ORIGINAL ARTICLE

Evolution of Full Facial Feminization Surgery: Creating the Gendered Face With an All-in-one Procedure

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Abstract: Facial feminization surgery (FFS) has recently gained popularity to enhance the female facial profile and promote a real transformation of the male to female face in transgender patients. The term involves overlapping of the surgical procedures devoted to feminization and represents a dual and reversible procedure unique in plastic and reconstructive surgery. Indeed, FFS envisages modifications of the hard and soft tissues and is both reductive and augmentative. For these reasons, full FFS (F-FFS) is used by surgeons with special expertise in FFS. This study describes a novel approach to F-FFS performed in a single surgery and thus renamed, de facto, all-in-one and representing its most recent evolution. Forty-nine consecutive nonrandomized patients underwent FFS at a private clinical practice (Face Surgery Center, Parma, Italy) between January 2003 and December 2017. Following a retrospective review according to specific inclusion criteria, the authors identified 9 patients aged 19 to 33 years (mean age, 21 years) who underwent all-in-one F-FFS. Patients were discharged the day after surgery with written postoperative care instructions. No reports of wound infection/dehiscence or nerve/vessel damage were recorded. Patients typically returned to work within 30 days following surgery. The mean operative time was 281 minutes (range, 245–305 minutes). The evolved all-in-one F-FFS provides a further step technically (overlapping several procedures) in terms of surgical outcome (higher satisfaction rate) and reduced overall costs and low morbidity.

Key Words: Aesthetic, cranioplasty, facial feminization surgery, genioplasty, lipofilling, mandibular reshaping, rhinoplasty, scalp shifting, transgender

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Facial feminization surgery (FFS) is a set of bone and soft-tissue surgical procedures that are used to feminize the faces of male-to-female transsexuals. The FFS is predicated upon the notion that femininity is a measurable quality that can be both reliably assessed and surgically reproduced. Such an assertion begs the questions: What does a woman look like? What forms of knowledge are used to support a claim to know? These questions were answered in several articles recently published by Ousterhout, Spiegel, and Capitán and in a previous study of ours.[1–7] Bones provide the underlying structure to the face and, in FFS discourse, are the site in which essential claims to femaleness reside.[1,3,5] While soft-tissue changes are an essential part of FFS, the desired effect of "feminization" is generally considered impossible to achieve through soft-tissue procedures alone.[8,9] Surgical discourse makes it clear that skulls are not neutral structures upon which sexually differentiated soft tissues are draped. Instead, it is the skull itself that provides the architecture of facial sex difference.[10–14] Ousterhout's 1987 article in *Plastic and Reconstructive Surgery* reported his early work in feminizing craniofacial surgery.[1] Although his innovations in this field were prompted by requests from transwomen, the overwhelming majority of patients seeking feminizing procedures, this initial article discusses the feminization of females with "masculine" features. In this context, "feminization" is a process that aims to produce a particularly pleasing aesthetic, as measured by the patient's postoperative attractiveness, as opposed to the transforming perceptions of the patient's sex per se.[1,3,4] The FFS is a dual procedure and, as such, fulfils a unique need in plastic and reconstructive surgery; indeed, not only does the procedure envisage hard- and soft-tissue modifications but it is reductive (through bone remodeling) and augmentative (through soft-tissue management) at the same time. For these reasons, full FFS (F-FFS) is performed by surgeons specializing in feminization surgery with special expertise in soft- and hard-tissue sculpting and functional anatomy to manage and prevent complications.[1,4] Although the importance of facial gender features is equally true for both sexes, female to male transsexuals generally do not require facial surgery, primarily because testosterone has a pronounced effect on the hard and soft tissues. Indeed, FFS surgery is almost exclusively a prerogative of adult females to correct the profound effects of testosterone on facial bone structure.[2] It is a somewhat reversible surgical procedure, at least in theory, even if it has not been reported; in any patient, such peculiarities are not applicable to genital surgery. Indeed, the most substantial changes are achieved through reductive bone procedures; as such, reaugmentation is possible thanks to permanent or temporary biomaterials.

