Journal of Forensic Pathology, 2024, Vol.9, Issue 1, 1-10 Review Article

Identification of Human Remains in Case of Transgender Individuals in Forensic Anthropology: A Systematic Review

Viana E[1], Selvaggi G[2] and Milani C[3,4*]

[1]*Department of Surgery, National Institute of Family Pedagogy (INPEF), Rome, Italy*

[2]*Department of Plastic Surgery, Institute of Clinical Sciences,Sahlgrenska Academy, University of Gothenburg,Sahlgrenska University Hospital, Gothenburg, Sweden*

[3]*Department of Odontology, Italian Society of Forensic Odontology (SIOF), Modena, Italy*

[4]*Department of Forensic Science, National Institute of Family Pedagogy (INPEF), Rome, Italy*

Corresponding Author*

Milani C
Department of Odontology,
Italian Society of Forensic Odontology (SIOF),
Modena, Italy
E-mail: milanich@gmail.com

Received: November 23, 2023, Manuscript No. JFP-23-28123; **Editor assigned:** November 25, 2023, PreQC No. JFP-23-28123 (PQ); **Reviewed:** December 09, 2023, QC No. JFP-23-28123; **Revised:** January 03, 2024, Manuscript No. JFP-23-28123 (R); **Published:** January 10, 2024,
DOI: 10.35248/2684-1312.24.09(1).002

Abstract

During anthropologic analysis of human skeletal remains, estimation of sex is a key element in the forensic identification of individuals. For transgender individuals, complications may arise during estimation of biological sex, as physical characteristics may not correspond with the documented gender recorded at registration of the missing person with authorities. In this systematic review, we analyzed the current literature focusing on methods employed for state-of-the-art identification of skeletal remains of transgender and gender-diverse individuals in forensic anthropology, including the effects on the skeleton of gender-affirming hormone therapy and/or facial gender-affirmation surgery. Our findings support the need for additional studies using larger sample sizes and control groups involving different treatment regimens or longitudinal studies at different follow-up intervals. Furthermore, studies suggest that the impact of surgery involving the skull may provide identifying elements due either to the presence of surgical artifacts, traces of materials used for implants, or the possible incongruence with the pelvis in cases of sex estimation. Further studies are needed to investigate the impact of these anatomical aspects on outcomes related to forensic anthropology.

Keywords: Forensic anthropology • Sex assessment • Transgender • Gender diversity • Facial gender-affirming surgery • Gender-affirming surgery • Gender-affirming hormone therapy • Facial feminization surgery

Introduction

During anthropological analysis of human skeletal remains, estimation of sex, as well as other elements of anthropological significance, is a key element in identifying individual remains. Estimation relies on metrics, morphological methods, and instrument and imaging diagnostics. Because artificial intelligence systems have yet to be sufficiently developed for these tasks [1], there remains a need for models capable of objective and reliable estimation.

Sexual dimorphism has been studied across all skeletal contexts for multiple populations and presenting varying degrees of accuracy. Previous studies report that most sexually dimorphic traits present an expression gradient, and that skeletal features do not consistently align withing a single descriptive category but rather present a spectrum ranging from female to male. Application of all cranial and post-cranial methods is generally used to develop a final estimation of biological sex within forensic anthropological profiles. Because accurate analysis of human skeletal remains and sex assessment are important in the fields of forensic sciences and medicine, the analytical methods used need to be validated by the scientific community. From an anthropological standpoint, there are cases where the estimated sex may be contradictory to that reported in the missing-person profile. This is particularly true for transgender individuals, whose physical characteristics may not correspond with the reported gender. Such cases may complicate the construction of anthropological profiles of such individuals during examination of partially or completely skeletonized remains. Therefore, methods supporting the accurate classification of remains belonging to a transgender individual would be extremely useful.

Current techniques used for sex estimation are rigidly binary and based on the gender assigned at birth, making them inadequate for transgender and gender diverse individuals. In fact, skeletal features are inadequate indicators of individual gender identity or expression; however, these subjects have not been sufficiently addressed in the anthropology and forensics literature. Although the population of transgender individuals, including those actively changing their legal gender and receiving treatments for gender dysphoria, is rapidly increasing, there are limited data reporting the incidence and prevalence of transgender and gender-diverse individuals. International data estimates the transgender population at between 0.5% and 1.2% of the total population; however, the data in these studies are not comparable due to different methods of data collection and eligibility criteria used for study inclusion.

Given the rise in this population of individuals, there is a growing interest in forensics fields regarding methods used to investigate homicides and suicides. Data from the Transgender Europe (TGEU) trans murder monitoring project report 71 murders of transgender people in Europe from 2008 to 2013 (Table 1) [2]. Prunas, et al. retrospectively analyzed murders recorded at the department of legal medicine in Milan, Italy, from January 1993 to December 2012, identifying 20 transgender victims (all trans women). Furthermore, this vulnerable population presents multiple factors, including experiences of discrimination, stigma, violence, rejection by family and society, and reduced access to gender-affirming health care, that significantly increase the risk of suicide. Findings from a 2015 survey conducted in the United States highlighted a ~12-fold higher prevalence of suicidal ideation among transgender adults relative to the rest of the population and an ~18-fold higher prevalence of suicide attempts [3]. To date, there are no available data concerning identification of the skeletal remains of transgender and gender diverse people.

