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# Barbed Ribbon Device for Progressive Tension Closure Reduces Seroma After Breast Reconstruction

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**Purpose:** Implant-based breast reconstruction is fraught with complications related to seroma formation. Soft tissue stabilization with progressive tension closure (PTC) has been shown to decrease seroma formation after various procedures but is less suitable for mastectomy flap stabilization. We evaluate the incidence of seroma in breast reconstruction using bioabsorbable barbed ribbon devices (BRDs) as a novel approach to PTC.

**Methods:** We performed a retrospective review of all patients whose mastectomy flaps were stabilized with BRDs. These patients were compared with consecutive patients who underwent mastectomy and reconstruction without progressive tension flap stabilization. Patient demographics and outcomes were recorded, including comorbidities, complications, presence of seroma, and total drain days.

**Results:** In the BRD-PTC group, there were 36 breasts compared with 56 in the nonstabilized control group. There were no significant differences in rate of tobacco use, age, or body mass index. We identified 11 seromas in the control group (19.6%) and none in the intervention group ($P = 0.05$). In the PTC group, drains were removed an average of 5 days sooner than those in controls ($P = 0.006$).

**Conclusion:** Progressive tension stabilization of mastectomy flaps with BRD significantly reduces seroma formation and the duration for which closed suction drainage is required.

**Key Words:** breast reconstruction, mastectomy, seroma, closed suction drain, tissue expansion, progressive tension closure, acellular dermal matrix

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Implant-based breast reconstruction (IBBR) is currently the most common method of breast reconstruction in the United States. In 2013, approximately 80% of breast reconstructions were implant based, and the trend toward IBBR is on the rise.[1] Seroma formation represents a vexing problem in IBBR, which can lead to delayed healing, infection, and implant loss.[2–4] Use of acellular dermal matrix (ADM) in IBBR is standard of care.[2,3] In direct-to-implant reconstruction, covering the entire implant with ADM is popular. However, multiple studies demonstrate that higher volumes of ADM are associated with increased rates of seroma.[5–8] Thus, we can anticipate that seromas will continue to be an important problem in IBBR.

Flap stabilization techniques significantly decrease the incidence of seroma and its sequelae in a variety of plastic surgery procedures. These techniques include suture fixation, progressive tension closure (PTC), closed suction drainage, and others.[9–19] Seroma prevention by PTC through dead space obliteration has been previously used in abdominoplasty and myofascial flap harvest[4,10,14,20,21] No study has yet investigated this seroma-reducing strategy in breast reconstruction. The common theme of PTC and parallel interventions is the temporary apposition of surgically separated tissue planes in a manner that leads to permanent healing and scar. Seroma is necessarily prevented any time the theory is successfully applied.

Upon careful consideration of the scientific foundation of PTC, we were inspired to investigate their application in our own IBBR practice. Because of puckering and local ischemic effect, traditional suture fixation was found to be an inadequate approach to PTC for our breast reconstructions.

Most recently, we developed a novel technique for progressive tension mastectomy flap stabilization using bioabsorbable barbed ribbon devices (BRDs). Barbed ribbon devices are classically used in brow lift procedures and other procedures requiring soft tissue anchoring.[22–26] They are composed of polylactic-*co*-glycolic acid; they are resorbable and flexible (Fig. 1). Angled tines hook tissue without encircling potential vasculature. For the BRD used in our study, tines measure 2.5 mm in length (compared with 3–3.5 mm typically used in brow lift).[22,23] Although not specifically intended to prevent seroma, the barbs of the device are oriented to oppose gravitational forces and prevent forehead flap descent or motion. In brow lift, scar forms as the barbed ribbon is absorbed and the immediate, operative result is maintained in the long term.[27] We sensed that we could apply BRDs for PTC in IBBR, with the goal of flap stabilization and seroma prevention. We theorized that seroma would be reduced when mastectomy flaps and ADM were optimally affixed. Barbed ribbon would be advantageous over more traditional methods of PTC (ie, suturing abdominoplasty flaps) in that ischemia and puckering associated with stitches would be completely avoided.

Herein, we demonstrate a significant decrease in seroma formation and drain duration using BRD-PTC as compared with controls treated without BRD-PTC.