What has been already described? The question is answered in several studies describing novel techniques to feminize the face that are often related to single aesthetic subunits such as the forehead, nose, and mandible.[1,4,5,10,13,15,16] Furthermore, not all published articles focus on a uniform cohort since the process of feminization involves even female patients requiring facial profile softening.[17,18] The further question is *what is new?* The FFS has recently evolved to a feminization process shifting toward a novel concept of F-FFS including a number a simultaneous procedures and higher satisfaction with the surgical outcome.[7] Here we describe a series of male patients who underwent F-FFS in a single procedure that we renamed all-in-one F-FFS to reflect its most recent evolution.

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TABLE 1. Criteria to Enter Facial Feminization Surgery (FFS)

- Patients must be physically fit for surgery
- Patients must be psychologically prepared to FFS
- Patients must have realistic goals and expectation
- Patients must have understood the interventions to be performed
- Patients have been informed on any alternative procedures
- Risks and complications must be reviewed and understood
- Written informed consent for the procedures and digital documentations archiving

METHODS

Forty-nine consecutive nonrandomized patients underwent FFS at a private clinical practice (Face Surgery Center, Parma, Italy) between January 2003 and December 2017. The patients had no comorbidities influencing surgical outcomes and were instructed to stop smoking and hormonal therapy at least 1 month preoperatively. All patients met specific criteria for FFS as previously reported (Table 1).[7]

Study Design

We retrospectively analyzed the medical charts of 49 patients who underwent male-to-female F-FFS. The inclusion criteria were as follows: available preoperative standardized photographs, available pre- and postoperative 3-dimensional (3D) cone-beam computed tomography (CT) scans, and a minimum follow-up of 15 months. Ultimately, 9 patients aged 19 to 33 years (mean age, 21 years) who were referred for FFS between January 2013 and December 2017 entered the study. Three patients had already undergone other surgical procedures in other centers including breast augmentation (n = 1) and genitalia (n = 2). All patients underwent complete F-FFS in a single surgical session performed by the senior surgeon (MR) and his assistant as shown in the flow charts (Figs. 1-2).

Preoperative Evaluation and Operative Planning

Preoperative evaluation consists of a meticulous evaluation and diagnosis protocol. During the 1st consultation, patients' requests were evaluated together in the clinical identification of the masculine features in the different subunits of the face and neck; documentation attesting gender reassignment and psychologic evaluation was requested from the personal reference center and patients were asked to undergo a maxillofacial CT scan and teleradiography X-ray. Before the 2nd medical consultation, the patients underwent our orthodontic and psychologic evaluations and preoperative standardized photographs were taken. The successive virtual FFS was discussed with 2 surgeons of the team and the patients' expectations were adjusted before a definitive treatment plan was chosen (Fig. 1).

Management Principle and Inclusion Criteria

The reduction of the frontal sinus is considered the most aggressive of all FFS-related procedures because of the risk of infection and acute sinusitis and mucocele. We usually improve the frontonasal profile in separate sessions due to the high risk of acute frontal sinusitis as in a prior report of a patient who underwent revision surgery to improve frontonasal communications without functional or aesthetic sequelae.[19–21] The thickness of the anterior wall of the frontal sinus was the determinant for choosing between a set-back (patient candidate for 2-step F-FFS) or bone remodeling (patient candidate for all-in-one F-FFS) (Figs. 1-3). This item was

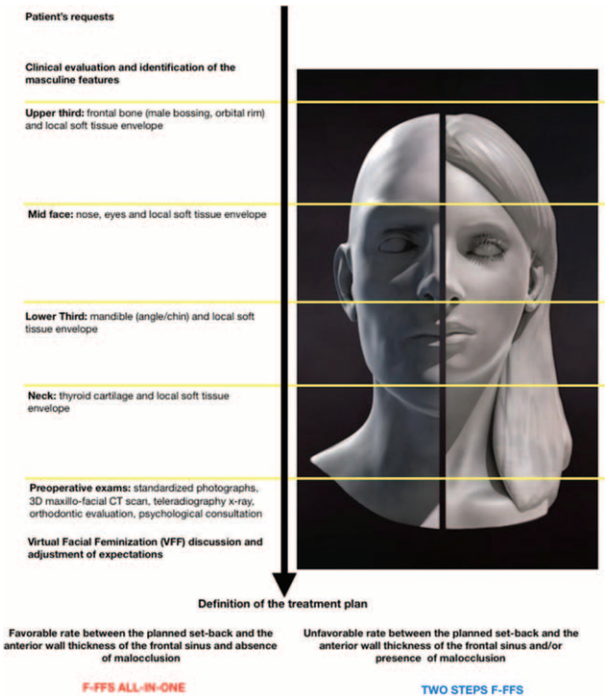

FIGURE 1. Preoperative evaluation and operative planning.

