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Central Tunnel Technique and Fat Grafting for Surgical Correction of Inverted Nipples and Introduction of a Treatment Algorithm

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Abstract

Background: Inverted nipples are prevalent in 3% to 10% of women and can often cause functional, psychological, and aesthetic problems.

Objectives: The authors sought to treat inverted nipples and restore the aesthetic appearance of the nipple while minimizing ductal disruption, preserving the ability to breast-feed, and reducing recurrence rates.

Methods: A retrospective review was performed on a total of 161 inverted nipples in 86 consecutive patients who underwent correction of inverted nipples at Oslo Plastic Surgery Clinic. Mean age at operation was 28.7 years and mean follow-up period was 14 months. A novel technique with central tunnelization of the retracted fibers/ducts was employed in 39 patients (45%); partial incision of the center of the inversion through a tunnel in 31 patients (36%); and total cut of the lactiferous ducts in 16 patients (19%). Fat grafting was utilized as support in 14 patients (26 nipples). Postoperatively, nipples were suspended for 4 weeks with a manually constructed device.

Results: Most patients had moderate (grade 2, 40 patients) or severe (grade 3, 52 patients) nipple inversion. Infection occurred in 4 patients and 2 patients had local irritation. Recurrence was seen in 32 patients (55 nipples) after the first operation, in 6 patients (6 nipples) after the second operation, and in 1 patient (1 nipple) after the third operation.

Conclusions: The authors propose a treatment algorithm that addresses important therapeutic goals when treating inverted nipples. Clinical examination is crucial to determine the method to be employed. The new central tunnel method and fat grafting to support the nipple are promising, although additional follow-up is necessary.

Level of Evidence: 4

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Inverted nipples are a common pathologic condition in which the nipple does not project above the areola plane.[1] This deformity affects approximately 3% to 10% of women[2,3] and might cause problems with the aesthetic appearance and function of the nipple, potentially hampering breast-feeding.[4-6] Severe nipple inversion might also be the source of recurrent irritation and inflammation of the breast tissue due to poor hygiene of the nipple-areola complex and might interfere with psychosexual satisfaction of affected individuals.[4,6] Although most inverted nipples are congenital, nipple inversion can occur as a result of recurrent ductal mastitis, breast surgery, macromastia, or ductal carcinoma.[7,8]

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Han and Hong[4] developed a grading system based on the severity of inversion that is widely used today[9]: grade 1 has intact soft tissue with minimal or no fibrosis and normal lactiferous ducts; the nipple can be pulled out easily and maintains its projection. In grade 2, the nipple can be pulled out manually but retracts on release. Grade 3 inverted nipples are the most severe form and are very difficult to pull out manually.[4]

Since the initial description of inverted nipples by Sir Astley Cooper in 1840 and the first approaches to surgical treatment by Kehrer in 1879 and Axford in 1889,[10,11] various techniques have been developed to correct the condition.[12,13] These range from conservative methods such as continuous traction,[14,15] aspiration/suction,[16-20] and piercing[5,21,22] to surgical treatments such as dermal and dermoglandular flaps,[1,23-35] internal sutures,[9,36-38] stabbing incisions,[39] endoscopic release of fibers,[40] and interposition of artificial or autologous materials.[41-44]

Many of these techniques are associated with postoperative disturbance in lactation, decreased sensation, areolar deformity, and high risk for recurrence. No consensus of a preferred treatment method has been reached yet.[37] The ideal method should be simple, safe, and reliable. It should not be time-consuming, and it should allow for easy application of dressings and result in minimal visible scarring and a low recurrence and complication rate.[1]

Despite the abundant studies on inverted nipple repair, a small number of studies[14,29,30,45-48] have included a greater patient sample. Only a few studies have presented data on long-term postoperative outcome such as complications and recurrence rates.[47,49]

Therefore, the authors present the results of an attempt to establish an algorithm for treating inverted nipples, which includes a new, minimally invasive surgical technique and already established techniques. The authors aimed to treat inverted nipples and minimize ductal (lactiferous) disruption, preserve the ability to breast-feed, restore the aesthetic appearance of the nipple, and reduce recurrence rates.

METHODS

Patients

Between December 2005 and September 2018, a total of 161 inverted nipples among 86 consecutive female patients were treated at the Oslo Plastic Surgery Clinic. The study included all patients with available medical records and photograph follow-up. Patients with a follow-up of less than 2 months were excluded from the satisfaction evaluation. Written informed consent was obtained for using patient photographs. The authors followed the guiding principles from the Declaration of Helsinki.

Treatment Algorithm

The authors have developed a unique treatment algorithm dealing with all aspects of the inverted nipple patient including the way of releasing the inverted lactiferous ducts, support of the underlying dead space, and postoperative support with a suspension device. These 3 aspects must be evaluated and applied in each patient. The age of the patient, the severity of the inversion, and the pressure define the method of choice in each patient (Figure 1). For release of the lactiferous ducts, we have developed the central tunnel technique, which produces the least traumatic effect on the ducts and manages to preserve most of them.

Surgical Techniques

All surgical procedures were performed by the main author (A.K.) with the patient under moderate sedation and local anesthesia or only local anesthesia. The surgical technique comprised 3 aspects of treatment in every patient: treatment of the inverted lactiferous duct itself, support of the remaining dead space after treatment of the ducts, and suspension for support of the nipple after performing the first 2 procedures.

After sterile washing and dressing, local anesthesia with 3 mL xylocaine (1%) with adrenaline was infiltrated into each nipple as a round block. The inverted nipple was elevated to a maximum with a hook and suspended by a 3-0 PDS thread (Ethicon Inc, Sommerville, NJ) attached vertically to the inversion line from the 12 o'clock to the 6 o'clock position or from the 11 o'clock to the 5 o'clock position, etc. The thread should be placed deep to the very base of the nipple and capture its entire width. The thread was then lifted and stabilized by a needle holder to pull the nipple out while the correction of the nipple was performed.

