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Effect of Segmentation Techniques (Manual Versus Semiautomatic) on the Accuracy of the Reconstructed Mandibular Condyle using Cbct (A Diagnostic Accuracy Study)

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KEYWORDS
CBCT-Condyle-Manual segmentation-Semi-automated segmentation.

ABSTRACT:

Aim: The aim of the present study was to assess the effect of the technique of segmentation (manual or/ semi-automatic) on the accuracy volumetric measurements of the reconstructed mandibular condyle from CBCT images as compared to the real measurements of the actual condyle which act as the gold standard.

Methodology: 30 dry mandibular condyles were included in this study.For real Volumetric measurements, water displacement technique was used. Each skull &mandible assembly was scanned using the standard imaging protocol using Planmeca Promax 3D Mid CBCT machine. DICOM files were imported to 3D slicer open-source segmentation software. Manual and semiautomatic segmentation techniques were used to obtain 3D reconstructed mandibular condyles.Volumetric measurements were automatically measured by the software. Data were normally distributed and were analyzed using repeated measures ANOVA followed by Bonferroni post hoc test. Correlations were analyzed using Pearson's correlation coefficient. Reliability was analyzed using the intraclass correlation coefficient (ICC).

Results: The overall agreement of the manual and the semiautomatic segmentation techniques with the real gold standard was excellent in volumetric measurements. Concerning the measurement errors of both modalities, the semiautomatic technique showed a higher error
Conclusion: CBCT is an accurate and reliable imaging modality for maxillofacial structures. segmentation. Semi-automated segmentation of the mandibular condyle is a reliable and time-saving segmentation approach that can yield accurate volumetric results compared to manual segmentation.

INTRODUCTION

Over the years, three-dimensional '3D' radiographic techniques have been developed to assist clinicians in the analysis of complex craniofacial structures like the temporomandibular joint (TMJ) **(Kim et al., 2021).** The gold standard imaging modalities for the TMJ were magnetic resonance imaging (MRI) and computed tomography (CT). However, the assessment of the osseous component cannot be done using MRI and the drawback of CT is the high radiation dose. Subsequently, Cone beam computed tomography (CBCT) has been considered the optimum technique to evaluate the osseous component of the TMJ due to its high spatial resolution and low radiation dose **(Giudice et al., 2020).**

CBCT offers 3D volumetric assessment of the condyle which is a complex anatomical structure of great importance in maxillofacial dentistry. The mandibular condyle significantly affects the mandibular growth, therefore morphological and dimensional condylar changes can affect craniofacial growth. Furthermore, temporomandibular disorder (TMD), as well as various malocclusions can be the consequences of improper mandibular condylar growth and development **(Giudice et al., 2020; Ezz et al., 2023).** Morphological and

histological changes in the temporomandibular joint can be caused by age progression and functional disorders as well **(Altan Şallı & Öztürkmen, 2021).**

3D visual assessment of the condyle became possible through a process called segmentation, this process works to separate a specific tissue from the background into reconstructed homogeneous structure concerning intensity or texture **(Sabancı et al., 2021).** Different segmentation techniques have been used to segment the mandibular condyle like manual technique; in which the clinician demarcates the condylar outline in each slice to produce a segmented 3D reconstructed condyle. Whereas, in the automatic technique, the operator chooses a specific range of threshold intervals to guide the segmentation. Nonetheless, the automatic technique is fast and convenient, a major drawback emerges which is the precise delineation of complex structures. On the other-hand, semi-automatic segmentation combines the steps of both automatic and manual segmentation using the binary threshold-based volume or the region-growing algorithm. The characteristic advantage of the semiautomatic technique, in comparison to the manual technique, is the time saving which is clinically essential. However, manual segmentation was supposed to be of higher accuracy in detection of anatomical structures with low-density or non-apparent borders especially complex structures such as the TMJ **(Giudice et al., 2020; Sabancı et al., 2021).**

The possible inaccuracies and inconsistent condylar segmentation procedures from 3D imaging will have significant clinical implications during the evaluation of the findings related to the condylar changes **(Kim et al., 2020).** For that, this study was planned to assess the effect of different segmentation techniques, manual and semiautomatic, on the accuracy of volumetric measurements of the 3D reconstructed mandibular condyle from CBCT scans, as compared to the actual physical volumetric measurements of the mandibular condyles as a gold standard.

