E	Response interval
	At least five attacks that fulfill categories B, C, D	Headache lasts 4 to 72 hours (untreated or unsuccessfully treated)	At least two from categories C1 through C4	Headache unilateral	Pulsating or throbbing	Intensity inhibits daily activity	Aggravated by walking up stairs or routine activity	Nausea, vomiting, or both	Photophobia and phonophobia	Organic disease	
Headache disappeared											
L.B.	+	>4 hours	+	+	+	+	+	Both	+	-	Immediate
R.D.	+	>8 hours	+	+	+	+	+	Nausea	+	-	Immediate
E.K.	+	24 hours	+	-	+	+	+	Nausea	+	-	Immediate
L.L.	+	24 hours	+	+	+	+	+	Nausea	+	-	Immediate
D.R.	+	48 hours	+	+	+	+	+	Nausea	+	-	Immediate
D.S.	+	24 to 48 hours	+	+	+	+	+	Both	+	-	Immediate
W.M.	+	>6 hours	+	-	+	+	+	Nausea	+	-	Immediate
E.V.	+	24 hours	+	+	+	+	+	Both	+	-	Immediate
M.G.	+	24 hours	+	-	+	+	+	-	+	-	Immediate
G.B.	+	>4 hours	+	+	+	+	+	Nausea	+	-	Immediate
C.S.	+	72 hours	+	+	+	+	+	Both	+	-	Immediate
Headache improved											
D.D.	+	>4 hours	+	-	+	+	+	Both	+	-	Immediate
B.H.	+	24 hours	+	+	+	+	+	Nausea	+	-	Immediate
E.C.	+	48 to 72 hours	+	+	+	+	+	Both	+	-	Immediate
M.F.	+	24 to 72 hours	+	+	+	+	+	Nausea	+	-	Immediate
L.K.	+	12 hours	+	+	+	+	+	Both	+	-	Immediate
S.L.	+	24 to 72 hours	+	+	+	+	+	Nausea	+	-	Immediate
E.R.	+	24 hours	+	-	+	+	+	Both	+	-	Immediate
A.S.	+	>4 hours	+	-	-	+	+	Nausea	+	-	Immediate
M.H.	+	72 hours	+	+	+	+	+	Both	+	-	Immediate
G.M.	+	6 to 8 hours	+	+	+	+	+	Both	+	-	Immediate
D.P.	+	24 to 48 hours	+	-	+	+	+	-	+	-	Immediate
T.G.	+	24 to 72 hours	+	-	+	+	-	Nausea	+	-	Immediate
G.C.	+	>8 hours	+	-	+	+	+	Both	+	-	Immediate
No change											
M.F.	+	4 to 24 hours	+	-	+	+	+	Nausea	+	-	
D.L.	+	48 to 72 hours	+	+	+	+	+	Nausea	+	-	
K.B.	+	>24 hours	+	+	+	+	+	Both	+	-	
L.F.	+	72 hours	+	+	-	+	+	Both	+	-	
S.Z.	+	4 to 8 hours	+	+	+	+	+	Nausea	+	-	

gery were included, as depicted in Tables II and IV. The prevalence of migraine headaches in women at 56 (the average age when surgery took place on this group of patients) and 60 (the average age when the follow-up ended) has been reported as 16 percent and 12 percent, respectively.^{3,8,18} This reflects a 25 percent reduction in migraines between these age groups. Our findings were still statistically significant, even when taking this variable into consideration.

We are extremely enthusiastic about this report and hopeful that it will mark the beginning of a new era for the management of migraine headaches. More studies are needed to clearly define the pathophysiology and the rationale for the effects of muscle resection and to more predictably identify patients who would benefit from this surgery. It is likely that, by removing the corrugator supercilii muscle, a trigger point is being eliminated. This study seems to confirm the role of a peripheral mechanism in migraine headaches. Stimulation of the trigeminal nerve results in a release of substance P, calcitonin gene-related peptide, and neurokinin A.^{8,19} These chemicals cause neurogenic inflammation and may further enhance neuronal sensitivity and altered blood flow in the microcirculation. Neurogenic inflammation-induced meningeal irritation may produce some of the migraine pain.⁸ Considering that at least one of the terminal branches of the trigeminal nerve pierces the corrugator supercilii muscle to reach the subcutaneous plane, it is likely that compression of these nerves instigates the trigeminal nerve inflammation and triggers migraine headaches.

It is critical to learn whether there is a correlation between inadequate removal of the muscle, initial improvement, and subsequent recurrence of the migraine headaches. It will also be interesting to find out whether there is a connection between a failure to adequately remove the corrugator supercilii muscle and the persistence of migraine headaches. We are currently conducting a more elaborate study to investigate all of these points in a prospective manner in a collaboration with our neurology colleagues. It would be unrealistic to expect every type of migraine headache to respond to muscle removal, yet it would be prudent to explore every potential.

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