

Breast Tissue Preservation

A Paradigm Shift in Aesthetic Breast Surgery

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KEY WORDS

- Breast augmentation • Minimally invasive • Tissue preservation

KEY POINTS

- Breast tissue preservation prioritizes cellular, structural, functional, and dynamic integrity of the breast.
- A minimally invasive technique that preserves essential ligamentous and fascial structures.
- A surgical approach that avoids the use of electrocautery and its related thermal injury.
- Novel surgical concepts improve implant integration and aesthetics.
- Clinical evidence supports reduced device-related and technique-related complications, faster recovery, stable long-term outcomes, and high patient satisfaction.

 Video content accompanies this article at <http://www.plasticsurgery.theclinics.com>.

INTRODUCTION

The demand for aesthetic breast enhancement has evolved significantly in recent years, reflecting the values and expectations of modern, health-conscious patients, who increasingly prioritize overall well-being, minimal downtime, and safe and natural-looking results, as much as volume enhancement.¹ Although breast augmentation remains one of the most commonly performed aesthetic procedures worldwide,² conventional techniques are often associated with drawbacks such as soft tissue trauma, artificial feel and appearance, and extended postoperative downtime. These factors may limit the appeal of standard approaches for a broader patient population.

Breast tissue preservation (BTP) introduces a patient-centered, biologically respectful surgical philosophy that emphasizes a minimalistic surgical approach and anatomic integrity. This article

outlines the principles of BTP, its anatomic and physiologic foundations, and surgical indications.

DEFINITION

BTP is an advanced surgical concept that represents a transformative advancement in aesthetic breast surgery. Whereas conventional augmentation techniques have typically focused on increasing volume and reshaping the breast, they can often disrupt the baseline tissue integrity. BTP is founded on a conceptual framework that prioritizes identifying the patient's native anatomy, employing a surgical approach designed to maintain the structural and functional integrity of breast tissue through minimally invasive and atraumatic methods.

At its core, BTP seeks to minimize surgical disruption using specialized minimal invasive instrumentation, precise 3-dimensional (3D) planning, and preservation of natural tissue planes.

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Abbreviations

3D	3-dimensional
BTP	breast tissue preservation
BVD	breast volume distribution
CML	circummammary ligament
FBR	foreign body response
IB	inflatable balloon
IMF	inframammary fold
NAC	nipple areola complex
PMM	pectoralis major muscle
TLA	tumescent local anesthesia

THE 4 LEVELS OF BREAST TISSUE PRESERVATION**Cellular Level**

At the cellular level, BTP focuses not only on minimizing trauma but also on actively preserving the biological integrity of native breast tissue by modulating the foreign body response (FBR) during and after surgery. Together, the BTP surgical approach and the selection of implants with a low-inflammatory surface topography foster an environment that facilitates the formation of a stable tissue envelope composed of preserved ligament structures and a low-fibrotic, uniform periprosthetic capsule. This, in turn, contributes to lasting tissue softness and reliable implant integration.

Regarding implant surface topography, research has shown that implants with a 4-micron surface elicit the lowest inflammatory response when compared to traditional smooth, microtextured, and macrotextured surfaces (Fig. 1). This topography was specifically designed to enhance biocompatibility and minimize tissue disruption by suppressing the FBR and fibrosis by the presence of higher levels of immunosuppressive FOXP3 + regulatory T cells.³

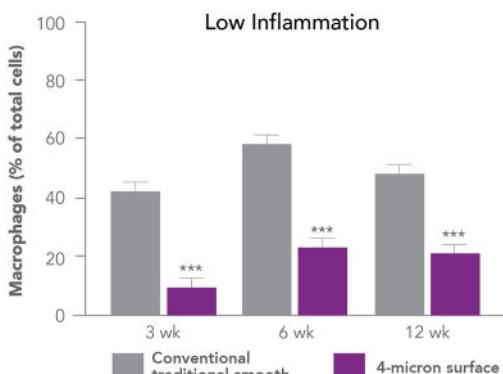


Fig. 1. Composition of immune infiltrate in capsules surrounding conventional smooth and 4-micron surface implants. *** $P<.001$. (Adapted from Doloff et al, 2020; with permission.)

This unique behavior matches the clinical evidence with low capsular contracture rates regardless of implant placement behind or above the pectoralis major muscle (PMM), exemplifying the first level of tissue preservation by establishing a biologically stable interface that supports implant softness and integration over time.