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investigated and planned in the preoperative period through a cone-beam maxillofacial CT scan and 3D reconstruction of the skeleton, which gives more accurate measurements than traditional cephalometric X-rays, which are invalidated by image overlapping and possible difficulties evaluating bone thickness in nonexperienced hands. Hence, all-in-one F-FFS was provided to patients equipped with a proper ratio between the planned set-back and the anterior wall thickness of the frontal sinus (ie, if the planned set-back was 6 mm and the bone thickness was 7 to 8 mm, then the patient underwent all-in-one F-FFS; if the planned set-back was 5 mm and the bone thickness was 3 to 4 mm, then the patient underwent 2-step FFS as previously described). The indication was driven to prevent

FIGURE 2. Flow chart of all-in-one full facial feminization surgery. Dark red indicates the aesthetic subunit of the face; yellow, the incision performed; green, the skeletal units modified; and light red, the soft-tissue improvement.

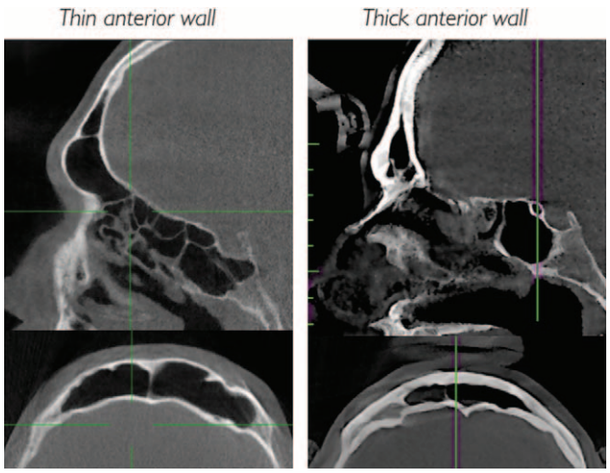

FIGURE 3. Sagittal computed tomography scan of the facial skeleton focusing on the frontal sinus. The thickness of the anterior wall was the main determinant for all-in-one full facial feminization surgery (F-FFS): on the left, a thin anterior wall candidate to frontal bone graft set-back candidate for 2-step F-FFS[7]; on the right, a thick anterior wall candidate for all-in-one F-FFS.

infection (acute frontal sinusitis) caused by abnormal drainage of the frontal sinus toward the paranasal sinus that could threaten the forehead cortical bone graft with devastating sequelae. Such a risk is not negligible considering that the true nasofrontal duct is absent in 85% of people, in whom drainage occurs indirectly via ethmoidal air cells to the middle meatus.[20] Further, late complications include meningitis, mucocele formation, and brain abscess.[19,20] This risk was considered high, at least in our experience, in patients with combined rhinoplasty and invasive frontal surgery with bone set-back.[7] Regarding the midface, all of our patients required augmentations of variable grades of the zygoma, malar, and cheek subunits achieved thorough lipofilling in primary patients and thorough prosthesis removal and substitution with autologous fat; hence, the midface does not present discriminating factors for all-in-one F-FFS. Instead, in the lower face, the mandible represented a factor influencing the surgical indication[1,4,7]; patients who underwent all-in-one F-FFS were free from malocclusion or orthodontic correction, while those who suffered malocclusion underwent 2-step F-FFS.[7] Accurate surgical planning was proposed to patients following CT scan evaluations with 3D reconstruction using an OsiriX (Fig. 4).[22]

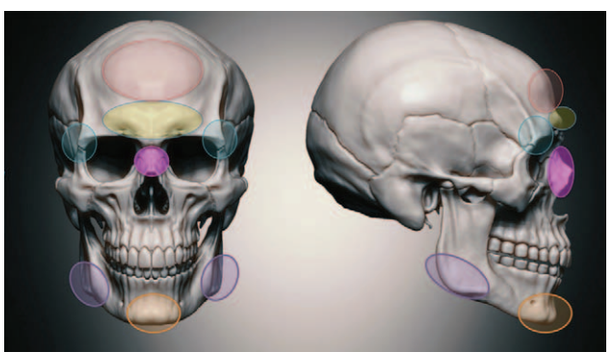

FIGURE 4. Virtual simulation of different bone structures modifications based on preoperative computed tomography scans.