MATERIALS & METHODS

This is a diagnostic accuracy study, the data collection was planned before the index test and reference standard were performed (prospective study).

Study Subjects:

A total of 30 condyles were included in this study. Fifteen skulls and mandibles recruited in this study were obtained from the Anatomy Department, Faculty of Medicine, Cairo University. Sample preparation, direct measurements, radiographic examination, and data collection were performed in the Oral and Maxillofacial Radiology Department, Faculty of Dentistry, Cairo University.

Human skulls and mandibles were recruited according to the following eligibility criteria:The inclusion criteria were mandibles with sound condyles and skulls with sound glenoid fossae. Exclusion criteria were the Presence of fracture, pathological lesions, or skeletal deformities in the condylar area.

Real Volumetric Physical Measurements of the Condyles:

Volumetric measurements of the dry human condyles were considered as reference standard where the water displacement method was used (according to Archimedes' principle). An L-shaped metal hanger and rope were used for hanging the condyle. The condyle was immersed in a graduated transparent glass beaker filled with black-colored water as supported by **García-Sanz et al. (2017).**The water level was recorded on the transparent graduated beaker before the condyle immersion. The condyle was allowed to be totally immersed under the water level.Then the displaced amount of water was aspirated by using a graduated clear pipette**.** The volume of water aspirated was recorded by cm^3. This technique was supported by **García-Sanz et al. (2017).** The volume was then converted from cubic centimeters to cubic millimeters to match the one measured by the software (1 cm^3 = 1000 mm^3).

For standardization purposes, the level of the immersed condyle was demarcated by a marker after immersion and Gutta-percha cones (size 50) were glued all around the condyles following the marker. Gutta-percha cones are radiopaque which helped in the determination of the condylar volume, corresponding to the real physical one, for volumetric assessment after imaging.

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CBCT imaging for the Dry Skulls and Mandibles:

Each mandibular condyle was fitted with the corresponding glenoid fossa in the skull and attached in place firmly using wrapping film. Dry human skulls and assembled mandibles were scanned in the Oral and Maxillofacial Radiology Department, Faculty of Dentistry, Cairo University; using the CBCT machine Planmeca ProMax® 3D Mid.

Each skull &mandible assembly was scanned using the standard imaging protocol as follows **:**

- Kilovoltage: 90 kV.
- Milliampere: 8 mA.
- Field of view: 20 x 6 cm.
- Voxel size: 0.4 mm.
- Exposure time: 13.5s

Index Test Application:

Manual segmentation technique **(Index test 1)** and semiautomatic segmentation technique **(Index test 2)** were done using this 3D slicer software.

Manual Segmentation (Index test 1) :

The “Paint” option was selected, and the diameter of the brush was set at 0.7 mm to precisely delineate the condylar outline. This was followed by applying the paintbrush (using a larger diameter) in each slice in the axial plane until the whole condylar volume was painted**.** The whole condylar volume was indicated by the level of the gutta-percha cones.

Semiautomatic Segmentation (Index test 2):

Two segments were created (for the condyle and the surroundings).The slices of the condyle were painted randomly till the level of the gutta-percha, and the surroundings were. This was done in all planes (axial, coronal, and sagittal). The two segments were painted with two different colors. Thereafter, the “Grow from seeds” option was selected.

For both techniques, the 3D condylar volume was created and any mishaps were edited using the “erase” option.

Volumetric Measurements for the Segmented Condyle:

Eventually, volumetric measurements were calculated on the software for the segmented condylar volume either generated from the manual or semiautomatic segmentation techniques.

First, “Segmentation Statics” module was selected on the 3D slicer software.

This was followed by the selection of “Apply” button, then the volume of the segmented condyle was automatically calculated and tabulated.The software automatically provided the volume of the condyle by different units including the cubic millimeter.

