An Algorithm for Correction of Mild Tuberous Breast Deformity in Augmentation Mammaplasty: Camouflage or Correct?

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Abstract

Background: Tuberous breast deformity (TBD) is a common abnormality, particularly in patients presenting for breast augmentation. Failure to correct each regional abnormality, including the inframammary fold, lower pole deficiency, nipple-areola complex widening or herniation, or any degree of ptosis, will result in exaggeration of the deformity and a poor aesthetic outcome.

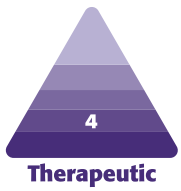
Objectives: To describe an algorithm, including novel techniques, to address each region of mild TBD in patients undergoing breast augmentation.

Methods: This is a retrospective review and description of the senior author's (K.T.) techniques for correction of early-stage TBD from 2016 to 2021.

Results: One hundred forty-two patients underwent a stepwise approach to correct milder TBD features when undergoing breast augmentation.

Conclusions: The authors propose a regional algorithm for management of TBD, to allow mostly single-stage correction, except in cases with marked ptosis, severe asymmetry, or marked macroareola.

Level of Evidence: 4



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Tuberous breast deformity (TBD) was first described by Rees and Ashton in 1976.[1] They identified that this complex breast asymmetry and deformity could not be corrected by standard augmentation. Two theories exist on the cause of this abnormality, one being that a constricting fibrous ring of superficial fascia, densest in the lower pole, inhibits the normal development of the breast. The second theory is that an adherence between the dermis and muscular plane restricts peripheral expansion of the breast. The abnormality presents in puberty when the developing breast cannot expand inferiorly, and tissue herniates through the nipple-areola complex.

The characteristics of TBD include varying degrees of parenchymal hypoplasia, breast base constriction with widened cleavage, inferior breast skin deficiency, superior malposition of the inframammary fold (IMF), areolar herniation, and asymmetry.[2] Particularly because the condition becomes evident at puberty, TBD leads to a poorer quality of life for the female patient and can have psychosocial implications. With the advent of social media, patients have become more aware of TBD, more sensitive to mild

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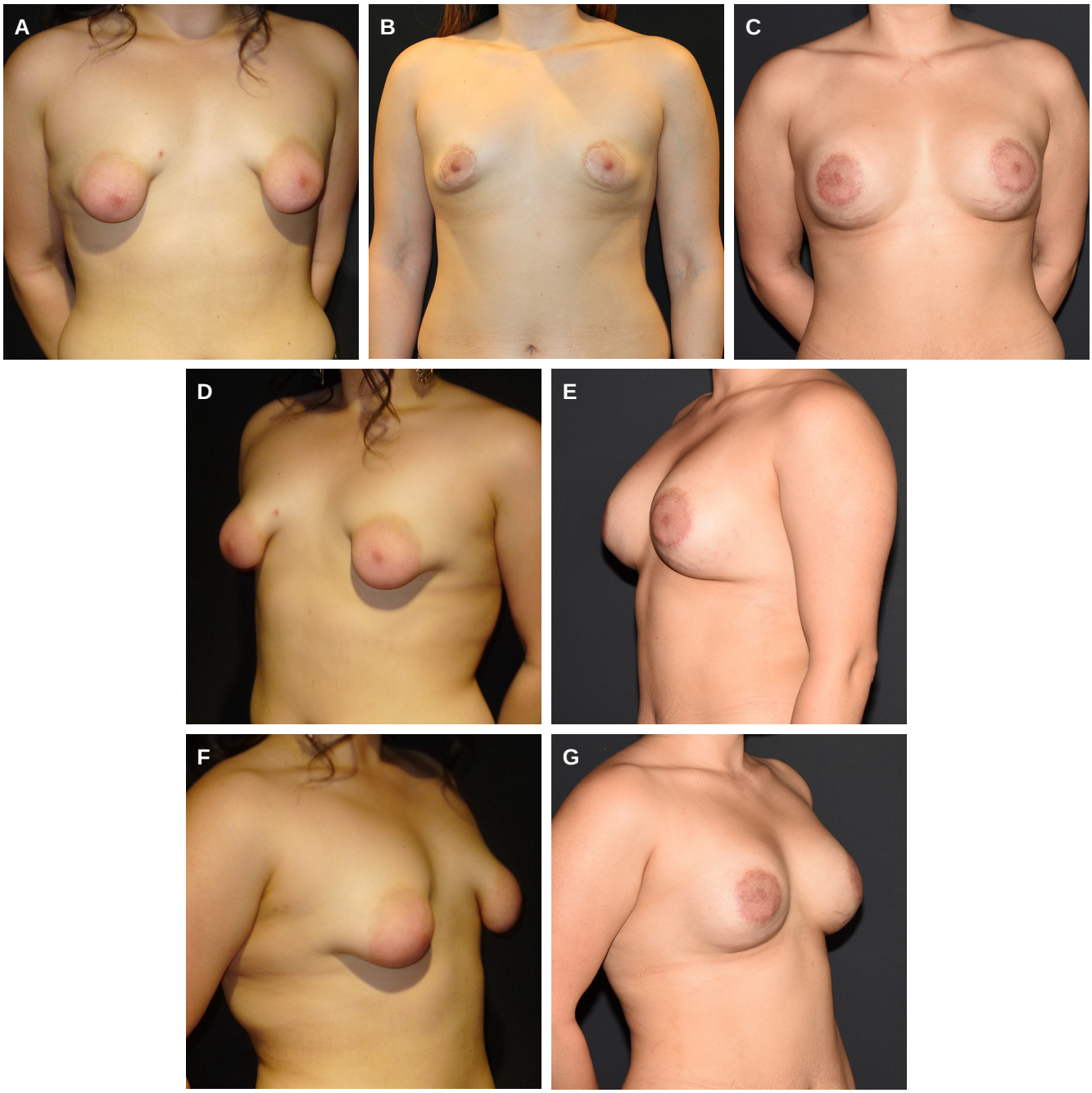

