Comparison of the Transpalpebral and Endoscopic Approaches in Resection of the Corrugator Supercilii Muscle

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Abstract

Background: Corrugator resection is an integral part of periorbital rejuvenation and can be accomplished through the open coronal, endoscopic, or transpalpebral technique. While most authors concur about the importance of corrugator resection during brow lift surgery, considerable debate remains regarding the efficacy and technical ease of muscle resection with these approaches.

Objectives: The authors conducted a cadaver study to compare the completeness of resection of the corrugator muscle with the transpalpebral and endoscopic techniques.

Methods: A split-face study was performed in 10 fresh cadavers. On one side, the corrugator muscle was resected through an endoscopic approach, and on the opposite side of the face, a transpalpebral resection was performed. After the completion of both procedures, a coronal incision was made; gross observations were noted; photographs were taken; and muscle weights were recorded.

Results: In 19 of 20 cadaver halves, subtotal or total resection of the corrugator muscle was accomplished. In only one endoscopic instance was any muscle left in continuity. This occurred along the superior aspect of the arcus marginalis release when the corrugator muscle was hidden by the upper edge of the cut periosteum.

Conclusions: Unlike the previous reports, the authors found that transpalpebral and endoscopic techniques both allow subtotal or total resection of the corrugator muscle. Inadequate resection is technique dependent rather than procedure dependent.

Keywords

facial surgery, corrugator resection, supercilii muscle, transpalpebral, endoscopic
METHODS

All procedures were performed by a single surgeon (AA). Five cadavers were initially operated on to refine the surgical technique. Subsequently, in 12 consecutive cadavers (seven males and five females), a transpalpebral corrugator resection was performed on one side, followed by an endoscopic resection on the contralateral side. Two cadavers were later excluded, owing to bilateral absence of the corrugators in one and excessive scarring from a previous injury in another.

The excised muscle specimens on each endoscopic and transpalpebral side were weighed in grams and recorded. After completion of the procedure on both sides, a coronal incision was made to identify any remaining muscle following the endoscopic approach, while the transpalpebral resection was reexamined directly. Any muscle remnants remaining from the approach were then excised and weighed.

Surgical Technique

The surface anatomy of the corrugator supercilii muscle, as described by Janis et al., was marked on the skin of each cadaver as a guide to muscle location. The transpalpebral procedure was performed first, through an upper blepharoplasty incision. Once the orbicularis oculi muscle was incised, dissection proceeded in a cephalad direction, making certain that the orbital septum was not violated. The supraorbital rim was reached, and the corrugator supercilii muscle was identified directly in front of the supraorbital rim and deep to the orbicularis oculi muscle and the frontalis. The muscle can be identified by its anatomical location, the direction of its fibers, and its color (Figure 1). The corrugator is distinctly darker than the orbicularis. Of note, the periosteum was not released during the transpalpebral approach. The corrugator muscle was then separated from the overlying orbicularis oculi muscle, taking care medially to identify and protect the branches of the supratrochlear nerve. The deep surface of the corrugator muscle was separated from the underlying bone, identifying and preserving the supratrochlear and supraorbital nerves (Figure 2). The supraorbital nerve passes through a foramen or a notch in line with the medial limbus. At this point in the procedure, most of the extent of the muscle could be appreciated, with the supraorbital and supratrochlear nerves passing through or close to the muscle. (The supraorbital nerve passes closer to the deep surface of the muscle, while the supratrochlear nerve courses closer to the superficial surface.) The corrugator muscle was then divided into two pieces directly over the supraorbital nerve, isolating the nerve under direct vision and protecting it for the remainder of the procedure (Figure 3). The lateral portion of the muscle was excised. The medial portion was then followed medially, gently separating it from the multiple branches of the supratrochlear and infratrochlear nerves. Once the muscle was excised, its bed was checked for any muscle remnants, including its medial origin and the course of the supraorbital nerve (Figure 4). No attempt was made to excise the procerus, the depressor supercilii, or the orbicularis oculi in our dissections.

