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ORIGINAL ARTICLE

Gender-Affirming Surgery

Developing Practice Guidelines on Chest Masculinization: Designing Male Neo-nipple–Areolar Complex

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Background: Successful nipple–areolar complex (NAC) reconstruction greatly influences patient outcomes for transgender patients undergoing chest masculinization. Despite the recent rise in case volume, little is known on designing the ideal NAC that maintains its aesthetics in dynamic settings. This study aimed to examine the characteristics of male NACs and their dimensional variability to help develop guidelines on designing the neo-NAC.

Methods: Thirty cisgender male participants were enrolled. NAC height and width, sternal notch-to-nipple distance, and internipple distance (IND) were measured in standing and supine positions with stable room temperature to prevent measurement bias. Other variables recorded included chest circumference, NAC angulation, body mass index, weight, height, age, and ethnicity.

Results: Mean standing and supine measurements were as follows: NAC height, 21.2 mm (SD, 3.9) versus 23.4 mm (SD, 4.7); NAC width, 29.0 mm (SD, 5.1) versus 29.7 mm (SD, 5.6); sternal notch-to-nipple distance, 20.8 cm (SD, 2.1) versus 19.3 cm (SD, 1.8); and IND, 22.4 cm (SD, 2.3) versus 23.5 cm (SD, 2.5). NAC height-to-width ratio decreases from supine to standing, as well as IND, indicating a medialization of the NACs when upright.

Conclusions: Our findings suggest that during chest masculinization surgery, the design of the male neo-NAC has a risk of being positioned too medial and elliptical with upright positioning. Care must be taken intraoperatively to account for changes in neo-NAC dimensions that occur with body position changes. We strongly recommend that surgeons determine the final position of the neo-NAC intraoperatively while having the patient in upright sitting position. *(Plast Reconstr Surg Glob Open 2024; 12:e6376; doi: 10.1097/GOX.0000000000006376; Published online 20 December 2024.)*

INTRODUCTION

In recent years, there has been a notable surge in the number of individuals openly identifying as transgender. As of 2021, national surveys collected from the Centers for Disease Control and Prevention's Behavioral Risk Factor Surveillance System and the Youth Risk Behavior Survey have reported an estimated 1.6 million adults and adolescents identifying as transgender in the United States, with conservative estimates suggesting a global prevalence near 25 million.[1,2] Although these figures likely underreport the true size of the transgender population, the rate of transgender individuals seeking gender-affirming care through traditional healthcare channels has recently experienced substantial growth. This is most likely driven in part by the clear mental health benefits these procedures provide, along with progressive shifts in healthcare reforms that now encompass gender-affirming care in light of these findings.[2–7]

Mastectomy and masculinization of the chest wall is a key procedure for female-to-male (FTM) transformation and brings forth significant improvement of gender dysphoria and quality of life with both short- and long-term benefits.[8,9] Nonetheless, masculinizing chest procedures

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have increased by more than 180% from 2016 to 2020.[10,11] Furthermore, it is often the first and most common gender-affirming surgery pursued by transmasculine individuals.[12–14] Moreover, despite transgender men making up the minority of the transgender community, a 2015 US Transgender Survey found transgender men were more likely to undergo surgery than transgender women.[3,15] However, patient outcomes for chest masculinization are exceedingly surgeon-dependent and can vary drastically owing to differences in operator technique.[16] Although the majority of patients are satisfied, the lack of standardization in chest masculinization procedures can lead to poor results requiring revisions.[17]

A key element of chest masculinization is determining the size and position of the nipple–areolar complex (NAC). However, there is substantial variability in the design of the neo-NAC. Some studies have suggested the optimal positioning for a male NAC using techniques centered around 3 landmarks for NAC positioning: one-third lateral of the clavicle length, the lower larger cross on the midline axis of the sternum, and the line from the sternal notch to nipple, measured preoperatively in standing position.[8,18] One study stated that the male NAC should be placed 19 cm from the sternal notch with an internipple distance (IND) of 22 cm.[19] Another study described the NAC position in relation to the pectoralis major muscle, specifically 3 cm medial to the lateral border and 2.5 cm superior to the inferior insertion site.[18] In addition, another study describes placing NAC grafts by identifying the vertical component at the level of the fourth rib near the lateral border of the pectoralis.[20] The typical masculine NAC is described as being elliptical-shaped, with dimensions of roughly 2.5 cm (width) by 2 cm (height).[19,21] Although these recommendations help guide the design of a male NAC, they do not account for the variability in patient physique. For example, the chest circumference can vary drastically among people of the same height and weight. As such, the "one-size-fits-all" approach without accounting for these factors inevitably leads to poor outcomes in some patients. Moreover, to date, no study has described how the dimensions of the male NAC vary with changes in patient positioning.

