

## The thickness of the cortical bone in different maxillae using medical images

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**ABSTRACT:** The aim of this study was to investigate whether there is a relationship between the thickness of the cortical bone of mandible human and the age and the sex of patient. In this work the measure of the cortical bone thickness was obtained in different computed tomography (CT). Different human mandibles were scanned using high resolution micro-CT instrument in which many axial slices were obtained. A total of four medical images were studied and observed. Two different groups were characterized. The first one, with two female maxillae (F): an old and a young patient. The second group of two males mandibles (M), with similar age. A comparison between the male and female sex was also obtained. The cortical bone thickness of the mandible may be affected by tooth extraction, age and sex patient. The use of this type of information is useful for complementary diagnostic information and treatment planning.

### 1 INTRODUCTION

CT is the most common technique used for examination of maxillofacial because it permits the visualization of soft tissues and bone structures in the same medical image (Cavalcanti et al. 2001). This technique is used in several clinical dentistry applications even by axial slices and two (2D) and three-dimensional (3D) reconstructed images (Rocha et al. 2003).

In some regions of the mandible is very difficult to distinguish between cortical and trabecular bone (Natali et al. 2003). Therefore, with thresholding, segmentation operations and to built separate models, the modelling procedure is possible using dedicated software package. Many researchers have studied the relation between CT values and the bone material properties.

The cortical bone at the alveolar bone ridge is in general much thinner than the basal bone (Natali et al. 2003), and generally much lower than CT values of cortical bone at other locations.

Tooth extraction causes continuous and irreversible bone reduction at the mandible (Polat

et al. 2001). A number of factors affect the bone and cortical thickness, hormonal, metabolic, endocrinology and dietary factors.

With this work many conclusions will be produced through the analysis of four different human mandibles.

### 2 METHODOLOGY

Different layers from each human mandible were selected to measure the number of pixels values. Pixel by pixel for each slice and using image control system software, different layers were measured.

A total of four medical images were studied and observed. The measure was made since bottom mandible until above.

A CT high resolution was used and the pixel value is equal to 0.269531 mm. Four different CT were analysed.

Figure 1 represents different axial planes scans of each female maxilla in study, considering the outer and inner side for the points of measurement.

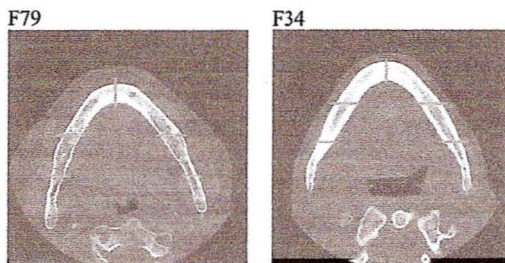


Figure 1. 2D scans of female maxillae and points for measure the cortical bone (F79 and F34).

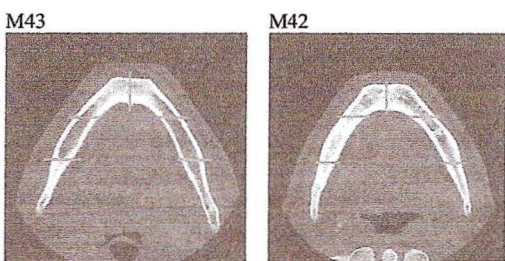


Figure 2. 2D scans of male mandibles and points for measure the cortical bone (M43 and M42).

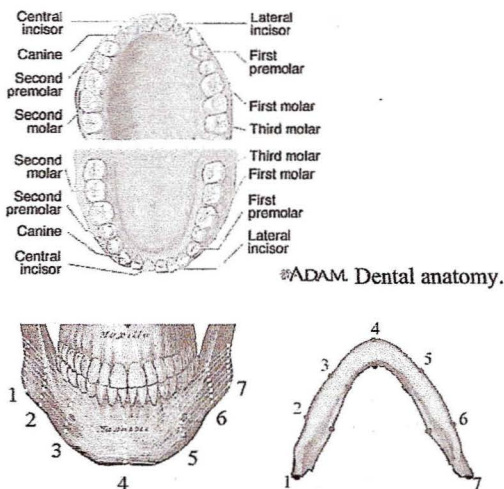


Figure 3. Dental anatomy. Layers and seven measured points. (Courtesy of ADAM).

The axial planes scans of male mandibles are represented in figure 2. The points of measurement are also considered for outer and inner side.

The numbers of teeth are similar between male and young female mandible. Only the old female maxilla has no teeth.

