An Original Application of the Endotine Ribbon Device for Brow Lift

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Background: Correction of brow ptosis and lateral temporal laxity is one of the goals of surgical rejuvenation of the aging face. The Endotine Forehead (Coapt Systems, Inc., Palo Alto, Calif.) device is an effective bioabsorbable fixation tool for forehead and brow-lift procedures. However, the Endotine Forehead device alone is not able to correct lateral brow ptosis and temporal laxity. In this article, the authors propose an innovative use of another special device, the Endotine Ribbon (Coapt Systems), to provide long-lasting results in lateral brow-lift surgery and temporal lateral laxity correction.

Methods: Between February of 2006 and April of 2007, a total of 30 patients, aged between 38 and 70 years (average, 50 years), underwent brow-lift surgery. With this technique, the Endotine Ribbon is cut in halves and each portion of it is anchored to the deep temporal fascia with sutures, and its multiple tines facing outward grasp the superficial temporal fascia. The amount of brow elevation produced was assessed by comparison of the preoperative and postoperative vertical distances between the superior eyebrow hairline and the midpupil and lateral and medial canthal angle. The average follow-up period was 18 months.

Results: Using this technique, perfectly symmetric lateral eyebrows and temporal laxity correction were obtained in all patients. A lasting result was observed, and no significant adverse events were encountered.

Conclusions: The application of the Endotine Ribbon for brow-lift procedures provides significant and reproducible lateral brow elevation and temporal laxity correction. This fixation method is effective, safe, and easy to use, and leads to high patient satisfaction. (*Plast. Reconstr. Surg.* 124: 1652, 2009.)

Forehead and brow-lift procedures are essential elements in the rejuvenation of the aging face.[1] The brow has both static and dynamic qualities that combine to give it a vital role in determining facial aesthetics and expression.[2] As people age, brow ptosis occurs to varying degrees, changing the shape and position of the brows.

Endoscope-assisted techniques were conceived initially with the aim of obtaining an effective correction of the aesthetic defects of the upper third of the face with limited scars.[3] Early enthusiasm, however, was tempered by reports of brow ptosis relapse.[4,5]

Brow lifting includes adequate release, intraoperative brow elevation and shaping, tension-free fixation in the desired position, and postoperative tissue relaxation/stretching.[6] This led to the development of multiple fixation techniques in attempts to suspend the elevated brows until natural scarring fixes this new position.[7] Nevertheless, no single technique has completely satisfied the demands of surgeons.

Many authors have described their experience with the forehead and brow lift with the Endotine Forehead (Coapt Systems, Inc., Palo Alto, Calif.) fixation device.[6,8] However, many surgeons felt that although the amount of central lift achieved was satisfactory, lateral brow lift could not be obtained by means of the Endotine Forehead device.[9,10] This problem is particularly evident in patients with severe brow ptosis and temporal laxity. For this reason, the authors propose an inno-

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vative surgical technique coupling the Endotine Forehead device for central brow lift and the Endotine Ribbon (Coapt Systems) device for lateral brow lift.

The Endotine Ribbon was created for the treatment of the lower third of the face and neck, whereas with this technique, it is shortened and used to lift the temporal soft tissues. It grasps the superficial temporal fascia with its tines and is anchored to the deep temporal fascia with sutures; it is set with its multiple tines outward and not inward like in neck and lower third face lifts. Thus, the Endotine Ribbon permits a strong anchorage between the deep and superficial temporal fascia.

PATIENTS AND METHODS

Between February of 2006 and April of 2007, a total of 30 patients, aged between 38 and 70 years (average, 50 years), underwent brow-lift surgery by means of this new application. Except for four, all patients were women. All patients were treated under general anesthesia.

The brow lift was associated with an upper/lower blepharoplasty in 16 cases and with a cervicofacial lift through a different incision, performed later on, in 12 cases. To avoid overresection of upper eyelid skin, all patients are marked for adequate eyelid skin excision preoperatively in the upright position, with the brow corrected manually by the surgeon. Our general guidelines involve placement of the central brow at the level of the orbital rim, whereas the lateral brow should lie just slightly above the orbital rim. The postoperative follow-up was 12 to 24 months, with an average of 18 months.

Full-size, 1:1, standardized black-and-white photographs (Frankfort horizontal plane) were taken of each patient 4 to 6 weeks before surgery. An additional set of photographs was taken postoperatively. The postoperative photographs included at least one image with a scale (centimeters and millimeters) to validate measurement accuracy. The distance between a horizontal line drawn through the medial canthus and the eyebrow superior margin was measured on each side of the before-and-after images (Fig. 1): (1) at the medial canthus level, (2) at the midpupil level, and (3) at the lateral canthus level.

