3D CBCT human adult odontometrics: Comparative assessment in Saudi, Jordan and Egypt population

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\textbf{KEYWORDS}
3D CBCT; Odontometry; Sexual dimorphism; Asymmetry

\textbf{Abstract}  \textbf{Objectives:} To inspect the human adult odontometrics by the assistance of 3D cone beam computerized tomography (CBCT) imaging in Saudi, Jordan and Egypt population.

\textbf{Materials and Methods:} Data of this cross sectional study from 252 subject were analysed by 3D CBCT volumetric data in college of dentistry, Aljouf University, from December 2016 to May 2017. All measurements were done by 3D on demand software. The tooth size from 2nd molar to 2nd molar of maxillary and mandibular arch was measured. Independent \textit{t} test and ANOVA were used to examine the differences between gender and among Arabic population (Saudi, Jordan and Egypt) on the all tooth size.

\textbf{Results:} Comparison between the right and left side odontometrics were significantly dissimilar in 9 out of 14 pairs (\textit{p} < 0.05). The odontometrics of the 2nd molar to 2nd molar tooth of maxillary and mandibular arch between gender and among Saudi, Jordan and Egypt population were insignificant (\textit{p} > 0.05).

\textbf{Conclusion:} 3D CBCT imaging permits us to measure the tooth size effectively and accurately. Based on results, significant asymmetry was revealed in 9 out of 14 pairs in relation to side.

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1. Introduction

Odontometric morphometry and symmetry/asymmetry is an indispensable in the field of dentistry, specially, Orthodontics, Prosthodontics, Conservative dentistry, Oral surgery, Forensic dentistry and anthropology. Odontometric analysis (Haque and Alam, 2017; Purmal et al., 2013) using direct measurement methods including hand-held digital calipers (Alam et al., 2015a; Rahman et al., 2014; Hasan et al., 2015; Sajib and Alam, 2017; Alam et al., 2015b), graphical representation to record dimensions on dental casts (Khursheed et al., 2014), 2D digital model (Shahid et al., 2016; Shahid et al., 2017), Digital impression model (Noor et al., 2014; Jamayet et al., 2014; Sithiphan et al., 2015), 3D CBCT model (Alam et al., 2014b; Alam et al., 2015c; Tarazona et al., 2011), laser scanned model (Massoud et al., 2016) have been used. Recent development in technology such as 3D CBCT has made it possible that the odontometric measurements in three-dimension (Alam et al., 2015c). These 3D model findings deliver more precise and consistent tools for obtaining measurements in odontometric study (Alam et al., 2014b; Alam et al., 2015c; Tarazona et al., 2011). Furthermore, 3D CBCT data provides surplus benefits, such as availability of the images produced, lessening in storage expenses and the facility to evaluate the images by sophisticated software (Alam et al., 2014b; Alam et al., 2015c; Tarazona et al., 2011). CBCT technique of 3D digital acquisition can be used in innumerable dental divisions such as endodontic, orthodontics, prosthodontics and implantology.

CBCT permits to determine odontometric morphometry as hastily, consistently and accurately matched with dimensions (measurement) obtained on digitalized plaster models using the Digital Method. No clinical dissimilarities between measurements using the CBCT method and those by means of the Digital Method exists. (2D) (Alam et al., 2014b; Alam et al., 2015c; Tarazona et al., 2011). CBCT helps orthodontist, prosthodontist and other specialist in the dentistry field to utilize the digital diagnostic simulation models (DDS) by the scanning the dental cast or direct in vivo. CBCT delivers excellent and high resolution images in short time and with a minimum amount of radiation than conventional CT. CBCT also offers more specific and precise 3D data of the dentofacial structures than 2D radiographs (Alam et al., 2015c; Tarazona et al., 2011).

