Comparison between OPG and CBCT in Posterior Roots Detection and Protrusion into the Maxillary Sinus

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Abstract
Background The maxillary sinus is the most important of paranasal sinuses in dentistry. Objectives This study aims to assess the accuracy and sensitivity of OPG and CBCT in detecting maxillary root protrusion into the maxillary sinus. Materials and Methods 118 dental records of OPG images and CBCT scans were retrospectively collected for patients who attended the Radiological Department, Erbil City, Iraq, for various clinical indications. The included subjects comprised males and females with an age range from (19-45). The topographic connection of the maxillary posterior teeth to the sinus floor was determined using both imaging modalities, in 3 groups, in group 1 the root penetrates the sinus, in group 2 the root contacts the sinus, and group 3 the root below the sinus. Results the majority of roots had penetrated the maxillary sinus, as shown by OPG, and the most frequent root that penetrated the sinus was the mesiobuccal root of the first and second molar. The buccal root of the first premolar was among the most frequent ones while there was no root penetrated the sinus, as shown by CBCT. Out of 254, total roots detected by OPG, 156 (61.4%) were from Group 1, and 98 (38.5%) were from Group 3. While 319 roots had been detected by CBCT, 313 (98.1%) were from Group 3 and only 6 (1.9%) were from Group 2. Conclusion CBCT is superior to OPG in all diagnostic aspects but it is ordered based on vague abnormalities found in OPG.

Keywords: CBCT; OPG; maxillary sinus; posterior roots.

Introduction A perennial difficulty in dentistry has been the anatomic interaction between the teeth and the maxillary sinus, especially for nonsurgical and surgical endodontics as well as for extraction or surgical removal of posterior maxillary teeth (Nedbalski and Laskin DM, 2008). Furthermore, periodontal and periradicular pathologies originating from posterior maxillary teeth may invade the maxillary sinus (Shanbhag et al, 2013). An improved understanding of the relationship between posterior maxillary teeth and maxillary sinus is useful for dentists and oral surgeons who frequently treat patients in this region because the maxillary sinus and the maxillary posterior teeth may be close neighbours, and the oral cavity is located near several other important anatomic structures in the head and neck region.
One of the common issues in dentistry is the detection of posterior root protrusion into the maxillary sinus. Cone beam computed tomography (CBCT) and orthopantomography (OPG) are imaging techniques used in dentistry to evaluate dental structures. The most popular method for determining how the roots of the maxillary posterior teeth relate to the maxillary sinus is panoramic radiography, which enables imaging of anatomical features at a reasonable cost and with a relatively low radiation dosage. However, panoramic radiographs may not be sufficient to examine the interactions between the upper posterior teeth and the maxillary sinus. Since it was first introduced in 1998, CBCT has gained popularity in dentistry for both diagnostic and treatment planning. CBCT is typically favored for clinical applications because of its lower radiation dosage, superior resolution, and quicker scanning time. CBCT uses a cone-shaped beam of X-rays to capture images of the target area, which provides more detailed information about the dental structures. Numerous variables, including age, maxillary sinus size, and maxillary sinus pneumatization, have an impact on the topography of the maxillary sinus floor. Cone beam computed tomography (CBCT) and orthopantomography (OPG) are imaging techniques used in dentistry to evaluate dental structures. The most popular method for determining how the roots of the maxillary posterior teeth relate to the maxillary sinus is panoramic radiography, which enables imaging of anatomical features at a reasonable cost and with a relatively low radiation dosage. However, panoramic radiographs may not be sufficient to examine the interactions between the upper posterior teeth and the maxillary sinus. Since it was first introduced in 1998, CBCT has gained popularity in dentistry for both diagnostic and treatment planning. CBCT is typically favored for clinical applications because of its lower radiation dosage, superior resolution, and quicker scanning time. CBCT uses a cone-shaped beam of X-rays to capture images of the target area, which provides more detailed information about the dental structures. Numerous variables, including age, maxillary sinus size, and maxillary sinus pneumatization, have an impact on the topography of the maxillary sinus floor. CBCT enables 3-dimensional cross-sectional imaging, removing superposition and distortion. CBCT uses a cone-shaped beam of X-rays to capture images of the target area, which provides more detailed information about the dental structures. Numerous variables, including age, maxillary sinus size, and maxillary sinus pneumatization, have an impact on the topography of the maxillary sinus floor. CBCT enables 3-dimensional cross-sectional imaging, removing superposition and distortion.

Histological investigations showed that most radiographically projecting roots into the sinus are rarely covered by a thin layer of cortical bone, with true mucosal perforations being discovered in 14–28% of the studied samples. Therefore, it is evident that when considering dental implants, extractions, endodontic treatment, or orthodontics in the posterior maxilla, a comprehensive analysis of the maxillary sinus topography should be performed. Several studies have compared the accuracy of OPG and CBCT in detecting posterior root protrusions in the maxillary sinus. A study conducted by Ramesh et al. (2016) compared the accuracy of OPG and CBCT in detecting posterior root protrusions in the maxillary sinus. Another study by Kim et al. (2018) compared the accuracy of OPG and CBCT in detecting root perforations in the maxillary sinus. According to the research stated above, CBCT has a better detection rate for posterior root protrusions in the maxillary sinus than OPG. A significant tool in diagnosing, planning, and monitoring numerous dental diseases, CBCT gives more in-depth information on dental structures. However, because CBCT has a higher radiation dose than OPG, it should only be used in situations where the advantages outweigh the risks (Nino-Barrera et al., 2018). In view of the aforementioned considerations, the current study aims to provide a reason for making decisions regarding the necessity of pre-operative CBCT scans before any dentoalveolar operation in the posterior maxilla. To identify whether panoramic radiographic indications, if any, may warn for real protrusion of dental roots.
into the sinus cavity, our goal was to evaluate the accuracy of panoramic radiography against that of CBCT.

Materials and Methods
Sample selection
This study was conducted on (118) dental records of OPG images and CBCT scans for patients who attended the Radiological Department, Erbil City, Iraq, for various clinical indications including implant planning, trauma, assessment of impacted upper wisdom teeth with root or crown in or close to the maxillary sinus, impacted canine, odontoma, pathological conditions, and other dental problems. The selected subjects comprised males and females with ages ranging from (19-45) regardless of social class or other socioeconomic characteristics.

Study design
Fifty-nine patients had 59 OPG and 59 CBCT.

Inclusion criteria
1. The presence of maxillary posterior teeth (premolar and molar) and third molar is not taken into consideration.
2. Any patient who has had both OPG and CBCT which were taken for pathology, implant, impacted teeth, or surgical purposes.
3. No history of surgical intervention at the maxillary sinus or periapical surgery for the maxillary posterior teeth.

Data collection
All OPG and CBCT that were archived for the diagnosis impacted canine, upper wisdom teeth, and implant planning were involved in this study.

Image analysis
Images were selected considering a high-level standard technique (i.e. appropriate sharpness, density, and contrast), that clearly shows the maxillary posterior teeth apices and the sinus floor in both OPG and CBCT. In OPG The distance from each root of the first and second premolars and the first and second molars to the sinus floor was measured in mm. This vertical relationship between the sinus floor and the roots was classified according to (Sharan and Madjar 2006) creating some modification into three groups as follows:

Group 1: The roots penetrate the sinus floor (the measurement score was in minus degree).
Group 2: The roots contact the sinus floor (the measurement score was in zero).
Group 3: The roots extend below the sinus floor (the measurement score was in a positive degree).

In CBCT image analysis was selected from different views (coronal and sagittal) and the measurement of the sinus floor distance to the apical end of the posterior teeth roots was done for each root in mm distance.

Ethical consideration
All the OPG and CBCT were respectively collected.

Statistical analysis
All measurements were entered and analyzed using Statistical Package for Social Sciences (SPSS software version 19). Variable were presented as mean, SD and percentages. Univariate analysis of variance (ANOVA) was also conducted to compare between genders. t-test for the differences which were considered statistically significant when P values were less or equal to 0.05.

Results
All data in table1 showed no differences in the detection of the buccal root of the 1st premolar by both devices (OPG and CBCT), while in dealing with the palatal root of the same tooth OPG detects only 8 roots in comparison to 19 roots had been detected by CBCT so the percentage error in OPG was (57.8 %) as shown in Table 2. There were no differences in 2nd premolar roots detection, both OPG and CBCT showed that there were 4 teeth with double roots and 33 with single roots. Both devices
detect the MB root of 1st molar, while there were differences in the detection of the other (DB&P) roots. OPG detected 36 DB roots while CBCT detected 37 roots, for palatal roots OPG detected 20 roots while CBCT detected 37 roots. The percentage errors by OPG were (2.7%, and 45.9%), respectively. For the 2nd molar there were differences in the detection of all roots by OPG (MB34, DB31, P10) and the percentage errors were (MB 8.1%, DB 16.2%, and P 73%) as shown in Table 2. The data analysis by t-test for the variance between OPG and CBCT in the estimation of root detection for upper posterior teeth showed high significant difference as a P value < 0.01. Table 3 showed classification according to three groups, concerning the root protrusion into the maxillary sinus, it was clear that the majority of roots had been penetrated the maxillary sinus by OPG and the most frequent root that penetrated the sinus was the MB root of the first and second molar, and the buccal root of the first premolar was between the most frequent one while there was no root penetrated the sinus by CBCT. Out of 254, total roots detected by OPG, 156 (61.4%) were Group 1, and 98 (38.5%) roots were Group 3. While 319 roots had been detected by CBCT, 313 (98.1%) were group 3 and only 6 (1.9%) were Group 2. (Table 4).

Table (1): Data analysis of root detection in maxillary posterior teeth by both OPG and CBCT.

Table (2): Percentage error of root detection by OPG in comparison to CBCT.

Table (3): Vertical relationship between maxillary posterior roots and maxillary sinus floor shows roots protruded into maxillary sinus by both OPG and CBCT.

Table (4): Percentages of total number of roots according to the three groups by both OPG and CBCT.
Discussion
In dentistry, it is crucial to compare OPG with CBCT for posterior root detection and protrusion into the maxillary sinus. The precise number of roots that protrude into the sinus might vary significantly depending on the patient as a whole and the clinical situation. Furthermore, several variables can affect the sensitivity and accuracy of OPG and CBCT in detecting root protrusion, including the caliber of the imaging technology, the patient’s positioning, and the knowledge and skill of the clinician interpreting the images. A study by Ramesh et al, (2016), found that the sensitivity and specificity of OPG were relatively low compared to CBCT, while Kim et al, (2018) reported higher sensitivity for OPG but still found CBCT to be more accurate in detecting root perforations in the maxillary sinus. Also, higher sensitivity and specificity for CBCT in detecting maxillary sinus involvement by periapical lesions compared to OPG reported by Chrcanovic et al, (2020). The fact that CBCT exposes patients to a larger radiation dose than OPG does, despite offering more precise information about the dental structures, must be noted. As a result, practitioners should only employ CBCT in situations where the advantages outweigh the dangers, and they should follow the As Low As Reasonably Achievable (ALARA) concept whenever doing so. The study showed differences in root detection between OPG and CBCT. Both devices detected the same number of roots for the second premolars, the buccal root of the first premolar, and the mesiobuccal root of the first molar. There were differences in observation of other roots between OPG and CBCT with a percentage error by OPG; (57.8%) for the palatal root of the first premolar and (73%) error for the palatal root of the second molar (Table 2). This study reported that both maxillary first and second molars 100% had three roots and these results agree with those of Ng et al, (2001) and Alavi et al, (2002), which showed 100% of maxillary first and second molars of the Burmese and Thai populations, had three roots. The results disagreed with those of (Al Shalabi et al, 2000) who reported that 97.6% of maxillary first molars in an Irish population had three roots and 2.4% had two roots. In the Indian population, 96.8% of maxillary first molars and 93.1% of maxillary second molars had three roots. According to the results of this study, 156 (61.4%) out of 254 roots seemed to penetrate the maxillary sinus and 98 (38.5%) were below the sinus floor on panoramic radiography, CBCT showed no root penetration into the maxillary sinus, with 313 (98.1%) out of 319 roots seemed to be below the sinus floor and only 6 (1.9%) were in contact with the maxillary sinus floor. These results agreed with Sharan and Madjar, (2006), who used panoramic and cross-sectional computed tomography.
imaging to examine the relationship between the topography of the maxillary sinus and the roots of adjacent posterior teeth. In addition, they concluded that no vertical protrusion into the sinus was seen in CT scans for the bulk of the roots that were shown protruding onto the sinus cavity in panoramic radiography. Ali et al, (2012) compared topographic relationships by panoramic and CT, they revealed and that roots that were reported to be projecting into the sinus cavity on panoramic radiography may not have been there on CT scan examinations. On the other side, Lopes et al, (2016) and Terlemez et al, (2019) found that panoramic radiography yielded a higher proportion of root tips seen in the sinus than CBCT. The study findings disagree with that of (Shukla et al, 2014) who concluded that roots that did protrude into the sinus on the CT revealed a protrusion length that was significantly shorter than what was seen in panoramic radiography. Moreover, the study results disagree with those of (Eberhardt et al, 1992; Sharan and Madjar 2006; and Kilic et al, 2010) who concluded that the sinus floor did not contact the roots of the molars. These results are explained by a 2-dimensional panoramic radiograph, which allows the roots that are buccal/lingual to the sinus to be projected on the sinus chamber, may provide an explanation, superposition of anatomic structures, magnification in both the horizontal and vertical axes and a dearth of cross-sectional data are all factors in panoramic radiographs (Sharan and Madjar, 2006). The main focus of the available literature on the relationship between maxillary teeth roots and the maxillary sinus was based on CBCT alone (Jung and Cho 2012; Pagin et al, 2013), which makes it difficult to compare with their findings. Jung and Cho, (2012), performed evaluations for the first and second molars and found that the root protruding into the maxillary sinus was most frequent in the buccal roots of the molars. Pagin et al, 2013, evaluated the relation of 601 posterior teeth roots with the maxillary sinus floor using CBCT by measuring the vertical relationship between molar roots and maxillary sinus floor type, they revealed a high prevalence of type 2 (the inferior wall of the sinus is located below the level connecting the buccal and palatal root apices, without an apical protrusion over the inferior wall of the sinus), followed by type 1 relationship (the inferior wall of the sinus is located above the level connecting the buccal and palatal root apices). Few studies examined each root of maxillary posterior teeth, as in our study. Ok, and colleagues found that the maxillary first premolars have no relationship with the maxillary sinus floor, but the maxillary second molars were closer to the sinus floor (Ok et al, 2014). Roque et al, showed that CBCT and panoramic radiographs findings were poorly correlated when roots were in contact or within the maxillary sinus floor (Roque et al, 2015). Projection of the root onto the sinus cavity was a strong indicator of an invaded maxillary sinus. It has long been debatable whether there is actual root protrusion whether these pictures are the consequence of the X-ray beam being in a negative position or the fact that panoramic radiography is bi-dimensional. Furthermore, the results presented in the study showed that, despite the relative lack of accuracy of panoramic radiography, it is still an invaluable tool to determine whether one should ask for a pre-operative CBCT scan. The use of panoramic radiography as the principal imaging modality for the majority of routine treatments in the posterior maxilla firmly supports the surgeon always weighing the risks and advantages of CBCT’s greater radiation dosage and expense.