Intraoperatively, the NAC shape and position is determined according to surgeon preferences, with many making operative markings while the patient is supine. However, the postoperative results are often assessed when the patient is standing or sitting upright in a clinic chair. In fact, patients most often assess their own chest in the mirror while standing. Although some technical reports consider the dynamic nature of NAC positioning on the chest wall, there are limited characterizations of NAC *shape* design, which should incorporate patient positioning into the process.[20,22,23] Therefore, we designed a study to obtain measurements of the male chest and NAC size and position and to determine how it changes with different body positions. Our study results will help improve the quality of care provided for patients with gender dysphoria, leading to better surgical and patient outcomes for patients undergoing chest masculinization.

Takeaways

Question: What are the optimal characteristics of male nipple–areolar complexes (NACs) given their dimensional variability?

Findings: Traditional design of the male neo-NAC has a risk of being positioned too medial and elliptical, which becomes evident with upright positioning. Therefore, care must be taken intraoperatively to account for changes in neo-NAC dimensions that occur with body position changes.

Meaning: Chest masculinization surgeons should determine the final position of the neo-NAC intraoperatively while having the patient in an upright position. This will help reduce aesthetic complications and, ultimately, improve surgical outcomes and patient satisfaction.

METHODS

This was an observational study approved by the institutional review board (IRB #2483) at the University of California, Irvine Medical Center. Inclusion criteria were cisgender male participants without a history of procedures resulting in a surgical scar over the anterior thoracic region and with the ability to lay supine and stand upright. After informed consent was obtained, we collected demographic data, including age and ethnicity. Measurements were then collected while subjects were standing with arms in adduction, including body weight and height, body mass index (BMI), chest circumference, NAC height and width, sternal notch-to-nipple distance (SNND), and IND (Fig. 1). NAC angulation measurements, defined as the degree of orientation of the NAC's long axis relative to a perpendicular horizontal line, were also collected (Fig. 2). Study participants were then instructed to lay in a supine position with arms in the standard anatomical position. Measurements were again obtained for NAC height and width, SNND, and IND. A new variable, NAC height-to-width ratio (HWR), was calculated separately for standing and supine positions. Measurements were obtained with a weight and height scale, a standard tape measure, a micrometer caliper, and a protractor. To prevent interobserver variability, all measurements were collected by 2 researchers (J.V. and A.G.) using the same set of instruments in a private room at stable temperature (22°C) to protect patient privacy and prevent dimension variability secondary to cold-induced NAC contraction.

The overall target sample size was determined by conducting a proportions 2-sample/2-sided equality power analysis to distinguish between supine and standing measurements. According to previous literature, the average standing male NAC is oval-shaped, measures approximately 2 × 2.5 cm, and yields a proportion of $2/2.5 = 0.8$.[10,19] Similarly, descriptions of round male NACs were found to be approximately 2.59 cm in diameter, yielding a proportion of $2.59/2.59 = 1$. To achieve statistical power of 80% with an alpha error rate of 5%, a conservative power analysis dictated a requirement of 30 study participants to detect differences between standing and supine NAC dimensions.

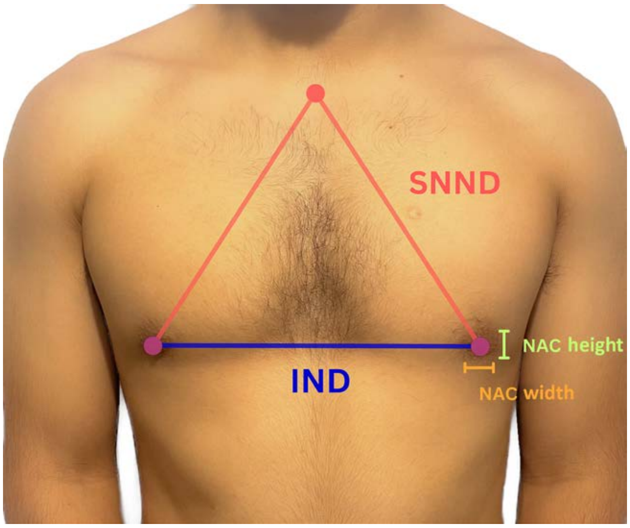

Fig. 1. Measurement guide. Front profile of a study participant, outlining properties measured. SNND (red): sternal notch-to-nipple distance; measured from sternal notch to center of nipple. IND (navy blue): internipple distance; measured from center of both nipples. NAC height (green): nipple–areolar complex height; measured from topmost to bottommost point. NAC width (orange): nipple–areolar complex width; measured from most lateral to most medial point.