Structural Level

At the structural level, BTP emphasizes preserving the breast's native anatomic framework. This approach respects the integrity of the fascial and ligamentous networks, which play a critical role in maintaining long-term stability and optimal implant positioning.

The posterior extensions of Cooper's ligaments connect with the circummammary ligament (CML), a dense fibrous ring that surrounds the corpus mammae and provides structural support along its perimeter.⁴ This ligamentous ring anchors the breast to the chest wall and delineates a natural boundary between the superficial and deep fascial layers, thereby preserving vascular and lymphatic integrity and facilitating the even distribution of mechanical forces across the breast and chest wall (Fig. 2).⁵

In addition, placing the implant in a prepectoral pocket preserves the PMM, helping to maintain the chest and upper arm function while minimizing the risk of complications such as animation deformity.⁶

Despite the 4-micron implant surface not promoting tissue ingrowth and the use of a prepectoral placement, a prospective 100-patient IRB-approved study of breast enhancement using a BTP technique reported a 0% incidence of inferior malposition rates at 3 years.⁷ This underscores the significance of preserving the breast's supportive structures and leveraging the precision of the BTP tools and methods.

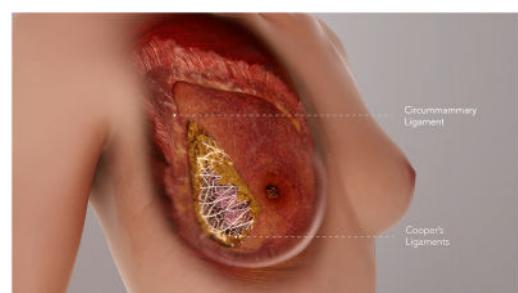


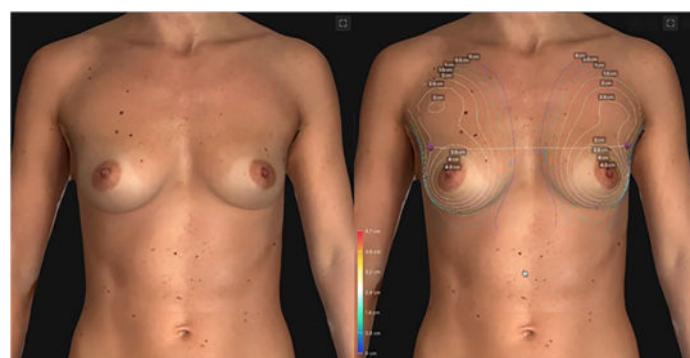
Fig. 2. 3D rendering illustrating the CML delineating the boundary of the breast, with Cooper's ligaments as a supportive structural network. (From Establishment Labs; with permission.)

Dynamic Level

Whereas the structural level defines the breast's anatomic footprint, the dynamic level relates to its spatial projection and behavior in motion, represented through Preexisting Breast Volume and Projection. These parameters shape how the breast appears in profile and frontal view, responds to gravity and movement, and maintains a natural aesthetic. Understanding this dynamic level requires more than measuring overall volume; it requires understanding breast volume distribution (BVD).⁸

To assess and plan augmentation dynamically, the BTP approach uses the concept of Breast Topography, a mapping system that visualizes BVD across the thorax. This tool identifies natural areas of prominence and deficiency, enabling precise implant placement within the preserved tissue envelope. A key landmark within this mapping is the *M Line*, a horizontal line positioned 1–1.5 cm above the superior border of the areola. This line represents the apparent transition zone between the chest wall and the projecting breast mound, serving both as a surgical reference point and a communication aid for patient consultations. Integrated into the breast topography system (Fig. 3), the *M line* helps clarify that, in most patients, the primary volumetric deficiency is located in the upper pole, making it the first target for augmentation.

The second objective is to enhance medial cleavage, which is often compromised by lateral breast orientation, the natural slope of the thoracic cage, or low native volume. By simultaneously addressing upper pole restoration and medial projection, BTP achieves optimal aesthetic outcomes using minimal implant volume, preserving tissue quality while enhancing shape. The outcome of this dynamic concept is a lighter breast that is proportionate, stable with natural movement, and organically contoured, rather than heavy or overfilled with unnecessary breast implant volume.



Functional Level

The functional level of BTP focuses on preserving key physiologic systems essential to postoperative quality of life, including somatosensory innervation, musculoskeletal integrity, and the ability to resume daily activities without impairment.

