Bone Modification in Male to Female Transgender Surgeries: Considerations for the Forensic Anthropologist

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BONE MODIFICATION IN MALE TO FEMALE TRANSGENDER SURGERIES: CONSIDERATIONS FOR THE FORENSIC ANTHROPOLOGIST

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Arts

in

The Department of Geography and Anthropology

by
Shelby Buchanan
B.A., Boston University, 2011
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Abstract

No forensic anthropological standards exist for the identification of transsexual individuals from skeletal material. In fact, current standards produce inaccurate biological profiles for transsexuals. The reason being that current standard for ascription of sex from skeletal remains relies on pelvic morphology. Positive identification of unidentified individuals relies on the accuracy of the biological profile, which includes sex, provided by the forensic anthropologist. In the case of male-to-female (MTF) transsexuals, ascription of sex based on pelvic morphology will result in an inaccurate assessment of sex. This study, therefore, attempts to determine whether or not there exists evidence in the skeleton of facial feminization surgeries (FFS) that are almost solely utilized to aid in the feminine appearance of MTF transsexuals. Survey research established that a large portion of the MTF transsexual community, approximately 64% of MTF individuals surveyed, either already had bone-modifying FFS or planned to in the future.

Large and small oscillating saw blades as well as dome-shaped dental burrs were used on fleshed pig skulls to recreate the marks left during two popular FFS procedures, the mandibular angle shave/taper and the forehead contour. Analysis revealed that the marks made on wet bone are distinct enough to catalyze remodeling, which, when seen on unidentified remains, can indicate having undergone FFS. Each of the surgical tools was also utilized on a dried pig skull; comparative analysis of the tool marks made on wet bone and dry bone demonstrated that there would be discernable differences between surgical marks made antemortem and postmortem.

Finally, surveys distributed to forensic anthropologists revealed that laboratories across the US and outside of the US have already had to consider transgenderism in
certain forensic cases and that knowledge of the tool marks created during FFS can aid in
the consideration that an unidentified skeleton may have belonged to a MTF transsexual.
Chapter 1: Introduction

Transsexual individuals endure an extraordinary amount of emotional turmoil due to the disparity they feel between their biological and internal manifestations of sex. This distress is intensified by social conventions that rigidly adhere to the idea that gender is firmly established by one’s anatomy rather than culturally constructed. The desolation felt by transsexuals is indicated by higher rates of suicide, psychiatric disorders, and self-mutilation (Dhenje et al. 2011; Pauly 1968) in the transgender community. Transsexuals may be able to reconcile their own internal struggle through psychological help, but integrating into society as the gender opposite one’s anatomical sex is often a far more tumultuous journey. Over the past hundred years, surgical procedures have been pioneered and perfected to aid in the transition from one sex to another.

Several of the procedures available for the transition from male to female involve structural changes to the facial skeleton. The prevalence of transsexuals and individuals choosing to undergo feminizing procedures has been rising steadily. With legislation and public opinion in the United States becoming increasingly more accepting of lesbian/gay/bisexual/transgender/queer (LGBTQ) equality and rights, it is likely that individuals will become more comfortable expressing their transsexuality. For this reason, the number of individuals surgically altering their facial skeleton may also increase.

Knowledge of the modifications made to the skeletal structure of male-to-female transsexuals is of importance to forensic anthropologists. In cases in which an unidentified skeleton is discovered, a forensic anthropologist will create a biological profile of the individual, which includes age, ancestry, and sex, for identification.
purposes. Facial reconstructions are made and distributed via the media to the public based on the biological profile ascribed by the forensic anthropologist. The accuracy of sexing the skeleton based on cranial measurements ranges from 53.3% to 80% (Franklin et al. 2009), while the accuracy of sexing the skeleton based on pelvic morphology is often slightly over 90% (Gonzalez et al. 2009). Transsexual female individuals who received feminizing facial procedures that have altered the appearance of the skull will present a dilemma for the forensic anthropologist. The features of the skull may appear feminine, but pelvic morphology will reflect natal sex and appear masculine.

The forensic anthropologist is likely to rely on pelvic morphology for gender assessment because of the higher accuracy associated with the pelvis in sexing the skeleton compared to the skull. If a facial reconstruction of a transsexual woman is created without knowledge of her transsexualism, the depiction distributed to the media and police will be that of a male. The chances of identification are lessened when such reconstructions are based on an inaccurate assessment of gender. Forensic anthropologists should, therefore, be aware of facial feminization procedures and the resultant marks left by such procedures. With this knowledge, in the case of an unidentified skeleton presenting incongruence between pelvic and skull morphology, the forensic anthropologist can consider the possibility that the remains are those of a transsexual individual.

This study addresses the bone modifications made through structurally-altering facial feminization procedures in the attempt to identify by what means forensic anthropologists can determine whether an unidentified skeleton belongs to a transsexual individual. Bone mark experimentation was carried out on wild pig (Sus scrofa) bone
using the same tools that are employed in facial feminization surgery (FFS) procedures for the purpose of determining what marks a forensic anthropologist may expect to find on a male-to-female (MTF) transsexual’s skeleton. Also, surveys distributed to MTF transsexuals provided data regarding ethnic trends and age trends for each of the surgical procedures as well as served to support or refute the hypothesis that facial feminization procedures are becoming increasingly desired in the United States.

Finally, survey data collected from practicing forensic anthropologists served to determine whether or not forensic anthropologists should consider guidelines for evaluating a transgender status when ascribing sex to unidentified remains. Additionally, the survey for forensic anthropologists was intended to aid in any current unidentified cases that could potentially be solved through consideration of a transsexual status.
Chapter 2: Literature Review

Terminology

Gender Identity Disorder (GID), as defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV), is a strong and persistent cross-gender identification characterized by patient discomfort with his or her anatomical sex and the sense of inappropriateness in the gender role of that sex (Ralph et al. 2010). Researchers have estimated that GID occurs in one in every thousand people (Jenner 2010). Those individuals who suffer from GID are said to be transgendered. Transgenderism is a blanket category for a wide range of gender and sexual minorities including transvestites, intersex, and transsexuals (Ainsworth and Spiegel 2010) (see Appendix A for terminology regarding various aspects of transgenderism).

Transvestites, also commonly referred to as cross-dressers, are individuals who wear clothing and/or cosmetics to appear as opposite their birth sex. Transvestites cross-dress because it is sexually exciting, not because they feel as if their gender is opposite their sex (Pauly 1968). Intersex, more commonly referred to by the politically incorrect term, hermaphrodite, describes individuals who were born with ambiguous genitalia. Intersex does not imply that the individual was born with both male and female sexual organs, as is often misunderstood, but that physicians have a difficult time identifying whether a baby is male or female. In rare instances, intersex babies will undergo corrective genital surgery to combat the insecurity that parents feel about birthing a child that cannot be medically described as male or female; however, corrective surgery was standard procedure for intersex newborns until very recently (Harper 2007).
Transsexualism, the most extreme form of GID, is characterized by the intense feeling that one belongs to the opposite gender and was born with the wrong anatomical parts. Transsexuals do not get the same sexual satisfaction from cross-dressing that transvestites do (Ainsworth and Spiegel 2010; Pauly 1968). The term transsexual refers to those individuals with GID who use hormones and surgery to physically affiliate themselves with a self-identified gender (Ainsworth and Spiegel 2010). Specifically, transsexuals are defined by having undergone genital reassignment surgery; yet, individuals using exogenous hormones without surgery, individuals who have undergone surgical procedures other than genital reassignment to better align their appearance with their identified sex, or individuals who may eventually seek out surgical intervention may self-identify as transsexual (Jenner 2010). Males who desire to become physically female are referred to as transwomen, commonly denoted by MTF (male-to-female) in medical texts; females who desire a male physical form are referred to as transmen, denoted by FTM (female-to-male) in medical texts. Though the subcategories within the overarching category “transgender” may appear fairly easy to distinguish, placing any one individual into a subcategory is far more difficult than it appears. Subcategorization is highly individualized and two people who may share exactly the same GID symptoms may self-identify as different types of transgendered (confidential sources, personal communication, September 5, 2013).

**Prevalence**

Accurate prevalence rates for transsexualism are difficult to obtain and the estimates vary widely by researcher and region of the world. During the mid 20th century, the early years of transsexual emergence, estimates ranged from an occurrence of 1 in
every 100,000 individuals to 1 in every 400,000 individuals (Pauly 1968). These estimates are outdated and more recent cross-cultural studies in the United States and Britain approximate the incidence of transsexualism as occurring in 1 in every 50,000 individuals (Dempf and Eckert 2010). Most estimates for the extensiveness of MTF transsexuals range from one occurrence in every 12,700 individuals to an occurrence in every 45,000 individuals. For FTM transsexuals, estimates typically range from an occurrence in every 30,400 people to an occurrence in every 45,000 people (Veale 2008). Relatively high prevalence estimates have also been posited; Tsoi (1988) estimated that, in Singapore, transsexualism occurs in 1 in every 2,900 men and in 1 in every 8,300 women. Prevalence estimates from Thailand are also high, though estimates from Thailand only consider MTF transsexuals or “ladyboys” as they are referred to natively. Estimates for the prevalence of these “ladyboys” range from an occurrence in every 3,000 individuals to as high as an occurrence in every 180 individuals (Winter 2006). Estimates from Singapore and Thailand may reflect cultural differences that make transsexualism more acceptable in Southeast Asia or may reflect a more comprehensive tracking system.

Prevalence studies from the United States and the United Kingdom reflect MTF:FTM ratios that range from 2.5:1 to 4.4:1. Reports of a reversal of this ratio also exist in the literature; Japan and Eastern Europe report a higher preponderance of FTM transsexuals than MTF transsexuals (Veale 2008). Reports from other regions of the world reflect a more even male to female ratio. A 2011 study from Iran estimated lower overall instances of transsexualism, but a 1:1 ratio of male and female transsexualism (Ahmadzad-Asl et al. 2011). Serbia also reports a 1:1 ratio between MTF and FTM instances of transsexualism (Ralph et al. 2010). There exists the possibility that the 1:1
ratio observed in Iran and Serbia reflects the patriarchal cultural character of these two countries in which men have considerably more advantages than women; however, the ratio does appear to be in a state of reduction in other countries. Estimates from the late 1960s in Sweden reflect a male to female transsexualism ratio of 2.8:1, which was re-estimated as 1.4:1 in 1996. A similar effect is being observed in Germany, where estimates have decreased from 2.8:1 to 1.2:1 (Ahmadzad-Asl et al. 2011).

Typically, prevalence estimates are based on the number of transsexuals seeking treatment, both surgically and psychologically, as compared to a region’s total population over the age of 15 (Cohen-Kettenis and Gooren 1999). Estimates may therefore be grossly underestimated because negative social conventions may discourage individuals from seeking psychiatric help and the high cost of surgery deters many from pursuing medical intervention (De Cuypere et al. 2007); multiple feminization surgeries typically cost upwards of 30,000 US dollars (Fee et al. 2003). Though likely still underestimated, the trending rise in prevalence may reflect changing attitudes toward the issue of transsexualism as well as more willingness to express transsexual identity.