Conclusions
Although panoramic radiography is a helpful and affordable diagnostic technique. Compared to CBCT imaging, panoramic radiography might lead to unreliable diagnoses as it showed a high percentage of error for examination and detection of maxillary posterior root numbers and a high frequency of root protruding into the maxillary sinus by panoramic radiography. CBCT is superior to OPG in all diagnostic aspects but it is ordered based on vague abnormalities found in OPG.
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Comparative Evaluation of Surface Hardness and Accuracy of 3D-Printed DLP Model Resin Materials

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Abstract

Background It seems that the effect of three-dimensional DLP printing parameters on the surface hardness of printed model resins is neglected. Objectives The objective of the present study is to investigate and assess the surface hardness and dimensional accuracy of two different DLP model resin materials printed using one 3D printer machine. Materials and Methods Two different DLP 3D-printing resins were used to prepare a total of 20-disc specimens of (20×5)mm diameter and thickness respectively of (SENERTEK, Turkey), and (HARZ Labs, Russian) in addition to (CREALITY, China) as a control group (n=10). All specimens were printed using one 3D printer (CREALITY, HALOT, China) followed by the measuring of surface hardness (Shore D, China) and dimensional accuracy (Digital Vernier, China). Results ANOVA (Tukey HSD, post hoc) test was used for data analysis at a significant level of (P≤0.05). There was a significant difference in the surface hardness and dimensional accuracy of studied 3D-printed DLP model resins (P≤0.05). Conclusion Compared with CREALITY resin, the highest surface hardness was noticed in the experimental group of HARZ Labs followed by SENERTEK DLP model resins. All the DLP 3D-printed resin materials used in this study showed unstable dimensions when printed using the CREALITY HALOT printer machine.

Keywords: 3D printing; DLP; Surface hardness; Model Resin material.

Introduction

Additive 3D printing is one of the Computer-aided design-Computer aided manufacturing (CAD/CAM) digital concepts and it attracted more attention than the milling technique due to some advantages (Prasad et al, 2018; Kraemer Fernandez et al, 2020; Baba et al, 2021). These benefits include reduced material loss, no milling burs wear, and an easily reproducible prosthesis with precise features. Due to 3D printing production for more complicated shapes, the design possibilities are not limited (Reymus et al, 2020; Gad et al, 2022). 3D printing has been rapidly introduced and developed in medical and dental field due to applicable accuracy and reliability. The applications of 3D printing products were used in many aspects of health care including medical and dentistry devices (Revilla-León and Özcan, 2019; Jawahar and Maragathavalli, 2019; Baba et al, 2023). This method provides quick conversion of digital files of 3D models into physical items by first creating an STL (standard triangulation language) format and then printing 3D small-volume elements.
by either connecting, bonding, or polymerizing them (Prasad et al, 2018). Many variables must be controlled during the 3D printing process. Mechanical properties are influenced by the printed layer, thickness, the deepness of polymerization, shrinkage volume, and the volume and angle of the light source (Puebla et al, 2012). Understanding the numerous factors that determine the quality of the 3D printing product is crucial (Puebla et al, 2012; Coon et al, 2016; Ţălu, 2022). The most widely used 3D technologies in dentistry are Stereolithography (SLA), digital light projection (DLP), then fused deposition modelling (FDM), powder bed fusion (PBF), followed by laser powder forming and inkjet printing (Barazanchi et al, 2017; Akhila et al, 2019; Alshamrani et al, 2022). The main differences between the processes are the materials used and how the layers are joined to create the 3D object. However, SLA and DLP are the two most common 3D printing technologies in dental applications. SLA, which was first used for 3D systems in 1986, is a photopolymerization technology that uses a bath of photosensitive liquid resin and laser or an ultraviolet (UV) light to harden the material. This is to build up solid parts on a model-building platform in the form of multilayers (Alharbi et al, 2017; Pagac et al, 2021; Gad et al, 2022; Aati et al, 2022). This method’s layers are cured and joined to form a solid item. Whereas in the DLP 3D printing technology, the photopolymer resin is cured with a digital light projector rather than a laser (Kessler et al, 2020). DLP technology is comprised of a light-emitting diode (LED) that is projected as individual pixels throughout the entire projection surface layer, causing simultaneous curing (KEßLER et al, 2021; Unkovskiy et al, 2021). A liquid-based prototype system is constructed from the stereolithography file’s cross-sectional data (STL). This is the industry specification that all RP technologies must adhere to. The prototype model is constructed in a vat of photocurable resin on a platform which is lowered to a depth adequate for laser penetration just below the resin’s surface. The model is built in stages by using UV-emitting lasers to scan and cure the liquid surface of the photopolymer. The cross-section outlines are scanned first, followed by a hatch pattern scan to fill in the gaps. Photoinitiated polymerization produces a solid layer. The platform is then lowered to the previous depth beneath the resin surface, allowing one layer of resin to be swept across and scanned. The resin in liquid form provides no structural support, so supports must be constructed to support overhanging portions. Following the printing process, the model is approximately only cured up to 95% and is referred to as ‘green’. The product must next be cleaned with a chemical isopropanol bath and post-cured by being exposed to broad-spectrum UV radiation (Bletcher, 2016). DLP 3D printing is faster than traditional SLA because it prints and cures a single layer in seconds across the entire build plate. DLP has another benefit over SLA and other 3D printing technologies is that it consumes less material, lowering production costs. In the dentistry sector, DLP printing is currently being used to manufacture surgical guides, castable restorations, splints, and even interim crowns all made using digital imprints. DLP printing’s application in dentistry is projected to increase due to its speed and accuracy. However, there have been few studies examining the surface and mechanical properties of 3D-printed resin materials in dentistry, including surface hardness and accuracy. As a result, the production method, as well as the strength and polymerization ratio, are areas that demand additional investigation. Several factors, including accuracy, strength, printing speed, and layer thickness, may improve the dependability of 3D-printed materials for clinical and dental applications (Alharbi et al, 2016; Tahayeri et al, 2018; Shim et al, 2020), as well as curing procedures (Li et al, 2016; Osman et al, 2017). According to researchers, printing resin types, processes, and settings are all elements that influence the qualities of printed products (Tian et al, 2021). Oral structures and restorative materials are affected by their environment, and the oral environment is particularly problematic which
can affect material qualities (Hao et al., 2018, Szczesio-Wlodarczyk et al., 2020). Following printing, the photopolymerized resin is cured in a UV light source. Some resins require post-processing light-curing treatment. This is used to cross-link unreacted monomers and finish the polymerization process after printing (Shumkov et al., 2020; Barragán-Paredes et al., 2021). The post-curing technique is intended to improve the mechanical properties of the printed object (Al-Dulaijan et al., 2022; Alshamrani et al., 2022) to ensure complete and uniform polymerization enhancing mechanical strength which improves the final mechanical properties (Reymus et al., 2019). The time required for the post-curing operation varies based on the photopolymerized 3D-printed resin and the parameters of the manufacturer. It is also significantly different from 3D printing to post-curing devices (Shin et al., 2018; Wu et al., 2019). The degree of conversion quantifies the quantity of polymerization (DC). As a result, higher DC improves mechanical characteristics and biocompatibility significantly (Perea-Lowery et al, 2021; Dantagnan et al., 2023). Many studies investigated different post-curing equipment resulting in significant mechanical differences in the final printed products (Reymus et al., 2019; Reymus et al., 2020; Perea-Lowery et al, 2021). A power analysis was not performed since no prior knowledge of the impact of the production method and storage conditions on 3D-printed dental cast dimensional accuracy and stability was available. As a result, greater research into the manufacturing process, including printing conditions and their impact on the mechanical properties of 3D-printed DLP material is required. Understanding how different parameters affect the mechanical characteristics of printed materials can assist in enhancing the quality and performance of dental restorations in regular application. 3D printing material selection for dental performance is determined by the end product’s intended application. The restorative materials must have strong mechanical qualities and extended biodegradation rates.

**Materials and Methods**

The disc-shaped specimen dimensions of 20×5mm diameter and thickness respectively were used to evaluate the surface hardness and dimensional accuracy (ISO 4049:2019), (Reymus and Stawarczyk, 2020). EXOCAD software system was used to design the disc specimens for 3D-printed resins (Yu et al, 2023). The STL file then exported to a 3D printing machine (DLP-CREALITY, HALOT, China). The model printing supports were produced automatically at the bottom of the disc-shaped specimens with 0.8mm tip diameter, 1.2mm support diameter, 0.50 density, and 6.0mm height. In the DLP printer’s build platform, this configuration was reproduced ten times, and ten identical specimen setups were created, Figure (1). To print all specimens in the same configuration, this design was saved and retrieved again to print the specimens in identical dimensions but with different study resin materials, Figure (2). After removing the printing support structures, the bottom-base surfaces of the specimens were ground with silicon carbide paper (800, 1500, and 2000 grit) and cleaned with alcohol as recommended by de Camargo et al., (de Camargo et al., 2021). The specimens were then post-cured using a light-cure unit for 4min (Silver Crest, Germany). Before the testing procedure, the specimens’ dimensions and surface integrities were examined and stored in dark boxes for 48h at room temperature (25±1°C), Figure (3). For the hardness value, a Shore D (Shanghai, China) was used. A pyramid-shaped diamond indent was used to indent each specimen with a 50g force and a 30-second dwell duration at three different places per specimen, followed by average calculations (Aati et al, 2022), Figure (4). While the dimensional accuracy was measured using a digital vernier (China). One-way ANOVA (Tukey post-hoc Test, HSD) (SPSS-V23) was used to statistically analyze the data of surface hardness and dimensional accuracy. All p-values considered statistically significant at less than 0.05.
Results
Generally, there was a significant difference in the surface hardness of studied 3D-printed DLP model resins in terms of top finish and bottom base surfaces (P≤0.05). Furthermore, there was a significant difference in the surface hardness between both the top finish and bottom base surfaces of each SENERTEK and HARZ Labs and that of CREALITY DLP model resins, Figure (5) and Table (1). The highest mean value of the surface hardness test was in the top finish and bottom base surfaces of the experimental group.
of HARZ Labs followed by SENERTEK DLP model resins. In terms of thickness accuracy, the experimentally SENERTEK and HARZ Labs DLP model resins showed significant differences in the thickness accuracy in comparison to that of CREALITY as a control group (P≤0.001), Figure (6) and Table (2). However, concerning diameter accuracy, non-statistically significant differences were reported between the studied groups (P>0.05), except between that of HARZ Labs and CREALITY model resin which shows a significant difference (P≤0.05), Figure (7) and table (3).

