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Patient's proprioceptive remnants in nipple reconstruction planning

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Abstract. – OBJECTIVE: The aim of this study is to demonstrate that for patients undergoing mastectomy the use of the proprioceptive memory represents a valid method to identify the perfect position of the nipple, which will be reconstructed on an operated breast.

PATIENTS AND METHODS: Fifty-one patients undergoing breast reconstruction after unilateral Modified Radical Mastectomy or unilateral Skin Sparing Mastectomy were included in the study. All patients were asked to identify, while keeping their eyes closed, the mammary segment where they perceived their nipples, both on the reconstructed breast mound and on the contralateral breast. Sternal Notch-to-nipple distance (SN), Nipple-to-inframammary Fold distance (NF), Midclavicular line-to-nipple distance (CN), the distance from the nipple to the chest Midline (NM), Anterior Axillary line-to-nipple distance (ZN) were measured on both breasts. The ideal position of the nipple to be reconstructed was evaluated using a geometric method based on the Pythagorean Theorem.

RESULTS: A statistically significant correlation emerges between the distances measured from the anatomical landmarks of the chest to the point coinciding with the patient's perception of the nipple on the reconstructed breast, and the distances measured from the same chest landmarks to the nipple on the contralateral native breast and to the nipple placed in the ideal position assessed with the geometric method.

CONCLUSIONS: The patient's proprioceptive memory of the nipple position can be useful to identify the exact place to reconstruct the nipple in breast reconstruction.

Key Words:
Nipple reconstruction, Breast anatomy, Nipple position, Phantom breast syndrome.

Introduction

Many techniques have been described for nipple-areola complex (NAC) reconstruction as an essential part of breast reconstruction[1-3].

However, little attention has been paid, in the literature, to define guidelines in decision-making processes for nipple positioning on the breast mound.

When considering the anatomical variability of the breast shape, volume and position between breasts, defining the perfect position of the NAC on a breast that has been reconstructed or for which a reduction or remodeling is planned is a challenge for the surgeon[4,5].

So far, geometrical reproduction of the contralateral dimensions and proportions[2] is the most common approach which nipple reconstruction techniques are based on.

The frequent, even minimal, residual asymmetry with the other breast and NAC due to reconstructive outcome or ageing process must be taken into account when planning the procedure.

Phantom breast syndrome has been described more than 130 years ago as a painful dysesthesia syndrome, a profound discomfort referred to as a "pins and needles" feeling in the amputated breast[6]. This condition has been correlated to the persistence of somatosensory pathways of which cortical areas are adjacent to the ones related to the amputated segment[7].

The aim of this study is to evaluate if patients maintain nipple position memory after mastectomy and if this memory may help in locating the nipple reconstruction position on the new breast mound.

Patients and Methods

Fifty-one patients, aged between 38 and 72 years (average age of 56.18 ± 7.81), who underwent breast reconstruction surgery after Modified Radical Mastectomy (MRM) or Skin-Sparing Mastectomy (SSM) at the Department of Plastic and Reconstructive Surgery of Policlinico Um-

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berto I (Rome) between 2018 and 2020, were enrolled in the study.

No Ethical committee approval has been required because of the consolidated protocol treatment of nipple reconstruction in breast reconstruction surgery. The study followed principles outlined in the Declaration of Helsinki. Patients were informed about the study protocol, risks, benefits, and potential complications before giving their consent to this research. Informed consent was obtained from all individual participants included in the study.

For the purpose of this study, only patients having sustained unilateral breast reconstruction surgery were enrolled: 36 patients were reconstructed with tissue expander, which was subsequently replaced with a prosthesis; eight patients were reconstructed with the Direct-to-Implant Technique (DIT); two patients underwent Latissimus Dorsi flap reconstruction and five were reconstructed with DIEP flap.

All patients were invited to a follow up visit after ten to thirty-six months (median 18 months) after the mastectomy.

All patients were asked to pinpoint, with their eyes closed, the breast segment where they feel their nipples, both the native and the "phantom" one (Figure 1a, b).

These positions were marked with a skin marker, and their symmetry was checked both in upright and supine position. For each point identified as the site of the perceived nipple in reconstructed breast, the following measurements were taken: sternal notch-to-nipple distance (SN), nipple-to-inframammary fold distance (NF), midclavicular line-to-nipple distance (CN), the distance from the nipple to the chest midline (NM), anterior axillary line-to-nipple distance (ZN).

These measurements were then compared with the ideal distances of the nipple on chest landmarks, calculated on the surface of each reconstructed breast according with a geometric method based on the calculation of the hypotenuse of two right-angled triangles marked on the breasts of the patient. This reproducible and fast method applies the Pythagoras principle allowing identification of the ideal nipple position in each breast. The following distances between nipples and thoracic landmarks in both breasts were measured, by the same author and with the same measuring tape.

With the patient standing, the inframammary fold (IMF), the median sternal line, a straight line that goes from the sternal notch to the umbilicus, and the aesthetic breast meridian line were marked.

