Suture suspension techniques have been used in various surgical specialties for decades. Among the more common applications are bladder suspension, uterine suspension, upper lid ptosis correction, treatment of sleep apnea, and a variety of other plastic surgical procedures, both aesthetic and reconstructive.

In the field of aesthetic facial plastic surgery, in particular, much of the popularity of these techniques has focused on minimally invasive approaches—a phenomenon that has been largely patient driven rather than data driven. In fact, there is a dearth of peer-reviewed clinical data based on objective outcome measures from long-term controlled studies in this field. To the best of my knowledge, no Level 1 or 2 and minimal Level 3 evidence currently exists to support claims about the longevity of patient satisfaction and lower complication rates with these techniques. For the most part, the Level 3 evidence that does exist concerns the Aptos device (Kolster Methods, Inc, Anaheim, California), which has been commercially available for the longest duration.

This article reviews the evolution of barbed suture technologies and their application to the field of plastic surgery. The features of various modified suture designs used in aesthetic plastic surgery are presented in Table 1. Many of the preferences for the techniques discussed in this article are my opinion, based on more than 30 years of personal experience in private clinical practice.
The introduction of suture suspension techniques in aesthetic plastic surgery began in the late 1990s with the presentations and publications of Dr Marlen Sulamanidze, who introduced the Aptos threads.3 His procedure, called the “featherlift,” was performed by inserting bidirectional barbed sutures into the subcutaneous plane of the face. These sutures were manufactured with a nonabsorbable polymer (polypropylene) and designed to be used in freely mobile tissue. Barbs are cut at an angle in the suture and organized facing toward the midline in a bidirectional fashion (Figure 1). Certainly, it was attractive to be able to offer patients a “noninvasive” approach to lifting ptotic facial soft tissues. As we do with all new technology, we began with “exuberant enthusiasm” (in the words of the former Federal Reserve Chairman, Alan Greenspan). However, as we witnessed the relapse of ptosis and the possible complications of a nonabsorbable suture—which included palpation, migration, extrusion, and abnormal facial expression on animation—our initial “exuberant enthusiasm” was replaced with unhappiness. Reports of these types of complications began to appear in the literature throughout the early 2000s, based on large retrospective data sets of more than 100 patients with up to 2.5 years of follow-up.1,4-7 Modifications have since been made to the Aptos thread, needle design, and its placement method,8 and further experience has allowed the technique and technology to assume a niche in our surgical repertoire. However, there has never been widespread acceptance in the US market for this type of nonanchored, nonabsorbable barbed suture suspension device.

This experience with the Aptos device clearly illustrates the 3 phases in the introduction of a new technique and/or technology: first excitement, followed by disappointment, then by defined applications. This was certainly the case with the “free-floating,” nonabsorbable, Aptos barbed suture technology.

**EARLY BARBED SUTURE TECHNOLOGY**

**Aptos Thread**

The introduction of suture suspension techniques in aesthetic plastic surgery began in the late 1990s with the presentations and publications of Dr Marlen Sulamanidze, who introduced the Aptos threads.3 His procedure, called the “featherlift,” was performed by inserting bidirectional barbed sutures into the subcutaneous plane of the face. These sutures were manufactured with a nonabsorbable polymer (polypropylene) and designed to be used in freely mobile tissue. Barbs are cut at an angle in the suture and organized facing toward the midline in a bidirectional fashion (Figure 1). Certainly, it was attractive to be able to offer patients a “noninvasive” approach to lifting ptotic facial soft tissues. As we do with all new technology, we began with “exuberant enthusiasm” (in the words of the former Federal Reserve Chairman, Alan Greenspan). However, as we witnessed the relapse of ptosis and the possible complications of a nonabsorbable suture—which included palpation, migration, extrusion, and abnormal facial expression on animation—our initial “exuberant enthusiasm” was replaced with unhappiness. Reports of these types of complications began to appear in the literature throughout the early 2000s, based on large retrospective data sets of more than 100 patients with up to 2.5 years of follow-up.1,4-7 Modifications have since been made to the Aptos thread, needle design, and its placement method,8 and further experience has allowed the technique and technology to assume a niche in our surgical repertoire. However, there has never been widespread acceptance in the US market for this type of nonanchored, nonabsorbable barbed suture suspension device.

This experience with the Aptos device clearly illustrates the 3 phases in the introduction of a new technique and/or technology: first excitement, followed by disappointment, then by defined applications. This was certainly the case with the “free-floating,” nonabsorbable, Aptos barbed suture technology.