Techniques to Treat Inverted Lactiferous Ducts

Three different surgical techniques to treat inverted lactiferous ducts were employed based on patient age, fertility, and grade of nipple inversion.

Technique 1: Central Tunnel Method

After elevation of the nipple with a 3-0 PDS suture, a central tunnel was created utilizing a 14- or 18-gauge cannula (hollow needle) ending at the base of the nipple, severing the main inversion line that is usually oblique from side to side as from 2 o'clock to 8 o'clock or 4 o'clock to 10 o'clock, etc. (Figures 2 and 3). Subsequent incisions in the fibers at this position while retracting the nipple led to severing most of the inverted part of the nipple. Initially, the technique was performed with a knife but was replaced by a less traumatic

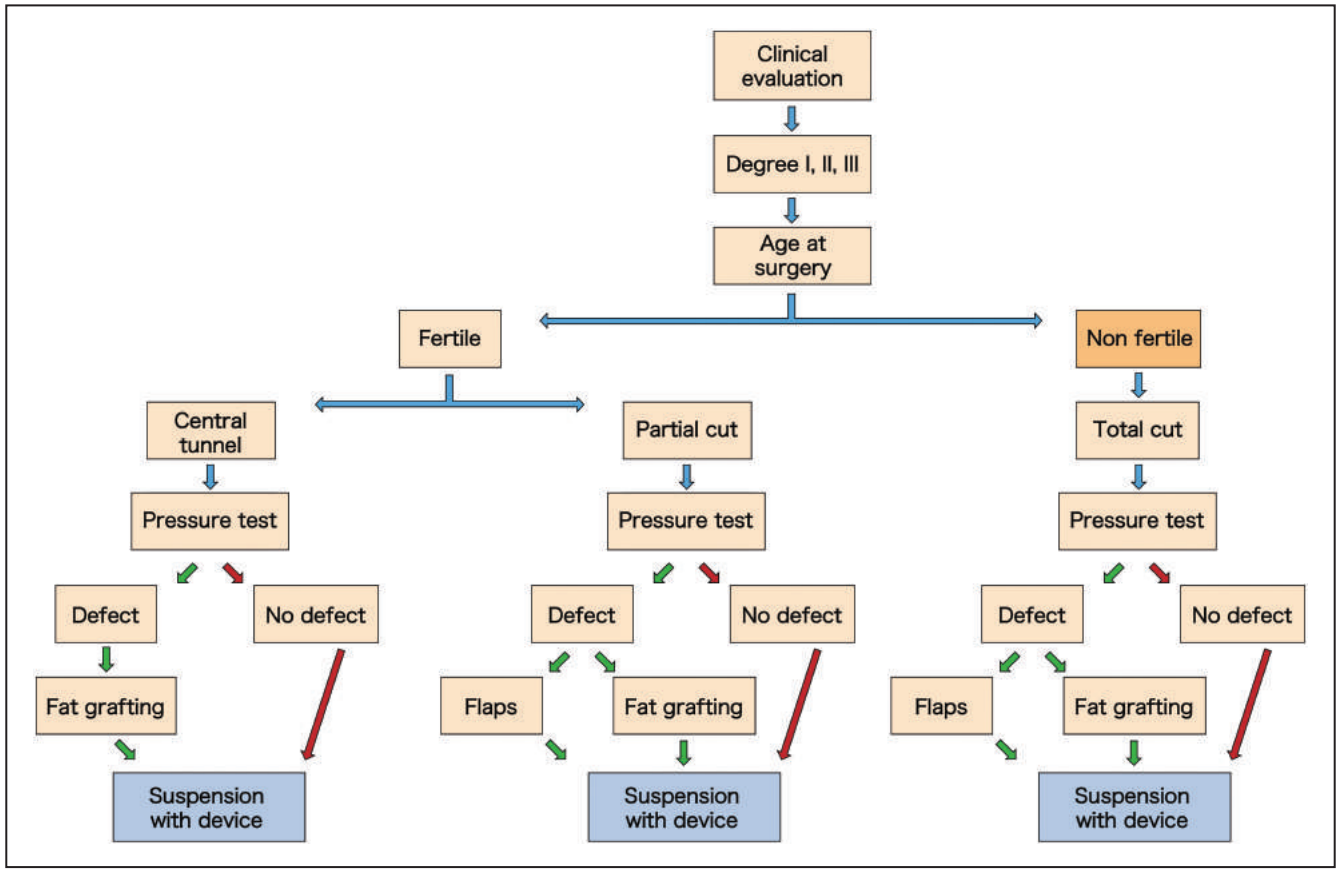

Figure 1. Treatment algorithm of inverted nipples.

method employing an 18- or 23-gauge needle and a 14-gauge needle for severe (grade 3) nipple inversion.

Depending on the necessity of support inside and under the tunnel, the resultant dead space was filled with fat grafting. The width of the tunnel was approximately 1 to 2 mm. This technique preserved most of the lactiferous ducts from above and below the tunnel (Figure 4A,B).

Technique 2: Lateral Partial Cut to Create a Central Tunnel

After elevation of the nipple, a small bilateral incision of 2 mm with a No. 11 blade was performed, and the contracted connective tissue was cut through a narrow tunnel underneath the inversion line of about 2 mm while preserving the lactiferous ducts that emerge from superior and inferior (Figure 4C).

Technique 3: Cutting All Ducts (Crestinu Method)

The total cut method described by Crestinu[23] was applied in patients who were not of childbearing age or did not want to have children. All lactiferous ducts were cut utilizing a small incision of 2 mm around the 6'clock position. The connective tissue inverting the nipple was severed with a No. 11 blade or small scissors (Figure 4D).

