

Technique and Uses for Absorbable Barbed Sutures

The author describes barbed sutures as a unique wound closure tool. Their advantages include the closure of wounds without any knots or the need for a third hand. They are also capable of shifting tissues differentially along the suture to redistribute tensile and compressive forces. The author discusses the development of these tools and their application. (*Aesthetic Surg J* 2006;26:620-628.)

A bidirectionally barbed suture has many barbs serially placed along its length, which change direction somewhere near the suture midpoint to create a mirror image array of barbs in the opposite direction. Therefore, when engaged in tissue, one end anchors the other. They can thereby be used to close wounds or move tissues differentially along the suture toward the point at which the barbs change direction.

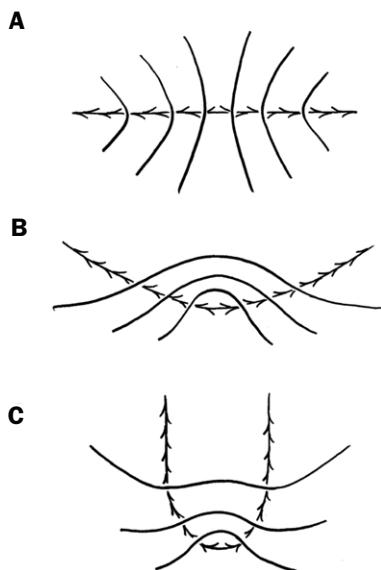


Figure 1. **A**, Linear compression at the point where the barbs change direction. **B**, Arcuate placement imparts a mound by adding a vertical vector to the horizontal vector. **C**, U-shaped deployment results in the forces on the barbs being opposed by the bend in the U (rather than the opposing barbs).

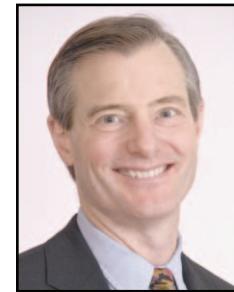
This creates new gradients of tension and compression (Figure 1). (Although the suture can be placed through a cannula, this paper will only describe methods employing double-armed sutures.)

Permanent barbed sutures are approved for correcting facial and cervical ptosis and for approximating wounds in soft tissue. Absorbable barbed sutures

are only approved for soft tissue approximation. They are made of polydioxanone (PDO). This polymer hydrolyzes, and so its strength degrades in an inverse fashion to the increase in strength of a healing wound.

Design/Methods

The rate of absorption and strength of a suture can be ideally matched to the healing strength necessary for a given surgical technique (Figures 2 and 3). Barb morphology also influences both holding and tensile strength (also called, respectively, *pull-out* and *breaking* strength). The deeper the barb is cut, the lower the tensile strength



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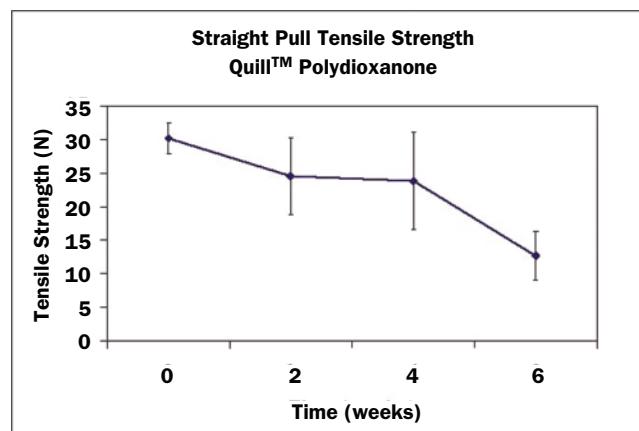


Figure 2. Tensile (breaking) strength of PDO in rabbit subcutaneum.

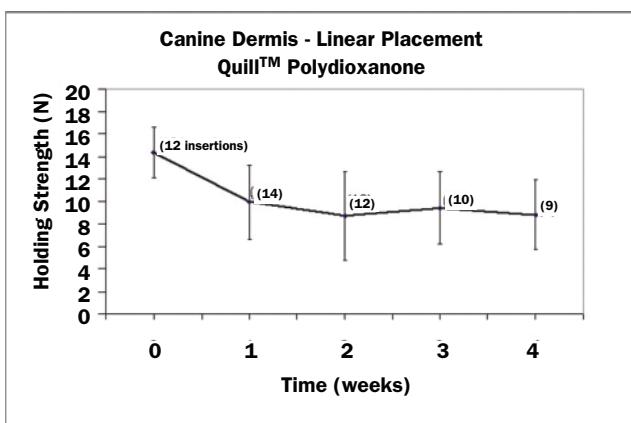


Figure 3. Holding (pull-out) strength of PDO in canine dermis.