Flow Chart for All-in-one F-FFS

Facial feminization procedures were standardized and staged as shown in the flow chart (Fig. 2). Patients were approached under general anesthesia and orotracheal intubation in a stepwise sequence. First, the lower 3rd of the face was approached with focus on the mandible playing a key role in successful FFS. Alterations of the mandible focus on the undesirable squareness of the masculine jaw. This squareness is attributed to mandibular angle, mandibular flare, and the chin.[4,7,12,16] The mandibular angle describes the angular value of the posterior and inferior portion of the jaw and is responsible for the vertical height. The more acute the angle, the more masculine the jaw appears in profile views. Mandibular flare describes the extent to which the squareness of the jaw extends toward the lateral sides of the face on frontal views. In both patients, bone was removed to reduce the masculine squareness of the mandible through ostectomies combined with remodeling using the intraoral approach. In addition, patients suffering from masseter hypertrophy were injected with botulin toxin 3 months before surgery to obtain proper muscle reduction and better visualization of the bone to be resected at this level.

Based on the claim that female chins are shorter than male chins (measured from the top of the bottom teeth to the most inferior point of the chin), a wedge of bone can be removed from the chin and slid forward.[1,4] Moving the bottom section forward also results in a more pointed chin. A pointed chin is recognized as feminine, whereas a square chin is considered masculine.[4] In combination with advancement of the inferior portion of the chin, contouring is done to enhance this characteristic. A vestibular incision (intraoral) was used for the osteotomies to reduce the vertical dimension of the chin combined with a sliding genioplasty or bone remodeling depending on the specific aesthetic canons used to feminize the features and achieve edge and angle mandibular sculpting to reduce the bigonial width in relation to the transverse zygomatic distance.[22–25] Lipofilling of the mandibular contours and lips completes this stage.

Next, a bicoronal incision was performed to expose the frontal vault and superior orbital margins. The frontal bone was remodeled as described by Capitàn et al.[5] The frontal bone was ground down with burring alone at the level of the frontal eminence and the frontal sinus where the procedure was undertaken under endonasal supervision with fiber-optic-induced epiluminescence to avoid a frontal sinus violation (Fig. 5). Male orbital bossing was mitigated as well, thus completing hard-tissue management at this level. The

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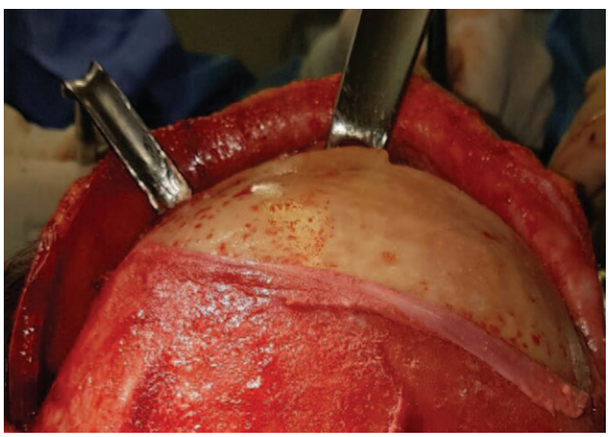

FIGURE 5. Intraoperative view of frontal bone remodeling ground down with burring alone under endonasal supervision with fiber-optic-induced epiluminescence to avoid frontal sinus violation.

prominence of the orbital bossing (brow), one of the most distinctive and recognizable aspects of a masculine face, was accomplished through burring down (the thickness of the bones) just at the level of the eyes. Brow lifting and lateral canthopexy were performed just prior to the excising of a variable amount of skin of the scalp to shift the hairline and round out the typical masculine M-shaped hairline to reduce temporal baldness due to testosterone. In particular, the scalp may be brought forward toward the face to help a patient compensate for a receding hairline. Scalp advancement, hairline reshaping, and eyebrow raising can occur through the coronal incision (from ear to ear just behind the hairline).[8,14]

