OPEN

PRS GLOBAL OPEN

ORIGINAL ARTICLE
Gender-Affirming Surgery

Facial Feminization Surgery: A Systematic Review of Perioperative Surgical Planning and Outcomes

Abigail R. Tirrell, BS*
Areeg A. Abu El Hawa, BS*
Jenna C. Bekeny, MD†
Brian L. Chang, MD†
Gabriel Del Corral, MD†

Background: Facial feminization is a critical step in a transfeminine patient's surgical transition. However, the existing literature on the various types of feminization surgeries suffers from inadequate reporting on perioperative aspects of care, such as preoperative evaluation and postoperative outcomes. The aim of this study is to evaluate facial feminization surgery (FFS), preoperative planning, and patient reported outcomes after various types of procedures.

Methods: An electronic database search of Ovid MEDLINE was completed according to PRISMA guidelines for articles pertaining to FFS. Study characteristics, operative information, and patient demographics were collected. Data concerning preoperative imaging, virtual simulation, postoperative complications, and patient-reported outcome measures (PROMs) were collected and analyzed for patterns.

Results: A total of 22 papers representing 1302 patients were included for analysis. The most commonly discussed operations included upper face procedures, particularly of the forehead (17 studies, 77%). When discussed, preoperative planning for FFS included standard photography in 19 (86%) studies, advanced imaging, such as cephalometry or computed tomography, in 12 (55%) studies, and virtual simulation of surgical outcomes in four (18%) studies. Patient-centered outcomes, such as postoperative satisfaction, were described in 17 (77%) studies. Standardized PROMs were heterogenous across included studies with only 11 (50%) including at least one PROM.

Conclusions: FFS is common, safe, and highly satisfying for transfeminine patients seeking surgical intervention for identity actualization. Future research concerning transgender care must evaluate advanced surgical planning and 3D simulation combined with more standardized assessment of PROMs to ensure high-quality analysis of patient satisfaction. *(Plast Reconstr Surg Glob Open 2022;10:e4210; doi: 10.1097/GOX.0000000000004210; Published online 17 March 2022.)*

INTRODUCTION

As many as 1.4 million Americans, or 0.6% of the adult population, identify as trasngender.[1] As cultural norms shift and insurance coverage expands, more patients seek gender affirming surgery (GAS) to fulfill gender expression goals, and procedures such as facial feminization surgery (FFS) are increasingly performed.[2,3] In this marginalized patient population, GAS has been shown to reduce gender dysphoria, depression, and suicidality—highlighting its significant impact on patient well-being.[4,5]

FFS describes craniomaxillofacial procedures that transform masculine-appearing features into more feminine-appearing structures.[4] It includes procedures such as chondrolaryngoplasty to reduce thyroid cartilage prominence, mandibular setback, genioplasty, rhinoplasty, facial implants, forehead cranioplasty, hairline advancement, and fronto-orbital reshaping.[3,4] FFS is often a pivotal step in the surgical journey of nonbinary and transgender patients, critical to achieving congruence between a person's facial features and the physical expression of their gender identity.[3] As a highly visible area, facial misgendering is an exceedingly common problem with devastating impacts on a person's daily experience.[5]

Unfortunately, the existing literature on FFS suffers from inconsistent outcome reporting, underpowered studies, and lack of standardized perioperative management

*From the *Georgetown University School of Medicine, Washington, D.C.; and †Department of Plastic and Reconstructive Surgery, MedStar Georgetown University Hospital, Washington, D.C.*

Received for publication November 2, 2021; accepted January 14, 2022.

DOI: 10.1097/GOX.0000000000004210

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

guidelines.[6] Information regarding virtual surgical planning in the transfeminine population is limited, but its use may help to achieve treatment goals and educate patients for appropriate expectations.[6,7] It is also important to assess how FFS impacts patient lives from a patient-centered approach. GAS has been shown to significantly improve quality of life (QOL); however, there are disparities in how patient-reported outcomes are measured, and therefore it is difficult to understand which methods of FFS have high patient satisfaction and improve dysphoria.[4,8]

The aim of this study is to assess the literature on FFS and its perioperative period by analyzing the prevalence of various FFS procedures, planning techniques employed in the preoperative stage, and postoperative patient-reported outcomes.

Takeaways

Question: A lack of comprehensive reporting of preoperative planning and patient-centered outcomes of facial feminization surgery (FFS) exists.

Findings: Twenty-two studies were identified, primarily describing upper face procedures. Only 12 (55%) incorporated advanced imaging in preoperative planning, and even fewer (18%) implemented virtual simulation. Patient-centered outcomes were described in 17 (77%), using heterogenous patient-reported outcome measures (PROMs) in 11 (50%).

Meaning: FFS procedures are infrequently reported, precluding adequate ability to assess advances in preoperative planning and patient-centered outcomes, calling for improved reporting.

METHODS

Study Design and Search Strategy

A systematic review was performed to identify all studies that report any FFS procedure in the literature. The primary endpoints of this review were to assess (1) the prevalence of different types of FFS described in the literature; (2) the proportion of studies that report preoperative surgical planning; and (3) the prevalence of reporting clinical-centered outcomes (CCOs) and patient-centered outcomes (PCOs). Additional endpoints included details of the methods of surgical preoperative planning and common outcomes and findings reported after FFS procedures.

This review adhered to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A search of Ovid MEDLINE was performed using Medical Subject Heading (MeSH) terms and keywords including, but not limited to: *rhinoplasty, chondrolaryngoplasty, blepharoplasty, rhytidoplasty, nasal surgical procedures, mandible reconstruction; feminization, feminize* (**see table, Supplemental Digital Content 1**, which displays systematic review search strategy, **http://links.lww.com/PRSGO/B971**). No restrictions were set on the year of publication or country of origin.

Study Selection

For inclusion, studies had to report any FFS and any outcome of FFS, including clinical or patient satisfaction outcomes. Two reviewers (A.A.A. and J.C.B.) screened each citation for relevance based on title and abstract. If a screening decision was not unanimous, a third reviewer (A.R.T.) was consulted until consensus. The remaining studies underwent full-text review. All included papers were English language observational studies published in peer-reviewed journals from any country of origin. Systematic reviews, editorials, or case reports on less than three patients were excluded. The Newcastle-Ottawa Scale (NOS) was applied to assess the quality and possible biases of each article by a single reviewer.

Data Collection and Analysis

The specific facial feminization procedures and patient demographics were collected for each study and reported as weighted value means. Facial regions were defined as upper face (including forehead and eyes), middle face (including nose, cheeks, and ears), lower face (including lips, chin, and jaw), and neck, and were quantified by proportion of total procedures performed in all studies. The primary study outcomes assessed were preoperative planning modalities, including photography, imaging, and outcome modeling, and postoperative evaluation in the categories of CCOs and PCOs. Types of preoperative planning modalities and postoperative outcomes were quantified by proportion of studies reporting each modality and outcome. Weighted mean complication rates were calculated, and qualitative satisfaction outcomes were collected.

A flowchart was then generated based on the data collected to portray key considerations in the perioperative period for full or partial FFS procedures. The most common procedures performed in each facial region were highlighted, and commonly reported preoperative measurements, imaging, and planning modalities were incorporated for each facial region. The most prevalent outcomes measured in the included studies were also integrated in the flowchart.

