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Authors

Kiessling, Patrick
Balakrishnan, Karthik
Fauer, Alex
et al.

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Social Perception of External Laryngeal Anatomy Related to Gender Expression in a Web-based Survey

Patrick Kiessling MD[1]; Karthik Balakrishnan, MD, MPH[1]; Alex Fauer PhD, RN[2]; Akshay Sanan MD[3]; Daniella McDonald PhD[4]; James Thomas MD[5]; Elizabeth Erickson-Direnzo PhD, CCC-SLP[1]; C. Kwang Sung MD, MS[1]; Brian Nuyen MD[1,5]

[1]Department of Otolaryngology-Head and Neck Surgery, Stanford University School of Medicine, Stanford, CA; [2]National Clinician Scholars Program, Division of General Internal Medicine and Health Services Research, School of Medicine, University of California, Los Angeles, CA; [3]Facial Plastic and Reconstructive Surgery, Private Practice, Los Angeles, CA; [4]University of California San Diego School of Medicine, San Diego, CA; [5]Voice Doctor Clinic, Portland, OR

Corresponding Author:
Patrick Kiessling, MD
patkiess@stanford.edu
801 Welch Rd
Palo Alto, CA 94304

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Abstract

Objective(s): To quantify the effect of laryngeal prominence size on socially perceived attributes relating to gender expression. Chondrolaryngoplasty (“tracheal shave”) is a common procedure performed for transgender women to feminize neck appearance. The extent of thyroid cartilage resection needed to convey socially-perceived feminine gender expression without destabilizing the voice is incompletely understood.

Methods: Cross-sectional evaluation of a randomized allocation of images of varying laryngeal prominence to a non-repeated, random sample from November 2021 to December 2021. Photos of laryngeal prominence were isolated against a constant neck baseline with lateral, oblique, and frontal views. The images were embedded into a web-based survey with visual analogue scales to capture perceived scaled gender expression (masculinity, femininity) and social traits (e.g., attractiveness, friendliness, leadership). We performed bivariate and multivariate analyses relating the laryngeal prominence to perceived gender expression and social traits.

Results: The analytic sample included 1,026 respondents. Laryngeal grades similar to the demonstrated “grade M” in this study and smaller demonstrated similar perceptions of increased femininity and decreased masculinity. Grades larger than M demonstrate significantly increased perceived masculinity and significantly decreased perceived femininity. The lateral and oblique views of the neck appear to be the most gender-informative.

Conclusion: This crowd-sourced analysis of external laryngeal anatomy by a large population of observers provides clear, reproducible insights into social perceptions of gender identity and specifically femininity. These data will meaningfully inform

patient counseling and surgical planning for gender-affirming interventions by establishing normative data representing the general public's perceptions.

Lay Summary: Chondrolaryngoplasty for gender-affirming care must balance perceived gender expression with preserved thyroid cartilage to maintain laryngeal function. This study measures social perceptions of femininity and masculinity related to laryngeal prominence size.

Keywords: Gender and the voice; laryngeal anatomy and physiology; transgender; quality of life (laryngology).

Level of Evidence:

Level 2b: Individual cohort study (cross sectional)

Introduction

Transfeminine individuals, or transgender and gender non-conforming (TGNC) persons assigned male at birth who identify as female and/or with a more feminine gender expression, have been shown to experience poorer quality-of-life as a result of gender dysphoria.[1–4] Gender dysphoria refers to the psychological distress from the incongruence between an individual's sex assigned at birth and their gender identity.[1,5] This distress often occurs due to the presence of secondary sex characteristics and other gender cues (i.e. vocal pitch, jawline, chest size, neck contour, brow bossing, etc.) not being in alignment with their gender identity.[6–9] In particular, secondary sex characteristics such as the laryngeal prominence (known colloquially as the "Adam's Apple") can communicate an individual's gender.[7,10,11] A pronounced laryngeal prominence can cause significant distress for transfeminine individuals,[8,11–13] and lead to deleterious social and health outcomes.[9,14] Upon undergoing chondrolaryngoplasty (known colloquially by the misnomer "tracheal shave"), quality of life is greatly improved for transfeminine individuals.[7,11,15–17]