With the endoscopic approach, the procedure was performed through two paramedian incisions placed behind the anterior hairline. The forehead was dissected widely subperiosteally, extending the dissection to the temporal line of fusion on the right and left sides. The periosteum was then incised at the level of the supraorbital rim with a curved periosteal rim elevator. The supraorbital nerve and the midline were noted. The corrugator muscle was readily identified between the nasal midline and the anterior hairline.
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supraorbital neurovascular bundle. An attempt was then made to separate the corrugator muscle from the overlying frontalis and orbicularis oculi muscle. Separating the corrugator muscle from the surroundings before its removal facilitated the excision and more readily ensured complete muscle removal. Care was taken to preserve the multiple branches of the supratrochlear nerve lying within the corrugator muscle. The resection was deemed complete when no muscle remnants were identified and the subcutaneous fat was visualized (Figure 5).

After the completion of both procedures, a coronal incision was made; gross observations were noted; photographs were taken; and muscle weights were recorded. Weight measurements were assessed with medians and quartiles. Differences between procedures were calculated and summarized similarly. A Wilcoxon signed-rank test was used to assess whether the weight differed between the two sides.

RESULTS

Since two cadavers were excluded (owing to bilateral absence of the corrugators in one and excessive scarring from a previous injury in another), the following data are based on 10 cadavers.

Specimen Weights

The median weight of the resected muscle in the 10 cadavers was 31.5 g on the endoscopic side and 46.0 g on the transpalpebral side. In each of the 10 cadavers, the weight of the transpalpebral resection exceeded that of the endoscopic excision. Table 1 shows the weights by technique (means, standard deviations, medians, and quartiles). Note that the transpalpebral weight exceeded the endoscopic weight. Table 2 summarizes the differences in weight between the two techniques. The median difference between the two was 18.5 g. The weight of the transpalpebrally-resected muscle was significantly greater than that of the endoscopic side ($P = .002$).

Table 1. Resected Muscle Weight by Technique

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<th>Endoscopic</th>
<th>Transpalpebral</th>
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</thead>
<tbody>
<tr>
<td>Median (25th, 75th)</td>
<td>31.5 (28.0, 37.0)</td>
<td>46.0 (43.0, 67.0)</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>33.4 ± 10.6</td>
<td>59.0 ± 26.7</td>
</tr>
</tbody>
</table>

*N = 10. In grams.
approaches and techniques. At approximately the mid-1990s, predominantly because of the smaller incisions and greater patient acceptance. The literature is replete with descriptions of a variety of endoscopically-assisted brow lifts. Endoscopic procedures gained increasing popularity in the mid-1990s, predominantly because of the smaller incisions and greater patient acceptance.3-7 While Walden et al.3, on the basis of a cadaver study, stated that transpalpebral resection of the corrugator can leave up to one-third of the transverse head of the muscle intact, both Guyuron and Knize felt that these results were technique dependent.3,4 However, in none of the above reports nor in any other study has a direct comparison of these two techniques been made—hence, the reason for our study, which directly compares the two techniques with regard to the completeness of muscle resection in a fresh cadaver model.

In our dissections, all cadaver surgery was performed by a single surgeon (AA), to avoid operator-induced variability. Total or subtotal removal of the corrugator muscle was accomplished with the transpalpebral and endoscopic techniques in 19 of 20 cadaver halves. Muscle continuity was found in only one of 20 cadaver hemiforeheads, on the endoscopic side above the periosteal release. Therefore, we currently do not hesitate in our own clinical approach to incise the periosteum longitudinally, extending superiorly from the transverse periosteal release for a short distance, to make certain that the superior edge of the muscle has been identified. In the remaining 19 cadaver halves, any remaining muscle fibers were found either at the origin of the muscle or around the supraorbital neurovascular bundle. Therefore, the data show that with regard to completeness of resection, the two techniques in our cadaver dissection were similar.