## MATERIALS AND METHODS

In accordance with ethical standards of clinical research, this study was performed with institutional review board approval from the University of Tennessee College of Medicine Chattanooga.

### Study Design

We report a retrospective review of all patients who underwent IBBR by a single surgeon at a breast reconstruction center. Eligible treatment group patients included all those treated with PTC by bioabsorbable BRDs (EndotinE Ribbon; MicroAire Surgical Instruments, Charlottesville, VA). Patient demographics, operative characteristics,

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**FIGURE 1.** Photograph of bioabsorbable BRD illustrating flexibility and tine dimensions.

**FIGURE 2.** Preoperative marking for circumvertical mastectomy.

**FIGURE 3.** Tissue expander reconstruction of circumvertical mastectomy with ADM. Lateral flap falls away from midline.

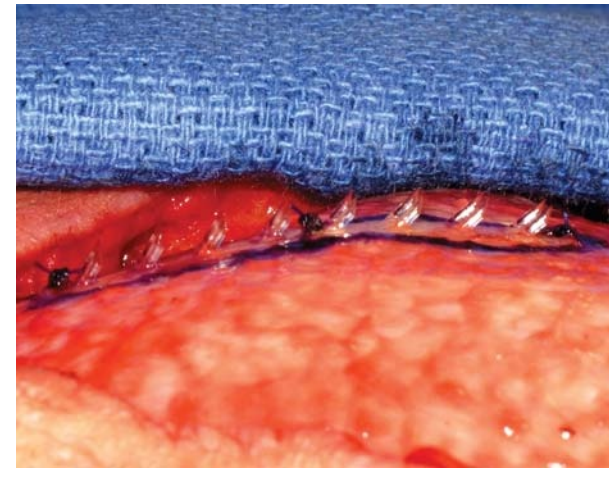

**FIGURE 4.** Barbed ribbon device is easily secured to ADM with 3 interrupted sutures.

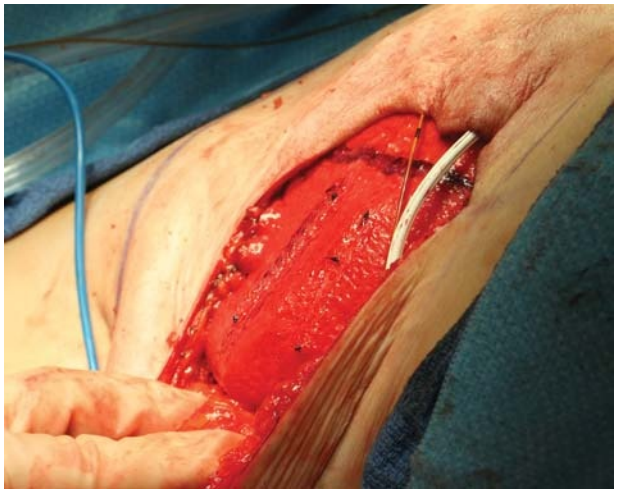

**FIGURE 5.** Tines are oriented to midsagittal axis of breast and placed 2 to 3 cm apart allowing for maximum adherence of mastectomy flap to underlying muscle and ADM.

and complications were recorded. Compiled data included smoking status, body mass index (BMI), implant loss, incidence of seroma, flap ischemia, and drainage requirement. Seroma was defined as a postoperative fluid collection requiring aspiration as per a previously published classification system from Brzezienski et al.[6] Consecutive patients who underwent IBBR immediately before the introduction of the BRD-PTC technique were selected as a control group.

## Surgical Technique

The general surgeon performs the mastectomy in our usual vertical technique (Fig. 2). Reconstruction is performed with a tissue expander placed beneath an ADM sling secured to the chest wall and pectoralis (Fig. 3). For each breast, 2 BRDs are cut in half with 2 pieces oriented to stabilize the medial portion of the mastectomy flap and 2 for the lateral. The pieces are placed a few centimeters apart in a transverse orientation and sewn to the ADM (Fig. 4). The tines of the 4 BRDs face the midsagittal axis of their respective breast to prevent flap movement from its desired position on the ADM (Fig. 5).