Analysis of odontometric morphometry and symmetry/asymmetry is fundamental in clinical orthodontics, prosthodontics and operative dentistry for esthetics and durable occlusal stability through the preservation of the original mesiodistal tooth size (Alam et al., 2014a). There are some basic differences in odontometric morphometry between the different sub-populations. Findings of other populations have supplementary confirmed these verdicts. From the orthodontics, prosthodontics and operative dentistry treatment planning and diagnosis the odontometric morphometry has a prodigious significance for the position of teeth, smile, esthetics, stability of teeth and dental arches. Current literature reveal relatively few 3D studies of odontometric morphometry and symmetry/asymmetry (Alam et al., 2014b; Tarazona et al., 2011). Based on literature search till to date no such studies has been done in Arabian population. 3D images acquisition, using the CBCT method has great authenticity and reliability for the odontometric morphometry (Alam et al., 2014b; Alam et al., 2015c; Tarazona et al., 2011). Hence, the current study was designed to evaluate the odontometric morphometry between gender and among races (Saudi + Jordan + Egypt = Arabian) and symmetry/asymmetry via side disparities by in vivo 3D CBCT.

2. Materials and methods

Informed consent was obtained from all participants regarding willingness prior to CBCT, and this study was approved by the Ethical Committee of the college of Dentistry, Jouf University, which conforms with the Declaration of Helsinki. This study followed the guidelines of Strengthening the Reporting of Observational studies in Epidemiology (STROBE), and the STROBE checklist was utilized in the preparation of this manuscript (Vandenbroucke et al., 2007).

Subject Characteristics & Study design: This Cross sectional study was performed on secondary data procured from College of dentistry, Jouf University during period from December 2016 to May 2017. The data source was CBCT volumetric data from the archives of the college of Dentistry Jouf University and samples were selected using simple random technique. Odontometric morphometry and asymmetry was analysed and recorded in 252 3D CBCT volumetric data of maxilla and mandibular arches. Details of the demographic information and selection criteria are shown in Table 1.

Odontometric analysis on CBCT digital image: The linear dimensions were made for odontometric morphometry and asymmetry. Tooth size of 2nd molar to 2nd molar of maxilla and mandible were measured. Tooth size, is the mesio-distal width which resembles to the maximum distance across the anatomic contact point of teeth for the maxillary and mandibular teeth. Malposed tooth is measured through imaginary contact point of the proximal area. The carefully chosen 252 CBCT images were analyzed using software OnDemand 3D for odontometric morphometry and symmetry/asymmetry.

Measurement of error: Measurements were repeated two weeks delayed to evaluate the systemic and random errors for 50 CBCT images that were randomly selected. Systemic errors were calculated using a two-sample t-test for each pair of analyses. Houston (1983) stated that there systemic bias doesn’t exists if the p-value is larger than 0.1. Arbitrary errors were assessed by measuring the correlation between repeated
measurements (index of reliability). Stirrup (1993) stated that a correlation value larger than 0.95 is satisfactory (Stirrup, 1993). All test and retest measurements presented an intra-class correlation of value greater than 0.91. Outcomes form these variables showed that there were no random errors. All pairs of measurements showed a p-value greater than 0.1, suggesting that there was no systemic bias in these analyses.

Statistical Analysis; Obtained data were introduced to the Excel spreadsheet and the data was statistically analysed using SPSS version 24 (Chicago, IL, USA). Independent t test and
The paired t test was used to examine the disparities in gender and side asymmetry respectively. For the racial disparities, ANOVA was used. \( p < 0.05 \) were considered to be statistically significant.

### 3. Results

#### 3.1. Gender comparison

A total of 28 variables were measured. The odontometric morphometry (mesio distal tooth width of the 2nd molar to 2nd molar of the maxilla and mandible) between gender show no significant differences \( (p > 0.05) \) (Table 2). Out of 28, male had larger value in 23 variables than female.

#### 3.2. Race comparisons

Among 3 races (Saudi, Jordan and Egypt) odontometric morphometry of all 28 variables of maxilla and mandible show no significant differences \( (p > 0.05) \) (Table 3).