Table (1): ANOVA (post-hoc, Tukey) test shows the surface hardness of the 3D-printed study model resins

<table>
<thead>
<tr>
<th>Model Resin</th>
<th>Surface</th>
<th>Mean Difference</th>
<th>Std. Error</th>
<th>P Value</th>
<th>Sig.</th>
<th>95% Confidence Interval Lower Bound</th>
<th>Upper Bound</th>
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<td>Top Finish Surface</td>
<td>CREALITY</td>
<td>-3.03300</td>
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<td>0.000</td>
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<td>2.60053</td>
<td>0.0462</td>
<td>0.000</td>
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<td>-3.9352</td>
<td>9.1361</td>
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<tr>
<td></td>
<td>HARZ Labs</td>
<td>-1.3107</td>
<td>0.0451</td>
<td>0.000</td>
<td>S</td>
<td>-2.9263</td>
<td>0.2959</td>
</tr>
<tr>
<td>Bottom Rake Surface</td>
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<td>0.000</td>
<td>S</td>
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Table (2): ANOVA (post-hoc, Tukey) test shows the thickness of the 3D-printed study model resins

<table>
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<th>Std Error</th>
<th>P-Value</th>
<th>Sig</th>
<th>95% Confidence Interval Lower Bound</th>
<th>Upper Bound</th>
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<td>0.0001</td>
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<tr>
<td>HARZ Labs</td>
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<td>0.001</td>
<td>0.001</td>
<td>S</td>
<td>-0.0001</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Figure (6): Bar Chart showing the mean distribution of specimens’ thickness of 3D-printed study model resins

Figure (7): Bar Chart showing the mean distribution of specimens’ diameter of 3D-printed study model resins

Table (3): ANOVA (post-hoc, Tukey) test shows the diameter of the 3D-printed study model resins

Discussion
The dental research community has been interested in additive technology because of the potential usage of digital applications in dentistry. As a result, comprehending the mechanical properties of the newer DLP 3D-printing model materials is essential for verifying the claims by the manufacturer, and for comparing them with conventional materials. Numerous factors might determine the quality of 3D-printed products. Different variables might affect the mechanical properties of the 3D-printed objects such as polymerization depth, layer thickness, amount of
shrinkage, and the volume or light source angle (Puebla et al, 2012; Coon et al, 2016; Ţălu, 2022). The top finish and bottom base surfaces of HARZ Labs of DLP 3D-printed specimens model resin of show higher hardness followed by SENERTEK compared to that of CREALITY as a control group. Yet, there was a lesser surface hardness in the bottom base surfaces than the top finish surfaces of SENERTEK, HARZ Labs, and CREALITY respectively. The highest mean value of the surface hardness test was in the top finish and bottom base surfaces of the experimental group of HARZ Labs followed by SENERTEK DLP model resins. This might agree with a few studies they found that the post-printing curing could improve the mechanical properties of the printed resins (Al-Dulaijan et al, 2022; Alshamrani et al, 2022). It seems that the flashlight or UV light device indicates a higher degree of conversion in addition to the postpolymerization period that might have positively influenced the tested specimens. The emitting wavelength spectra of the postpolymerization UV devices may vary substantially. Since the flashlight operation mechanism has the largest spectrum, this could imitate a higher number of photoinitiators. This could explain why UV light devices despite their shorter operating duration produced better results (Reymus et al, 2020; Reymus et al, 2019). Significant differences also were between the tested post-photopolymerization specimens in terms of thickness and diameter dimensional parameters. An increase in the thickness was noticed within the SENERTEK and HARZ Labs DLP model resin specimens in comparison to the CREALITY control group. However, concerning specimen diameter, no differences were reported between the studied groups except in HARZ Labs which shows less discrepancy in diameter. Products created with 3D printing are built up layer by layer. The adhesive is important for the mechanical properties of all resin-based products. DLP printers polymerize each layer on the bottom of a resin-filled vat. As a result, the polymerization occurs in the absence of oxygen, and no oxygen inhibition layer may interfere with the attachment of the two layers. Consequently, additively made products exhibit a high degree of conversion immediately after the printing process, which is further enhanced by the use of postpolymerization equipment (Reymus et al, 2019; Reymus et al, 2020).

Conclusions
From using the CREALITY HALOT 3D-printer machine for DLP model resin, the following was concluded:
1. The higher surface hardness was in the top finish and bottom base surfaces of HARZ Labs followed by SENERTEK DLP model resins.
2. An increase in the DLP resin specimen thickness was reported in SENERTEK and then HARZ Labs compared to CREALITY resin.
3. The less diameter discrepancy was in HARZ Labs specimens compared to SENERTEK and CREALITY DLP model resins.

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The Use of Mini-implants for the Fixation of Bilateral Mandibular Fractures

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Abstract

Background
Closed reduction and open reduction with internal fixation (ORIF), bars and eyelet wiring are among the common MMF techniques. However, these techniques have their limitations, such as time consumption when placing it and the patient’s uncomfortable. And arch bar technique causes movement of teeth in lateral and extrusive directions, constant traction applied to the wire can distract the fracture parts and possibly cause complications, difficulty to secure the arch bar in isolated posterior teeth, periodontal tissue injury, needle stick type of injuries to the operator, difficulty in maintaining good oral hygiene. Objectives In this case report a bilateral mandibular fracture was treated with mini-implants will be presented and discussed. Materials and Methods Thirty-two-year-old male patient attended the Department of Maxillofacial Surgery Center at Al-Wasiti Teaching Hospital, with 10 days history of a mandibular fracture due to trauma to the anterior region. Results During surgical planning, a decision was made of placing mini-implants originally designed for orthodontic anchorage systems between 13 and 14, 23 and 24, 33 and 34, 43, and 44, After intraoral incisions, these fractures were fixed with an L-shaped 4 holes 2.0 mini-plate and mono-cortical screws inserted in the tension region, followed by suturing of the incisions with silk suture size 0/3. Conclusion The mini-implant MMF technique is easy to perform does not require special expertise and is more convenient for the patient.

Keywords: Bilateral mandibular fractures; intermaxillary fixation; mini-implants.

Introduction
Mandibular fractures are the most common type of facial trauma (Murray, 2013). They account for about 60% of facial trauma because of mandibular bone prominence and relative lack of support (Murray, 2013). Treatment of mandibular fractures depends on the type, severity, and location of the fractures. Accordingly, there are two approaches for the reduction and fixation of mandibular fractures; closed reduction and open reduction with internal fixation (ORIF) (Coletti et al, 2007). Both techniques require initial maxillary-mandibular fixation (MMF) to ensure optimum reduction. Arch bars and eyelet wiring are among the common MMF techniques. However, these techniques have...
their drawbacks. These drawbacks are related to their difficulty in application and their influence on patients’ comfort, operation time, and tissue health (Baurmash et al., 1988; Lello and Lello, 1988). Recently, the use of orthodontic mini-implants has been suggested as an alternative MMF method in the management of mandibular fractures (Busch, 1994). This case report aims to demonstrate the use of mini implants in bilateral mandibular fracture.

Case report
A thirty-two-year-old male attended the Department of Maxillofacial Surgery Center at Al-Wasiti Teaching Hospital in Baghdad/Iraq. He had a bilateral mandibular fracture due to trauma to the anterior region as a result of a car accident 10 days ago. He has no history of systemic diseases, he is a heavy smoker, though. Clinical examination showed poor oral hygiene with multiple carious teeth, with mild periodontitis. The fractures involved the parasymphysial region with mild mobility. There was a stay-wire on the left side extending from #30 to 34 and #41 to 44 (Figure 1). The patient’s CT scan revealed a fracture line extending obliquely from the upper border of the mandibular arch between #31 and 32 (Figure 2) to the lower border of the mandible. Another fracture line was also shown extending obliquely at #42 and 43 (Figure 3). After examining the panoramic radiograph for the patient, a decision was made to position four mini-implants originally designed for orthodontic anchorage systems (Vector™ Ormco Corporation, West Collins, Orange, CA, USA) with a diameter of 2 mm and a length of 10-12 mm was chosen for the initial fixation. These implants were placed between 13 and 14, 23 and 24, 33 and 34, and finally, between 43 and 44 (Figure 4). A 2mm diameter and 10 mm length, self-tapping implants were placed, with torque resistance up to 25 Newton-Centimeter (N-cm) according to the manufacturer’s instructions (Schneider et al., 2000). The chosen mini-implants were made of Titanium (Coletti et al., 2007). Four orthodontic mini-implants After their placement in the fractured area, After intraoral incisions Fractures were fixed with an L-shaped 4 holes 2.0 mini-plate and mono-cortical screws inserted in the tension region (Figure 5) followed by suturing of the incisions with silk suture size 0/3 (Figure 6). The patient was instructed to continue with a non-chew diet postoperatively to reduce the bite force on the fracture sites. Oral hygiene measures included using a mouth rinse solution twice daily for ten days and using tooth brushing daily after each meal and before going to sleep. Clinical examination to assess the status of oral hygiene and following instructions by the patient, the healing status of fractures, and tooth occlusion during the healing period.

Figure (1): Placing wire on the left extends from 30 to 34 and 41 to 44.
Figure (2): CT scan revealed a fracture line extending obliquely from the upper border of the mandible arch between 31 and 32.
Figure (3): CT scan shows fracture line extending obliquely 42 and 43.
Figure (4): mini screws between 13 and 14, 23 and 24,33and 34, 43and44.
Figure (5): L-shaped 4 holes 2.0 miniplate and monocortical screws.
Figure (6): Suturing the incisions with silk suture size 0/3.
Discussion
The Maxillary Mandibular fixation technique has been a well-known fixation technique for many years (Sinbel et al, 2015). However, they have their problems. These problems include being time-consuming during placement; the patient being uncomfortable; lateral movement of teeth in lateral and extrusive directions when using the arch bar; constant traction applied to the wire can distract the fracture parts (Baurmash et al, 1988); difficulty to secure the arch bar in isolated posterior teeth; periodontal tissue injury; needle stick type of injuries to the operator; and difficulty in maintaining proper oral hygiene (Lello and Lello, 1988). In our case report, orthodontic mini-implants were used for MMF because of easy application, improved patient tolerance, well mechanical performance, low cost, and less trauma to the buccal Mucosa, and they are easily maintained with simple oral hygiene measures. Compared to other MMF techniques they reduce surgical time, and provide reasonable occlusal stabilization. The material for the mini-implant screws was titanium for strength and biocompatibility. They are self-tapping and inserted using a screwdriver. Self-tapping eliminates overheating of the surrounding bone during the drilling process (Cornelius and Ehrenfeld, 2010). The decision to use mini-plate as MMF, in this case, was based on easiness of placement, cost-effectiveness, and better patient tolerance. Furthermore, the placement of screws helps to stabilize occlusion for placement of rigid internal fixation by mini-plate (Uemura et al, 2012; Cornelius et al, 2010), and screws are better for maintaining good oral hygiene without causing trauma to soft tissues, with time patient does not recognize them (Wiechmann et al, 2007).

Conclusion
Mini-implant MMF technique is easy to perform, does not require special expertise, and is more convenient for the patient.

References


The Oral Ulcer Types Associated with eNOS Genotyping in Systemic Lupus Erythematosus

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Abstract

Background Oral ulcer (OU) is considered one of the systemic lupus erythematosus (SLE) types, Oral manifestations in different ages: children, adults or older in both genders males and females. Objectives The current investigation aims to associate oral ulcer types with eNOS SNP (rs1799983) genotyping in systemic lupus erythematosus (SLE) types. Materials and Methods The Current research covered 51 SLE with Juvenile JSLE patients of different ages for both sexes which were divided into two subgroups with oral ulcers and without oral ulcers. Genomic DNA extracted from whole blood. Results The results show a high percentage of patients have buccal OU (44.44%). A low percentage was observed on the floor and lip (5.55%) respectively. Non-significant associations were found among Thymine- Guanine (TG), Guanine- Guanine (GG) (P= 0.214) and Thymine-Thymine (TT) (P= 0.8292). The allele frequency shows that the G allele was more frequent in SLE with or without OU. The association of rs1799983 genotypes with OU sites shows that TG was more observed in the buccal and palatal in about (66.66%). The GG observed in all OU sites, is more frequent in the tongue (66.66%). The TT was observed only in the buccal (16.66%). The pain of OU is not affected by rs1799983 genotyping. Only the TT (10%) was found with the non-painful OU. The oral ulcer number shows that TG was observed in (57.14%) in single OU and (50%) in multiple OU. The GG found low in the multiple OU (37.5%). The TT was found in the multiple OU (12.5%) only. Conclusion The current study didn’t find an association between eNOS in the Single Nucleotide Polymorphism SNP rs1799983 and types of oral ulcers.