Table 1. Violence and hate crimes against transgender individuals in Europe (2008-2013).

Europe	2008	2009	2010	2011	2012	2013
Turkey	4	7	7	6	6	4
Italy	5	7	1	3	6	2
Spain	1	2	0	2	1	0
France	0	0	0	1	1	1
UK	0	2	1	1	1	1
Russia	0	0	0	2	0	0
Azerbaijan	0	0	2	0	0	0
Netherlands	0	0	0	0	0	0
Georgia	0	0	0	0	0	0
Germany	2	0	0	0	0	0
Portugal	1	0	0	0	0	0
Serbia	0	1	0	0	0	1

This systematic review was designed to assess current literature to ascertain the following:

- The current state-of-the-art methods used to identify the skeletal remains of transgender and gender-diverse individuals.
- The impact of Gender-Affirming Hormone Therapy (GHT) and Facial Gender-Affirmation Surgery (FGS), respectively, on the skeleton and their effect on sex estimation during evaluation of skeletal remains.

Literature Review

We performed searches using PubMed, Science Direct, and Google Scholar, as well as the relevant references in the included articles. Different Population, Intervention, Comparison, and Outcome (PICO) frameworks were employed for the literature review.

To assess the identification of remains of transgender individuals in the context of forensic anthropology, we employed the following PICO framework: P, transgender women and men; I, identification in the context of forensic anthropology; C, not available; and O, identification result. The search strings used were “forensic anthropology AND transgender” and “forensic identification AND transgender”. Inclusion criteria for these studies were as follows: Studies in any language conducted within any time frame, those addressing identification of transgender individuals in the context of forensic anthropology, and case reports. Exclusion criteria included cases outside of the field of forensic anthropology.

To assess the impact of GHT on the skeleton, we employed the following PICO framework: P, transgender women and men; I, documented uses of GHT for gender affirmation or Cross-Sex Hormone Therapy (CSHT); C, individuals having not undergone GHT or those assigned female/male at birth and without gender incongruity; O, effects of GHT on bone metabolism and Bone Mineral Density (BMD). The search strings used were “transgender AND bone structure”, “transgender AND bone mineral density”, “gender affirmation hormonal therapy AND bone mineral density”, and “gender affirmation hormonal therapy AND bone mineral density”. Inclusion criteria for these studies were as follows: Long-term investigations completed in adult transgender individuals (transgender women and men) who received CSHT; studies in any language conducted from 1990 to August 2023; reports that included clinical follow-up; documented findings of biological effects related to CSHT on bone markers, bone metabolism, and BMD in transgender individuals. Exclusion criteria included the following: Studies reporting the effects of CSHT in non-adult patients; reports not including therapy-related effects on bones; animal or in vitro studies; and other reviews or meta-analyses (Tables 2-5).

Table 2. Cross-sectional studies on the effects of GHT in transgender women.

References	n	Control	Therapeutic regimen	Therapy duration (y)	BMD-LS* *vs.* control	BMD Femur neck, total hip, *vs.* control
Reutrakul, et al.	11	Cisgender men	Ethinyl estradiol or estradiol valerate	<2	=	Decreased
	17	Cisgender men		>2	+	Femur +
Sosa, et al.	27	Cisgender men	Cyproterone acetate, ethinyl estradiol	3-35	+	Femur +
Ruetsche, et al.	24	Cisgender women	Cyproterone acetate, ethinyl estradiol	12.5	=	=
		Cisgender men			=	=

Lapauw, et al.	23	Cisgender men	Cyproterone acetate, ethinyl estradiol	8	Decreased	Decreased hip
Valentini, et al.	20	/	Cyproterone acetate, ethinyl estradiol, estradiol valerate	15.6	Decreased	Decreased femur
T'Sjoen, et al.	50	Cisgender men	Cyproterone acetate, estradiol valerate	3-33	Decreased	Decreased hip
Miyajima, et al.	15	Cisgender men no HRT	Estradiol dipropionate	19.2-32.4	+	
Dobrolińska, et al.	68	/	Cyproterone acetate, estradiol and antiandrogens not indicated	10-15	Unknown	Hip, decreased at 15 years relative to 10 years
Bone microarchitecture evaluated in non-dominant distal tibia and radius						
Bretherton, et al.	40	51 Cisgender men	Cyproterone acetate (n=21), spironolactone (n=4), progesterone (n=5), GnRH (n=1), ethinyl estradiol, estradiol valerate	1	Cortical and trabecular vBMD lower than control group	
Note: +: increase in BMD; =: no difference in BMD; vBMD: vertebral BMD; GnRH: Gonadotropin Hormone-Releasing Hormone; LS: Lumbar Spine						

Table 3. Longitudinal studies on the effects of GHT in transgender women.