First described in 1975, chondrolaryngoplasty aims to flatten the laryngeal prominence to feminize a patient's appearance, and improves quality of life in TGNC patients by decreasing the laryngeal prominence.[2,4,13,15] Risks of chondrolaryngoplasty include vocal fold injury, destabilization of the epiglottis leading to dysphagia or aspiration, and weakening of the attachment of the anterior commissure tendon resulting in deepening of the voice and vocal fold destabilization.[7,13,18] Leaving some thyroid cartilage to the level of the anterior commissure in place during chondrolaryngoplasty is mandatory to avoid these complications, especially if there is anteriorly projecting cartilage inferior to the level of the anterior commissure.[13] Additionally, some patients will likely have

residual prominence of the larynx following improvement of the thyroid cartilage contour if they have a large larynx and prominent superior thyroid notch,[13] which raises the question of how much cartilage is safe to resect while optimizing socially perceived gender expression.

Studies exist assessing the laryngeal prominence and what size is within the range of normal for cisgender males and females.[11] Analysis of unaltered laryngeal prominence suggested that a laryngeal prominence standard of 2 mm or less could be considered to obtain a more feminine appearance.[19] These studies of laryngeal prominence standards were created based on cisgender patients, and did not assess social perception of the laryngeal prominence, instead relating it to self-identified gender.

One study examined physical appearance of the neck and its relationship to gender perception, though these ratings of appearance were completed by a small panel of observers influenced by the context of voice recordings.[20] No study to our knowledge has assessed the public perception on laryngeal prominence size and neck contour in its relation to gender. Having these data would be crucial to understanding how the public views neck contour to best aid transfeminine individuals in being perceived as their experienced gender. Previous work has assessed public perception on overall facial feminization and vocal feminization with great success.[21,22] An independent analysis of the visual appearance of the neck by a larger population is warranted to provide clear, reproducible insights into social perception as related to gender identity and specifically femininity.

In this study, we examined the social perception of neck contour by quantifying the effect of laryngeal prominence size on socially perceived attributes as they relate to gender expression, with the long-term goal to better inform

surgeons of gender information inherent to external laryngeal anatomy and guide appropriate resection. We used crowd-sourced analysis of external laryngeal anatomy by a large population of observers, with the hypothesis that decreasing laryngeal prominence would be associated with increased perceived femininity and decreased perceived masculinity. This study provides insight into social perceptions of gender identity and more specifically femininity. While gender perception is influenced by multiple patient features, these data will help inform surgical planning for gender-affirming surgeries, specifically chondrolaryngoplasty, by establishing normative data via the general public's perceptions of neck contour as it relates to gender.

Materials and Methods

This study was a cross-sectional evaluation by non-experts of standardized photographs featuring varied sizes of laryngeal prominence and associated perceived gender identity and social traits among a random sample. The study was approved by the Stanford University (Stanford, CA) Institutional Review Board (IRB #62629).

Survey Design. Eight cisgender male patients and eight cisgender female patients seen at an otolaryngology clinic for reasons outside of neck complaints were recruited for neck photography. They provided written informed consent for their photographs to be used for research and publication purposes. Photographs were taken in frontal, oblique, and lateral views with a consistent background. Using the Delphi method, three authors (P.K., A.S., and B.N.) selected one cisgender male volunteer's photographs. These images were selected based on the perceived "middle ground" of laryngeal prominence, and likely ability to easily digitally

augment or minimize this prominence. These images also did not have any overt markers of gender, and were cropped to mask other features that may have influenced gender perception. Photoshop CC 2022 (Adobe Systems Inc., San Jose, CA) was used for image manipulation. The patient volunteer's photographs were converted to grayscale to reduce the effect of color texture variation on social perception (Jones 2016).[23] The "Face Aware Liquify" tool was used to create varying degrees of laryngeal prominence in the lateral, oblique, and frontal views of the study neck. Qualtrics Survey Software 2022 (Qualtrics LLC, Provo, UT) was used to administer surveys to an existing panel of vetted adult research survey respondents who were recruited through website advertisements, social media, and email lists.

Exposure. The varying degrees of laryngeal prominence size were generated from deidentified images of the volunteer's neck against a constant neck baseline, generating five total grades of laryngeal prominence: Extra-Small (XS), Small (S), Medium (M), Large (L), and Extra-Large (XL). These images are shown in Figure 1. In each survey, respondents were randomized to one grade of laryngeal prominence and exposed to lateral, oblique, and frontal views of the study neck.