The measurements were recorded and compared. To analyze the statistical variability between preoperative and postoperative measurements, the authors applied the paired t test. A value of $p < 0.05$ was considered significant. Aesthetic results were evaluated using a visual analogue scale: the patient's self-estimation (i.e., excellent, good, or poor) and the plastic surgeon's estimation (i.e., excellent, good, or poor).

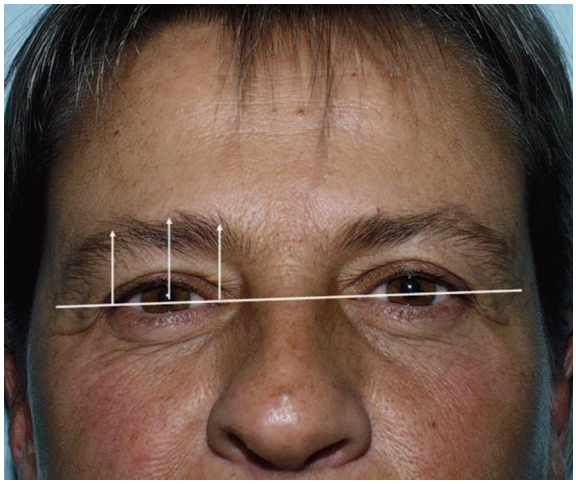

Fig. 1. Scheme of preoperative and postoperative measurements.

Technique

A series of four incisions (3 to 4 cm long) are made in the scalp 2 cm posterior to the hairline (two paramedian and two temporal ones). The shorter vertical paramedian incisions are traced 1 cm above the hairline, down to the calvaria; two temporal incisions intersect a line traced from the lateral aspect of the ala nasi to the lateral canthus. The limited temporal incisions are placed just lateral to the superior temporal fusion line.

Through the temporal incision, dissection is carried out superficially to the deep temporal fascia and extended anteriorly until the temporal crest and inferiorly along the superior and lateral orbital rim and the anterior third of the zygomatic arch. Temporal dissection is performed up to the conjoined fascia, the region where the temporoparietal fascia, the superficial layer of the deep temporalis fascia, and the periosteum meet. This is accomplished by hugging the deep temporalis fascia and sweeping the superficial tissues away bluntly. The conjoined fascia is taken down lateral to medial and superior to inferior under direct visualization. Through the paramedian incision, subperiosteal undermining is carried down to the orbital rim and the glabella,[9] staying medial to the supraorbital foramen and extending beyond the nasal radix, where the periosteum is completely released (Fig. 2).

Thus, a frontotemporal flap is created because of a combination of subperiosteal and sub–superficialis temporalis fascia dissections fusing along the temporal crest (Fig. 3). Through the

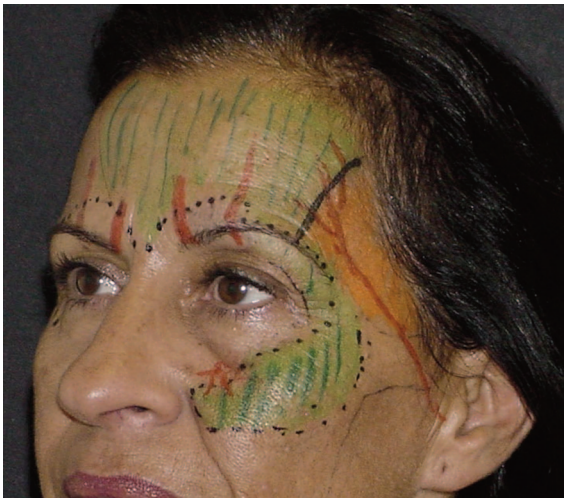

Fig. 2. The operative technique is shown on the left side of the head. The preoperative markings are illustrated. The fusion line (*black line*) and the orbital rim (*black hatched line*) are palpated and displayed on the skin. The dissection is carried out subperiosteally in the frontal region and in the orbital rim (*green region*); the dissection is sub–superficialis temporalis fascia in the temporal region (*orange region*). Note the supraorbital, supratrochlear, and temporal branches of the facial nerve (*red line*).