Sensory preservation

Sensory integrity, particularly of the nipple areola complex (NAC), is a fundamental component of functional breast surgery. BTP techniques prioritize the protection of the fourth and fifth anterior intercostal nerve branches, which are primarily responsible for afferent innervation in this region.^{9,10} Incision placement along the inframammary fold (IMF), especially when slightly lateralized to the 5 and 7 o'clock positions, plays a significant role in protecting these nerves¹⁰ (Fig. 4A and B). Additionally, by adhering closely to native anatomic planes and avoiding thermal dissection, BTP reduces the risk of sensory compromise. Clinical follow-up data report no loss of NAC sensation, reinforcing the neuroprotective potential of this approach and underscoring its relevance to both functional outcomes and psychosocial well-being.⁷

Preservation of muscular anatomy and its function

Conventional submuscular implant placement often requires detachment or manipulation of the PMM, which has been associated with postoperative discomfort, animation deformity,¹¹ and delayed recovery.¹² BTP employs a prepectoral approach, thereby preserving the structural and functional integrity of the PMM. This technique minimizes complications commonly associated with submuscular disruption and helps maintain the mechanical function of the upper thoracic girdle, facilitating the postoperative course.

Fig. 3. Crisalix preoperative assessment, Breast Topography enabled. The image highlights areas of natural volumetric prominence and deficiency. The *M line*—a dotted line between the purple indicators.

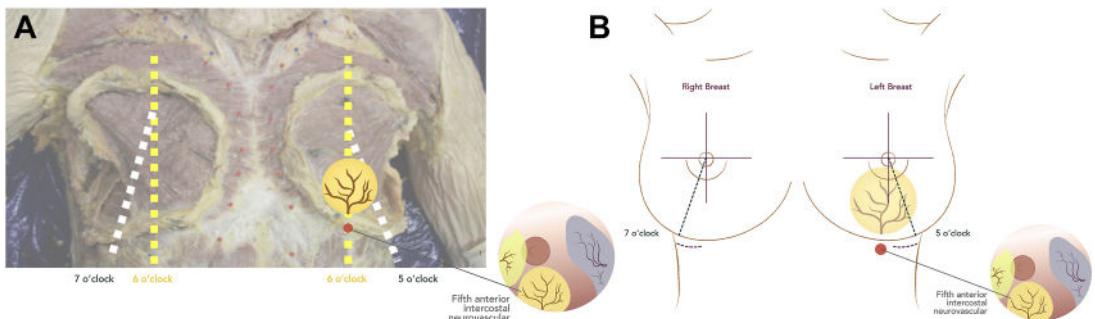


Fig. 4. (A and B) Lateralization of the IMF incision, preserving the NAC sensation through protection of the 5th anterior intercostal nerve. Anatomic (A) and graphical (B), with magnified view, illustrate the 5 and 7 o'clock positions. (From Establishment Labs; with permission.)

Preservation of lifestyle

The atraumatic nature of BTP, combined with preservation of neurovascular and musculoskeletal structures, enables an earlier recovery compared to conventional augmentation techniques. Patients can typically resume light daily activities within the first postoperative week, sometimes as early as immediately after surgery, with a gradual return to more strenuous tasks over 2 to 3 weeks, based on individual tolerance and clinical guidance. This is an improvement from previous fast recovery protocols, as it is a self-managed process in which the patient instinctively engages in daily activities at their own pace with minimal discomfort. This accelerated functional recovery does not compromise tissue integrity and reflects the lower inflammatory and mechanical burden inherent to this approach.

TECHNOLOGIES USED IN BREAST TISSUE PRESERVATION

The BTP approach utilizes a specialized set of technologies designed to preserve native anatomic structures through atraumatic dissection and precise implant placement. Together, these tools facilitate the creation of the BTP Space, a 3D anatomic plane that fosters implant integration while minimizing disruption to surrounding tissues (Fig. 5, Video 1).

Tunneling Technology

Tunneling is a minimally invasive technique used to access the implant pocket through a narrow anatomic corridor, typically originating from either the axillary crease or the IMF. A 2 cm diameter tunnel is created with a specialized instrument with a tip that navigates atraumatically and precisely through the CML at 1 cm above the PMM fascia, and toward the posterior aspect of the breast gland. This space is located directly behind the

pseudocapsule of the corpus mammae and within the posterior lamellar fat of the superficial fascia (Video 2).^{4,5}

Importantly, this trajectory respects the boundaries of the CML and preserves both Cooper's ligaments and deep fascial layers. This preservation enables controlled, consistent tunneling through tissue planes, facilitating precise medial and lateral pocket definition while minimizing mechanical trauma.