Figure 1. (A, D, F) Preoperative views of an 18-year-old female with severe macroareola planned for 2-stage correction, (B) 4-year postoperative view following stage 1 of correction with a vertical mastopexy, and (C, E, G) 12-month postoperative views following stage 2 of correction with subglandular 255-cc anatomical implants and fat grafting to the cleavage.

changes, and more likely to seek augmentation mammaplasty. These patients have high expectations of corrective surgery to reverse the deformity, with their main concerns usually being to obtain symmetry, cleavage, and less prominent, pointy areolas.

Von Heimburg first classified TBD in 1996 with 4 categories; type 1 being deficiency of the lower medial quadrant, type 2 being both lower poles with sufficient skin, type 3 both lower poles with insufficient skin, and type 4 whole breast hypoplasia.[3] Grolleau simplified this in 1999, combining types 2 and 3.[4] Although a number of classifications exist, the condition truly presents a spectrum of severity, and there may be subtle presentations and variations of each component of the deformity. The exact prevalence

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Table 1. Techniques for Management of Regional Tuberous Breast Deformities Based on Severity

Severity	Inframammary fold	Nipple-areola complex	Lower breast pole hypoplasia
Mild = camouflage	Effaces with arm elevation → fat graft	Popcorn + nanofat graft	Fat graft
Moderate = correct	Does not efface with arm elevation → effacement flap + nanofat graft	Macroareola + herniation → periareolar mastopexy Mild ptosis → vertical mastopexy	Tuberopexy flap

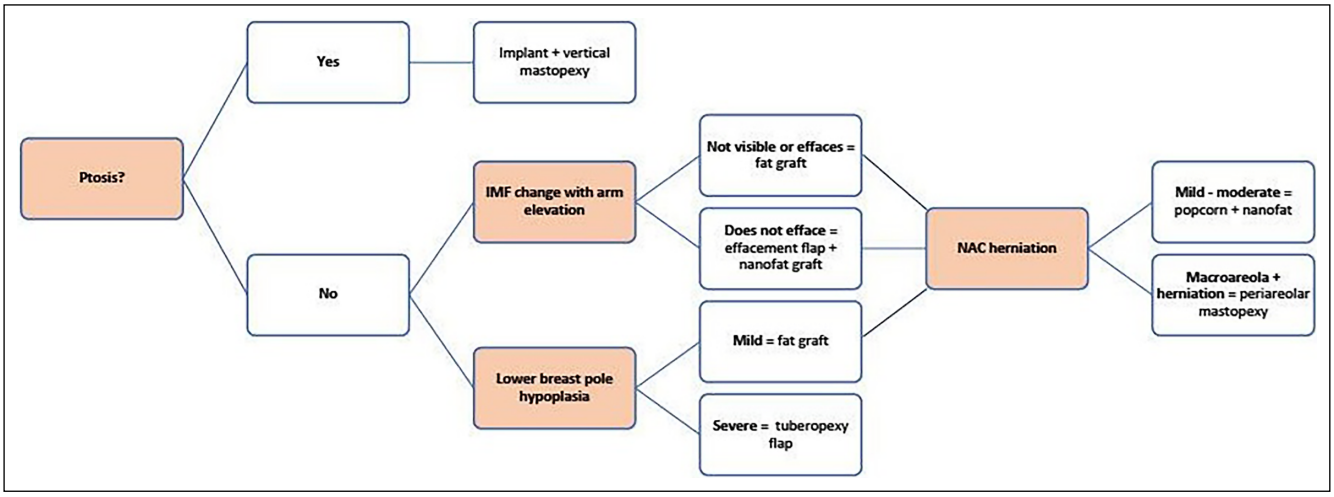

Figure 2. Algorithm for approaching tuberous breast deformity based on regional assessment. IMF, inframammary fold; NAC, nipple-areola complex.

of TBD is unclear; however up to 50% of female patients presenting for breast augmentation or reduction have a degree of the deformity.[5] This makes it important to identify and manage even mild forms of deformity to avoid exaggeration of any asymmetry. Each regional deformity needs to be treated respectively to optimize outcomes. We present the senior author's (K.T.) experience and a stepwise algorithm for managing regional abnormalities in milder tuberous breast deformity cases (Grolleau types 1 and 2), which can often be subtle in patients presenting for augmentation mammaplasty.