In a further attempt to compare efficacy of resection, the muscles removed from each endoscopic and transpalpebral procedure were weighed, and mean and quartile weights were compared. Since each cadaver acted as its own control, we hoped that muscle weight would serve as an objective measure of completeness of resection. In fact, the mean weight of muscle removed via the transpalpebral approach was quite high and consistently greater than the mean weight of muscle removed via the endoscopic approach. In retrospect, we do not believe that these differences reflect more complete transpalpebral muscle resection. Rather, we believe that the dichotomy in specimen weights can be better explained as follows: When muscle is removed through the transpalpebral approach, it is removed in two pieces. Fat and superficial fascia are removed in addition to the corrugator muscle itself. This is in contrast to muscle removal through the endoscopic approach, in which muscle is removed piecemeal and fat and fascia are generally spared. Fat grafting following transpalpebral corrugator resection might therefore be advisable to prevent contour irregularities, as suggested by Guyuron et al.34 This is perhaps less important following the endoscopic approach.

Several nuances regarding both techniques might be worth emphasizing. With both approaches, drawing the surface anatomy of the muscle on the forehead skin, as described by Janis et al.,5 guides the surgeon with regard to location and extent of the muscle. With the transpalpebral approach, the dissection should be immediately superficial to the orbicularis oculi muscle, and penetration of the orbital septum should be avoided. The plane between orbicularis and septum will lead directly to the corrugator muscle superiorly. If the orbital septum is violated, cephalad dissection will lead to the orbital roof, and it will be necessary to incise either the orbital septum again or the periosteum to gain access to the corrugator muscle. Once the supraorbital nerve is identified, the muscle is divided.

### Table 2. Difference in Weight by Technique

<table>
<thead>
<tr>
<th>Technique</th>
<th>Mean (g)</th>
<th>Median (25th, 75th)</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transpalpebral</td>
<td>25.6</td>
<td>25 (15, 30)</td>
<td>.002</td>
</tr>
<tr>
<td>Endoscopic</td>
<td></td>
<td></td>
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**Gross Findings**

On the transpalpebral side, there was no evidence of remaining muscle in five cadavers and only minute remnants near the medial origin of the muscle (average weight, 0.03 g) in the other five. On the endoscopic side, there was no evidence of remaining muscle in two cadavers; there were minute remnants of the muscle (average weight, 0.04 g) near the origin and along the supraorbital nerve in seven cadavers; and in only one cadaver were muscle fibers present along the full length of the upper border of the muscle. In this single case, the most superior fibers of corrugator muscle were hidden under the periosteum above the periosteal release. In all transpalpebral and endoscopic cases, both branches of the supraorbital nerve and at least two branches of the supratrochlear nerve were preserved (Figure 2).

**DISCUSSION**

Corrugator resection—either as an isolated procedure or in concert with brow lifting—has been practiced for over 40 years.1,2 Open approaches through a coronal or hairline incision predated the more limited techniques frequently employed today.1-4 The long-term effectiveness of the open brows lift, however, has been well documented.5-7 Endoscopic procedures gained increasing popularity in the 1990s, predominantly because of the smaller incisions and greater patient acceptance.2,18-22 The literature is replete with descriptions of a variety of endoscopically-assisted approaches and techniques.2,9,19,21,23-28 At approximately the same time that endoscopic browlifting gained popularity, several authors described the transpalpebral approach to the corrugator muscle.6,7

Each of the above procedures has its proponents, with various authors citing specific reasons for their preferences. While some have documented long-term maintenance of brow position with endoscopic techniques, others question its long-term efficacy.29-33 Similarly, there is controversy with regard to the completeness of corrugator resection through the transpalpebral approach. Since incomplete resection of the corrugator will lead to persistent furrows, this issue is quite pertinent.

While Walden et al.,3 on the basis of a cadaver study, stated that transpalpebral resection of the corrugator can leave up to one-third of the transverse head of the muscle intact, both Guyuron and Knize felt that these results were technique dependent.3,4 However, in none of the above
along the course of the nerve, recognizing the division of the nerve into superficial and deep branches as mentioned earlier. This divides the muscle into a smaller lateral segment, which is removed first, and the main medial segment, which can be followed to its medial origin. Gentle traction on the branches of the supratrochlear nerve will allow removal of the muscle from its origin.