Inflatable Balloon System

Following tunneling, an inflatable balloon (IB) with an integrated handle to support controlled expansion is introduced deflated and then incrementally inflated to achieve mechanical elongation of tissue planes and hemostasis, rather than disruption by blunt or sharp dissection. This system allows for radial expansion that respects the fascial and ligamentous architecture of the breast (Video 3). The diameter and geometry of this balloon create a 3D space with equivalent dimensions to the implant that will be subsequently placed for a tight, controlled pocket within the boundaries of the CML. This approach contrasts with pocket creation using electrocautery, which may lead to complications such as devitalization of breast tissue, disruption of sensory nerves causing pain, inadequate hemostasis, and thermal tissue damage to skin flaps.¹³ Additionally, pocket creation using diathermia or manual techniques is highly dependent on the surgeon's skills and patient tissue characteristics, often resulting in unprecise and uncontrolled pocket dissection.

This controlled balloon elongation technique preserves neurovascular integrity and prevents over-dissection, supporting long-term implant stability and sensory function. The resulting pocket enables natural implant movement within a preserved tissue matrix, promoting dynamic nesting,

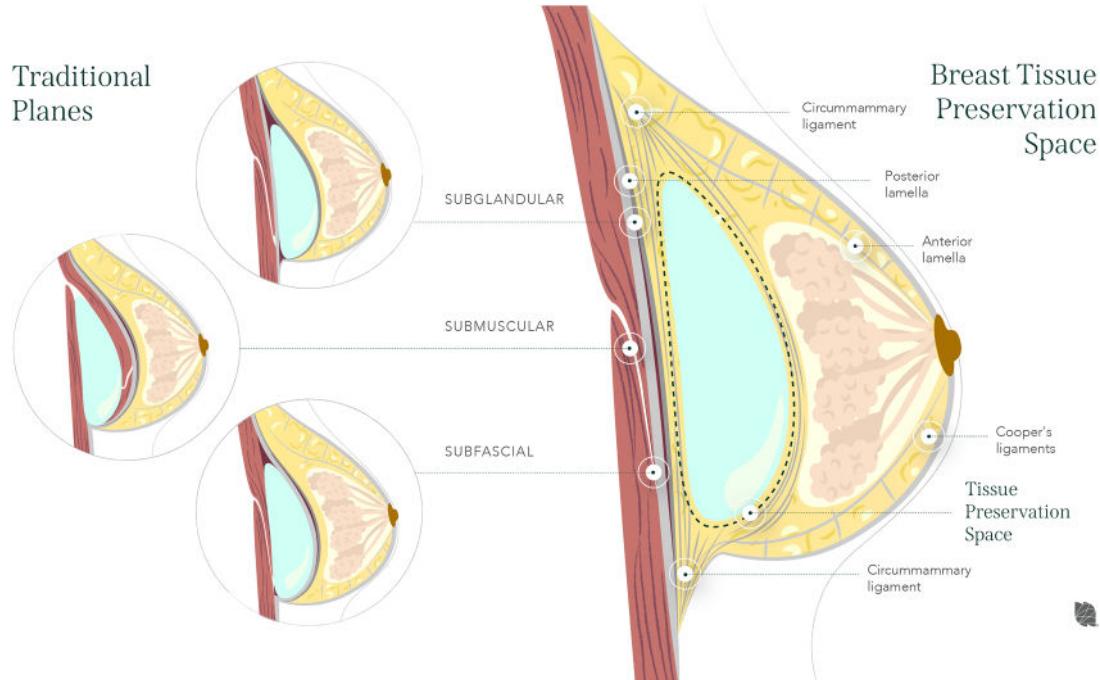


Fig. 5. Graphical representation of the 3D BTP Space, accompanied by a comparison with conventional bidimensional subglandular, subfascial, and submuscular planes. (From Establishment Labs; with permission.)

sustained softness, and predictable positioning through reinforced fibroglandular support and parenchymal enclosure.