Keywords: Oral ulcer; types; eNOS genotyping; systemic lupus erythematosus.
Introduction
Oral Ulcer (OU) is one of the SLE oral manifestations encountered (Rutter-Locher et al., 2017). Several clinical findings of oral ulcers present in the JSLE (Rodsward, et al, 2017). SLE is registered as a chronic autoimmune disorder which is described by heterogeneity in clinical findings with disease participation. (Narváez et al, 2020; Kiriaikidou et al, 2020). SLE etiology was associated with different genetic criteria (Hameed et al, 2021). Its etiology is obscure, but some be tangled in triggering SLE are evident in its physiology and pathology, which include genetic, epigenetic and environmental factors (Fortuna et al, 2013; Weinstein, et al, 2021). Nearly twenty present of SLE are noticed in pediatrics and adult, who were aged eleven and twelve years (Tarr et al, 2015). (The oral ulceration, raised keratotic plaque, honeycomb plaque, purpura, nonspecific erythema, and cheilitis are also considered as main symptoms of SLE (Chi et al, 2010). Evidence found about 25% of SLE cases suffered from lip involvement and oral mucous membrane with petechiae possibility. The patients with hyposalivation and xerostomia lead to oral ulcerations, dental caries and recurrent noninfectious pharyngitis. Because of SLE treatment by corticosteroid oral infection like candidiasis is also common (Atherley and Taylor, 2012). Chiefly, Oral ulceration is documented to be noticed in persons with SLE (Tsokos, 2011), with a predominance proportion (7 - 41%), found to be more severe as the progressive disease (Rhodus and Johnson, 1990). Others found (8–45%) of oral lesions in SLE (Schiodt, 1984). In an early study, Rhodus and Johnson, (1990) found oral lesions in a high prevalence in SLE cases, including ulcers, mucositis, angular cheilitis, and glossitis. A high predominance of oral complaints like soreness in the tongue and sexual disorders. (Paula García-Ríos et al, 2022) reported many clinical manifestations of oral ulcers, cheilitis, pigmentation, decrease in saliva flow, cleft of tongue mucle, glossodynia, arthritis, and 2ndray Sjogren s syndrome. Evidences studied the association of oxidative stress and oral ulcer in different diseases like SLE using pro-oxidant-antioxidant balance method (Jafari et al, 2016; Hassan et al, 2011). The eNOS has produced an important nitric oxide (NO) (Shamsi et al, 2010). That considered as free radicals of membrane-preamble which was architected as substrates by 3 nitric oxide synthesis (NOS) isoforms by oxygen and arginine (Tasoko, 2011). Among the eNOS effeteness had been identified as fundamental line endothelial cell physiology .coagulation and leucocytes adhesion and blood pressure continuance (Sing et al, 2010). Other researchers are pointed for decreasing in the activity of eNOS in substituted persons (Wang et al, 1997). The eNOS impersonation was still anonymous in SLE and still under exploration (Albilia et al, 2007). The current investigation aims to associate of oral ulcer types with eNOS SNP (rs1799983) genotyping in systemic lupus erythematos (SLE) types.

Materials and Methods
Current investigate is a cross sectional study from the March, 2018 to the September 2020, that is suggested to detect the association of the oral ulcer types with rs1799983 in the eNOS gene, the Current study included 51 SLE and juvenile JSLE patients with differ ages included children, adults and older ranged between 9 to 47 years both sex, males (29) more than females (22) which divided into two subgroups with oral ulcer (24) and without an oral ulcer (27). Samples distribution was accumulated with the approval of Iraq›s environment and the Ministry of Health. Morgan Medical City, Chronic Diseases Unit, Babylon. Genomic DNA was extracted from whole blood using a FavorPrep™ DNA extraction kit, and then concentration and purity were detected by Nanodrop. The primer sequence of eNOS rs1799983 is shown in table (1). It's amplified at 60 ℃ for 40 sec to produce G allele (475bp) T allele (271 bp) Control band (701 bp). According to Heidari MM and Khatami M designed the table (Heidari and Khatami, 2017) with a little modification by us.
Statistical analysis
SPSS Version 24 was used for data analysis which was loaded into Excel program 10 System. Descriptive statistics include Percentages, Tables, Bar charts, and Graph Pad Software. The chi-square test, odd ratio (C195%) performed, P<0.05 considered as a significant value.

Results
Our work aimed to detect the genotyping of rs1799983 (TT, TG and GG) and its relation with oral ulcers and with types of oral ulcers in SLE and JSLE patients. Three categories were included in a current study about oral ulcers; whether it is single or multiple, painful or not, and its site. The DNA was extracted from whole blood, the electrophoresis showed good quality one band for each patient (Figure 3). The association of rs1799983 genotypes with OU sites shows that TG was observed in the buccal and palatal in about (66.66%), in labial and tongue (50, 33.33%), the GG observed in all OU sites. It was more frequent in the tongue (66.66%) and labial (50%), and the TT was observed only in the buccal (16.66%). The floor sites didn’t have amplification products (Figure 4). The pain of OU wasn’t affected by rs1799983 genotyping, and TG was observed in both groups (painful, non-painful) (Figure 5). The rs1799983 genotyping distribution according to an oral ulcer number of SLE. Patients show that TG was observed in (57.14%) in single OU and (50%) in multiple OU. The GG was low in the multiple OU (37.5%) and (42.85%) in single OU. The TT was found in the multiple OU (12.5%) only (Figure 6).

Table (1): Primer sequence F1 and R1 (outer primers). F2 and R2 (inner primers), produces G allele (475bp) T allele (271 bp) Control band (701 bp).

![Figure (1): The distribution of study subjects according to the number of ulcers and whether they are painful or not. The distribution of oral ulcers in study subjects shows that (33.33%) were painful and (66.66%) non-painful, about (38.89%) had single OU, while (61.11%) had multiple OU (Figure 1).](image_url)

The sites of OU were also included in the current study, there were six sites observed of OU including buccal, palatal, labial, tongue, floor and lip. A high percentage of patients have buccal OU (44.44%) then tongue OU (33.33%), labial (27.77%), and palatal (22.22%) low percentage was observed in the floor and lip (5.55%) (Figure 2).
The current study was suggested to detect rs1799983 genotyping in the eNOS gene and its relation to oral ulcer types and sites. The association of rs1799983 genotypes with oral ulcers was clarified in Table 2. Non-significant associations were found among TG, GG and GT (OR 2.5000, P 0.214), (OR 0.7500, P 0.892) respectively. The frequency of the allele displays that the G allele was more frequent in both groups.

Table 2: The distribution of rs1799983 genotypes in the SLE patients with and without oral ulcers.

<table>
<thead>
<tr>
<th>Genotype</th>
<th>With oral ulcer</th>
<th>Without oral ulcer</th>
<th>Odd ratio (CI95%)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TG</td>
<td>(58.82%)</td>
<td>(35.29%)</td>
<td>2.5000</td>
<td>0.2143*</td>
</tr>
<tr>
<td>GG</td>
<td>(35.29%)</td>
<td>(52.94%)</td>
<td>(0.5886 to 10.6175)</td>
<td></td>
</tr>
<tr>
<td>TT</td>
<td>(5.88%)</td>
<td>(11.76%)</td>
<td>0.7500</td>
<td>0.8292*</td>
</tr>
</tbody>
</table>

* P value > 0.05, non-significant.

Figure (2): Distribution of study subjects according to oral ulcer sites.

Figure (3): A; DNA extract from study samples, B; The rs1799983 genotypes of SLE patients. DNA marker (100-1 kb), the amplification bands Control band (701 bp), G allele (475bp) and T allele (271 bp) 100 V, 20 mA, 40 min, the products had been electrophoresed on an Ethidium-Bromide staining 1% agarose gel.

The current study was suggested to detect rs1799983 genotyping in the eNOS gene and its relation to oral ulcer types and sites. The association of rs1799983 genotypes with oral ulcers was clarified in table (2). Non-significant associations were found among TG, GG and GT (OR 2.5000, P 0.214), (OR 0.7500, P 0.892) respectively. The frequency of the allele displays that the G allele was more frequent in both groups.
Discussion

An oral ulcer is one of the health problems associated with several diseases, in the present study SLE was suggested to detect eNOS genotyping and its correlation with oral ulcers because it occurred in 51% of SLE patients (Durcan et al, 2015). The mucocutaneous manifestations are common signs and symptoms in (JSLE) and they are appeared in nearly 70–75% of the over populations in the world (Huang et al, 2010; Chiewchengchol et al, 2015; Ramirez et al, 2008; Supavekin et al, 2005). Different types of OU were observed, the same to certain disorders are inclined to concern one type of tissue more than the others, thus, it plays an important role in the diagnosis of SLE. Several types of OU were dependent on JSLE including erythematous ulcer of Palatal, Oral discoid LE, plaque of Honeycomb, Verrucous LE and Aphthous ulcer (Nico et al, 2008; Burge et al, 1989). Some of this ulcer is Painless and appear as single or multiple ulcers (Rodsaward et al, 2017). On the other hand, the association of rs1799983 in the eNOS gene with oral ulcer was studied, present study shows a non-significant association of rs1799983 with oral ulcer, the OU is associated with SLE activity and development (Del Barrio-Díaz et al, 2022). Lee and Bae, (2017) suggested in a meta-analysis study that the 4b/ polymorphism in the eNOS gene may be correlated with SLE development. The effect of the eNOS genotype in the SLE phenotype was investigated, Serrano et al, (2004) didn’t find any obvious effect of eNOS polymorphism on the immune response, genetically in susceptible cases, found in SLE that their clinical look is altered by sufficient and guarded environments happened in over-time. SLE is a complex disease produced by an interaction between genetic mutations and environmental factors, it’s a polygenic disease (Al-Terehi et al, 2021a; Al-Terehi et al, 2021b). The SLE phenotype was varied in grouped persons. Therefore, the genotype effectual on phenotype in specific persons may alterd according to surrounding factors and its exposure lengthening, thus the effect of eNOS polymorphism in the oral ulcer types and sites may vary according to other factors like disease activity, several pieces of evidence found lack concerning relation of dysfunction of endothelium and disease activity (Serrano et al, 2004). In an early study, Belmont, et al, (1997) reported that SLE activity didn’t depend on the endothelial cell expression of constitutive NOS while Clancy et al, (2001) noticed that SLE activity related to the levels of circulating endothelial cell activities. However, other studies didn’t find an association between oral ulcers and eNOS gene polymorphism, such as in Behçet’s disease (Karasneh et al, 2009). Another study found that in Jordanian patients, the Inheritance of an NOS2 SNP rs2297518 is correlated with the risk increasing of recurrent aphthous stomatitis (Karasneh et al, 2011). On the other hand, as a result of the role of eNOS in oxidative stress balance, The oxidative stress impact has been studied in the oral ulcer, Bagan et al, (2014) found an association between oxidative stress and recurrent aphthous stomatitis.

Conclusions

The current study didn’t identify the relationship between eNOS in the SNP rs1799983 and types of oral ulcer and this may be because there was another genetic etiology of OU in the SLE and JSLE, or due to the limitation of sample size.
References


HASSAN, S.Z., GHEITA, T.A., KENAWY, S.A., FAHIM, A.T., EL-SOROUGY, I.M. and ABDOU,


Knowledge and Behavior of Oral Health Care among Dental Students in Kurdistan Region of Iraq – A Questionnaire-Based Study

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Abstract
Background Oral health programs must first be delivered to oral health care providers. Objectives This study was designed to assess oral health care understanding among preclinical and clinical dental students and male and female dentistry students at Sulaimani University. Materials and Methods A cross-sectional, self-administered structured questionnaire was designed with a total of (38) items allocated in (7) domains of diverse oral health questions covering the main attributes of oral health care knowledge, attitude, and behavior among 232 pre-clinical and clinical dental students, 140 and 92, respectively, comprising 176 females and 56 males. Results No wide diversity in students’ responses was reported between preclinical and clinical, or between male and female students in this study despite some significantly different responses to a few of the total number of items. The significant differences between preclinical and clinical students were mainly in the following areas: in domains (1), the amount of gingival display; in a group (2), professional scaling and polishing and time intervals for visiting a dentist for scaling and polishing; in domains (3), interdental use of floss and brushes; and in domains (4&5), respectively, type of toothpaste and toothbrush. Finally, the two domains responded differently on the cause of dental caries and whether implants could fail due to disease, as in natural teeth, in question domains (6&7). Conclusion Preclinical and clinical students responded similarly to the majority of the items, while male and female responses were not widely divergent despite a few significant differences in answers to some items.

Keywords: Oral Health care; education; knowledge, attitude; oral hygiene; preclinical; clinical.
Introduction

Oral diseases and disorders including dental, periodontal, and oral mucosal lesions are considered the most prevalent diseases worldwide that damage individuals well-being and the community financially (Peres et al., 2019). It is accredited that oral health is strongly linked to individuals’ overall health (Baiju et al., 2017). This relationship can be demarcated as an oral status free of diseases and disorders that improves people’s visual appearance while also accomplishing the normal functioning of the oral cavity (Kumar et al, 2017). There have been reports of close interactions between oral diseases, particularly periodontal diseases, and other systemic diseases and conditions such as diabetes, atherosclerotic cardiovascular diseases, strokes, adverse pregnancy outcomes and metabolic diseases, and obesity (Nazir, 2017; Zardawi et al, 2021). Vice versa, some systemic diseases that enhance the release of pro-inflammatory mediators such as diabetes, obesity, and stress may participate in the development and exacerbation of certain periodontal and oral diseases and conditions (Tavares et al, 2014).