METHODS

This is a retrospective review of all patients with early-stage TBD who underwent augmentation by K.T. from January 2016 to January 2021. All patients who underwent single-stage correction of tuberous breast characteristics and augmentation were included. They were all managed with a regional approach to address the deformity. Data were collected, including demographics, operative details, and outcomes such as the need for revision, implant complications, infection, hematoma, and follow-up duration. Ethics approval was obtained from East Sydney Private Hospital medical advisory committee and written consent was obtained from all patients for procedures.

Assessment and Planning

Based on the severity of the TBD, 1- or 2-stage correction must be determined. Two-stage correction, with first-stage mastopexy and second-stage augmentation, was undertaken if there was marked glandular ptosis, moderate to severe asymmetry, or marked macroareola (Figure 1). Marked glandular ptosis risks implant malposition, recurrent ptosis, and waterfall deformity associated with correcting a heavy lower pole at the same time as placing an implant. Management of these more severe cases is not the focus of this paper.

Surgical decision-making in TBD patients for single-stage management needs to consider and carefully examine the patient for glandular ptosis, abnormalities of the IMF (length and indentation or effacement with arm elevation), lower breast pole volume, and nipple-areola complex (NAC) herniation. The severity dictates whether to camouflage, in mild cases, or completely correct, in moderate cases, the deformity of each anatomical region.

Mild deformities, with an IMF that effaces, or is not visible with arm elevation, mild NAC herniation, and mild lower pole hypoplasia can be managed with camouflage techniques. In these cases, the IMF incision is lowered, breast fascial bands are scored, the implant inserted, fat grafting performed to the lower pole, and NAC popcorning and nanofat grafting can be performed to the nipple.

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Figure 3. Fat grafting between old and new inframammary fold in a 19-year-old female whose fold was not visible or completely effaced with arm elevation.

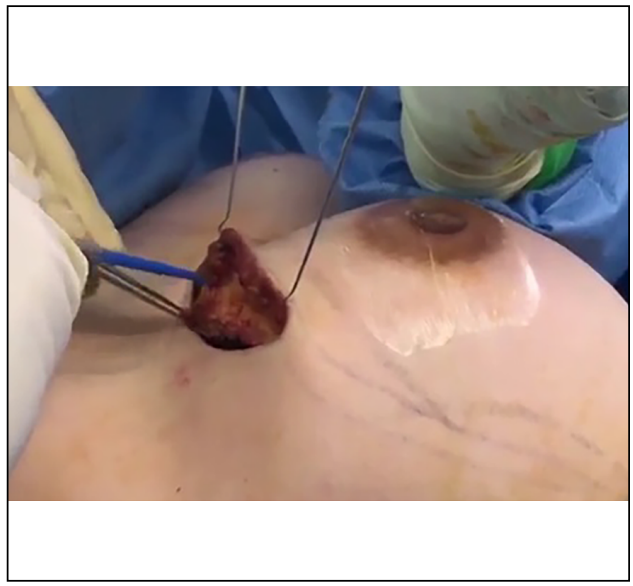

Figure 4. Inframammary fold effacement flap in a 20-year-old female whose fold did not efface with arm elevation.

Moderate deformities, with an IMF that is still visible with arm elevation, severe NAC herniation, and lower pole hypoplasia need correction. In these cases, the IMF is lowered, breast fascial bands are scored, a tuberopexy flap is performed to fill the lower pole, with periareolar mastopexy to manage the NAC.

Preoperative markings are performed in a standard, vertical standing position. Markings include the midline, interbreast distance, meridian breast lines, and the existing and new lowered IMF.

Implants

To allow for maximal lower pole expansion, our preference is to place the implant in a high dual-plane subpectoral pocket. In patients with skin flaps at least 3 cm thick and a well-indented IMF that does not efface with arm elevation, a subglandular pocket may be created. This reduces the chance of double bubble deformity and also allows better dissection and control of cleavage in these patients, who usually have wide cleavage. To correct the pathology of TBD, when creating the implant pocket the tight lower pole–constricting fascial bands need to be scored longitudinally to allow the gland to expand. Anatomical implants, from the Mentor microtextured CPG range (Mentor Worldwide LLC, Irvine, CA), are first preference, to best expand the lower pole.

Regional Deformity Management

Each regional deformity is analyzed and managed accordingly; because TBD exists on a spectrum there can often be variable combinations of abnormalities and techniques involved. Our approach and algorithm are described in Table 1 and Figure 2.