RESULTS

Systematic Review

The initial search strategy yielded 698 citations. 659 citations were excluded based on title and abstract screening, leaving 39 manuscripts for full text review. Ultimately, 22 manuscripts were included for review after 17 were excluded for reporting on nonfacial feminization procedures or lacking appropriate data (Fig. 1). The NOS found all studies met a minimum score of six, designating study quality as "good" or higher.

Study Characteristics and Patient Population

Table 1 displays the characteristics of the 22 articles included. Most were retrospective (n = 18, 81.8%) and from a single study center (n = 20, 90.9%). Study period ranged from 1 to 12 years, with size ranging between four and 220 patients. Mean follow-up ranged from 2 to 40 months.

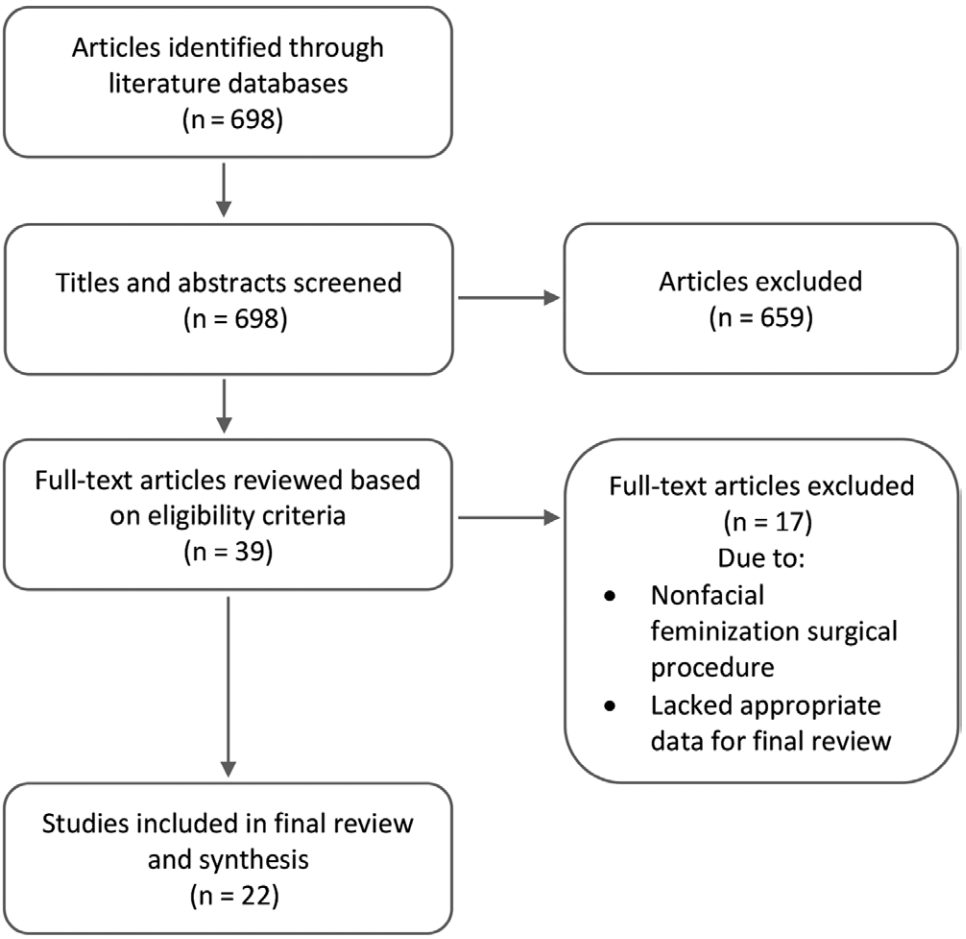


Fig. 1. Flowchart demonstrating the search strategy and article selection process for inclusion in this systematic review according to PRISMA guidelines. Twenty-two studies met criteria for inclusion.

The 22 manuscripts represented a total of 1302 patients undergoing at least one FFS. The median number of patients per study was 28 (IQR 16–66). Table 2 illustrates the mean patient age, hormone use, prior GAS and FFS procedures, and comorbidities. Comorbidities described included cardiovascular disease, mood disorders, and hypertension.[14,16,22] Only three studies reported patient demographics, including race or ethnicity, employment status, and median income, were only described by three studies in total.[8,14,26]

Facial Feminization Operations

Seven articles described "full FFS" in one or multiple stages.[9,20,22,23,25,28] Six reported on one single procedure,[17–19,21,26,29] whereas nine reported multiple procedures.[10–16,24,27] The median number of FFS per patient was two (IQR 1–4.9).

The most common region operated on was the upper face, reported by 17 (77.3%) studies (Fig. 2). The forehead was the most common facial structure operated on, described in 17 (77.3%) studies. Others frequently operated on were the nose, jawline, chin, and neck. Figure 3 specifies the assortment of FFS performed in each facial region. Four thousand one hundred eight procedures were performed on 1211 patients, based on data from 18 studies. Two thousand nineteen procedures were performed in the upper face, 695 in the middle face, 1030 in the lower face, and 408 in the neck. Frequently performed procedures were frontal bone reduction, rhinoplasty, mandibuloplasty, hairline repositioning, and chondrolaryngoplasty.

Preoperative Evaluation

Preoperative planning was described by most studies (n = 21, 95.5%) (Table 3). The majority included standard facial photography in their planning, including frontal and profile views in 18 studies, three-quarter view in 14, and basal views of the nose in two. Additional imaging was utilized in 12 (54.5%) articles including cephalometry and computed tomography. Facial measurements were recorded in half of the studies through in-person measurements (n = 1 study, 4.5%), photogrammetric assessment (n = 5, 22.7%), cephalometry (n = 1, 4.5%), or computed tomography (CT) imaging (n = 5, 22.7%). Other preoperative planning is reported in Table 3, including orthodontic and vocal evaluation.[8,9,19,23,29]

Four studies (18.2%) included two-dimensional (2D) and three-dimensional (3D) postsurgical simulation and