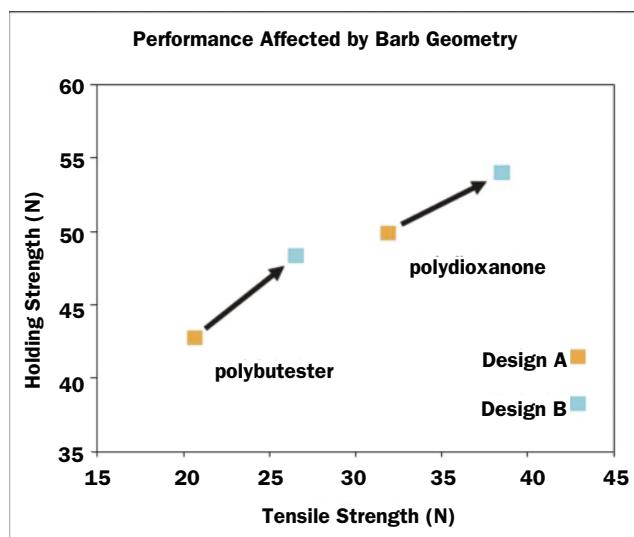


Figure 4. Effect of barb geometry on holding strength.

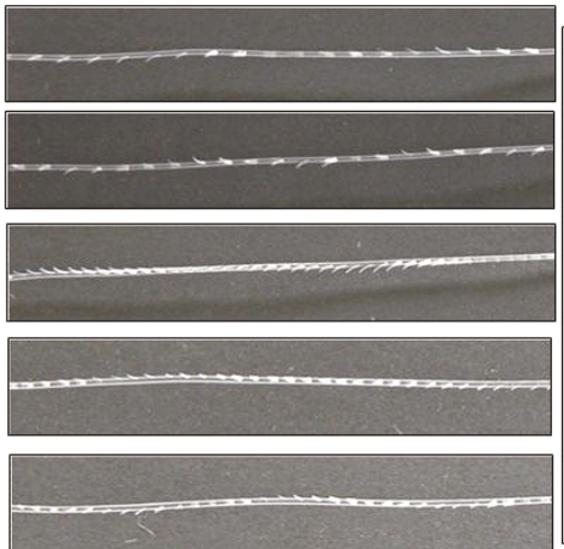
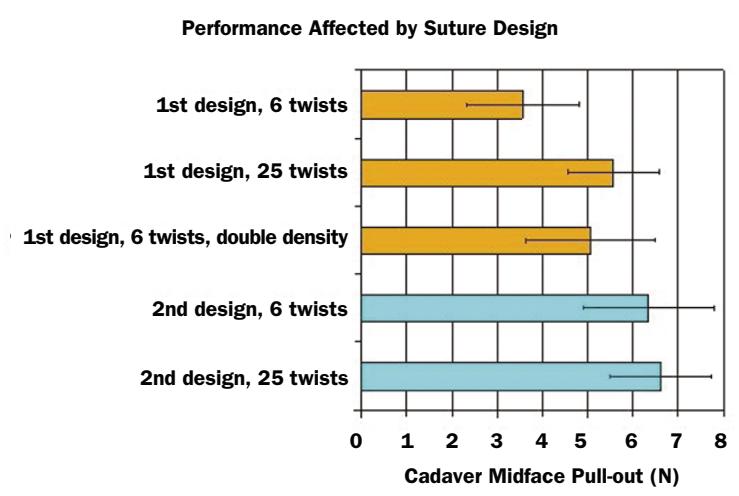


Figure 5. Effect of helicity (25 twists is more helical than 6 twists), barb density, and barb geometry on holding design.



(Figure 4). (When a suture is knotted, the tensile strength is reduced by approximately half). A helical barb array holds better than an axial one (Figure 5). Fortunately, a variety of monofilament sutures can be barbed effectively, and thus, a spectrum of absorption rates can be provided (Figure 6). Less traumatic needles in terms of diameter, and presumably tip design, improve holding strength (Figure 7).