Reference	n	Therapeutic regimen	Follow-up	BMD-LS	BMD Femur, Hip
van Kesteren, et al.	56	Cyproterone acetate, ethinyl estradiol	1 year	+	
Schlatterer, et al.	10	Cyproterone acetate, estrogen	11.5 years	No-significant reduction	
van Kesteren, et al.	20	Cyproterone acetate, ethinyl estradiol	1 year; 28 and 36 months	+ 1 year, decreased to 28 and 36 months	
Haraldsen, et al.	12	Ethinyl estradiol	1 year; and 3 months	=	=
Mueller, et al.	84	Cyproterone acetate, estradiol valerate	1, 2 years	+	Femur =
Wierckx, et al.	50	Cyproterone acetate, estrogen	10 years	Decreased	
van Caenegem, et al.	49	Cyproterone acetate, estradiol valerate	1, 2 years	+	Femur +, Hip =
Gava, et al.	40	Cyproterone acetate, leuprolide acetate, estradiol	1 year	=	data n.a.
Wiepjes, et al.	231	Cyproterone acetate, estradiol valerate	1 year	+	Femur +, Hip +
Muniz-Fighera, et al.	142	Cyproterone acetate, estradiol valerate spironolactone	3 months	=	Femur =, Hip =
Wiepjes, et al.	102	Unspecified	10 years	=	Femur =, Hip =

Gava, et al.	50	Cyproterone acetate, leuprolide acetate, estradiol	5 years	+	data n.a.
Yun, et al.	11	Cyproterone acetate, estradiol valerate spironolactone	6 months	+	Femur =, Hip =

Table 4. Cross-sectional studies on the effects of GHT in transgender men.

Reference	N	Control group	Therapeutic regimen	Therapy duration	BMD-LS *vs.* control group	BMD femur neck, total hip, *vs.* control group
Ruetsche, et al.	15	Cisgender women	Testosterone	7.6 years	=	Femur =, Hip =
		Transgender men			=	Femur =, Hip =
Mueller, et al.	35	/	Testosterone	1 year	=	Femur =
Miyajima, et al.	50	Transgender men no hormone therapy	Testosterone	15.2-33.4 years	Decreased	data n.a.
van Caenegem, et al.	50	Cisgender women	Testosterone, phenylpropionate, propionate undecanoate	3.2-27.5 years, average 9.9 years	=	Femur =, Hip =
Broulik, et al.	35	Cisgender women	Testosterone isobutyrate, propionate, undecanoate	18 years	=	Femur =
		Transgender men			+	+
Dobrolińska, et al.	43	/	Testosterone	10 e 15 years	data n.a.	Hip: decreased BMD at 15 compared to 10
Andrade, et al.	19	Transgender men	Testosterone	2 years	=	Femur decreased, Hip =
Bone microarchitecture evaluated in non-dominant distal tibia and radius						
Bretherthon et al.	41	Cisgender women	Testosterone undecanoate		No change in bone microarchitecture	

Table 5: Longitudinal studies on the effects of GHT in transgender men.

Reference	N	Therapeutic regimen	Follow-up	BMD-LS	BMD femur, hip
van Kesteren, et al.	35	Testosterone	1 year	=	data n.a.
Schlatterer, et al.	10	Testosterone	11.5 years	no-significant reduction	
van Kesteren, et al.	19	Testosterone	1 year	=	data n.a.
			28, 36 months	decreased	data n.a.
Turner, et al.	15	Testosterone	1 year	=	Femur =
			2 years	=	Femur +
Haraldsen, et al.	21	Testosterone enanthate	1 year	=	Femur =

Meriggiola, et al.	15	Testosterone undecanoate+ letrazole or dutasteride	1 year	=	data n.a.
Mueller, et al.	45	Testosterone undecanoate	1,2 years	=	=
Wierckx, et al.	50	Testosterone	+/- 10 years	=	=
Pelusi, et al.	45	Testosterone, testosterone undecanoate	1 year	=	data n.a.
van Caenegem et al.	23	Testosterone undecanoate	1 year	=	Femur =, Hip +
Wiepjes, et al.	199	Testosterone	1 year	+	Femur =, Hip +
Wiepjes, et al.	543	Testosterone	10 years	=	=
Wiepjes, et al.	70	Testosterone	10 years	=	=

To assess the impact of FGS on the skeleton, we employed the following PICO framework: P, transgender women and men; I, FGS, facial feminization surgery, or facial masculinization surgery; C, not available; O, the effects of FGS on the skeleton. The search strings used were "facial feminization surgery", "facial masculinization surgery", "facial gender confirmation surgery", and "facial gender affirmation surgery". Inclusion criteria for these studies were as follows: Studies in any language conducted from 1990 to August 2023; reports on FGS procedures; and clinical studies, including case series and case reports. Exclusion criteria included the following: Studies not focused on FGS procedures, including non-skeletal surgical procedures; animal or *in vitro* studies; other reviews or meta-analyses; and duplicate reports of results by the same author.