Table 1. Included Manuscripts and Study Characteristics

Study	Type of Study	Location	Centers	Study Period	No. patients	Facial Regions	Facial Feminization Surgeries	Average No. FFS Per Patient	Average Follow-up Period
Balaji[9]	Prospective	India	Single center	2007–2014	7	Upper, middle, lower	Forehead reconstruction, rhinoplasty, genioplasty, gonial angle reduction, jaw contouring, zygoma correction	Multiple	—
Becking et al.[10]	Retrospective	The Netherlands	Single center	1992–1994	16	Middle, lower	Bimaxillary osteotomy, gonial angle reduction, genioplasty, zygoma augmentation, zygoma osteotomies	1.3	—
Bellinga et al.[11]	Retrospective	Spain	Single center	2010–2015	200	Upper, middle, lower	Rhinoplasty, forehead reconstruction, lip lift	2.1	18.8 mo
Capitán et al.[12]	Retrospective	Spain	Single center	2008–2014	214	Upper, lower	Forehead reconstruction, genioplasty, gonial angle osteotomy, jaw recontouring	1.8	28 mo
Capitán et al.[13]	Retrospective	Spain	Single center	2012–2015	65	Upper	Forehead reconstruction, hair transplantation	2	26 mo
Chou et al.[14]	Retrospective	The United States	Single center	2016–2018	121	Upper, middle, lower, neck	Scalp advancement, cranioplasty, brow lift, rhinoplasty, upper lip lift, mandibuloplasty, chondrolaryngoplasty	4.9	2.2 mo
Garcia-Rodriguez et al.[15]	Retrospective	The United States	Single center	2018	29	Upper	Hairline advancement, brow lift, galeotomy, frontal cranioplasty	Multiple	—
Gupta et al.[16]	Retrospective	The United States	Single center	2005–2017	25	Upper, middle, lower	Rhytidectomy, forehead contouring, cheek implants, rhinoplasty, mandible contouring	3	5.2 mo
Hoenig[17]	Retrospective	Germany	Single center	36-mo period	21	Upper	Frontal cranial vaultplasty	1	18 mo
Hage et al.[18]	Retrospective	Netherlands	Single center	1985–1996	22	Middle	Rhinoplasty	1	30 mo
Khafif et al.[19]	Prospective	Israel	Single center	2019	4	Neck	Chondrolaryngoplasty	1	2 mo
La Padula et al.[20]	Retrospective	France	Single center	2015–2018	25	Upper, middle, lower, neck	Frontal bone grinding, hairline advancement, rhinoplasty, malar implant, malar osteotomy, facial lipofilling, mandibular angle grinding, masseter muscle resection, mandibular angle implants, upper lip lift, orthognathic surgery, genioplasty, cervical liposuction, reduction laryngoplasty	7.6	—
Lipschitz et al.[21]	Retrospective	Israel	Single center	2006–2015	27	Neck	Thyroid chondroplasty, cricothyroid approximation	1.6	2.7 mo
Morrison et al.[8]	Prospective	The United States	Multicenter	—	66	Upper, middle, lower, neck	Hairline lowering, hair transplantation, brow contouring, brow/frontal sinus setback, genioplasty, mandibular contouring, rhinoplasty, thyroid cartilage reduction, lip lift, brow lift, face lift, otoplasty, blepharoplasty, fat grafting	4.2	—
Raffaini et al.[22]	Retrospective	Italy	Single center	2003–2013	33	Upper, middle, lower, neck	Rhinoplasty, mandibular reshaping, genioplasty, orthognathic surgery, frontal bone reshaping, tracheal shave, midface lift, liposuction of neck, fat grafting to lip and zygoma, prosthesis removal	5.5	24 mo
Raffaini et al.[23]	Retrospective	Italy	Single center	2003–2017	9	Upper, middle, lower, neck	Mandible contouring, genioplasty, chin osteotomy, lipofilling of lips, frontal bone grinding, brow lift, canthoplexy, scalp advancement, rhinoplasty, malar/cheek lipofilling, laryngochondroplasty, cervical fat removal	Multiple	15 mo
Salgado et al.[24]	Retrospective	The United States	Single center	—	4	Upper, middle	Frontal bone reduction, reduction rhinoplasty	2	21 mo
Shams and Motamedi[25]	Retrospective	Iran	Single center	1990–2007	10	Upper, middle, lower, neck	Reduction genioplasty, total mandibular angle and body reduction, maxillomandibular osteotomy, zygoma advancement, reduction rhinoplasty, forehead feminization, chondroplasty	6	—
Tang[26]	Retrospective	The United States	Multicenter	2016–2020	91	Neck	Laryngochondroplasty	1	20.7 mo
Tawa et al.[27]	Prospective	France	Single center	2018–2019	45	Upper, lower	Frontal bone osteotomy, mandibular osteotomy, genioplasty	3	5.1 mo
Telang[28]	Retrospective	India	Single center	2016–2019	220	Upper, middle, Lower, neck	Forehead contouring, orbital shave, hairline advancement, rhinoplasty, blepharoplasty, cheek augmentation, jaw shave, gonial angle shave, chin reduction, tracheal shave, lip lift and augmentation, neck lift	6.3	40 mo
Villepelet et al.,[29]	Retrospective	France	Single center	2011–2014	8	Upper	Frontal remodeling, orbital remodeling, canthopexy	1	12.4 mo

Describes type of study, patient cohort size, facial procedures described, and average number of procedures performed per patient. Twenty-two studies were included reporting a range of 4 to 220 patients.

Table 2. Patient Demographics and Medical History

	No. Studies	No. Patients	Weighted Value, Mean ± SD, n (n%)
Mean age, y	20	1261	36.53±5.64
Hormone use	10	391	385 (98.5%)
History of GAS	10	367	207 (56.4%)
History of FFS	10	367	20 (5.4%)
Gender affirmation process length <5 y	1	66	42 (63.6%)
Comorbidities	3	179	56 (31.3%)
Smoking history	5	273	
Median income, USD	2	212	81,305±9,670
Employment status	1	66	
Race or ethnicity	2	212	

Includes mean age, history of FFS, and socio-demographics. When data available, weighted values were calculated as means with SDs or "number of patients (% of patients)."

the development of 3D surgical guides (Table 3).[20,22,23,27] Each utilized software to generate 3D virtual simulations based on CT imaging of outcomes after full FFS, frontal bone osteotomy, or mandibular osteotomy.[20,22,23,27] Two studies by Raffaini et al[22,23] integrated the OsiriX image processing application to generate 3D simulation of bone structure modifications before full FFS. Similarly, Tawa et al[27] utilized preoperative CT DICOM data to generate a 3D model of the skull and simulate frontal bone and mandibular osteotomies. In addition to 3D simulation, La Padula et al[20] used the Morpheus Photograph Warper photoediting software to generate 2D modeling of full FSS outcomes. Custom-made surgical guides were only described by two studies.[20,27] Tawa et al[27] incorporated 3-matic software to generate custom titanium guides for forehead and chin reconstruction and polyamide guides for mandibular angles. La Padula et al[20] 3D printed two models, a bone and soft tissue renderings, both used to explain the surgery to patients and as a physical guide intraoperatively.

CCOs and Complications

Twenty studies (90.9%) described CCOs including complications, measurement changes, and clinician assessment (Fig. 4A). The average complication rate was 5.4% based on data from 16 studies. Table 4 displays commonly reported complications. Major complications were exceedingly rare, and multiple studies described no postoperative complications at all.[9,16,17,20,24,26] Only four studies discussed the management of complications, with intervention in 15 (5.6%) patients including hematoma aspiration and revision rhinoplasty.[8,11,28] Seven studies that described inpatient stay of patients reported that most stayed through postoperative day 1; however, Chou et al[14] reported that five (4.0%) patients were discharged the same day as their FFS.[16,19,22–24,29]

Pre and postoperative measurements were compared in eight studies (36.4%) (Fig. 4A).[8,11,12,15,17,22,24,27] Frontonasal angles were increased by an average of 13.4 degrees,[8,11] frontal bossing was setback by an average of 8.2 mm,[12,17] Frankfort horizontal to mandibular plane angle was decreased by 1.3 degrees,[8] and chin advancement was reduced by 0.55 cm.[8] Three studies reported clinician ratings and assessments.[8,22,23] Morrison et al[8] used photogrammetric analyses to quantify trends toward feminization. Both studies by Raffaini et al[22,23] described uninvolved surgeons who objectively rated aesthetic outcomes on a scale to indicate feminization; both rated more than 80% of outcomes as significant feminization. Other CCO included rates of revisional surgery in two rhinoplasty studies and vocal alterations after chondrolaryngoplasty in one study.[11,18,19]