**CONTINUED EVOLUTION OF BARBED SUTURE TECHNOLOGY**

Stress relaxation occurs when soft tissue, particularly skin, is held under tension in 2 points. The tensile relaxation properties of the dermis will reorganize the collagen, elastin, and ground substances to lengthen the distance between the fixation points. As with tissue expansion, the body’s ability to recruit tissue to reduce tension loading will compromise the elevation when the repositioning is supported in only 2 points (Dr Stephen Mulholland, oral communication). Multiple-point fixation techniques and technologies, such as the Endotine device (Coapt Systems, Inc, Palo Alto, California) or barbed sutures, can greatly minimize the stress relaxation and “cheese wiring” associated with 2-point fixation.9 Without multiple fixation

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**Table 1. Comparison of Barbed Suture Devices.**

<table>
<thead>
<tr>
<th>Suture Name</th>
<th>Description</th>
<th>Suture Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aptos Thread (Kolster Methods, Inc, Anaheim, California)</td>
<td>Bidirectional, nonabsorbable barbed suture</td>
<td>Free floating</td>
</tr>
<tr>
<td>Contour Thread (Surgical Specialties, Reading, Pennsylvania)</td>
<td>Unidirectional, nonabsorbable, looped or nonlooped barbed suture</td>
<td>Anchored proximally</td>
</tr>
<tr>
<td>Isse Endo Progressive Facelift Suture (Kolster Methods, Inc, Anaheim, California)</td>
<td>Unidirectional, nonabsorbable barbed suture</td>
<td>Anchored proximally</td>
</tr>
<tr>
<td>Silhouette Mid-Face Suture (Kolster Methods, Inc, Anaheim, California)</td>
<td>Nonabsorbable suture material with absorbable knots at 10-mm intervals</td>
<td>Anchored proximally</td>
</tr>
<tr>
<td>Woffles Thread (Kolster Methods, Inc, Anaheim, California)</td>
<td>Bidirectional, nonabsorbable barbed suture doubled in a sling format</td>
<td>Anchored proximally</td>
</tr>
<tr>
<td>V-Loc Wound Closure Device (Covidien, Mansfield, Massachusetts)</td>
<td>Unidirectional, knotless, absorbable barbed suture</td>
<td>Anchored or not anchored</td>
</tr>
<tr>
<td>Quill Knotless Tissue-Closure Device (Angiotech Pharmaceuticals, Inc, Vancouver, British Columbia, Canada)</td>
<td>Absorbable and nonabsorbable, knotless, bidirectional barbed suture with central nonbarbed segment</td>
<td>Anchored or not anchored</td>
</tr>
</tbody>
</table>

**Figure 1.** Aptos thread 2G suture with insertion needles. From Sulamanizde and Sulamanidze.3 Reprinted with permission from Elsevier.
points, pure suture suspension techniques often have limited long-term efficacy. An implied benefit of bidirectional barbed suture technology, which can elevate tissue by compressing the tissues between the barbs in 1 direction without placing tension at the opposite end, is that it distributes retention forces along the entire length of the barbed segments. Any device with an anchoring mechanism fixed at one end does not possess this feature.

**Contour Thread**

In a renewed effort to introduce barbed suture technology into the field of aesthetic plastic surgery, the Contour Thread device was developed by Dr Gregory Ruff and marketed by Surgical Specialties (Reading, Pennsylvania). It received US Food and Drug Administration (FDA) clearance for midface suspension in 2005. This clear, nonabsorbable polypropylene unidirectional thread was designed with barbs arranged in a helical design similar to DNA. The basic advantage of this suture was that it could be fixed at the proximal end to a nonmobile structure such as the deep temporal fascia or mastoid fascia. In addition, it was thought that having barbs along almost the full length of the suture eliminated cheese wiring, reduced stress relaxation, and allowed for tension unloading. The original and most widely used design included a long Keith needle at one end and a curved needle at the other end (Figure 2). Another design featured a looped barbed suture with long needles on both ends. The looped suture did not require the tying of a knot at the proximal ends of the sutures, since the needle from one end of the suture was passed through the fixation point in fascia and then advanced to pierce the target soft tissue. The procedure was labeled the “Contour Threadlift,” and the device was marketed along with numerous teaching courses that taught participants, both through didactic lectures and live surgical demonstrations, how to utilize the device for brow lifting, midface lifting, and jawline lifting.