Techniques Related to Support Under the Elevated Nipple

A dead space was created when the ducts of fibrous tissue were dissected. In mild cases, this space was limited to the tunnel itself, whereas in more severe cases this space was enlarged and extended from the subcutaneous space to the breast tissue itself after severing the connective fibrous tissue inverting the nipple. A simple test (pressure test) was employed to determine whether support was necessary and was performed together with a preoperative evaluation to decide which filling, if any, should be applied.

The Pressure Test

The pressure test was developed to determine the volume of breast tissue underneath the inverted nipple, mostly related to the size of the breast and degree of inversion. When severing an inverted nipple of severe grade, a large dead space is expected and, independent of which technique is chosen, must be filled to maintain eversion.

The test is performed by placing a finger on the nipple, gently pressing it vertically backward to determine resistance or emptiness in the area behind the nipple toward the breast tissue. It is expected that severe mammary

Figure 2. Inversion lines. Inversion line from 1 to 8 o'clock position (line A-B) demonstrated on this 61-year-old female.

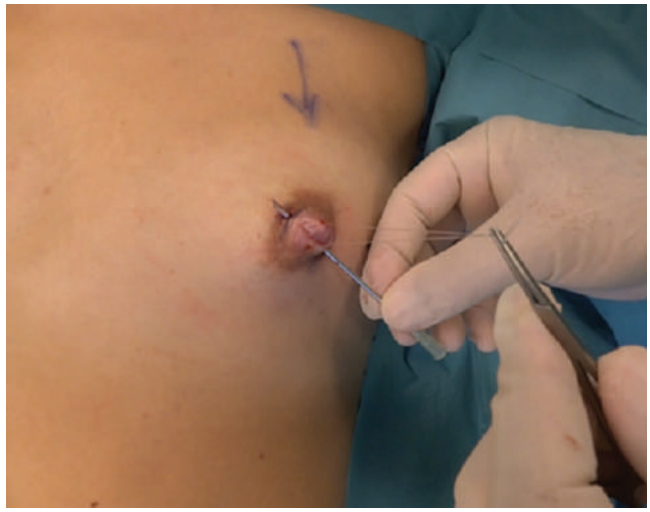

Figure 3. Central tunnel performed with 14 G needle at the base of the nipple from side to side parallel to the inversion line demonstrated on this 28-year-old female.

hypoplasia or severe ptotic breasts and severe degrees of nipple inversion (grade 2 or 3) necessitate support.

As support for the elevated nipple the management was divided into 3 techniques:

- **Technique 1: no filling.** Owing to adequate support and, usually, only a mild degree of inversion (grade 1), there was no need to support the under-nipple area mechanically. In these cases, it was possible to proceed directly with the suspension device as the final stage of treatment.
- **Technique 2: subdermal triangular flaps.** Two small dermal flaps of 3 × 6 mm were designed at the edges of the inversion line of the nipple. After the flaps were marked, they were de-epithelized and turned under the tunneled area (technique 2 for lactiferous ducts mentioned previously) to provide support to the elevated nipple. A suture of 4-0 Vicryl (Ethicon Inc, Sommerville, NJ) was placed on the tip of 1 flap and then tunneled to the opposite side where the tip of the other flap was caught and returned to the original side. The knot was tied and positioned exactly in the center of the nipple just under the created tunnel (Figure 4E-G).
- **Technique 3: fat grafting.** When the central tunnel method was chosen to treat the lactiferous ducts, a less invasive method was utilized to maintain eversion by grafting the tunnel and the potential large dead space with fat. The so-called "microfat" was harvested from the abdomen with a small multihole cannula (0.8 mm) after administration of lipotumescent to the area. A 10-mL syringe with luer lock was utilized. The extracted fat was decanted for 10 minutes, separated, transferred to a 1-mm syringe, and then injected through a minimal incision by a 0.7-mm cannula.

The amount of grafted fat necessary for adequate filling was about 1 to 4 mL, depending on the severity of the inverted nipple and the amount of dead space to be filled (Figure 5).

Postoperative Suspension

All nipples were suspended utilizing a suspension device/stent obtained from the bottom of a 10-mL syringe and applied for 4 weeks postoperatively. The device was approximately 1 cm high with an opening at both ends about 8 mm from the base, where it could be bridged with a pin from each side from where the nipple was suspended by a 3-0 PDS thread, without compromising circulation. A possible variation is a 20-mL syringe, which may be employed for wider nipples. The height of the suspension may also be modified by utilizing a 6-, 8-, or 10-mm device.

The blood flow was checked while the knot was tightened to avoid compromising capillary circulation. Taking into account the patient's desired amount of nipple lift, eversion was determined and both breasts were checked for symmetry. The PDS suture was then locked on the pin, bridging the holes on the side. There should at least be a 10-time roll of the knot to prevent failure of the suture during the 3 to 4 weeks of application. Finally, Jelonet paraffin gauze (Smith & Nephew, Watford, UK) was applied under the base of the syringe and around the nipple.

Immediate Postoperative Follow-Up

Before the patient was discharged from the clinic, the nipple was checked for color and capillary filling. On the day after surgery, it was crucial to check the nipple again. If the nipple was entirely blue or whitish, the suture should be released to preserve circulation and vitality of the nipple. Patients