Patient-centered Outcomes

PCO after FFS included assessment of satisfaction via informal surveys or standardized PROMs in 17 articles (77.3%) (Fig. 4B). Seven (31.8%) reported general patient satisfaction without validated surveys as displayed in Table 5.[9,10,16,18,25,28,29] Two articles reported return to work

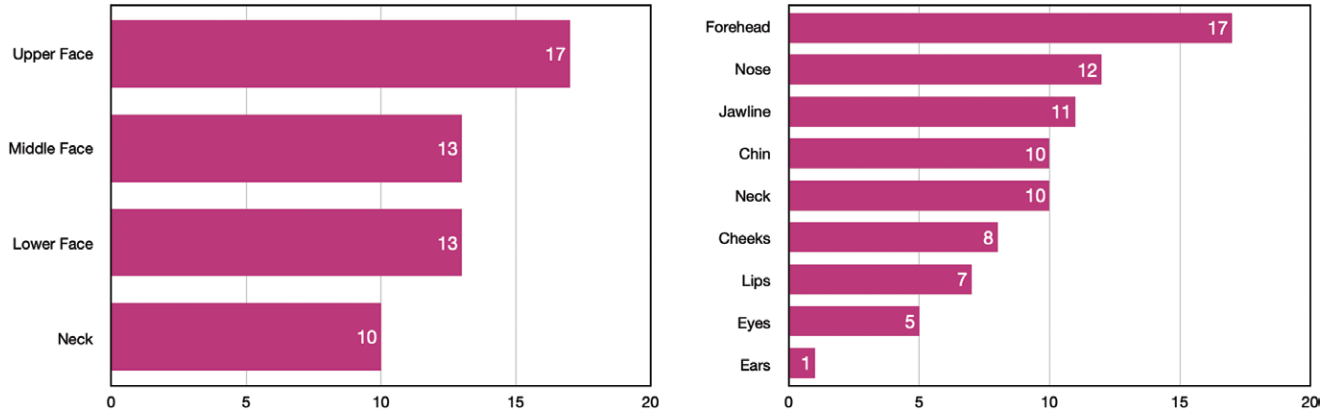
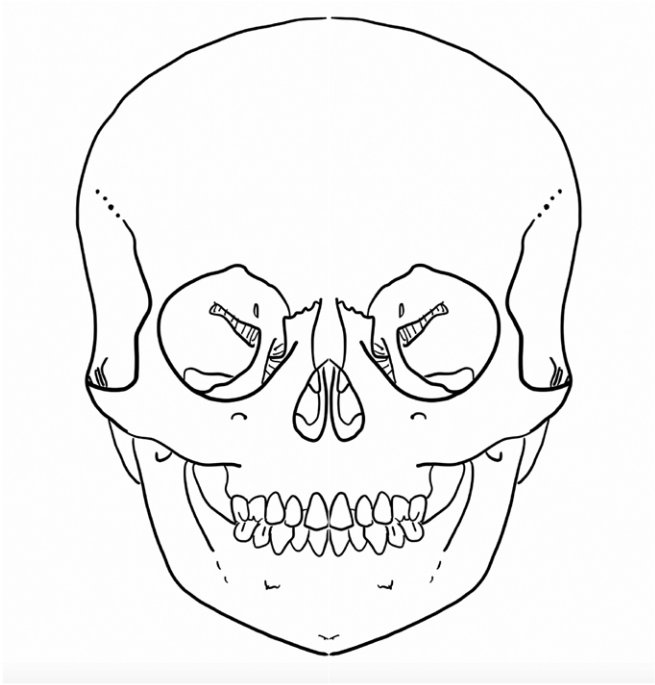


Fig. 2. Facial areas of feminization procedures performed in included articles. A, Most studies reported on procedures of the upper face, with the least performed on the neck. B, The highest number of procedures were performed on the forehead and nose.



UPPER FACE
- *Frontal Bone Grinding or Reduction*: 631 (52.1%)
- *Hairline Repositioning*: 411 (33.9%)
- *Frontonasal-Orbital Recontouring*: 335 (27.7%)
- *Blepharoplasty:* 197 (16.3%)
- *Cranioplasty*: 159 (13.1%)
- *Brow Lift*: 122 (10.1%)
- *Hair Transplant*: 90 (7.4%)
- *Galeotomy*: 71 (2.2%)
- *Canthopexy*: 3 (0.3%)

MIDDLE FACE
- *Rhinoplasty:* 520 (42.9%)
- *Zygoma Augmentation*: 168 (13.9%)
- *Zygoma Osteotomy*: 3 (0.3%)
- *Midface Lift*: 4 (0.3%)

LOWER FACE
- *Mandibuloplasty*: 447 (36.9%)
- *Genioplasty:* 211 (17.4%)
- *Lip Lift*: 199 (16.4%)
- *Gonial Angle Reduction or Osteotomy:* 77 (6.4%)
- *Chin Osteotomy*: 35 (2.9%)
- *Lip Lipofilling*: 33 (2.7%)
- *Masseter Muscle Resection*: 19 (1.6%)
- *Orthognathic Surgery*: 7 (0.6%)
- *Maxillary Osteotomy*: 2 (0.2%)

NECK
- *Chondrolaryngoplasty:* 274 (22.6%)
- *Neck Lift:* 110 (9.1%)
- *Cervical Liposuction:* 24 (2.0%)

Fig. 3. Facial feminization procedures in included articles. Four thousand one hundred eight procedures in the upper, middle, and lower face and neck were performed based on data from 18 studies. Data is displayed as "number of procedures (% of patients)."

within 30 days.[22,23] No articles described sexual or social well-being outcomes.

Questionnaires that evaluated PROMs were used by 11 studies (50.0%) (Fig. 4B).[8,11,12,17,19,20,22–24,26,27] Table 6 highlights eight PROMs used to assess satisfaction, QOL, and benefit after FFS. Six studies used questionnaires to rate overall satisfaction, finding 89.9% of patients as "satisfied" or higher with their outcome.[8,12,17,24,26,27] A QOL survey in the Raffaini et al[22,23] studies showed positive responses, suggesting improvement. La Padula et al[20] reported significant improvements in pre and postoperative SLS and SHS scores. The SF-36v2 instrument used by Morrison et al[8] showed increased QOL scores across all domains from 42.7 to 80.6. Tang[26] utilized the GBS to measure the degree of benefit to patients, and found that 80% of patients reported improvements in all domains after chondrolaryngoplasty. PROMs more specific to FFS were used in three studies.[11,19,23] The Nose Feminization Scale (NFS) was used by Bellinga et al,[11] with patients rating postoperative satisfaction as a four out of five, indicating a very feminine result. Raffaini et al[23] implemented the Aesthetic Numeric Log, similar to the Wong-Baker FACES pain scale; 89% of their patients rated their appearance a 9 to 10 of 10, indicating high perceived aesthetic improvement. The Outcome Instrument for Chondrolaryngoplasty (OIC) was integrated by Khafif et al,[19] with all patients satisfied with their outcome; 75% of patients reported a perfect score.