#### 3.3. Side comparison

For the odontometric symmetry/asymmetry, among 14 pairs of comparison, 9 pairs revealed significant differences \( (p > 0.05) \) (Table 4). Pair no. 4-6 and no. 13 revealed highly significant differences \( (p < 0.001) \), pair no. 4 and no. 11 showed moderately significant differences \( (p < 0.01) \) and pair no. 7, 8 and no. 12 showed less significant differences \( (p < 0.05) \).

### Table 3: Racial comparison of odontometric morphometry in maxilla and mandible.

| Race | Maxilla | | | Mandible | | |
|------|---------|---|---|---------|---|---|
|      | Variables | Mean | SD | p value | Variables | Mean | SD | p value |
| Saudi | 11 | 8.008 | 0.966 | 0.936 | 31 | 5.107 | 0.651 |
| Jordan | | 8.032 | 1.015 | 0.963 | | 5.145 | 0.673 | 0.491 |
| Egypt | | 8.080 | 0.786 | 0.976 | | 5.276 | 0.722 |
| Saudi | 12 | 6.327 | 0.843 | 0.704 | 32 | 5.577 | 0.662 | 0.481 |
| Jordan | | 6.319 | 0.839 | 0.976 | | 5.744 | 0.828 |
| Egypt | | 6.287 | 0.760 | 0.976 | | 5.744 | 0.828 |
| Saudi | 13 | 7.171 | 0.870 | 0.725 | 33 | 6.274 | 0.875 |
| Jordan | | 7.210 | 0.862 | 0.725 | | 6.392 | 0.896 |
| Egypt | | 7.128 | 0.722 | 0.725 | | 6.367 | 0.882 |
| Saudi | 14 | 6.417 | 0.833 | 0.858 | 34 | 6.377 | 0.858 |
| Jordan | | 6.538 | 0.807 | 0.750 | | 6.427 | 0.792 | 0.715 |
| Egypt | | 6.422 | 0.648 | 0.896 | | 6.523 | 0.896 |
| Saudi | 15 | 5.989 | 0.861 | 0.906 | 35 | 6.345 | 0.906 |
| Jordan | | 6.224 | 0.924 | 0.311 | | 6.409 | 0.793 | 0.682 |
| Egypt | | 6.143 | 0.867 | 0.831 | | 6.504 | 0.831 |
| Saudi | 16 | 8.956 | 1.295 | 0.518 | 36 | 9.683 | 1.521 |
| Jordan | | 9.175 | 1.359 | 1.068 | | 10.161 | 1.618 |
| Egypt | | 9.193 | 1.122 | 1.440 | | 10.300 | 1.440 |
| Saudi | 17 | 7.879 | 1.493 | 0.491 | 37 | 8.927 | 1.451 |
| Jordan | | 7.965 | 1.427 | 0.363 | | 9.182 | 1.269 |
| Egypt | | 8.073 | 1.206 | 1.188 | | 9.290 | 1.188 |
| Saudi | 21 | 8.014 | 0.955 | 0.646 | 41 | 5.083 | 0.646 |
| Jordan | | 8.111 | 1.070 | 0.55 | | 5.042 | 0.668 |
| Egypt | | 8.084 | 0.763 | 0.728 | | 5.225 | 0.728 |
| Saudi | 22 | 6.306 | 0.876 | 0.602 | 42 | 5.554 | 0.692 |
| Jordan | | 6.297 | 0.865 | 0.643 | | 5.537 | 0.657 |
| Egypt | | 6.406 | 0.649 | 0.643 | | 5.689 | 0.661 |
| Saudi | 23 | 7.244 | 0.904 | 0.968 | 43 | 6.257 | 0.968 |