The technique strongly influences results. Both barbed and conventional sutures hold best when they engage connective tissue at a right angle to the collagen bundles. However, an ordinary closed loop generally compresses tissues at opposite poles, 180 degrees across

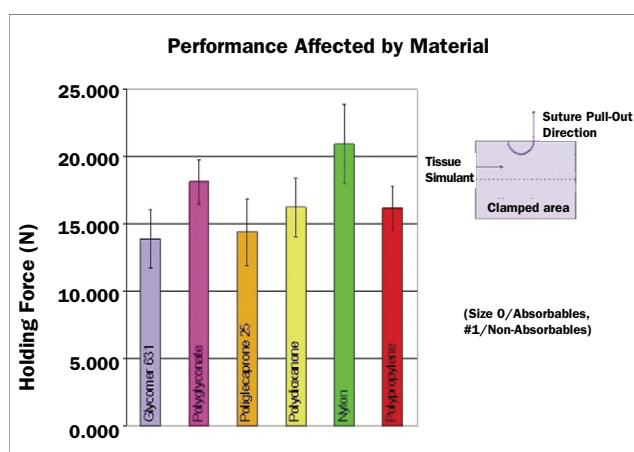


Figure 7. Holding strength of FDA-approved barbed monofilaments.

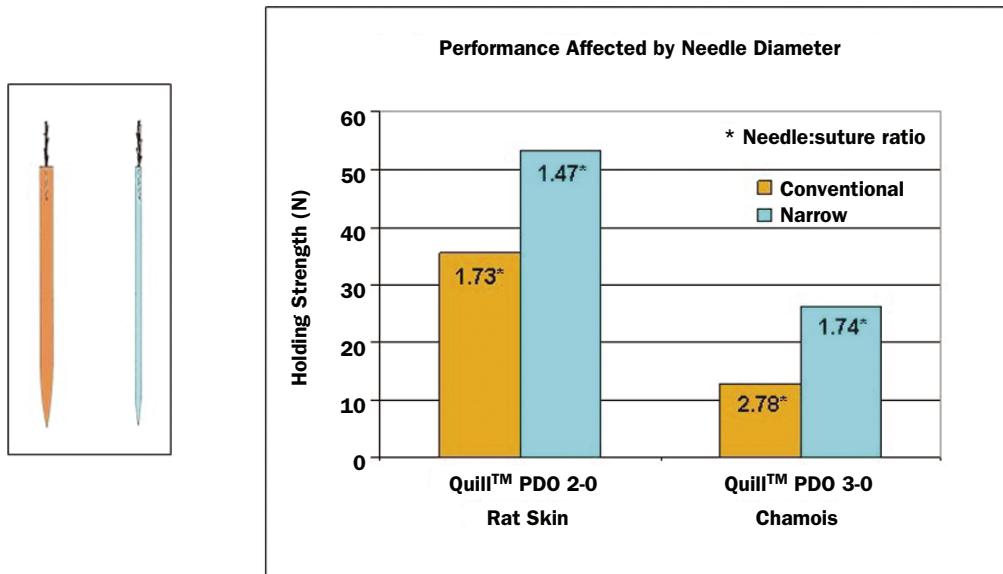


Figure 7. Effect of needle diameter on holding strength.

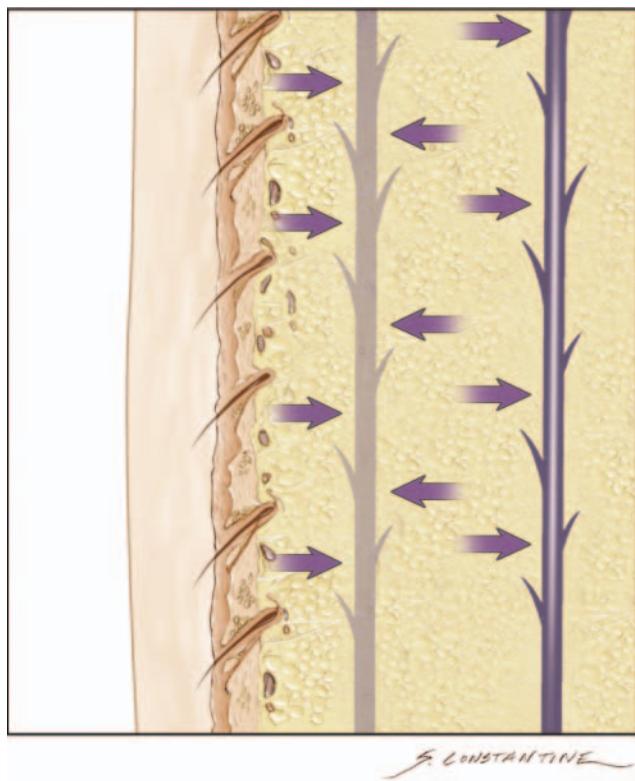


Figure 8. Sinusoidal placement creates alternating vectors of force along the suture.