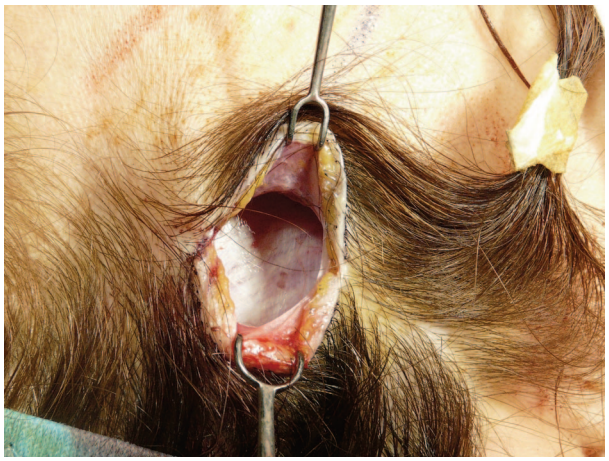

Fig. 3. The operative technique is shown on the right side of the head, with limited temporal incision. During dissection, the fusion line is released to create a frontotemporal flap, including superficialis temporalis fascia, galea, and periosteum.

eyelid blepharoplasty incision, an incision is made to release the periosteum from the superior orbital rim. The supraorbital notch is palpated medially, and the incision is made lateral and medial to the notch, thereby avoiding the supraorbital nerve. A subperiosteal dissection is then performed from the upper eyelid blepharoplasty incision, communicating this plane from the paramedian and temporal incisions. The retaining ligamentous structure extending to the lateral aspect of the supraorbital rim where it is adherent to the superficial temporal fascia was also identified during dissection. This entire structure must be released to obtain optimal elevation of the lateral brow.[11]

The flap is also dissected for 3 to 4 cm posterior to the temporal and paramedian incisions. An upper blepharoplasty is usually performed at the same time.

Orbicularis myotomies are performed to provide better mobilization of the eyebrow.[12] Having the pupil as the centrum, the myotomies are performed with a radial vector. The myotomies divided the orbicularis oculi muscle just above the lateral canthal level, disconnecting the upper and lower parts of the muscle. This allow more efficient lifting of the eyebrow and release of depressor forces.

In patients in whom corrugator supercilii or procerus muscle hyperactivity contributes to eyebrow ptosis, these muscle can be reached easily and resected as required by means of the transpalpebral approach as described by Knize.[11] When available, endoscopic assistance is helpful for extended dissection and treatment of medial musculature.[9] The brow is then lifted manually to verify that its orbital attachments have been released completely. At first, we use the Endotine Forehead 3.0-mm device to lift the brow medially and achieve the desired position. A manual or power drill with an Endotine drill bit is then used to create two monocortical holes at the anteroinferior ends of the two paramedian incisions. These holes should be medial to the temporal fusion line and anterior to the coronal suture. In this particularly thick area, the calvaria is drilled using low speed and high torque to avoid incidental enlargement of the hole, down to the drill-bit sleeve.[10]

The Endotine Forehead 3.0-mm devices are then set firmly against the outer table in each hole, using the provided insertion tool. The Endotine device consists of a triangular platform with a dowel on the undersurface that acts as a peg that is inserted in a hole drilled in the skull. Brows are elevated to the desired position and the scalp is then fixed by means of digital pressure to the tines projecting from the platform of the Endotine device to achieve multipoint fixation (Figs. 4 and 5).

The Endotine Forehead allows a satisfactory lift of the middle and medial third of the brow to be obtained. The vector of traction is perpendicular to the horizontal plane.

Although the amount of central brow lifting achieved is optimal, lateral brow lifting cannot be

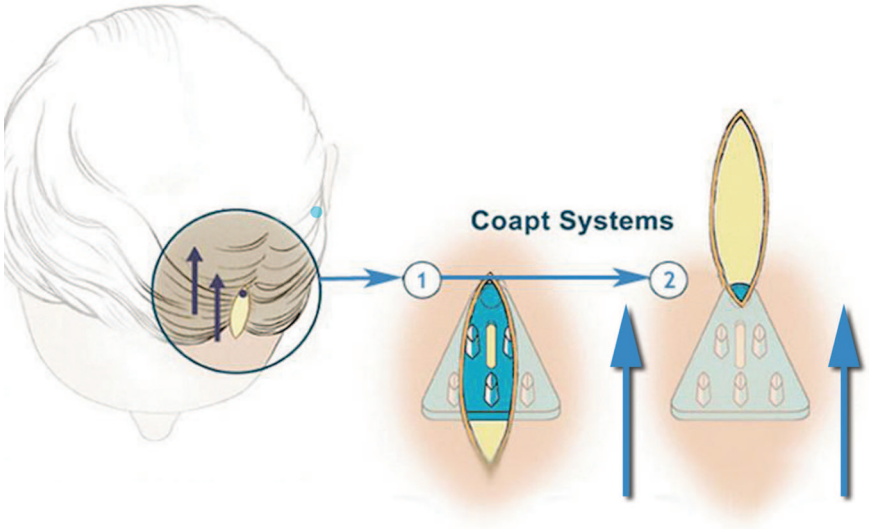

Fig. 4. Operative technique illustrated on the right side of the head.