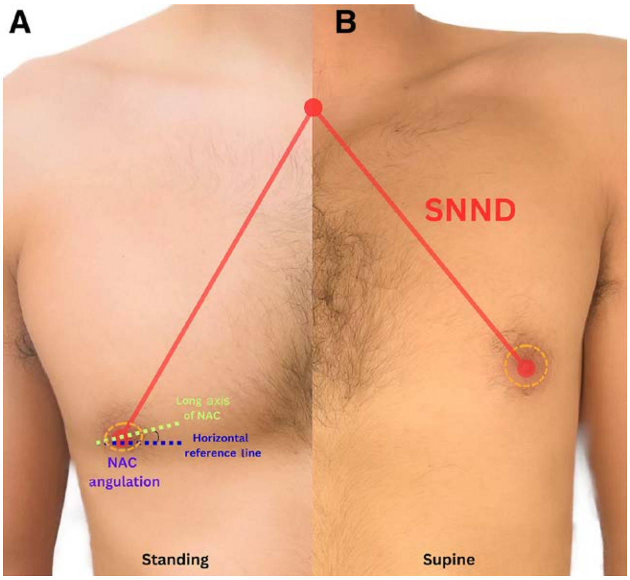

Fig. 2. NAC angulation and body positioning changes. Side-by-side profile of the same participant standing (A) and supine (B), demonstrating variability of NAC with different positioning. The dashed orange lines depict the boundaries of the NAC. NAC angulation is measured by the angle between a horizontal reference line (blue) and the long axis of the NAC (green). SNND (red) increases from supine to standing.

Descriptive statistical analysis was performed on all variables. Measurement data on NAC HWR, SNND, and IND was analyzed using paired *t* tests to compare mean differences from standing and supine positions and Cohen *d* effect sizes were calculated. A multiple linear regression model was also constructed to determine the effect of patient factors on the mean difference between standing and supine NAC HWR. Residual statistics were calculated to test for heteroscedasticity, defined as the presence of unequal variances in the error terms, to ensure that the regression model's estimates were reliable. We calculated 95% confidence intervals when appropriate, and *P* values of less than 0.05 were considered statistically significant.

RESULTS

Thirty cisgender male patients were enrolled in the study, and all their data were included in the analysis. The demographic information and collected measurements are summarized in Table 1. Specifically, the mean age and BMI was 27.40 years (range, 19–76 years) and 24.78 kg/m^2 (SD, 3.05 kg/m^2), respectively, whereas NAC angulation measured at a mean of 27.8° (SD, 8.48°).

Measurements for NAC height and width both decreased as subjects transitioned from supine (height 23.41 mm [SD, 4.67], width 29.68 mm [SD, 5.55]) to standing (height 21.23 mm [SD, 3.95], width 29.01 mm [SD, 5.07]). Notably, NAC height experienced a greater decrease than NAC width, leading to an overall decrease of NAC HWR when transitioning from supine to standing (0.80 [SD, 0.14] versus 0.74 [SD, 0.13], $P = 0.004$) (Fig. 2). Similarly, IND decreased from supine to standing (23.54 cm [SD, 2.46] versus 22.38 cm [SD, 2.34], $P < 0.001$), whereas SNND increased from supine to standing (19.35 cm [SD, 1.77] versus 20.80 cm [SD, 2.09], $P < 0.001$) (Table 2, Fig. 2).

Standardized residual plotting of all measurement data was not significant for heteroscedasticity, supporting the implementation of our multiple linear regression model. There was no significant association between race/ethnicity, age, BMI, chest circumference, or NAC angulation on the magnitude of NAC HWR reduction when transitioning from supine to standing (Table 3).