Blinding & Inter and Intra-Observer Agreement

The assessment was done by two oral radiologists with different experiences ranging from 5 to 18 years. Each observer was blinded to the real physical measurements and to the results of other observer. The second observer evaluated 33% of the total sample size for inter-observer assessment.

One of the two oral radiologists had done the assessment twice with a two-week interval between the two sessions to assess intra-observer agreement.

RESULTS

1-Volumetric measurements descriptive statistics Intergroup comparisons:

The highest value was found in **semi-automated technique** measurements (2243.43±365.79) (mm^3), followed by real measurements (2126.67±383.21) (mm^3), while the lowest value was found in **manual technique** measurements (2094.03±415.83) (mm^3). Post hoc pairwise comparisons showed **semi-automated technique** measurements to have significantly higher values than other measurements (p<0.001)) **Table (1), (Figure 1).**

Table (1): Intergroup comparison of volumetric measurements.

Measurement	Mean±SD			p-value
	Real measurements	Semi-automatic technique measurements	Manual technique measurements	
Volume (mm^3)	2126.67±383.21^B	2243.43±365.79^A	2094.03±415.83^B	<0.001*

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Values with different superscript letters within the same horizontal row are significantly different *; Significant ($p<0.05$).

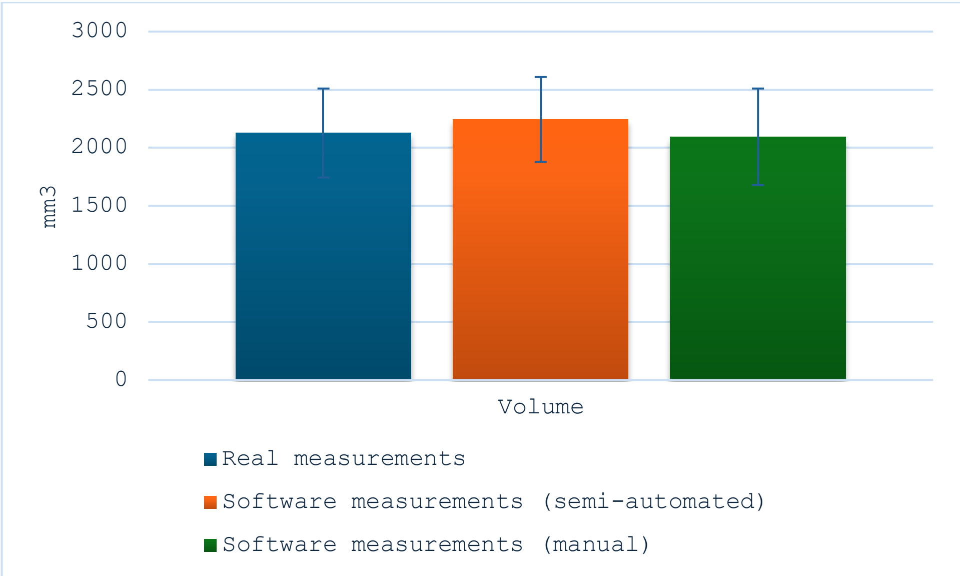

Figure (1): Bar chart showing mean and standard deviation (error bars) values for volumetric measurements.

2-<u>Volumetric measurements Agreement of Software Measurements:</u>

Both modalities had excellent agreement with real measurements that were statistically significant (ICC>0.9, $p<0.001$) **Table (2).**

Table (2): Agreement analyses for software measurements considering volumetric measurements.

Measurement	ICC (95% CI)	
	Real- (Semi-automatic technique)	Real- Manual technique
Volume (mm^3)	0.959 (0.550:0.988)*	0.981 (0.959:0.991)*

*; Significant ($p<0.05$)

3- <u>Measurements Errors Descriptive statistics</u>

For **semi-automatic technique** measurements, the mean was (134.17) (mm^3) with a 95% confidence interval of (107.64:160.69) (mm^3), the standard deviation was (74.13) (mm^3), the minimum value was (19.00) (mm^3), and the maximum value was (344.00) (mm^3).