Results

Figure 1 summarizes the seven articles included in this review (Table 6). Schall and Rogers evaluated the impact of facial feminization interventions on skull measurements and consequently on sex estimation in the construction of anthropological profiles. Their assessment used 11 sets of pre and post-operative computed tomography images of transgender women who had undergone feminization surgery and obtained 17 measurements, 10 of which involved areas affected by feminization surgery. Their findings indicated that skeletal and soft-tissue modifications associated with facial feminization surgery influenced morphology but not size.

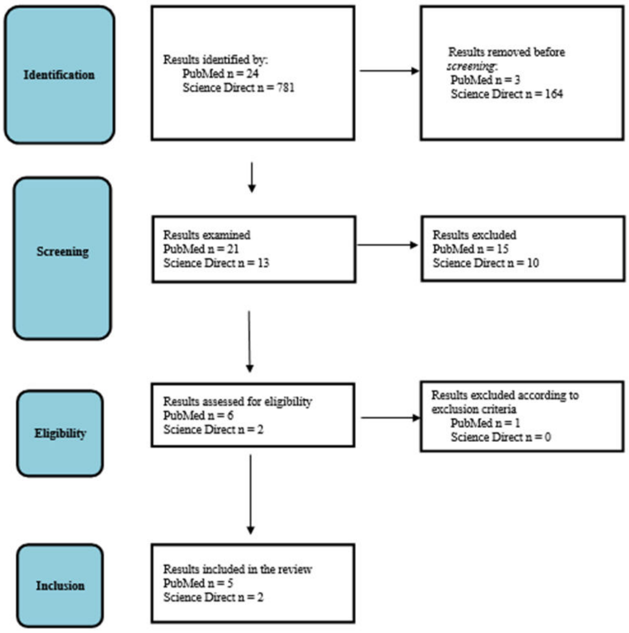

Figure 1. Selection of studies on the anthropological-forensic identification of skeletal remains belonging to transgender individuals.

Table 6. Studies of anthropological-forensic interest.

Authors	Procedure
Schall-Rogers	Sex estimation following FFS interventions-FORDISC
Buchanan	Experimental study on bone indicators following FFS surgery
Mackenzie-Wilkinson	Morphological and metric changes of the face following HRT with testosterone
Sitek, et al.	Pelvic metric characteristics of transgender men
Marquez-Grant, et al.	Effects of GnRH agonists on the skeleton
Flaherty TM, et al.	Case study: Estimation of ASAB of a transgender woman using FORDISC
Adams DM, et al.	Suggested strategies to improve identification of transgender and gender-diverse persons

Buchanan conducted an experimental study reproducing forehead shaping and mandibular angle-reduction surgeries for facial feminization on animal skulls and documenting the marks left by surgical instruments on the bones. The experiments involved three pig (*Sus scrofa*) skulls, two with the presence of soft tissue and one without soft tissue, and three different instruments used in three different areas: An oscillating saw with a wide blade for shaping the left gonial angle of the jaw, an oscillating saw with a narrow blade for shaping the right gonial angle of the jaw, and a dome-shaped dental burr for the frontal region. Differences in outcomes according to the surgical method and tissue type were documented and the images used to survey 203 forensic anthropologists. A majority of participants (91%) reported no observed similarities between the marks left by the instruments and actual cases in their clinical experience.

Mackenzie and Wilkinson investigated morphological and morphometric changes of the faces of 25 transgender men receiving testosterone treatment for at least 3 years (average administration period: 8.6 years). Morphometric analyses comparing pre-transition two-dimensional images with post-transition Three-Dimensional (3D) scans resulted in 32% of pre-transition subjects classified as male versus 95.5% classified as male in post-transition. Their findings identified larger facial dimensions in 44% of the post-transition subjects, with 100% of these involving a narrower nose.

Sitek, et al. assessed characteristics of the pelvis in 24 transgender men relative to 24 cisgender men and 24 cisgender women. Of the 17 measurements taken from radiographic images, the resulting model included four (pubic symphysis height, greater pelvic width, intra-ischial distance, and acetabulum diameter) that adequately discriminated between cisgender women and transgender men; however, this model was considerably less effective at discriminating between transgender men and the two control groups. The results indicated pelvic measurements of transgender men included changes in somatometric traits that distinguished them from those of cisgender men.

Marquez-Grant, et al. assessed the possible effects of drug use and medications on the skeleton and the potential implications for estimating age at death, sex, and other indicators for the anthropological profile [4]. Among the drugs analyzed were agonists of gonadotropin-releasing hormones, which influence the activity of osteoblasts and osteoclasts to suppress bone formation, increase bone resorption, and reduce BMD. The resulting acceleration in bone loss is greater in women than men. During the first year of treatment, the authors reported a reduction in BMD of 5% to 10%, which increased according to the length of therapy.

Flaherty, et al. reported a case study on anthropologic estimation of sex assigned at birth in a transgender woman according to the FORDISC version 3.1 (male or female) classification and based on craniometric measurements. The subject of the study was a 38-year-old transgender woman of European origin living in the United States and assigned male at birth. She received testosterone-based hormone therapy from age 11 to 14 in order to achieve a more masculine physical appearance and address gender dysphoria. At age 21, she began estrogen and anti-androgen hormone therapy and underwent multiple facial feminization surgeries. To determine whether these surgeries supported her classification as a woman, 27 measurements were obtained using a 3D replica of her skull and compared with 37 white females and 77 white males. The comparison using FORDISC resulted in her classification as a white male, suggesting that forensic methods would likely classify her as a male despite her surgical history.