Again, the initial enthusiasm for the Contour Thread was replaced with disappointment in many cases when the suspension simply did not hold nonundermined soft tissue. In a report of 33 patients followed for a mean of 21 months, aesthetic improvements noted at 1 month were not maintained in those who had received a threadlift. In contrast, patients who underwent other rejuvenation procedures (eg, lipotransfer, chemical peels, surgical rhytidectomies) showed longer-lasting improvements. In a second report—this time of 72 procedures—31% of patients required revision cosmetic surgery after a mean of 8.7 months. A third report, 45% of 29 subjects who underwent threadlift procedures experienced recurrence of laxity within 6 months. Other problems with the Contour Thread emerged due to the position of the device and the fact that the suture was nonabsorbable. Although some, including myself, were able to achieve some reasonably good results with repositioned soft tissue of the brow, midface, and neck in well-selected cases, the efficacy of threadlift procedures tended to be unpredictable. In addition to the problem of failure to maintain soft tissue elevation, complications of the threadlift included palpability of sutures, tenderness, extrusion of knots, fracture of the suture, migration, and abnormal traction lines in the skin with or without animation. While acceptable improvements in the position of ptotic soft tissue were achieved in select patient groups, surgeons could not consistently predict who would do well and who would not. This led, for the most part, to the abandonment of the use of the Contour Thread to hold nondissected soft tissue. Today, the device is no longer manufactured. Evolving concepts for utilizing fixed-point barbed sutures included minimal and extensive dissection to free the soft tissue attachments.

![Figure 2. The Contour Thread, a 25-cm, 2-0 polypropylene suture with barbs cut into the central 10 cm of suture. The Contour Thread device was the first contour suture approved by the US Food and Drug Administration. From Kress.](http://asj.oxfordjournals.org/)

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and then use of the barbed sutures to support the soft tissues.\textsuperscript{17,18} Soft tissue dissection followed by the use of barbed sutures to suspend tissue has been more reliable as a method to correct ptotic soft tissues than simply passing these sutures subcutaneously without first performing the dissection.

**Other Suture Designs**

Dr Nicanor Isse, a plastic surgeon in Newport Beach, California, first developed a unidirectionally barbed, non-absorbable polypropylene suture known as the Isse Endo Progressive Face Lift Suture (Kolster Methods, Inc), before designing an alternate type of modified suture, the Silhouette Mid-Face Suture (Kolster Methods, Inc), which received its US FDA approval for midface suspension in November 2006. Instead of having barbs contained within the polypropylene suture, the Silhouette suture has knots tied at 10-mm intervals along the distal 10 cm of the suture (Figure 3).\textsuperscript{19} The knots hold unidirectional absorbable cones of polyglactic acid in place. These cones, which are actually a copolymer of glycolic acid and lactic acid, provide the tension loading for soft tissue elevation. The cone anchors the suture and allows in-growth of soft tissue. Whereas a barb only grasps the soft tissue at 1 fixed point, the cone grasps tissue across 360 degrees. This enhances the tensile loading capability, which is no longer just across the barbed length of the suture but 360 degrees around the cone and the cone length of the suture. The Silhouette suture is used principally for lifting and repositioning the soft tissue of the midface and not for wound closure. The initial reports on the Silhouette, based on 17 patients who underwent midface repositioning with this suture, have been favorable.\textsuperscript{20} Patient satisfaction was 90% at 9 months; resuspension of the sutures was necessary in only 1 case. No larger data sets for this device are yet available.

Still another barbed suture developed for facial soft tissue suspension is the Woffles thread (Kolster Methods) (Figure 4).\textsuperscript{7,21} With the Woffles lift, a bidirectional, non-absorbable, polypropylene thread is introduced using an 18-gauge spinal needle placed in the temporal region. The thread is doubled to form a sling, suspending sagging tissues of the face from the stable temporal scalp. Data published in 2004 from 112 patients indicated that approximately 30% of the aesthetic benefit of the Woffles lift was lost at 3 months but was otherwise maintained at 1 year.\textsuperscript{7} Knot palpability/exposure occurred in 9% of cases.