Inframammary Fold Manipulation

The new lower IMF position is usually marked for incision at 7.5 to 8.5 cm (±0.5 cm depending on skin thickness) from the nipple, depending on implant size. A 7.5-cm (±0.5 cm) nipple to IMF measurement is utilized for a less than 300-cc implant, adding 0.5 cm for every additional 50 cc up to 10 cm.

For cases with an IMF that is not visible or completely effaces with arm elevation, the old IMF can be camouflaged with fat grafting. Fat is usually harvested from bilateral medial thighs after infiltration with 100 mL of normal saline with 1 mg adrenaline 1:1000 and 100 mg ropivacaine (10 mL). Fat is harvested with a serrated liposuction cannula on luer-lock 10-mL syringes, usually 40 mL from each thigh. Fat is then centrifuged at 2000 rpm for 2 minutes before liquid and oil are discarded. Once an implant sizer is in place, usually 10 mL of fat is placed in each breast to fill the subcutaneous region between the old and new IMF (Figure 3). Additional fat can also be placed to fill the medial pole and create cleavage.

In cases with an IMF that does not efface with arm elevation, an IMF effacement flap is performed for the correction (Figure 4). From the IMF incision, once the implant is in place and before closing the pocket, a superiorly based 2-cm flap of subcutaneous tissue and fascia is separated from overlying skin to release the previous fold. This flap

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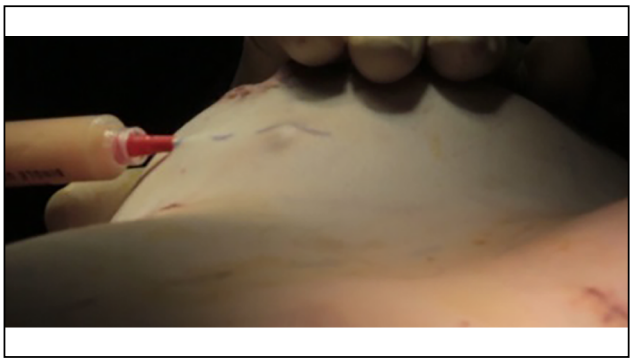
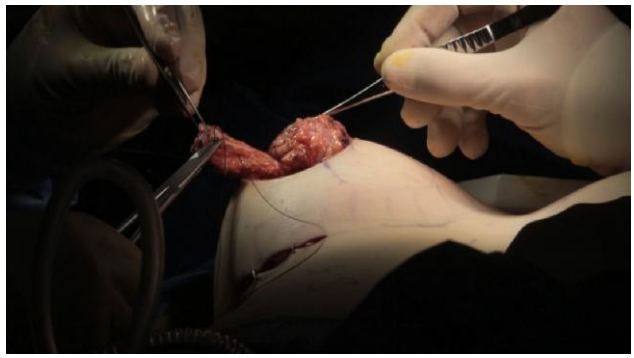


Figure 5. Nanofat grafting to previous inframammary fold indentation in a 19-year-old female.



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can then control and anchor the IMF to the chest wall with a 3-point suture when closing, with 3-0 polydioxanone.

To address any residual indentation from fascial adherence at the old IMF, intradermal injection of nanofat is performed. After fat harvest and centrifuge, nanofat is created by emulsification; shifting the fat between two 10-mL syringes connected to each other by a female-to-female luer-lock connector. Intradermal injection of nanofat is performed with an 18-gauge blunt-fill needle (1.2 mm × 40 mm). First, the needle is inserted intradermally for rigotomy, then on withdrawal fat is injected (Figure 5). Usually 5 mL of fat is required for each breast.

Hypoplastic Lower Breast Pole

In cases with a mildly hypoplastic lower breast pole, fat grafting in the same technique as described earlier is performed. In cases with severe lower pole constriction and excess upper pole glandular tissue, a superiorly based "tuberopexy flap" is performed. First, from the desired new IMF location, the implant is inserted. A 42- to 45-mm periareolar incision is then made with a superiorly based dermoglandular pedicle for the NAC. In the mastectomy or subcutaneous plane, an inferior or lower breast pole pocket is developed between the nipple and IMF to receive the flap. Glandular tissue is incised from 3 to 9 o'clock around the inferior nipple, down to a layer of fascia that covers the implant. Then the gland is divided deep to the NAC pedicle in the coronal plane, dissecting cranially until above the areola and preserving 2 cm deep to the NAC. Then the deeper tissue slides to be redistributed to fill the lower pole (Video 1). The flap is then secured to the lower pole with 2-0 polydioxanone. This technique also addresses NAC herniation and macroareola.