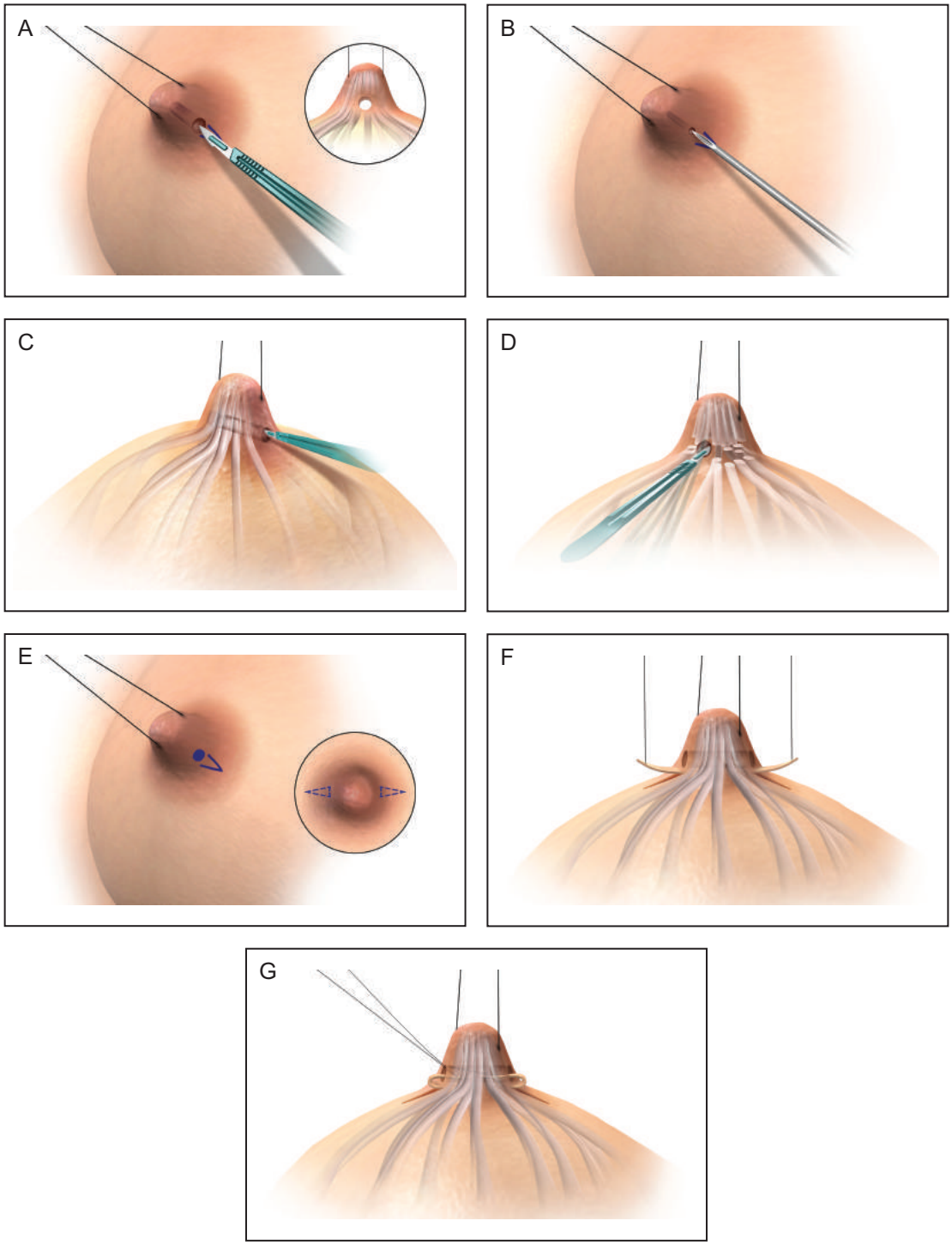

Figure 4. Schematic illustrations of the technique. (A) Central tunnel created with knife in lateral view (left); note that lactiferous ducts are mostly intact in the circle on the right. (B) Central tunnel made less traumatic with gauge 14-18. (C) The tunnel seen from anterior; the intact anterior lactiferous ducts are shown. (D) Crestinu method with complete cut of the ducts. (E) Dermal flap design (right) and the thread lifting the nipple at the beginning of the operation (left). (F) Raising the flaps while preserving the lactiferous ducts in frontal view. (G) Flipping and suturing the flaps. The knot will be in the center of the nipple at the tunnel base.

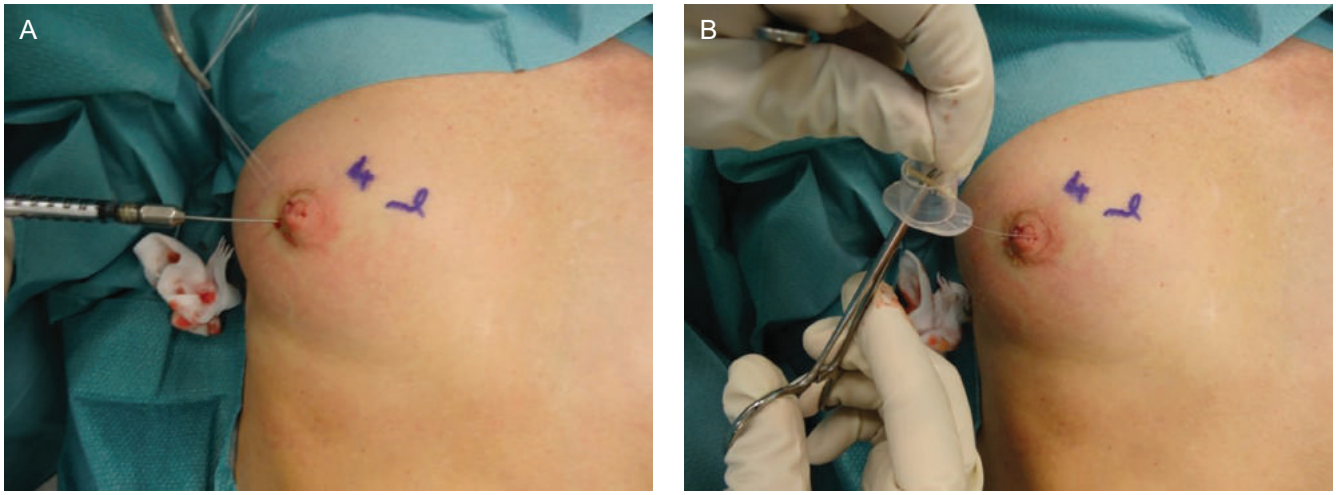

Figure 5. Fat grafting to support the elevated nipple and fill the dead space after the total cut technique was performed on this 61-year-old female. (A) Fat grafting with 1-mL syringe from the lateral opening (B) application of the suspension device.

were instructed on daily care of the nipple: to disinfect it by utilizing Hibiscrub antimicrobial skin cleanser (chlorhexidine gluconate solution; BCM Ltd., Beeston, Nottingham, UK) and to apply sterile petroleum jelly (Vaseline; Unilever, London, UK) to keep the wound area moisturized. Patients were also advised to put gauze under the device toward the skin to avoid friction and irritation. Postoperative views of the nipple are shown in Figure 6.