Table 3. Frequency of Preoperative Planning Modalities Described

Preoperative Assessment Method	No. Studies
Standard photography	19 (86.4%)
Imaging	
Cephalometry	7 (31.8%)
CT	9 (40.9%)
Preoperative measurements	
Any measurements	11 (50.0%)
Frontonasal angles	2 (9.1%)
Forehead dimensions	4 (18.2%)
Frontal bossing	2 (9.1%)
Frankfort mandibular plane angle	1 (4.5%)
Frontal sinus anterior wall thickness	3 (13.6%)
Chin advancement	1 (4.5%)
Surgical outcome modeling	
Photographic modeling	1 (4.5%)
Virtual 3D simulation via CT	4 (18.2%)
3D surgical guides	2 (9.1%)
Other	
Interview to assess expectations	1 (4.5%)
Preoperative gender appearance rating	1 (4.5%)
Orthodontic evaluation	1 (4.5%)
Vocal assessment	1 (4.5%)
Ophthalmic exam	1 (4.5%)

Describes imaging techniques, preoperative measurements, and virtual modeling. Most studies incorporated standard photography in their preoperative planning, while only half described preoperative measurements and four reported virtual simulation.

DISCUSSION

This assessment of FFS provides a much needed, comprehensive review on critical aspects of the perioperative period. We identified minimal reports concerning FFS, which encompassed heterogenous procedures in multiple facial regions, highlighting a clear deficit in gender affirming research. Of the existing research, the articles are small in cohort sizes and widely varied in procedures, making results difficult to generalize and compare. Though a significant number of studies reported forehead feminization, for example, it was often in combination with other

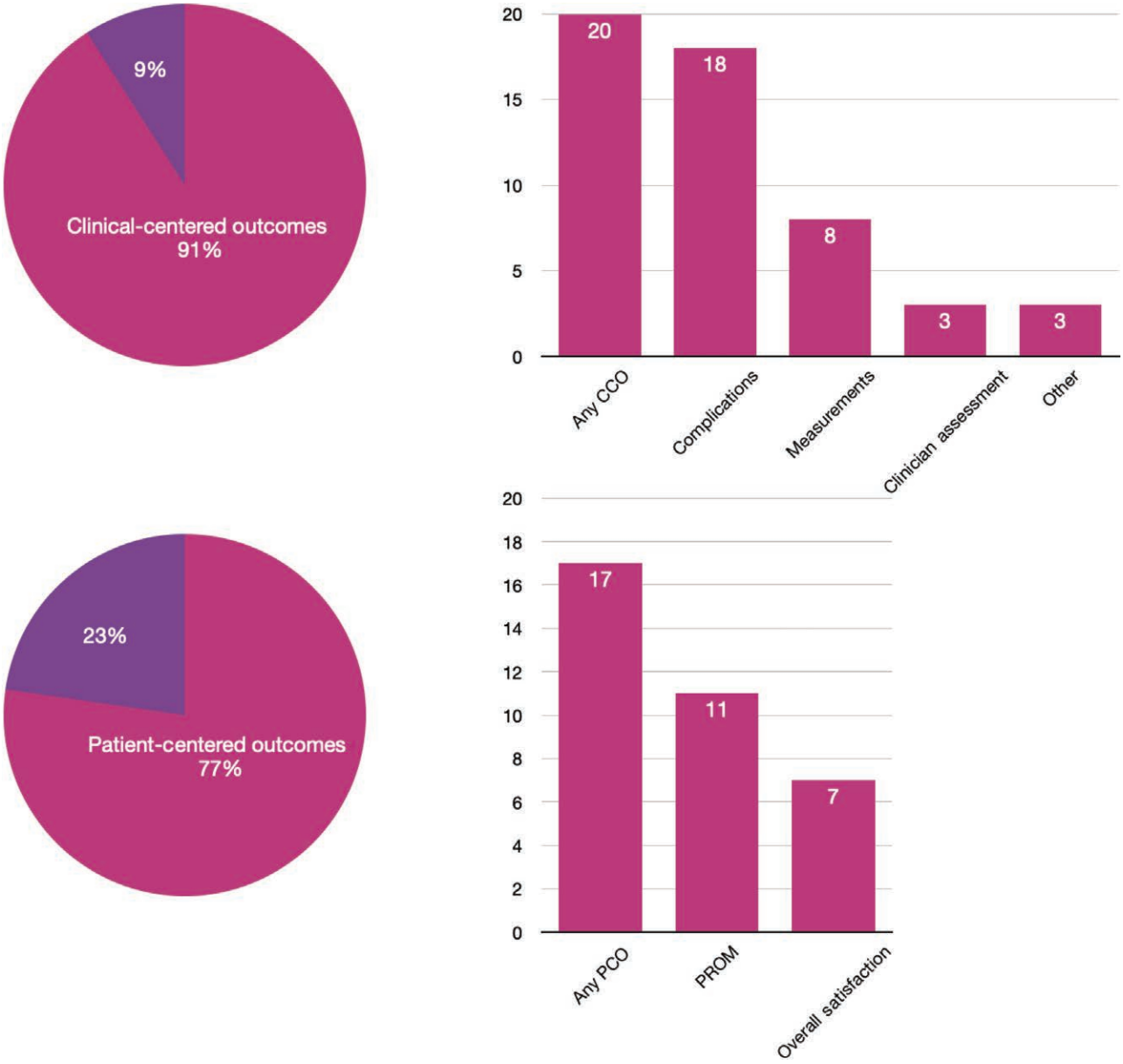


Fig. 4. Clinical- and patient-centered postoperative assessment. A, Ninety-one percent of studies reported CCOs, including complications and facial measurements. B, Seventy-seven percent of studies reported patient-centered outcomes, with only 11 utilizing PROMs.

procedures and therefore difficult to isolate individual procedures for analysis.

Patient satisfaction with surgery is directly associated with satisfaction in the perioperative period, which includes a patient's preoperative interactions and assessment.[30] A study on breast augmentation found that patients who underwent 3D imaging and virtual planning had significantly higher BREAST-Q scores, a patient-reported metric that assessed satisfaction, confidence in implant size selection, and communication with provider.[31] As FFS is complicated by the need for multiple procedures of highly unique facial features with the goal of gender congruence, preoperative planning is of even higher importance in this population.[32] CT and 3D virtual modeling to develop custom 3D surgical guides has been used infrequently among FFS procedures. Within facial plastic surgery, the growing use of CT imaging for preoperative planning allows surgeons to obtain subsurface imaging and measurements, with the potential for 3D simulation.[33] Preoperative measurements are important aspects of surgical planning, as feminine-appearing facial structures tend to have less forehead inclination (–5.9 versus –9.8 degrees), more acute nasofrontal angles (120 versus 134 degrees), greater Frankfort horizontal and mandibular plane angles (29.6 versus 26.2 degrees), and less prominent supraorbital ridges than masculine-appearing structures.[24,34–36] CT imaging can improve accuracy and reduce complications of procedures to reduce brow prominence, increase nasofrontal angles, and decrease chin and jaw prominence.[37] Furthermore, incorporating CT image-based modeling

Table 4. Complications after Facial Feminizing Surgery

Complication	No. Studies (No. Patients)	Weighted Reported Complications
All complications	16 (994)	54 (5.4%)
Wound complication or dehiscence	4 (415)	21 (5.1%)
Major wound infection	5 (273)	7 (2.6%)
Hematoma	5 (529)	7 (1.3%)
Epistaxis	3 (236)	5 (2.1%)
PE or DVT	4 (183)	3 (1.6%)
Ophthalmic injury	1 (121)	3 (2.5%)
CSF fistula or leak	3 (479)	1 (0.2%)
Pulmonary edema	1 (121)	1 (0.8%)
Nerve injury	3 (292)	0 (0.0%)
Seroma	2 (235)	0 (0.0%)
Sinus dysfunction or fractures	1 (214)	0 (0.0%)