Outcome measures. Participants rated each photograph with a particular grade along a visual analogue scale (VAS), evaluating the same 8 metrics: femininity, masculinity, friendliness, trustworthiness, attractiveness, health, intelligence, and leadership ability. The additional social traits beyond perceived masculinity and femininity were chosen based on their relationship to masculinity and femininity as demonstrated in prior social perception studies.[23] Facial rejuvenation surgery appears to increase perceptions of youth, and these perceptions may be tied to increases in perceived femininity, likeability, and attractiveness.[23,25] Conversely, increased perceived facial masculinity appears to be

correlated with higher perceived leadership abilities, while increased masculinity may not directly relate to perceived attractiveness.[26,27] A VAS score of 0 least embodied each characteristic, whereas a score of 100 most embodied each characteristic. Number of clicks and time spent viewing the image prior to completion of scoring were measured. The participants were unaware of the purpose of the study, did not take the survey more than once, and were reimbursed for responses.

Demographic factors. We collected demographic information of the respondents at the time of survey completion, including gender, ethnicity, political party, sexual identity, and if the respondent was a medical professional. Gender was defined as male, cisgender; female, cisgender; non-binary/genderqueer; male, transgender; female, transgender; and other. Ethnicity was defined as white/Caucasian, black/African-American, Hispanic/Latino, East Asian, or multiracial/ other. Political party was designated as Democrat, Independent, Republican, or other. Sexual identity was defined as straight (heterosexual), Asexual, Bisexual, Lesbian/Gay (homosexual), Pansexual, Queer/Questioning, or other. Being a medical professional was dichotomized as yes versus no. Demographic targets for respondents were specifically designed for this study to be representative of the general US population based on sampling standards set by Qualtrics.

Data Analysis. Statistical analyses were performed using Stata version 17 (StataCorp, College Station, TX). An alpha of $P < 0.05$ was used to define statistical significance.

First, we conducted bivariate assessments of masculinity and femininity scores across each laryngeal prominence grade with unpaired t-tests. We also used the Pearson correlation method to compare associations of social traits amongst

each other, and with masculinity and femininity. Next, we used ANOVA adjusted for race and income level to compare mean femininity and masculinity scores across laryngeal prominence gradings. Adjustments for race and income level were performed due to a weak moderation effect between laryngeal prominence grade and the outcome measures. Multiple linear regression models were performed relating perceived masculinity, and, separately femininity, to time spent viewing the laryngeal grade and number of clicks performed prior to completing scoring.

Finally, we performed unadjusted and race- and income-adjusted multivariate analysis with generalized linear models using an identity link function to estimate the relationship between laryngeal prominence and the primary outcome. All assumptions of linear regression within a normal distribution were met. We did not observe evidence of multicollinearity or overfitting while numerous covariates were added to the adjusted models.

Results

The analytic sample (n = 1,026 adult respondents) was administered the survey provided by Qualtrics LLC. All respondents had a 100% survey completion rate. The mean survey completion duration was 10.98 minutes with standard deviation of 9.93 minutes. No meaningful variations in the number of clicks or time spent viewing the laryngeal grade prior to completing scoring of perceived masculinity or femininity were observed in any of the three views. Among the laryngeal prominence grades, the XS grade was evaluated by 205 respondents, S by 204 respondents, M by 206 respondents, L by 205 respondents, and XL by 206 respondents. The sociodemographic characteristics of all survey respondents are

shown in Table 1. The cohort of adult respondents was consistent with targeted demographic distributions.

Masculinity and Femininity. Unpaired t-tests comparing the unadjusted VAS score means for masculinity and femininity between grades XS, S, M, L, and XL are seen in Table 2. For masculinity VAS scores, significant differences are seen when directly comparing M vs. L, M vs. XL, and XS vs. XL in both the lateral and oblique views. Significantly different masculinity scores in the frontal view were only seen when comparing XS to XL. Femininity VAS scores in the lateral view showed significant differences when comparing XS vs. M, M vs. XL, and XS vs. XL. Femininity VAS scores in the oblique view were significantly different when comparing M vs. XL, L vs. XL, and XS vs. XL. The only significantly different comparison noted in femininity scores was XS vs. XL in the frontal view. Further, unpaired t-tests compared the mean differences between masculinity and femininity scores across all grades, as seen in Table 3. Significant differences were seen in the lateral view in XS vs. M, M vs. XL, and XS vs. XL. In the oblique view, significant differences were seen in M vs. L, L vs. XL, M vs. XL, and XS vs. XL. In the frontal view, the only significant difference was seen in XS vs. XL.