Etiology

The etiology of transsexualism is undetermined and highly contested, though a number of hypotheses have been posited, both biological and psychological in nature. In the early 1960s, physicians believed MTF transsexualism to originate from the presence of estrogen-secreting tumors of the testes and adrenal gland in combination with psychosocial factors, specifically parenting. Researchers hypothesized that MTF transsexuals had excessively close relationships with their mothers while having punitive relationships with their fathers; thus, the hypothesized etiology for the condition was the
lack of a model for masculine identification (Pauly 1968). The presence of estrogen-secreting tumors in MTF transsexuals has been debunked, but psychologists still consider parenting a factor in the etiology of transsexualism despite the lack of empirical support. MTF transsexuals do often report more emotional distance from their fathers than the average male population, but this finding may be a consequence of the feminine development of the boy rather than the cause of said feminine development. FTM transsexuals report both parents as being more rejecting than does the average female population; therefore, the lack of an appropriate gender role model as an etiology for transsexualism is likely not accurate (Cohen-Kettenis and Gooren 1999). Though psychosocial factors may influence the transsexualism of an individual, they are likely not a universal factor; biology likely plays a larger role in the development of transsexualism than psychosocial factors.

Biomedical research into transsexualism has addressed two potential areas extensively: abnormal endocrine history and abnormal morphologies of the brain nuclei that are sex-differentiated. Studies (Cohen-Kettenis and Gooren 1999) have demonstrated that an abnormal endocrine history is incorrect as an etiology of transsexualism. Were this hypothesis true, XX individuals, such as girls with congenital adrenal hyperplasia (CAH), which causes prenatal exposure to high levels of androgens, would be expected to adopt a male gender identity. Some girls with CAH do become transmen; however, the occurrence is far too rare to be correlated with the disease’s abnormal endocrine regulation (Cohen-Kettenis and Gooren 1999).

An etiology based on abnormal sexual differentiation of the brain nuclei garners more support. Several hypothalamic nuclei are sexually dimorphic in the human brain.
Hypothalamic sex differences are believed to underlie differences in gender identity and sexual orientation (Cohen-Kettenis and Gooren 1999). One of the sexually dimorphic regions of the hypothalamus, the bed nucleus of the stria terminalis (BSTc), is smaller in MTF transsexuals than in average males; they possess a BSTc that lies within the normal female range. Non-transsexuals who take estrogen for medical reasons did not have an abnormal BSTc size, which implies that the difference in MTF transsexuals’ BSTc size compared to the remainder of the population is not caused by cross-hormone therapy (Cohen-Kettenis and Gooren 1999; Luders et al. 2009). Postmortem studies have revealed female-like volumes and neuronal densities of the interstitial nucleus of the anterior hypothalamus (INAH3) in MTF transsexuals. Additionally, in MTF transsexuals, the putamen, a structure in the forebrain that influences various types of learning, was found to possess a gray matter volume within the normal female range (Luders et al. 2009). These findings suggest that a deviation of the sexual differentiation of the brain from the sexual differentiation of the body during embryonic development may be responsible for the development of transsexualism. However, more research, especially in regard to FTM transsexualism, needs to be conducted before a definite etiology can be specified.

Whatever the cause, the scientific community generally accepts that transsexualism develops in utero (Jenner 2010) and manifests early in life. Transsexuals often reported that they started to feel a strong desire to belong to the opposite sex at around five or six years of age (Van de Ven 2008). Parents corroborate this finding, stating that from an early age, their son or daughter insisted on dressing and playing in a manner opposite his or her natal gender role (Cohen-Kettenis and Gooren 1999; Dempf
and Eckert 2010; Pauly 1968). Evidence thereby supports a congenital basis for GID. As such, the disorder is not a matter of choice, but a clinical state in which medical intervention is warranted to alleviate the discrimination and pain that come along with the condition.

**Treatments**

A number of therapies are available for transsexuals; these include psychotherapy, hormone treatments, gender reassignment surgeries, and facial feminization surgeries. Any transsexual undergoing surgery to alter the appearance of his or her anatomical sex will have to first undergo psychotherapy. Surgeons in the United States and Europe will not carry out genital reassignment surgery or bone-modifying procedures without a diagnosis of GID by two separate psychiatrists. In order for a psychiatrist to make this diagnosis, the patient must have lived at least one year, though more often at least two years, as the self-identified gender (Goddard et al. 2007; Reza Nouraei 2007). The possibility exists that these standards are not as rigidly adhered to in other regions of the world.

**Hormone Therapy**

Typically, the first step in a transsexual individual’s transformation is hormone replacement therapy (HRT), though there are some individuals for whom this is the only step. The World Professional Association for Transgender Health (WPATH) lays out eligibility and readiness requirements before adult hormone therapy can be approved. Eligibility criteria include being at least 18 years old, having at least three months’ experience living as the self-identified gender, having demonstrable knowledge about what hormones can and cannot do, being aware of the social risks and side effects of
hormone therapy, and having a physical exam and blood work done (Meyer 2009). Once eligible, a patient must meet the readiness requirement before beginning HRT. Psychiatrists deem patients ‘ready’ when they feel the patient’s mental state is stable and the patient is likely to take hormones responsibly (Meyer 2009). Once given approval, hormone therapy will become a persistent aspect of the transsexual’s life, continuing after all sex reassignment surgeries, likely until death (Valentini et al. 2009; Wierckx et al. 2012).

The goal of HRT is to obtain a hormonal concentration in the normal physiological range of the sex of which the individual is to become. This goal is accomplished through cross-sex hormone administration. In FTM transsexuals, testosterone administration is started after the suppression of menstruation by a progestin (Wierckx et al. 2012). Testosterone therapy changes hair patterns, reduces breast and ovary size, and enlarges the clitoris (Jenner 2010). In MTF transsexuals, anti-androgen therapy, which reduces testosterone levels, is followed by exogenous estrogen administration (Lapauw et al. 2008). Estrogen therapy enlarges the breasts, shrinks the testicles, softens the skin, and thins the hair (Jenner 2010).

Several risks and concerns are associated with cross-sex hormone therapy. Cross-sex hormones may be associated with cardiovascular problems; studies have found long-term estrogen administration to be associated with higher cardiovascular mortality (Dhenje et al. 2011; Weirckx et al. 2012). The development of cancer is also a concern associated with estrogen therapy. Hormone-related cancers have been linked to HRT undergone by postmenopausal women. As the estrogen dosage for MTF transsexuals is two to three times higher than the dosage given to postmenopausal women, there is a
definite cause for concern (Valentini et al. 2008). Though no studies currently verify the association, long-term studies of the side effects of cross-sex hormone therapy are necessary to corroborate or discredit major concerns.

Cross-sex hormone therapy also poses risks to the skeletal structure. Sex steroids are important in regulating skeletal growth, peak bone mass (PBM), and bone mass maintenance in the skeletons of both sexes. A wealth of knowledge has been accumulated to demonstrate that estrogen plays a large role in bone formation processes as well as in the development of PBM in both males and females (Fischer 2011). Epidemiological studies have found no association between testosterone levels and PBM, bone mineral density (BMD), or fracture rate (Valentini et al. 2008). In older women, menopause-related estrogen deficiency is associated with bone loss, trabecular deterioration, disconnection, and cortical thinning. FTM transsexuals, who are administered estrogen suppressants to increase the effects of testosterone, are, therefore, at a higher risk for osteoporosis than MTF transsexuals.

In fact, no evidence has been found of osteoporosis developing in MTF transsexuals undergoing estrogen administration (Fischer 2011). Some studies have even found that MTF transsexuals show an initial increase in lumbar and femoral neck areal BMD as well as a decrease in bone turnover with cross-sex treatment, though values return to normal levels after four years of hormone therapy (Lapauw et al. 2008). However, other studies have suggested that estrogen therapy, in the long run, leads to lower bone strength in the MTF transsexual. Evidence for this is found in markedly lower trabecular BMD at the distal radius and significantly smaller bone size of the mid-shaft radius and tibia in MTF transsexuals as compared to FTM individuals and the general
public (Lapauw et al. 2008). The effects of estrogen suppression and testosterone administration are relatively well known; contradictions found in the medical literature suggest that more studies are needed to determine the effect of androgen suppression and estrogen administration on the male skeleton.

**Surgical Intervention**

After several years of hormone therapy, transsexuals may consider surgical intervention. FTM transsexuals often undergo far fewer surgical procedures than do MTF transsexuals. That females use surgery less than males could be due to the fact that fewer procedures have been developed to aid in the transition from female to male or it could be due to the fact that females tend to fare better in their new gender role than males do (Pauly 1968). Transitioning females may fare better than transitioning males because females consult doctors about their transsexual symptoms an average of eight years earlier than males (De Cuypere et al. 2007). Or, this trend may be resultant of feminine features on males being more aesthetically pleasing than masculine characteristics in females (Ousterhout 2009). Often, hormone therapy provides results for transmen that are satisfactory enough that no other interventions are pursued.

**FTM Surgeries**

For individuals who opt for surgical intervention, several types of surgeries are available that will help the FTM transsexual transition. Mastectomy – the surgical removal of the breasts – is the most common FTM procedure and should precede other operations because it greatly facilitates the adjustment to a male lifestyle and is highly influential in altering other peoples’ perceptions of the individual’s gender (Sohn and Exner 2008). Hysterectomy and ovarectomy – surgical removal of uterus and ovaries,
respectively – should also be performed as a preliminary intervention to genital reassignment surgery (GRS). FTM patients who desire GRS have two options: metoiodoioplasty or phalloplasty. The metoiodoioplasty is often chosen when patients are unsure about undergoing phalloplasty. First appearing in 1973, the metoiodoioplasty describes surgical enlargement of the clitoris, resulting in a micropenis and a prolongation of the urethra, allowing the patient to void the bladder in a standing position. Those individuals who desire the possession of a penis capable of sexual intercourse will more likely choose the phalloplasty for their GRS (Ralph et al. 2010).

The phalloplasty has appeared in medical texts since 1936. The goal of the surgery is to create a neopenis that provides enough bulk to insert a prosthetic device that will allow maintenance of an erection (Sohn and Exner 2008). No single ideal technique exists for the creation of a neopenis, but the most widely cited technique is that of the free forearm flap. This technique uses non-hair bearing sections of the forearm to create the penis and the urethral tube. The free forearm flap procedure gives an overall satisfaction rate of 80-85% (Ralph et al. 2010) and enables most patients to achieve orgasm by use of a phallus implant (Wierckx et al. 2011).

**MTF Surgeries: Soft Tissue**

A wealth of surgical procedures is available for the transition from male to female. Unlike transmen, transwomen do not achieve satisfactory results by use of cross-sex hormone therapy alone. Soft tissue changes can be made by way of relatively simple and safe surgical procedures. One of the more important soft tissue surgeries is the chondrolaryngoplasty, or the thyroid cartilage shave. This surgery is an important procedure because the Adam’s apple is a clear indicator of natal male sex. In addition to
reducing the Adam’s apple, breast and cheek implants can aid in an individual’s self-presentation as a woman.