Once the BRDs are in place, the mastectomy flap edges are brought to midline and the deep layer is allowed to settle onto the tines. This design allows the surgeon to position (and reposition) an entire mastectomy flap in one movement (Supplemental Video 1, http://links.lww.com/SAP/A243). The flaps are then redraped, as needed, until the desired contour and scar position are achieved (Figs. 6 and 7). Before placing any sutures, the flaps are apposed to the ADM in a secure, "progressive tension" fashion. Dead space between the flaps

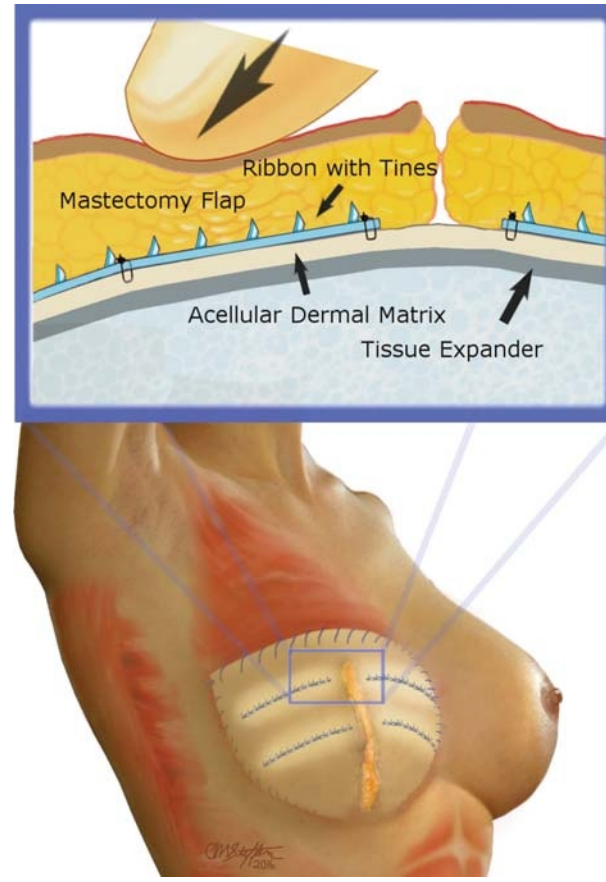


**FIGURE 7.** Final mastectomy flap progressive-tension stabilization to ADM with BRDs. Tines from opposing ribbons are oriented to midsagittal breast. Flap is secure in "progressive-tension" fashion without puckering, contour deformity, or flap ischemia. Drains are placed per routine and incision is closed in a typical fashion.

and ADM is eliminated. Intraoperative problems with ischemia and the contour irregularities of tacking sutures are eliminated. To allow for sufficient soft tissue recovery and scar maturation, a minimum of 3 months is allowed before implant exchange.

## Statistical Analysis

$\chi^2$ Analysis was used to compare categorical data, and odds ratios, Fisher exact, and Student *t* tests were used to quantify differences

**FIGURE 6.** Lateral breast flap falls away from midsagittal breast axis before securement (left). Flap closed in a progressive tension fashion with BRDs before placement of any sutures (right).

**TABLE 1.** Patient Characteristics

| | Study Group | Control Group | *P* |
|---|---|---|---|
| Age, y | 54.6 ± 11.7 | 49.8 ± 9.7 | 0.1 |
| BMI, kg/m$^2$ | 26.5 ± 3.8 | 24.7 ± 3.8 | 0.1 |
| Tobacco use | 6 (27.3%) | 5 (13.9%) | 0.2 |

**TABLE 2.** Treatment Outcomes

| | Study Group | Control Group | *P* |
|---|---|---|---|
| Ischemia | 8 (22.2%) | 10 (17.9%) | 0.54 |
| Drain days | 17.3 ± 3.4 | 22.4 ± 7.5 | 0.006 |
| Seroma | 0 (0%) | 11 (19.6%) | 0.005 |

in continuous variables. Levene test was used to assess the homogeneity of the variance between groups. Statistical significance was assumed at an $\alpha$ value of 0.05, and all analyses were run using SPSS Version 21 (IBM Corp, Armonk, NY).