The breast meridian line intersects the IMF line, at a point called B, point B is then projected horizontally at the level of the Median sternal line, meeting it at point P. The PB and the SP lines were accurately measured; they represent the base and the height of a right-angled triangle. The Pythagorean Theorem ($SN^2=PB^2+ SP^2$) was applied to calculate the hypotenuse of the described triangle which corresponds to the ideal SN to nipple distance[4].

Once point N has been identified as the transposition on the anterior surface of the breast of point B in correspondence with the meridian breast line, we measured the following distances: point N -to-inframammary fold distance, the distance from the point N to the chest midline, anterior axillary line-to-point N distance and midclavicular point to point N (Figure 2).

Parametric values were described by mean ± standard deviation (±SD). Statistical analysis was performed using IBM SPSS Statistical software (Armonk, NY, USA). *t*-test was used to compare the distances from the thoracic landmarks of the perceived nipple: either those calculated through the geometric method or those after taking measurements of the contralateral native breast. A *p*-value of 0.05 was considered statistically significant.

Results

All patients completed the test uneventfully. The perceived "*phantom*" nipple position, indicated by the patient with eyes closed, bringing the index finger of the ipsilateral hand on the surface of the reconstructed breast, was found to have an average distance from the sternal notch of 20.43 (±2.00) cm. The average of the distance from midclavicular point to the perceived nipple was 19.79 (±1.94) cm; the mean of the distances between the perceived nipple and the Median sternal line was 8.85 (±1.04) cm. Finally, the mean distances from the perceived nipple to the inframammary fold and to anterior axillary line were 6.76 (±1.29) cm and 10.04 (±1.78) cm respectively.

The average of the distances measured SN, CN, NM, NF, ZN in the contralateral breast to the reconstructed breast were 23.70 (±2.37) cm; 23.00 (±2.54) cm; 10.93(±1.22) cm; 8.09 (±1.05) cm and 11.82 (±1.35) cm respectively.

The mean length of the hypotenuse SN calculated by the geometric method was 22.81 (±1.8) cm. The average of the distances of the point N from the IMF resulted 7.67 (± 1.35) cm, while the mean distance of the nipple points from midclavicular

Figure 1. a, Patient pinpointing the nipples position with the eyes closed. Perceived nipple on the left side and native nipple on right side. **b,** After having marked the perceived nipple position on the left side, IMF-N, SN, CN distances were measured on both breast and compared.

point, chest midline and anterior axillary line measured 22.4 (±1.97) cm; 10,11 (±1.46) cm and 10.02 (±1.56) cm respectively.

By comparing the means of the different distances measured (perceived nipple - nipple of the contralateral breast and perceived nipple - ideal nipple position) a statistically significant correlation emerges (p <0.05) (Figures 3, 4).

Discussion

Defining the perfect position of the new nipple in a breast reconstructed after mastectomy is a challenge for the surgeon and there are many possible methods described in the literature, also with the aid of dedicated software[8]. Liu and Thomson[9] defined the ideal sternal notch to nipple distance as 21 to 21.5 cm, and the ideal nipple to base distance as 6 cm.

Because of the inter-variability of breast proportions, the use of a single objective measurement or a single anatomical relationship to identify the flawless position of the NAC in each breast cannot be considered[5].

Aiming to determinate the ideal position of the NAC in the reconstructed breast, Khan and Bayat proposed to place it along the mammary meridian line matching the contralateral breast in the case

Figure 2. 56 years old Patient submitted to mastectomy and expander to implant reconstruction. The intersection between the mammary breast and the inframammary fold corresponds to point B. The new position of the nipple is represented by the point N, which is located on the breast meridian, and it is calculated with theorem $SN^2=PB^2+ SP^2$; SN corresponds to the distance between the sternal notch and the nipple; SP represents the sternal notch to level of inframammary fold distance and PB is the distance from the median sternal line to the junction point between the breast meridian and the inframammary fold. SX corresponds to the median line passing through the sternal notch and the umbilicus.