| Jordan | | 7.237 | 0.905 | 0.756 | | 6.371 | 0.882 |
| Egypt | | 7.134 | 0.697 | 0.863 | | 6.359 | 0.863 |
| Saudi | 24 | 6.518 | 0.793 | 0.867 | 44 | 6.449 | 0.867 |
| Jordan | | 6.601 | 0.806 | 0.861 | | 6.438 | 0.831 |
| Egypt | | 6.579 | 0.628 | 0.865 | | 6.616 | 0.865 |
| Saudi | 25 | 6.100 | 0.839 | 0.902 | 45 | 6.393 | 0.902 |
| Jordan | | 6.287 | 0.870 | 0.674 | | 6.429 | 0.889 |
| Egypt | | 6.204 | 0.788 | 0.909 | | 6.565 | 0.909 |
| Saudi | 26 | 9.107 | 1.242 | 1.471 | 46 | 9.862 | 1.471 |
| Jordan | | 9.283 | 1.324 | 0.213 | | 10.186 | 1.587 |
| Egypt | | 9.204 | 1.107 | 0.186 | | 10.336 | 1.386 |
| Saudi | 27 | 7.932 | 1.471 | 0.323 | 47 | 8.971 | 1.323 |
| Jordan | | 8.096 | 1.264 | 0.494 | | 9.149 | 1.315 |
| Egypt | | 8.194 | 1.352 | 0.326 | | 9.271 | 1.326 |
The uniqueness of the current study stands upon the following points: (1) 252 CBCT data; (2) Three different Arabian subpopulation data; (3) assessment of odontometric morphometry and symmetry/asymmetry using new approach. This study assessed the overall odontometric morphometry which is imperative for different field in dentistry. The records existing for the population are advantageous in the forensic odontology, orthodontic, prosthetic and operative treatment designs. Before managing different orthodontic analysis for the odontometric morphometry and symmetry/asymmetry there should be records for the odontometric morphometry for gender, relevant ethnic and several variations in malocclusion. The 3D CBCT are as accurate and duplicate as the digital models accomplished from the plaster study casts for analyzing the odontometric morphometry. The inconsistencies present among both methodologies were clinically acceptable (Alam et al., 2014b; Alam et al., 2015c; Tarazona et al., 2011). CBCT digital models are as precise as OrthoCAD digital models in production of linear measurements for overjet, overbite, and crowding assessments (Kau et al., 2010). This study was carried out on CBCT data of 252 patients using the In-Vivo Dental program and the digital models obtained out of 3D onDemand software. The sample size was significantly higher than the previous studies (Alam et al., 2014b; Alam et al., 2015c; Tarazona et al., 2011; Kau et al., 2010).