The most significant soft tissue alteration is, obviously, the vaginoplasty. The date of the vaginoplasty’s origin is unclear because early techniques may have been disguised as treatment for intersex conditions or, in some cases, carried out in secret. However, MTF GRS was being performed openly in Europe in the 1920s. The aim of the vaginoplasty is to create a neovagina that can accommodate intercourse as well as the creation of a sensate clitoris that can achieve orgasm (Goddard et al. 2007). Until 1995, the creation of a sensate clitoris was not inherent in MTF GRS but, today, is a standard procedure. The neovagina is created using penoscrotal skin flaps to make the lining of the vagina as well as the vulva, and well-vascularized scrotal skin is used to create the labia majora. The neoclitioris is made from the glans penis with its neurovascular dorsal bundle intact (Ralph et al. 2010; Sohn and Exner 2008). Postoperatively, patients are bedridden for five to six days with an intravaginal dilator in place; regular dilation of the neovagina must be maintained throughout life (Ralph et al. 2010).

**Facial Feminization Surgeries**

Though hormone therapy can greatly impact the appearance of a person’s soft tissue, the interest for forensic anthropologists lies in the set of surgical procedures that makes changes to one’s skeletal structure. Soft tissue changes can add significantly to a MTF transsexual’s overall feeling of womanhood, but structural changes are, perhaps, more important in convincing others of one’s status as a woman. Surgical procedures that alter the postcranial skeleton are not indicative of a transsexual status because the predominance of alterations made to the postcranial skeleton correct trauma or pathology.
However, there are two elective procedures that cosmetically alter the skeleton that may be used to further feminize a MTF transsexual; these procedures are not used solely by transsexuals and they are both rarely performed by surgeons in the US (plasticsurgeryportal.com).

The first procedure is that of rib removal. The theory that women in the Victorian era had their 11th and 12th ribs removed to create smaller waists has been popularized in books and documentaries. However, it is unlikely that this surgery was successfully performed in the 19th century because anesthesia had not been invented; the removal of the ribs would, therefore, have been performed without anesthetic or sterilization, making it highly unlikely that physicians would have performed this surgery (Cochran 2009). Despite the fact that the rib removal was likely a socially constructed explanation for the small waist size of women in eras past, surgeons today are performing the rib removal. Plastic surgeons in Los Angeles advertise this procedure online (aaronstonemd.com) and videos of the surgical procedure are even available for curious eyes on youtube.com.

The second cosmetic surgery that alters the postcranial skeleton that a transsexual may opt to undergo in order to appear more feminine is a toe amputation. This procedure is commonly nicknamed the “stilettosurgery” in newspaper and journal articles because it involves the amputation of the fifth digit of the foot for the purpose of narrowing the foot to fit into more feminine shoes, like stilettos. The website plasticsurgeryportal.com acknowledges that both the stiletto surgery and the rib removal are being performed by surgeons today, though very rarely because the majority of US surgeons feel these two surgeries are vain cosmetic procedures that carry more risk than reward (plasticsurgeryportal.com). Because there is a lack of postcranial surgical procedures
available to the MTF transsexual and a wealth of procedures available to alter the facial skeleton, the interest for forensic anthropologists centers on the cranial skeleton of MTF transsexuals.

Men and women have uniquely distinct skeletal features of the face; if a MTF transsexual wishes to fully assimilate into society as a woman, she will have a more positive outcome if a surgeon has addressed and altered her facial skeleton. Facial feminization surgery (FFS) describes the set of procedures that alter the typically male facial features to become more feminine (Ainsworth and Spiegel 2010). FFS includes both procedures that make structural changes to the face and soft tissue surgeries that normally accompany the skeletal surgeries. The common FFS procedures include forehead reduction, rhinoplasty, lip lift, genioplasty, and mandibular angle shave (Altman 2012; Ousterhout 2009). Dr. Douglas Ousterhout of California pioneered these FFS procedures in the 1980s (Altman 2012).

Males and females differ significantly in the shape and size of the forehead. Typically, the male forehead has extensive supraorbital bossing, above which there is often a flat area before the upper forehead begins to curve. In females, the degree of supraorbital bossing is significantly less than in males and frequently non-existent. Female foreheads do not exhibit the same flatness found in male foreheads and, instead, exhibit continuous mild curvature (Dempf and Eckert 2010; Lee et al. 2010). As the forehead represents 25-40% of the face (Ousterhout 2003) and is distinctly sexually differentiated, it is an important factor in a feminine presentation (Figure 1). Several gender identification studies have found that, in isolation, the forehead region is most significant in accurate identification of an individual’s gender (Spiegel 2011).
Ousterhout classified forehead shape and contour into three types, which subsequently determine the surgical procedure that will be employed for forehead contouring. Classification of forehead type (type I, type II, and type III) is determined after a combination of one or more of the following are evaluated: skeletal and artistic evaluations, radiograph imaging, asymmetry gauges, facial masks and photographs (Ousterhout 1994). Individuals that fall into the first type (type I) have a mild to moderate projection of the supraorbital brow and either no frontal sinuses or an anterior wall so thick that its reduction does not compromise the sinus air space. Reduction of the frontal bossing is achieved relatively easily with the use of an acrylic-trimming burr, also referred to as a bone-contouring burr (Altman 2012).

Type II individuals have normal brows with mild to moderate bossing and a thick anterior sinus wall. Forehead contouring is accomplished in type II individuals in the same manner as in type I, but a type II reduction in bossing may result in a concavity superior to the bossing that will need to be filled using methyl methacrylate, a type of
bone cement. Type II contouring is the least commonly practiced surgical procedure addressing male forehead bossing. In Ousterhout’s experience, Asian individuals most often comprise the type II group (Ousterhout 2009).

Type III individuals exhibit excessive brow fullness and have an anterior table of the frontal sinus that is set back further than in type I and type II individuals (Altman 2012). During the type III procedure, the anterior table is excised, medically referred to as osteotomized, and the forehead is contoured into a more feminine shape. The excised bone is then resituated in the hole created by cutting out part of the sinus wall and secured using metal wires (Ousterhout 2009). The type III procedure is accomplished by use of a bone-contouring burr or a sagittal saw (Altman 2012). According to Ousterhout (D. Ousterhout, personal communication, April 9, 2013), should a skeleton show signs of metal wiring fixing the central forehead in place, one can rightfully assume that the individual was transgendered in life. Ousterhout has solely performed the type III feminizing procedure on transsexuals, but has performed both type I and II surgeries on non-transgendered females wishing to make their features more delicate; however, he has done so in less than 10 cases. The large majority of people undergoing forehead reduction are MTF transsexuals (D. Ousterhout, personal communication, April 2013; J.H. Spiegel, personal communication, August 2013).

Two soft tissue procedures often accompany the forehead reduction: the scalp advancement and brow lift. Men and women not only differ in the skeletal aspect of the forehead, but also in the appearance of the soft tissue. Men typically have higher hairlines than women, making their foreheads appear larger. The length of the forehead is measured from the hairline to the top of the eyebrows and averages 2.6 inches in men and
two inches in women (Ousterhout 2009). The higher hairline obvious on male individuals holds true even without any evidence of common male patterned balding (Ousterhout 1994). Men also have lower eyebrows than women; the female eyebrow is located above the supraorbital ridge while eyebrows on males generally sit at the level of the ridge (Altman 2012). The procedures to correct the difference in hairline and brow position require cuts to be made at the crown of the head, the same spot in which the skin is cut for the forehead contouring procedures. Therefore, they are normally carried out at the same time. The scalp advancement excises a premeasured section of skin at the top of the forehead and brings the remainder of the skin toward the crown of the head to be secured in place. In doing so, not only does the forehead appear shorter, but also the eyebrows are elevated to a more feminine position (Ousterhout 2009).

When performing forehead contouring, the nose is additionally considered. The radix, or the bridge just below the forehead, is more gradual in females and more angular in males. Thus, to create the appearance of a feminized face, the radix may have to be set back as far as eight or nine millimeters behind the nose. Dr. Ousterhout strongly encourages making structural changes to the nose at the same time as forehead contouring because forehead-contouring procedures allow the surgeon the opportunity to fix the radix from above. Standard rhinoplasty procedures contour the nose from below, which, when the radix needs to be set back extensively, creates the possibility of producing an abnormal passageway into the frontal sinus, called a fistula (Ousterhout 2009).

Though the rhinoplasty structurally alters the nose and leaves visible evidence in the skeleton, it cannot alone indicate that an individual was transgendered. The procedure
is of utmost importance in the surgical recreating of MTF transsexuals, but it is also an extremely common plastic surgery procedure used by all types of people (Ainsworth and Spiegel 2010). The rhinoplasty is important for transsexual individuals because of both the structural and soft tissue differences observable in the noses of males and females. In addition to the sexual differentiation of the radix, males have larger noses overall, with larger nostrils. Male noses typically point inferiorly or anteriorly at the tip, while female noses point slightly superiorly at the tip (Ousterhout 2009). Finally, males often possess a dorsal hump, while the bridge of the female nose tends to slant inward before sloping slightly inferiorly (Dempf and Eckert 2010; Ghasem Shams and Motamedi 2009; Ousterhout 2009). The goal of a feminizing rhinoplasty is to reduce the nose as a whole and the parts that interfere with an individual’s appearance as a woman. The rhinoplasty may be a common aesthetic procedure, but in the opinion of Ousterhout (2003), it is one of the most important procedures of FFS.

Another sexually differentiated trait is the height of the upper lip, the distance of which is measured from the nasal sill to the vermillion border of the lips (Ousterhout 2009). In females, this distance is shorter, resulting in the exposure of a woman’s upper teeth when she barely opens her mouth. Men, on the other hand, show more of their lower teeth than do women (Ousterhout 2009; Van de Ven 2008). Part of FFS, though it is strictly a soft-tissue procedure, the lip lift is the surgical procedure that aims to reduce the discrepancy between male and female vertical lip height. A lip lift is accomplished by excising an ellipse of skin adjacent to the nasal sill; generally, no more than 25% of the overall height of the upper lip is excised (Altman 2012). In addition to addressing the height of the upper lip, a surgical lip lift will also address the morphology of the philtrum
complex, the groove directly below the nose and above the upper lip, because women typically have a more defined philtrum complex than do men (S. Leis, personal communication, September 6, 2013).

That males tend to show more bottom teeth than females is the result of vertically shorter lower lips in men. There is no procedure that directly addresses lengthening the lower lip, but the discrepancy in the visibility of teeth between the sexes when slightly opening the mouth is normally corrected in MTF transsexuals during a procedure known as the sliding genioplasty. This skeletal altering facial feminization procedure reduces the vertical height of the chin by moving the base of the chin upward, which automatically raises the lower lip and results in less bottom teeth showing (Ousterhout 2009).

The chin is an area of concern in MTF transsexuals because it, too, is distinctly sexually dimorphic (Figure 2). Male chins are vertically higher, typically by 17% (Ousterhout 2009), wider, and more square than female chins (Dempf and Eckert 2010; Van de Ven 2008). The genioplasty serves to create in the MTF transsexual a chin that is overall smaller and more rounded (Ghasem Shams 2009). The reproduction of a feminized chin is accomplished via the genioplasty by reducing chin height by cutting the mandible with a reciprocating saw (Altman 2012) and removing or repositioning segments to give the chin the shorter, more rounded appearance. The excised segments are then stabilized with plates and screws (Ousterhout 2009).