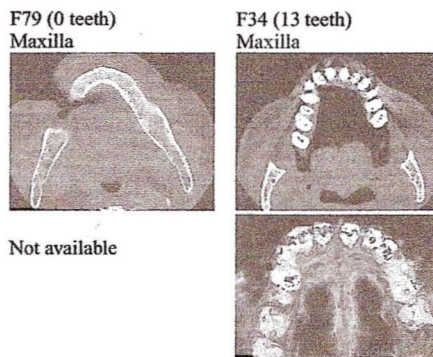


Figure 4. Number of teeth, 2D and the 3D scan of female maxilla for each study case.

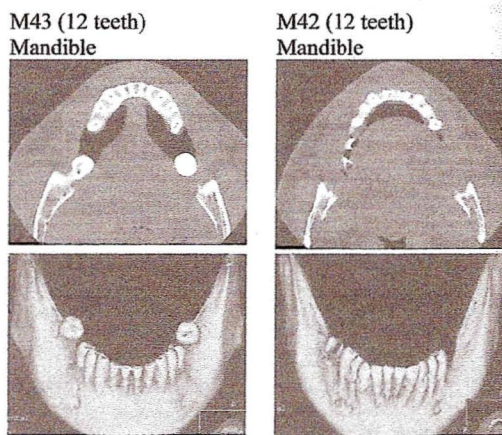


Figure 5. Number of teeth, 2D and the 3D scan of male mandible for each study case.

For female group maxillae were studied and inferior maxillae or mandibles for male group. The patient age is given close by each medical image.

The cortical bone thickness was calculated from the outer to the inner side in seven different portions for different layers, through the measure of pixels numbers.

Figure 3 shows a dental anatomy and different selected seven points along each mandible and maxilla.

All studied cases are represented in figures 4 and 5. A 3D scan of each case was represented. The CT visualization was made with GE medical system DICOM, a viewer Software.

### 3 RESULTS

In this work 2 females maxillae and 2 males mandibles CT were studied.

Table 1. Mean values of cortical thickness in different mandibles for outer side, mm.

Measured points	F79 (0 teeth)	F34 (13 teeth)	M43 (12 teeth)	M42 (12 teeth)
1	0.977	2.021	1.168	2.366
2	1.715	2.734	3.264	3.658
3	1.348	1.920	2.036	1.685
4	1.579	2.387	1.201	1.583
5	1.572	1.977	1.563	1.482
6	1.572	2.464	2.931	2.426
7	0.931	2.313	0.988	1.707
CTM	1.39	2.26	1.88	2.13

Table 2. Mean values of cortical thickness in different mandibles for inner side, mm.

Measured points	F79 (0 teeth)	F34 (13 teeth)	M43 (12 teeth)	M42 (12 teeth)
1	0.977	2.021	1.168	2.366
2	0.515	1.386	1.737	1.887
3	1.348	1.887	2.336	2.325
4	3.157	2.734	2.867	2.628
5	1.168	1.977	1.941	1.853
6	0.786	1.040	1.314	1.437
7	0.931	2.313	0.988	1.707
CTM	1.27	1.491	1.76	2.03

Different axial slices were selected, as can see in figure 3, and seven measurements were made for each other. The estimated value was the mean of these calculations.

The average values of cortical thickness are given in the table 1 and 2, according the age and sex patient for each measured point.

A cortical thickness of maxillae (CTM) is also represented in tables 1 and 2.

CTM is the mean of all collected values from the measured points for one maxilla.

The values of cortical thickness are calculated for outer and inner side of mandibles, as represented in figures 1 and 2.

#### 4 DISCUSSION AND CONCLUSIONS

The CTM measurements in tables 1 and 2 show significant differences between the age and the tooth extraction.

As can see in figure 6, F79 patient has the lesser value. CTM greater value is for F34 patient. The CTM values for M patients are similar and approximately equal 2 mm.

Figure 7 represents the values for inner side in F group. The value with more difference between inner and outer side is the obtained for F34 patient.

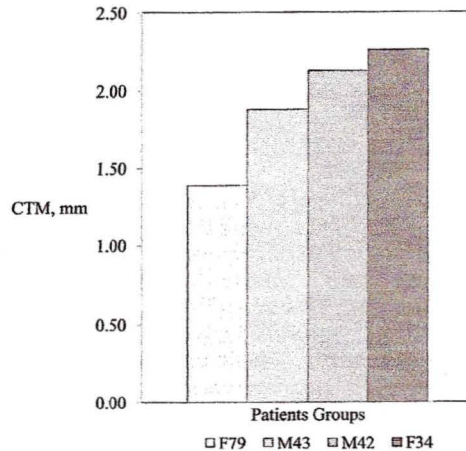


Figure 6. CTM values for F and M patients, (outer side).