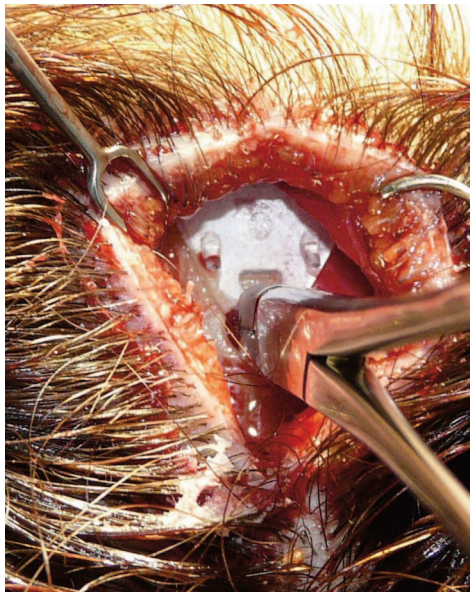

Fig. 5. Insertion of the Endotine Forehead device.

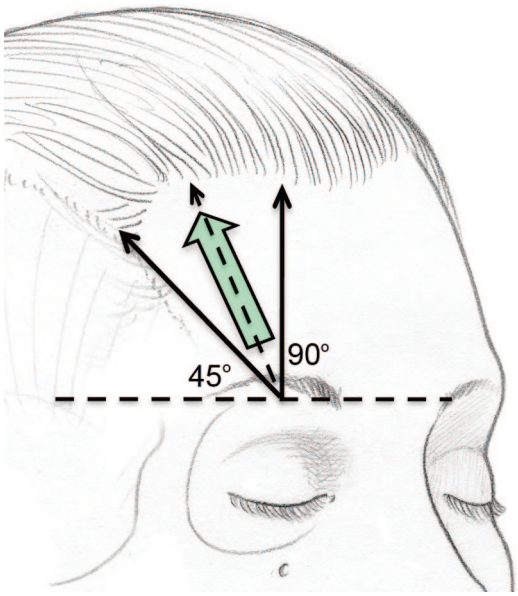

Fig. 6. The vectors of traction were different: the first one, obtained by the Endotine Forehead, was vertical; and the second, obtained by means of the Endotine Ribbon, was lateral, making an angle of 45 degrees with a horizontal plane. The resultant vector pulled obliquely in a superolateral direction almost along the temporal crest (*green arrow*).

obtained by means of the Endotine Forehead device[10]; in fact, the traction vector needed to elevate the lateral third of the brow lies on a line making a 45-degree angle with a horizontal plane[13] (Fig. 6).

In our technique, the full length of 15.5 cm of the Endotine Ribbon is shortened to 5 to 6 cm, thus obtaining two devices from one single ribbon that we can use for both sides.

Then, the shortened ribbon is set with tines outward (not inward as when lifting the neck and lower third of the face) and anchored to the deep temporal fascia with 4-0 polydioxanone mattress sutures. A fenestration on the deep temporal fascia is usually performed to create adhesions between the temporal muscle and the temporoparietalis fascia.[11] The ribbon has central holes that make its fixation easy; normally, we use only two to three stitches (Fig. 7).

The lateral temporal flap is pulled along a traction vector of 45 degrees, and the height and shape of the brow are evaluated. When the desired

