The Effect of Osteoporosis on Facial Dimensions and Indices

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Abstract: Osteoporosis is a common medical condition affecting over 5% of the population. It affects all bones, including those of the facial skeleton, which in turn might have an effect on facial dimensions and indices. We examined 196 healthy volunteer adults and 155 osteoporotic patients. Three longitudinal, transverse and diagonal measurements were taken and three indices were estimated. Osteoporosis was found to increased most of the dimensions in male and female patients. However, it decreases some parameters and indices that include upper facial length, total facial length, nasal width, upper facial index and prospective index. We also found that some of the studied parameters significantly changed in one gender, but did not change in the other. The parameters used in this study can be used as indicators of the effect of osteoporosis on facial dimensions. However, more studies are required to confirm the current findings considering the duration of the disease and the effect of treatment.
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1. Introduction

Studying the morphology of the human face is one of the interesting fields of anthropometric research. It is a well-known fact that facial features differ among different races and ethnic groups [1]. Cephalometry is one of the important parts of anthropometry, in which the dimensions of the head and face are measured. There are several factors that affect facial parameters which include age and gender [2-5]. Cephalometric results are used in forensic medicine [3], plastic surgery [6], oral surgery [6] and dentistry [7].

Osteoporosis is a common medical condition affecting over 5% of the population [8] with a significant socioeconomic burden [9]. In 1994, the World Health Organization (WHO) published criteria for the diagnosis of osteoporosis based on bone mineral density (BMD) measurement at the spine, hip, or forearm with dual-energy X-ray absorptiometry (DEXA) [10]. With this classification, a patient with a BMD that is 2.5 SD or more below the mean BMD of a young-adult reference population (T score= -2.5 or less) has a diagnosis of osteoporosis. When the BMD is between 1.0 and 2.5 SD below that of the reference population (T-score= -1.0 to -2.5), the diagnosis is low bone mass (osteopenia), and when the BMD is 1.0 SD below the mean BMD of the reference population or greater (T-score= -1.0 or higher), the BMD is called normal. Patients with a fragility fracture are classified as osteoporotic (clinical diagnosis) regardless of T-score [11].

There is some evidence that radiological examination of the facial skeleton can be a cost-effective adjunct to complement the early diagnosis and the follow up of osteoporosis [11]. Osteoporosis affects all bones, including those of the facial skeleton. It has been reported that patients with osteoporosis have hearing impairment and vertigo due to involvement of bones of the inner ear particularly in postmenopausal women [12-14]. Due to relatively high cost of DEXA, there have been some payment cuts for its use in osteoporosis diagnosis in the USA [15]. The case might be even worse in other countries with lower income. The current study prompts to establish a cheap method that can be used to diagnose osteoporosis by comparing the mean facial dimensions and indices of normal male and female adults with patients with confirmed osteoporosis who have no other medical conditions using WHO criteria for the diagnosis. Comparison of facial indices of the normal and osteoporotic patients may help in early diagnosis and follow up of the future complications of the disease.

2. Material and Methods:

In total, 196 healthy volunteer adults with an average age of 56 years (108 males and 88 females), and 155 patients with osteoporosis (T score= - 2.5 or less for at least 6 months) with an average age of 59 years (90 males and 65 females) participated in the study. The subjects are all native Egyptians, Resident in Mansoura, Egypt. All were otherwise healthy and selected randomly and showed no apparent facial deformities or scars.

The measurements were carried out using the method described by **Didia and Dapper** [16]. They were taken by the same physician using Martin spreading caliber. Each parameter was measured with

the subject sitting and the head unsupported and placed in anatomical position with facial muscles relaxed and mouth closed and breathing quietly.