from each other. A barbed suture holds better when each barb ensnares collagen fibers; therefore, a sinuous passage is preferable to a straight one because more collagen is encountered. A wavy path will straighten as the

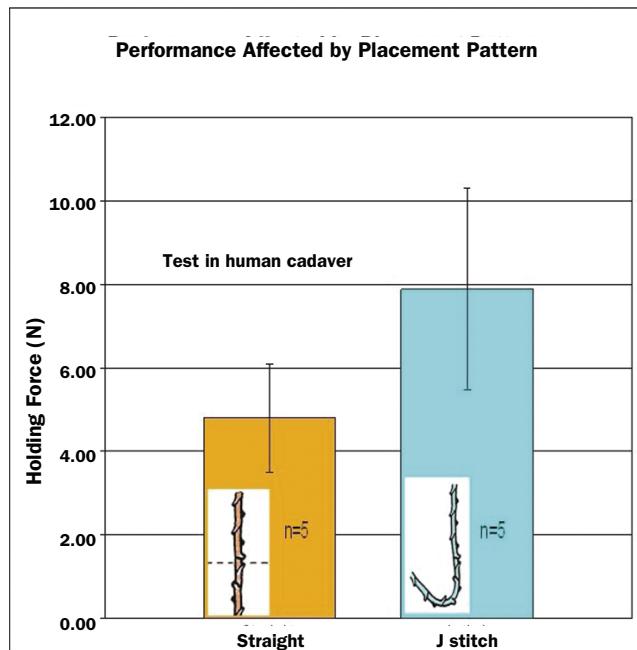


Figure 9. A 6-cm barbed polypropylene suture has greater holding strength when half of it is curved at about 180°.

suture is tightened, but it will then encounter alternative vectors of force pushing against it (Figure 8). If a suture begins to pull out, new fibers are then pressed against the barbs. In contrast, the barbs in a suture that traverses a straight line will only encounter a loosened column of tissue as it is pulled out (Figure 9). Undulations also impart elasticity, helping to prevent suture breakage, particularly with ballistic movements of the engaged tis-

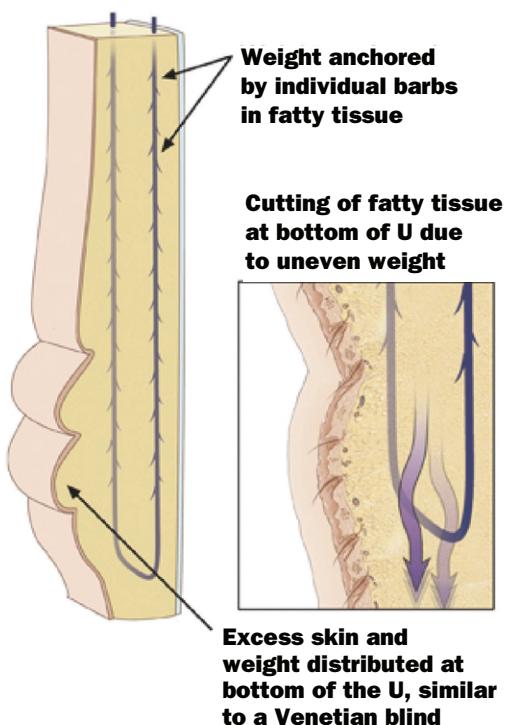
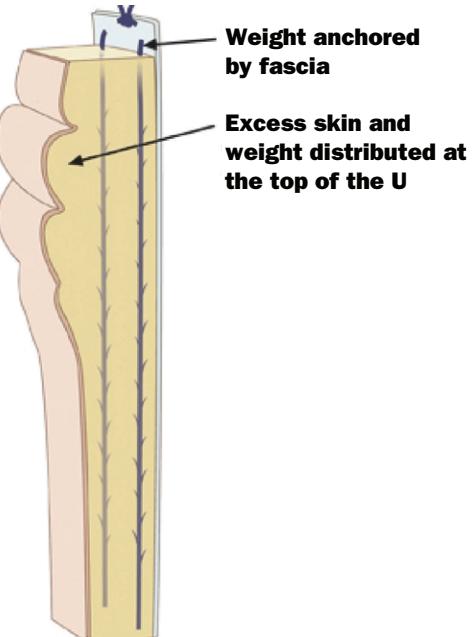
A. Distribution of tissue weight with U-shaped barbed suture**B. Distribution of tissue weight with inverted U-shaped contour suture**