Table 4 illustrates ANOVA analyses of masculinity and femininity VAS ratings across all grades, divided into frontal, lateral, and oblique views. Our ANOVA models demonstrated significant differences in both masculinity and femininity scores across laryngeal prominence grades for lateral and oblique views. The adjusted means of perceived masculinity and femininity are shown in panel Figure 2A-2C. Femininity scores remained below masculinity scores across all prominence grades in all views. Significant differences in perceived masculinity were observed across all grades of laryngeal prominence in each view (lateral $p < .001$, oblique $p < .001$,

frontal p = .004). However, perceived femininity varied significantly across lateral ($p < .001$) and oblique ($p < .001$) views only, and not the frontal view ($p = .11$).

Unadjusted and adjusted generalized linear models relating Grade-VAS to perceived masculinity and femininity in lateral, oblique, and frontal views were obtained, and all grades were directly compared to XS, as demonstrated in Tables 5A and 5B. Significant differences in masculinity VAS scores were only seen in grades L and XL in lateral and oblique views, and only XL in frontal view (5A). When directly compared to XS, femininity VAS scores for M, L, and XL were significantly different in the lateral view, and only grade XL was significantly different in the oblique and frontal views (5B).

Social traits. Table 6 demonstrates Pearson correlations between either masculinity or femininity and other scored traits (friendliness, trustworthiness, attractiveness, healthiness, intelligence, and leadership). Both masculinity and femininity correlated positively in all views with all other scored traits. However, only healthiness in the lateral view achieved a moderate correlation with masculinity. All other associations were weak at most. When analyzing the measured social attributes against laryngeal grade, there is a null association between grade to each of the social attributes across lateral, oblique, and frontal views.

Discussion

Within the context of chondrolaryngoplasty and providing gender-affirming care to transfeminine patients, this study evaluated how laryngeal contour influences social perceptions of gender expression. We demonstrated that laryngeal

prominences greater than Medium (M) modeled in this study were associated with greater differences seen in perceived masculinity and femininity, with oblique and lateral views being the most gender-informative.

Table 1 reveals that none of our study population identified as a transgender female, though three respondents identified as transgender male and seven respondents identified as non-binary/genderqueer. One study suggested that 871 per 100,000 individuals self-identify as transgender.[24] While our study focused on social perceptions by a study group representative of the general population, the input and contributions of transgender individuals is necessary and important in providing informed care.

Whether separately comparing mean masculinity or femininity scores across varying laryngeal prominence grades as seen in Table 2, assessing differences between masculinity and femininity scores within a given grade as seen in Table 3, or assessing linear models relating masculinity and femininity scores to laryngeal prominence, laryngeal prominence grades greater than Medium (M) convey significantly higher levels of perceived masculinity and lower levels of femininity. Conversely, Grade M did not significantly differ from lower grades, so this spectrum of laryngeal prominences should be taken into consideration when trying to obtain the most feminine neck while preserving functionality of the larynx. Notably, Grade M was the baseline image used to generate the altered images. The images for this patient, who identified as cisgender male, were specifically selected by the authors using the Delphi method because their laryngeal contour demonstrated a perceived "middle ground" that could be altered to have a more or less prominent contour. Additionally, the prominence and obviousness of the laryngeal framework externally may be affected by other elements of neck anatomy, including neck length, neck

width, and body habitus. While this study did not alter these additional elements of neck appearance, the prominence of the larynx in comparison to the study patient's neck created the basis of the labeled prominences XS-XL, and could therefore be analogously applied to the neck of any patient presenting for surgical evaluation.

