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EUR@SIAN DENTAL RESEARCH

VOLUME 2
ISSUE 2

ISSN
2980-2091

EUR@SIAN DENTAL RESEARCH

August 2024, Volume 2, Issue 2

Publisher
Biruni University Faculty of Dentistry

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Designer
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The publication languages of the journal English.

This is a scholarly, national, peer-reviewed and open-access journal published triannually in April, August and December

Publication Type: Periodical

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FROM THE EDITOR

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Prof. Dr. İlknur ÖZCAN
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CASE REPORTS

https://doi.org/10.62243/edr.1522985

Dimensional Stability of Additively Manufactured Maxillary Dental Casts for a Three-unit Fixed Partial Denture Fabricated with Different Build Orientations

Münir DEMİREL[1], Almira Ada DİKEN TÜRKSAYAR[1], Mustafa Borga DÖNMEZ[1]

Abstract

Aim This study evaluated the dimensional stability of maxillary dental casts used for a 3-unit fixed partial denture across four build orientations (0°, 30°, 45°, and 90°).

Material and method An upper jaw typodont with tooth preparations for a posterior 3-unit fixed partial denture was scanned by using an industrial scanner. The resulting scan file was nested with different orientations (0°, 30°, 45°, and 90°) and the casts were additively manufactured by using a digital light processing 3-dimensional (3D) printer (n = 7). Subsequently, all additively manufactured casts were scanned with the same scanner at 3 different time points (after fabrication, 1 month after fabrication, and 3 months after fabrication) and the deviations at the fixed partial denture region were assessed with the root mean square (RMS) method. Statistical analysis was performed using a generalized linear model at a significance level of $\alpha = 0.05$.

Results The build orientation and the time point significantly affected the RMS values ($P<.001$). However, the interaction between the main factors did not affect the RMS values ($P=.808$). Among tested build orientations, 0° led to the lowest and 90° led to the highest RMS ($P\leq.001$). In addition, casts with 30° build orientation had lower RMS than those with 45° ($P<.001$). Tested casts had their lowest RMS after fabrication ($P\leq.006$).

Conclusion Dimensional stability of tested casts decreased with increased build orientation. The dimensional stability of tested casts decreased 1 month after fabrication and did not change 3 months after fabrication.

Keywords Additively manufactured cast, Build orientation, Digital light processing, Preparation, Stereolithography

Introduction

Computer-aided design and computer-aided manufacturing (CAD-CAM) technologies have facilitated the digitization of intraoral conditions with intraoral scanners (IOSs) or extraoral scanners (1). These advancements have turned direct digital workflow into a viable alternative as using an IOS to digitize a patient's intraoral condition minimizes the drawbacks associated with conventional impressions (2), which are inconvenient for patients. In addition, generating virtual intraoral data eliminated the time-consuming fabrication of stone casts along with the space needed to store these casts (3-6). However, for those cases that require physical casts, additive or subtractive manufacturing can be used. CAD-CAM technologies have transformed dental practices by enabling digital workflows, minimizing the limitations of conventional impressions, and reducing material waste through additive manufacturing (AM) (7-9). Vat polymerization is a commonly used additive manufacturing method to fabricate dental casts where a photosensitive resin is polymerized layer by layer inside a vat using a light source (10,11). Among the vat polymerization technologies, digital light processing (DLP) has gained prominence in dentistry due to its capacity to reduce manufacturing time and produce intricate objects with smooth surfaces (12-15) .

The trueness of AM dental appliances has been reported to be influenced by several factors, one of which is the resin used (16). Another factor is the build orientation, which is the position of the AM object with respect to the build platform and is an adjustable parameter. The build orientation also affects the duration of the process and resin used due to the modification of the geometry, which results in a different number of layers. While previous studies investigated the impact of build orientation on the trueness of dentate casts (6-7, 17-20), the effect of this factor on the trueness of definitive casts for dental protheses remains unknown.

A dental cast should not only closely approximate the intraoral situation for accurate diagnosis but also should possess sufficient dimensional stability for long-term evaluation. However, the accuracy of AM molds can be compromised due to uneven layer deposition (20). Previous studies have investigated the fabrication accuracy of AM dental casts (5,6,15); while previous studies have examined the fabrication accuracy of these molds, their dimensional stability has not been extensively studied (21). Additionally, studies on the dimensional stability of AM casts have not included 3-unit fixed partial denture constructions (21-22).

A study examining the impact of build orientation on the accuracy of final casts with a 3-unit fixed partial denture prepa-

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Received: 28.07.2024 / Accepted: 02.08.2024 / Published: 30.08.2024

ration could enhance the knowledge base of clinicians and dental technicians, potentially streamlining the daily cast fabrication process. Accordingly, the objective of the present study was to assess the impact of build orientation on the dimensional stability of AM definitive casts for a 3-unit fixed partial denture over the course of three months. The null hypothesis was that the build orientation and the time point would not affect the dimensional stability of AM casts for a 3-unit fixed partial denture.

Material and Methods

A priori power analysis (α=.05, 1-β=95%, f=0.68) was performed with the results of a previous study on the effect of print orientation on the fabrication trueness of maxillary casts, and 7 samples per group were considered sufficient (20). A master maxillary typowdont (Dentsply Sirona, Bensheim, Germany) with a prepared right first premolar and right first molar for a 3-unit fixed partial denture was scanned with an industrial scanner (Artec Micro; Artec 3D, Luxembourg City, Luxembourg) to an accuracy of 10 μm (21). The manufacturer's proprietary software (Artec Studio v17; Artec 3D, Luxembourg City, Luxembourg) was used to generate a reference standard tessellation language (STL) file (R-STL). This R-STL was used as the basis for the production of final casts using a DLP-based 3D printer (MAX UV; Asiga, Sydney, Australia).