Implant Delivery System

Atraumatic and no-touch implant insertion technique is critical to maintaining tissue integrity and reducing contamination risk and postoperative complications.¹⁴ BTP uses sterile insertion systems to enable controlled implant placement through small incisions without excessive manipulation of the device or surrounding tissue. A funnel can be effectively used for IMF incisions to access BTP Space. In its most advanced version, implant insertion is performed using a validated pneumatic injector, ensuring safe delivery of the implant through the transaxillary incision along its long trajectory to the BTP Space. In addition, these tools further reduce frictional resistance during insertion, shorten operative time, and enhance procedural precision, leading to improved surgical efficiency.

Advanced Implant Design

As mentioned earlier, breast implants used in BTP are characterized by their low-inflammatory, 4-micron³ biocompatible surface properties that are best suited for prepectoral placement.⁷ This practice has demonstrated favorable outcomes

in minimizing the risk of capsular contracture^{15,16} and preserving long-term breast softness.

Beyond the surface topography, the implant composition plays a pivotal role in functional and aesthetic outcomes. Highly adaptive shells and cohesive gel constructions are engineered to mimic the viscoelastic behavior of the native breast tissue.¹⁷ Following ergonomic principles, its dynamic response to pressure allows the implant to move synchronously with the body, adapting to positional changes, while maintaining a natural breast contour.¹⁸ In the prepectoral plane, the combination of gel adaptability and shell flexibility within this type of implant supports tissue preservation and enables a soft result, minimizing implant rippling and enhancing patient comfort and satisfaction with minimal incisions.¹⁸

For the transaxillary approach using the pneumatic injector, a specially designed implant with lentiform geometry eliminates the risk of anterior or posterior malposition. Its projection-to-diameter ratio allows for a reduced implant volume while still achieving the desired increase in breast cup size.

BREAST TISSUE PRESERVATION LEARNINGS Nesting Concept

The nesting concept represents a fundamental evolution in breast surgery introduced through

the BTP approach. It redefines implant integration not as the insertion of a foreign volume into a surgically dissected space but as the biomechanically and biologically harmonious placement of an implant within a preserved, native tissue envelope.

Central to this concept is the use of the IB system, which allows for controlled multidirectional elongation of the tissue planes rather than disruption through blunt cutting or cautery. The balloon expands the pocket superiorly, medially, laterally, inferiorly, and anteriorly, creating a well-defined 3D space within the breast. This approach preserves critical structures, including the fascia, Cooper's ligaments, and neurovascular elements, and produces a pocket that adapts to the implant's geometry, which is referred to as the *nest*, demonstrated in MRI, **Fig. 6**.

The biological nest created by this method

- Provides intrinsic positional stability without reliance on muscular compression
- Preserves implant mobility and dynamic responsiveness
- Minimizes capsular formation due to reduced tissue trauma,³
- Enhances aesthetic softness and reduces implant palpability.¹⁸

Importantly, this BTP Space is adaptive rather than static, conforming to the implant's contour and consistency. The nest enables the use of smaller base-width implants while still achieving adequate projection and volume, supporting the principle of a softer and lighter augmented breast.

Breast Tissue Recruitment

Breast tissue recruitment is a core principle of BTP that emphasizes strategic anatomic native tissue utilization over prosthetic substitution. Rather than simply displacing tissue, it involves the repositioning and mobilization of undervalued native breast tissue based on a deeper

understanding of breast topography and volumetric distribution.

Conventional approaches often fail to account for the tissue present in the upper breast, especially the area between the *M Line* and the superior border of the *CML*, leading to an overreliance on implant volume to achieve shape.⁸ This region contains structurally functional tissue that is often overlooked during augmentation planning and surgical implant placement. With the development of breast topography, this neglected volume was quantified and found to contribute up to 30% of the total breast volume (**Fig. 7**).

By recruiting this undervalued tissue, BTP enables

- Implant right-sizing to the anatomic boundaries
- Preservation of the natural IMF
- Optimization of natural outcomes through anatomic efficiency

This repositioned volume contributes to improved upper pole fullness and better implant coverage, enhancing aesthetic outcomes without increasing the surgical footprint. Breast tissue recruitment allows the surgeon to reshape from within, maximizing endogenous volume rather than replacing it, and supporting the broader principle of natural augmentation with minimal intervention.

Tent Effect

The Tent Effect refers to the geometric contribution of implant design to vertical projection and central volume, independent of lateral expansion or increased device size. In the context of BTP, the Tent Effect allows surgeons to achieve vertical lift and upper pole enhancement without compromising the preserved anatomy or increasing incision size.