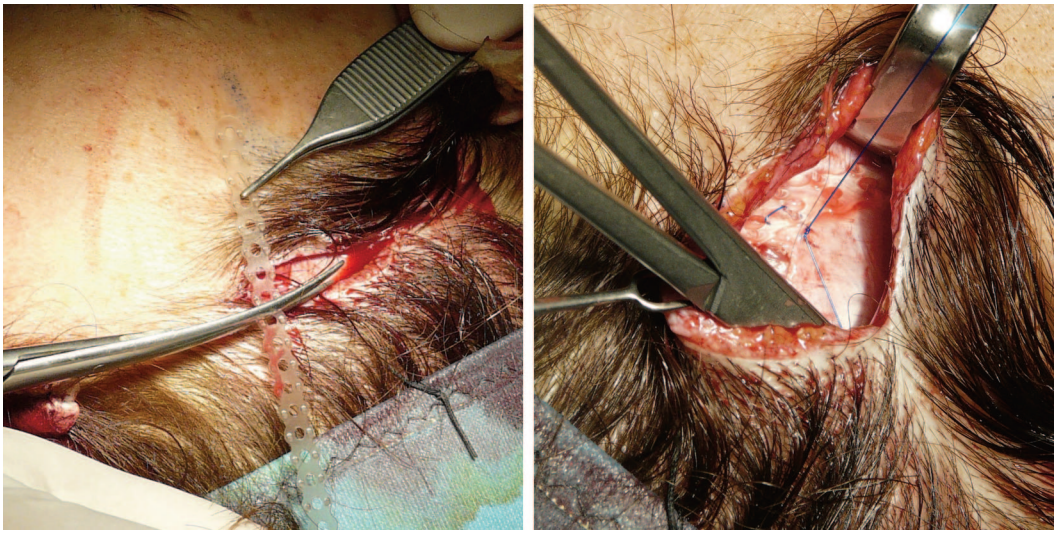

Fig. 7. (*Left*) The operative technique is shown on the right side of the head. In this technique, the ribbon is shortened to 5 to 6 cm. It is set with multiple tines outward and anchored to the deep temporal fascia with two or three 4-0 polydioxanone mattress sutures (*right*).

lift is achieved, digital pressure is used to ensure penetration of the temporalis superficialis fascia by the ribbon tines (Figs. 8 and 9).

Thus, we can control the brow's lift and evaluate the symmetry. If an unsatisfactory lateral brow lift is obtained, the scalp can be detached from the tines and readjusted intraoperatively until the desired lift and contour are achieved.

No resection or very limited removal of scalp excess is performed, avoiding any superficial tension that appears uniformly distributed along the entire length of the ribbon. The slight skin excess is distributed posteriorly to the temporal and parameadian incisions. The scalp incisions are closed either with a running 4-0 nylon suture or with staples, and a moderately compressive dressing is applied to the forehead and temporal region and removed after 24 hours.

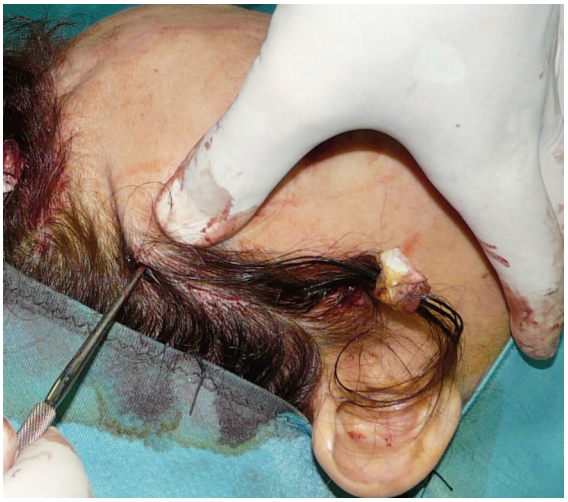

Fig. 8. The lateral temporal flap is uplifted and digital pressure is used to ensure penetration of the superficialis temporalis fascia by the tines of the ribbon.

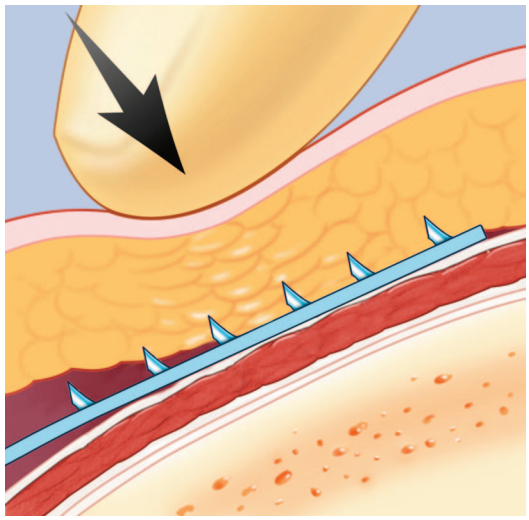

Fig. 9. This drawing shows the penetration of the superficialis temporalis fascia by the tines of the ribbon by digital pressure.

RESULTS

Thirty patients were evaluated, with follow-up ranging from 12 to 24 months (average, 18 months). Lasting results were observed during the follow-up period. The brow lift was evaluated, with the brow divided into three portions: medial, middle, and lateral. The amount of elevation pro-

duced was assessed by comparison of the three preoperative and postoperative vertical heights: (1) medial brow lift was evaluated on a vertical line passing through the medial canthus at the superior margin of the eyebrow; (2) middle brow lift was evaluated on a vertical line passing through the midpupil at the superior margin of the eyebrow; and (3) lateral brow lift was evaluated on a vertical line passing through the lateral canthus at the level of the eyebrow superior margin.

The length of the brow lift procedure was 1 hour, not including the blepharoplasty. Usually, the complete dissection time was 30 minutes.

The paired *t* test showed, on raw measurement data, a statistically significant variability in the three brow portions studied ($p < 0.001$). The lateral portion of the brow was more evidently lifted than the other regions: the mean difference was 8.3 mm on the left side and 8.1 mm on the right side (Table 1).