Figure 10. When placed as an upright "U" (left), the dependent tissues gather at the bend in the suture, just like those in a knotted loop. An inverted "U" allows the redundancy to be transferred to the scalp, far from the patient's area of concern.



Figure 11. Used in an S-lift, the sutures can be anchored to the deep temporal fascia or parotid fascia over the SMAS and zygomatic arch under direct vision (dashed areas near ear).



Figure 12. **A,** Preoperative view of a 76-year-old woman. **B,** Postoperative view 5 months after S-lift performed with barbed 2-0 PDO directed at the nasolabial folds and jowls.

sue. Accordingly, curved needles naturally create a stronger closure than straight ones, and can be effectively used in sinusoidal, helical, and mattress patterns.

Applications

Interrupted closures conventionally create loops in a variety of configurations, usually requiring 1 to 4 bites as well as making it necessary to bring the lead end and tail together to tie the knot. However, because they are knotless, the ends of a barbed suture can be far apart. Commonly used configurations can be created in the shape of the letters *J*, *U*, *C*, *S*, or *M*.

When used to approximate tissues in the face or neck, a barbed suture can extend from the scalp into the target tissues that bother the patient: the brow, nasolabial folds, jowls, or central neck. A loop of ordinary suture gathers tissues like a Venetian blind, creating fullness just lateral to the patient's problematic area. A barbed suture can further displace the redundant tissue up into the hairline. It accomplishes this because the barbed tines

point superiorly, and each one of them can support the elevated tissue. This allows for differential approximation which the central face is tightened and the peripheral wound compressed (Figure 10). When used to approximate the deep wound, as in an *S lift*, the anchoring portion of the suture can be placed in a deep fascia while the distal ends of the suture traverse the deep subcutaneous plane (Figure 11). A terminal J curve deflects the end away from the oral commissure when the patient smiles (Figure 12).

Another application of interrupted technique using a barbed suture is the lateral canthopexy with needles introduced through a single puncture over the tendon (Figure 13). One needle courses superior to the tendon and the other, inferior. They then engage the arcus marginalis superiorly to emerge from the skin. When these ends are pulled, the canthus is snugged tight and the ends trimmed to lie beneath the surface.

Although a trial is underway in Canada using permanent barbed sutures to lift the ptotic (but intact) breast,

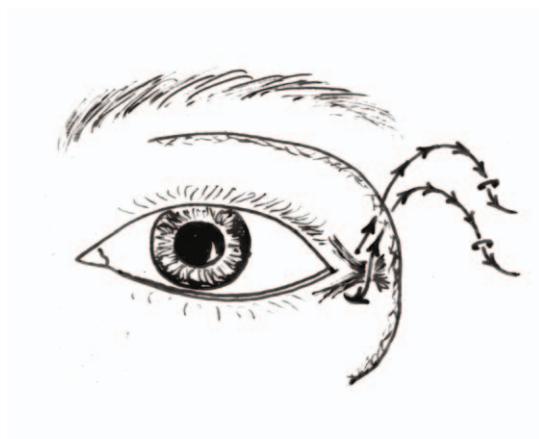


Figure 13. Percutaneous canthopexy. The needles course superior and inferior to the tendon, then engage the orbital periosteum and arcus marginalis deeply and superiorly. The ends are trimmed as they emerge from the skin.