This effect is optimally achieved using implants that feature specific design characteristics that

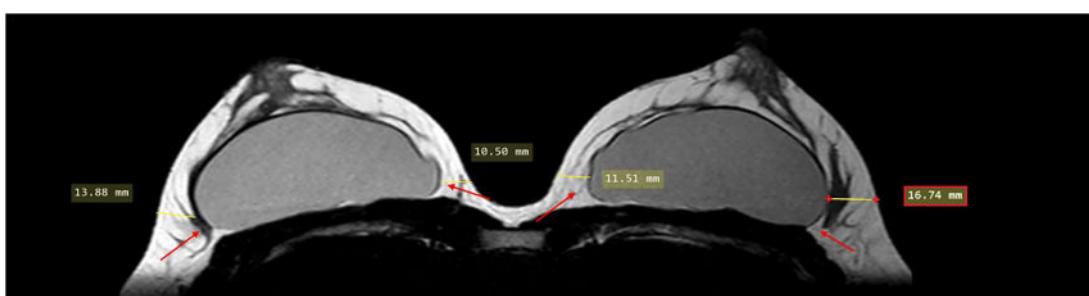
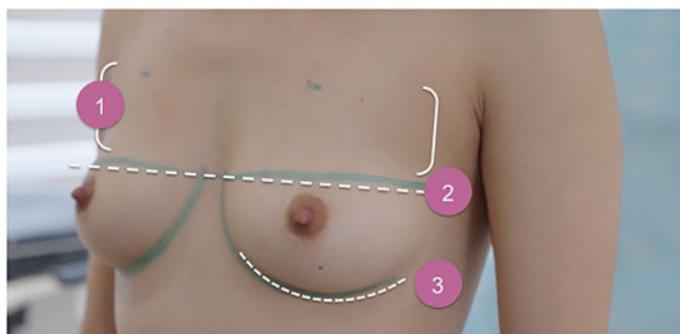


Fig. 6. T2 axial MRI of Motiva SmoothSilk Ergonomix2 Diamond Implants (Mini projection, 140 cc) confirming the preserved surrounding breast tissues (red arrows).



1 Undervalued breast tissue 2 "M" line 3 IMF

concentrate volume centrally while maintaining tapered lateral margins.

Key outcomes associated with the Tent Effect include

- Increased central projection with minimal lateral spread
- Enhanced upper pole and medial fullness, contributing to cleavage enhancement
- Selection of implants with lower volume, reducing strain on the inferior pole and IMF
- Improved volumetric distribution that conforms to the preserved anatomic envelope

This geometric strategy is synergistic with the nesting concept, as it enables implants to settle naturally into the adaptive pocket created through balloon-based elongation. The result is a refined, natural contour that requires less silicone volume to achieve a high-quality aesthetic outcome.

Implant Positioning

Implant positioning in the context of BTP is governed by anatomic adaptation rather than forced dissection, complicated technical maneuvers, or artificial fixation through implant texturing that can be associated with rare lymphoproliferative diseases, such as breast implant associated anaplastic large cell lymphoma (BIA-ALCL). The nesting effect and multidirectional tissue elongation create a biologically compliant pocket, into which the implant settles with predictable spatial orientation.

A consistent observation in BTP cases is that implants tend to assume a position approximately 1 cm higher than in conventional augmentation techniques (Figs. 8 and 9A and B). This elevated positioning allows recruitment of upper pole tissue,

Fig. 7. Definition of the superior undervalued breast tissue (1), corresponding to the area between the *M* Line (2) and the superior border of the CML (green dot).

specifically between the *M* Line and the CML, enhancing both projection and soft tissue coverage.

This positioning strategy yields several important surgical advantages:

- Optimal and selective pocket positioning and implant placement, matching volumetric deficiency
- Reduced base width due to enhanced medial and lateral tissue support
- A narrower, more projected breast contour with reduced lateral spillage that can negatively affect the proportions of the upper thorax
- Less volume directed to the lower pole, which in most cases naturally possesses greater native tissue mass

This approach results in anatomically precise augmentation. The implant is not merely filling a void but is guided into a space that reflects the breast's native architecture and topographic arrangement.

PROCEDURES

Breast Tissue Preservation in Transaxillary Approach

This procedure, also known as Mia Femtech, is a minimally invasive breast harmonization technique designed for patients seeking subtle enhancement of 1 to 2 bra cups with minimal recovery time.¹⁹ It integrates the BTP principles, leveraging proprietary tools that minimize trauma and maximize anatomic respect.

