A Novel Bioabsorbable Device for Facial Suspension and Rejuvenation

P. Daniel Knott, MD; James Newman, MD; Gregory S. Keller, MD; David B. Apfelberg, MD

To evaluate the safety and efficacy of a novel bioabsorbable suspension device made of a polymer of polylactic acid and polyglycolic acid (Endotine Ribbon), we performed a retrospective multi-institutional case study of 21 patients who underwent minimally invasive or open rhytidectomy with the use of the device in an ambulatory surgery center setting. Twelve patients had an excellent result, 7 a good result, and 2 a fair result. Early complications were corrected with technical modifications. Patient satisfaction was high. The Ribbon is a safe and effective adjunct for performing both minimally invasive and open rhytidectomy and cervical lifting.

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After nearly a century of technique-driven improvements in surgical outcomes, the field of facial plastic surgery is facing a paradigm shift in favor of technology-driven outcome improvements. Although surgical technique will continue to be the foundation of optimal rejuvenative surgery, laser technologies, radiofrequency and other transcutaneous energy delivery devices, injectable materials, and absorbable bioimplants will occupy a growing role in most successful practices. Many of these techniques are compatible with a minimally invasive approach, which affords limited tissue dissection, the possibility of local anesthesia, reduced postoperative edema, and, therefore, reduced recovery time, while still offering superior rejuvenation to select patients.

Many novel “minimally invasive” procedures, although initially very exciting, do not stand the test of time because of unacceptable complication rates, suboptimal long-term results, or patient dissatisfaction. Suture-based suspension systems, for example, experienced a recent surge in interest owing to their ability to be placed via minimally invasive incisions and approaches, while offering excellent suspension. Unfortunately, long-term results with these systems were disappointing, and suture removal was extremely difficult. Absorbable implants are particularly attractive to patients in that they offer superb suspension during rejuvenative facial surgery and resorb slowly and completely, allaying patients’ fears about the potential long-term appearance of permanent implants. Implants made of bioabsorbable polymers have a long history of clinical utility, having been used in craniofacial surgery and trauma surgery for more than 15 years.

A recently introduced polymer ribbon made of polylactic acid and polyglycolic acid (PLA/PGA) (Endotine Ribbon; Coapt Systems, Palo Alto, California) is a promising new tool for cosmetic surgeons to use in minimally invasive surgery and is a useful adjunct for improvement of cheek/jowl and neck contour in open face and neck procedures. This report describes the device and illustrates its use in improvement of contour and definition of the face and neck.

DESCRIPTION OF THE DEVICE

The device consists of a slender, 16-cm-long, 5-mm-wide, and 0.25-mm-thick ribbon of PLA/PGA polymer. There are 17 rows of double...
2.5-mm-high tines, with holes between the tines every 4.6 mm (Figure 1). The proximal one-third of the device constitutes the “leash,” which has no tines and serves as the area for fixation. For minimally invasive procedures, a protective sheath is used to direct and place the device in the proper location and orientation and is then removed to expose the tines (Figure 2). The device loses its mass strength in approximately 3 months and is bioabsorbed completely in approximately 9 to 12 months. It is not anticipated that there will be regression or re-descent of the tissue elevation at this point because (1) there has been true tissue dissection, separation, and suspension; (2) fibrosis develops around and through the holes in the device, connecting the underlying superficial muscular aponeurotic system (SMAS)/fascia or platysma to the overlying skin; and (3) SMAS/fascia or platysma held in a shortened position for 3 to 5 months undergoes shortening and fibrosis. Thus, the bioabsorbable ribbon provides temporary mechanical fixation until biological fixation occurs.

MINIMALLY INVASIVE SURGICAL TECHNIQUE

The PLA/PGA polymer ribbon may be inserted in a minimally invasive approach that is effective for neck lifting. When a minimally invasive approach is chosen, a protective sheath is used to direct and place the device in the proper location and orientation and is then removed to expose the tines (Figure 2). The device loses its mass strength in approximately 3 months and is bioabsorbed completely in approximately 9 to 12 months. It is not anticipated that there will be regression or re-descent of the tissue elevation at this point because (1) there has been true tissue dissection, separation, and suspension; (2) fibrosis develops around and through the holes in the device, connecting the underlying superficial muscular aponeurotic system (SMAS)/fascia or platysma to the overlying skin; and (3) SMAS/fascia or platysma held in a shortened position for 3 to 5 months undergoes shortening and fibrosis. Thus, the bioabsorbable ribbon provides temporary mechanical fixation until biological fixation occurs.