Results are shown in Figures 10 and 11. The aesthetic result was evaluated by the surgeon as excellent in 25 patients (83.3 percent) and good in five patients (16.7 percent). For each score given by the surgeon, the patient's assessment was the same or better (Table 2).

Only a few complications were observed (i.e., three cases of transient frontal paresthesia). The time of resolution suggest that the paresthesia is caused not by the insertion of the Ribbon device but by compression of the deep division of the supraorbital nerve, presumably caused by edema in the early postoperative period. This sensation usually returned by 6 to 12 weeks because continuity of the cutaneous nerves can be preserved with the technique.

In four cases, the implants were judged relatively palpable during 3 months of follow-up. Five patients with thin scalps complained of pain on pressure that resolved in 2 months, which was more evident with the Forehead device than with the Ribbon device. There were no reports of device extrusion, device removal, or alopecia.

DISCUSSION

From an aesthetic point of view, the eyebrow is among the most important structures of the face.[2] The brow is considered to be the master line of the face because it is the reference by which all other angles and contours of the face are set.[14] Plastic surgeons attempt to restore the youth and aesthetics of the face by elevating and repositioning the brow through either endoscopic or open brow-lift procedures.[2]

Table 1. Paired *t* Test on Raw Measurement Data

Measurement	Left				Right			
	Before	After	Difference	*p* (Paired *t* Test, before vs. after)	Before	After	Difference	*p* (Paired *t* Test, before vs. after)
Lateral canthus to superior brow								
Mean (SD)	20.2(2.2)	28.5(1.6)	8.3(2.1)	<0.001	20.4(2.3)	28.5(1.9)	8.1(1.5)	<0.001
Median	20.0	28.5	8.5		20.0	28.5	8.25	
Minimum, maximum	17.0, 24.0	23.0, 30.0	5.0, 12.0		17.0, 25.0	23.0, 30.0	5.0, 11.0	
Midpupil to superior brow								
Mean (SD)	19.5(1.6)	24.5(1.0)	4.9(1.4)	<0.001	19.0(2.1)	24.1(1.4)	5.0(1.5)	<0.001
Median	19.0	24.5	5.0		19.0	24.0	4.75	
Minimum, maximum	16.0, 23.0	23.0, 26.0	3.0, 7.0		16.0, 23.0	22.0, 27.0	3.0, 8.0	
Medial canthus to superior brow								
Mean (SD)	19.9(2.4)	23.8(1.6)	3.8(1.6)	<0.001	20.1(1.9)	23.8(1.5)	3.7(1.1)	<0.001
Median	20.0	24.0	3.75		20.0	24.0	4.0	
Minimum, maximum	16.0, 25.0	21.0, 27.0	1.5, 7.0		17.0, 24.0	21.0, 27.0	2.0, 6.0	