If the patient lived close to the clinic, they could attend a 1-week, 2-week, and 4-week follow-up visit during which the device would be removed by cutting the PDS thread and a hollowed gauze facing the bra would be applied for a period of 2 more weeks. This ensured that no pressure that might cause reinversion was exerted on the nipple, and the healing process of the flap, tunnel, and dead space underneath was as expected.

If the patient lived far from the clinic, a video call was arranged and the patient could remove the device by themselves or with the help of medical assistants under our supervision.

RESULTS

Patients

The mean age of the patients was 28.7 years (range, 18-61 years). Mean follow-up time was 14 months (range, 2-57 months). Fifteen patients were lost to follow-up after 2 weeks. A total of 75 patients (87%) were affected bilaterally and 11 patients (13%) were affected unilaterally (Table 1). According to the classification by Han and Hong,[4] 11 patients had grade 1 nipple inversion (16 nipples), 40 patients had grade 2 inversion (56 nipples), and 52 patients had grade 3 inverted nipples (89 nipples) (Table 2).

Techniques Related to Release of Inverted Lactiferous Ducts

During in-depth practice of inverted nipple correction, the authors developed the new technique with central tunnelization of the retracted fibers, which, because of its promising results, became the most frequently performed technique for releasing the nipple from fibrous bands and tethering lactiferous ducts. This technique was employed in 39 patients (45%). In women of childbearing age/ability, the partial cut technique was the second most commonly performed method, and it was employed in 31 patients (36%). The total cut technique by Crestinu was reserved for women not of childbearing age/ability and was utilized only if indicated. It was employed in 16 patients (19%) (Table 3).

Techniques Related to Support Under Elevated Nipple

In 56 patients, existing support underneath the nipple was sufficient and filling was not necessary in the first session of treatment. If support to fill the dead space was required, triangular flaps were employed in 25 patients, whereas fat grafting was utilized in 14 patients total in both the first and second session. In the group of patients treated with the partial cut technique, triangular flaps were most commonly employed for support (Table 4).

Degree of Inversion and Recurrence of Inversion

The recurrence rates related to the degree of nipple inversion according to the classification by Han and Hong[4] are summarized in Table 5.

