Aging and Sexual Differences of the Human Skull

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Background: The aging process of the face comprises all layers: skin, subcutaneous fat, muscles, and skeleton, and the signs of aging depend mainly on which layer is mostly affected.

Objective: To evaluate the aging facial skeleton, as well as establish the sexual differences, areas with a strong predisposition to resorption, and aesthetic repercussion for better treatment approach.

Methods: Skulls from the Forensic Anthropology Department of the Institute of Forensic Medicine of Belo Horizonte, Brazil, were classified according to gender and age group (i.e., <20 years, 20–50 years, >50 years). Structural changes were classified according to gender and age group.

Results: Of the 241 skulls included, 192 were male skulls and 49 female. Sexual dimorphism and age-related peculiarities are described herein.

Conclusions: The knowledge of the anatomy of the aging face, taking into consideration all the layers (skin, fat pads, muscles, and bones), as a whole, for the treatment of folds and shadows is vital for a better and more natural final aesthetic outcome. (Plast Reconstr Surg Glob Open 2017;5:e1297; doi: 10.1097/GOX.0000000000001297; Published online 27 April 2017.)

Despite being more remarkable at adult age, the aging process begins since birth, and continues throughout the whole life, due to genetic and external factors, such as UV exposure and smoking. The face, in most cultures, is one of the most exposed areas of our bodies, so that the aging process is not only earlier, but more easily recognizable. The aging process comprises all layers of the face: skin, subcutaneous fat, muscles, and skeleton, and the signs of aging depend mainly on which layer is mostly affected. Aging may affect the skin in terms of quantity (skin sagging) and/or quality (changes in skin hydration, appearance of spots and wrinkles). There is a reduction of the collagen content of the skin, not only due to decrease in synthesis, as a process of intrinsic aging, but also due to extrinsic factors, such as UV radiation, which may generate reactive oxygen species (ROS), leading to an increment in collagen breakdown by upregulating enzymes called matrix metalloproteinases. The decrease of collagen content may also affect deeper layers of the face. The loss of the subcutaneous facial fat compartments with age leads to the appearance of increased skin laxity or prominent folds around the nasolabial region, periorbital region, and jowl. The muscles may present hypo- or hypertonicity (i.e., glabella, masseter) depending upon the use and area of the face. The bone is a dynamic, sensitive, ever-changing tissue. Bone growth takes place from birth until the hormonal stimulus ceases, with long bone epiphysis consolidation usually around 15–18 years of age. On the other hand, bone remodeling continues throughout life, determined not by intrinsic factors, but mainly by regional changes in the soft tissues related to each bone, such as muscles, tongue, lips, skin, brain, among others. Bone remodeling serves to adjust bone architecture to meet changing mechanical needs, repair microdamages, and guarantee calcium homeostasis. Therefore, it is transitory and does not involve the totality of the bone. The process of bone remodeling involves the removal of mineralized bone by osteoclasts and the formation of bone matrix through the osteoblasts. Both processes of bone remodeling occur throughout life, although the balance between them changes according to the period of life. Bone formation is more prominent in childhood; the processes of bone remodeling occur more prominently at adult age, especially in the face.
are balanced in adults, although bone resorption is more prominent in the elderly. Among the theories of bone remodeling, the Functional Theory correlates bone remodeling to response to demand. When the bone is submitted to traction by a hypertrophic muscle or subcutaneous fat distension, a local demand is generated and bone is produced in that area. On the other hand, continuous pressure on the bone (e.g., silicon chin prosthesis) or intense muscle, ligament or skin laxity, may lead to bone resorption. The objective of this study is to evaluate the aging facial skeleton, and establish the sexual differences, areas with a strong predisposition to resorption and aesthetic repercussion for a better treatment approach.

**METHODS**

The study was approved by the national research ethic committee (number CAAE: 55561816.5.0000.5119). Between 2010 and 2015, skulls from the Forensic Anthropology Department of the Institute of Forensic Medicine of Belo Horizonte, Brazil, were evaluated and only intact skulls, with available clinical data, were included in the study. The skulls were further classified according to gender and age group (i.e., <20 years, 20–50 years, >50 years). Structural changes were then evaluated according to gender and age group.

Measurement of the distance from the superior orbital rim to the inferior orbital rim (OM) (Fig. 1) and from the inferior orbital rim to the lateral inferior portion of the pyriform aperture was performed (MM). The MM/OM ratio was calculated.

**RESULTS**

Overall, 241 skulls were included, being 192 male and 49 female (Fig. 2). The distribution among age groups and gender is described in Table 1.

**Sexual Dimorphism**

Among women, the forehead is straighter (Fig. 2, Table 2), the glabella is more curved and less pronounced, and the supraorbital rim is less noticeable than in men. The midface in women presents more subtle angles, whereas the midface in men presents more pronounced zygomatic bones (Fig. 3). In men the mandible is larger, stronger, and more faceted and has more clear-cut angles
than in women. Also, the chin is larger, giving men a square-shaped face, whereas women tend to have a triangular or heart-shaped face.

Aging Skull

The pyriform aperture becomes larger with aging, experiencing remodeling of lateral and inferior walls, whereas the upper and olfactory cavities remain intact, so that the nasal cavity presents a lateral and anterior expansion and the palatus is reallocated inferiorly. The maximum nasal aperture (the length of the base of the pyriform aperture) increases with age (Fig. 4).

With the process of aging, the floor of the orbit expands inferiorly and laterally, losing the round shape observed in younger skulls (Fig. 4). The lacrimal bone works as a pivot: its inferior portion rotates laterally, leading to an inferior slide of the maxilla. The maxilla is more anterior and more prominent in younger skulls, whereas in older skulls an anterior and inferior bone resorption takes place, giving the appearance of a retrusion of the face (Fig. 5). The zygoma presents an anterior resorption (Fig. 6), whereas the zygomatic arch suffers a posterior and anterior remodeling, increasing the temporal fossa. The MM/OM ratio increases from <20 years to 20–50 years and decreases in >50 years group (Table 3).