An additional surgery, though not traditionally included in the overarching category of FFS, which excises bone from the facial skeleton, is the widening of the zygoma prominence. During this technique, the area of the zygomaxillary suture is osteotomized and set more laterally, leaving the zygomatic arch intact and filling the
space created with implants of hydroxylapatite. Should the technique be combined with a mandibular angle shave, which will be described in the text that follows, the space created during the zygoma widening is filled with autogenous bone taken from the mandible. The result of this procedure is a more rounded facial morphology and larger eye orbits, both of which are considered more feminine features (Becking 1996). However, this technique does not appear often in the literature or on plastic surgery websites.

The genioplasty addresses chin height and the shape of the tip of the chin, but the reduction of typical male squareness of the jaw is addressed through mandible angle shaving. Typically, the genioplasty and mandible taper are performed together to address all the masculine aspects of the mandible at once. The square appearance of male jaws is associated with a sharper mandibular angle, a more pronounced oblique line, and bulkier masseter muscles (Altman 2012; Ousterhout 2009), (Figure 3). Using an acrylic burr, the prominence of the mandibular angle and the oblique line is shaved down to female dimensions. If an individual has significant mandibular angle flaring, the angle may need to be osteotomized, or excised, which is accomplished by use of an oscillating saw and/or
a curved osteotome (Altman 2012). In certain cases, the masseter muscle may need to be reduced. Masseter muscle reduction is accomplished by excising tissue from the medial surface of the muscle, closest to the bone (Ousterhout 2003).

![Figure 3: Female (Left) and Male (Right) Skeletal Mandibular Angle Differences.](image)

The combination of oblique line shaving with angle osteotomy and, sometimes, masseter muscle reduction, will produce in the transwoman a softer and more rounded appearance that is more typical of the female gender. However, several surgeons do not agree that altering the mandibular angle will enhance the feminine presentation and advise against this structurally altering surgery. A gender identification study by Dr. Spiegel (2011) indicated that jaw shape contributed the least to accurate gender determination. Dr. Sherman Leis (personal communication, September 6, 2013) has been vocal in his opinion of the mandibular angle shave and will not perform the procedure in MTF patients seeking feminization. Leis believes the procedure to be of great risk for little to no gain, while other facial surgeons continue to include the mandibular angle shave/taper as an integral aspect of facial feminization (S. Leis, Personal communication, September 6, 2013).
A number of surgical interventions are now available to lessen the discomfort of feeling like one was born into the wrong anatomical sex and gender role. For the FTM transsexual, hormone therapy, in combination with soft tissue changes are sufficient enough to ease into society as a man. For the MTF transsexual, hormone therapy and soft tissue changes alone do not adequately disguise birth sex. Instead, structural changes produced through the techniques involved in facial feminization surgeries create the feminine appearance desired to integrate into society as a woman.
Chapter 3: Materials and Methods

In this study, I collected data on the bone modifying surgical procedures available to MTF transsexuals for the purpose of distinguishing whether or not forensic anthropologists should establish guidelines for considering transsexualism when ascribing sex to unidentified remains. Three types of data were collected during the course of this study. These were tool mark analysis and two separate survey collections.

Tool Mark Analysis

Documentation of tool marks contributed the greatest amount of data. The facial feminization procedures that alter the structure of the facial skeleton include three variations of forehead contouring, rhinoplasty, genioplasty, and mandibular angle shaving. The resultant marks left by the surgical tools implemented in forehead contouring and mandibular angle shaving were documented qualitatively on wet and dry bone. Though rhinoplasty is included as a feminizing procedure, it cannot alone distinguish whether an individual was transsexual because it is a very common elective surgery regardless of gender status; therefore, no attempt at tool mark analysis for this procedure was made. A genioplasty includes the securing of plates and/or screws to the chin; therefore, tool mark analysis for this procedure was also unnecessary as the forensic anthropologist should quickly be able to determine whether or not an unidentified individual underwent this procedure.

The tool used in mandibular angle shaving is most often an oscillating saw (Altman 2012). Two oscillating saw blades were purchased from ebay.com, one Stryker model number 1107 and one Stryker model number 1116 (Figure 4). Model 1107 will be hereto referred to as the large blade and model 1116 will be hereto referred to as the
small blade. The purpose of purchasing two different sized blades was to catalogue whether the set and shape of blade teeth that will vary between blade sizes and, thus, by surgeon and by patient (N. van Der Dussen, personal communication, July 2013), affects the striations and overall shape of the marks left on the bone. Characteristics of each

Figure 4: Large and Small Oscillating Saw Blades.

blade are as follows, the large blade, model 1107, has a cut edge of 8.0 mm, a thickness of .64 mm, a cut depth of 41.0 mm, and 6.3 teeth per centimeter. The small blade, model 1116, has a cut edge of 17.5 mm, a thickness of .64 mm, a cut depth of 22.0 mm, and 8.7 teeth per centimeter. The tools used to contour the forehead are acrylic bone burrs; these burrs are also used to smooth out the mandibular angle after osteotomy and in cases in which the mandibular angle only needs minor contouring. Conversations in person with Dr. Sherman Leis, over the phone with Dr. Douglas Ousterhout, via Skype with Dr. Frans
Noorman van der Dussen, and by email with surgeons from seven countries revealed that neither one type nor one shape of burr is universal for reduction of the supraorbital bossing. I was informed that dental burrs were used because they are small and inexpensive, but the brand and shape of the burr varies by surgeon. Ousterhout informed me of his preference toward dome-end dental burrs. Ousterhout is one of the leading American FFS surgeons and the pioneer of the forehead contouring method. Therefore, I purchased 10 dome-end burrs, each measuring 0.9 mm in length, for my tool mark analysis (10 being the smallest quantity available from Dentalbursusa.com).

*Sus scrofa* (feral pig) skulls were used as an analog for human skulls for tool mark analysis. Dr. James LaCour, the state wildlife veterinarian for the Louisiana Department of Wildlife and Fisheries (LDWF), delivered two pigs to the FACES lab in early August of 2013. The pigs were killed, without damage to the skull, in Northern Louisiana during a LDWF pig hunt, which is carried out routinely by the department for population control and epidemiological survey. The pigs were stored in the FACES lab cooler over a weekend.

Next, both pigs were removed from the cooler and their heads were disarticulated using a scalpel, scissors, and hemostats. After disarticulating the skulls from the postcranial skeletons, one head was put in the FACES lab freezer. The other head was macerated; all flesh that could be removed without leaving scalpel marks on the bone was excised from the skull.

In order to degrade the remaining tissue, the skull was submerged in a solution of 12 liters of water and 1 and 1/12 cups Cascade detergent, which was heated over an electric burner. This maceration technique has been validated and is commonly employed.
in forensic anthropology labs (Wolfe Steadman et. al 2006). The skull sat in the solution over the burner for six hours on the day of maceration and sat in the solution without heat for the following two consecutive days. The skull was then removed from the pot and the congealed tissue that remained attached was removed with a scraper and brushed off under running water with a toothbrush. Afterward, the skull was left under the fume hood on a wire rack to dry. Drying one skull served to compare resultant surgical marks on dry bone to marks left by the same tool on wet bone so to distinguish whether or not the marks left during surgery could be confused with any marks that are inflicted outside of surgery, including marks made postmortem.

An additional pig head was procured from a meat market. The pig had been killed without causing damage to the skull and was butchered that same day. It was then vacuum-sealed and put in the market cooler until I could come retrieve it later that day. The head was then stored in the FACES lab freezer.

Two days later, both of the frozen heads were removed and placed in the cooler to defrost. The following day, maceration began. Using a scalpel, hemostat, scissors, and tweezers, the mandibular angles of the pigs were exposed, taking extra precaution to avoid leaving any marks on the bone that could be confused with marks resulting from the oscillating saw. The skin surrounding the gonial angle of the mandible was peeled back and the underlying muscle was cut out. Of course, during the mandibular angle shave procedure in humans, the masseter muscle would not be removed in such a crude manner, but carefully detached. However, as I was not going to reattach the muscle to the newly created angle, I simply excised and disposed of the muscle in biohazard.
Next, I began macerating the foreheads of both pigs using the same tools that were used for the mandibular angle maceration. Using the scalpel to cut a line from the front of the ears along the superior aspect of the eye orbit, I was able to easily pull back the skin and flesh of the face to expose the foreheads. The purpose of keeping the pig heads fully fleshed and only exposing the mandibular angles and forehead regions instead of completely macerating and boiling the bone before making the tool marks was to mimic the surgical procedure as accurately as possible. Though the forensic anthropologist will most likely view surgical tool marks on dry bone, the surgical marks are originally made on wet bone.

After maceration had been completed, the oscillating saw blades were affixed and screwed tightly into a Stryker model 810 autopsy saw belonging to the LSU FACES lab. Permission to use the saw was provided by the director of the FACES lab, Ms. Mary Manhein. The saw was first used on pig 3, the dried skull. One gonial angle was cut out using the small oscillating blade and the other angle was cut out using the large oscillating blade; both excisions measured 20 mm from the vertex of the gonial angle. Once I felt I could proficiently excise the angles in a continuously smooth line, the saw was used on the fleshed skulls that had their mandibular angles exposed. The small blade was used to remove the right angle of each mandible and the large blade was employed to cut out the left angle (Figure 5).

To recreate the marks left during a forehead reduction, I was assisted by research associates at the LSU Paleoclimate and Atlantic Studies (PAST) lab. Prior to recreation of surgical markings, the lab was prepared by covering every surface with garbage bags. Once the area was fully prepped, a dental burr was fastened into the drill bit attachment
of a computer aided TAIG 3200 Micromill with servomotors controlled by a CamPod system, powered by SuperCamXP programming (Figure 6).

Figure 5: Using the Oscillating Saw to Excise the Mandibular Angle.

Figure 6: Dome-Shaped Dental Burr Attached to TAIG 3200 Micromill.
Though surgeons use a hand-held surgical burr during the feminizing forehead procedures, the micro-milling machine accomplishes the same rapid spinning necessary for the reduction of the supraorbital bossing. However, because the machine is affixed to a table and the drill attachment site is affixed horizontally to the machine, I was not able to create burr marks across the entire forehead. Instead of marking horizontally across the forehead as would be done during surgery, I had to create vertical marks down the pig’s forehead, just above the eye sockets. Holding the pig head vertically and slowly moving the head up and down along the spinning burr, I shaved off one eighth of an inch by running the burr repeatedly over one area at a time, as instructed by Dr. Ousterhout, from both the left and right sides of both pigs’ foreheads (Figure 7). Although this method may be opposite that of the method used during surgery in which the skull stays stagnant and the burr moves; however, the resultant marks are the same.
Once tool marks had been made, complete maceration was necessary to observe the resultant marks under the microscope. To disintegrate the tissue that remained after scalpel maceration, the skulls were left in separate pots, each of which contained a solution of 1 and 1/12 cups cascade to 12 L water solution. The pots were heated over a burner until all of the tissue could be easily removed with a scraper.

The two skulls on which tool marks were made on wet bone were set on trays and placed under the fume hood to dry. Once the skulls dried, the resultant marks were observed under a Leica MZ123 binocular microscope. Each cranium and mandible was secured to the base of the microscope using masking tape to reduce shaking. When viewing the cut marks made on the mandibles, a beanbag was situated underneath the bone so that the cut aspect of the gonial angle was parallel to the microscope lens. Areas of interest were located using the visual option on the microscope; once located, the microscope was switched from visual to photo. Photos were taken using the Leica DFC 320 camera attached to the microscope in combination with the computer software Image Pro-Plus and In-Focus (version 1-82). Documented surface modifications included the overall surface of the cut mark, stria and ridge formation, and projections along the borders of the cut marks.