For **manual technique** measurements (mm^3), the mean was (93.30) (mm^3) with a 95% confidence interval of (72.45:114.15) (mm^3), the standard deviation was (58.27) (mm^3), the minimum value was (0.00) (mm^3), and the maximum value was (250.00) (mm^3) **Table (3), (Figure 2).**

Table (3): Descriptive statistics of measurement error values for volumetric measurements.

Measurement	Group	Mean	95% CI		SD	Min.	Max.
			Lower	Upper			
Volume (mm^3)	Semi-automatic technique measurements	134.17	107.64	160.69	74.13	19.00	344.00
	Manual technique measurements	93.30	72.45	114.15	58.27	0.00	250.00

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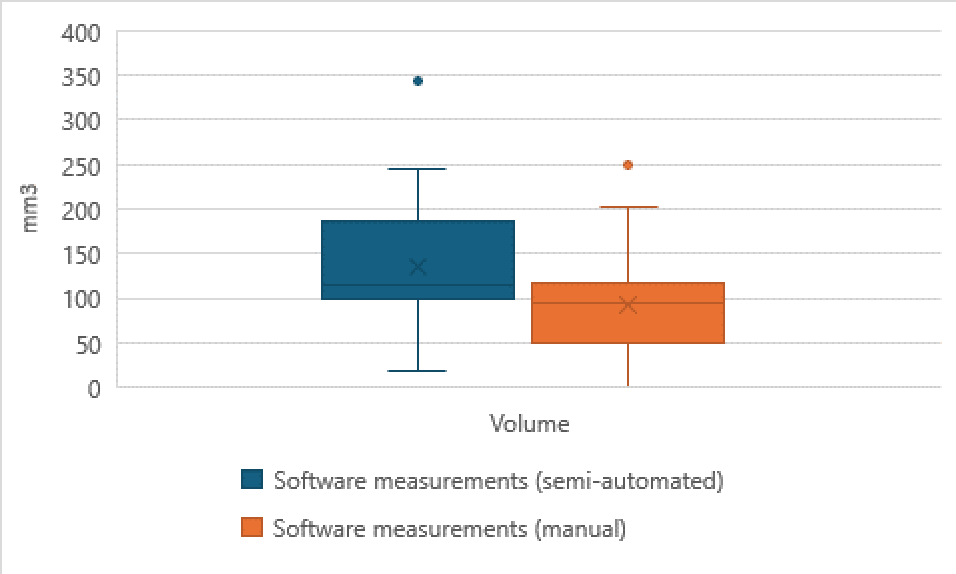

Figure (2): Box plot for of measurement error values for volumetric measurements.

4-Inter and intra-observer reliability.

There was an excellent agreement between both observers and measurements that was statistically significant (ICC>0.9, p<0.001).

DISCUSSION

Using CBCT data, a variety of methods have been implemented to render the condylar surface in three dimensions **(Xi et al., 2014)**. Manual and semi-automatic techniques are frequently used for the segmentation of the mandibular condyles **(Bayram et al., 2012; Engelbrecht et al., 2013; Xi et al., 2013; Xi et al., 2014; Da Silva et al., 2018; Giudice et al., 2020)**. This study was designed as an in-vitro one on dry human skulls and mandibles to use the physical measurements on the real structure as the gold standard **(García-Sanz et al., 2017).**

Assessment of the morphology, integrity, and structural changes of the osseous components of the TMJ has been accomplished by different modalities such as panorama, linear or complex motion tomography, CBCT, and multi-slice CT **(Librizzi et al., 2011).** CBCT is anticipated to be the ideal technique in TMJ osseous components assessment because of radiation dose reduction and easier convenience **(Librizzi et al., 2011).**

For the real volumetric measurements, the Archimedes principle was used by applying the water displacement technique of the mandibular condyles as **(Bayram et al., 2012; García-Sanz et al., 2017; Kim et al., 2021; Elrawdy et al., 2023; Ezz et al., 2023).** In our study, a radiopaque gutta-percha marker (size 50) was used to demarcate the immersed part of the condyle to obtain a standardized method.