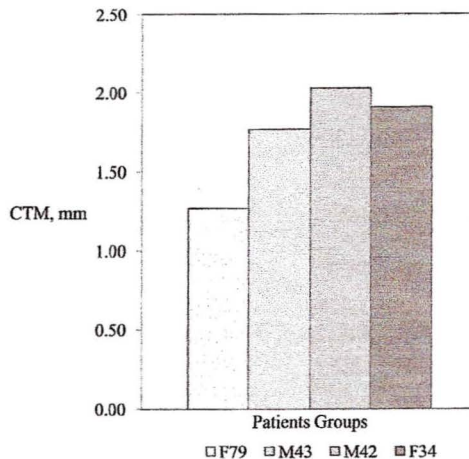


Figure 7. CTM values for F and M patients, (inner side).

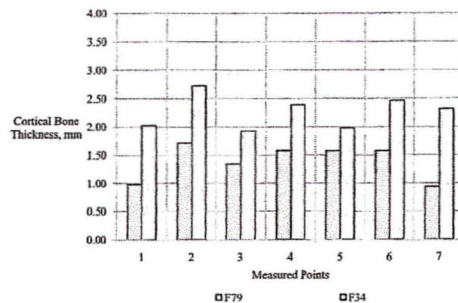


Figure 8. Values of cortical bone in F group, (outer side).

Figures 8 and 9 represent one graphic with the comparison of cortical bone thickness between different ages for F group, for outer and inner side of maxillae, respectively.

Figures 10 and 11 represent the comparison of cortical bone thickness in similar ages for M group.

As can see, the cortical thickness for old F patient is lesser than young F patient. The number of teeth in the F34 maxilla was also higher when compared with F79. The teeth extraction results in a decrease in the resistance of the maxillae. The values of cortical thickness for F maxillae have a constant behaviour for outer side measure. The range of F79 cortical thickness is between 1–1.6 mm. For F34 the values are in the 2 and 2.75 mm.

The values for M groups are more similar, except for the lateral points (1 and 7). The young

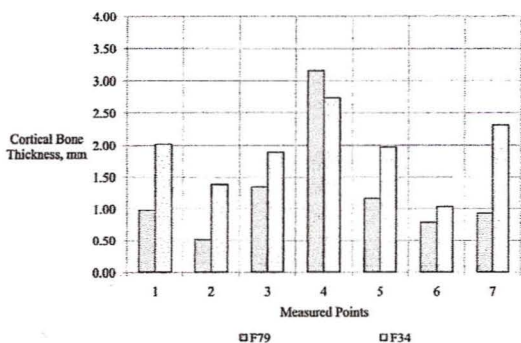


Figure 9. Values of cortical bone in F group, (inner side).

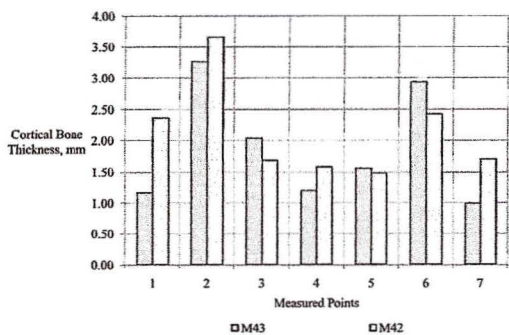


Figure 10. Values of cortical bone in M group, (outer side).

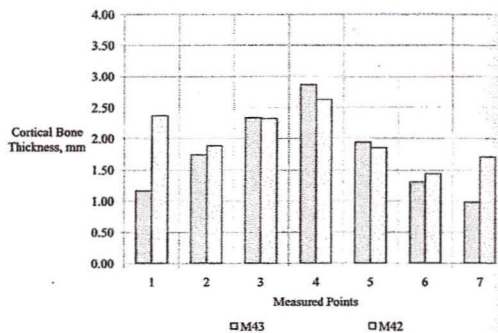


Figure 11. Values of cortical bone in M group, (inner side).

male and female maxillae present a relative differences and behaviour. For M group the range values have a greater oscillation and are between 1 and 3.75 mm.

In the middle of measure, and independently of sex and age, the cortical bone thickness is greater in inner side of mandibles.

More CT analysis should be analysed to determine the correlation between different groups and sex. The cortical thickness can be calculated in conventional radiographs, but the use of CT method is an excellent way to distinguish different tissues, in this case, to distinguish the inner and outer cortex.

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