**Transsexual Survey**

The second aspect of data collection involved surveying MTF transsexuals for the purpose of discovering if there exists significant desire within the trans community for feminizing procedures that modify bone. Approval from the LSU Institutional Review Board (IRB) to conduct the surveys involved in this research was given on May 10, 2013, (Appendix B). Surveys were distributed to willing MTF participants at the September 4-
8, 2013, Southern Comfort Conference (SCC), the world’s largest transgender conference, in Atlanta, Georgia. As it was difficult to determine who fit the category “transsexual” at a conference that brings together individuals from all aspects of the trans community, people were approached and asked, first, whether they would mind taking a short survey, and, second, if they were currently taking hormones. If individuals responded that they were taking hormones, they were then given the survey (Appendix C). Because many of the transgendered women at the conference fell under the category “transvestite,” the hormone question was necessary in excluding those individuals who will likely never present themselves as women full time.

**Forensic Anthropology Survey**

Finally, survey data were collected from practicing forensic anthropologists for the purpose of understanding whether or not there exists a need within the field for consideration of transsexual identity when ascribing sex to unidentified skeletal remains. First, four photos displaying the variation between the tool marks left by the dental burr and two photos demonstrating the marks made by the small and large oscillating saw blades were incorporated into a diagram of the human skull. Also highlighted in this diagram was the area of the mandible that would be altered during a genioplasty. The diagram was then attached to a forensic anthropology survey made through surveymonkey.com (Appendix D). A link to this survey was emailed to all the members of the physical anthropology section of the American Academy of Forensic Sciences (AAFS). Within the body of the email, recipients were asked to take the survey only if they were currently employed as forensic anthropologists or had worked as a forensic
anthropologist in a past career. The survey was made available for three weeks, after which the link was discontinued.
Chapter 4: Results

Results from each aspect of data collection revealed significant findings that suggest a transgender status for unidentified skeletal remains is possible and may become necessary in the future. Specific results from each portion of this study are discussed in detail in the following text.

Tool Mark Analysis

The three surgical tools used in this study were utilized to make marks on three skulls, two skulls of wet bone (pigs 1 and 2) and one dried skull (pig 3). Overall, the resultant marks left on the wet crania and mandibles of pigs 1 and 2 appeared similar to one another and differed from the resultant marks made on the dried skull, pig 3. Slight variation between resultant tool marks on the wet skulls was observed. Table 1 summarizes the observed variation between surgical tool marks on each of the three experimental crania, while the set of specific results is presented in the text below.

Large Oscillating Saw Blade

The large oscillating saw blade was used to excised the left gonial angles of pigs 1 and 2, leaving a kerf, a term that refers to the walls and floor of a cut (Symes et al. 2010), that was smooth and even. However, the overall appearance of the marks made with the large saw blade differed between pigs 1 and 2 in that the cut mark on pig 2 revealed trabecular bone down the midline of the kerf floor, or surface of the cut mark, that was not observed in the kerf floor made with the same blade on the mandible of pig 2 (Figure 8, taken at 0.8 magnification). In both wet specimens, the lateral kerf wall, or border, was more even than the medial kerf wall, on which there were some slight projections as
a result of entrance shaving in the direction of blade use (Figure 8). Additionally, when viewed microscopically, the large oscillating saw blade left striae on the lateral edge of the kerf floor of the wet mandibles and not on the medial edge of the kerf floor; the striae were more evident on the mandible of pig 1. The striae on the mandible of pig 1 extended less than one mm medially from the lateral wall and continued to decrease in width anteriorally toward the chin (Figure 9, taken at 1.6 magnification).

Both the gross and microscopic appearances of the markings left by the large oscillating saw blade differed between the mandibles of pigs 1 and 2 and the mandible of pig 3, the skull that was dried prior to removal of the gonial angles. The resultant kerf floor of the mandible on pig 3 was not as smooth and even as was observed in the marks made by the same blade on the wet specimens. Instead, when used on dried skeletal material, the large oscillating saw blade left floor dip, or residual ridges and imprints created by interruptions in the cutting stroke (Symes et al. 2010), that extended vertically
Table 1: Characteristics of Surgical Tool Marks Made Experimentally.

<table>
<thead>
<tr>
<th>Tool Type</th>
<th>Pig 1 (wet bone)</th>
<th>Pig 2 (wet bone)</th>
<th>Pig 3 (dried bone)</th>
</tr>
</thead>
</table>
| Large Oscillating Saw Blade (used to excise left gonial angle) | Kerf Floor: smooth and even.  
Entrance Shaving: minor along medial border, absent on lateral wall.  
Striae: pronounced on lateral wall.  
Entrance Shaving: minor along medial border, absent on lateral wall.  
Striae: minimal striae on lateral wall.  
Entrance Shaving: severe along medial border, absent on lateral wall.  
Striae: absent.  
Floor Dip: present as severe vertical ridges. |
| Small Oscillating Saw Blade (used to excise right gonial angle) | Kerf Floor: uneven.  
Entrance Shaving: minor along medial border, absent on lateral wall.  
Striae: absent.  
Floor Dip: present as severe vertical and transverse ridges. | Kerf Floor: uneven; midline reveals trabecular bone.  
Entrance Shaving: minor along medial border, absent on lateral wall.  
Striae: absent.  
Floor Dip: present as severe vertical and transverse ridges. | Kerf Floor: smooth and even; polished veneer.  
Entrance Shaving: moderate to severe on medial and lateral walls.  
Striae: absent.  
Floor Dip: absent. |
| Dome-shaped Dental Burr (used to shave down frontal region) | Kerf Floor: dark discoloration and slight porosity.  
Striae: transverse striae.  
Floor Dip: present as transverse ridges. | Kerf Floor: dark discoloration and slight porosity.  
Striae: transverse striae.  
Floor Dip: present as transverse ridges. | Kerf Floor: smooth; no discoloration.  
Striae: absent.  
Floor Dip: absent. |
along the kerf floor of the mandible (Figure 10, taken at 0.8 magnification).

Another difference between the marks made on wet bone and the mark left on dry bone was that the entrance shaving along the medial wall on the mandible of pig 3 was more severe than was observed in the mandibles of pigs 1 and 2 (Figure 10). However, like the cut marks made on wet bone, when utilized on dried bone, the large saw blade only resulted in entrance shaving along the medial border.

Figure 9: Striae on Lateral Edge of Mandibular Cut Mark of Pig 1.

**Small Oscillating Saw Blade**

Unlike the large saw blade, the small oscillating saw blade, when used on wet bone, resulted in an uneven kerf floor. Floor dip created using the small blade was pronounced, as demonstrated by the resultant ridges and furrows extending both vertically, down the kerf floor (Figure 11, taken at 0.8 magnification) and transversely, across the width of the ramus (Figure 12, taken at 0.8 magnification). As was the case
with the large oscillating saw blade, the midline of the kerf floor of pig 2 revealed a different appearance than the medial and lateral aspects of the same kerf floor. Trabecular bone comprised 2 mm of the center of the kerf floor in pig 2 (Figure 13, taken at 0.8 magnification), while no trabecular bone was revealed in the kerf floor created by the small blade on pig 1. Instead, the overall appearance of the kerf floor of pig 1 was comparable to the appearance of the medial and lateral sides of the kerf floor on the mandible of pig 2. In both pigs 1 and 2, the small blade left very minor entrance shaving along the lateral border, but not along the medial border. This is similar to the marks made with the large blade.

The cut marks made by use of the small blade on the dried skull appeared drastically different than the cut marks made using the same blade on wet bone. The overall appearance of the kerf floor on the mandible of pig 3 was smooth and even; no floor dip was observed, grossly or microscopically (Figure 14, taken at 0.8...
magnification). Another observable difference between the marks left on pig 3 and the marks left on the mandibles of pigs 1 and 2 was that both the medial and later kerf walls on pig 3 revealed bony projections, suggesting entrance shaving may not be responsible for the shavings, or wastage, produced by usage of the small blade on dried skeletal material.

Additionally, the wastage found on the cut mark made to dried bone was more severe than the wastage created using the small blade on wet bone. Finally, the small blade resulted in a polished veneer on the kerf floor of pig 3 that was not observed in the cut marks made with the small blade on wet bone, nor in any of the cut marks made using the large blade (Figure 15, taken at 1.6 magnification).

Figure 11: Vertical Ridges Left by Small Oscillating Blade on Mandible of Pig 1.

**Dome-Shaped Burr**

The dome-shaped dental burr resulted in a minimum kerf width of 4 mm (Figure 16, taken at 0.8 magnification). The width of the marks left by the dental burrs used in
feminizing forehead procedures will not vary should the same burr type be used continuously during the procedure, but the length of the marks will vary between

Figure 12: Transverse Ridges Left by Small Oscillating Blade on Mandible of Pig 1.

Figure 13: Cut Mark Left by Small Oscillating Blade on Mandible of Pig 2.
Figure 14: Small Blade Cut Mark on Inferior Aspect of Mandible of Pig 3.

Figure 15: Polished Area on Small Blade Cut Mark Surface on Mandible of Pig 3.
patients. Thus, the lengths of the marks made experimentally were not important to document. Overall, the burr did not leave markings on wet bone that differed drastically from the surrounding, unaltered bone due to the fact that dental burrs are not equipped with sets of teeth. The only visible differences between unaltered areas of the facial skeleton and the areas that were modified using the burr on pigs 1 and 2 were that the modified areas were slightly more porous and slightly darker in color than the surrounding bone (Figure 16). However, burring on wet bone did result in floor dip

Figure 16: Width of Dome-Shaped Burr Mark.

within the modified areas of the forehead (Figure 17, taken at 0.8 magnification). Only when the burr was used to shave down an area in which a cranial suture was located did the area of surgical modification appear drastically different from the unaltered bone. The coronal suture over which burring was completed was fused prior to modification, but after being shaved down by the burr, the suture appeared jagged and lighter in color than
the remainder of the suture which had not been touched by the burr (Figure 18, taken at 1.0 magnification).

Figure 17: Large Transverse Lines Left by Burr on Wet Bone.

Figure 18: Burr Mark Shaving of Cranial Suture on Pig 1.
The kerf floor left by the dome-shaped burr on the cranium of pig 3 differed from the marks left by the same burr on wet bone. The overall appearance of the kerf floors on dried bone was smoother and less porous than was the appearance of bone shaved while still wet. Additionally, while the floors in pigs 1 and 2 appeared slightly darker in color as compared to the surrounding bone, the areas of dried bone that were modified with the burr were analogous in color to the surrounding, unaltered bone (Figure 19, taken at 0.8 magnification).

Figure 19: Burr Mark Made to Pig 3.

**Transsexual Survey Results**

Seventy-eight surveys were completed at the Southern Comfort Conference. Six of the 78 surveys were removed from the survey population after returning from the
conference and finding that six respondents identified as cross-dressers and not as transsexuals, an inference made due to responses given when asked why the individual would not be undergoing surgery. By definition, cross-dressers will not have surgical intervention because they do not feel as if they were born with the wrong anatomical parts. Therefore, my final survey population included 72 transsexual females. Of these 72 individuals, approximately 31% of the study population, or 22 respondents, had already undergone one or more of the surgical procedures, be they soft tissue or structural, that aid in the transition from male to female (Table 2).