Differences in neck perception noted across laryngeal grades were seen in lateral and oblique views, and not in frontal views. Significant differences were only seen in the frontal view when comparing masculinity or femininity scores between the extremes of grades, XS and XL, as seen in Table 2 and Table 3. No significant differences were noted in frontal views for ANOVA analyses of either masculinity or femininity VAS ratings across all grades. One prior study examined laryngeal prominence in cisgender patients and suggested that the frontal view may be more gender informative when assessing the overall laryngeal prominence volume in relation to the rest of the neck, rather than exclusively the size of the laryngeal prominence protrusion from the neck.[19] In our analysis, the lateral and oblique views provide the greatest differentiation between laryngeal prominences when evaluating perceived masculinity and femininity. Therefore, these views should be used to evaluate laryngeal prominence in future studies and guide surgical planning. Lateral and oblique views will be most useful when counseling patients preoperatively and providing computer simulations of what can be expected post-operatively.

Figure 2 shows that mean perceived masculinity scores in all three views remained above femininity scores across all laryngeal prominence grades. Femininity scores may have remained below masculinity scores due to the limited extent of anatomy presented in each image and other external gender cues that remained un-altered. These features include the patient's jawline, which featured

prominently in these images and remained unaltered, and has been demonstrated to contribute to perceptions of masculinity and femininity.[7] This study focuses on the impact of a singular aspect of gender presentation to better understand its contribution within the multifactorial nature of perceived gender. Facial feminization and postoperative perceptions have many contributing elements that often vary patient-to-patient. Studying the individual impact of specific features is warranted, in that it allows providers to understand how targeted interventions may alter gender perception. Specifically, the analysis of a specific feature is especially applicable in evaluating the utility and effects of chondrolaryngoplasty, which aims to change the singular aspect of laryngeal prominence, therefore underscoring the importance of this study.

Prior studies have examined the connections between femininity and masculinity with other perceived characteristics when viewing a patient's face. Facial rejuvenation surgery appears to increase perceptions of youth, and these perceptions may be tied to increases in perceived femininity, likeability, and attractiveness.[23,25] Conversely, increased perceived facial masculinity appears to be correlated with higher perceived leadership abilities, while increased masculinity may not directly relate to perceived attractiveness.[26,27] While scores of perceived masculinity and femininity in our study correlated positively in all views with all other scored traits, only healthiness in the lateral view achieved a moderate correlation with masculinity. All other associations were weak at most. The null association noted between laryngeal grade and each of the social attributes across lateral, oblique, and frontal views reveals that there is not a clear association between larger (or smaller) laryngeal prominence and the perceived traits beyond masculinity and femininity.

While rigid measures of laryngeal prominence, including angle or length of projection, may provide a quantitative measurement convenient for study purposes or accessible for statistical analysis, these thresholds are not immediately measurable or perceived when a neck is viewed socially. These angles and measurements were purposefully withheld from participants in the study, focusing instead on their perceptions in a general sense of laryngeal prominence. Photoshop, as used to alter the images shown to study participants, is frequently employed in surgical offices to simulate outcomes in real time with patients, without specifically measuring angles of projection. Instead, discretion of image alteration is left to the surgeon, who must carefully balance expected reduction in prominence with functional preservation of structures. Sharing the images and outcomes of this study with providers allows them to demonstrate the lack of significant difference in gender perception below the “M” size to patients. Using these images to guide manipulation of patient photographs for surgical expectations, while taking into account the other contributing elements of neck appearance on an individual patient basis, would be an especially useful implementation of this study.

Transgender patients who report that others can perceive them as transgender are more likely to experience denial of equal treatment, verbal harassment, and be physically attacked.[28] Investigation of the optimally perceived laryngeal prominence that maximizes femininity, minimizes masculinity, and preserves laryngeal function is warranted and necessary in providing comprehensive gender-affirming care.

Conclusion

Gender affirming care is a growing area of health care that remains largely under-investigated, especially within surgical sub-specialties. TGNC patients fall across the spectrum of laryngeal prominence grades illustrated in this study. Patients presenting for chondrolaryngoplasty (“tracheal shave”) will benefit from understanding where they stand along this spectrum, and how their externally perceived masculinity and femininity may change based on how their neck will appear post-operatively. Providers and patients will benefit from understanding that the lateral view of the neck appears to be the most gender-informative. Laryngeal grades similar to the demonstrated “grade M” in this study and smaller will provide similar perceptions of increased femininity and decreased masculinity, while grades larger than M demonstrate significant differences in these perceptions. Understanding the expected change in perceived masculinity and femininity can help guide the extent of laryngeal cartilage resection desired while preserving the structural integrity of the larynx.

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