Both procedures have proponents claiming better visualization and greater technical ease with one technique over the other. In fact, each has its strengths and weaknesses. With the endoscopic technique, the trunk and major branches of the nerve are visualized on the undersurface of the muscle. With the transpalpebral route, the surgeon must dissect through the muscle to isolate the nerve. This is quite easy in the cadaver, but bleeding from the cut edges of the muscle can make this dissection tedious during live surgery. The cadaver endoscopic dissection is also technically easier than in the living patient, and bleeding during the endoscopic approach can frustrate the operating surgeon. This bleeding most commonly occurs from the lateral orbital subperiosteal release, the supraorbital arcus marginalis release, or the corrugator muscle resection, generally in that order. Corrugator muscle retraction, which occurs during endoscopic muscle resection in the live patient, can also make corrugator muscle resection more difficult. Generous infiltration of local anesthesia with epinephrine minimizes bleeding during the performance of both procedures.

With the endoscopic approach, the contour of the forehead and the position of the anterior hairline will dictate the technical ease of the surgery. A rounded forehead with a high hairline makes the endoscopic approach more difficult. While endoscopic instrumentation is curved, the rigid endoscope is straight, making visualization of the origin of the corrugator problematic in those patients. In addition, the instruments may not have the right curve for each forehead. In the patient with a high forehead or high hairline, the endoscopic procedure can be facilitated with the use of special endoretractors or by altering the incision site and placing it in a forehead crease. In the endoscopic brow lift, attention should be paid to the level of the periosteal release. If the incision is low, removal of the upper edge of the muscle may be difficult. This is addressed by a vertical extension of the incision superiorly.

Our study focused only on the completeness of corrugator muscle resection. We cannot infer from these results that complete muscle resection is critical or even advisable clinically. In fact, partial corrugator muscle resection in a certain setting is preferable, since complete resection may have the undesirable consequences of excess medial brow elevation or lateral splaying of the eyebrows. In those instances, when partial corrugator resection is performed, patients will, of course, maintain the ability to frown. Transverse frown lines due to an intact procerus muscle will also remain postoperatively unless the procerus muscle is resected. Procerus resection was not performed in our study.

For the practicing plastic surgeon, when should one procedure be favored over the other? The ideal candidate for the transpalpebral corrugator resection is that with a hyperactive corrugator muscle but with no or minimal brow ptosis. Those patients who need brow stabilization at the time of upper lid blepharoplasty are especially good candidates for this approach. This applies particularly well to the male patient since acceptable brow position tends to be lower in males than in females. The transpalpebral approach through the upper lid, accompanied by subperiosteal release and bony fixation, has recently been described by Cohen et al with consistent results. Our approach was not accompanied by subperiosteal release, since brow elevation was not our aim. In patients with significant brow ptosis with lateral hooding and/or temporal laxity, the transpalpebral approach is not a good choice, and the endoscopic brow lift is preferable.

Finally, one of our cadavers demonstrated bilateral absence of the corrugator muscles. A literature search failed to reveal any such previous description. Therefore, the clinical significance of this finding is questionable.

CONCLUSIONS

In our cadaver study, contrary to previously-published literature, transpalpebral and endoscopic approaches were both effective in achieving subtotal or total corrugator resection. While mean resected specimen weight was significantly greater for the transpalpebral removals, we believe that this is due to the en bloc removal of fat and superficial fascia as well as muscle via the transpalpebral approach. This is in contrast to piecemeal removal of muscle with the endoscopic technique. Therefore, as suggested by Guyuron and Knize, inadequate resection of the corrugator muscle in the cadaver appears to be technique related rather than procedure related. Ultimately, the choice between approaches rests on the comfort of the surgeon and the need for concomitant surgeries (eg, a blepharoplasty or brow lift).

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REFERENCES