Table 2: Survey Population.

<table>
<thead>
<tr>
<th>Survey Population</th>
<th>Individuals Who Have Already Had Surgery</th>
<th>Individuals Who Have Not Had Surgery, but Plan to in the Future</th>
<th>Individuals Who Have Not Had Surgery and Do Not Plan to in the Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>72</td>
<td>22 (31%)</td>
<td>30 (42%)</td>
<td>20 (28%)</td>
</tr>
</tbody>
</table>

Survey respondents represented a range of demographic backgrounds, though the majority of respondents self-identified as Caucasian. Demographic information for the survey population is presented in Table 3. Two individuals circled “other” when asked for their ancestry. One of these individuals elaborated and stated that she was of mixed Caucasian, Native American, and African ancestry. For fear of offending respondents, individuals were not asked for their ages, though several chose to share this information without being prompted.

Table 3: Respondents Demographics.

<table>
<thead>
<tr>
<th>Survey Population</th>
<th>European Descent</th>
<th>African Descent</th>
<th>Asian Descent</th>
<th>Hispanic Descent</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>72</td>
<td>65</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
The surgical procedures that SCC attendees had undergone before the conference are detailed in Table 4. Soft tissue procedures accounted for approximately 72% of the surgical procedures that had been completed prior to the conference; with vaginoplasty and breast implant being the most popular of all the surgical procedures. Of the structural procedures that survey respondents had completed prior to the conference, the forehead reduction was the most popular, followed by rhinoplasty, genioplasty, and then the mandibular angle shave. Respondents were asked at which age they underwent bone-modifying procedures. The ages at which individuals underwent a structurally altering procedure ranged from 26 to 50.

Table 4: Surgeries Completed Prior to the SCC.

<table>
<thead>
<tr>
<th>Surgical Procedure</th>
<th>Number of Individuals who have already undergone the procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaginoplasty</td>
<td>12 (17%)</td>
</tr>
<tr>
<td>Breast Implants</td>
<td>12 (17%)</td>
</tr>
<tr>
<td>Cheek Implants</td>
<td>4 (6%)</td>
</tr>
<tr>
<td>Lip Augmentation</td>
<td>4 (6%)</td>
</tr>
<tr>
<td>Scalp Advancement</td>
<td>6 (8%)</td>
</tr>
<tr>
<td>Thyroid Cartilage Shave</td>
<td>3 (4%)</td>
</tr>
<tr>
<td>Rhinoplasty</td>
<td>5 (7%)</td>
</tr>
<tr>
<td>Forehead Reduction</td>
<td>6 (8%)</td>
</tr>
<tr>
<td>Genioplasty</td>
<td>3 (4%)</td>
</tr>
<tr>
<td>Mandibular Angle Shave</td>
<td>2 (3%)</td>
</tr>
</tbody>
</table>

Fifty individuals, approximately 69% of the study population, had yet to have any transitioning procedure at the time of the conference. Of the 50 individuals who had never had a feminizing surgery, 30 respondents (60% of the study population who had never had a feminizing surgery), stated that they had plans to undergo surgery in the future. Twenty of the 50 individuals, or 40% of the survey population who had never undergone feminizing surgery, stated that they had no plans to seek out surgical
intervention in the future. The most common response to the question about why individuals never plan to have surgery was that the respondent was comfortable in her physical presentation having HRT as the sole feminizing endeavor; this reasoning was stated in ten surveys. Seven respondents stated that, due to social reasons, including family, work, and the current social condition of the United States, they do not plan on transitioning fully. The high out-of-pocket cost was the reason provided by two respondents as to why they would not be having surgery. One of the two stated that it was not the cost alone, but that the feminizing procedures had too high of a cost versus benefit due to her age. Finally, one woman stated that she currently had no plans to undergo surgery because she had just recently begun her transition and had only been on HRT for one month prior to the conference. She stated that, though she currently did not plan to have surgery, she could very well change her mind in the future.

Thirty of the 50 individuals, or 60% of the respondents who had yet to undergo feminizing surgery, stated that they planned to have one or more feminizing procedures in the future. Though soft tissue procedures appear to be more highly desired overall, 38% of respondents who had not yet had surgery at the time of the conference stated that they would be undergoing a bone-modifying procedure in the future. Additionally, 12 of the 22 respondents who had already had one or more feminizing procedures completed by the time of the conference also had plans to undergo further surgical intervention in the future. Of the 72 individuals surveyed, a total of 42 individuals, approximately 58% of the total survey population, intend to have future surgery to feminize their physical appearance. Desired future surgeries are presented in Table 5. Rhinoplasty and forehead reduction were the most sought after structural procedures. Though the most sought after
procedures overall are soft tissue surgeries, the third and fourth most desired procedures alter a person’s bone structure and will leave potential clues for the forensic anthropologist.

Table 5: Surgeries Planned for the Future.

<table>
<thead>
<tr>
<th>Surgical Procedure</th>
<th>Number of Individuals Who Have Yet to Have Surgery, but Plan to in the Future</th>
<th>Number of Individuals Who Have Had Surgery, but Plan to Have Additional Surgery</th>
<th>Total Number of Individuals Who Plan to Have the Procedure Done in the Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaginoplasty</td>
<td>20 (40%)</td>
<td>5 (23%)</td>
<td>25 (35%)</td>
</tr>
<tr>
<td>Breast Implants</td>
<td>18 (36%)</td>
<td>8 (36%)</td>
<td>26 (36%)</td>
</tr>
<tr>
<td>Cheek Implants</td>
<td>4 (8%)</td>
<td>2 (9%)</td>
<td>6 (8%)</td>
</tr>
<tr>
<td>Lip Augmentation</td>
<td>2 (4%)</td>
<td>2 (9%)</td>
<td>4 (6%)</td>
</tr>
<tr>
<td>Scalp Advancement</td>
<td>5 (10%)</td>
<td>3 (14%)</td>
<td>8 (11%)</td>
</tr>
<tr>
<td>Thyroid Cartilage Shave</td>
<td>7 (14%)</td>
<td>3 (14%)</td>
<td>10 (14%)</td>
</tr>
<tr>
<td>Rhinoplasty</td>
<td>13 (26%)</td>
<td>8 (36%)</td>
<td>21 (29%)</td>
</tr>
<tr>
<td>Forehead Reduction</td>
<td>13 (26%)</td>
<td>7 (32%)</td>
<td>20 (28%)</td>
</tr>
<tr>
<td>Genioplasty</td>
<td>5 (10%)</td>
<td>4 (18%)</td>
<td>9 (13%)</td>
</tr>
<tr>
<td>Mandibular Angle Shave/Taper</td>
<td>3 (6%)</td>
<td>3 (14%)</td>
<td>6 (8%)</td>
</tr>
</tbody>
</table>

**Forensic Anthropologist Survey Results**

Two hundred three individuals who were either currently employed as forensic anthropologists at the time the survey was administered or who worked as forensic anthropologists in a past career responded to the forensic anthropology survey. Survey respondents represented a wide range of US states and several different countries. Table 6 reveals the areas in which respondents worked as forensic anthropologists, separated into regions as defined by the US census. Approximately 10% of respondents worked outside of the US, while the other 90% of respondents were employed in the US. Approximately 11% of respondents stated that they have worked in several regions across America.
Overall, and within the US, the greatest number of respondents came from the South, representing approximately 34% of the entire survey population.

Table 6: Regions In Which Forensic Anthropology Was Practiced.

<table>
<thead>
<tr>
<th>Survey Population</th>
<th>West</th>
<th>Midwest</th>
<th>South</th>
<th>Northeast</th>
<th>Several Regions</th>
<th>Outside of the US</th>
</tr>
</thead>
<tbody>
<tr>
<td>203</td>
<td>42</td>
<td>26</td>
<td>69</td>
<td>23</td>
<td>22</td>
<td>21</td>
</tr>
</tbody>
</table>

Respondents also represented a wide range of experience. Table 7 demonstrates the varying experience levels of respondents as implied by the number of years in which the respondent had practiced forensic anthropology professionally. The majority of respondents, approximately 40%, had less than five years experience at the time the survey was administered. The second most represented experience level was the group in which individuals had greater than twenty years experience; this group constituted approximately 21% of the total survey population.

Table 7: Respondents’ Experience.

<table>
<thead>
<tr>
<th>Years</th>
<th>0-5 years</th>
<th>6-10 years</th>
<th>11-15 years</th>
<th>16-20 years</th>
<th>&gt;20 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>81</td>
<td>36</td>
<td>33</td>
<td>11</td>
<td>42</td>
</tr>
</tbody>
</table>

When asked whether or not survey participants had seen any of the markings made by surgical implements utilized in facial feminization procedures on unidentified skeletal remains, the large majority, 91% of respondents, stated that they had not seen such marks. Seven respondents, approximately 3% of the survey population, stated that they could not remember if they had seen similar modifications in any of their previous cases. Eleven participants, approximately 5% of the survey population, indicated that they indeed had noticed similar bone modifications in prior forensic cases on which they worked.
Of those eleven respondents, nine gave information regarding the identification status of the individuals on which the marks were observed. Two of the individuals on whom the marks were found still have yet to be identified, but positive identifications have been made for seven of the individuals whose skeletons demonstrated markings congruent with facial feminization surgery. Four of these positively identified individuals did not identify as transsexual and the information regarding gender status was unavailable for another four of the individuals for which identification had been established. Only one of the seven positively identified people whose skeleton exhibited marks consistent with FFS was determined to have been transsexual in life. A forensic anthropologist with 11-15 years experience identified this individual.

Though only one of 203 forensic anthropologists had positively identified an individual with surgical markings congruent with FFS, 25 respondents stated that they have had cases brought to their attention that presented the possibility that the unidentified individual may have been transgendered in life.
Chapter 5: Discussion

Significant results were garnered from each aspect of data collection involved in this study. The results from the tool mark analysis indicated that resultant FFS marks are identifiable in the skeleton and results from surveys suggested several trends amongst the transgender community and the skeletal populations within forensic anthropology labs. However, discrepancies between tools were observed. Potential explanations for which follow. Additionally, discerned survey trends may be the result of external factors, which are also discussed in the following text.

Tool Marks

The difference between the marks made with the same tool on the mandibles of pigs 1 and 2, as well as the variation between burr marks, demonstrates that marks that will be left on bone during FFS will be highly variable between patients and surgeons. For example, the appearance of the cut marks made using both the small and large oscillating blades differed between the mandibles of pigs 1 and 2 even though the same technique was employed to excise the same measurement (20 mm) of bone from each mandible. That the inner bone composition of the mandible of pig 2 was revealed to a greater extent than was observed in the mandible of pig 1 is likely due to the difference in the height of the ascending ramus of each pig’s mandible.

In addition to revealing potential differences in FFS marks between patients, tool mark experimentation also demonstrated how tool marks might vary between surgeons. In total, five burr marks were made on the skulls of pigs 1 and 2. Though floor dip was observable in each of the resultant burr marks, the number and depth of the resultant transverse lines differed in each burr mark. Floor dip is a result of slight pauses and
minimal pressure changes when shaving down the forehead (Symes et al. 2010). Pauses and pressure applied when using the tools in forehead contouring will not only potentially differ between surgeons, but will also slightly differ between each procedure one surgeon completes.