Health education is a major element in preventing disease development and progression in several healthcare areas such as oral, periodontal, and dental health (Menegaz et al, 2018). Oral health programs should be commenced first with health providers including dental students, dentists, dental hygienists, and dental assistants. These programs must potentially change their attitude, perception, and behavior positively toward their oral hygiene and improve their periodontal, dental, and oral status, to increase their future ability to improve public oral health (Peker and Alkurt, 2009). People’s attitudes and oral health knowledge and behavior vary among societies and individuals are influenced by factors such as culture, environment, and socioeconomic factors (Nyamuryekung’e et al., 2018). Periodontitis and dental caries are two worldwide oral health conditions that affect 60% and 36% of the population, respectively (Eke et al, 2012; Kassebaum et al, 2015). Therefore, to reduce the prevalence of dental and periodontal diseases and their consequences for society, education regarding the correct health behavior is considered to be a necessary element in successful implementation of preventive programs for a variety of medical specialties including oral public health (Menegaz et al, 2018). For a dentist to be an effective member of a team assigned to educate the public about oral health, his/her attitudes, behavior toward self-practiced oral hygiene measures must reflect his/her understanding about oral health programs. Proper understanding of preventive programs among a society’s oral health care providers can have an enormous impact on that society’s oral health (Mekhemar et al, 2020). According to the teaching system in dental colleges in Iraq and Kurdistan region of Iraq, students undertake three-year preclinical courses which usually focus on the basic oral sciences, with only limited provision of knowledge and training on oral hygiene and oral health care. They then undertake two further clinical years before graduation that involve practical training on patients. The educational transition from the preclinical to the clinical stages offers medical and dentistry students a new outlook on their future careers. Obvious improvement has been recognized in their educational knowledge after going into the practical unit, particularly in terms of their attitude, knowledge and behavior toward oral health principles. Numerous studies have evaluated the effect of this educational transition on dental and medical students regarding oral health behavior and attitude, with the outcomes of these studies being controversial. However, some studies recorded significant improvement of educational standards within the clinical stage compared to the preclinical (Yildiz and Dogan, 2011; Al-Wesabi et al, 2019; Peker et al, 2010; Sato et al, 2013; Ali, 2016). Other studies failed to record significant differences between the two educational levels (Mekhemar et al, 2020; Alrmaly and Assery, 2018; Halboub et al, 2016; Mekhemar et al, 2021). Oral health care is a wide topic includes several aspects, dentistry
students should have sufficient knowledge to design and implement an oral health program accurately, of course with some differences between preclinical and clinical students owing to their different level of education and clinical practice, and male-female differences because of their different attitudes and behavior toward oral health. Previous studies covered part of this wide topic, however, in the current study, the authors tried to cover most aspects of oral health care by investigating students’ responses to 7 groups of (39) inclusive questions. Hence, the present study was carried out to assess the basic oral health knowledge among clinical and preclinical dentistry students and to understand their attitude and behavior toward the basic principles of self-performed and professional oral hygiene measures. The study was designed to evaluate this understanding among male and female students and among preclinical and clinical dental students.

Materials and Methods
Study design and participants
A cross-sectional, self-administered structured questionnaire was designed with a total of 38 questions allocated in 7 domains of diverse oral health questions. The items were formulated based on different aspects of oral health status in order to evaluate perception, knowledge and behavior among preclinical and clinical dentistry students at the University of Sulaimani in Kurdistan region of Iraq. A total of 232 preclinical and clinical dental students (140 and 92, respectively, comprising 175 females and 57 males) participated in this study. The study was carried out in the academic year 2019–2020, after submitting the study proposal to the ethical committee of the College of Dentistry, University of Sulaimani for registration and attaining ethical approval for conducting this cross-sectional study. A convenience sampling technique was employed to select dental students for participation in this study. The 1st to 5th stages of the dental course were divided into two domains: preclinical involved years 1, 2, and 3, while the clinical group involved stages 4 and 5. Only properly filled-in forms were used and any inadequately completed questionnaire forms were excluded.

Questionnaire
The questionnaire addressed the following aspects of self-performed and professional oral hygiene behavior by asking the following seven sets or domains of items on oral health care knowledge and behavior:
1-Domains (1): Gingival health and appearance, spacing, amount of gingival display, and gingival recession.
2-Domains (2): Professional scaling and polishing, how often, attitude toward necessity, harmful effect on the teeth, such as sensitivity, and items about advantages of professional scaling and polishing.
3-Domains (3): Tooth brushing, methods, frequency and brushing consequences.
4-Domains (4): Types of toothpaste used by the students.
5-Domains (5): Interdental care and interdental plaque control plaque control aids.
6-Domains (6): Dental caries, role of bacteria in causing dental caries, visits to dentist for checkup.
7-Domains (7): Dental implants, components, knowledge and similarity to natural teeth.

Statistical analysis
Data were analyzed using the SPSS version 16.0 software (SPSS Inc., Chicago, IL, USA). Cronbach’s alpha test was used to determine reliability of the obtained data. Descriptive statistics regarding such as frequency and percentage were obtained. The Shapiro-Wilk test was applied to determine the mean distribution and normality of the obtained data. Since the data were not normally distributed, Mann Whitney test was applied to compare study variables such as male and female students and between pre-clinical and clinical students. The level of significance was set as P ≤ 0.05.

Results
Cronbach’s alpha test was applied to a sample
of 32 participants as a pilot study in order to determine the reliability of the variables applied in this study. The outcome of this pilot study was that Cronbach’s alpha values indicated the reliability of the variables applied in each domain and among all the variables applied in the study (Table 1). The questionnaire was applied to the entire sample of this study, which constituted 232 participants. In domains 1, the majority of the answers from preclinical and clinical students related to the gingiva being pink in color (133, 95% and 85, 92.4%, respectively). Whereas, the male-female responses to this question were 53, 93% - 165, 94.3%, respectively. In this group of questions, no significant results were detected except for a significant difference (P=0.034) in the preclinical responses to the question relating to the amount of gingival display, and this difference mainly concerned the small amount of gingival display compared to clinical students’ response (69, 49.3% and 45, 48.9%, respectively) as shown in Table 2. For domains 2 items relating to professional scaling, there was a statistically significant difference (P=0.004) in preclinical and clinical responses to the question on frequency of scaling. Whereas most of the clinical participants (41.3%) were having professional scaling at intervals of more than 12 months, the majority of preclinical students (47.9%) were not having professional scaling and polishing. Most of the participants responded that scaling improves the gingival health, however, there was a significant difference (P=0.00) between preclinical (71.4%) and clinical responses (82.6%). Furthermore, in this domains of items the majority of the participants stated that scaling improves the appearance of the teeth, with a significant difference (P=0.007) between preclinical (76.4%) and clinical (83.7%) students (Table 3). In domains 3, there was a significant difference between preclinical and clinical responses to the question relating to the segments of the mouth that participants flossed (P=0.048). Furthermore, there was a significant difference (P= 0.000) between preclinical (71.4%) and clinical (82.6%) responses regarding the importance of flossing; also, a significant difference (P=0.005) was recorded between preclinical and clinical responses to the question related to use of interdental brushes (68.6% and 84.8%, respectively). Results of this study show that the majority of preclinical and clinical students were not using interdental brushes. Besides, a significant (P=0.04) difference was recorded between preclinical and clinical responses to the items related to use of mouthwash (Table 4). In group 4, there was a significant difference (P=0.002) between preclinical (72.1%) and clinical use of fluoridated toothpastes (79.3%) (Table 5). The results of this study also showed that most of the females (53.4%) were using a medium toothbrush, whereas the majority of males (50.9%) were using a soft toothbrush, but the difference was not significant (P=0.535). There was a significant difference (P=0.003) between males and females in the timing of brushing. Meanwhile, the majority of preclinical (49.3%) and clinical (54.3%) participants were using a medium toothbrush, with a significant difference (P=0.02) between the two domains (Table 6). Regarding the domains 6 questions related to the causes of dental caries, the majority of preclinical students (52.6%) believed that the causes of dental caries are bacteria and genetics, while the majority of clinical students (57.1%) believed that the cause of dental caries is primarily bacterial, with a significant (P=0.04) difference between the two groups. Additionally, most of the females attended dental clinics for periodic examinations (80%) and they believed that filled teeth do not develop caries again (Table 7). For domains 7 questions regarding dental implant knowledge, there were no significant differences between males’ and females’ responses to these questions or between preclinical and clinical answers except for the question on whether dental implants can fail due to disease, where there was a significant difference between preclinical and clinical responses (P=0.003) as demonstrated in Table 8.
Table (1): Correlation coefficient reliability using Cronbach’s alpha test.

<table>
<thead>
<tr>
<th>Variables</th>
<th>n</th>
<th>Mean</th>
<th>Cronbach’s Alpha</th>
<th>Cronbach’s Alpha total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gingival Health and appearance</td>
<td>32</td>
<td>1.796</td>
<td>0.72</td>
<td>0.72</td>
</tr>
<tr>
<td>Scaling</td>
<td>32</td>
<td>2.016</td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td>Interdental care</td>
<td>32</td>
<td>1.738</td>
<td>0.76</td>
<td></td>
</tr>
<tr>
<td>Toothpaste</td>
<td>32</td>
<td>1.783</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>Tooth Brushing</td>
<td>32</td>
<td>1.719</td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td>Dental Implant</td>
<td>32</td>
<td>1.648</td>
<td>0.74</td>
<td></td>
</tr>
<tr>
<td>Dental carries</td>
<td>32</td>
<td>1.710</td>
<td>0.75</td>
<td></td>
</tr>
</tbody>
</table>

Table (2): Students’ response to domains 1 items related to gingival health and appearance - Frequency and percentage.

Table (3): Students’ response to Domains 2 items related to professional scaling and polishing and their consequences for the teeth and gingiva - Frequency and percentage.

Table (4): Students’ response to Domains 3 items related to interdental plaque control methods and tools - Frequency and percentage.

Table (5): Students’ response to Domains 4 items related to type and use of toothpastes - Frequency and percentage.
Table (6): Students’ response to domains 5 items related to frequency and type of toothbrush, Frequency and percentage.

<table>
<thead>
<tr>
<th>Tooth Brushing</th>
<th>Preclinical</th>
<th>Clinical</th>
<th>p-value</th>
<th>Female</th>
<th>Male</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I use</td>
<td>Soft toothbrush</td>
<td>41 (41%)</td>
<td>41 (41%)</td>
<td>0.39</td>
<td>0.55</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>Medium toothbrush</td>
<td>33 (33%)</td>
<td>33 (33%)</td>
<td>0.39</td>
<td>0.55</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>Hard toothbrush</td>
<td>25 (25%)</td>
<td>25 (25%)</td>
<td>0.39</td>
<td>0.55</td>
<td>0.65</td>
</tr>
</tbody>
</table>

Table (7): Students’ response to domains 6 items related to dental caries and management - Frequency and percentage.

<table>
<thead>
<tr>
<th>Question</th>
<th>Preclinical</th>
<th>Clinical</th>
<th>p-value</th>
<th>Female</th>
<th>Male</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Do you go to dental clinic regularly to check your teeth for dental caries (in grams)?</td>
<td>Yes</td>
<td>28 (28%)</td>
<td>28 (28%)</td>
<td>0.48</td>
<td>0.52</td>
<td>0.52</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>72 (72%)</td>
<td>72 (72%)</td>
<td>0.48</td>
<td>0.52</td>
<td>0.52</td>
</tr>
<tr>
<td>2. The cause of dental caries is</td>
<td>Necrotic Gingivae</td>
<td>70 (70%)</td>
<td>70 (70%)</td>
<td>0.40</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>Acidic Compounds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table (8): Students’ response to domains 7 items related to dental implants and how they differ from natural teeth - Frequency and percentage.

<table>
<thead>
<tr>
<th>Question</th>
<th>Preclinical</th>
<th>Clinical</th>
<th>p-value</th>
<th>Female</th>
<th>Male</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Have you heard about dental implants?</td>
<td>Yes</td>
<td>13 (13%)</td>
<td>13 (13%)</td>
<td>0.40</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>107 (107%)</td>
<td>107 (107%)</td>
<td>0.40</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>2. Dental implants are superior to natural teeth placed in the gum</td>
<td>Yes</td>
<td>104 (104%)</td>
<td>104 (104%)</td>
<td>0.40</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>7 (7%)</td>
<td>7 (7%)</td>
<td>0.40</td>
<td>0.50</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Discussion