Nipple-Areola Complex Remodeling

Camouflage is useful in cases of mild to moderate NAC herniation and younger patients. Less invasive techniques accommodate future changes, such as in pregnancy, and breastfeeding. NAC subcutaneous dermal popcorning is performed with Colorado needle-point diathermy (Stryker-Leibinger, Freiburg-im-Breisgau, Germany) set on 20 spray, targeting each quadrant of the areola for around 5 seconds when inserted subcutaneously (Figure 6, Video 2). It is important to avoid excessively high diathermy settings to avoid hyperpigmentation. Nanofat grafting is also performed intradermally, usually around 10 mL to each breast intradermally to the periphery of the NAC for rigotomy of the constricting ring fibres (Figure 7).

Correction of the herniating NAC with macroareola in cases of no glandular ptosis is performed with a periareolar mastopexy, modified from Benelli's technique.[6] First the nipple is marked to a 42- to 45-mm diameter, then an outer circle of remaining areola, less than double this diameter (84 mm) is marked. Minimal skin is resected to avoid scars stretching or keloid. Intervening tissue between the inner and outer circles is deepithelialized and dermis cauterized to force contraction, then surrounding tissue from 2 to 10 o'clock is undermined in a subcutaneous mastectomy plane up to the IMF to allow manipulation. A 3-layer closure is performed with 4-0 Monocryl (Ethicon; Raritan, NJ) and 2 layers of barbed 4-0 Stratafix (Ethicon; Raritan, NJ), like a spiral staircase, deep then superficial, to cinch in tissues. To avoid stretching of the incisions, a 3-0 Prolene subcuticular (Ethicon; Raritan, NJ) is sutured as a purse string in the outer ring only, ensuring it slides, and tied over an external pledget. The Prolene suture is removed after 1 week, the aim of this suture being to maintain a round NAC and reduce tension on sutures during the initial swelling period.

In cases with glandular ptosis, following implant insertion and pocket closure, tailor tacking is performed to determine ideal nipple position at the most projecting point of the breast and tighten the lower pole. A vertical scar mastopexy is then performed. These patients may have a unilateral ptotic breast and require a unilateral mastopexy. The nipple is marked with a 42- to 45-mm diameter. Surrounding skin to be tightened is deepithelialized and

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Figure 6. Needle-tip diathermy, set on 20 spray, in the subcutaneous nipple area to constrict or "popcorn" mild to moderate herniation in a 19-year-old female.

Video 2. Watch now at http://academic.oup.com/asj/article lookup/doi/10.1093/asj/sjad255

Table 2. Demographics and Baseline Tuberous Characteristics of Patients, 2016-2021

Demographic/characteristic	No. of patients ($n = 142$)
Age, years (mean)	23.9
Bilateral tuberous breast deformity, *n*	142 (100%)
Asymmetry, *n*	85 (59.9%)
Areolar herniation, *n*	136 (95.8%)
Tuberous grade, *n* (total breasts = 284)	Grade 1: 58 (20.4%)
	Grade 2: 170 (59.9%)
	Grade 3: 56 (19.7%)
Ptosis, *n*	Unilateral: 1 (0.7%)
	Bilateral: 8 (2.1%)

cauterized to contract. The edges are then incised to allow imbrication and tightening of the lower pole and elevation of the NAC.

RESULTS

In the 5-year study period 142 patients who underwent single-stage augmentation and correction were identified as having TBD (Table 2). Mean age at the time of surgery was 23.9 (range 18-42) years. All patients had bilateral TBD, with 85 (59.9%) asymmetrical and 57 (40.1%) symmetrical. In terms of severity of TBD, 58 breasts (20.4%) were Grolleau grade 1, 170 (59.9%) grade 2, and 56 (19.7%) grade 3.

Operative techniques to manage the deformities are described in Table 3. For the implant pocket, 14.8% of patients had subglandular augmentation and 85.2% dual-plane. To address the IMF, 32 breasts had the effacement flap and 62 had nanofat grafting. To manage the NAC, 144 breasts had popcorning, 53 had periareolar mastopexy, and 17 vertical mastopexy (Figures 8, 9). To manage the lower breast pole hypoplasia, 154 breasts required fat grafting and 8 had the tuberopexy flap.

Mean follow-up was 9.3 months (range 3.5 months to 7 years), with follow-up for 112 patients (78.9%) greater than 3 months, 63 (44.4%) greater than 6 months, 31 (21.8%) greater than 1 year, and 11 (7.7%) greater than 2 years. In terms of outcomes, there were no early complications such as infection or hematoma, and 6 (4.2%) patients had late complications and required revisions. Two patients had revision for capsular contracture, one 8 months and one 12 months following initial surgery. Two patients had scar revision of the periareolar mastopexy at 12 and 14 months following initial surgery. One patient had revision of the IMF 5 months following initial surgery, which involved vertical mastopexy and nanofat graft to the old IMF. One patient had removal of dual-plane implants 5 years following initial surgery, after pregnancy, due to multiple episodes of mastitis and seroma. There were no cases of early infection, hematoma, implant malrotation, or double bubble.