Regarding the index tests in our study, two segmentation methods were used to obtain 3D reconstructed mandibular condyle. Manual and semiautomatic segmentation techniques were done using 3D slicer software. 3D slicer software is an open source segmentation software (http://www.slicer.org) which is a user friendly software with comparable accuracy to other software programs (ITK-Snap, Invesalius Dolphin 3D), excellent intra-operator and inter-operator reliability in condylar segmentation as mentioned by **Giudice et al. (2020).**

Giudice et al. (2020) found that the volumetric measurements of the condylar models from 5 software programs (3D Slicer, ITK-Snap, Invesalius Dolphin 3D and Mimics) showed no significant difference.

Our results revealed that the highest volumetric measurements value was found in semi-automated technique measurements (2243.43±365.79) (mm3), followed by real measurements (2126.67±383.21) (mm3), while the lowest value was found in manual technique measurements (2094.03±415.83) (mm3).The

mean volumetric measurements from different studies showed variability from 663 mm3 to 2171 mm3 **(Saccucci et al., 2012; Xi et al., 2014; Nicolielo et al., 2017; Giudice et al., 2020; Altan Şallı & Öztürkmen, 2021; Shetty et al., 2021; Lentzen et al., 2022; Waghmare et al., 2023).** This could be attributed to the different methodologies and populations used in these studies.Post hoc pairwise comparisons showed that semi-automated technique measurements had significantly higher values than other measurements ($p<0.001$).

The mean measurement error in semi-automatic technique measurements (134.17±74.13) (mm3) was significantly higher than that measured in manual technique measurements (93.30±58.27) (mm3) ($p=0.023$). Both modalities had excellent agreement with real measurements that were statistically significant ($ICC>0.9$, $p<0.001$).

Comparing our results with those reported by previous studies assessing the accuracy of the volumetric measurements of the condyle we found a partial agreement with Kim et al. (2021) who reported an excellent agreement (ICC= 0.988) between the resulting condylar volumes from the CBCT images using the semiautomatic segmentation technique and those obtained from the physical condylar models. On the other side they found that the mean difference between the physical volume and the semi-automatic technique volume was 4.83 ±11.89 mm3 which is way lower than our error values of the semiautomatic segmentation (134.17±74.13)(mm3). This could be explained by the difference in methodological settings where they segmented the condyle from CBCT images of 3D printed model fitted in the skull where the condylar segmentation becomes easier due to the high contrast between the grey values of the 3D model and the surrounding bony structures which is not like the conditions in real situation.

Likewise, **Nicolielo et al. (2017)** aimed to validate a novel 3D segmentation procedure from CBCT and MSCT to objectively quantify both inner and outer condylar remodeling after bimaxillary surgery. They performed a pilot study within their study by segmenting one mandibular condyle and comparing its accuracy against the micro-CT (gold standard). They found that the semiautomatic segmentation from CBCT had a higher volume (1732 mm3) than that from micro-CT (1167 mm3). However, he didn`t mention the mean error which may be due to the use of one mandible. Nicolielo et al. suggested that the overestimation is due to inconsistent selection of the volume of interest. While Kim et al. (2020), in his systematic review which aimed to analyze the reliability and accuracy of methods used for three-dimensional condyle segmentation, clarified that, in contrast to the other utilized gold standards, the micro-CT assesses the interior mineralized bone within the condyle. So, any air space within condylar bone would not be considered in the resulting condylar volume which accounts for the overestimation.

On the other hand, **Giudice et al. (2020**), found no significant differences in the volumetric reconstruction of the condyles between semi-automatic and manual segmentation techniques in their study which aimed to assess the accuracy of 3D rendering of the mandibular condylar region obtained from different semi-automatic segmentation against the manual segmentation technique (gold standard). A large difference exists between our and their assessment method for the difference in the volumes obtained from the manual and semiautomatic techniques where they utilized a third-party software to generate a color-coded map for the deviation analysis that was expressed in the form of matching percentage instead of mean error values.