The difference between the tool marks made on wet bone and on dried bone demonstrated that there should be little to no confusion in deciphering between marks made during antemortem FFS and marks made postmortem or outside of the medical realm with the surgical tools utilized in this study. In general, each of the tools was easier to use on dry bone, resulting in the overall smoother and more even appearance of the cut and burr marks made to pig 3. The removal of the mandibular angle by use of the large oscillating saw blade was the only instance of a tool making a smoother, more even mark when used on wet bone. It is possible that the large blade was not as tightly affixed to the oscillating saw when used on the mandible of pig 3, resulting in the anomalous ridges and furrows observed on the dried mandible. Also, the first attempt with the oscillating saw was made with the large blade on the practice mandible, thus the ridges and furrows could potentially be a result of hesitation when using the tool for the first time.

Marks made outside of surgery, made postmortem or to non-living bone, should be distinguishable from marks made antemortem using the same tools. Marks made postmortem using the surgical tools involved in forehead shaving and mandibular angle osteomy should, when used properly, result in smooth and even kerfs. In addition, moderate to severe shavings projecting along the walls of mandibular cut marks are indicative of postmortem excision, as the projections along the borders of the cut marks on the mandible of pig 3 were not found to the same extent on the mandibles of pigs 1
and 2. Further, postmortem tool marks may be decipherable through the presence of a polished veneer.

Though the experimental tool marks were made on pig bone in this study, marks made to human bone should be similar, as pig bone is the closest analog to human bone. Human bone and pig bone are similar in density and the widths of the mandibles of the pigs used in this study are within the range of the widths of the ascending rami of human males. However, should an individual who has undergone one or more facial feminization surgeries heal from the procedures with no infection and survive for even a brief period of time after the surgery, the areas of bone that were altered with surgical tools will begin to remodel. Remodeling may alter the appearance of the tools marks.

Though the blades and the burr left obvious marks on the bone, these marks did not repetitively show distinct microscopic organization so their presence on a skeleton cannot be used to conclusively determine the specific tools involved in FFS procedures. The composition within the kerf floors of the cut marks cannot be used to conclusively reveal the source of the mark. Instead, due to the ability to identify gross changes in the skeleton as a result of FFS, and because of the process of bone remodeling that will definitely occur in response to the modification made to the bone in facial feminization surgeries, forensic anthropologists should be aware of the general areas that may be altered in FFS.

When ascribing sex to an unidentified individual, the forensic anthropologist should look for evidence of bone remodeling around the supraorbital region of the frontal bone, in the angle of the ascending ramus of the mandible, and should also look for evidence of surgical implements on the mental eminence of the mandible. However, one
should be cautious in immediately categorizing remodeling in these areas as evidence of transsexualism as these areas may also be surgically altered to correct trauma.

Knowledge of the general shape of burr marks left during forehead contouring will aid in making the distinction between surgery to correct trauma and surgery to feminize, at least in the forehead region of the facial skeleton.

**Transsexual Conference and Survey Results**

The large majority of transwomen with whom I conversed at the Southern Comfort Conference were white. This ancestral trend was extremely noticeable within the confines of the conference hotel, not just within the group of women whom I asked to take the survey. If the survey data are reflective of the greater transsexual population in the United States, then it appears that particular attention should be paid to unidentified skeletons that have been determined to be of white ancestry. However, the predominance of individuals of European descent at the conference could reflect trends other than an American transsexual community dominated by white faces.

Researchers believe that homosexuality is often less accepted in minority communities and that minority individuals have a more difficult time coming out to friends and family. Homosexual ethnic minorities are multiply marginalized, resulting in greater stigmatization and harassment (Balsam et al. 2011). Cultural norms and heightened social oppression contribute to the increased difficulty in coming out as a gay minority, resulting in greater numbers of minority homosexuals remaining closeted. It is logical then to extend this reasoning to transgenderism. The gay rights movement has made great strides in increasing acceptance for homosexuality; however, transgenderism has received little attention and the transgender movement is still in its infancy. It is
reasonable then to assume that, even more so than with homosexuality, transgender minorities face greater stigmatization than white members of the transgender community. The disproportionate demographics of the attendees of the Southern Comfort Conference may therefore reflect the fact that expressing transsexuality, as a member of an ethnic minority, is more difficult. Thus, fewer minority members of this community feel comfortable presenting themselves as a gender opposite their natal birth in a public setting.

The significant white representation at the conference may also be a result of the overall higher socioeconomic status held by white Americans over minority American groups. Attending the conference comes at significant financial cost. Registration for the event is over one hundred dollars; this fee does not include any conference events or workshops. Additionally, one must pay for a room at the conference hotel and meals each day. Should one wish to attend the conference, but live a great distance from Georgia, he or she will also need to purchase a plane ticket. Funding a trip to the conference requires a great deal of financial flexibility. As the unequal wealth distribution between ethnic groups is especially pronounced in the South (socialsecurity.gov) and the conference was held in Georgia, it is reasonable to assume that the lack of minority attendees is influenced by economic constraints.

Another trend that was observed among the MTF transsexual population at the conference was that the majority of attendees were middle-aged. With the exception of two individuals with whom I spoke on the final day of the conference, every person I met was over the age of 45. The respondents that had plans to undergo bone-modifying surgery in the future were, therefore, older than 45, suggesting that forensic
anthropologists should expect to see a higher frequency of modifications to the facial skeleton in individuals who are middle aged or older. However, two attendees who had undergone feminizing surgery did have the procedures completed before the age of 40—one at the age of 26 and one at the age of 35.

Like the preponderance of white attendees, the older age of attendees may, too, be explained by social reasons. As the transgender movement is still young, but gaining recognition through the recognition that is being given to the overall LGBTQ movement, it is very likely that transgender youth today have more resources and support than the older generation of the transgender community received in their youth. Lobbying efforts have increased awareness and acceptance of transgenderism; discrimination based on gender status is not tolerated in most states and is illegal in most school and workplace environments. Therefore, today’s generation of transgendered youth likely experiences an easier, albeit still challenging, transition from one gender to another. Younger members of the trans community may feel more comfortable in expressing their transsexuality in the public sphere and, therefore, do not require the support and inclusiveness that is provided by the conference atmosphere. Older individuals likely struggled with their transgender expression in youth and thus seek out an environment such as the one provided by SCC. These older individuals may have even adopted a heteronormative lifestyle, taking a wife and having children, and thus, view the conference as the one place and time in which they can express their true selves.

Regardless of ethnicity or age, it is clear that there is interest within the transgender community for bone-modifying feminizing surgery. Survey respondents indicated an interest in each of the bone-modifying FFS procedures. There was a
heightened interest in the forehead shaving procedure, which is not surprising when considering the emphasis surgeons place on the forehead region of the face in feminine presentation. Data from the transgender conference survey indicate that the number of individuals undergoing FFS will continue to stay steady if not increase as the social environment becomes more tolerant of transgenderism. Additionally, as social tolerance increases, it is likely that insurance coverage will extend to feminizing procedures, making the overall cost cheaper and increasing the number of individuals seeking out these procedures.

The data collected from the Southern Comfort Conference demonstrate that forensic anthropologists should already be considering transsexualism when ascribing sex to unidentified remains. The interest in FFS combined with the current social movement continuing in a progressive manner demonstrates that forensic anthropological standards for the consideration of transsexualism will need to be established in the near future.

**Forensic Anthropology Survey Results**

The individuals who responded to the survey worked as forensic anthropologists in a broad range of American states and countries outside of the US. No observable correlations could be made between state in which a respondent worked and any other survey question. Only one respondent from one US state indicated that he or she had worked a case in which an unidentified individual who had undergone FFS was positively identified as a MTF transsexual. As no trends between state and markings discovered on skeletal samples were observed, the possibility exists that unidentified skeletons which belonged to MTF transsexuals in life may become a forensic anthropological case in any region of the country and even of the world, though cultural
gender and sexuality norms will influence the countries in which these skeletons will likely be discovered.

It was surprising that 91% of respondents stated that they had not seen markings similar to the images attached to the survey in any cases on which they worked in the past and only 3% of respondents chose “I don’t remember” when asked the same question. As approximately 21% of respondents worked as forensic anthropologists for over 20 years, it seems that a greater majority of respondents should have selected “I don’t remember” when asked if they had ever seen the markings associated with FFS. It is logical to assume that after twenty years in the field an individual cannot remember every case on which he or she would have worked. Also, the low percentage of individuals who had seen such markings may be representative of the largest majority of respondents having worked less than five years in the field. Quite possibly, new professionals may overlook potential marks due to the fact that, within the field, the greatest emphasis is being placed on mastering the standard techniques for ascription of the biological profile to unidentified skeletal remains.

Though the majority of respondents stated they had never observed the marks congruent with FFS on an unidentified skeleton, 11 respondents indicated they had observed these markings. These 11 respondents represent multiple US states and multiple countries outside of the US. Therefore, because bone modifications congruent with the tool marks left during feminizing procedures are being observed in forensic cases all over the world, practicing forensic anthropologists should be made aware of the implications associated with these marks. It is necessary that forensic anthropologists who observe bone modifications of the sort associated with FFS consider the possibility that the
unidentified person was a transsexual and create a biological profile and facial reconstruction that is representative of the individual’s transgender status.

The survey also revealed that, even without observation of remodeling in the areas of the skull associated with FFS, some forensic anthropologists have considered a transgender status in certain forensic cases. Without the presence of surgical alteration, grave goods may be the only evidence for transgenderism. However, without evidence of surgical alteration, grave goods cannot definitively indicate transsexualism. Therefore, forensic anthropologists should use all resources available to them, including the observation of potential surgical marks, in ascribing a transgender status to a set of unidentified remains.
Chapter 6: Conclusion

There were several objectives for this study. The first objective was to catalogue the burring and cutting marks created during the FFS procedures that alter the facial skeleton, which are the forehead shave/contour and the mandibular angle shave/taper. The tools utilized for this research are distinct enough to leave an imprint in the bone that remodels and provides indications of surgery that will be evident after death and skeletonization. However, the tools did not leave an imprint in the bone characteristic of the size or exact type of blade or burr used to perform the feminizing procedure.

The second objective for the study, then, was to determine whether or not a significant proportion of the MTF transsexual population expressed interest in FFS. The results of the survey handed out at the Southern Comfort Conference, in combination with conversations with conference staff and attendees, revealed that there is significant interest in the transgender community in undergoing bone-modifying facial surgeries. Because significant interest exists and social tolerance of the transgender community is increasing, forensic anthropologists should be made aware of the modifications to the skeleton made during FFS so that transsexuality can be considered should an unidentified individual present markings in the areas associated with the surgical procedures.

The data collected from the tool mark analysis aspect of this study was additionally utilized for the third and final objective. Surveys that included an attachment revealing the appearance of surgical tool marks in the areas where these marks would be found on a MTF skull were sent to forensic anthropologists to determine whether or not similar evidence of FFS had been observed in any forensic cases on which the survey participants had worked. Eleven respondents had seen similar markings in one or more of
their forensic cases, but only one skeleton that bore these marks was positively identified as a MTF transsexual. However, 25 additional respondents indicated that during their career they had suspected that unidentified remains might have belonged to an individual who had been transgendered in life. Responses indicated that transsexualism is a possibility all over the world that should be considered when ascribing sex to unidentified remains.