OPEN SURGICAL TECHNIQUE

Because of its low profile and ease of insertion, the PLA/PGA ribbon may be used in a variety of open surgical techniques. When used with open neck lifting, the ribbon is placed against the platysma after complete surgical exposure is obtained and SMAS plication and/or elevation has been performed. The anterior aspect of the device is sutured to the ipsilateral anterior platysma with a 3.0 PDS suture (Figure 5). The housing is removed and the device is engaged against the platysma with gentle external manual pressure performed at the same time that steady superolateral traction is applied to the device. The leash is then sutured to the mas-
toid fascia with a single 4.0 nylon suture. Once again, care is re-
quired to ensure that the device is not seated superior to the angle
of the mandible; otherwise, it may become palpable or cause dis-
comfort to the patient. The 3.0 PDS suture used for anterior an-
choring is then used to imbricate the platysma over the device in
a running back-and-forth fashion and is ultimately sutured to the
mastoid fascia. Just as with the minimally invasive technique, an
additional ribbon may be anchored inferiorly for additional neck
contouring.

In a fashion similar to that in the neck, the devices may be placed
in the face for additional SMAS elevation. After complete eleva-
tion of the skin and SMAS plication, imbrication, and elevation
in a traditional skin-and-SMAS–type rhytidectomy, the anterior
aspect of the PLA/PGA ribbon is secured to the SMAS just supe-
rior to the jowls with a 3.0 PDS suture. The device is then deployed
from its housing. With gentle external manual pressure, the tines
are engaged against the SMAS and superolateral traction is applied
(Figure 6). Once ideal elevation of the SMAS is achieved, the tail
of the device is sutured to deep temporal fascia with a 4.0 nylon
suture. The SMAS is then imbricated over the device in a running
fashion by using the initial 3.0 PDS suture, such that the device
will be nonpalpable. A second device may be placed near the na-
solabial fold for additional SMAS elevation.

INDICATIONS FOR USE
AND PATIENT SELECTION

Although the PLA/PGA ribbon is certainly a useful adjunct in
SMAS elevation during open skin-and-SMAS–type rhytidectomy,
we have found it particularly helpful for additional cervi-
comental definition during open cervical lifting and during
all minimally invasive neck-lifts. As with any implantable de-
vices, patient selection and preparation are essential. Patients
with minimal subcutaneous fat may report palpability of the
device, particularly if it is used in the face. To date, we have
not had patients mention problems with the device in the neck.
Patients with thicker skin and heavier features may benefit more
from the device because of the extra elevation it offers.

The ideal patient for the minimally invasive procedure has
experienced advanced aging in a particular part of the face. The
patient is seeking restoration of facial harmony without requir-
ing full-face rejuvenative surgery. These patients are usually
in the fourth to fifth decades of life and wish to limit the amount
of recovery time.

Patients undergoing open surgical rejuvenation may ben-
efit from the addition of the PLA/PGA ribbon if they seek greater
definition of the cervicomental angle and jowls than would be
possible during a skin-and-SMAS–type rhytidectomy. A pa-
tient with anterior cervical banding, which is not amenable to
treatment via a lateral approach, will have unsatisfactory re-
sults with only a lateral approach using the ribbon.

RESULTS

To date, 21 patients with at least 6 months of follow-up
have undergone minimally invasive or open facial reju-
Venation with the PLA/PGA ribbon. Standard preoperative and postoperative photographs of the patients were taken, and results were judged according to the degree of neck and/or jowl elevation. Demographic data are provided in the Table. Eleven underwent minimally invasive face and/or neck lifting with the PLA/PGA ribbon, 3 underwent open neck lifting procedures, and 7 underwent open face and neck lifting with the ribbon. Results were graded by the surgeons as a whole as excellent, good, fair, or poor. Twelve cases were judged excellent, 7 cases were judged good, and 2 cases were judged fair. Complications included 1 case in which the device was palpable that resolved spontaneously and 2 cases of implant release. These occurred in patients treated by 2 of us (G.S.K. and D.B.A.) early in our experience with the PLA/PGA ribbon. In both cases the patients noted the development of a sudden lump in their necks in the second postoperative month. On examination, implant release was immediately noted, and the implants were removed via small transverse neck incisions with the patients under local anesthesia; the wounds healed eventually. Despite these complications, the patients were satisfied, and neither the surgeon nor the patient noted any asymmetry or contour irregularity at follow-up. Figure 7 and Figure 8 illustrate the preoperative and postoperative appearances of patients judged appropriate for treatment with the PLA/PGA ribbon lift (patients 1 and 10).