- **Landmarks:** The landmarks used in the study are defined as follows (Figure 1):
  1. **Nasion:** the point on the root of the nose where the mid-sagittal plane crosses the nasofrontal suture.
  2. **Subnasale:** the point at which the nasal septum merges with the upper cutaneous lip in the mid-sagittal plane.
  3. **Menton:** the lowest point on the lower border of the mandible in the mid-sagittal plane.
  4. **Gonion:** the most lateral point on the mandibular angel identified by palpation.
  5. **Zygon:** the most lateral point of the zygomatic arches.
- **Measurements:** The taken measurements (parameters) (Figure 2)were:
  - **A. Longitudinal:**
    1. Upper facial (Nasal) length (UFL): Nasion to Subnasale.
    2. Lower facial length (LFL): Subnasal to Menton.
    3. Total facial length (TFL) : Measured from Nasion to the Menton.
  - **B. Transverse:**
    1. Bizygomatic breadth (face width) (BB): Between the two Zygions.
    2. Mandibular (bigonal) width (MB): between the 2 Gonions.
    3. Nose Width (NB): Between the most lateral points on the wings (ala) of the nasal cartilage [17].
  - **C. Diagonal measurements:**
    1. Gonion to Nasion (GN).
    2. Gonion to Subnasale (GS).
    3. Gonion to Menton (GM).
- **Indices:** The following indices were calculated from the above parameters as follows:
  1. **The upper facial index (UFI):** the proportion of the UFL to the TFL. It was calculated as follows: UFI = UFL/TFL × 100
  2. **The lower facial index (LFI):** the proportion of the UFL to the TFL. It was calculated as follows: LFI = LFL/TFL × 100
  3. **The prospective index (PI):** It was calculated according to **Jahanshahi et al.** [17] as follows: PI = TFL/BB X 100

Statistical Analysis:

All data were analyzed using students't-test. P value ≤ 0.05 was considered statistically significant.

3.Results:

The results of the present study are shown in table 1 and figures 3,4. Table (1) shows the results of the t-test analysis in male and female volunteers separately to compare all the studied parameters and indices in our control and patients volunteers. A general look at the results shows that male controls tend to have larger measurements than female controls. When comparing controls with patients, there is a general trend in the female patients to have larger measurements in all the parameters and indices that was statistically significant except in the "Gonion to Subnasale" parameter, and upper and lower facial indices. The least prominent difference was observed in the bizygomatic parameter.

In males, osteoporosis show variable effect on the parameters and indices. Similarly to female patients, osteoporosis increase all the parameters and indices except on upper facial length and its related parameters (nasal width, Gonion to nasion) and indices (upper facial index, prospective index) where osteoporosis decreases the measurements. These effects range from highly significant effect to non-significant effect (Gonion to Menton).

Additionally, apart from the nature of the effect (an increase or decrease), the extent of the effect of osteoporosis was variable when comparing male and female patients. For example, despite that bizygomatic breadth was the least affected parameter in female patients; it was one of the most affected parameters in male patients.

4.Discussion:

In the current study, we investigated the effect of osteoporosis on variable facial parameters and indices in the adults. The age range of this study (50-60 years) is significant since the facial growth changes are maximum below 17 years [19, 20] and the incidence of the disease is commonly above 50 years [21]. We found that the nature and extent of the effect of osteoporosis is variable within and between both genders. On analysis of the nature of mentioned changes, osteoporosis increases all facial dimensions in female patients to a variable extent. However, osteoporosis increases most of the dimensions in male patients and decreases some parameters and indices that include upper facial length, total facial length, nasal width, upper facial index and prospective index. Collectively, these parameters and indices may reflect an effect on the size of the nose.

It is difficult to explain why osteoporosis increases these dimensions in females while decrease them in males. This may be explained by the fact that postmenopausal osteoporosis is associated with sex hormone changes [11], Furthermore, we found that some of the studied parameters significantly change in one gender, but does not change in the other. This might be explained by difference in duration of the disease and the difference in medications used to manage it. However, some parameters have similar

nature of change that was statistically significant in both genders.

Therefore, these parameters can be used as indicators of the effect of osteoporosis on facial dimensions. However, more studies are required to confirm the current findings. We suggest that any future studies should take into consideration the duration of the diseases and the effect of the type of treatment used to manage osteoporosis on facial dimensions.