Overall complication rate was low at 5.4%, with the most reported complication being delayed wound healing or dehiscence (5.1%).
CSF, cerebrospinal fluid; DVT, deep venous thrombosis; PE, pulmonary embolism.

into patient–physician decision-making merges the specific requests, motivations, and expectations of the patient with surgical objectives; improved communication can increase patient confidence, alleviate anxiety, and form realistic expectations.[38] Even 2D surgical photographic modeling is just as effective in increasing patient QOL and perceived aesthetic improvement in orthognathic surgery.[6]

Virtual planning before facial surgery is commonly used for orthognathic, aesthetic, and pediatric procedures, with recent improvements in 3D cephalometry, digital stereophotogrammetry, 3D CT, and laser surface scanning among other technologies.[39] Using modeling software, such as the OsiriX application used by Raffaini et al,[22,23] gives new opportunities for surgeons to assess feminization outcomes, where subtle alterations specific to individual patients' facial structure promotes substantial results.[39] Furthermore, custom surgical guides based on CT imaging improves efficiency, safety, and accuracy of procedures.[32] Three-dimensional printing is increasingly used in plastic surgery to improve the delivery of safe and effective surgical methods; its use has even expanded to precisely measure volume of fat necessary for fat grafting.[40] Limitations to using 3D virtual simulation and guides have been cost, time required to train, and skill of users.[39] Technological advances and increased availability, however, have led to a cost benefit when considering fewer revisional surgeries and expedited preoperative planning overall.[41] Thus, preoperative CT, virtual planning, and 3D surgical guides can mitigate patient desires and expectations with accurate and safe surgical planning.[42]

As FFS techniques and virtual simulation advance, it is critical to have appropriate methods to assess the effectiveness of procedures and preoperative planning through patient-reported outcomes. FFS is very safe and has low complication rates, as delineated by this review.[4] While most studies described high satisfaction among patients, only half used validated PROMs, and overall data from these assessments was limited in detail. PROMs are crucial assessments of patient QOL, satisfaction, function, and perceived value of treatment, and are indicators of the life-ability of a person, which with FFS includes gender conformity and improved dysphoria.[43,44] In the field of GAS, especially FFS, there are limited validated methods to assess this.[45] Previous systematic reviews have found similarly low use of validated PROMs in studies on FFS, and have only identified one specific to the transgender population.[46] Most PROMs used in our study were cisgender-validated aesthetic surveys; this is a common issue among literature as even the limited transgender-validated PROMs that exist, such as the Gender Identity/Gender Dysphoria Questionnaire for Adults and Adolescents (GIDYQ-AA) and Urtrecht Gender Dysphoria Scale (UGDS) Gender Spectrum, are not specifically designed for GAS outcomes.[47] The Nose Feminization Scale was used by one study; however, this is not validated.[11]

PROMs will aid in advancing surgical techniques and goals of FFS and enable improvements in virtual planning. The FFS Outcomes Evaluation Survey, developed by Ainsworth and Spiegel,[48] was adapted from a cisgender-validated facial plastic surgery instrument; however, it has not been fully studied among FFS patients. Adapting existing PROMs to be validated in the feminization population, or altering PROMs specific to transgender patients to accurately reflect outcomes after GAS is required to better understand the impact of FFS. Patients who have undergone GAS report less social anxiety and greater conformity to societal gender norm expectations, leading to less discrimination and rejection.[49] Utilizing validated FFS-specific PROMs will allow providers to optimize facial feminization strategies and surgical planning to promote satisfactory and successful gender affirmation.

Figure 5 highlights key considerations for providers in the planning and assessment of partial or full FFS, based on the data gathered in this review. Preoperative management should include appropriate imaging modalities,

Table 5. Nonstandardized Satisfaction Outcomes

Study	Patient Satisfaction
Balaji[9]	"Patients were satisfied with the outcome of the surgery."
Becking et al.[10]	"Without exception, all patients were convinced that their faces had become more feminine."
Gupta et al.[16]	"…all patients were satisfied with their cosmetic results"
Hage et al.[18]	"All patients were satisfied with the final result in that they were convinced their appearance had become more feminine;" "…one patient had expected a more radical hump reduction while another felt her nose was still too wide"
Shams and Motamedi[25]	"…our patients were satisfied with their improvement in appearance with these standard set of operations"
Telang[28]	"All operated patients reported satisfaction with the overall outcome. They reported significant improvement in their feeling of gender incongruence or being mis-gendered by others in the society."
Villepelet et al.[29]	"100% of our patients were satisfied in the short term."

Seven studies reported qualitative satisfaction outcomes for their patients.

Table 6. Patient-reported Outcome Measures

PROM	Studies
Satisfaction questionnaire	Capitan et al., 2014[12]; Hoenig[17]; Morrison et al.[8]; Salgado et al.[24]; Tawa et al.[27]; Tang[26]
QOL survey	Raffaini et al[22,23]
Nose feminization scale	Bellinga et al.[11]
Satisfaction with life scale and subjective happiness scale	La Padula et al.[20]
SF-36v2 QOL instrument	Morrison et al.[8]
ANS	Raffaini et al.[23]
Outcome instrument for chondrolaryngoplasty	Khafif et al.[19]
Glasgow benefit survey	Tang[26]

Six studies used satisfaction rating questionnaires, and two used QOL surveys. Validated surveys, including the SF-36v2 and ANL, were used in six studies.
QOL, quality of life; SF-36v2, 36-Item Short Form Health Survey version 2.

including both photography and 3D CT, with an emphasis on incorporating facial measurements to optimize feminization. The imaging and corresponding measurements should be integrated into virtual simulation of outcomes to aid in surgical planning and manage patient expectations for feminization. Surgical guides should be developed, particularly in cases of mandibular, frontal, or chin feminization for which custom guides can increase accuracy of achieving angle reduction or bone thickness goals. The most common procedures in each facial region, including frontal bone reduction, rhinoplasty, and mandibuloplasty, should be focused on as primary means of achieving feminization goals. Finally, postoperative outcomes should be assessed both in clinical- and patient-centered metrics. Complications and objective clinician assessments should be performed in combination with PROMs to assess overall satisfaction, sexual and social well-being, mental health outcomes, and misgendering experiences.