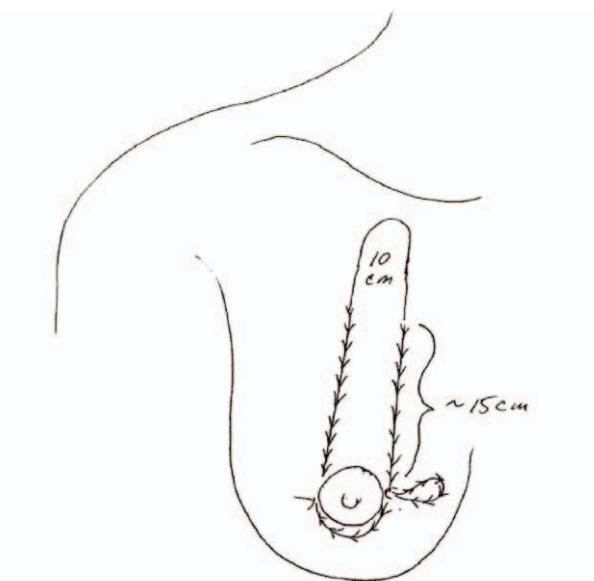


Figure 14. Mastopexy anchoring the bend in the suture to the pectoralis major fascia. A "J" is executed by bringing the needle out and reentering the same puncture. (The lateral segment will be terminated in a mirror image fashion.)

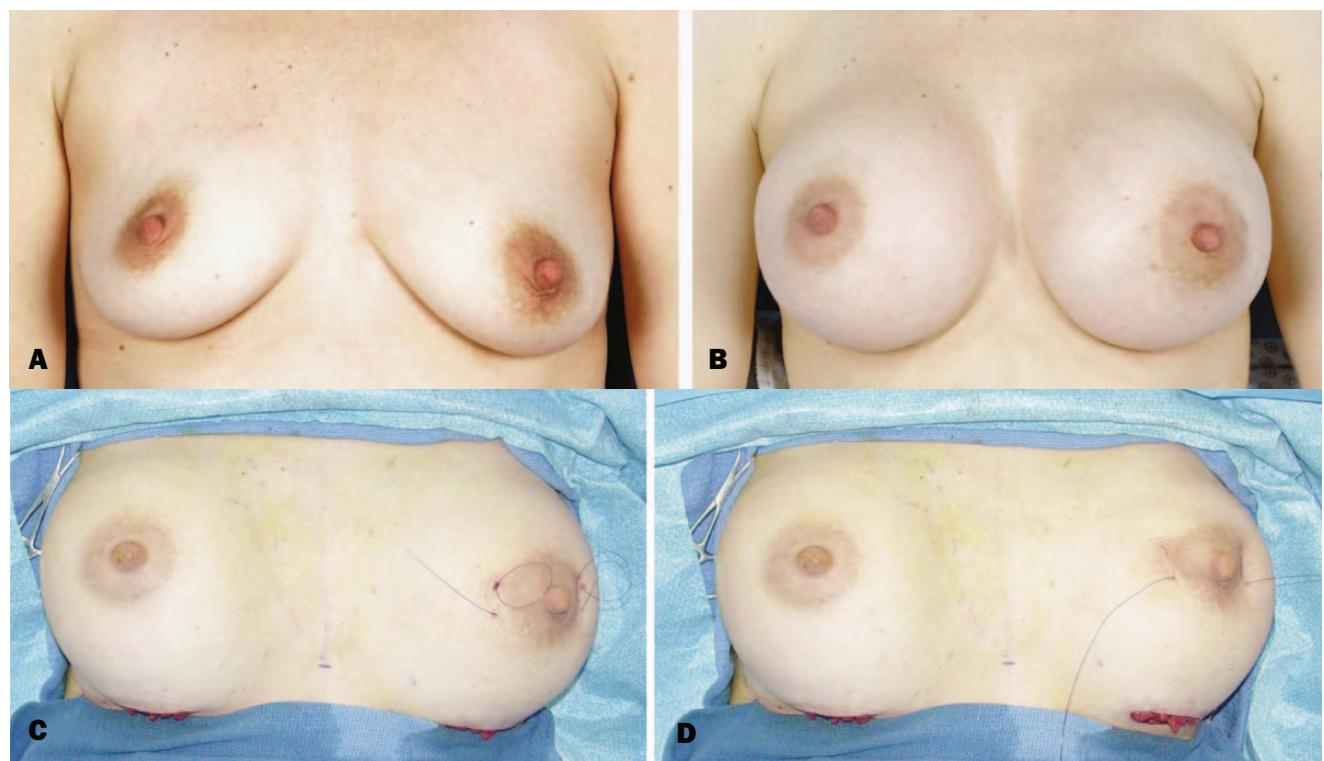


Figure 15. **A**, Preoperative view of a 30-year-old woman. **B**, Postoperative view 3 months following subglandular augmentation with 385 cc smooth, round silicone prostheses. **C, D**, Intraoperative views with a size 0 PDO placed as in Figure 14. Slack on left, tight on right.