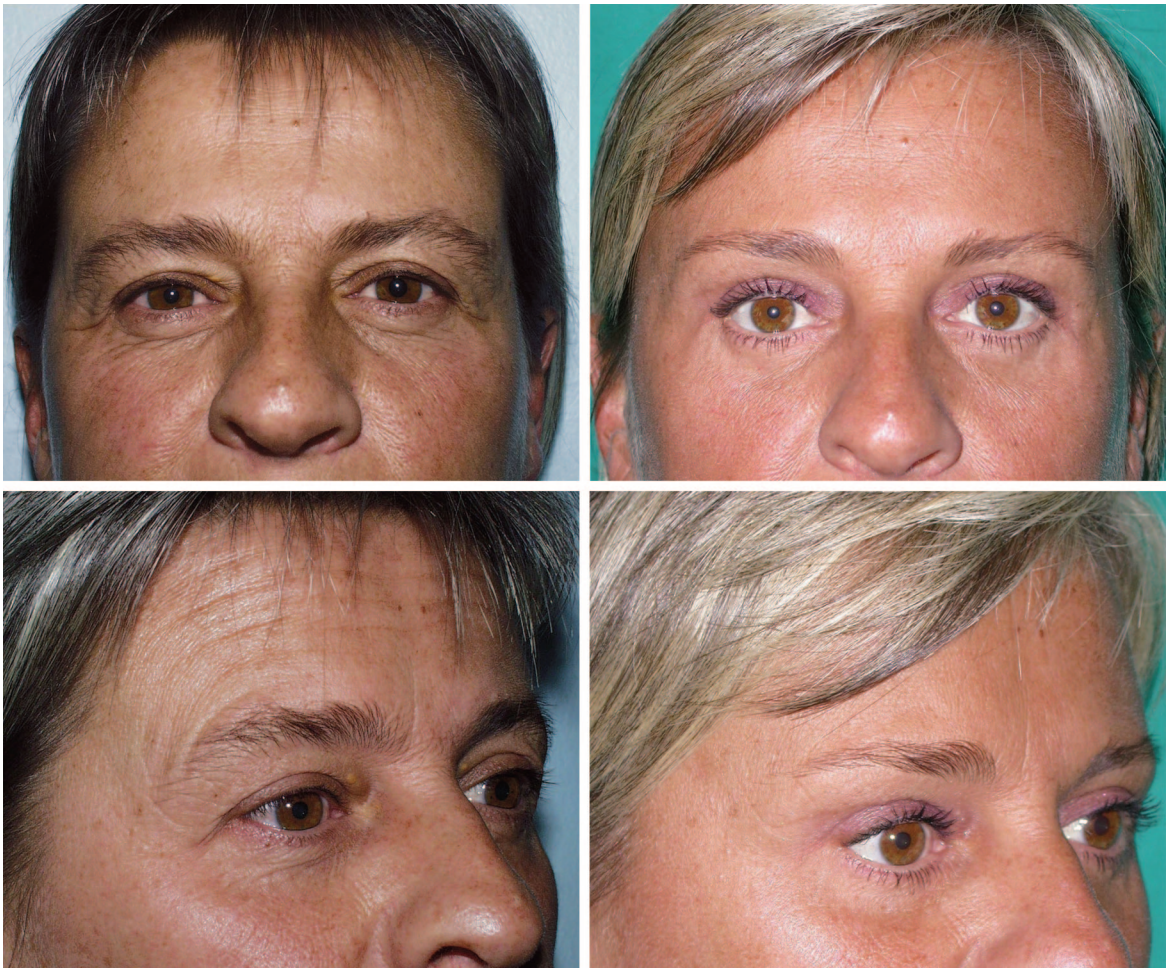

Fig. 10. Preoperative frontal view (*above*, *left*) and 1-year postoperative frontal view (*above*, *right*) of a 58-year-old patient; the brow lift was associated with an upper/lower blepharoplasty. Three-quarters preoperative (*below*, *left*) and postoperative (*below*, *right*) views.

Small-incision endoscopic methods are generally preferred because they lead to no facial scarring and to faster wound healing and reduced problems of postoperative alopecia or sensory loss when compared with the traditional approach.[7,15] Early enthusiasm, however, has been tempered by reports of brow position relaxation and relapse.[4,5]

Multiple and diverse techniques continue to be advocated by various authors, and no single technique has completely satisfied the demands of surgeons.[6] These have included the placement of permanent or absorbable screws, plates, and tacks[16,17]; Kirschner wires[18,19]; bolsters[20,21]; spanning sutures[22]; cortical tunnels and troughs with suture placement[23,24]; tissue adhesives[25]; and various nonfixation techniques.

All surgeons agree that a key factor in achieving a prolonged and stable brow lift is a complete release and an adequate tension-free fixation during the critical healing period.[8] In animal studies on fixation of bone to periosteum, investigators have concluded that periosteal adherence to the calvaria takes at least 6 weeks, with adherence being completed within 12 weeks.[26,27]

Biodegradable implants are designed to provide fixation until biological fixation occurs. The Endotine Forehead device is biodegradable and is absorbed by 1 year after fixation.[10]

Many authors have described their experience with the forehead and brow lift using the Endotine Forehead fixation device.[6,8,10] The Endotine Forehead device is an implantable bioabsorbable fixation device designed to provide intuitive, multipoint distributed tension and repeatable and predicable fixation during endoscopic and open forehead and brow-lift surgery.

However, many surgeons feel that, although the amount of midbrow lift achieved was satisfactory, lateral brow lift was not addressed by the Endotine Forehead device. Chowdhury et al.,[10] in

Fig. 11. Preoperative frontal view (*above*, *left*) and 1-year postoperative frontal view (*above*, *right*) of a 52-year-old patient; the brow lift was associated with an upper/lower blepharoplasty. Three-quarters preoperative (*below*, *left*) and postoperative (*below*, *right*) views.

Table 2. Cosmetic Results: Surgeon and Patient Assessments

Cosmetic Outcome	No. of Patients (%)
Surgeon	
Excellent	65(81.25)
Good	15(18.75)
Poor	0(0)
Patient	
Excellent	68(85)
Good	12(15)
Poor	0(0)

a retrospective, noncomparative case series of 31 patients who underwent forehead and brow-lift surgery using the Endotine Forehead device, reported a satisfactory contour and central but not lateral brow lift.