Adams, et al. assessed biological data and physical evidence related to transgender and gender-diverse individuals. The authors highlighted the need to consider aspects of social identity in addition to those used for scientific classification and the importance of constructing a biocultural profile encompassing the complexities of lived gender identity or expression.

Effects of hormone therapy on bone morphology and histology

We included 33 cross-sectional and longitudinal studies on the short and long-term effects of hormone therapy (Figures 2 and 3) [5-10]. Most of these were conducted in clinical settings in order to assess potential adverse effects on bone metabolism and the occurrence of diseases, such as osteoporosis, by investigating markers of bone turnover and BMD.

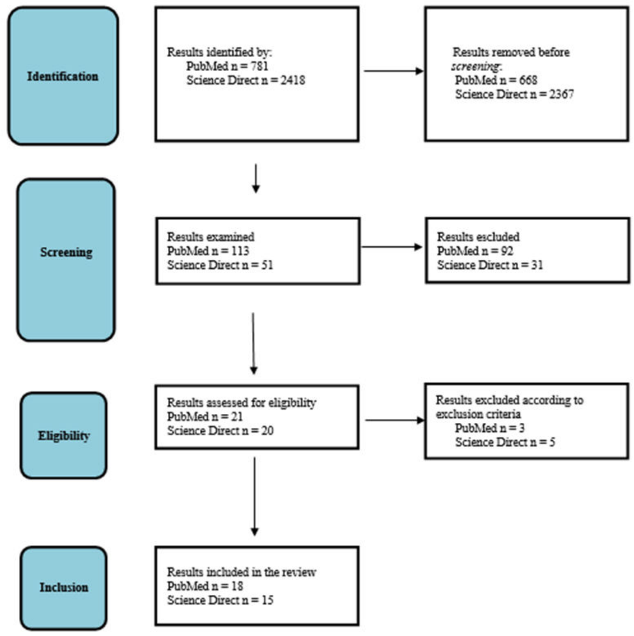

Figure 2. Selection of studies on the impact of CSHT on the skeleton.

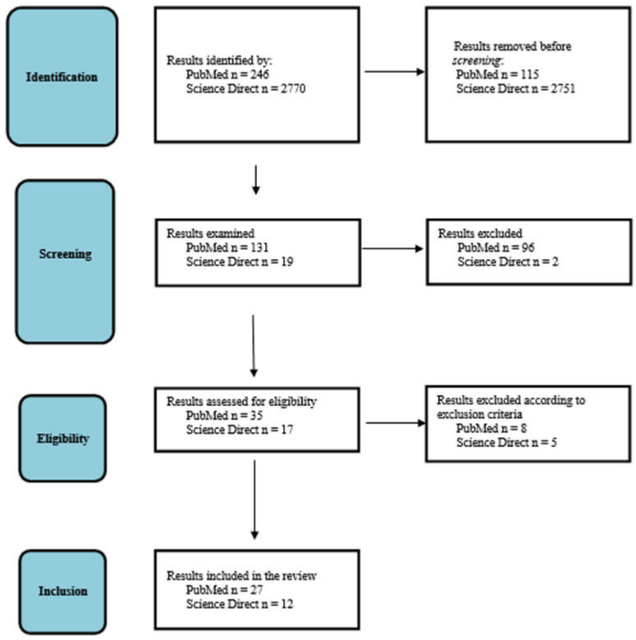

Figure 3. Selection of studies on the impact of FGS interventions on the skeleton.

Hormone therapy: GHT aims to partially or totally inhibit primary sexual characteristics and increase secondary sexual characteristics using exogenous endocrine agents. Most feminizing or masculinizing changes occur during the first 2 years after starting therapy and depending on the dosage, administration, and therapeutic regimen [11].

Hormone therapy for gender affirmation in AMAB individuals with gender dysphoria aims to lower testosterone concentration and increase estradiol concentration in blood using estrogen and anti-androgen drugs. For AFAB individuals with gender dysphoria, hormone therapy aims to increase testosterone concentration in the blood using testosterone and progestin drugs.

Markers of bone metabolism and BMD: Studies investigating the effects of GHT conducted in clinical settings report contradictory results on alterations affecting markers of bone turnover N-terminal propeptide of type I procollagen and C-terminal telopeptide of type I collagen. There are no studies conducted in the field of forensic anthropology.

Previous studies identified stable or increased values associated with BMD in transgender women suggestive of reduced bone resorption due to the protective effects of estrogens and mediated by serological levels of estradiol and insulin-like growth factor 1. Other studies revealed a relationship between BMD and signs of osteoporosis in the lumbar spine, reporting that the imbalance in bone resorption might be due to the effects of reduced muscle mass, non-adherence to treatment, inadequate estrogen dosage, and sedentary lifestyles. Additionally, Valentini, et al. reported testosterone suppression and estrogen above average physiological levels in male-to-female transsexuals receiving treatment for reassignment surgery, whereas no differences were observed in hormone or biochemical parameters.