Figure 16. **A,** Preoperative view of a 33-year-old woman. **B,** Postoperative view 8 months following lipoplasty reduction (350 cc per side) with size 0 PDO suspension as in *Figure 14*. **C, D, E, F,** Intraoperative views of the same patient. Slack on left, tight on right.

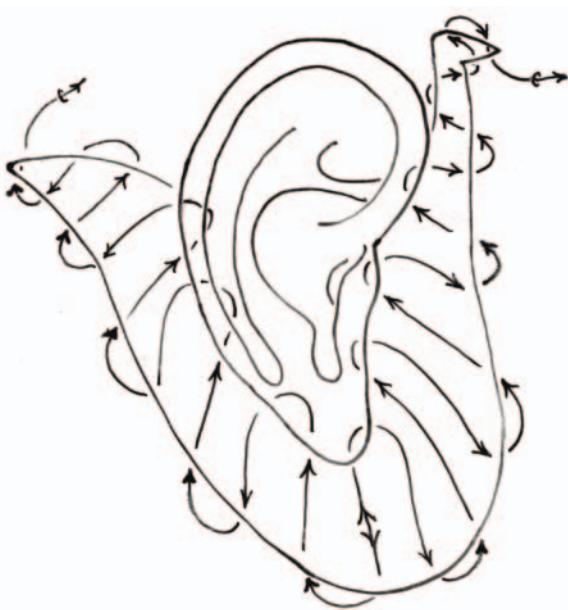


Figure 17. Subcuticular face lift closure initiated at the lobe.

absorbable barbed sutures might best be used to approximate tissues when a wound has been made. Anchored to the superior pectoral fascia, the nipple can be elevated during augmentation, capsulectomy, or lipoplasty reductions (Figures 14 to 16).

Running closures begin near the middle of the wound. As the needle is pulled through the first bite of tissue, the barbs that immediately follow it compress against the shaft of the suture and impart little resistance. As soon as the opposing set of barbs meets the tissue, however, those barbs catch. Then subsequent bites are taken with the first needle until the end of the wound is closed, at which point the needle is simply cut off. The opposite end of the barbed suture closes the wound in a mirror image fashion (Figure 17).

Discussion

Barbed sutures provide an alternative to conventional ones. They can be deployed with typically curved or long, straight needles. They are definitely preferable where knots are difficult to tie. Their unique attributes merit additional consideration for both the surgical plan and actual placement of the suture.

A major variable in facial rejuvenation is the degree to which the tissues swell and, more importantly, contract postoperatively. A barbed suture can be anchored proximally and deployed distally to grasp the tissues of concern. Not only should this minimize relapse, but it

should allow removal of more redundant tissue under less tension.

Given that the barbs are not designed to bend backwards, a suture that has been pulled too tight may need to be released, deforming and weakening the suture. If the adjustment is large it may be preferable to truncate the suture and use another. However, the fact that a surgeon can set the tension and then release the suture to reload the needle holder obviates the need for a "third hand." Also notable is the dynamic behavior of a running wound closure using barbed sutures compared with conventional ones. Unlike a smooth suture, a barbed suture will not move to the portion of the wound where the tension is greatest, most frequently the center of the incision. Thus, a running barbed closure can provide security similar to a conventionally interrupted one. Potentially, this may reduce the incidence of wound hernias and wide scars.

It is possible that by avoiding knotted loops the barbed suture may decrease ischemia and, consequently, pain and wound dehiscence. While these potential assets are yet unproven, it has been documented that the straight ends of a barbed suture are 4 times less prone to spitting than knotted ends when used in a running subcuticular fashion.¹

The first approved absorbable barbed sutures are made from PDO, which is often used for deep closures. Polydioxanone degrades commensurate with increases in wound strength in the soft tissues and the subperiosteal plane. Surgeons generally prefer more rapid degradation for intracuticular closures to reduce the incidence of extrusion or spitting of the sutures, and Food and Drug Administration (FDA) approval is being sought for barbed versions of these polymers. When used to lift intact tissues, as is done with polypropylene, perhaps a very slowly absorbed polymer will suffice to achieve a satisfactory result and obviate any concerns about long-term adverse effects.

Absorbable barbed sutures are new. They provide the opportunity to improve our current repertoire of rejuvenating operations. However, I foresee numerous improvements that will broaden their indications and presumably result in new techniques that take advantage of their novel properties. ■

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