Another contradiction with our results was reported by **García-Sanz et al. (2017)** who found that the mean difference between the reconstructed volumes from CBCT and the real physical volume (gold standard) was 10 ± 95 mm3 which is noticeably lower than our error values of both manual and semiautomatic techniques, however in their segmentation they utilized a surface model obtained by laser scanning of the condyle to be superimposed over the CBCT render volume to act as reference for the condylar isolation which claims the difference exists in error values with lack of difficulties in condylar delineation and isolation using the regular segmentation techniques either manual or semiautomatic. Moreover, they utilized a smaller voxel size (0.2 mm) which might invite a higher measurement accuracy.

On the other hand, a different study by **Ezz et al. (2023)** examined the accuracy of volumetric measurements from automatic segmentation of the condyle compared to its real physical measurements, and they found that the

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mean physical volume was 1930± 430 mm^3 while that of the CBCT volume was 2270 ± 420 mm^3. Automatic segmentation showed higher condylar volume measurements in comparison to physical measurements with a mean error = 340 mm^3. This finding showed a higher error value than that reported in our study for both manual and semiautomatic segmentation techniques which stands with the assumption of lower reliability and accuracy of the automatic segmentation technique, however further studies are still needed to be able to construct a systematic review for reaching an evidence-based knowledge about the validity and reliability of automatic condylar segmentation.

CONCLUSION

CBCT is an accurate and reliable imaging modality for maxillofacial structures. segmentation. Semi-automated segmentation of the mandibular condyle is a reliable and time-saving segmentation approach that can yield accurate volumetric results compared to manual segmentation.

RECOMMENDATIONS

More studies should be accomplished to assess the semiautomatic technique against a real physical reference. And because of the new era of artificial intelligence, more studies are required to assess its accuracy in mandibular condyle segmentation.

REFERENCES:

1. **Altan Şallı, G., & Öztürkmen, Z**. (2021). Semi-automated three-dimensional volumetric evaluation of mandibular condyles. *Oral Radiol.,* 37(1), 66–73.
2. **Bayram, M., Kayipmaz, S., Sezgin, Ö. S., & Küçük, M. (2012).** Volumetric analysis of the mandibular condyle using cone beam computed tomography. *Eur. J. Radiol*, 81(8), 1812–1816.
3. **Da Silva, R. J., Souza, C. V. V., Souza, G. A., Ambrosano, G. M. B., Freitas, D. Q., Sant'Ana, E., & de Oliveira-Santos, C.** (2018). Changes in condylar volume and joint spaces after orthognathic surgery. *Int J Oral Maxillofac Surg*, 47(4), 511–51.
4. **Elrawdy, A. M., Amer, M. E., Algariah, A. K., Eid, M. H., Abu-Elsaoud, A. M., & Ghoneim, M. M.** (2023). Appraisal of the Accuracy and Reliability of Cone-Beam Computed Tomography and Three-Dimensional Printing for Volumetric Mandibular Condyle Measurements of a Human Condyle. *Cureus*, 15(10).
5. **Engelbrecht, W. P., Fourie, Z., Damstra, J., Gerrits, P. O., & Ren, Y.** (2013). The influence of the segmentation process on 3D measurements from cone beam computed tomography-derived surface models. *Clin. Oral Investig.,* 17, 1919–1927.
6. **Ezz, N., El Rawdy, A., & El-Desouky, G. G. E.-D.** *(2023)*. Accuracy of Cone Beam Computed Tomography in Volumetric Evaluation of the Mandibular Condyle. *DSU*, 4(2), 233–242.
7. **García-Sanz, V., Bellot-Arcís, C., Hernández, V., Serrano-Sánchez, P., Guarinos, J., & Paredes-Gallardo, V.** (2017). Accuracy and Reliability of Cone-Beam Computed Tomography for Linear and Volumetric Mandibular Condyle Measurements. A Human Cadaver Study. Sci. Rep., 7(1).
8. **Giudice, A. Lo, Quinzi, V., Ronsivalle, V., Farronato, M., Nicotra, C., Indelicato, F., & Isola, G.** (2020). Evaluation of imaging software accuracy for 3-dimensional analysis of the mandibular condyle. A comparative study using a surface-to-surface matching technique. Int. J. Environ. Res. Public Health, 17(13), 1–15.
9. **Kim, J. J., Lagravere, M. O., Kaipatur, N. R., Major, P. W., & Romanyk, D. L.** (2021). Reliability and accuracy of a method for measuring temporomandibular joint condylar volume. *Oral Med Oral Surg Oral Pathol Oral Radiol*., 131(4), 485–493.
10. **Kim, J. J., Nam, H., Kaipatur, N. R., Major, P. W., Flores-Mir, C., Lagravere, M. O., & Romanyk, D. L.** (2020). Reliability and accuracy of segmentation of mandibular condyles from different three-dimensional imaging modalities: A systematic review. *DMFR*, 49(5), 20190150.
11. **Lentzen, M.-P., Riekert, M., Buller, J., Grandoch, A., Zirk, M., Zoeller, J. E., & Kreppel, M.** (2022). A volumetric study of mandibular condyles in orthognathic patients by semiautomatic segmentation. *OMS*, 26(2), 205–212.
12. **Librizzi, Z. T., Tadinada, A. S., Valiyaparambil, J. V, Lurie, A. G., & Mallya, S. M.** (2011). Cone-beam computed tomography to detect erosions of the temporomandibular joint: effect of field of view and voxel size on diagnostic efficacy and effective dose. *AJODO*, 140(1), e25–e30.

Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(6), 2716-2723 | ISSN:2251-6727

13. **Nicolielo, L. F. P., Van Dessel, J., Shaheen, E., Letelier, C., Codari, M., Politis, C., Lambrichts, I., & Jacobs, R.** (2017). Validation of a novel imaging approach using multi-slice CT and cone-beam CT to follow-up on condylar remodeling after bimaxillary surgery. *Int. J. Oral Sci.*, 9(3), 139–144.
14. **Sabancı, S., Şener, E., Turhal, R. I., Gürses, B. O., Gövsa, F., Tekin, U., Baltacı, A., Boyacıoğlu, H., & Güneri, P.** (2021). Is Manual Segmentation the Real Gold Standard for Tooth Segmentation? A Preliminary in vivo Study Using Conebeam Computed Tomography Images. Meandros *J. Med. Dent.*, 22(3)
15. **Saccucci, M., D'Attilio, M., Rodolfino, D., Festa, F., Polimeni, A., & Tecco, S.** (2012). Condylar volume and condylar area in class I, class II and class III young adult subjects. *HEAD FACE MED*, 8, 1–8.
16. **Shetty, H., Shetty, S., Kakade, A., Shetty, A., Karobari, M.I., Pawar, A.M., Marya, A., Heboyan, A., Venugopal, A., Nguyen, T.H. and Rokaya, D.,** (2021). Three-dimensional semi-automated volumetric assessment of the pulp space of teeth following regenerative dental procedures. *Sci. Rep.*, *11*(1), p.21914.
17. **Waghmare, M., Pagare, S., Manoj, R., Pinto, J., Bhutani, H., & Shetty, N. K**. (2023). Volumetric Analysis of Mandibular Condyle in a Subset of the Indian Population Using CBCT—A Retrospective Observational Study. *JIAOMR*, 35(3), 363–367.
18. **Xi, T., Schreurs, R., Heerink, W. J., Bergé, S. J., & Maal, T. J. J.** (2014). A novel region-growing based semi-automatic segmentation protocol for three-dimensional condylar reconstruction using cone beam computed tomography (CBCT). *PLoS ONE*, 9(11).
19. **Xi, T., Van Loon, B., Fudalej, P., Berge, S., Swennen, G., & Maal, T.** (2013). Validation of a novel semi-automated method for three-dimensional surface rendering of condyles using cone beam computed tomography data. *Int J Oral Maxillofac Surg*., 42(8), 1023–1029.