This systematic review was substantially limited by the overall dearth in literature on FFS, emphasizing a greater need to report findings after feminizing procedures. The studies that do exist are most often retrospective with small patient cohorts and inconsistent reporting, precluding strong conclusions. Studies reported from the same surgical centers may have reported outcomes in overlapping patient populations, further limiting our ability to understand preoperative planning and PROMs used in the general FFS population. Additionally, non-English language studies were not evaluated in this review. Satisfaction outcomes described were general, and lacked exploration into the social well-being and psychological and sexual satisfaction of patients after FFS. Additionally, we are limited by the highly mobile transgender patient population that faces numerous disparities in access to healthcare, making extended follow-up after FFS difficult to obtain.[29]

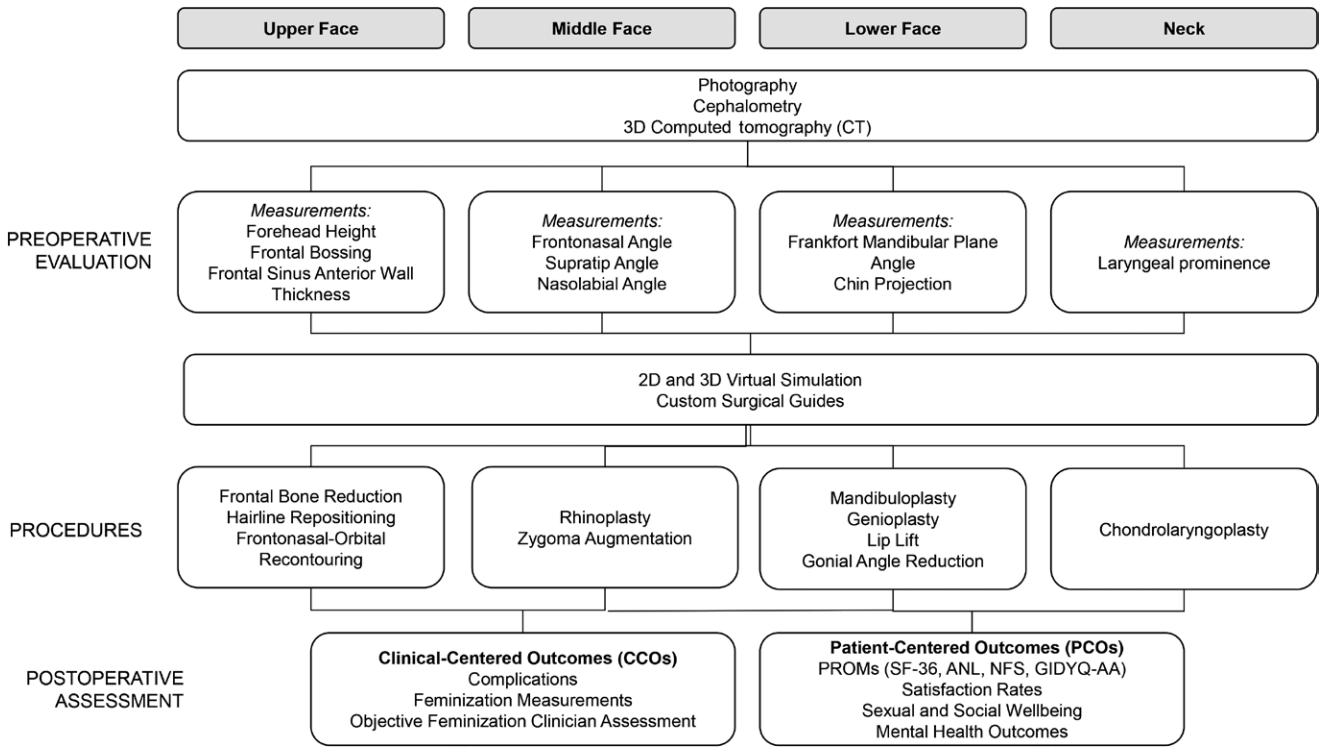


Fig. 5. Flowchart demonstrating the key considerations for pre and postoperative planning and assessment of full or partial facial feminization procedures, based on the most common perioperative practices reported in the 22 included studies. Preoperative evaluation is recommended to include imaging in the form of photography, cephalometry, or 3D CT in addition to measurements specific to each facial area. The most common procedures performed in each facial region are emphasized, including frontal bone reduction, rhinoplasty, mandibuloplasty, and chondrolaryngoplasty. Postoperative assessment should include CCOs, such as complication rates, as well as PCOs in the form of PROMs, satisfaction rates, and mental and sexual well-being. ANL, Aesthetic Numeric Log; GIDYQ-AA Gender Identity/Gender Dysphoria Questionnaire for Adults and Adolescents; NFS, Nose Feminization Scale; SF-36 36-item Short Form Health Survey.

We noted that only three studies reported demographic information, which is critical to understand in this often disadvantaged population. Future studies are essential to develop PROMs specific to the FFS patient population that will reflect changes in QOL and gender congruence, related to the ongoing developments in 3D surgical simulation and other technologies.

CONCLUSIONS

FFS is an underreported area of plastic surgery, diminishing the effective assessment of advances in preoperative surgical planning, techniques, and patient-reported outcomes. Investigation of facial feminization procedures should be further explored, as the limited existing studies show safe and satisfying outcomes for transfeminine patients. Improved use of advanced preoperative planning in combination with patient-centered postoperative assessments has the potential to merge patient goals and expectations with improvements in perioperative practices in this uniquely challenging patient population.

Gabriel Del Corral, MD
MedStar Franklin Square Medical Center
9000 Franklin Square Dr
Baltimore, MD 21237
E-mail: drgabrieldelcorral@hotmail.com