DISCUSSION

Due to the diversity of TBD, no single technique allows adequate aesthetic results in all cases. Any technique that does not address the thick fibrous parenchyma of the gland and superficial fascia may incompletely correct the deformity resulting in secondary surgery. Our approach systematically identified each anatomical contributing factor and corrected these in a stepwise manner to achieve optimal aesthetic outcomes.

Following our techniques, correction in 1 stage was achieved in the majority of cases, which is beneficial because 2-stage reconstruction 6 months or more apart can

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Figure 7. Nanofat grafting intradermally around nipple-areola complex to divide and destroy constricting ring fibers in a 19-year-old female.

be a challenge for young patients. This contrasts to a number of authors who describe 2-stage techniques, such as either mastopexy and augmentation or tissue expander use.[7] Salibi et al were the first to propose a comprehensive algorithm for tuberous breast correction.[8] They suggest 1-stage reconstruction for Von Heimburg grade 1 or 2 abnormalities and 2-stage reconstruction for grade 3 or 4. Following our techniques, 2-stage correction was only undertaken if there was marked glandular ptosis, moderate to severe asymmetry, and marked macroareola. When lower pole skin and soft tissue were distensible, with conservative-size goals, our techniques, with the adjunct of fat grafting, made single-stage correction possible in more cases.

Fat grafting with macrofat improves soft tissue cover, and nanofat overcomes the memory of the preexisting IMF. Nanofat has previously been described for treatment of scars, rhytids, and skin discoloration, with the benefit of intradermal filling and rigotomy, as found in our tuberous breast patients.[9,10] Fat grafting has been described as a sole modality for treatment of tuberous breast deformities and as a second-stage procedure; however Brault et al demonstrated that tuberous breast correction with implants can achieve better satisfaction and outcomes than lipofilling, as evaluated by the BREAST-Q.[11-13]

An anatomical implant, inserted from the inframammary fold in a high dual plane, is our preference. Similar to Panchapakesan et al, we found the anatomical implant increased the stretch and volume in the often constricted lower pole of tuberous breast.[14] Subglandular implant

Table 3. Operative Techniques Performed for Mild Tuberous Breast Deformity Patients Undergoing Breast Augmentation

Technique	No. of breasts ($n = 284$)
Implant pocket	Subglandular: 42 (14.8%)
	Dual plane: 242 (85.2%)
Inframammary fold	Nanofat grafting: 62 (21.8%)
	Effacement flap: 32 (11.3%)
Nipple-areola complex	Popcorning: 144 (50.7%)
	Periareolar mastopexy: 53 (18.7%)
	Vertical mastopexy: 17 (6.0%)
Lower pole hypoplasia	Fat grafting: 154 (54.2%)
	Tuberopexy flap: 8 (2.8%)
Cleavage fat graft	244 (85.9%)

placement was only possible in 14.8% of cases, with skin pinch >2 cm and high dual-plane pockets created in 85.2% of cases to ensure adequate upper pole cover. Insertion of the implant from the IMF, in contrast to Muti et al and Zholtikov et al, allowed adequate dissection and manipulation to lower the IMF and avoided the risks of infection and biofilm associated with periareolar implant insertion.[15-18]

Variations in the IMF have previously been classified by Phillips et al.[19] They describe F0 as no fold, F1 as fold effaces with arm elevation, F2 as incomplete effacement, and F3 as no effacement. They warn that the highest risk group when adjusting the IMF is F3, and for this group to be cautious with implant selection, to avoid overprojection implants and to drop the IMF by less than 2 cm. For this category of patients, we would recommend the IMF effacement flap, nanofat grafting, and, if skin flaps are at least 3 cm thick, subglandular implant placement. For F1 and F2 categories, we would recommend fat grafting between the old and new IMF.

Multiple flap techniques have been described to correct tuberous breast deformity, with a great deal of variety between inferior-based flaps described by Ribeiro et al; unfurl and fold-down techniques by Puckett et al, Muti et al, and Mandrekas et al; medial-based flaps described by Bruck et al; and Z-plasty techniques described by Dinner et al.[17,20-24] Our method of flap correction with the superiorly based "tuberopexy flap" has not previously been described in the literature. It successfully redistributes the excess upper pole and herniating glandular tissue, retains a reliable blood supply being superiorly based, and avoids any vascular congestion because it is not folded.