The current study included seven groups of questions covering the most common aspects of oral health care; the purpose of asking these questions was to investigate students’ general perceptions, knowledge and behavior toward different aspects of oral health care and to interpret their understanding of these aspects. The study also attempted to investigate the differences between preclinical and clinical students’ levels of understanding of these considerations. Furthermore, this questionnaire based study attempted to interpret the differences in levels of perception between male and female students. In questionnaire based studies, the respondents sometimes neglect to answer the questions or part of the items, because they are not interested, or not well acquainted with the nature or the style of the questioning, or sometimes they may tick without reading the questions carefully, which may lead to data inconsistency. Therefore, the reliability and validity of the current data were tested; additionally, inadequately completed forms were excluded and only forms that were fully completed or missing only one or two answers were considered. The responses of preclinical and clinical, male and female students to most of the questions in the seven groups were mostly consistent in this study except for a few cases in which there were significant differences in responses between preclinical and clinical and between male and female students that will be discussed in this section. In (domains 1) there was a significant difference between preclinical and clinical responses to the amount of gingival display. The gingival display is a clinical attribute of the smile and beauty, with students attaining their knowledge about esthetics from the clinical courses in their studies. Meanwhile, although women are more aware about their appearance and thus follow oral health care procedures to achieve an attractive smile, in this study, no significant statistical difference was detected between males and females. Additionally, there was no wide variation in the student domains’ responses on interdental aids to plaque control.
in group (2) except for a few differences between preclinical and clinical students regarding use of interdental flossing and brushing. However, the only significant difference between males and females in responses to this domains of questions related to the use of mouthwash. There was also variation between preclinical and clinical groups’ responses on the use of fluoridated toothpaste and whether the primary cleansing action derives from the toothpaste or the toothbrush. They also responded differently to a similar question in domains 5, which related to whether toothpaste works properly with improper brushing technique. There was a further difference between the clinical and preclinical students in answers to the question related to the type of toothbrush they used, while the only difference between males and females was in responses to the question on time of brushing during the day. For domains 6, which included questions related to dental caries, the only significant difference between responses of preclinical and clinical students related to the causes of dental caries. Meanwhile, the only difference between preclinical and clinical students in responses to the dental implant items in group 7 related to whether a dental implant can become diseased and fail like a natural tooth. Recently, numerous studies worldwide have assessed the educational transition regarding oral health attitude and knowledge, and behavior from the preclinical to the clinical level of study as primary signs of educational progress. Outcomes of these studies have demonstrated significant progress in relation to educational transition among preclinical and clinical students (Al-Wesabi et al, 2019; Ali, 2016; Yildiz and Dogan, 2011; Peker et al, 2010). In this regard, the current study identified significant differences between preclinical and clinical students’ responses to the items related to professional dental scaling and polishing and to questions related to interdental cleaning aids and the use of interdental flossing. Furthermore, there were significant differences in responses to items related to the type of toothbrush, type, and action of toothpaste used by preclinical and clinical students. They also responded differently to the items related to the causes of dental caries and whether a dental implant can succumb to any kind of disease or disorder. These differences could be attributed to students’ regular contact with their patients during the clinical courses of their study and improvement in their clinical dental practice and knowledge as they become more conscious of the significance of oral health knowledge and more attentive to the need to guide their patients appropriately (Al-Wesabi et al, 2019). However, a number of studies have identified weakness in the preclinical-clinical transition (Mekhemar et al, 2020; Mekhemar et al, 2021; Alrmaly and Assery, 2018; Halboub et al, 2016). This was reflected in the current study by the lack of significant differences between preclinical and clinical students’ answers to most of the questions that determine students’ level of knowledge, attitude and behavior toward the majority of oral health attributes. This indicates a lack of significant improvement in the level of oral health knowledge in their clinical stages and that at this stage of their education students may not be sufficiently qualified to perform oral health care programs. It is a fact that women usually care more about their appearance and looking after their bodies and thus may be more concerned about adopting behaviors and habits that promote their dental and oral health (Mamai-Homata et al, 2016; Halboub et al, 2016; Ali, 2016); consequently, they might practice better oral health care than males (Mekhemar et al, 2020; Mekhemar et al, 2021; Hamasha et al, 2018). Although the female dental students in this study differed from their male counterparts on some aspects of oral health knowledge and attitudes, there were no significant differences between males’ and females’ answers to the majority of the items. This result was consistent with other studies that reported no male-female differences in terms of oral health behavior (Muthu et al, 2015; Al-Omari and Hamasha, 2005; Hassan et al, 2020). Generally, preclinical and clinical students’ responses to the majority of the items were similar, possibly indicating that
the students achieved the required knowledge about oral health care from oral health education courses in the preclinical stages. These preclinical courses on oral health care helped prepare them to implement oral health programs with their patients in the clinic, and could explain why the preclinical and clinical students gave similar answers. Another possibility could less often to be, is that dental education has had a weak effect on students’ oral health knowledge, which calls for special attention to double-check the programs that are approved to be taught during the clinical courses. Supplementary courses may be required, focusing on the importance of delivery of appropriate oral health performance by health care providers.

Conclusions
Although preclinical and clinical students responded differently to some of the items designed to assess their knowledge, attitudes and behavior toward oral health care, there were no obvious variation in their responses to the majority of the questions. This indicates that the preclinical learning programs and their educational program is well designed to prepare the male and female learners to the clinical sessions during their undergraduate program. The study also revealed a few differences in responses between males and females, but none of these were significant.

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References


SATO, M., CAMINO, J., OYAKAWA, H. R., RODRIGUEZ, L., TONG, L., AHN, C., BIRD, W.


Assessment of Some Mechanical Properties of CNC Laser Treated Ti13Zr13Nb Alloy

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Abstract

Background Alloys with the addition of zirconium and niobium eliminate the adverse effects of aluminum and vanadium on the nervous system, the possibility of metallosis and the initiation of diseases (including cancers or Alzheimer’s disease). In addition, they have better corrosion resistance, and a Young’s modulus value similar to longitudinal bone tissue. Therefore, only choosing appropriate materials does not guarantee proper functioning of the implants, the surfaces of the implants also have to be suitable to meet the requirements. The laser surface hardening process modifies the surface properties by imparting microstructural changes, whereas surface remelting induces changes in the surface topography, roughness, wettability and wear and corrosion resistance, influencing the biocompatibility of the surface. Such changes are brought in essentially because of the characteristic melting, evaporation and rapid solidification during laser surface remelting processes. Objectives This study was aimed at evaluating the electrochemical corrosion of commercial pure Titanium disks (CP Ti) and the Ti13Zr13Nb (Alloy) with a zigzag pattern of laser surface treatment. Materials and Methods a total of 40 discs of Cp Ti & 40 of Ti13Zr13Nb were fabricated. The surfaces of the test groups were treated with unique zigzag patterns using CNC Laser treatment on the texturing surfaces, the samples then are analyzed by using XRD, microhardness and electrochemical corrosion tests. Results The study revealed a proper increase in the surface hardness and corrosion resistance without crack formation or a dramatic change of the core substance of the CP Ti and Alloy disks. Conclusion The CNC laser is considered an effective and suitable method for surface texturing of CP Ti and Alloy for dental implantology.

Keywords: Commercial pure Titanium; Ti13Zr13Nb alloy; CNC Laser; laser surface texturing; dental implant and corrosion.
Introduction

Titanium and titanium alloys have been used widely for several decades as the materials of choice for dental implants because of their biocompatibility, good mechanical properties, corrosion resistance, no cell toxicity and weaker inflammatory response in peri-implant tissues. The usage of Ti and its alloys as dental implants may be correlated with some disadvantages despite the good evidence of its usage like the elastic moduli difference between Titanium implant and the surrounding bone, which led to stress in the bone-implant interface and peri-implant bone loss (McSarot et al, 2010). The dental implant surface modification, specifically the topographical, is considered as an effective method for improving the bioactivity of dental implants (Mandracci, 2019). Several studies showed that implant surface modification by the laser technique can reduce dental implant contamination with implant torque removal increasing after their implantation in rabbit tibia and femur (Brånemark et al, 2011; Azzawi et al, 2017; Al Khafaji et al, 2020). The laser surface modification techniques could offer better osseointegration due to the formation of surface microstructures with significant hardness enhancement, corrosion resistance, standard roughness, a high degree of purity and an increase of the oxide layer (Hällgren et al, 2003). Berezani et al. Stated that the oxide layer increases more than doubles after implant surface laser treatment (Berezani et al, 2003). Ti13Zr13Nb is a high-strength, low modulus and biocompatible alloy. Implants of this alloy would have a modulus of elasticity closer to that of bone than other typically-used metal alloys and do not include any elements which have been shown or suggested as having short-term potential adverse effects (Henriques et al, 2005). Ti13Zr13Nb is a near β alloy formulated at the beginning of the 1990s to be used in orthopaedic applications due to its low Young’s modulus (40–80 GPa) and its non-toxic composition. It presents tensile values of approximately 1,300 MPa and a superior corrosion resistance when compared to Ti–6Al–4V and Ti–6Al–7Nb alloys (Henriques et al., 2010). The first-generation orthopaedic α+β Titanium alloys such as Ti–6Al–4V ELI (extra low interstitial), Ti–6Al–7Nb and Ti–5Al–2.5Fe are already in use. In recent years, second-generation low-modulus near β and type Titanium alloys have been developed for orthopaedic applications to avoid the “stress shielding” effect caused by the modulus mismatch between the implant and the bone (Ni et al, 2009). The Ti–13Nb–13Zr has Niobium as a beta-phase stabilizer. The other alloying element, Zirconium, is isomorphous with both the alpha and beta phases of Titanium. A combination of these two alloying elements has made it possible to develop a structure that is a “near” beta phase supposedly possessing a superior corrosion resistance over the alpha–beta phase alloys, with enough alpha phase present in the final structure to provide the necessary mechanical strength. It has been proposed that Ti13Nb13Zr alloy is more favourable for orthopaedic implants than Ti6Al4V alloy because of its superior corrosion resistance and biocompatibility. Reasons for this superiority have included the fact that less metal ion release is likely to occur during spontaneous passivation of Ti–13Nb–13Zr alloy because of its superior corrosion resistance and biocompatibility. For this reason, it is very important to prevent corrosion. Suitable modifications can be made to control the corrosion of metal (Rawaa et al, 2019). Hence, this study aimed to evaluate the corrosion of commercial pure Titanium disks (CP
Ti) and the Ti 13Nb 13 Zr (Alloy) with a zigzag pattern of laser surface structuring with zigzag lines is the favourable surface treatment of dental implants.

**Material and Methods**

**Sample grouping**
The CP Ti and Alloy disks were divided into four groups, as follows:

- (Ti) CP Ti control group, without any surface treatment or structuring.
- (TiL) CP Ti with laser surface structuring.
- (TZN) Alloy control group, without any surface treatment or structuring.
- (TZN L) Alloy with laser surface structuring.

**Samples preparation**
Circular disks, 9 mm diameter and 2 mm thickness of commercial pure Titanium disks (CP Ti) and the Ti 13Nb 13 Zr (Alloy) were cut with a wire cut machine (Knuth Smart DEM-Germany). Then, these disks were polished to a mirror-smooth uniform appearance via rotation machine with sandpapers proceeded from 500 to 2400 grit. For removing contamination, the samples were placed in the ultrasonic cleaning device for 15 minutes with ethanol, and then for 10 minutes with distilled water, respectively. Finally, the samples were dried at room temperature for 15 minutes (Duarte et al, 2009).

**Pilot study**

**Laser surface structuring**
Five scanning speeds were tested, 2000, 1200, 500, 300 and 150 mm/sec. Speeds 2000, 1200 and 500 mm/sec. Resulted in creating scattered dots that didn’t reveal the pattern required. Speed of 150 mm/sec. made pattern lines overlap and the surface turn blackish grey, which may strongly suggest scorching the surface. The speed of 300 mm/sec. was selected for it created the distinct pattern required without signs of burning the surface nor scattered dots. Three designs were tested before settling for this one. The other ones had right and sharp angles in the zig-zag lines instead of the obtuse ones used in this study. But the other designs were eliminated due to increased wettability angles (reduced surface wettability) since most studies have found that hydrophilic surfaces tend to enhance the early stages of cell adhesion, proliferation, differentiation and bone mineralization compared to hydrophobic surfaces (Al Khafaji et al, 2021). The laser system performed the desired profile on the CP Ti and Alloy disk surfaces. The surfaces of the CP Ti and Alloy were structured under a normal atmosphere by using a pulse mode CNC fibre laser machine (Al Khafaji et al, 2020) (Raycus 50 Watts-China) with laser power 30-Watts, wavelength 1064 nm, Frequency of 200 pulses per second and scanning speed up to 300 mm/sec. Corel Draw software (version XII) was used for drawing the zig-zag design shapes. The samples-laser source disk distance was 22 cm. When the system was triggered, the laser beam started shooting at the sample with a continuous series of laser pulses in an ablation process to form the zig-zag lines design. The lines were made 416.38 μm with 116.1 μm spaces in between the lines. The zig-zag lines were created with an angle of 134.88º. Scanning electron microscope (SEM) images of the samples are shown in Figure (1).

**Phase analysis by the X-ray diffraction test**
The X-ray diffraction pattern for the control and the laser structure specimens for the 3 different designs on CP Ti groups are shown in Figure (2). The X-ray diffraction pattern for the control and the laser structure specimens for the 3 different designs on Alloy groups are shown in Figure (3). One disk was examined for each group. Laser structuring did not give rise to noteworthy interchanges in the phases of the Ti as seen in the XRD pattern; which is of which is of high importance to ensure biocompatibility after laser irradiation (Al Khafaji et al, 2021). A new peak of TiO2 was observed beside the Ti after laser structuring which could probably be due to the titanium-air interaction during the surface structuring.
The main study

Micro hardness test

Digital Vickers micro-hardness tester was used to record the micro-hardness of the control and laser-treated disks of the CP Ti and the Alloy according to (Al Khafaji et al, 2021), for 15 seconds 500g load was applied to the surface of the disk by using Vickers indenter that joins optical microscopy shown in figure (4). An average of 3 different readings was measured from the ten specimens of each one of the groups.

Electrochemical corrosion

Samples were used for the electrochemical tests. All samples were connected to a copper wire and then mounted in epoxy resin with an exposed area of a 7 mm. diameter & and an area of 0.385 cm² as the working electrode, as shown in figure (5). Before the electrochemical test, the mounted sample was carefully degreased with acetone and ethanol and rinsed with distilled water, then finally dried in a stream of warm air. The open circuit potential (OCP) and potentiodynamic polarization curves for sample measurements carried out according to the defined ASTM standards (ASTM 2009; 2015; 2017). Soaked in electrolytes such as simulated body fluid (SBF) (Safi, 2019). A Potentiostat, as shown in figure (6), Electrochemical system provided by three-electrode cell system with a saturated Calomel electrode (SCE) as the reference electrode, a platinum electrode (15 x 15 mm2) as the counter-electrode and the sample mounted in epoxy resin as the working electrode was used in this study. The scan rate was 1Mv/sec. for 30 minutes for each sample. All experiments were carried out at a temperature of 37°C controlled by a thermostat (Li et al, 2011) these tests done in the Ministry of Science and Technology-Baghdad- Iraq.