Although the bidirectional Quill Knotless Tissue-Closure Device (Angiotech Pharmaceuticals, Inc, Vancouver, British Columbia, Canada), described below, is by far the most commonly used barbed suture in aesthetic plastic surgery at this time, a unidirectional absorbable barbed suture device (V-Loc Wound Closure Device; Covidien,
Mansfield, Massachusetts) has also been developed for knotless soft tissue approximation with the goal of reducing operating times and knot-related complications. The V-Loc is armed with a surgical needle attached to one suture end and a loop end effector at the other end. I have had no experience with this device and, at the time of writing, there have been few publications of its use in plastic surgery applications.

**Quill Device**

Since the development of the early barbed suture devices described above, barbed suture technology has progressed to the development of both absorbable and nonabsorbable bidirectionally barbed sutures, with barbs arranged in opposing directions on either side of an unbarbed segment (ie, the Quill device). This device is armed with a surgical needle on each end. Absorbable materials for the device include polydioxanone (PDO) and Monoderm (Angiotech Pharmaceuticals, Inc), a polyglycolide-poly-e-caprolactone copolymer (Figure 5). Nonabsorbable materials include nylon and polypropylene. A novel helical design in the placement of the barbs supports the concept of better tissue adherence to the barbs (Figure 6). As with prior barbed suture configurations, the goal of this new design was to avoid knot tying, which has, on occasion, resulted in palpability of the knots. Extensive preclinical testing was conducted to ensure that the tensile strength of the Quill materials provided sustained soft tissue approximation, with an absorption curve compatible with the time required for neo-collagen formation to maintain the integrity of the soft tissue approximation.

The Quill Monoderm (Figure 5B) is the most recently available absorbable bidirectional suture. It is designed for placement in the mid-dermis. Compared with Quill PDO, the Quill Monoderm has a more rapid absorption curve and eliminates the exposure/extrusion issue that has been seen when larger diameter PDO sutures are placed too superficially in the dermis.

Barb morphology influences holding and tensile strength. The deeper the barb is cut, the lower the tensile strength. Therefore, with the Quill device, it is important to select a suture size that is 1 thickness above the size of any conventional suture. For example, in cases where a 2-0 absorbable conventional suture would have been used, a 0 bidirectional barbed suture should be used to account for the difference in the strength of the suture material.

In my experience, both midface and brow elevation can be maintained with absorbable bidirectional barbed sutures, but, as expected, patients with the most favorable anatomy (eg, low body mass index, minimal fullness to the soft tissues, strong underlying bony projection to support the elevated tissue, good skin quality) have shown the best results and, most commonly, extensive soft tissue dissection has been required to ensure that elevated soft tissue remains elevated. Specific techniques in aesthetic facial plastic surgery that I have developed to take advantage of the unique properties of the Quill device are outlined below. Unfortunately, no large data sets of patient experience have been reported to date with this device in aesthetic facial plastic surgery. As a result, no objective outcome data accompany these descriptions. My preference for the use of the bidirectional barbed device over conventional sutures for these procedures is based solely on anecdotal experience that better outcomes are achieved with the Quill barbed device.

**Quill Techniques**

*Suspension of the brow*

In this technique, incisions are made behind the temporal hairline. The temporal dissection proceeds on top of the deep temporal fascia, releasing the periorbital lateral to
The supraorbital neurovascular bundle. The bidirectional barbed suture is threaded onto a long Keith needle that is passed over the deep temporal fascia, piercing the flap about 1 cm above the orbital rim, exiting below the lowest brow hairs. The second half of the suture is placed through the deep temporal fascia, continuing above the plane of dissection, then exiting the lowest brow hairs about 1 cm medial to the first suture. The brow is lifted on the barbs of both suture halves until satisfactory correction has been achieved. The temporal incision is closed with skin clips after securing the superficial temporal fascia to the deep fascia with an absorbable suture (3-0 PDS; Ethicon, Somerville, New Jersey) (Figure 7). If the brows are symmetrical, the opposite brow may be positioned the same way. If there is asymmetry or if the tissues are heavy, the ends of the sutures are left long and covered with an antibacterial ointment, a nonadherent pad, and sterile gauze. Two to 3 days later, the brow(s) may be further adjusted if necessary. In the case of brow asymmetry, the higher brow is positioned at the right level and the sutures are cut at the skin level in the operating room (OR). The lower brow height is adjusted in the OR, and the suture ends are left long to be adjusted as needed a few days after surgery to achieve brow symmetry. This allows further elevation only on the more ptotic side a few days later and avoids “chasing” the other side in the clinic.