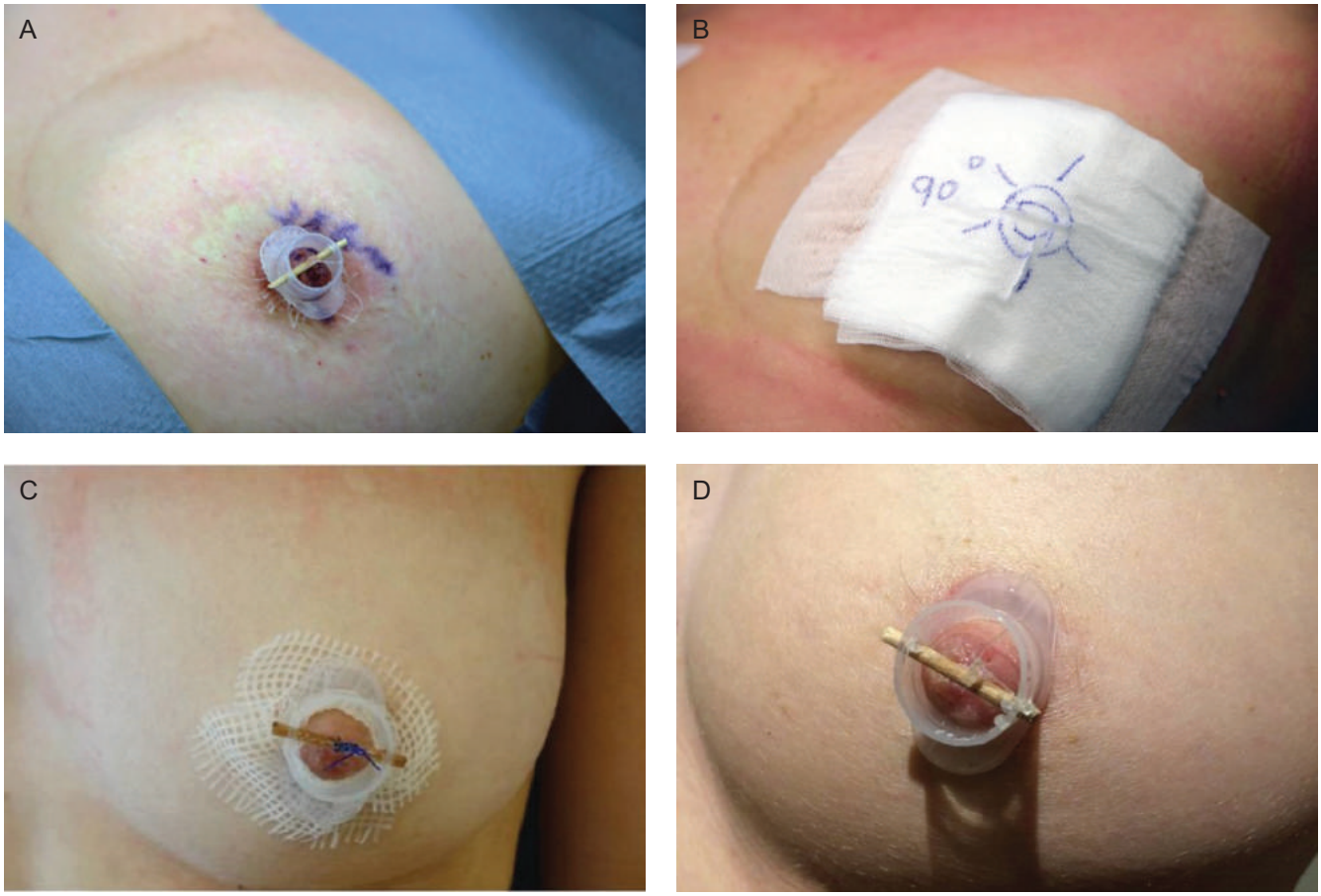

Figure 6. Postoperative views in 2 patients: (A-C) this 33-year-old female and (D) this 32-year-old female. View of nipple at the end of the operation: (A) note the pink color of the nipple and (B) with the dressing applied 90°C to the surface. (C) After 3 weeks, the suspension device with the hanging thread becomes loose; that is, the device has suspended the nipple adequately, and the healing process in the previous dead space resultant from correction of the ducts is taking place properly. (D) Five weeks postoperatively.

Table 1. Affected Side and Number of Patients and Nipples

Type	Patients, No. (%)	Nipples, No. (%)
Bilateral	75 (87)	150 (93)
Unilateral	11 (13)	11 (7)
Total	86 (100)	161 (100)

Recurrence Rate in Different Groups

Thirteen of 39 patients (33%) treated with the central tunnel method underwent second surgery due to recurrence or unsatisfying results. Thirteen of 31 patients (42%) treated with the partial cut technique needed a second surgery because results were not satisfactory. Six of 16 patients (38%) treated with the total cut technique required a second surgery (Table 3).

Postoperative Complications

Minor complications were encountered after surgery. Infection requiring treatment with antibiotics occurred in 4 patients (5%), local irritation not requiring antibiotics was observed in 2 patients (2%), and anesthesia-related complications (delayed awakening) were observed in 1 patient (1%).

Patient Satisfaction

Patients evaluated the cosmetic outcome of the procedure by assessing the level of satisfaction with the aesthetic results and the eversion grade. The subjective rating was discussed in an in-person or video/phone call consultation during a follow-up visit at our clinic 1 day, 2 weeks, 3 months, 6 months, and 1 year postoperatively together with our clinical evaluation and comparison of pre- and postoperative photographs.

Table 2. Number of Patients With Degree of Inverted Nipple

Degree	Patients	Unilateral patients	Bilateral patients	Nipples
First	11	3	8[a]	16
Second	40	4	36[b]	56
Third	52	4	48[c]	89
Total	103[d]	11	92[d]	161

[a]Five patients with 2 first-degree and 3 patients with 1 first-degree inverted nipple. [b]Nineteen patients with 2 second-degree and 14 patients with 1 second-degree inverted nipple. [c]Thirty-five patients with 2 third-degree and 15 patients with 1 third-degree inverted nipple. [d]Seventeen patients had 2 different degree nipples; that is, the total number is higher than the total number of patients (86) and total number of bilateral patients (75).

Table 3. Lactiferous Ducts Releasing Techniques and Number of Patients

Technique	Patients in 1st operation, No. (%)	Patients in 2nd operation, No. (%)	Patients in 3rd operation, No. (%)
Central tunnel	39 (45)	13 (33)[a,b]	0 (0)
Partial cut	31 (36)	13 (42)[c]	3 (23)[e]
Total cut	16 (19)	6 (38)[d]	1 (17)[f]

[a]These patients do not necessarily belong to central tunnel as first treatment. [b]One of these patients had previous total cut. [c]All patients had previous partial cut. [d]One of these patients had previous central tunnel. [e]One of these patients had previous central tunnel and 2 had partial cut. [f]One of these patients had previous partial cut.

Table 4. Support for Everted Nipple and Number of Patients

Dead space filling	Patients in 1st operation, No. (%)	Patients in 2nd operation, No. (%)	The 2nd filling method, No. (%)	Patients in 3rd operation, No. (%)
No filling	56 (66)	23 (41)	No filling: 12 (52) Triangular flaps: 3 (13) Fat grafting: 8 (35)	3 (5)
Triangular flaps	25 (29)	9 (32)	No filling, 6 (67) Triangular flaps: 1 (11) Fat grafting: 2 (22)	0 (0)
Fat grafting	4 (5)	-	10[a]	1 (7)

[a]These patients were mainly operated with other support such as flaps or no filling. The recurrence for fat was 1 patient (7%).

Patient satisfaction with the cosmetic outcome was achieved in 43 of 71 cases (61%) after the first operation, in 23 patients (93%) after the second operation, and in 3 patients after the third operation (97%). Two patients were not satisfied and 15 patients were not available for follow-up.

Technique Characteristics and Inversion Severity

The techniques employed for treatment of the lactiferous ducts and the methods to support the everted nipple with regard to the degree of inversion are summarized in Table 6. Supplemental Figure 1 depicts unilateral nipple repair with the total cut method and fat grafting. Supplemental Figure 2 shows microfat decanting in preparation for fat grafting. Figure 7 and Supplemental Figure 3 illustrate bilateral nipple repair with the central tunnel technique without the utilization of a filling method.