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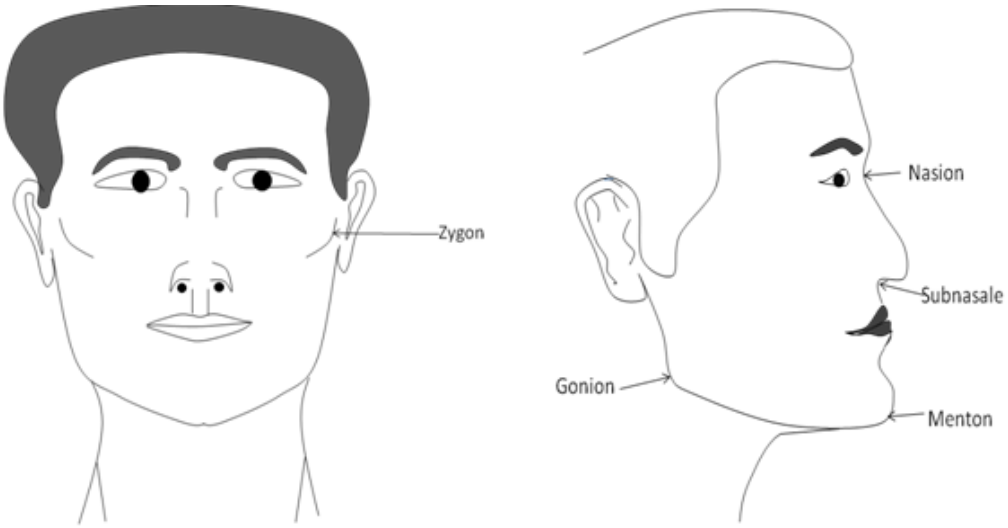

Figure 1: This figure shows the facial landmarks that were used in the current study.

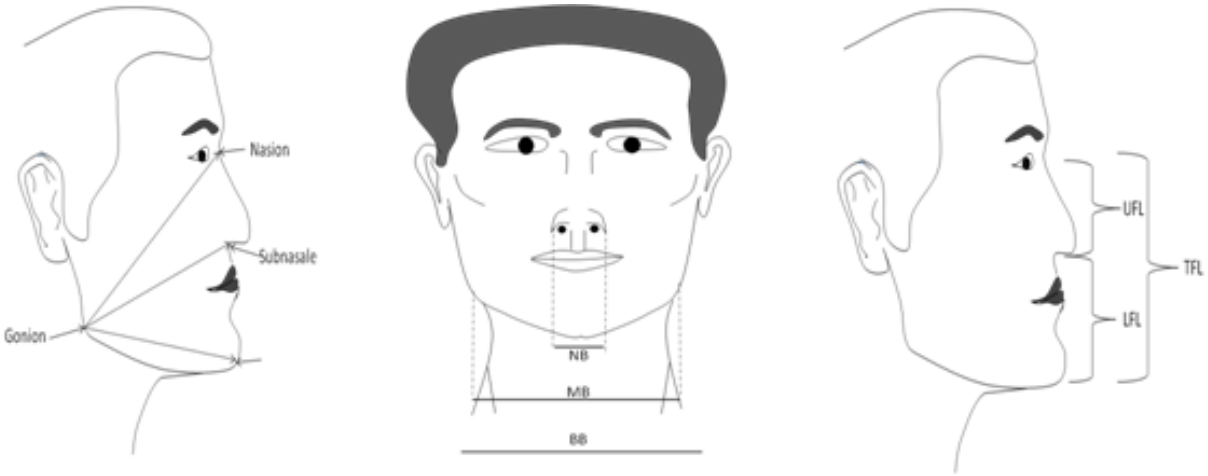

Figure 2: This figure shows the facial parameters that were used in the current study.

Table 1: This table shows the results of t-test analysis of all the parameters and indices which were used in the study. CTL= control (for males N=108, for females N=88), PT= patients (for males N=90, for females N=65), SEM= standard error of mean.