**Midface suspension**

In a technique for midface elevation similar to that of Hobar and Flood,25 I have used a temporal access incision (similar to that described above for a lateral browlift), dissected over the malar bone, and joined this with a transbuccal approach (Figure 8). A suture was placed intraorally through the soft tissue over the malar bone and then passed out of the temporal access incision, anchoring it to the deep temporal fascia (Figure 9). With conventional sutures, this was, at times, quite tedious. It also required more precision in placement to produce a symmetrical result and, in a few cases, resulted in a midface infection that required intraoral drainage. The availability of the bidirectional, absorbable barbed suture has allowed me to perform a much easier dissection, one that requires little visualization and produces lasting improvement in elevating and repositioning ptotic midface soft tissues (Figure 10). Using barbed sutures for midface lifting allows one to support the elevated tissues by passing the bidirectional barbed suture through all tissue planes, exiting lateral to the nasolabial crease, avoiding intraoral suture placement.

**Platysmaplasty**

The neck has always been challenging to correct when addressing facial aging. I have utilized Joel Feldman’s corset platysmaplasty to unite the platysmal muscles in the midline combined with pre-, inter-, and subplatysmal fat removal as indicated by the patient’s anatomy.26 The advent of the bidirectional barbed absorbable PDO suture allows more finesse in suture placement and impressive cervicomental contouring. Two or 3 permanent nylon sutures should be used at key points as an added support to the underlying corset (Figures 11 and 12).

**Lateral neck suspension**

The bidirectional barbed device can similarly be anchored in the mastoid fascia. One end is passed through the platysma muscle along the jawline, exiting the skin in the submental area. The second half of the suture parallels the first half and may support a ptotic submaxiallary gland. The central neck skin is advanced on the barbs to tighten the upper neck (Figure 13).
Lateral SMASectomy
One of the most frequently performed procedures for face lifting is the lateral SMASectomy.27 Bidirectional barbed absorbable sutures allow secure plication of the mobile to the nonmobile SMAS and allow “anywhere” suture placement that will enhance results. Avoiding knots is valuable, as is the availability of an absorbable polymer (Figure 14).

MACS lift
Another frequently performed facelift technique is the minimal access cranial suspension (MACS) lift.28 This technique utilizes a purse-string suture beginning and ending with anchor points in the deep temporal fascia in front of the ascending helix. Utilizing the bidirectional, barbed PDO suture, there is no need for a purse string to achieve the desired result. Therefore, there is no knot tying, nor is there the bunching of the soft tissue that frequently requires trimming and the placement of a layer of sutures to control shape (Figure 15).

Basic wound closure techniques with the Quill device
Emerging applications for barbed sutures in wound closure followed the availability of bidirectional barbed sutures in both absorbable and nonabsorbable materials. Fundamental to an understanding of the application of bidirectional barbed sutures to wound closure are the basic wound closure techniques utilizing these devices. It is my opinion that the learning curve with this technology is short, requiring the completion of only 1 to 2 cases to achieve competency in the closure techniques outlined below.

Simple wound closure. If the wound includes only the full thickness of the skin and subcutaneous fat, a single bidirectional barbed suture can be started in the middle of the wound. Each half travels to opposite ends of the wound. The needle exits the skin 1 cm lateral to the end of the incision on each side (Figure 16).

Multilayered skin closure. A multilayered closure is necessary when the wound includes the full thickness of the
skin, subcutaneous fat, and superficial fascia (deep fat may be included). First, the deep layer is closed utilizing the bidirectional barbed suture. At each end of the wound, the needle is passed in a J-loop to ensure good wound approximation. Then, the full-thickness skin incision is closed as described above (Figure 17).

Figure 8. Transtemporal and intraoral incisions for the midface lift. From Paul. Reprinted with permission from Sage Publications.

Figure 9. (A) Passage of the bidirectional barbed suture from the temporal area exiting lateral to the nasolabial crease. (B) Volumetric stacking of soft tissue (the “shish kebab” effect). SMAS, superficial musculoaponeurotic system; SOOF, suborbicularis oculi fat. From Paul. Reprinted with permission from Sage Publications.

Figure 10. (A) A 37-year-old woman shown preoperatively. (B) Five months after open subperiosteal browlift and midface lift with the bidirectional barbed suture. From Paul. Reprinted with permission from Springer-Verlag.
Closure of wounds with excessive tension. In cases where there is excessive tension, the wound can be closed in 2 directions. First, a bidirectional barbed suture with a short straight needle is passed at right angles to the wound and exits the skin. The opposite end of the suture is passed in the opposite direction. Having been divided into equal segments, the wound is then closed at right angles to the wound with several of the short sutures on the straight needle. After the right angle tension is adjusted, the standard closure is performed as described above (Figure 18).