**Table. Demographic Data on All Patients Included in the Study**

<table>
<thead>
<tr>
<th>Patient No./Sex/Age, y</th>
<th>Procedure Type</th>
<th>Follow-up, mo</th>
<th>Ancillary Procedures</th>
<th>Complications</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/F/53</td>
<td>Minimally invasive face and neck</td>
<td>19.75</td>
<td>None</td>
<td>None</td>
<td>Good</td>
</tr>
<tr>
<td>2/M/69</td>
<td>Open neck</td>
<td>14.00</td>
<td>None</td>
<td>Implant release</td>
<td>Fair</td>
</tr>
<tr>
<td>3/M/54</td>
<td>Open face and neck</td>
<td>7.50</td>
<td>4-Quadrant blepharoplasty, endoscopic brow-lift, hair grafts</td>
<td>None</td>
<td>Good</td>
</tr>
<tr>
<td>4/F/48</td>
<td>Minimally invasive face</td>
<td>8.25</td>
<td>None</td>
<td>None</td>
<td>Excellent</td>
</tr>
<tr>
<td>5/M/56</td>
<td>Open face and neck</td>
<td>9.50</td>
<td>4-Quadrant blepharoplasty and hair grafts</td>
<td>None</td>
<td>Excellent</td>
</tr>
<tr>
<td>6/F/59</td>
<td>Open face and neck</td>
<td>6.75</td>
<td>None</td>
<td>None</td>
<td>Good</td>
</tr>
<tr>
<td>7/F/60</td>
<td>Open face and neck</td>
<td>10.00</td>
<td>4-Quadrant blepharoplasty and rhinoplasty</td>
<td>None</td>
<td>Excellent</td>
</tr>
<tr>
<td>8/F/51</td>
<td>Open neck</td>
<td>9.50</td>
<td>4-Quadrant blepharoplasty</td>
<td>None</td>
<td>Excellent</td>
</tr>
<tr>
<td>9/F/48</td>
<td>Minimally invasive neck</td>
<td>10.00</td>
<td>None</td>
<td>None</td>
<td>Good</td>
</tr>
<tr>
<td>10/F/51</td>
<td>Open face and neck</td>
<td>8.75</td>
<td>None</td>
<td>None</td>
<td>Excellent</td>
</tr>
<tr>
<td>11/F/76</td>
<td>Minimally invasive neck</td>
<td>8.75</td>
<td>Poly-L-lactic acid injection</td>
<td>Implant release</td>
<td>Fair</td>
</tr>
<tr>
<td>12/F/48</td>
<td>Minimally invasive neck</td>
<td>12.25</td>
<td>Cervical liposuction</td>
<td>None</td>
<td>Excellent</td>
</tr>
<tr>
<td>13/F/54</td>
<td>Minimally invasive neck</td>
<td>9.00</td>
<td>None</td>
<td>None</td>
<td>Excellent</td>
</tr>
<tr>
<td>14/F/53</td>
<td>Minimally invasive neck</td>
<td>13.50</td>
<td>None</td>
<td>None</td>
<td>Excellent</td>
</tr>
<tr>
<td>15/F/48</td>
<td>Minimally invasive neck</td>
<td>15.50</td>
<td>Cheek-lift</td>
<td>None</td>
<td>Good</td>
</tr>
<tr>
<td>16/M/48</td>
<td>Minimally invasive face and neck</td>
<td>13.75</td>
<td>Lower blepharoplasty</td>
<td>Facial device palpable</td>
<td>Good</td>
</tr>
<tr>
<td>17/F/58</td>
<td>Open neck</td>
<td>10.50</td>
<td>None</td>
<td>None</td>
<td>Excellent</td>
</tr>
<tr>
<td>18/F/60</td>
<td>Open face and neck</td>
<td>7.25</td>
<td>None</td>
<td>None</td>
<td>Good</td>
</tr>
<tr>
<td>19/F/63</td>
<td>Open face</td>
<td>11.25</td>
<td>None</td>
<td>None</td>
<td>Excellent</td>
</tr>
<tr>
<td>20/F/62</td>
<td>Minimally invasive neck and face</td>
<td>14.00</td>
<td>Lip augmentation</td>
<td>None</td>
<td>Excellent</td>
</tr>
<tr>
<td>21/F/45</td>
<td>Minimally invasive neck-lift</td>
<td>12.25</td>
<td>Chin revision</td>
<td>None</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

Following the introduction of the first bioabsorbable brow-lift anchor in 2003 (Endotine Forehead; Coapt Systems), a series of bioabsorbable fixation devices have been developed to aid in facial aesthetic surgery. The devices consist of a polymer of various formulations of PLA and PGA, each formulation designed to be bioabsorbed at different time intervals, providing for mechanical fixation until biological fixation occurs. These devices have now found positive acceptance in the plastic surgery community.