Key Features

- Outpatient procedure under local anesthesia with or without light sedation
- No incisions in the breast, single entry point via a 2.5–3 cm transaxillary incision

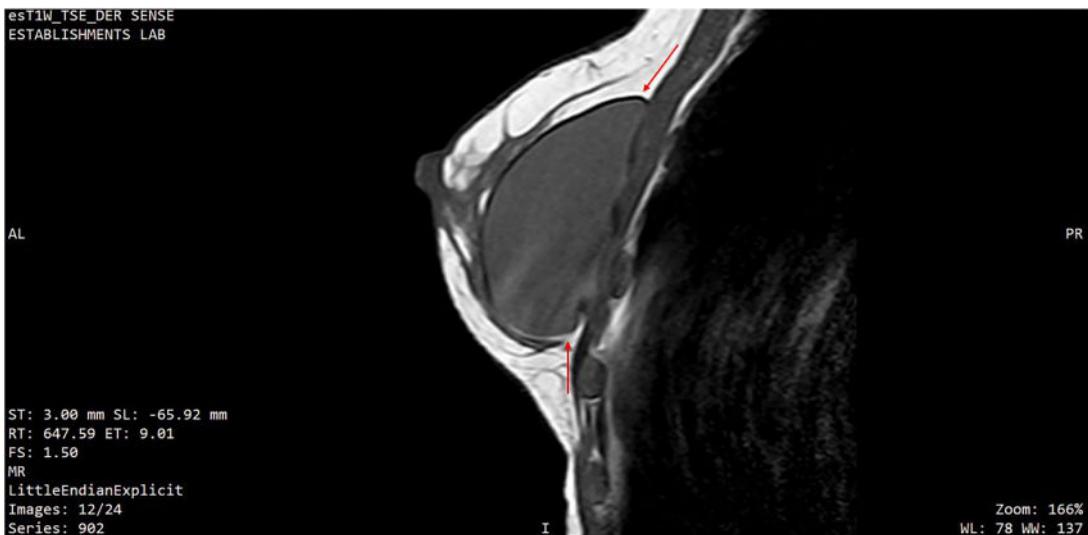


Fig. 8. T1 sagittal MRI of Motiva SmoothSilk Ergonomix2 Diamond Implant (Mini projection, 140 cc) demonstrating the tenting effect (indicated by red arrows).

- Fast recovery: patients typically return to daily activities 24–48 hours

Step-by-Step Overview (existing technologies) (Video 4):

1. Preoperative Planning: Assessment of breast topography and identification of the *M line* to guide volume distribution and implant positioning.
2. Tumescent Local Anesthesia (TLA) Infiltration: A modified Klein solution is prepared and delivered under ultrasound guidance to achieve anesthesia, hydrodissection, and vasoconstriction

within BTP Space. Total volume per breast ranges from 120 and 150 cc.

3. Tunneling: A prepectoral tunnel is created from a transaxillary crease toward the inferomedial breast pole using the Motiva Channel Separator.
4. Pocket creation: The Motiva IB is used to elongate tissue planes, thereby forming a preserved 3D pocket without blunt or sharp dissection.
5. Implant Delivery: The implant is injected using the Motiva Injector for minimal manipulation.
6. Implant selection: The Motiva SmoothSilk Ergonomix2 Diamond silicone-gel filled breast implant is used. It features a lentiform geometry



Fig. 9. (A and B) Sagittal MRI comparing a conventional breast augmentation (A), positioned 4.91 mm above the IMF, with a Mia Femtech breast enhancement (B) positioned 12.43 mm above the IMF.

for consistent projection regardless of implant orientation. Available in low, medium, high, and extrahigh projections with volumes ranging between 95 and 195 cc.

- Closure and Recovery: Skin is closed using a single intradermal suture. No drains are required, and patients have an immediate return to their daily routine and a gradual return to exercise.

Breast Tissue Preservation Through the Inframammary Fold

This technique, also known as Preservé, is a less invasive BTP procedure designed for a broader augmentation of patients, specifically for those seeking enhanced volume while maintaining tissue preservation.²⁰

Key Features.