Next, the midface was approached with nose reshaping and malar/cheek subunit modeling. Patients underwent open rhinoplasty and lipofilling of the malar and cheek subunits avoiding alloplastic materials to produce the desirable oval shape of the female face. The neck was subjected to laryngochondroplasty using an open direct approach with triangle-shaped resection to refine the upper border of the thyroid cartilage and with care to not inadvertently violate the site where the vocal chords insert, resulting in a radical modification of vocal pitch (vocal chords may undergo widening with voice pitch detriment toward a masculine tone). Indeed, voice pitch can be safely performed through endoscopy to narrow the vocal chords and achieve female tones.[26] Cartilage procedures were preferred to achieve proper amount of cartilage resection, which may be altered by the Klein solution preemptive liposuction. Cervical fat was removed according to compartment: subplatysma fat underwent direct excision through a 4-cm submental incision allowing boundary muscle sutures when necessary; supraplatysma fat was removed with 3-point liposuction in the midline using the vestibular incision and 2 further skin entry points just at the level of the mandibular angles.

Outcome Assessment

An objective evaluation of the pre- and postsurgery facial appearances of each patient was performed by 2 surgeons not involved in the study (plastic surgeon, maxillofacial surgeon) at the end of the follow-up period (12 months). Facial appearance was evaluated through clinical examinations and photograph analyses. Furthermore, an aesthetic judgment numerical scale, similar to the Wong-Baker FACES pain rating scale[24] and the 11-point box scale,[25] was administered to the patients to determine whether they perceived postoperative improvements in their facial appearance. This scale was recently introduced by Kim et al as the aesthetic numeric analog (ANA) scale for aesthetic assessment purposes.[26] The ANA scale is scored from 0 to 10, with 0 indicating no perceived aesthetic improvement ("insufficient") and 10 indicating the highest degree of perceived aesthetic improvement after surgery ("perfect"). To determine self-reported quality of life, a 9-question survey was delivered 12 months postoperatively to assess the physical, emotional, and social domains.[7]

RESULTS

Postoperative Complications and Operative Times

Patients were kept overnight and discharged the day after with written instructions for postoperative care. Once discharged, the patients were instructed to remain well hydrated and mobile to reduce facial edema. All patients received prophylactic antibiotics and pain medications. Postoperative edema spontaneously resolved approximately 2 months after surgery. We encountered no patients with intranasal bleeding requiring nasal packing or respiratory distress requiring tracheostomy. All patients were monitored according to conventional follow-up at 1, 3, 6, and 12 months. We encountered no patients with wound infection/dehiscence or nerve/vessel damage except for a variable grade of numbness in a patient with a vertex hairline incision. Patients typically returned to work within 30 days following surgery. Operative times were recorded from the time of the incision to wound closure counting a mean operative time of 281 minutes (range, 245–305 minutes). Clinical examples are represented in Figures 6-9.

FIGURE 6. (A) Preoperative frontal view of a 25-year-old transgender patient candidate for all-in-one full facial feminization surgery. (B) One-year postoperative outcome of the patient shown in Figure 5 who underwent all-in-one full facial feminization surgery as shown in the flow chart. (C) Three-quarter right preoperative view of a 25-year-old transgender patient candidate for all-in-one full facial feminization surgery. (D) Three-quarter right postoperative view of a 25-year-old patient who underwent all-in-one full facial feminization surgery at 1 year postoperative. (E) Right profile preoperative view of a 25-year-old transgender patient candidate for all-in-one full facial feminization surgery. (F) Right profile 1-year postoperative view of the patient shown in Figure 10.