DISCUSSION

There is no single technique for treating inverted nipples.[12] Our algorithm is based on 3 important aspects that must be addressed for successful treatment of inverted nipples: (1) complete release of the tethering structures hampering the nipple from eversion; (2) adding support to the tissue underneath the nipple to fill the dead space; and (3) suspension of the nipple postoperatively to protect the nipple from reinversion (Figure 1).

The algorithm suggests performing 1 of 3 surgical techniques depending on patient age and severity of nipple inversion. In patients of childbearing age and able to have children, either the central tunnel or the partial cut technique should be employed. This is determined by considering the extent of the tethering bands pulling the nipple inward: milder inversion might be best treated with central tunnelization, which is duct-sparing and leaves no visible scarring, whereas the partial cut technique might be more suitable for treatment of nipples that warrant greater release of the fibrous structures.

The total cut technique by Crestinu[23] should be performed strictly in patients that are not of childbearing age or are unable to have children. In these patients, it represents a promising method that reliably avoids reduction of projection over the years, recurrence, and concomitant psychological consequences.

Depending on whether a defect is detected with the pressure test, it can be decided whether support of the nipple through fat grafting (smaller defect) or triangular

Table 5. Recurrence Related to Degree of Nipple Inversion

Degree of inversion	Patients before 1st operation, No.	Nipples before 1st operation, No.	Patients after 1st operation, No.	Nipples after 1st operation, No. (%)	Patients after 2nd operation, No.	Nipples after 2nd operation, No. (%)	Patients after 3rd operation, No.	Nipples after 3rd operation, No. (%)
1st	11	16	3	5 (31)	1	1 (6)	0	0 (0)
2nd	40	56	11	15 (27)	3	3 (5)	1	1 (2)
3rd	52	89	18	35 (39)	2	2 (2)	0	0 (0)
Total	103[a]	161	32	55 (34)	6	6 (4)	1	1 (<1)

[a]Seventeen patients had 2 different degree nipples; ie, the total number is higher than the total number of patients (86), and total number of bilateral patients (75).

Table 6. Techniques Used Related to Degree of Inversion

Technique	Total patients	Degree 1 patients	Degree 2 patients	Degree 3 patients
Central tunnel with no filling	29	5	11	13
Central tunnel with fat	10	0	4	6
Partial cut with no filling	9	5	3	1
Partial cut triangular flaps	22	2	7	13
Total cut Crestinu with no filling	10	0	2	8
Total cut Crestinu with fat	4	0	1	3
Total cut Crestinu triangular flaps	2	0	1	1
Total	86	12	29	45

flaps (bigger defect) is necessary. The choice between fat grafting and flaps is available in all cases. Fat grafting represents a rather new technique that is less traumatic and leaves no visible scarring. The choice varies among patients and must be decided individually. The pressure test, a complementary test to the clinical evaluation, is a very simple and quick method to decide if support is needed or treatment is sufficient with mere duct release and suspension.

To enhance the surgical result, postoperative suspension with a distraction device is recommended in every case of nipple inversion. In cases of hypotrophy or hypertrophy of the breasts, mastopexy or breast augmentation with implants or fat grafting may be performed to further support the nipples. This should be considered when support of the underlying tissue is necessary.

Purse-string suture methods have not been incorporated into the algorithm because of the risk for ischemia from excessive burden on the blood supply. Furthermore, sufficient correction of the loss in volume underneath the nipple after removal of the fibroductal tissue might not be feasible. This shows in postoperative nipple height reduction, which ranges from 10% to 50% for this technique.[25] Although alternative suture techniques have been proposed,[9] breast-feeding ability cannot be preserved in most of the techniques owing to obliteration of lactiferous ducts.[38]

Central Tunnel as Optimal Technique to Deal With Lactiferous Ducts

When treatment of the inverted nipple was initiated at our clinic in 2005, established techniques for that time were utilized. However, with constant practice, the limitations of the many flap designs and the inconsequent filling of the dead space associated with severing the ducts were realized. The purse-string suture was not a good alternative at the time because of the high rate of complications as a result of reduction of blood supply to the nipple. We realized that the challenge of appropriate nipple repair did not lie in the extent of duct severance, but in achieving sufficient support underneath the nipple to fill the dead space. If the dead space is not adequately filled, recurrence is likely, regardless of which method is employed for the fibrous tissue dissection.

Later, the idea for a device for postoperative suspension was born and has been applied in all the cases that have followed since. Once these treatment principles were established, we focused on reducing the traumatic effect of the procedure, including minimizing operation time and preserving nipple sensibility by abandoning the use of flaps and employing only a tunnel. The magnitude of the trauma was further reduced by utilizing the central tunnel method with a 14- or 18-gauge needle, which was least traumatic for the surrounding lactiferous ducts and did not leave any visible scarring as opposed to the partial cut technique. In addition, there was better control by employing this method to generate the tunnel than by utilizing a blade or separating the tissue with scissors.

Figure 7. This 38-year-old female presented with grade 2 (left) and grade 3 (right) inversions and underwent central tunnel shown in preoperative (A, C, E) and 12-month postoperative (B, D, F) photographs.

As a matter of fact, the central tunnel technique represents a refinement of the partial cut method that is less invasive and does not leave any visible scarring compared with the utilization of a blade. Furthermore, the diameter of the central tunnel is more exact and controllable than in blade utilization, thus inflicting less damage to the peripheral lactiferous ducts. The central tunnel technique only severes the fibrous bands and tethering lactiferous ducts in the center of the nipple which are mainly responsible for retraction, and preserves presumably 80% (2-mm-wide

tunnel of an average 12-mm nipple diameter) of the lactiferous ducts in the peripheral nipple area.

It is our belief that even in third-degree inverted nipples there are intact lactiferous ducts in the nipple periphery, which can potentially be saved and lifted with the presented technique. Considering that other reasons might be responsible for impaired breast-feeding function such as hypotrophic mammae, preserving approximately 11 to 15 ducts of the 15 to 20 normally existing ducts is deemed very beneficial.