Parameter or Index		Male (Mean±SEM)	*P*-value	Female (Mean±SEM)	*P*-value
Upper Facial Length (cm)	Control	5.47±0.05	0.001	4.58±0.02	<0.0001
	Patients	5.23±0.04		4.90±0.04	
Lower Facial Length (cm)	Control	6.38±0.06	<0.0001	5.64±0.06	0.0005
	Patients	6.91±0.08		6.03±0.08	
Total Facial Length (cm)	Control	11.86±0.08	0.01	10.23±0.06	<0.0001
	Patients	12.15±0.08		10.94±0.09	
Upper Facial Index (percentage)	Control	46.19±0.36	<0.0001	44.95±0.37	0.97
	Patients	43.20±0.40		44.97±0.45	
Lower Facial Index (percentage)	Control	53.81±0.36	<0.0001	55.05±0.37	0.97
	Patients	56.80±0.40		55.03±0.45	
Prospective Index (percentage)	Control	92.86±1.10	0.001	78.25±0.37	0.001
	Patients	87.94±0.97		81.68±1.10	
Bizygomatic Breadth (cm)	Control	12.93±0.19	<0.0001	13.08±0.07	0.002
	Patients	13.90±0.10		13.48±0.11	
Bimandibular Breadth (cm)	Control	11.14±0.07	0.0001	9.84±0.07	<0.0001
	Patients	11.60±0.08		10.90±0.09	
Nasal width (cm)	Control	3.98±0.04	0.02	3.28±0.05	0.001
	Patients	3.84±0.04		3.51±0.04	
Gonion to Nasion (cm)	Control	13.63±0.08	<0.0001	10.53±0.2	<0.0001
	Patients	13.15±0.07		12.17±0.07	
Gonion to Subnasale (cm)	Control	11.40±0.07	<0.0001	9.98±0.09	0.1
	Patients	10.76±0.06		10.19±0.09	
Gonion to Menton (cm)	Control	9.77±0.08	0.3	9.00±0.07	<0.0001
	Patients	9.88±0.1		9.62±0.08	

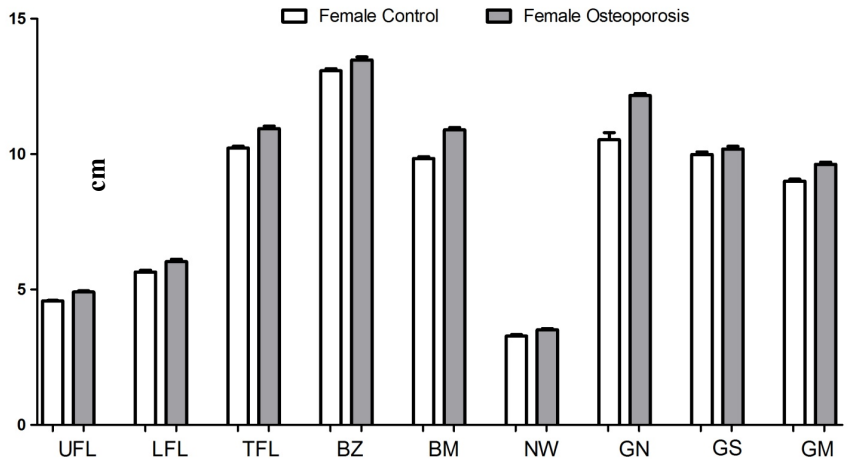

Figure 3: This graph shows the measurement of variable parameters in female controls and patients. UFL=upper facial length, LFL=lower facial length, TFL=Total facial length, BZ=bizygomatic width, BM=bimandibular width, NW=nasal width, GN=Gonion to Nasion, GS=Gonion to Subnasale, GM=Gonion to Menton.

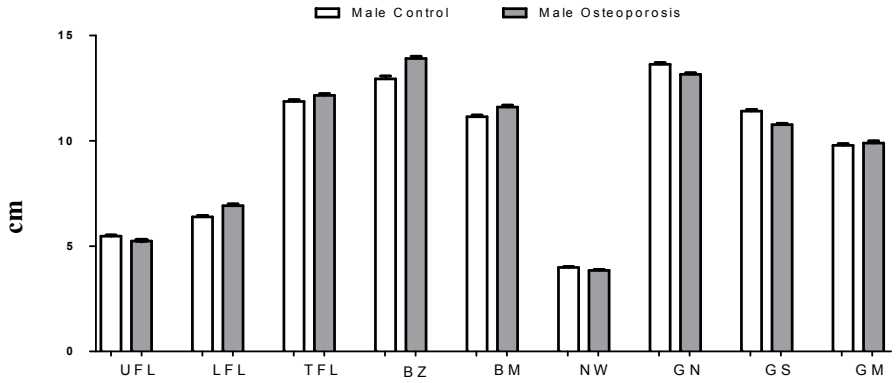

Figure 4: This graph shows the measurement of variable parameters in male controls and patients. UFL=upper facial length, LFL=lower facial length, TFL=Total facial length, BZ=bizygomatic width, BM=bimandibular width, NW=nasal width, GN=Gonion to Nasion, GS=Gonion to Subnasale, GM=Gonion to Menton.

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