Aesthetic plastic surgery wound closure applications with the Quill device

Having mastered the routine closures, one can move on to utilizing this technology in closing incisions in aesthetic plastic surgery, including breast and body contouring applications, which may bring with it benefits such as shorter operating time.

To provide convincing evidence that fewer sutures were required and the operating time was shortened when bidirectional barbed sutures were deployed in aesthetic plastic surgery procedures, I measured time for incision closure in a single cadaver. Procedures included closure of brachioplasty, mastopexy, and abdominoplasty incisions. Separate surgeons performed each of the 3 procedures. Closure of a single half of the cadaver (breast, arm, abdomen) was performed with a bidirectional barbed suture (Quill PDO device). Serving as the control arm, closure of the other matched half of the cadaver was performed by the same surgeon with absorbable standard sutures (eg, Vicryl; Ethicon). In every case, the operating time was shortened with the use of the bidirectional barbed closure technique (Figure 19). This is an important consideration, since shorter operating times translate to cost savings for the patient and may allow the surgeon to add another case on the same day, if so desired.

The following aesthetic plastic surgery procedures have been found to be appropriate for utilization of the bidirectional barbed suture technology:

**Mastopexy.** Using the Quill PDO device, the deep dermis can be closed around the areola. One half of the suture begins at 12 o’clock and travels clockwise to the 6-o’clock position.
The other half of the suture travels the same distance counterclockwise. The sutures can be continued down the vertical limb, and each half can continue in opposite directions to close the inframammary incision, if indicated for breast shaping. Going the full distance requires a suture 24 cm to 30 cm long so that enough suture length is available to close the incisions with one suture. The mid- and superficial dermis is closed in a similar manner with the Quill Monoderm device, which is used instead of Monocryl (poliglecaprone 25; Ethicon) (Figure 20). In patients with a thin dermis, a 1-layer closure with the Monoderm is indicated to avoid the possibility of extrusion of barbed segments with a longer lasting polymer (ie, Quill PDO).

**Reduction mammaplasty.** The pedicle can be supported to the pectoralis fascia with a larger diameter, 0 or 1 PDO or nonabsorbable barbed suture. This allows firm fixation of the pedicle and may decrease the chance for late “bottoming out” of the breast. The incisions are closed the same as for a mastopexy. Interestingly, the even distribution of tension along the incisions may result in better scar cosmesis and a lesser tendency for dehiscence of the tension point where the medial and lateral breast flaps are brought to the inframammary incision line (an area prone to dehiscence and delayed healing).

**Figure 13.** Lateral neck contouring with the bidirectional barbed sutures. (A) Placement of the sutures. (B) A 40-year-old woman is shown preoperatively. (B) Three months after subperiosteal browlift and midface lift with barbed sutures, liposuction of the jawline, and barbed suture suspension and chin augmentation. From Paul.23 Reprinted with permission from Elsevier.
Abdominoplasty. Extensive experience with the bidirectional barbed device in abdominoplasty has convinced me that there are clear advantages to using this technology. The midline diastasis recti and periumbilical hernias can be securely approximated and repaired quickly. To perform the repair, a larger diameter, 1 nylon barbed suture is passed from the fascia adjacent to the umbilicus to the xiphoid. The other half travels from the umbilicus to the

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**Figure 14.** Lateral SMASectomy performed with the bidirectional barbed suture. From Paul.²³ Reprinted with permission from Elsevier.

**Figure 15.** Minimal access cranial suspension (MACS) technique performed with the bidirectional barbed suture. From Paul.²³ Reprinted with permission from Elsevier.