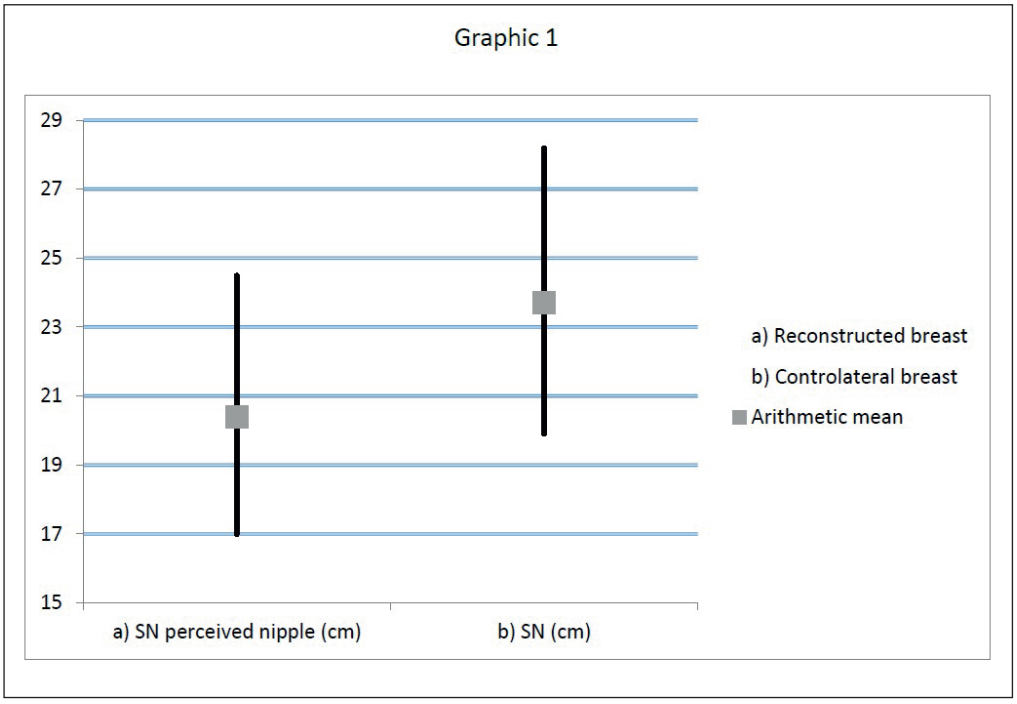

Figure 3. Comparison between the perceived nipple position on SN distances on the reconstructed breast, and SN nipple position on native breast distances. A statistically significant correlation emerges ($p<0.05$).

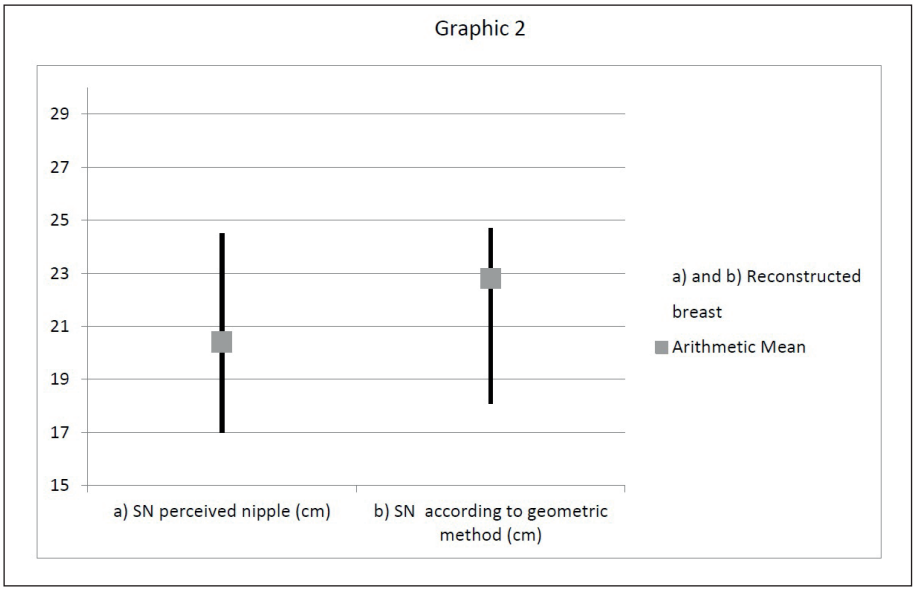

Figure 4. Comparison between the SN perceived nipple position distances and the SN ideal distances for a nipple to reconstruct position on breast mound, as identified with a geometric method applied to the reconstructed breasts. The two measurement groups largely overlap, and a statistically significant correlation emerges ($p<0.05$).

of unilateral reconstructions; though ultimately the comparison with the patient's opinion remains primary to increase the patient's level of satisfaction[4].

Lewin et al[10], ideally comparing the breast shape to a complex paraboloid structure, positioned the nipple at the boundary between the upper and lower pole, suggesting the ideal nipple position as slightly lateral to the midpoint.

Alternatively, reconstructive surgeons tend to place the nipple at the point of greatest breast pro-

jection[11] which generally corresponds to a sternal notch-to-nipple distance of 19-21 cm and a nipple-to-inframammary fold distance of 7-8 cm[12].

The correlation we found between the distances of the new nipple on the surface of a reconstructed breast identified by the different methods ($p<0.05$), allows us to affirm that patient's proprioceptive memory of the nipple can represent a valid option in defining the exact point to reconstruct a new one.

The time elapsed from mastectomy did not influence the patient's final perception and identification of the nipple position on the breast mound.

The perception and identification of the nipple position on the reconstructed breast was similar in patients submitted to unilateral Modified Radical Mastectomy (MRM) or Skin Sparing Mastectomy (SSM) and having received breast reconstruction with either autologous tissues or implants. Therefore, these aspects were not considered as potential limitations for the study.

We believe that patient's proprioception and indications involve the deepest level of self-awareness, thus helping to identify the correct position of the nipple on the reconstructed breast, in accordance with the position of the contralateral nipple and saving laborious geometric calculations, which allow for the possibility of error.

Conclusions

By relying on the proprioceptive memory of the patient's own nipple, as a support to better identify the best location of the nipple on a reconstructed breast, it is possible to obtain not only a good aesthetic outcome but also, much more importantly, patient's satisfaction and return to self-esteem.

Conflict of Interest
The authors declare that they have no competing interests.

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