Outcome Analysis

Patients showed noticeable postoperative facial aesthetic improvement: 8 patients (89%) reported a top score (5, very beautiful with remarkable improvement), 1 patient (11%) reported evident improvement with mild irregularities and/or residual deformities (Fig. 8). The ANA scale self-evaluation collected from the patients at 12 months postoperative showed that 8 patients were satisfied with the postoperative aesthetic outcomes (89%) (satisfaction scores of 9 ["very satisfied" in 22%] and 10 ["beautiful" in 67%]); 1 patient (11%), although not fully satisfied, expressed mild satisfaction of "as expected." The self-evaluation satisfaction scores of all patients according to the ANA scale are shown in Figure 9. The surgical outcome was assessed according to the physical, social, and emotional impacts on each patient's life. Each question was graded on a 5-response scale. All patients answered the 9-question survey positively, suggesting an improved quality of life regarding physical, mental, and social functioning following FFS (Table 2). Of interest, 7 patients (78%) requested to perform more facial improvements as possible; the all-in-one approach was proposed to the other 2 patients with high satisfaction acceptance scores.

FIGURE 7. (A) Preoperative frontal view of a 21-year-old transgender patient candidate for all-in-one full facial feminization surgery. (B) One-year postoperative outcome of the patient shown in Figure 12. (C) Three-quarter right preoperative view of a 21-year-old transgender patient candidate for all-in-one full facial feminization surgery. (D) Three-quarter right postoperative view of the patient shown in Figure 14 at 1 year postoperative. (E) Right profile preoperative view of a 21-year-old transgender patient candidate for all-in-one full facial feminization surgery. (F) Right profile 1-year postoperative view of the patient shown in Figure 16.

DISCUSSION

As the pioneer in FFS, Ousterhout's representation of sex differences is considered established fact.[1] Transgenders typically start psychotherapy in specialized centers for a prolonged period before and after hormonal therapy before undergoing FFS to ease the transition and increase acceptance of their new gender, thus beginning a "real-life experience."[2,7,27] The FFS has become the hallmark of a truly beginning transition and making an irreversible commitment to living a new gender.[3,5] Here we provide the evolution of our previous transgender work articulated in a 2-step procedure that provides feminization of the masculine face in a single surgical procedure, now called the all-in-one. The procedure

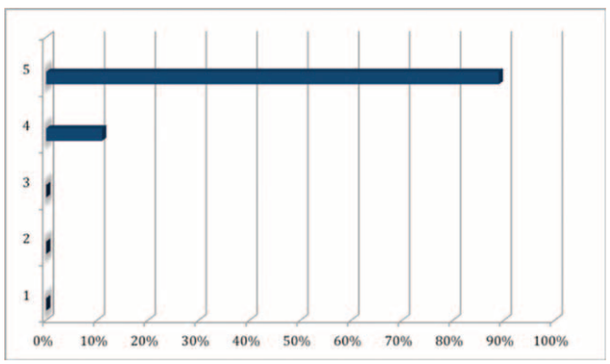

FIGURE 8. The clinicians' clinical assessment of aesthetic outcomes at the end of follow-up. The scale ranges from 1 to 5: 1, no noticeable improvement with some mild drawbacks; 2, no noticeable improvement; 3, moderate improvement with residual defects; 4, evident improvement with mild irregularities; and 5, very beautiful with remarkable improvement.

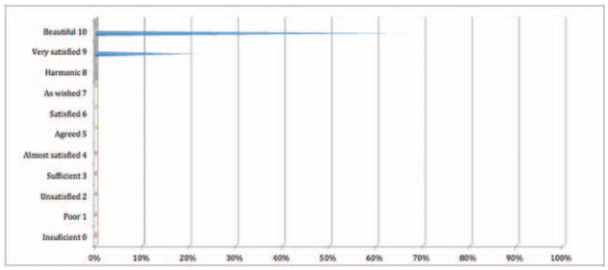

FIGURE 9. Patient satisfaction scores for aesthetic outcomes achieved at the end of follow-up (12 months after surgery). The score is based on the aesthetic numeric analog scale, which ranges from 0 to 10: 0, insufficient; 1, poor; 2, unsatisfied; 3, sufficient; 4, almost satisfied; 5, agreed; 6, satisfied; 7, as expected; 8, harmonic; 9, very satisfied; 10, beautiful.

proposed is equipped with several advantages including a higher satisfaction rate for patients who underwent feminization via multiple procedures and the utilization of autologous tissues over alloplastic materials, that is, visor pericranial flap over cements to cranioplasty and structural fat grafting over silicone or MEDPOR prosthesis. Moreover, the all-in-one F-FFS optimized surgical incisions normally made in multiple procedures and permits the transformation of the facial skeleton and soft tissue to meet patient expectations and is less expensive than multiple procedures.