**Figure 16.** A simple wound closure technique utilizing the bidirectional barbed suture. (A) Begin by taking one end of the suture and pulling it through until the transition zone has reached the tissue. Estimation of the center of the device can be aided by taking a single bite of tissue, then aligning the needles until both ends of the suture are of roughly equal lengths. (B) Taking one arm of the suture, complete at least 2 loose arcs through the tissue, then takes a few tissue bites with the other arm of the device. (C) Once at least 2 arcs per side have been deployed, each of the strands can be grasped and the tissue approximated to the desired tension. Continue the bites sinusoidally until the end of the wound is reached. (D) Take the last bite 2 cm beyond the end of the wound, exiting through the skin. Repeat the technique on the opposite side. Complete the procedure by pushing down on the tissue and cutting the device and needle flush with the skin. Copyright 2011, Angiotech Pharmaceuticals, Inc. Reprinted with permission.
Figure 17. Multilayered wound closure technique utilizing the bidirectional barbed suture. (A) Begin the wound closure with a Quill PDO suture of appropriate size. Place the suture in the superficial fascia at the midpoint of the wound, pulling the suture until it locks due to barbs facing the opposite direction. (B) Continue suture placement in a sinusoidal fashion until the end of the wound is reached. (C) Then reverse the direction of the needle, placing it under the last suture loop and continue in a J-loop fashion to secure the closure. (D) Then complete the wound closure as described in Figure 16. From Paul and Budd. Reprinted with permission from Allied Media.

Figure 18. Closure technique for wounds with excessive tension utilizing the bidirectional barbed suture. (A) Mark the vector lines of the suture at 5-cm intervals. Insert the needle from either side of the wound through the full thickness of the wound, exiting the skin at least 3 cm from the border of the wound. (B) Hold tension on the device and ratchet the wound edges close together. (C) Repeat the procedure until the wound is an optimal size. Close the wound in layers as shown in Figure 17. Copyright 2011, Angiotech Pharmaceuticals, Inc. Reprinted with permission.
suprapubic incision. This is followed with a second row using 1 or 0 PDO (Figure 21). I have demonstrated the strength of this closure in the cadaver laboratory, where a midline laparotomy incision was closed in layers with the bidirectional barbed suture and the incision could not be dehisced when pressure was applied from behind the closure (data unpublished). If a high-tension lateral abdominoplasty is preferred, the barbed sutures can be used to apply evenly distributed tension to the lateral aspect of the flap, anchoring the flap to the deep fascia. This may take the place of basting sutures, which are important in reducing incision-line tension. At the same time, by eliminating the dead space, the incidence of seroma formation is reduced. A larger diameter (1 or 0 PDO) is useful for this purpose. The effectiveness of this progressive tension quilting suture technique to close the dead space and thus reduce the risk of seroma formation was first established more than 13 years ago by Baroudi and Ferreira,30 and later by Pollock and Pollock.31,32

The transverse abdominoplasty incision can be closed in 2 layers, with the deep layer including Scarpa’s fascia closed with a 0 or 2-0 PDO device. The deep dermis is closed with a 3-0 Monoderm device. A few 3-0 nylon sutures are placed to set up the closure and add additional support in areas of tension, which are important in patients who are encouraged to ambulate soon after the abdominoplasty procedure is performed (Figure 21). If a seroma develops, the wound can be readily opened by cutting the device in the nonbarbed middle segment. Each device arm can then be pulled out from the distal end.

**Bodylifting.** In a similar manner as described for abdominoplasty, the extensive incisions required in postbariatric surgery skin envelope reduction and shaping can be closed more securely and quickly with bidirectional barbed sutures.

**Brachioplasty.** Prone to scar widening, this incision can easily be closed in layers with bidirectional sutures. One can choose to add additional barbed sutures at a right angle to allow distribution of tension in 2 directions.

**CONCLUSIONS**

Thought and process in the emerging technology of barbed sutures has evolved from procedures that were ineffective and prone to complications—including relapse, palpability, and extrusion—to reliable methods to reposition dissected and mobilized soft tissues of the aging brow, face, and neck. The bidirectional barbed Quill Knotless Tissue-Closure Device, with a helical barb design...
and available in absorbable and nonabsorbable polymers, has allowed this technology to be applied to longer incisions that carry varying soft tissue loads. Controlling tension along the incision line has always been the goal of any wound closure. It is my experience that the Quill device decreases the incidence of wound dehiscence and subsequent unfavorable scarring. The observation that wound closure times are shortened, that fewer sutures are required, and that many of the scars may be better in appearance than scars resulting from standard wound closure techniques has led to widespread adoption of this technology. Both patients and surgeons are the beneficiaries of the value added by use of bidirectional barbed sutures.

**Disclosures**

Dr Paul is currently employed on a part-time basis as a consultant for Angiotech Pharmaceuticals, Inc (Vancouver, British Colombia, Canada). He receives a consultant fee and holds stock options.

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