Effective, minimally invasive treatment of the aging neck has a history of significant exploration and innovation. Techniques involving direct excision of excess skin and subcutaneous fat with platysma plication have been repeatedly described. Recently, Biggs and Steely reported on the T-Z-plasty, Miller described direct excision with Z-plasty, and Zins and Fardo described an “anterior-only” approach with or without skin excision. Although some of these approaches may be met with success, they suffer from lack of lateral suspension. The minimally invasive neck lifting approach with the PLA/PGA ribbon offers a true minimally invasive technique with or without a need for platysmaplasty.

Any implantable device used for long-term suspension of facial structures must by necessity rely on the normal biological mechanisms of wound healing for ultimate success. As evidenced by the failure of multiple suture-based suspension systems, face-lifting techniques not relying on the development of scar tissue and tissue fibrosis will ultimately fail. The composition of the PLA/PGA ribbon was engineered with this goal in mind. The device is resorbed slowly, causing minimal tissue toxic effects. However, the device must elicit a low degree of inflammation to stimulate tissue fibrosis. The composite PLA/PGA polymer has been used extensively in facial rejuvenation as well as in mandible reconstruction, and adverse effects have been minimal.

Several aspects of the device are interesting and efficient from a bioengineering and minimally invasive surgical perspective. Primarily, minimally invasive surgical
techniques performed with minimal tissue undermining offer the advantage of minimal tissue edema, faster recovery times, and the potential for local anesthesia with or without sedation. Disadvantages may include less dramatic rejuvenation and a shorter duration of efficacy. Such outcomes have been encountered with many of the suture-lifting techniques that have undergone experimentation during the past decade.

The PLA/PGA ribbon offers improvement over suture-lifting techniques in a variety of ways. Primarily, through its 17 rows of double mini-tines, it permits secure fixation to the SMAS and/or platysma along two-thirds of the device, thereby preventing the puckering that may be seen with suture fixation. Furthermore, because of the secure fixation obtained with the device, mobilization or tearing of the ribbon from the underlying SMAS and/or platysma, a common occurrence with suture fixation, is avoided. The PLA/PGA ribbon also benefits from a low profile, permitting placement in narrow pockets with minimal tissue undermining.

The length of the ribbon device allows it to be inserted under a long bridge of tissue, extending its tissue

Figure 7. Patient 1. Right (A) and left (B) preoperative photographs and right (C) and left (D) 8-month postoperative photographs of a patient who underwent a cervical polymer ribbon lift without adjunctive procedures.
effects a long distance from its point of fixation. In this
manner, it resembles a midface device (Endotine Mid-
face ST; Coapt Systems). Moreover, the device is easily
trimmed by cutting away either some of the tines or some
of the leash, permitting a custom fit for particular clini-
cal indications. In this manner, the device is easily re-
moved from its housing and just as easily replaced in it.

The most important question regarding the efficacy
of this type of bioabsorbable suspension device is the du-
ration of the lift provided by the device. To date, there
have been multiple reports on the duration and effec-
tiveness of other devices with this mix of polymers. Ef-
fective suspension and a long duration of effectiveness
have been noted in these cases.

The complications noted in this series must be men-
tioned. Each of the patients experiencing a complica-
tion underwent surgery early in this series, and these
experiences led to important modifications in the surgi-
cal technique. Weakening of the suspension sutures
was recognized as the cause of the device failure. There-
fore, in all subsequent cases, the ribbon was anchored
with a permanent suture, and no further premature de-
vice failures were noted. As well, the single case of pal-
pability of the device led us to recognize that extra care
was required for patients with relatively thin subcuta-
nous tissue. Therefore, both patient selection and
technical modifications were made, such that treatment
of patients with little subcutaneous fat was avoided and

Figure 8. Patient 10. Right (A) and left (B) preoperative photographs and right (C) and left (D) 6-month postoperative photographs of a patient who underwent a
cervical polymer ribbon lift in conjunction with open face- and neck-lift.
the SMAS was imbricated over the device in all subsequent cases, and no further patients reported device palpability.

In conclusion, the bioabsorbable suspension ribbon tested in this study (the Endotine Ribbon) is a safe and effective device that may be used for SMAS elevation and/or for providing extra definition to the jowl and cervicomental angle in open or minimally invasive techniques.

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Correspondence: P. Daniel Knott, MD, Facial Plastic and Reconstructive Surgery, Head and Neck Institute, Desk A-71, Cleveland Clinic Foundation, 9500 Euclid Ave, Cleveland, OH 44195 (knottp@ccf.org).

Author Contributions: Study concept and design: Keller. Acquisition of data: Knott, Newman, and Apfelberg. Analysis and interpretation of data: Knott. Drafting of the manuscript: Knott. Critical revision of the manuscript for important intellectual content: Knott, Newman, Keller, and Apfelberg. Statistical analysis: Not applicable. Obtained funding: Not applicable. Administrative, technical, and material support: Knott and Keller. Study supervision: Knott, Newman, and Apfelberg.

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REFERENCES


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