The anatomy of the frontal sinus assumes a central role in enrolling patients suitable for all-in-one F-FFS. It comprises thick cortical bone measuring 4 to 12 mm thick and although it reaches adult size at about 12 years, pneumatization continues until 40 years. Aplasia of both frontal sinuses has been reported in 3% to 5% of patients and is rudimentary in 5%. Moreover, only 1 well-developed frontal sinus (with a contralateral aplastic sinus) is present in 1% to 7% of the population.[19–21] Hence, it is reasonable to expect that young patients and those suffering from aplasia will be the best transgender candidates for all-in-one F-FFS. This is in part confirmed by the young age of the patients we presented here.

The limitations of the present study include both functional issues such as voice pitch elevation corrected in other specialized centers and aesthetic concerns as follows:

- *Frontal feminization*: The procedure can be performed via endoscopy but is ineffective for the frontal eminence and cannot be applied for F-FFS, since it precludes the realization of several procedures through a single bicoronal incision but more extended but well-hidden procedures (brow lift, canthopexys, scalp shifting).[28,29]
- *Upper lip shortening*: Males have a longer upper lip and correction can be achieved with a lip lift resulting in a final scar just below the base of the nose; here we did not have satisfactory results since a visible and difficult-to-camouflauge scar resulted. Nonetheless, the recent use of a novel incision to access both rhinoplasty and lip lift should be kept in mind for selected patients.[30]
- *Malar/cheek lipofilling*: An interesting hidden intraoral single access to buccal fat pad augmentation with structural fat grafting was recently described. This is applicable to the patients undergoing all-in-one or 2-step FFS; this idea suggests utilization of the same intraoral incision to remodel mandibular flare and angle.[31]
- *Laryngochondroplasty*: Thyroid cartilage shaving can be achieved by a submental incision in conjunction with the mandibular symphysis and direct lipectomy of subplastysmatic tissue, thus allowing the performance of multiple procedures through a single incision.[32]

TABLE 2. Self-reported Quality

1. I like the appearance of my face.	Patients (n = 9) (100%)
Not at all	0
Somewhat	0
Moderately	0
Very much	3 (33%)
Completely	6 (67%)
2. The appearance of my face is feminine.	
Not at all	0
Somewhat	0
Moderately	0
Very much	1 (11%)
Completely	8 (89%)
3. My friends and loved ones perceive my face as feminine.	
Not at all	0
Somewhat	0
Moderately	0
Very much	0
Completely	9 (100%)
4. My current facial appearance limits my social activities.	
Never	9 (100%)
Rarely	0
Sometimes	0
Usually	0
Always	0
5. My current facial appearance limits my professional activities.	
Never	2 (22%)
Rarely	7 (78%)
Sometimes	0
Usually	0
Always	0
6. In public I am confident my facial appearance is perceived as feminine.	
Not at all	0
Somewhat	0
Moderately	0
Very much	4 (44%)
Completely	5 (56%)
7. I would like to alter the appearance of my face (new surgery???).	
Not at all	2 (22%)
Probably not	3 (33%)
Possibly	4 (45%)
Most likely	0
Definitely	0
8. Facial feminization surgery is/was important to my ability to live as a woman.	
Not at all	0
Somewhat	0
Moderately	0
Very much	1 (11%)
Completely	8 (89%)
9. Body surgery is/was important to my ability to live as a woman.	
Not at all	0
Somewhat	0
Moderately	0
Very much	8 (11%)
Completely	1 (89%)

In conclusion, the present single-center experience reported the evolution of all-in-one F-FFS provided evidence of higher satisfaction than our previous experience. The all-in-one approach is well accepted and easily reproducible by other surgical centers although deserved to selected patients.

CONCLUSION

The F-FFS can be considered a unique process of male to female transformation patients to create a "gendered face" in 2 steps in the presence of malocclusion within 6 months. The all-in-one approach to feminize the male face provides a further step both technically (overlapping several procedures) in terms of surgical outcome (providing higher satisfaction rate) and reduced overall costs.

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