Our method for NAC popcorning is not previously described in the literature. This technique is useful for minor

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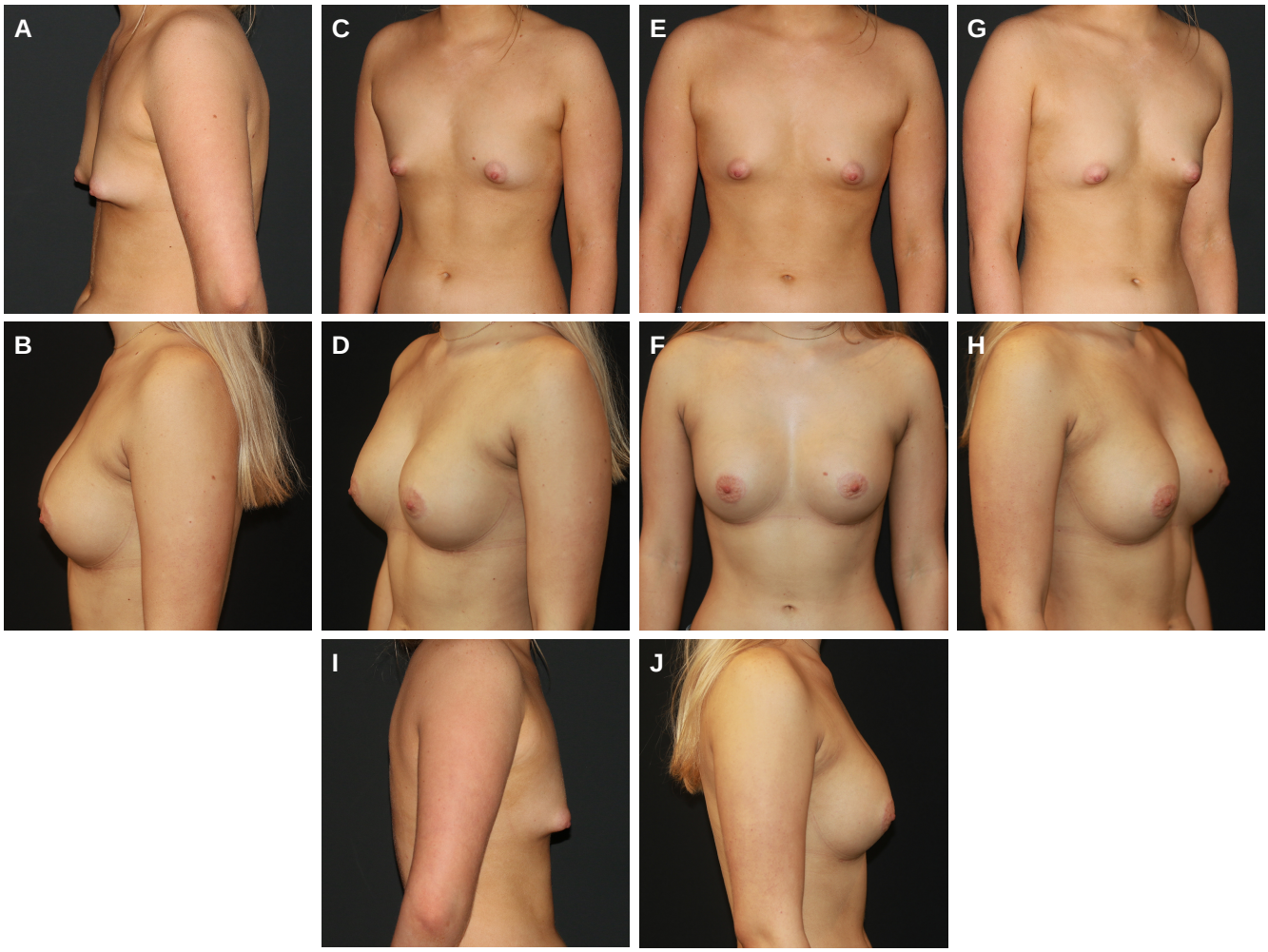

Figure 8. (A, C, E, G, I) Preoperative side, oblique, and front views, and (B, D, F, H, J) 12-month postoperative photographs of a 20-year-old female who underwent dual-plane augmentation with 330-cc anatomical implants, right tuberopexy flap, left periareolar mastopexy, inframammary fold effacement flap, and fat graft to cleavage.

herniation and in younger patients, accommodating future changes such as in pregnancy and allowing breastfeeding. The contraction that occurs subcutaneously is similar to popcorning the breast capsule or dermis in skin-only mastopexy and corrects the pointed, tuberous nipple appearance.

Risks associated with the periareolar mastopexy include scar widening or hypertrophy, suture infection, change in areola shape, and rupturing of sutures.[25-28] To avoid these complications, we have modified this technique for areola reduction in a number of ways. First, the periareolar reduction is employed purely to correct the macroareola, resecting minimal skin, only pigmented areola, to avoid tension on sutures and not using the technique as a mastopexy. Second, the Prolene reinforcement suture, which is only placed in the outer circumference of skin, further cinches and reduces tension once final dissolvable sutures are in place.

This study is somewhat limited by its retrospective nature, because we could not assess patient satisfaction such as with the BREAST-Q. We were limited by low follow-up rates, with a mean of 9.3 months. This is due to patients being from all over Australia, including interstate and regional, coming to a tertiary referral center for tuberous breast deformity. Due to distance, it can be difficult for regional patients to return for follow-up. Follow-up was higher for Sydney patients, and lower for regional patients. In this paper we have only discussed 1-stage correction of mild deformities in patients who presented for augmentation. The message became too confusing with inclusion of the 2-stage severe tuberous deformity patients; however, these will be addressed in a second paper. Future studies of single- or 2-stage procedures will look at larger groups and include the BREAST-Q.