REFERENCES

1. Flores AR, Herman JL, Gates GJ, et al. (2016) How many adults identify as transgender in the United States? The Williams Institute website. June 2016. Available at https://williamsinstitute.law.ucla.edu/publications/trans-adults-united-states/. Accessed February 24, 2022.
2. Canner JK, Harfouch O, Kodadek LM, et al. Temporal trends in gender-affirming surgery among transgender patients in the United States. *JAMA Surg.* 2018;153:609–616.
3. Becking AG, Tuinzing DB, Hage JJ, et al. Transgender feminization of the facial skeleton. *Clin Plast Surg.* 2007;34:557–564.
4. Akhavan AA, Sandhu S, Ndem I, et al. A review of gender affirmation surgery: what we know, and what we need to know. *Surgery.* 2021;170:336–340.
5. Owen-Smith AA, Gerth J, Sineath RC, et al. Association between gender confirmation treatments and perceived gender congruence, body image satisfaction, and mental health in a cohort of transgender individuals. *J Sex Med.* 2018;15:591–600.
6. Bengtsson M, Al-Ateyah A, Wall G, et al. Outcome of photographic evaluation of facial appearance in orthognathic surgery: how does it correlate with planning of treatment and patient-reported outcome? *Br J Oral Maxillofac Surg.* 2019;57:345–351.
7. Gray R, Gougoutas A, Nguyen V, et al. Use of three-dimensional, CAD/CAM-assisted, virtual surgical simulation and planning in the pediatric craniofacial population. *Int J Pediatr Otorhinolaryngol.* 2017;97:163–169.
8. Morrison SD, Capitán-Cañadas F, Sánchez-García A, et al. Prospective quality-of-life outcomes after facial feminization surgery: an international multicenter study. *Plast Reconstr Surg.* 2020;145:1499–1509.
9. Balaji S. Facial feminization—surgical modification for Indian, European and African faces. *Ann Maxillofacial Surg.* 2016;6:210–213.
10. Becking AG, Tuinzing DB, Hage JJ, et al. Facial corrections in male to female transsexuals: a preliminary report on 16 patients. *J Oral Maxillofac Surg.* 1996;54:413–418; discussion 419.
11. Bellinga RJ, Capitán L, Simon D, et al. Technical and clinical considerations for facial feminization surgery with rhinoplasty and related procedures. *JAMA Facial Plast Surg.* 2017;19:175-181.
12. Capitán L, Simon D, Kaye K, et al. Facial feminization surgery: the forehead. Surgical techniques and analysis of results. *Plast Reconstr Surg.* 2014;134:609–619.
13. Capitán L, Simon D, Meyer T, et al. Facial feminization surgery: simultaneous hair transplant during forehead reconstruction. *Plast Reconstr Surg.* 2017;139:573–584.
14. Chou DW, Tejani N, Kleinberger A, et al. Initial facial feminization surgery experience in a multicenter integrated health care system. *Otolaryngol Head Neck Surg.* 2020;163:737–742.
15. Garcia-Rodriguez L, Thain LM, Spiegel JH. Scalp advancement for transgender women: Closing the gap. *Laryngoscope.* 2020;130:1431-1435.
16. Gupta N, Wulu J, Spiegel JH. Safety of combined facial plastic procedures affecting multiple planes in a single setting in facial feminization for transgender patients. *Aesthetic Plast Surg.* 2019;43:993–999.
17. Hoenig JF. Frontal bone remodeling for gender reassignment of the male forehead: a gender-reassignment surgery. *Aesthetic Plast Surg.* 2011;35:1043–1049.
18. Hage JJ, Vossen M, Becking AG. Rhinoplasty as part of gender-confirming surgery in male transsexuals: basic considerations and clinical experience. *Ann Plast Surg.* 1997;39:266–271.
19. Khafif A, Shoffel-Havakuk H, Yaish I, et al. Scarless neck feminization: transoral transvestibular approach chondrolaryngoplasty. *Facial Plast Surg Aesthet Med.* 2020;22:172–180.
20. La Padula S, Hersant B, Chatel H, et al. One-step facial feminization surgery: the importance of a custom-made preoperative planning and patient satisfaction assessment. *J Plast Reconstr Aesthet Surg.* 2019;72:1694–1699.
21. Lipschitz N, Wolf M, Amir O, et al. Thyroid chondroplasty: Smoothing the thyroid cartilage—a retrospective study of thyroid chondroplasty for feminine neck appearance. *Int J Transgend.* 2017;18:389-394.
22. Raffaini M, Magri AS, Agostini T. Full facial feminization surgery: patient satisfaction assessment based on 180 procedures involving 33 consecutive patients. *Plast Reconstr Surg.* 2016;137:438–448.
23. Raffaini M, Perello R, Tremolada C, et al. Evolution of full facial feminization surgery. *J Craniofac Surg.* 2019;30:1419-1424.
24. Salgado CJ, AlQattan H, Nugent A, et al. Feminizing the face: combination of frontal bone reduction and reduction rhinoplasty. *Case Rep Surg.* 2018;2018:1947807.
25. Shams MG, Motamedi MH. Case report: feminizing the male face. *Eplasty.* 2009;9:e2.
26. Tang CG. Evaluating patient benefit from laryngochondroplasty. *Laryngoscope.* 2020;130 (Suppl 5):S1–S14.
27. Tawa P, Brault N, Luca-Pozner V, et al. Three-dimensional custom-made surgical guides in facial feminization surgery: prospective study on safety and accuracy. *Aesthet Surg J.* 2021;41:NP1368–NP1378.
28. Telang PS. Facial feminization surgery: a review of 220 consecutive patients. *Indian J Plast Surg.* 2020;53:244–253.
29. Villepelet A, Jafari A, Baujat B. Fronto-orbital feminization technique. A surgical strategy using fronto-orbital burring with or without eggshell technique to optimize the risk/benefit ratio. *Eur Ann Otorhinolaryngol Head Neck Dis.* 2018;135:353-356.
30. Ho AL, Klassen AF, Cano S, et al. Optimizing patient-centered care in breast reconstruction: the importance of preoperative information and patient-physician communication. *Plast Reconstr Surg.* 2013;132:212e–220e.
31. Hutchinson LE, Castaldo AD, Malone CH, et al. A pilot study evaluation of 3-dimensional imaging in cosmetic breast augmentation: results of a single surgeon 3.5-year retrospective study using the BREAST-Q questionnaire. *Aesthet Surg J Open Forum.* 2021;3:ojab005.

32. Gray R, Nguyen K, Lee JC, et al. Osseous transformation with facial feminization surgery: improved anatomical accuracy with virtual planning. *Plast Reconstr Surg.* 2019;144:1159–1168.
33. Tarassoli SP, Shield ME, Allen RS, et al. Facial reconstruction: a systematic review of current image acquisition and processing techniques. *Front Surg.* 2020;7:537616.
34. Farkas LG, Katic MJ, Forrest CR. Comparison of craniofacial measurements of young adult African-American and North American white males and females. *Ann Plast Surg.* 2007;59:692–698.
35. Lee MK, Sakai O, Spiegel JH. CT measurement of the frontal sinus—gender differences and implications for frontal cranioplasty. *J Craniomaxillofac Surg.* 2010;38:494-500.
36. Bondevik O. Differences between high- and low-angle subjects in arch form and anterior crowding from 23 to 33 years of age. *Eur J Orthod.* 2007;29:413–416.
37. Callen AL, Badiee RK, Phelps A, et al. Facial feminization surgery: key ct findings for preoperative planning and postoperative evaluation. *AJR Am J Roentgenol.* 2021;217:709–717.
38. Lekakis G, Claes P, Hamilton GS III, et al. Evolution of preoperative rhinoplasty consult by computer imaging. *Facial Plast Surg.* 2016;32:80–87.
39. Lekakis G, Claes P, Hamilton GS III, et al. Three-dimensional surface imaging and the continuous evolution of preoperative and postoperative assessment in rhinoplasty. *Facial Plast Surg.* 2016;32:88–94.
40. Lynn AQ, Pflibsen LR, Smith AA, et al. Three-dimensional printing in plastic surgery: current applications, future directions, and ethical implications. *Plast Reconstr Surg Glob Open.* 2021;9:e3465.
41. Ho CT, Denadai R, Lin HH, et al. Three-dimensional computer-assisted orthognathic surgery: traditional hybrid versus full digital planning models. *Ann Plast Surg.* 2021;86(2S Suppl 1):S70–S77.
42. Kuruoglu D, Yan M, Bustos SS, et al. Point of care virtual surgical planning and 3D printing in facial gender confirmation surgery: a narrative review. *Ann Transl Med.* 2021;9:614.
43. Locklear T, Weinfurt KP, Abernethy A, et al. Patient-reported Outcomes. *NIH Collaboratory: Rethinking Clinical Trials.* Health Care Systems Research Collaboratory. January 2014.
44. Estoque RC, Togawa T, Ooba M, et al. A review of quality of life (QOL) assessments and indicators: towards a "QOL-Climate" assessment framework. *Ambio.* 2019;48:619–638.
45. Morrison SD, Vyas KS, Motakef S, et al. Facial feminization: systematic review of the literature. *Plast Reconstr Surg.* 2016;137:1759–1770.
46. Oles N, Darrach H, Landford W, et al. Gender affirming surgery: a comprehensive, systematic review of all peer-reviewed literature and methods of assessing patient-centered outcomes (Part 1: Breast/Chest, Face, and Voice). *Ann Surg.* 2022;275:e52-e66.
47. Dy GW, Nolan IT, Hotaling J, et al. Patient reported outcome measures and quality of life assessment in genital gender confirming surgery. *Transl Androl Urol.* 2019;8:228–240.
48. Ainsworth TA, Spiegel JH. Quality of life of individuals with and without facial feminization surgery or gender reassignment surgery. *Qual Life Res.* 2010;19:1019–1024.
49. Butler RM, Horenstein A, Gitlin M, et al. Social anxiety among transgender and gender nonconforming individuals: the role of gender-affirming medical interventions. *J Abnorm Psychol.* 2019;128:25–31.