DISCUSSION

The NAC is an essential component for achieving a natural-appearing male chest in chest masculinization surgery.[24,25] However, the lack of standardized guidelines for optimal NAC dimensions and placement can lead to poor surgical and patient outcomes. In an effort to address this gap in knowledge, we designed our study to obtain a more robust understanding of the dynamic nature of male NACs by quantifying the change in male NAC dimensions with different body positions. Our study results could help plastic surgeons improve outcomes in chest masculinization for the transgender patient population. In our study, we found that the NAC height decreased by an average of 2.18 mm and width by 0.67 mm when transitioning from supine to standing. This finding shows that although the male NAC may be round and radially symmetric while supine on the operating table, the NAC may, in fact, become increasingly elliptical while in the upright position. As expected, the SNND exhibited a significant increase of 1.45 cm from supine to standing,

Table 1. Summary of Patient Demographics and NAC Measurements

N = 30	Mean	Minimum	Maximum	Standard Deviation	Standard Error
Age, years	27.4	19	76	10.9	2.0
Weight, kg	77.6	60.9	99.8	11.9	2.2
Height, cm	176.7	160.0	193.0	7.6	1.4
BMI, kg/m^2	24.8	19.1	32.1	3.0	0.6
Room temperature, °F	71.8	70.5	75.0	1.2	0.2
Chest circumference, cm	100.3	87.0	120.7	8.9	1.5
NAC angulation, °	27.8	9.1	46.3	8.5	1.5
Supine NAC height, mm	23.4	15.7	38.5	4.7	0.9
Supine NAC width, mm	29.7	17.7	46.3	5.6	1.0
Standing NAC height, mm	21.2	16.0	35.8	3.9	0.7
Standing NAC width, mm	29.0	17.0	46.4	5.1	0.9
Supine NAC HWR	0.8	0.5	1.1	0.1	0.0
Standing NAC HWR	0.7	0.5	1.0	0.1	0.0
Ratio difference	0.06	−0.2	0.2	0.1	0.0
Supine SNND, cm	19.3	15.5	23.5	1.8	0.3
Standing SNND, cm	20.8	17.0	26.0	2.1	0.4
Supine IND, cm	23.5	19.0	29.5	2.5	0.4
Standing IND, cm	22.4	18.5	29.5	2.3	0.4

Table 2. Paired Differences of NAC Properties From Supine to Standing Position

	Mean Difference	95% CI	Effect Size*	*P*
NAC HWR	0.6	(0.02, 0.1]	0.6	0.004
SNND	−1.5	(−1.9, −1.0)	1.2	<0.001
IND	1.2	(0.9, 1.5)	1.5	<0.001

*Effect size as measured by Cohen *d* statistic.
CI, confidence interval.

Table 3. Multiple Linear Regression Model for Factors Affecting NAC HWR With Position Changes (Supine to Upright)

Model	Odds Ratio	95% CI	*P*
Age, years	−0.001	(−0.005, 0.003)	0.54
BMI, kg/m^2	−0.005	(−0.033, 0.024)	0.73
Room temperature,°F	−0.014	(−0.047, 0.019)	0.40
Chest circumference, cm	−0.004	(−0.030, 0.023)	0.78
NAC angulation,°	−0.002	(−0.007, 0.003)	0.46
Race/ethnicity	0.029	(0.000, 0.057)	0.05

CI, confidence interval.

which supports the recommendation against placing the NACs too inferiorly. Interestingly, we discovered that the mean IND demonstrated a significant decrease of 1.16 cm from supine to standing. This finding supports the recommendation not to place NACs too medially while patients are supine in the OR, as this feature may become more pronounced when patients stand.

Mastectomy and masculinization of the chest wall is a key procedure for FTM transformation and encompasses many surgical techniques.[14,26–29] As previously noted, different studies have explored the ideal size, configuration, and placement of the NAC.[18,19,21,25,30] For example, Tanini et al[18] strived to characterize the ideal NAC to develop a technique that would expedite the sizing and placement of the NAC in chest masculinization procedures. Although they describe a very practical and novel technique, their subject population included a homogenous group of cis-male water polo players, which characteristically have a more athletically built physique compared with the general population. Therefore, similar to previous studies, they have not accounted for several patient variables that would affect final NAC outcomes, such as chest circumference. For this reason, several authors advocate for an intraoperative visual assessment for the ideal NAC positioning, specifically in patients with higher BMI and more dynamic chest walls, as they acknowledge these factors can greatly affect outcomes.[19,31] Another key factor that had not been explored in the literature before our study is patient positioning during the neo-NAC design. The shift of center of gravity from horizontal to vertical positions causes the underlying soft tissue and chest wall to be pulled downward. This, in turn, leads to a slight drooping or sagging of the overlaying soft tissue, which inevitably distorts and alters the NAC dimensions in ways that were not previously documented. From the data obtained in this study, we now have evidence that the NACs become flatter and more medial on the chest wall when patients become upright.