Holzapfel et al.[9] studied 53 patients undergoing brow-lift surgery with the Endotine Forehead device. All patients in their study had midbrow rather than lateral brow fixation with the Endotine device, and for this reason, the brow was fixed laterally to the temporal fascia with a 2-0 braided polyester suture.

The ptosis of the lateral third of the eyebrow occurs earlier and is more conspicuous than that of the medial area[13]; this is probably emphasized because the anatomical limits of frontal muscle fibers do not extend as far laterally as the lateral part of the brow. Thus, frontalis contraction cannot prevent lateral brow ptosis.[28]

In the ideal brow lift, it is necessary to consider the whole brow. Thus, when we project it, we usually divide the brow into three portions: lateral, middle, and medial (Fig. 12). With the Endotine Forehead device, we obtain elevation of the middle and medial portions of the brow,

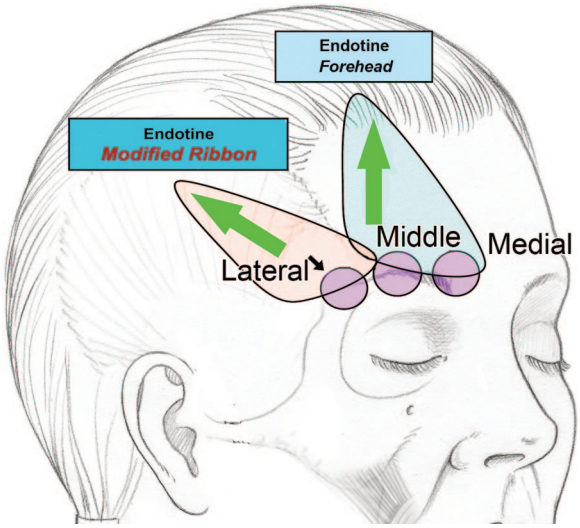

Fig. 12. Drawing showing the three portions of the brow: lateral, middle, and medial. We obtained elevation of the middle and medial portion of the brow with the Endotine Forehead device and elevation of the lateral portion with the Endotine Ribbon.

whereas with the Endotine Ribbon, we obtain elevation of the lateral portion.

The vectors of traction were different: the first one, obtained by means of the Endotine Forehead, was vertical; and the second, obtained by using the Endotine Ribbon, was lateral, making an angle of 45 degrees with a horizontal plane. The resultant vector pulled obliquely in a superolateral direction almost along the temporal crest (Fig. 6).

In our technique, the ribbon is shortened to 5 to 6 cm, whereas the original device is 15.5 cm. Thus, we obtained a fixation based on 10 to 12 tines presents in the portion of the ribbon used.

The multiple tines of the Endotine Ribbon allow multiple points of fixation to create a wide distribution of strength and a strong anchorage between the deep temporal fascia and the superficial temporal fascia. This property is the major advantage of the ribbon over simple suture fixation. When an important traction is focused on a single fixation, the suture loop, which is passed through tissue, can cause tissue necrosis because of excessive tension. Thus, we minimize damage to overlying hair follicles and maximize fixation strength.[8,9] When the elevated position of the eyebrow is maintained with suspension sutures or anchor threads, the forces that pull the eyebrow downward, such as gravity and the facial mimics, create a remarkable linear stress on each suspension thread. This often causes dimple formation and makes precisely symmetric eyebrows difficult to obtain.[29] In contrast with the other suspension techniques, the presented technique provides suspension evenly along the entire lateral eyebrow because it is elevated with a 5- to 6-cm-long suspender. This allows the surgeon to create a pleasant eyebrow curve easily, with no risk of dimple formation or asymmetry. Moreover, it is an easy-to-perform procedure, because no time is wasted with suture adjustment maneuvers, which may often be a burdensome part of brow-lift surgery.[10]

The cut of the Endotine Ribbon allows for two devices, to use for the right and left sides, to be obtained. The cost of one Endotine Ribbon device is approximately $130. In this way, the procedure is less expensive for the surgeon.

The anatomical region where we fix the flap is not the bone but the deep temporal fascia, and the overlying soft tissue (the flap) is the superficial temporal fascia and not the periosteum and the galea, as when using the Forehead device. In our experience, this original application of the Endotine Ribbon together with the Endotine Forehead allowed us to obtain optimal control of the height and shape of the brow. In our series of 30 patients, we obtained a more natural superolateral rather than central elevation of the brow because of the association of the two devices (Table 1). No major complications were encountered.

CONCLUSIONS

In our experience, lateral brow ptosis is not corrected by the Endotine Forehead device; the association with the Endotine Ribbon provides a simple, effective, and predictable solution to the problem. Our experience indicates that this technique is safe, quick, and easy to use.

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