The mandible undergoes a posterior and superior bone formation, although it suffers an anterior and inferior resorption (Fig. 5). Without the presence of teeth, the mandible experiences further atrophy. The angle of the mandible increases with age (97 degrees in younger skulls to 135 degrees in older skulls), mainly due to resorption of the inferior border of the angle, next to body–ramus junction (Fig. 7). Also, the chin becomes more anterior, oblique, and shorter with age (Fig. 7).

Not all the bones in the skull suffer resorption. Although the midface recedes, the forehead suffers contin-

### Table 1. Distribution of Skulls According to Gender and Age Group

| Age Group | Male | Female |
|-----------|------|--------|
| <20 y     | 23   | 68     |
| 20–50 y   | 120  | 28     |
| >50 y     | 49   | 13     |
| Total     | 192  | 49     |

### Table 2. Sexual Dimorphism Among Skulls

| Area          | Female                        | Male                                |
|---------------|-------------------------------|-------------------------------------|
| Forehead      | More straight                 | More oblique                        |
| Glabella      | Curved and subtle             | Frontal-nasal suture is more prominent |
| Supraorbital rim | Less conspicuous            | More striking                       |
| Midface       | Subtle angles                 | Irregular surface and little anterior projection |
| Zygoma        | More prominent and curvilinear | Less prominent                       |
| Mandible      | Lighter, with subtle angles   | Larger, stronger, with clear-cut angles |
| Chin          | Smaller and rounded shape     | Larger and square-shaped             |

![Fig. 3. Midface and mandible. In men, the midface presents more clear-cut angles, irregular surface, and little anterior projection, and the mandible is larger and more angled and has a square shape, whereas in women both the midface and mandible are more subtle, discrete, and rounded in shape.](image)
uous expansion, due to bone deposition in the external wall of the frontal bone, especially in the supraorbital rim (Fig. 8).

**DISCUSSION**

The sexual dimorphism among human skulls is a well-established subject in anthropology. These differences have aided in the distinction of male and female skulls (Fig. 2). Nevertheless, it is the array (Table 2), and not single characteristic that allows gender determination of skulls.7,8

The correct knowledge of gender differences of the human skull is vital in the aesthetic approach to aging, because exaggerated filling of particular areas may render a masculine appearance to women, for example. A prominent supraorbital region is characteristic of men (Fig. 2), so that filling these areas in women must be careful and subtle, only to restore the retro-orbicular fat loss. On the other hand, when treating the aging midface, it is imperative to remember that a more curvilinear prominent cheekbone is peculiar to women, whereas men present a more angled face, due to strong muscle insertions.
Furthermore, deep knowledge of the anatomy of the aging face allows a better approach to the underlying cause of the fold, rendering better and more natural results than just simply filling up the fold. The maxillary retrusion, associated with the decrease in collagen content of the skin and loss of fat compartments, works as a true slide for soft-tissue descent (Figs. 5, 6). Because the zygoma works as a support of the soft tissue of the midface, restoring the volume of the zygomatic prominence would not only improve the local area, giving a youthful and more natural appearance, but would also improve\(^\text{10,11}\) and minimize the need to treat the nasolabial fold itself. The changes in MM/OM ratio observed in this study reflect the increase in orbit and pyriform aperture size, at the expense of the maxillary bone in the process of aging, corroborating the findings of previous authors.\(^\text{6,12,13}\) High G prime hyaluronic acid or poly-lactic acid injections deep in the supraperiosteal area and in the pyriform fossa help soften the lengthening of the nose, drooping of the nose tip, and enlargement of the nostrils.

![Fig. 6. Zygoma.](image)

The orbit does not age homogeneously. The superior-medial and inferior-lateral aspects of the orbit have the greatest tendency to resorb, which is associated with soft-tissue laxity that occurs with aging, leading to an increased prominence of the medial fat pad and lengthening of the nose (Fig. 7). The changes in MM/OM ratio observed in this study reflect the increase in orbit and pyriform aperture size, at the expense of the maxillary bone in the process of aging, corroborating the findings of previous authors.\(^\text{6,12,13}\)

![Fig. 7. Mandible angle and chin.](image)

### Table 3. MM/OM Ratio

| Age Group | Male (n = 192) | Female (n = 49) |
|-----------|----------------|-----------------|
| <20 y     | 0.75           | 0.78            |
| 20–50 y   | 0.77           | 0.77            |
| >50 y     | 0.68           | 0.71            |

\(N = 241.\)

![Table 3. MM/OM Ratio](image)
enning of the lid–cheek junction, giving the patient a sad appearance.\textsuperscript{13-16} The facial remodeling depends entirely on growth, development, and overlying soft-tissue function. All bone volume or size changes throughout life occur in response to functional demand of the face.\textsuperscript{17,18} Indeed, loss of teeth, due to infection, trauma, or aging, increases local bone resorption and is listed among the major bone factors that impact aesthetic outcome.\textsuperscript{19,20} The decrease in mandible volume and shortening of the chin, due to decrease in bone support, lead to further soft-tissue excess and sagging (Fig. 7).\textsuperscript{21,22}

CONCLUSIONS
The clinical approach to the aging face has changed in the past years.\textsuperscript{7} The knowledge of the anatomy of the aging face, taking into consideration all the layers (skin, fat pads, muscles and bones), as a whole, for the treatment of folds and shadows, is vital for a better and more natural final aesthetic outcome.

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