Bishara et al. investigated the mesio-distal and buccolingual crown dimensions of the permanent teeth in three populations from Egypt, Mexico and the United States. The findings from this report demonstrated significant disparities in the mesio-distal dimension among the evaluated populations. Besides racial disparities, the other aspects correlated with tooth size inconsistency are gender, environment, hereditary factors (Bishara et al., 1989). Current study also revealed racial differences among Saudi, Jordan and Egypt population. 18/24 variables, Egypt population had larger measurements then Saudi and Jordan. However, the differences were not statistically significant. Between gender disparities, male showed larger measurements then female without any significant differences. In a study by Asiry and Hashim, (Al-Khateeb and Abu Alhaija, 2006) and Al-Khateeb and Abu Alhaija, (Asiry and Hashim, 2012), Saudi and Jordan population respectively showed gender disparities without any significant disparities. These results coincide with the current study. However, these measurements were done by digital caliper on plaster model. In relation to odontometric symmetry/asymmetry, our results coincide with the findings of Al-Khateeb and Abu Alhaija, (Asiry and Hashim, 2012; Al-Khateeb and Abu Alhaija, 2006). Significant differences between right and left side tooth size measurement were reported.

Our results verdict with the results presented by Alam et al. (Alam et al., 2014a; Alam et al., 2013) and Shahid et al. (Shahid et al., 2015) in relation to the gender differences. Tooth size in upper and lower canine presented the greatest variation of sexual dimorphism (Shahid et al., 2015). Shahid et al. (Shahid et al., 2015) reported that the greatest difference in the tooth size was associated with the upper lateral, second premolars and lower lateral incisors in males whereas in females it was associated with upper canine and lower incisors. However, Shahid et al. (Shahid et al., 2015) found the tooth dimensions of right and left side were alike with only exception in second premolar which was significantly higher than its counterpart. This outcome was significant but the disparity was very small, hence findings verdict with the results of the current study. In a study by Alam and Iida, (Alam and Iida, 2013) found overjet, overbite, dental midline shifting as a contributing factor in tooth size discrepancy. Al-Khateeb and Abu Alhaija, (Asiry and Hashim, 2012) found tooth size varies in relation to different type of malocclusion. We intend to discover such disparities using 3D CBCT methods in future studies.

We measured odontometric morphometry and symmetry/asymmetry through the 3D CBCT analysis of several measurements for 252 maxilla and 252 mandible. Findings from the current study provide an insight knowledge to orthodontist for appropriate diagnosis and treatment planning within the Arabian sub-population. We did multi-population comparison using 3D CBCT with the limitation of less number subjects of Jordan and Egypt and other nationals are not included within

| Pair | Variables | Mean | 95% CI Lower | 95% CI Upper | p value |
|------|-----------|------|--------------|--------------|---------|
| Pair 1 | 11 vs 21 | -0.015 | -0.045 | 0.016 | 0.335 |
| Pair 2 | 12 vs 22 | 0.007 | -0.035 | 0.049 | 0.727 |
| Pair 3 | 13 vs 23 | -0.062 | -0.098 | -0.025 | 0.001** |
| Pair 4 | 14 vs 24 | -0.102 | -0.141 | -0.063 | 0.000*** |
| Pair 5 | 15 vs 25 | -0.101 | -0.140 | -0.062 | 0.000*** |
| Pair 6 | 16 vs 26 | -0.132 | -0.189 | -0.076 | 0.000*** |
| Pair 7 | 17 vs 27 | -0.069 | -0.129 | -0.008 | 0.026* |
| Pair 8 | 31 vs 41 | 0.036 | 0.111 | 0.062 | 0.006** |
| Pair 9 | 32 vs 42 | 0.013 | -0.022 | 0.047 | 0.481 |
| Pair 10 | 33 vs 43 | 0.017 | -0.052 | 0.086 | 0.632 |
| Pair 11 | 34 vs 44 | -0.067 | -0.107 | -0.027 | 0.001** |
| Pair 12 | 35 vs 45 | -0.046 | -0.087 | -0.004 | 0.033* |
| Pair 13 | 36 vs 46 | -0.147 | -0.205 | -0.090 | 0.000*** |
| Pair 14 | 37 vs 47 | -0.029 | -0.127 | 0.070 | 0.566 |

4. Discussion

Table 4: Side comparison for odontometric symmetry/asymmetry (Maxillary right vs left and Mandibular right vs left, 2nd molar to 2nd molar teeth).
the range of Arabian peninsula. Comparable outcomes might be obtained in another population thereby providing a scope for further research in this field.

5. Conclusion

Within the limitations of the study following summary can be drawn -

- 3D CBCT imaging allows us to measure the odontometric morphometry and symmetry/asymmetry.
- The odontometric morphometry didn’t showed any variation in gender and racial dimorphism.
- The odontometric symmetry/asymmetry revealed the significant differences in 9/14 pairs of measurements.
- CBCT provides a valuable tool in record and data management for odontometric morphometry and symmetry/asymmetry assessment obtained directly from the digital image.

6. Authorship/Researcher contribution

1. Conception and design of the work: MKA, BKA, IK, KKG, SP.
2. Acquisition of data, or analysis and interpretation of data: MKA, IK, SP.
3. Drafting the article or revising it critically for important intellectual content: MKA, BKA, IK, KKG, SP.
4. Final approval of the version to be published: MKA, BKA, IK, KKG, SP.

Conflict of interest

None declared.

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