## RESULTS

Thirty-six breast reconstructions in 22 patients were performed using BRDs for PTC. In the control group, there were 53 breast reconstructions in 36 patients. The 2 groups were statistically similar in tobacco use, age, and BMI (Table 1). Clinically significant flap ischemia was similar between the 2 groups, with 8 (22.2%) occurrences in the PTC group and 10 (17.9%) in the control group ($P = 0.54$). Closed suction drains were in place for an average of 22.4 days for the control group and 17.3 days for the PTC group, a significant difference with an average decrease of 5.1 days in the PTC group ($P = 0.006$). The senior surgeon's criterion for drain removal was a drain output of less than 20 mL per 24 hours, which was the same for both groups. We detected 11 seromas (19.6%) in the control group. There were no seromas (0%) in the PTC group ($P = 0.05$; Table 2). Tines were palpable in right and left mastectomy flaps (5.5%) of a single patient (4.5%). This patient's flaps were particularly thin; however, the tines were eventually reabsorbed and the problem was resolved. In this patient, prominent tines were associated with no additional adverse outcomes (eg, endotine extrusion, flap ischemia, etc).

No implant losses or infections were observed in either group. Of note, there were no implant exposures, postoperative bleeds, or significant contour irregularities (ie, dimpling) observed in the PTC group.

## DISCUSSION

This is the first study to examine the effect of progressive tension stabilization on incidence of seroma in IBBR. Seromas are an important problem in implant-based breast reconstruction, and our hypothesis spoke to the need for better solutions. Seroma management contributes to significant morbidity for the patient and can lead to implant loss.[6,19,28] To date in IBBR, closed suction drains have been the mainstay of seroma management/prevention, but they are cumbersome, poorly tolerated, and a potential source of infection.[28–31] Progressive tension closure is a classic technique with a recently renewed excitement for its use in seroma reduction and decreased need for drains.[4,10,14,20,32] In our patients, the previously published methods of PTC (suture fixation) were unsuitable for IBBR because of the inherent problems of suturing mastectomy flaps (ie, puckering and ischemia). Clinically, puckering was not observed in our patients and we demonstrated no difference in ischemia relative to the controls.

Thin flaps are always a concern for the reconstructive surgeon, and this was certainly a consideration in using a device with tines. In brow lift, where flaps are uniformly thin, tines are occasionally palpable, but this typically resolves with time and without complication.[23] In brow-lift BRDs, tines typically measure 3 to 3.5 mm.[22,23] By contrast, tines of our BRDs are shorter, measuring 2.5 mm. In our study, a single patient with thin flaps had palpable tines; however, the problem spontaneously resolved as the tines reabsorbed. There were no further complications.

Beyond its statistical significance, our dramatic reduction in seroma is an important clinical finding. Perhaps we should be less surprised? The effectiveness of PTC in reducing seroma in our series parallels the results of similar techniques in abdominoplasty and other procedures.[15,16] Therefore, we are encouraged about the general applicability of our results to other techniques of reconstruction (eg, nipple sparing). As is seen in other PTC studies, our study results also demonstrate an improvement in drain duration.[15–17] We remained relatively conservative in drain management with the BRD-PTC group, but drains were removed an average of 5 days sooner compared with controls. As our comfort has increased with BRD-PTC, we continue to reduce drain duration. Randomized studies of larger groups could increase the validity of our preliminary results.

Limitations of our study include its retrospective nature and relatively small sample size. Another potential drawback is the subjective nature of seroma classification. We used a previously published classification system[6] to provide consistency and reproducibility to our measurements. Additionally limiting is the fact that mastectomy and IBBR are approached with many distinct surgical techniques. With these variations, we expect that the relative success of BRD-PTC may change. A final drawback is the added cost of the BRDs to reconstruction. Although this may be offset by reduction in the costs of seroma management, our study was not designed to answer this question.

## CONCLUSIONS

In this moderately sized retrospective review, BRD-PTC is shown to dramatically reduce seroma incidence and the need for closed suction drains in IBBR. There are plausible scientific explanations as to why this is the case. Our novel technical execution is tailored to mastectomy flap stabilization but is intended to parallel other methods of PTC. Incidence of mastectomy flap ischemia is unchanged from controls. Generalizability, cost effectiveness, and our perception of improved contour are avenues for further study.

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