Although most studies involving transgender men show stable BMD levels following treatment initiation, some report contradictory results. Broulik, et al. observed increases in BMD in transgender men relative to cisgender men, and other studies reported decreases in the lumbar spine, hip, and femur in transgender men relative to cisgender men.

FGS: The face is what identifies individuals and the first apparent, visible element of our identity, including gender. People with gender dysphoria undergo surgery and treatments to alter features incongruent with their gender identity. Although diagnosis of sex remains of the utmost importance in forensic medicine, identification of gender is now a necessary component in this process. There were 39 articles describing procedures for feminization and masculinization of the facial skeleton [12-19].

According to a survey conducted by Tallman, et al., ~30% of forensic anthropologists have addressed cases involving a transgender person, ~75% are unfamiliar with gender-affirmation surgery, 42.4% considered sex as binary (male and female), 39.5% agreed that gender should be indicated in an anthropological profile, and 95.8% agreed that further research is needed regarding forensic identification of transgender individuals.

Gruental-Rankin, et al. suggested the need to adopt a biocultural profile, as well as biological and anthropological profiles, to support contextualization of data and provide aspects of social identity useful for identification [20]. Their described framework of structural vulnerability involves biomarkers that include evidence of gender-affirming surgeries

Feminization techniques: Techniques to reconstruct the forehead were first described by Ousterhout, with classifications of four different surgical techniques based on the morphology of the frontal sinuses. These techniques range from frontal sinus thinning to osteotomy with subsequent reconstruction (performed on 90% of patients) to alloplastic forehead augmentation by means of artificial grafts. All of these techniques involve orbital rim reduction.

Rhinoplasty for feminization is often performed along with forehead surgeries to adjust the nasal-frontal angle (*i.e.*, with reduction and repositioning). During these procedures, appropriate angles are created to allow reduction of the dorsal line from the forehead to the caudal tip of the septum, with the width of the tip reduced due to lateral cartilage in males.

Although not usually included among feminization procedures, alteration of the zygomaticomaxillary complex may be necessary to achieve harmony in facial proportions. This procedure involves combined osteotomies and the interposition of hydroxyapatite or autologous bone between the zygomatic arch and jaw suture area. Performance of a combined operation involving the mandible and zygoma enables use of a portion of the excised mandibular bone to reduce the gonial angle. Segment repositioning is guided by titanium microplates placed in the lower part of the infraorbital margin.

Concomitant and combined surgical treatment of the jaw and chin enables their balanced reductions in size to feminize the lower part of the face. The most common interventions include remodeling with surgical instruments via thinning of the gonial angles or osteotomy and removal of layers of the outermost part of the mandibular plane down to a minimal amount of trabecular bone to reduce the size. Reduction of the square shape of the mandible is performed with an osteotomy. In some cases, the masseter muscle is reduced by excision of tissue from the surface of the muscle close to the bone. Additionally, genioplasty reduces chin size and creates a more rounded shape. In some cases, height reduction occurs via T-shaped osteotomy, followed by reshaping and fixation of the bone segments using plates and screws.

Masculinization techniques: Facial masculinization surgery was first described by Ousterhout, who performed the first surgical procedures on six cisgender men and later on transgender patients (Table 7). In 2017, Jordan Deschamps-Braly documented the first thyroid cartilage augmentation to create the "Adam's apple" for facial masculinization using autologous rib cartilage.

Table 7. Articles included from the literature investigating surgical procedures.

Authors	Year	Procedures	
Ousterhout	2011	Forehead augmentation, mandibular angle and chin augmentation, genioplasty	FMS
Boucher, et al.	2016	Malar region augmentation, rhinoplasty, mandibular angle reduction, genioplasty	FFS
Deschamps-Braly, et al.	2017	Chin size augmentation, creation of Adam's apple	FMS
Altman, et al.	2018	Forehead and supraorbital margin remodeling	FFS
Deschamps-Braly, et al.	2018	Forehead and supraorbital margins remodeling, rhinoplasty, mandibular angle reduction, genioplasty, thyroid cartilage augmentation	FFS FMS
Salgado, et al.	2018	Mandibular angle reduction, genioplasty, chondroplasty, jaw size, chin, and thyroid cartilage augmentation,	FFS FMS