Finally, the survey for forensic anthropologists also served as an attempt to have professionals reconsider their past cases in the hope that showing evidence of bone modification from FFS may spark some memory of any cases which presented similar evidence. Future research in regard to evidence of transsexuality in the skeleton is necessary before official guidelines can be established for considering the ascription of transsexual sex to unidentified remains. However, as transsexuality is becoming more transparent in American society, forensic anthropologists should already be considering the possibility that any skeleton that comes to their lab may have been a transsexual in life. Evidence of surgical tool marks on skeletal remains congruent with the marks outlined in this study should now influence forensic anthropologists to explore the possibility that the individual whose remains displayed these marks had been born a male, but lived as a female.

**Future Research**

The results of this study reveal that evidence of transsexualism can be found in the facial skeletons of those MTF transsexuals who have undergone FFS and that forensic anthropologists should consider the possibility of transsexuality when ascribing sex to skeletal remains. While the findings made in this study are significant in their own right,
there is still much research that needs to be done to aid the forensic anthropologist in confidently ascribing a transsexual status to a set of skeletal remains.

Future research into the modifications made to the facial skeleton of MTF transsexuals could expand on the present study by cataloging the variation between the tools used for each procedure of FFS, as the specific blade and burr utilized will vary between plastic surgeons. The extent of bone modification will also vary between patients for each of the procedures categorized under FFS. Knowledge of the range of modification for each procedure would be beneficial to the forensic anthropologist to determine whether or not marks found on the facial skeleton are the result of surgery, trauma, or even genetic anomaly. Future research should therefore seek out access to medical records for individuals who have undergone any of the facial feminization procedures. Radiographic information is the most promising avenue from which to collect these data. Promising results could be attained should future researchers be given permission to take post-surgery x-rays in plastic surgery clinics in which before x-rays are taken as standard procedure.

The most necessary avenue of future research is in regard to cross hormone therapy and its effect on bone. Though bone-modifying surgical procedures are only available for MTF transsexuals, both MTF and FTM transsexuals utilize hormone therapy. While research into FFS only gleans information for the forensic anthropologist regarding transwomen, research into hormones may reveal potential techniques for determining both male and female transsexuality from skeletal remains. Significant results regarding the effect of cross sex hormones on bone morphology and histology could be collected in a longitudinal study in which x-rays are taken at specific intervals.
Knowledge of the effect of cross sex hormones on bone combined with knowledge of the areas and extent of modifications made during surgical procedures would greatly heighten the forensic anthropologist’s ability to determine transsexuality from skeletal remains. Further research into evidence of transsexuality in bone is necessary as the social currents in America reveal transgenderism as an increasingly evident gender phenomenon.
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## Appendix A: Abbreviations for the Discussion of Transgenderism

<table>
<thead>
<tr>
<th>Terminology</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Gender Identity Disorder</td>
<td>GID</td>
</tr>
<tr>
<td>Male-to-female transsexual</td>
<td>MTF; transwoman</td>
</tr>
<tr>
<td>Female-to-male transsexual</td>
<td>FTM; transman</td>
</tr>
<tr>
<td>Hormone replacement therapy</td>
<td>HRT</td>
</tr>
<tr>
<td>Gender Reassignment Surgery</td>
<td>GRS</td>
</tr>
<tr>
<td>Facial feminization surgery/ies</td>
<td>FFS</td>
</tr>
<tr>
<td>Peak bone mass</td>
<td>PBM</td>
</tr>
<tr>
<td>Bone mineral density</td>
<td>BMD</td>
</tr>
<tr>
<td>Bed nucleus of the stria terminalis</td>
<td>BSTc</td>
</tr>
</tbody>
</table>
Appendix B: IRB Application and Approval

Application for Approval of Projects Which Use Human Subjects

This application is used for projects/studies that cannot be reviewed through the exemption process.

- Applicant, please fill out the application in its entirety and include two copies of the completed application as well as parts A-E, listed below. Once the application is completed, please submit to the IRB Office for review and please allow ample time for the application to be reviewed. Expedited reviews usually take 2 weeks. Carefully completed applications should be submitted 3 weeks before a meeting to ensure a prompt decision.

- Complete Application Includes All of the Following:
  (A) Two copies of this completed form and two copies of part B thru F.
  (B) A brief project description (adequate to evaluate risks to subjects and to explain your responses to Parts 18 and 20).
  (C) Copies of all instruments to be used.
  (D) The consent form that you will use in the study (see Part 3 for more information).
  (E) Certificate of Completion of Human Subjects Protection Training for all personnel involved in the project, including students who are involved with testing or handling data, unless already on file with the IRB. Training link: (http://research.lsu.edu/files/item/20774.pdf)
  (F) IRB Security of Data Agreement: (http://research.lsu.edu/files/item/20774.pdf)

1) Principal Investigator:* Ms. Mary H. Manheim
   *Must be an LSU Faculty Member
   Dept: Anthropology Ph: 225-578-6084 E-mail: paman@lsu.edu

2) Co-Investigator(s): Please include department, rank, phone, and e-mail for each
   Shelby Buchanan
   Department of Anthropology Graduate Student
   shelleycb@lbu.edu, (859)471-9814

3) Project Title: Bone Modification from Transgender Surgery: Are the Changes Distinct Enough to Aid Forensic Anthropologists in Identification of Unidentified Skeletal Remains?

4) Proposal Start Date: ____________________ 5) Proposed Duration Months: ____________________

6) Number of Subjects Requested: ____________________ 7) LSU Proposal #: ____________________

8) Assurance of Principal Investigator named above
   I accept personal responsibility for the conduct of this study (including ensuring compliance of co-investigators/co-workers) in accordance with the documents submitted herewith and the following guidelines for human subject protection: The Belmont Report, LSU’s Assurance (FWA00003892) with OHRRP and 45 CFR 46 (available from http://www.lsu.edu/irb). I also understand that copies of all consent forms must be maintained at LSU for three years after the completion of the project. If I leave LSU before that time, the consent forms should be preserved in the Departmental Office.

Signature of PI: ____________________ Date: 18/13

ASSURANCE OF STUDENT/PROJECT COORDINATOR named above, if multiple Co-Investigators, please create a "signature page" for all Co-Investigators to sign. Attach the "signature page" to the application.

I agree to adhere to the terms of this document and am familiar with the documents referenced above.

Signature of Co-PI(s): ____________________ Date: 15/13

LSU Proposal #: ____________________

Full Expedited Human Subjects Training Complete Application

Study Approved By: Dr. Robert C. Matthews, Chairman
Institutional Review Board
Louisiana State University
256 LSU Schexnayder, Baton Rouge, LA 70803
F: 225.578.9862
Institutional Review Board
LSU/LSUHSC

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ACTION ON PROTOCOL APPROVAL REQUEST

TO: Mary Manhein
   Anthropology

FROM: Robert C. Mathews
   Chair, Institutional Review Board

DATE: May 9, 2013

RE: IRB# 3388

TITLE: Bone Modification from Transgender Surgery: Are the Changes Distinct Enough to Aid Forensic Anthropologists in Identification of Unidentified Skeletal Remains?


Review type: Full ___ Expedited X ___ Review date: 5/10/2013

Risk Factor: Minimal X ___ Uncertain _____ Greater Than Minimal ______

Approved ___ X ___ Disapproved ______

Approval Date: 5/10/2013 Approval Expiration Date: 5/9/2014

Re-review frequency: (annual unless otherwise stated)

Number of subjects approved: _______

Protocol Matches Scope of Work in Grant proposal: (if applicable) _______

By: Robert C. Mathews, Chairman

PRINCIPAL INVESTIGATOR: PLEASE READ THE FOLLOWING – Continuing approval is CONDITIONAL on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submission of a termination report), prior to the approval expiration date, upon notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual parties, including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
8. SPECIAL NOTE: *All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, C (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print or on our World Wide Web site at http://www.lsu.edu/irb
Appendix C: Survey for the Trans Woman

Your participation in this survey aids in the collection of data that will allow forensic anthropologists to consider a transgender status when ascribing sex to unidentified human remains. This survey is entirely anonymous and your participation is greatly appreciated. With your help, more individuals, currently can be properly identified and returned to their families.

1. What is your ancestry? Circle one.
   Caucasian     Hispanic     Black/African Am.     Asian     Native Am.     Other

2. Have you undergone any surgical procedures to align your physical appearance with your self-identified gender? Circle one.
   Yes        No

3. If you answered yes, please circle any additional procedures you plan to undergo then move on to question 5. If you answered no, do you plan to undergo any surgical procedures? Which ones? Circle all that apply.
   No plans to undergo surgery    Thyroid cartilage shave    Breast implants
   Cheek implants    Vaginoplasty    Forehead reduction    Rhinoplasty    Lip augmentation
   Genioplasty    Mandibular angle shave    Scalp advancement

4. If you circled “No plans to undergo surgery”, what are your reasons for not choosing surgical intervention?

5. Which surgical procedures have you undergone? Circle all that apply.
   Thyroid cartilage shave    Breast implants    Cheek implants    Vaginoplasty
   Forehead reduction    Rhinoplasty    Lip augmentation    Genioplasty
   Mandibular angle shave    Scalp advancement

6. Of the procedures you’ve had, which do you feel have had the most impact on your own perception of your gender? And which do you feel have had the most impact on other people’s perception of your gender?
7. If you have undergone forehead contouring, rhinoplasty, mandible angle shave or tapering, or genioplasty to alter the appearance of your chin, at what age did you have each procedure done?

- Forehead contour
- Rhinoplasty
- Mandible angle shave/taper
- Genioplasty
Appendix D: Survey for the Forensic Anthropologist

1. In what state do you practice forensic anthropology?

2. How long have you been practicing forensic anthropology? Circle one.
   
   0-5 years   6-10 years   11-15 years   16-20 years   >20 years

3. In your tenure have any unidentified remains been brought to your attention that displayed modifications to the facial skeleton in the areas highlighted by the attached diagram?

4. If yes, were the remains identified?

5. If the remains were identified, did the individual identify as a transsexual?

6. In your career, have any cases presented to you the possibility that the unidentified individual was transsexual?

7. If yes, what indications made you consider the possibility that the unidentified individual may have been a transsexual?
The areas that are altered through facial feminization are highlighted. The tool marks left by these surgeries are pictured, but when seen on a skeleton may simply appear as areas of bone remodeling.

Plates and/or screws in the anterior portion of the chin
Vita

Born in Visalia, California, Shelby Buchanan moved to Boston, Massachusetts in 2007 to begin her undergraduate career at Boston University. She graduated with her Bachelor of Arts in Anthropology, with an emphasis on biological anthropology, in May of 2011. After taking a year off to travel, she began work on her Master of Arts in Anthropology, with a focus on forensic anthropology, at Louisiana State University in the fall of 2012, studying under Ms. Mary H. Manhein. While at Louisiana State University, Shelby worked as a graduate assistant in the Forensic Anthropology and Computer Enhancement Services Laboratory. After graduating, Shelby will be joining the Teach For America Corps to teach high school biology in Phoenix, Arizona.