Through the cut in the tunnel, the central tunnel method achieves a traction effect that manages to lift the nipple and creates a dead space and an expansion effect of the rest of the structures that include the lactiferous ducts external to the central tunnel. Importantly, not only the degree of the inversion determines whether a smaller or larger gauge can be used, but also the diameter of the nipple has to be considered.

Support of Underlying Tissue

Schwager et al[7] found that the thickness of the dense connective tissue underneath congenitally inverted nipples was only one-half as developed as in normal, healthy nipples. Correspondingly, Han and Hong[4] showed that the subareolar tissue of inverted nipples is composed differently than normal nipples and varies depending on severity of inversion; more severely inverted nipples feature atrophy of lactiferous ducts with fibrosis, mainly in the center underneath the nipple. This substance defect might necessitate filling the existent dead space with some sort of material.

In the current study, depending on the emptiness beneath the inverted nipple detected by the pressure test, the dead space was filled with subdermal triangular flaps or by fat grafting. The subdermal triangular flaps were employed in cases of a more distinct substance defect underneath the nipple, mainly in combination with the partial cut technique. Fat grafting was predominantly employed in patients treated with the central tunnel method because the underlying defect was of minor extent and fat was adequate for support. The central tunnel technique and the total cut technique by Crestinu warranted further support with fat or triangular flaps in relatively few cases. Contrarily, the partial cut technique required support with triangular flaps in approximately 70% of cases, indicating that this technique does not sufficiently elevate the nipple on its own. It does not come as surprise that the higher the severity of the nipple inversion, the greater the need for additional support by one of the described methods.

Clinical Evaluation and Pressure Test

Clinical evaluation is important to determine the status of inversion, the breast volume, and ptosis. The pressure test enables evaluation of the underlying tissue and the need for support. It is a simple and quick method to estimate the existent dead space between the nipple and the underlying breast tissue. Generally, severe mammary hypoplasia or severe ptotic breasts and severe nipple inversion (grades 2 and 3) may necessitate support. Nevertheless, application of the pressure test seems useful even in this group of patients given the heterogenous nature of these conditions.

Recurrence Rate

The relatively high recurrence rate in the current study, compared with previous studies, could be explained by our reluctance to sever the lactiferous ducts by performing a fiber- and duct-sparing approach that might not have completely removed all the tethering fibrous bands. It was hoped that this problem could be addressed sufficiently by the subsequent filling and suspension methods. If that was not the case, a second operation requiring less than 15 minutes was performed to remove the remaining bands. All accruing costs were covered by the clinic within 1 year of primary surgery. Patients were informed preoperatively about the possibility of undergoing second/third treatment to achieve an adequate and long-lasting correction. Moreover, second correction was generally performed on nipples with already improved eversion through the first treatment and was most often necessary only on 1 side.

Recurrence after the second correction was rare. Longer application of the retraction device might have further reduced the recurrence rate; however, this might warrant exceptional patient compliance and somewhat restrict the daily life of patients.[34]

Although other studies have reported lower rates of recurrence, many proposed techniques require long-term utilization of external nipple retractors or might damage the lactiferous ducts.[15,34] Demographic differences among patients also have to be taken into account considering their impact on grade of contracture and fibrosis.[47] For example, it has been suggested that a correlation might exist between a low body mass index and the prevalence of nipple inversion[47] and possibly reinversion. Furthermore, the high proportion of severely inverted nipples among the study population (over 50% were classified as grade 3) undoubtedly manifests in the recurrence rate. This crucial aspect must be considered when comparing the current study with previous works in which severe nipple inversion might have been less frequent among the study population.

The recurrence rate was found to be rather similar among inversions of varying severity. This might be attributed to the fact that the authors aimed to maintain breast-feeding function and full sensation by reluctant dissection

of tethering structures even in severely inverted nipples. The concept was to ensure maximum safety of the nipple by keeping the lactiferous ducts intact and to utilize the least traumatic method for freeing the nipple regardless of the degree of inversion. Nevertheless, we discerned no substantial differences in reoperation frequency with regard to the degree of inversion considering that slight modifications of the techniques were made based on the present case. For example, when severe inversion was present, a deeper and slightly broader tunnel was created and flaps or fat were utilized as support.

Limitations and Recommendations

Documentation of demographic information such as brassiere size, body mass index, breast ptosis, and medical comorbidities might be of great importance in further classification to offer the best available treatment to the individual patient. Another limitation might be the retrospective design of the current study, which did not allow for tracking of potential differences between pre- and postoperative quality of life. Evaluation of whether patients were able to breast-feed postoperatively would have been of particular value to better understand the influence of the presented techniques on the disruption of milk ducts and breast-feeding. No validated measurement tool was employed to assess patient satisfaction, and the time for the evaluation ranged from 3 months to 1 year postoperatively. Finally, the 15 patients lost to follow-up at 2 weeks were included only for general information and technique evaluation but were not included in the satisfaction rating and other follow-up data.

More large-scale and preferably multicenter studies are warranted to further delineate the importance of duct-sparing techniques for correction of nipple inversion. Systematic investigations on the impact of the proposed techniques on preservation of nipple-areola complex sensibility and breast-feeding function are recommended.

CONCLUSIONS

We propose a treatment algorithm that deals with 3 important goals of inverted nipple repair: release of the structures hampering the nipple from eversion; supporting the tissue underneath the nipple after a dead space has been created; and suspension of the everted nipple postoperatively.

Clinical examination of the patient and grading the severity of inversion is crucial for determining which procedure to use. The central tunnel technique and the utilization of fat grafting to support the nipple is promising, although longer follow-up is necessary. Future research is encouraged to evaluate postoperative breast-feeding function and to investigate whether more extensive postoperative suspension may enhance results and further reduce the recurrence rate.

Supplementary Material

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

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