- Performed under local with sedation or general anesthesia, depending on the surgical plan
- Accommodates a wider range of anatomic variations in routine augmentation procedures up to 4 cups
- Single entry point through a 2.5–3 cm IMF incision
- Fast recovery: patients typically return to daily activities within 1 week
- Enables enhanced control over volume distribution and breast contour shaping, compatible with a hybrid approach

Step-by-Step Overview (existing technologies) (see [Video 4](#)):

- Preoperative Planning: Breast topography analysis is used to identify tissue deficiency zones. Implant selection is guided by native anatomic boundaries (eg, CML), implant height, and projection characteristics.
- TLA Infiltration: Same as transaxillary approach.
- Tunneling: A prepectoral tunnel is created via a 2.5 to 3 cm IMF incision using the Motiva channel separator.
- Pocket creation: The Motiva Inflatable Balloon is used for atraumatic tissue expansion and 3D pocket creation.
- Implant Placement: The implant is introduced using the Motiva Insertion Sleeve.
- Implant selection: The Motiva SmoothSilk Ergonomix2 silicone-gel filled breast implant is used. Available in low, medium, and high projections with volumes ranging between 95 and 330 cc.
- Closure and recovery: Skin is closed using a single intradermal suture. No drains are

required, and patients have a quick return to daily activities.

CLINICAL OUTCOMES

Evidence supporting the BTP concept is demonstrated by data from the Mia Femtech prospective study⁷ of 100 consecutive patients, which evaluated outcomes of its minimally invasive breast harmonization technique. The study reported a low device-related and technique-related complication rate of 3.2%, with no nipple or breast skin sensory loss at 3-year follow-up, underscoring the potential of BTP to deliver clinical safety.

BREAST TISSUE PRESERVATION LIMITATIONS

Patients with a history of prepectoral implants, dual plane procedures, poor-quality breast tissue, severe ptosis, unstable weight, or significant health conditions may not be ideal candidates for the BTP breast procedure. BTP is best suited for individuals with stable body composition and sufficient natural breast tissue seeking subtle, natural-looking enhancements. Certain anatomic variations may require modifications to the standard approach—for example, combining BTP with an advanced mastopexy technique in cases of grade III ptosis, or using internal reinforcement (such as mesh or acellular dermal matrix [ADM]) in patients with thin or weakened ligamentous support.

SUMMARY

BTP represents a paradigm shift in aesthetic breast surgery, prioritizing anatomic conservation, functional integrity, and biologically harmonious outcomes over volume-centric augmentation. Central to the BTP philosophy is the use of less-invasive and minimally invasive technology-assisted techniques, including atraumatic tunneling, controlled balloon-based tissue elongation, and advanced implant designs, all of which support soft tissue preservation and refined implant integration.

The BTP approach is structured across 4 key levels: cellular, structural, dynamic, and functional. Each level addresses a distinct aspect of tissue integrity, from immunomodulation and fascial preservation to dynamic contouring and postoperative recovery. Innovations such as the nesting concept, breast tissue recruitment, the tent effect, and anatomically selective implant positioning collectively redefine the relationship between implant, tissue, and patient outcomes.

By respecting native anatomic planes and leveraging underutilized breast volume with smaller implants, BTP enables surgeons to achieve a

stable, soft, and natural augmentation. As patient expectations continue to evolve toward minimally invasive, biologically respectful solutions, BTP offers a clinically validated and future-oriented framework for aesthetic breast surgery.

CLINICS CARE POINTS

- Preserve native fascial and ligamentous structures by using atraumatic tunneling and balloon-based pocket creation to reduce trauma and improve implant stability.
- Slight lateralization of the IMF incision (5–7 o'clock) protects the 4th–5th intercostal nerves and preserves NAC sensation.
- Use breast topography to identify true volumetric deficiencies—especially upper pole deficit—to guide selective implant positioning and avoid unnecessary volume.
- Choose low-inflammatory 4-micron Smooth-Silk® surfaces to reduce fibrosis and maintain long-term softness.
- Prepectoral placement with preserved pectoralis major function decreases pain, prevents animation deformity, and supports faster return to activity.
- Avoid over-dissection; a controlled, tight pocket is essential for nesting, superior implant positioning, and reduced malposition risk.

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DISCLOSURE

The author discloses a consultancy and equity interest in Establishment Labs. This consultancy involves the development of the BTP concept, related surgical procedures, and includes the role of Scientific Director for the BTP Programs.

SUPPLEMENTARY DATA

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.cps.2025.11.015>.

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