Statistical Methods

All obtained data were analyzed using the one-way Analysis of Variance (ANOVA) and t-test in the GraphPad Prism (version 6.0.1) Software. Differences were considered significant at P>0.05. Values were represented as Mean >Standard Error (M > SE).

Results

Micro hardness test

The test was conducted by applying a load of 5 to 500 gm for a 15 sec. period. Images of the resulting penetration are shown in figure (4). Descriptive statistics of microhardness measured in Kg/mm² of all groups shown in table (1), demonstrated that the highest average surface hardness was in the TNZ L group while the lowest average was in the Ti group as shown in figure (7). Normality and Lognormality Tests of surface Microhardness (Test for normal distribution Shapiro-Wilk test) shown in table (2) revealed that the P value for all groups is higher than 0.05 (non-significant), which means that data were normally distributed among the groups & and one way ANOVA is applicable. One way ANOVA test demonstrated a highly significance difference in the microhardness among the four groups, P<0.0001 at three degrees of freedoms as shown in table (3). Tukey’s multiple comparisons test of microhardness Multiple comparison shown in table (4) revealed highly significant difference between contact angles between all groups except Ti L vs. TNZ.

Electrochemical corrosion test:

The corrosion tests measuring techniques were involved, Tafel and cyclic polarization; besides open circuit potential. Potentiodynamic polarization test in SBF at 37°C, carried out to evaluate the bio-degradation behavior of Ti, Ti L, TNZ & TNZ L groups. The corrosion rate was calculated according to the formula:

\[
\text{Corrosion Rate (mmpy)} = 0.00327 \text{ Icorr (EW)/d}
\]

Where:

EW: equivalent weight
D: density

Descriptive statistics of electrochemical corrosion for all groups shown in table (5), demonstrated that the highest average corrosion rate was in Ti group while the lowest average was in TNZ.
group as shown in figure (8). Normality and Lognormality Tests of corrosion rate (Test for normal distribution Shapiro-Wilk test) shown in table (6) revealed that the P value for Ti & Ti L groups is higher than 0.05 (non-significant), while the P value for the TNZ & TNZ L groups is lower than 0.05 (significant & highly significant respectively) which means that data were not normally distributed among the groups & Kruskal-Wallis testing was applicable. Kruskal–Wallis one-way analysis of variance demonstrated a highly significance difference in the corrosion rate among the four groups, P<0.0001 (highly significant) as shown in table (7) and Dunn’s test is applicable. Dunn›s multiple comparisons test of Surface Roughness of among the tested groups revealed that the differences in surface roughness of Ti vs. Ti L, Ti vs. TNZ L & TNZ vs. TNZ L were highly significant, while between Ti vs. TNZ, Ti L vs. TNZ & Ti L vs. TNZ L groups are non-significant, as shown in table (8).

Figure (4): A. Microhardness test machine. B, C, D, E indentation marks on Ti, TNZ, Ti L & TNZ L respectively.

Figure (5): A cylindrical sample mounted by epoxy resin and connected with copper wire.

Figure (1): SEM images of the samples A. where sample from Ti group, B. sample from Ti L group C. sample from TZN group & D. sample from TNZ L group.

Figure (2): 2 XRD patterns of Ti groups.

Figure (3): XRD patterns of Alloy groups

Figure (6): Wenking-M lab Potentiostat.

Figure (7): Mean Microhardness in Kgm² for tested group.
### Table (1): micro hardness test Descriptive statistic for tested groups.

<table>
<thead>
<tr>
<th></th>
<th>Ti</th>
<th>TiL</th>
<th>TNZ</th>
<th>TiNZ L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of values</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Minimum</td>
<td>200.4</td>
<td>249.5</td>
<td>222.8</td>
<td>251.8</td>
</tr>
<tr>
<td>Maximum</td>
<td>284.8</td>
<td>301.5</td>
<td>265.8</td>
<td>259.5</td>
</tr>
<tr>
<td>Range</td>
<td>84.7</td>
<td>52</td>
<td>43</td>
<td>107.7</td>
</tr>
<tr>
<td>Mean</td>
<td>238.2</td>
<td>285</td>
<td>246.2</td>
<td>210.1</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>18.52</td>
<td>12.63</td>
<td>12.32</td>
<td>26.01</td>
</tr>
<tr>
<td>Lower 95% CI of mean</td>
<td>231.3</td>
<td>280.3</td>
<td>241.7</td>
<td>200.4</td>
</tr>
<tr>
<td>Upper 95% CI of mean</td>
<td>245.1</td>
<td>289.7</td>
<td>250.8</td>
<td>219.8</td>
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</tbody>
</table>

### Table (5): Descriptive statistic for Electrochemical corrosion for tested groups.

<table>
<thead>
<tr>
<th></th>
<th>Ti</th>
<th>TiL</th>
<th>TNZ</th>
<th>TiNZ L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of values</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.01103</td>
<td>0.062176</td>
<td>0.003044</td>
<td>0.000116</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.01193</td>
<td>0.062504</td>
<td>0.004874</td>
<td>0.000215</td>
</tr>
<tr>
<td>Range</td>
<td>0.0009</td>
<td>0.003288</td>
<td>0.001813</td>
<td>0.0908-05</td>
</tr>
<tr>
<td>Mean</td>
<td>0.01144</td>
<td>0.002317</td>
<td>0.005686</td>
<td>0.000189</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>0.00030</td>
<td>0.000169</td>
<td>0.000682</td>
<td>2.65E-05</td>
</tr>
<tr>
<td>Lower 95% CI of mean</td>
<td>0.01123</td>
<td>0.002339</td>
<td>0.003198</td>
<td>0.00017</td>
</tr>
<tr>
<td>Upper 95% CI of mean</td>
<td>0.01165</td>
<td>0.002595</td>
<td>0.004172</td>
<td>0.000208</td>
</tr>
</tbody>
</table>

### Table (2): Normality and Lognormality Tests of Microhardness (Test for normal distribution Shapiro-Wilk test).

<table>
<thead>
<tr>
<th></th>
<th>Ti</th>
<th>TiL</th>
<th>TNZ</th>
<th>TiNZ L</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>0.9838</td>
<td>0.9992</td>
<td>0.9552</td>
<td>0.9404</td>
</tr>
<tr>
<td>P value</td>
<td>0.9149</td>
<td>0.6087</td>
<td>0.2331</td>
<td>0.0934</td>
</tr>
<tr>
<td>Passed normality test (alpha=0.05)?</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>P value summary</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

### Table (6): Normality and Lognormality Tests of Electrochemical Corrosion.

<table>
<thead>
<tr>
<th></th>
<th>Ti</th>
<th>TiL</th>
<th>TNZ</th>
<th>TiNZ L</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>0.8764</td>
<td>0.8791</td>
<td>0.7979</td>
<td>0.6039</td>
</tr>
<tr>
<td>P value</td>
<td>0.1186</td>
<td>0.1274</td>
<td>0.0137</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Passed normality test (alpha=0.05)?</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>P value summary</td>
<td>ns</td>
<td>ns</td>
<td>*</td>
<td>****</td>
</tr>
</tbody>
</table>

### Table (3): Ordinary one-way ANOVA of Microhardness.

<table>
<thead>
<tr>
<th>ANOVA table</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment (between columns)</td>
<td>302168</td>
<td>3</td>
<td>34056</td>
<td>P&lt;0.0001</td>
</tr>
<tr>
<td>Residual (within columns)</td>
<td>35255</td>
<td>36</td>
<td>332.1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>345423</td>
<td>39</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table (4): Ordinary one-way ANOVA of Microhardness Multiple comparison.

<table>
<thead>
<tr>
<th>Tukey’s multiple comparisons test</th>
<th>Mean Diff.</th>
<th>Summary</th>
<th>Adjusted P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ti vs. TiL</td>
<td>-46.76</td>
<td>***</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Ti vs. TiNZ</td>
<td>-8.003</td>
<td>ns</td>
<td>0.3279</td>
</tr>
<tr>
<td>Ti vs. TNZ</td>
<td>-71.85</td>
<td>***</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>TiL vs. TNZ</td>
<td>38.76</td>
<td>***</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>TiL vs. TiNZ L</td>
<td>-25.09</td>
<td>***</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>TNZ vs. TNZ L</td>
<td>-63.85</td>
<td>***</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

### Table (7): Kruskal-Wallis test of Electrochemical Corrosion.

<table>
<thead>
<tr>
<th>P value summary</th>
<th>***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do the medians vary significant (P &lt; 0.05)?</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of groups</td>
<td>4</td>
</tr>
<tr>
<td>Kruskal-Wallis statistic</td>
<td>36.59</td>
</tr>
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</table>

### Table (8): Kruskal-Wallis test of Electrochemical Corrosion by Dunn’s multiple comparisons test.

<table>
<thead>
<tr>
<th>Dunn’s multiple comparisons test</th>
<th>Mean rank diff.</th>
<th>Summary</th>
<th>Adjusted P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ti vs. TiL</td>
<td>20</td>
<td>***</td>
<td>0.0008</td>
</tr>
<tr>
<td>Ti vs. TiNZ</td>
<td>10</td>
<td>ns</td>
<td>0.3346</td>
</tr>
<tr>
<td>Ti vs. TNZ</td>
<td>30</td>
<td>***</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>TiL vs. TNZ</td>
<td>-10</td>
<td>ns</td>
<td>0.3346</td>
</tr>
<tr>
<td>TiL vs. TiNZ L</td>
<td>10</td>
<td>ns</td>
<td>0.3346</td>
</tr>
<tr>
<td>TNZ vs. TNZ L</td>
<td>20</td>
<td>***</td>
<td>0.0008</td>
</tr>
</tbody>
</table>
Discussion
A novel implant material the Ti13Nb13Zr alloy seems to be the best choice compared to the widely used commercial alloys, as it possesses Young’s modulus approaching that of a bone, and it contains no harmful elements such as Al or V, promising to minimize stress shielding phenomenon and enhancing the longevity of dental implants. Along the use of novel laser surface structuring patterns designed to gain the benefits of both lines-based and dots-based designs from previous studies. This study was aimed to evaluate an important aspect of dental implants: surface hardness and electro-chemical corrosion and how are those characteristics affected with laser surface treatment. Tests results revealed that Ti Group showed lower surface microhardness and Electrochemical corrosion resistance than all the other groups. To obtain the proper prospective; commercially pure Titanium is proven to be very successful in dental implants (Chen et al, 2020), these results can only give high praise to the other groups. TNZ group showed higher surface microhardness and electromechanical corrosion resistance than Ti group, which support the hypothesis of this study that Ti–13Nb–13Zr might be a preferable substrate of dental implants. TiL group showed higher surface microhardness and electromechanical corrosion resistance than both Ti group and TNZ group, which support the hypothesis of this study that CNC laser surface modification might be a preferable surface structuring technique of dental implants. TNZ L group showed higher surface microhardness and electromechanical corrosion resistance than Ti group, TNZ and TNZ groups, which support both hypothesis of this study that Ti–13Nb–13Zr might be a preferable substrate of dental implants, & that CNC laser surface modification might be a preferable surface structuring technique of dental implants. Which coincide with the previous studies that laser surface treatment alloys improve surface qualities relevant to dental implant applications. Which could be attributed to laser remelting (LRM), which involves laser irradiation to improve the surface quality. The remelting of material surfaces using lasers can remove any pores, bead traces, unmelted powder, and spatter from the surface of the deposited layers. Unlike other postprocessing treatments, the areas subjected to laser irradiation are cooled rapidly to obtain a fine microstructure. LRM technology is used on deposited surfaces, and many studies have been conducted for improving the mechanical properties of the surface (John et al, 2020). Yasa and Kruth reported that using selective laser melting showed increased density and improved porosity when subjected to LRM (Seung et al, 2021). Further, Yu et al. employed LRM to improve the porosity and roughness of a treated surfaces (Yu et al, 2020). Studies have also improved the quality and mechanical properties of the surface by changing the process parameters of LRM (Yasa et al, 2011; Wei et al, 2019; Kim et al, 2020 & Aboulkhair et al, 2014).

Conclusions
Laser surface modification of Cp Ti and Ti alloys has pronounced positive effect on enhancement of desirable qualities for the field of dental implants. This study showed that the Ti13Zr13Nb alloy already have much of the mechanical advantages in the field of dental implants over Cp Ti, and can better accept laser surface structuring leading to intensified surface Ti oxide protective layer. Additionally, the adoption of zigzag lines pattern can combine many benefits of previously used patterns of dots or straight lines. In the light of this study, the usage of Ti13Zr13Nb alloy and CNC laser surface modification might resolve some of the problems that were found in other Titanium alloys and might further enhance osseointegration and better serve dental implant purposes.