Deschamps-Braly, et al.	2019	Forehead and supraorbital margins remodeling, rhinoplasty, mandibular angle reduction, genioplasty, thyroid cartilage augmentation	FFS FMS
Deschamps-Braly, et al.	2019	Genioplasty	FFS
Di Maggio, et al.	2019	Rhinoplasty	FFS
Lundgren K, et al.	2019	Supraorbital margins remodeling, zygomatic region advancement	FFS
Morrison-Satterwhite	2019	Jaw size reduction; jaw size augmentation	FFS FMS
Natghian, et al.	2019	Forehead and supraorbital margins reshaping, zygomatic process repositioning, rhinoplasty	FFS
Spiegel, et al.	2019	Jaw remodeling	FFS
Eisemann, et al.	2020	Forehead and supraorbital margins remodeling	FFS
Sykes, et al.	2020	Forehead and supraorbital margins remodeling, rhinoplasty, mandibular angle reduction, genioplasty	FFS
Gupta and Clark	2023	Forehead contouring	FFS
Massenburg, et al.	2023	Lower jaw remodeling	FFS FMS
Weinstein, et al.	2023	Cheek augmentation	FFS
Flaherty, et al.	2023	Rhinoplasty	FFS
Wang, et al.	2023	Genioplasty	FFS
Bonapace-Potvin, et al.	2023	Forehead remodeling	FFS
Patel, et al.	2023	Forehead remodeling, rhinoplasty, jaw remodeling, thyroid cartilage augmentation	FMS

Forehead-masculinization techniques are similar to type II and type IV feminization procedures. Augmentation of the forehead and supraorbital margin involves implanted alloplastic materials, such as methyl methacrylate, applied directly to the frontal bone, fixed with surgical aids (screws), and modeled. Additionally, procedures to improve nose definition and projection employ infralobular, onlay, and combined grafts obtained from septum cartilage. Surgical techniques for proportionating the lateral projection of the mandible to the lateral projection of the zygoma involve increasing the mandibular angle using bone grafts or alloplastic implants placed below the masseter muscle. No screws or plates are needed to stabilize the bone graft, as the masseter muscle provides the necessary support.

Chin enlargement both vertically and horizontally is accomplished through multi-segment osteotomy using bone grafts and the implantation of hydroxyapatite granules, with the segments fixed with screws and plates. Jaw augmentation is achieved with an implant placed in the plane below or above the periosteum or along the lower margin of the mandible and inferior to the exit of the chin nerve and following dissection in the upper part of the periosteum. The implant is fixed to the jaw with screws or sutures.

Longitudinal studies documenting post-operative changes in patients undergoing these procedures would be useful. Bone remodeling can alter the appearance of the marks left by surgical instruments, and the extent of bone changes varies between patients for each procedure. The limited evidence available challenges accurate estimation of what may have motivated performance of a particular procedure.

Some areas affected by facial gender-confirmation surgery may involve fractures resulting from various types of trauma, for which reconstructive and reparative interventions are necessary. If these surgical aids are found, their location and type must be distinguished. For example, surgical treatment for mandibular fractures involves osteosynthesis with screwed miniature plates. Generally, if the trauma occurs in the anterior portion, plates, screws, or pins are placed superiorly to the chin foramen. In feminization surgery they are placed inferiorly to fix the lower segment of the chin following osteotomy. Some implants in facial masculinization involve the use of Medpor, an alloplastic material widely used in cranio-maxillofacial surgery. These include correction of a depression or indentation resulting from trauma to the frontal bone.

Discussion

Not all transgender individuals undergo transition surgery. Transition has social and legal ramifications often resulting from difficulties in finding employment, accessing medical treatment, and/or obtaining legal representation. A transgender individual may consider a social transition as sufficient and express their gender identity in different aspects of daily life (e.g. behavior and clothing).

During identification of transgender persons, issues may arise curing comparison of antemortem/postmortem data. In the missing person report, the gender of the person may be indicated, which in the case of a transgender individual may not correspond with the sex estimate. There may be misleading assumptions and errors in the compilation of documents and how data are entered, managed, and searched.

It is also possible that disappearance of the individual will not be reported by the family due to discomfort or broken relationships within the family. In such cases, reports may originate from those unaware of the gender status of the missing person (Table 8).

Table 8. Articles included from the literature investigating specific cases.

Forehead and supraorbital margin remodeling			
Becking, et al.	2007	2	*
Dempf and Eckert	2010	1	
Cho and Jin	2012	1	
Bachelet, et al.	2016	12	
Lundgren K, et al.	2017	10	
Salgado CJ, et al.	2017	4	
Capitan, et al.	2019	129	
Raffaini, et al.	2019	49	
Chou DW, et al.	2020	109	
Pansritum K	2020	23	
Telang PS	2020	220	
Zygomatic alignment and bimaxillary osteotomy			
Becking, et al.	2007	3	
Shams MG and Motamedi MHK	2009	10	
Lundgren K, et al.	2017	10	
Rhinoplasty			
Becking, et al.	2007	21	
Dempf and Eckert	2010	1	
Salgado CJ, et al.	2017	4	
Raffaini, et al.	2019	49	
Chou DW, et al.	2020	84	
Telang PS	2020	155	
Jaw remodeling and gonial angle reduction			
Ousterhout DK	2005	688	
Becking, et al.	2007	23	
Shams MG and Motamedi MHK	2009	10	
Mommaerts MY, et al.	2019	5	
Raffaini, et al.	2019	49	
Chou DW, et al.	2020	102	
Telang PS	2020	145	
Daurade M, et al.	2021	21	

Simon D, et al.	2022	837
Chin, genioplasty		
Ousterhout DK	2003	485
Becking, et al.	2007	14
Shams MG and Motamedi MHK	2009	10
Mommaerts MY, et al.	2019	5
Telang PS	2020	35
Simon D, et al.	2022	837

*This study included 920 individuals who underwent one or more additional interventions.