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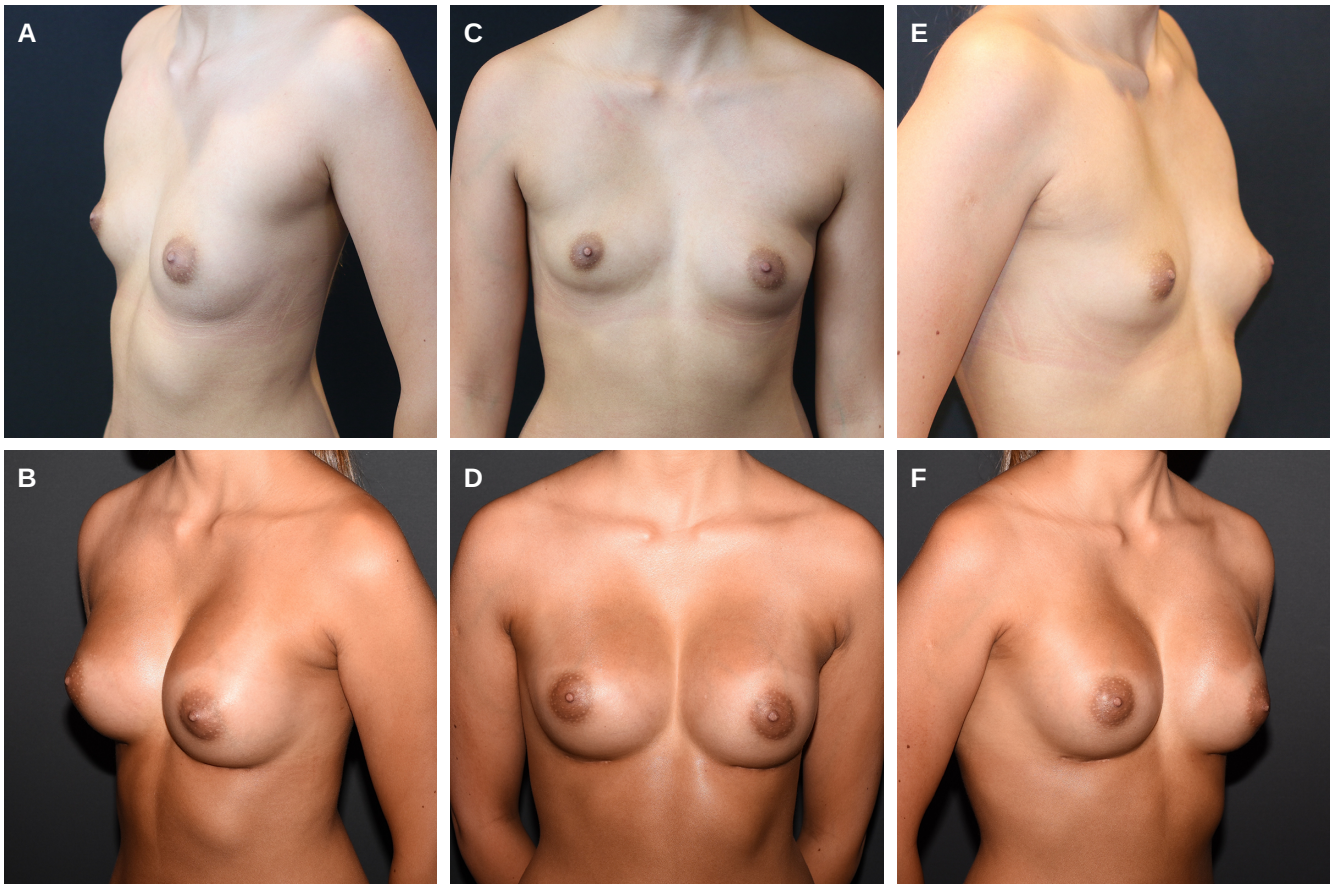

Figure 9. (A, C, E) Preoperative oblique and front views, and (B, D, F) 12-month postoperative photographs of a 19-year-old female who underwent high dual-plane augmentation with left 225-cc and right 300-cc anatomical implants, popcorning, and nanofat grafting to the nipple-areola complex bilaterally, and lower pole fat graft, including nanograft to the right inframammary fold.

CONCLUSIONS

TBD is a spectrum of complex anomalies that pose significant challenges to plastic surgeons. It is important to identify each subtle anatomical abnormality to correct it, achieve better aesthetic results, and improve patient satisfaction. We present strategies to address these abnormalities.

Supplemental Material

This article contains supplemental material located online at www.aestheticsurgeryjournal.com.

Disclosures

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