This study has a few limitations. Our study sample is subject to selection bias as all of the participants reside in Orange County, California. However, because Orange County is considered an ethnically and socioeconomically diverse population as outlined by the US consensus, it would be safe to say that our study results are generalizable despite the geographical concentration.[32] Our sample size of 30 patients may suggest sampling bias; however, our power calculation and statistical analysis results with multiple regression model confirm that any inherent bias or confounding effects have been minimized. In addition, the majority of the participants were young adults, age 21–30 years. Although a greater diversity in ages would improve external validity, it is important to note that almost half of transgender patients (48%) initiate their gender-affirming transition between ages 18 and 24 years, 25% between 25 and 34 years, and only 18% after 35 years.[15] Therefore, our study sample age range accurately reflects the typical patient population for chest masculinization surgery. In addition, the findings of these data may not be generalizable to patients with extremely low or high BMIs. However, our participants represent a large percentage of the population with BMIs from 19.08 to 32.09.[33] Finally, one may note that our study population of cis-male patients do not match the transgender patient population undergoing FTM transformation. Nevertheless, the goal of our study was to examine the dynamic nature of male NACs in different body positions. For this purpose, obtaining measurements of the NACs of a cis-male population, instead of a transgender FTM population, most accurately captures the variability in NAC dimensions from different body positions. We are confident that our study design and results are valid and strongly applicable. Nonetheless, we acknowledge the subjectivity involved in determining a successful NAC reconstruction and recommend a shared decision-making process that balances the patients' aesthetic preferences with what is feasible. We recommend that surgeons and clinicians providing gender-affirming care inform patients that outcomes may vary due to individual factors such as unique anatomy, testosterone levels, natural asymmetry, skin quality, and unpredictable healing patterns. Specifically, free nipple graft scarring and distortion may occur due to a potential downward pull by a healing inferior incision. Thus, although there may be limited generalizability in the setting of variable factors affecting healing and scarring, the recommendations in this study can help improve the odds of adequate final NAC shape.

Our study results provide insight into important NAC attributes that change from a supine to an upright position, which may guide surgeons' techniques in designing the dimensions of the neo-NAC. Although an elliptical shape may be the most natural conformation for the male NAC, it is important to be aware of the changes in position to improve surgical planning and avoid an overly elliptical NAC, which may be further pronounced by postoperative skin tension and contracture.[31,34] The data collected in this study dictate the recommended NAC height × width dimensions to be 23.4 mm (±4.7) × 29.7 mm (±5.6) (HWR, 0.8), whereas supine should roughly translate to a measurement of 21.2 mm (±3.9) × 29.0 mm (±5.1) (HWR, 0.7) while standing with an angulation of approximately 27.8 degrees. Although the exact measurements may be difficult to gauge with the naked eye, it is crucial to recognize the pattern of change. The changes observed in IND caution that placing the male neo-NACs in what seems to be an acceptable position in the operating room can lead to medialized NACs with shorter INDs when patients stand up. Similarly, the increase in SNND appreciated while standing suggests that the NAC may conform to an exaggeratedly inferior position if placed too low intraoperatively, which may result in a ptosis-like appearance.[16] These patterns remained relevant despite accounting for patient characteristic factors such as age, ethnicity, and chest circumference, indicating that our findings are mostly generalizable and will be applicable to most patients across diverse profiles seeking chest masculinization surgery. Moreover, BMI or chest circumference did not significantly influence how much the NAC changed, suggesting that patients with relatively low or high BMIs could expect similar variations in NAC dimensions with changes in position.

CONCLUSIONS

Our study findings provide a more robust understanding that describes the dynamic variability of the male NAC dimensions and positioning that occur with body position changes. Most notably, we have demonstrated that the NAC HWR decreases and its position becomes more medial in a standing position. A male neo-NAC that seems appropriate while the patient is supine on the operating room table could result in an NAC that is overly flattened and medial when the patient is upright. Furthermore, scar contractures over time along the horizontal incisions could pose the threat of additional flattening of the NAC. The positioning of the patient's arms is also important, as this can affect the underlying base of the neo-NAC. Having the arms in adduction is optimal, as this ensures the base is not distorted superolaterally. Plastic surgeons should incorporate these considerations into the design of the NAC to achieve increased patient satisfaction following top surgery.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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