Conclusion

This review offers insight into the current literature associated with forensic studies related to transgender individuals. The findings emphasize the lack of clear guidance, case histories, and data pertaining to this area of research and practice, as well as the importance of using all available methodologies for identifying the remains of transgender individuals. Our presentation of the methods employed to support gender transition focused on their potential impact on the skeleton, highlighting elements that could provide useful indications when identifying the skeletal remains of transgender and gender-diverse individuals.

In cases of hormone therapy to support gender affirmation, the impact of this practice on the skeleton requires further investigation using larger cohorts and appropriate control groups comprising those undergoing different treatment regimens or longitudinal studies at different follow-up intervals. Moreover, the effects of craniofacial surgery may provide identifying elements due to the presence of marks left by surgical instruments, the surgical systems employed for fixation, trace materials used for implants, or possible incongruence with the pelvis in cases of sex estimation. Our findings support the need for further studies to support the practice of forensic anthropology in cases involving transgender individuals.

Sources of Funding

No funding was received in support of this review.

Conflict of Interest

None to report.

References

1. Toneva, D.H., et al. "Data mining for sex estimation based on cranial measurements." *Forensic Sci Int* 315 (2020): 110441.
2. Prunas, A., et al. "Transphobic murders in Italy: An overview of homicides in Milan (Italy) in the past two decades (1993-2012)." *J Interpers Violence* 30.16 (2015): 2872-2885.
3. Haas, A.P., et al. "Suicide and suicide risk in lesbian, gay, bisexual, and transgender populations: Review and recommendations." *J Homosex* 58.1 (2010): 10-51.
4. Márquez-Grant, N., et al. "How do drugs affect the skeleton? Implications for forensic anthropology." *Biology* 11.4 (2022): 524.
5. Ruetsche, A.G., et al. "Cortical and trabecular bone mineral density in transsexuals after long-term cross-sex hormonal treatment: A cross-sectional study." *Osteoporos Int* 16.7 (2005): 791-798.
6. Dobrolińska, M., et al. "Bone mineral density in transgender individuals after gonadectomy and long-term gender-affirming hormonal treatment." *J Sex Med* 16.9 (2019): 1469-1477.
7. Haraldsen, I.R., et al. "Cross-sex pattern of bone mineral density in early onset gender identity disorder." *Horm Behav* 52.3 (2007): 334-343.
8. Wiepjes, C.M., et al. "Bone mineral density increases in trans persons after 1 year of hormonal treatment: A multicenter prospective observational study." *J Bone Miner Res* 32.6 (2017): 1252-1260.
9. Mueller, A., et al. "Long-term administration of testosterone undecanoate every 3 months for testosterone supplementation in female-to-male transsexuals." *J Clin Endocrinol Metab* 92.9 (2007): 3470-3475.
10. Meriggiola, M.C., et al. "Effects of testosterone undecanoate administered alone or in combination with letrozole or dutasteride in female to male transsexuals." *J Sex Med* 5.10 (2008): 2442-2453.
11. Ettner, R., et al. "Principles of transgender medicine and surgery." Haworth Press, New York (2007).
12. Ousterhout, D.K. "Dr. Paul Tessier and facial skeletal masculinization." *Ann Plast Surg* 67.6 (2011): S10-S15.
13. Salgado, C.J., et al. "Gender reassignment: Feminization and masculinization of the neck." *Clin Plast Surg* 45.4 (2018): 635-645.
14. Morrison, S.D., & Satterwhite, T. "Lower jaw recontouring in facial gender-affirming surgery." *Facial Plast Surg Clin North Am* 27.2 (2019): 233-242.
15. Gupta, N., & Clark, C. "Forehead contouring." *Facial Plast Surg Clin North Am* 31.3 (2023): 363-370.
16. Bonapace-Potvin, M., et al. "Facial gender-affirming surgery: Frontal bossing surgical techniques, outcomes and safety." *Aesthetic Plast Surg* 47.4 (2023): 1353-1361.
17. Bachelet, J-T., et al. "Facial feminization surgery-upper third." *Ann Chir Plast Esthet* 61.6 (2016): 877-881.
18. Chou, D.W., et al. "Initial facial feminization surgery experience in a multicenter integrated health care system." *Otolaryngol Head Neck Surg* 163.4 (2020): 737-742.
19. Mommaerts, M.Y., et al. "Mandibular feminization osteotomy—preliminary results." *Int J Oral Maxillofac Surg* 48.5 (2019): 597-600.
20. Gruenthal-Rankin, A., et al. "Beyond the report: Prospects and challenges in forensic anthropological investigations of structural vulnerability." *Forensic Sci Int Synerg* 6 (2023): 100315.

Cite this article: Milani C, et al. "Identification of Human Remains in Case of Transgender Individuals in Forensic Anthropology: A Systematic Review. J Forensic Pathol, 2024, 9(1), 1-10.