References
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Frequency of Immediate Implant in Aesthetic Zone

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Abstract

Background immediate dental implant treatment is a well-established strategy. It preserves the bone and reduces treatment time. It also allows the preservation of the soft tissues as well as enables enhancement of the overall aesthetics. Technically, immediate placement of the implant is a challenging task and can be done by clinicians possessing extensive experience in implant dentistry, both prosthetically as well as surgically. Objectives This descriptive study aims to assess the frequency of immediate implants placed in the aesthetic zone of the maxilla and mandible about the site, gender, and age of a group of Iraqi patients. Materials and Methods This study has been carried out in the Modern Specialized Dental Clinic from January 2019 to March 2022. One hundred patients were included in this study with a total number of 372 implants. Bibliographic information as well as radiographic information taken at the time of implantation were taken from the center record for all patients involved in this study. Results female-to-male ratio in this study was 1.63:1. The highest percentage (38.3%) of implants was found in the female esthetic zone within the 41-50 age group. The most favorable side of implantation for the esthetic zone was found in the right maxilla (44%) for the same age group (41-50). Conclusions there is a female predilection for immediate implantation in the maxillary aesthetic zone, middle-aged females in particular.

Keywords: Dental prosthesis; Immediate implant; Aesthetic Zone.

Introduction

Missing teeth in the aesthetic zone may impact a person’s smile. Given the importance of a smile in the day-to-day life of a person (middle-aged women in particular) (Kannaiyan, 2021) therefor could be a traumatic experience when there is a loss of a tooth in the aesthetic zone with or without compromising the phonetics. Thus, quick replacement of the implant-supported single tooth is regarded to be a major challenge for a clinician. Conventionally, the maturation of the extraction socket needs almost 3–4 months of the healing period. Regarding prosthetic treatment, patients seeking to replace a lost tooth generally wait for >6 months (Buser, 2017). To reduce the treatment period, efforts have been made by adopting approaches like immediate or early loading after placing the implant, immediate implant placement, early or immediate loading as well as immediate placement of the implant.
in a fresh extraction site (Wong Lee. 2021). To carry out implantation in delayed post-extraction approaches successfully, primary implant stability is still regarded to be a key requisite (Al-Samman, 2022). In The osseointegration process, biological stability gradually substitutes primary mechanical stability. After completing the healing phase, biological stability completely substitutes primary mechanical stability (Gupta 2019; Gultekin, 2016). The phenomenon of osseointegration with the alveolar bone in the surrounding tissue determines the success of immediately placing the implant at the extraction site (Parithimarkalaignmentan, 2013). Modifying the tissue architecture may concern that good results can be achieved. These alterations with regards to tissue architecture happen post or before the extraction process via gingival recession that facilitates the loss of buccal or interproximal tissue, or via bone remodelling or resorption (Budhiraja, 2021).

Materials and Methods
Study sample: In this descriptive retrospective study of 100 patients who attended a private dental implant clinic (Modern Specialized Dental Clinic) in Baghdad from 2019-2022. Their information was recorded as follows: age, gender, and implant zone (upper anterior, upper posterior, lower anterior, and lower posterior). The esthetic zone was considered as the area from the canine to the canine (Feher, 2022). The implant system used during the study period was the (Endosseous Dental Implant System S-Systems) (IHDE Dental) (IHDE Dental Catalogue 2021).

Inclusion criteria:
1. Patients aged ≥ 20 years of both genders.
2. Patients with non-restorable single or multiple maxillary teeth (canines, incisors, and premolars) are indicated for edentulous or extraction.
3. Medically fit patients with controlled medical conditions who do not have local or systemic conditions that can risk dental implant surgery and bone healing potential.

Exclusion criteria:
1. Patients who are contraindicated for dental implant surgery, including immune-compromised patients, those who experienced a recent myocardial infarction, have uncontrolled diabetes, and patients undergoing chemotherapy or radiotherapy in the head and neck region.
2. Patients who cannot achieve primary stability because of severe alveolar bone resorption.
3. The patient showing signs of acute infection as well as purulent exudates in the extraction zone as identified via radiographical and clinical examination.
4. Patients who possess no or a gap of ≤ 2 mm near the inserted dental implant.

Statistical Analysis
Frequency distributions have been depicted, as a table. Distributions also have been displayed using percentages and the mean of all variables included in this study.

Results
The average age was 40 ± 20 years old (ranging from 20 to 60). Males were 38(38%), whereas females were 62(62%) Table (1). The distribution of patients’ ages is displayed in Table (2). The age ranges from 20 to 60 years, with the highest percentage belonging to 41-50 years. As shown in Table (3), the highest number of implants was reported in the age group 50-60. Most of the cases were full arch, or half arch implants, with the highest percentage in the left maxilla, whereas the lowest percentage was distributed equally between the mandible right and left. The lowest number of implants was found in the age group 20-30. The most favorable side of implantation in the esthetic zone was found in the right maxilla of the age group (41-50), whereas the lowest percentage of implants was reported in the left mandible. As illustrated in Table (4), the highest proportion of implants in the 51-60 age group was equally distributed between the posterior maxilla and posterior mandible. The lowest percentage of cases was found in the anterior mandible. In age group 20-30
the lowest proportion of implants was found in the anterior mandible. Comparable percentages were also found in the same location for the age groups 31-40 and 41-50. The highest number of implants in the aesthetic zone was reported in females aged 41-50 in Table (5).

Table (1): Total implant distribution in males and females from 2019-2022.

<table>
<thead>
<tr>
<th>Year of Implant</th>
<th>Males</th>
<th>Females</th>
<th>Total number of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>4 (57.1%)</td>
<td>3 (42.9%)</td>
<td>7</td>
</tr>
<tr>
<td>2020</td>
<td>7 (23.9%)</td>
<td>20 (74.1%)</td>
<td>27</td>
</tr>
<tr>
<td>2021</td>
<td>25 (42.4)</td>
<td>34 (57.6%)</td>
<td>59</td>
</tr>
<tr>
<td>2022</td>
<td>2 (28.6%)</td>
<td>5 (71.4%)</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>38</td>
<td>62</td>
<td>100</td>
</tr>
</tbody>
</table>

Table (2): Distribution of the patients according to age and gender.

<table>
<thead>
<tr>
<th>Age</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-30</td>
<td>11 (40.7%)</td>
<td>16 (59.3%)</td>
<td>27</td>
</tr>
<tr>
<td>31-40</td>
<td>13 (39.4%)</td>
<td>20 (60.6%)</td>
<td>33</td>
</tr>
<tr>
<td>41-50</td>
<td>7 (25%)</td>
<td>21 (75%)</td>
<td>28</td>
</tr>
<tr>
<td>50-65</td>
<td>7 (58.3%)</td>
<td>5 (41.7%)</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>38</td>
<td>62</td>
<td>100</td>
</tr>
</tbody>
</table>

Table (3): Total implant distribution in the maxilla and mandible according to age.

<table>
<thead>
<tr>
<th>Age</th>
<th>Maxilla</th>
<th>Mandible</th>
<th>Total number of implants</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-30</td>
<td>9 (21.4%)</td>
<td>24 (58.5%)</td>
<td>3 (11.0%)</td>
</tr>
<tr>
<td>31-40</td>
<td>29 (24.2%)</td>
<td>15 (12.5%)</td>
<td>16 (11.8%)</td>
</tr>
<tr>
<td>41-50</td>
<td>44 (27.4%)</td>
<td>13 (24.6%)</td>
<td>22 (27.8%)</td>
</tr>
<tr>
<td>50-65</td>
<td>34 (28.3%)</td>
<td>35 (28.3%)</td>
<td>29 (21.7%)</td>
</tr>
<tr>
<td>Total</td>
<td>141</td>
<td>131</td>
<td>131</td>
</tr>
</tbody>
</table>

Table (4): Total implant distribution in age groups according to their location in the anterior or posterior zone in the maxilla and mandible.

<table>
<thead>
<tr>
<th>Age</th>
<th>Maxilla</th>
<th>Mandible</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-30</td>
<td>10 (23.7%)</td>
<td>18 (41.9%)</td>
<td>12 (28.9%)</td>
</tr>
<tr>
<td>31-40</td>
<td>17 (41.2%)</td>
<td>22 (52.9%)</td>
<td>30 (37.5%)</td>
</tr>
<tr>
<td>41-50</td>
<td>27 (27.4%)</td>
<td>50 (42.7%)</td>
<td>44 (40.8%)</td>
</tr>
<tr>
<td>50-65</td>
<td>28 (19.3%)</td>
<td>42 (28.3%)</td>
<td>16 (32.7%)</td>
</tr>
</tbody>
</table>

Table (5): Total number of implants in esthetic zone.

<table>
<thead>
<tr>
<th>Age</th>
<th>Maxilla</th>
<th>Mandible</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-30</td>
<td>7 (43.7%)</td>
<td>7 (43.7%)</td>
<td>6 (9.9%)</td>
</tr>
<tr>
<td>31-40</td>
<td>12 (33.4%)</td>
<td>21 (55.3%)</td>
<td>6 (0.9%)</td>
</tr>
<tr>
<td>41-50</td>
<td>2 (5.0%)</td>
<td>20 (50.0%)</td>
<td>1 (2.5%)</td>
</tr>
<tr>
<td>50-65</td>
<td>23 (25.3%)</td>
<td>5 (11.4%)</td>
<td>13 (29.5%)</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>63</td>
<td>36</td>
</tr>
</tbody>
</table>

Discussion

Immediate placement of the implant can act as a treatment option only when clinical criteria are met stringently, like the integrity of the adjacent teeth’s bone peaks, the buccal bone plate integrity, thick gingival biotype, integrity of soft tissue (adequate amounts of keratinized gingiva, interdental papillae, and gingival scallop) (Quirynen, 2007). This approach provides several benefits such as shorter treatment times, similar survival rates when compared with the delayed implantation procedures (Wong Lee, 2009), and a decrease in the number of invasive surgeries, subsequently mitigating patient discomfort as well as preserving the height and width of buccal bone as well as soft tissues profile (Perez, 2018) and nearly no disadvantage versus traditional approaches. The most prominent disadvantages include delay in early bony support with a gap between the fixture and the extraction socket as well as likely deficiencies concerning the peri-implant keratinized gingiva, which could raise the risk of implant loss and infection (Perez, 2018).
The phenomenon related to integration with surrounding tissue determines the success of immediately placing the implant at the extraction site (Parithimarkalaignan, 2013). By modifying the tissue architecture, the primary concern regarding to maintaining good results can be achieved. These alterations with regards to tissue architecture may happen post or before the tooth extraction process via gingival recession that facilitates loss of buccal or interproximal tissue, or via bone remodelling or resorption (Budhiraja, 2021). Various proposed benefits are involved in the immediate implant placement as well as restoration of a single implant in the aesthetic zone, such as fewer surgical procedures, decreased overall treatment time, greater patient satisfaction, and less traumatic surgery in this treatment (Mehta, 2015; Nørgaard, 2022). The patient needs to be informed regarding the aesthetic risk involved in the implant process when choosing the maxillary anterior single-tooth implant therapy. Numerous single implants were carried out connected to the aesthetic zone in our study, wherein we considered suitable surgical and restorative procedures, careful case selection, clinical experience, and suitable implant design and surface (Meng, 2021; Brägger, 2005; Negri, 2014). A key role is played by the anterior maxilla, also referred to as the aesthetic zone, in the smile and facial aesthetics. With regards to a dental implant, this study evaluated the frequency referred to implant treatments with a focus on the aesthetic zone of patients. Both functional osseointegration and satisfactory aesthetic outcomes are key to the success of dental implant therapy in the aesthetic zone. It is very difficult to maintain balance, harmony, and continuity of gingival architecture between the adjacent natural dentition and implant restoration. Also, it should be noted that this is a complex procedure that needs high surgical skills, even when all the clinical conditions concerning immediate placement are set (Buser, 2017). The current study also aimed to assess the impacts cast by age during implantation on gender. It was found that higher implantation was recorded for the age group 31-40 years amongst female predilection with regards to all age groups (Alhamdani, 2021; Álvarez-Camino, 2013). For implant restoration, age is regarded to be a key factor, since it is a fact that with ageing bone, mass density also decreases, which is common with age-related osteoporosis in both female and male patients. Age-related bone loss is prominent in the cancellous compartment due to several mechanisms like direct control of osteoclast activity on trabecular bone as well as increased oxidative stress but has been found to limitedly impact cortical bone (Guarnieri, 2013). In the current study, the high prevalence related to the placement of implants in the anterior maxilla also signifies a high incidence of anterior tooth loss, which could be because of poor oral hygiene or trauma (Rasouli Ghahroudi 2015; Alhamdani, 2021). Regarding implant therapy in the aesthetic region, the most challenging goal would be maintaining the hard and soft tissue stability for a long duration. A commonly reported complication post-immediate placement of the implant is the midfacial mucosal recession. When implants are placed in the cingulum position, it often leads to a gap between the labial cortical plate and the implant. Histological and clinical studies have reported significant changes in ridge dimension after tooth extraction, while bone augmentation is regarded to be optimum in encouraging bone fill as well as the resolution of defects at immediate implant sites (Kim, 2022; Khzam, 2015).

Conclusions
There is a female predilection for immediate implantation in the maxillary aesthetic zone, middle-aged females in particular. Acknowledgements Thanks to the co-authors for their support and special thanks to the Modern Specialized Dental Clinic to the Director of the Dental Department In Al Hadi Collage and with all respect to the Dean of Al Hadi Collage
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