To produce the casts, the R-STL was imported into the nesting software of a DLP 3D printer (Composer v1.3; Asiga, Sydney, Australia) and positioned on the build platform in 4 different orientations (0°, DLP-0 ; 30°, DLP-30; 45°, DLP-45; 90°, DLP-90) (n=7) (Figure 1). The manufacturer-specific dental model resin (DentaMODEL; Asiga, Sydney, Australia for the DLP 3D printer) with a layer thickness of 100 μm was used to fabricate the specimens (4,8) after the nesting software automatically generated the supports for each orientation. After fabrication, the casts were ultrasonically cleaned (Wash & Cure 2.0; Anycubic, Shenzhen, China) in isopropyl alcohol for 10 minutes (5 minutes pre-wash and 5 minutes post-wash) and post-polymerized by using a xenon polymerization device (OtoFlash G171; NK Optik GmHb, Baierbrunn, Germany) under a nitrogen oxide gas atmosphere for 4000 flashes (2000×2). Within 48 hours of fabrication, all casts were scanned using the same industrial scanner to generate cast STLs (C0-STLs). The same industrial scanner was used to re-scan all the casts to generate cast STLs 1 month (C1-STLs) and 3 months (C2 STLs) after fabrication and all casts were stored in light-proof boxes at room temperature until the second and the third scans (22). After all scans were completed, the R-STL and C-STLs (C0-STLs, C1-STLs, C2-STLs) were imported into a metrology-grade analysis software (Geomagic Control X v.2022.1.1; 3D Systems) for deviation evaluation. The R-STL served as the reference file and was automatically segmented using the software's auto-segment feature within the region tool. Segmented regions were merged to individually define the fixed partial denture preparations and the remaining surfaces on the dental arch. Alignment of the C-STLs (C0-STLs, C1-STLs, C2-STLs) over the R-STL was achieved by using the software's automated quick initial alignment and iterative closest point-based best-fit alignment tools. After alignment, the software's "3D Compare" tool generated color maps indicating deviations, with red indicating over-contoured surfaces, blue indicating under-contoured surfaces, and green indicating acceptable deviations. Deviations at the fixed partial denture region were automatically calculated using the root mean square (RMS) method (Figure 2). Throughout the process, all scanning and analysis was performed by a single experienced prosthodontist (M.D.).

Normality of data distribution was confirmed using the Shapiro-Wilk test. Subsequently, a generalized linear model analysis test was used to evaluate the data. The analysis included build orientation and time point as main factors and also involved their interaction. Statistical analyses were performed by using SPSS v25 (IBM Corp) with a significance level of α = 0.05.

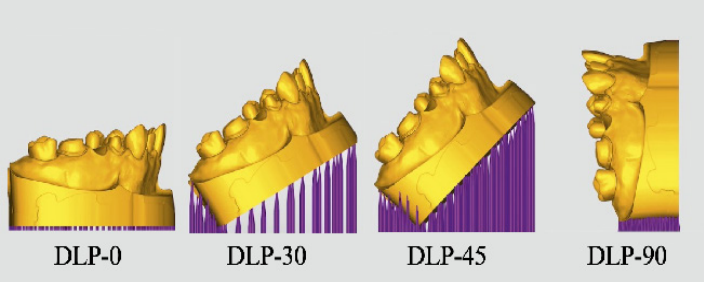

Figure 1: Print orientations with supports of different designs and numbers

Results

Table 1 shows the descriptive statistics of measured deviations. The generalized linear model analysis revealed that the build orientation and time point affected RMS values (P<.001). However, the interaction between these factors did not affect the RMS values (P=.808). DLP-0 casts had the lowest and DLP-90 casts had the highest RMS values (P≤.001), while DLP-45 casts had higher RMS than DLP-30 casts (P<.001). All casts had their lowest RMS values after fabrication (P≤.006) and the difference between the remaining time points did not affect the RMS values (P=.654).

Table 1: Mean±standard deviation RMS values (μm) within each material-time point pair

Build orientation	Time point			Total
	After fabrication	1 month after fabrication	3 months after fabrication	
0°	43.4 ± 3.8	47.9 ± 4.4	54.7 ± 13.4	48.7 ± 5.3^{A}
30°	54.8 ± 9.1	60.0 ± 10.7	61.0 ± 10.8	58.6 ± 10.1^{B}
45°	69.0 ± 14.2	76.3 ± 12.3	77.3 ± 11.7	74.2 ± 13.4^{C}
90°	120.5 ± 10.7	132.8 ± 9.9	134.3 ± 9.1	129.2 ± 11.3^{D}
Total	71.9 ± 31.5a	79.3 ± 34.4b	81.8 ± 33.7b	

Different superscript lowercase letters indicate significant differences among building orientations, while different superscript uppercase letters indicate significant differences among time points. Total values are derive from the pooled data of each build orientation and time point (P<.05).

Discussion

The null hypothesis of the present study was rejected as tested build orientations and time points affected the fabrication trueness of tested maxillary definitive casts for 3-unit fixed partial dentures. DLP-0 casts exhibited the highest dimensional stability, while DLP-90 casts showed the lowest. DLP-30 casts were more stable than DLP-45 casts. The highest dimensional stability of test-

ed casts was observed after fabrication.

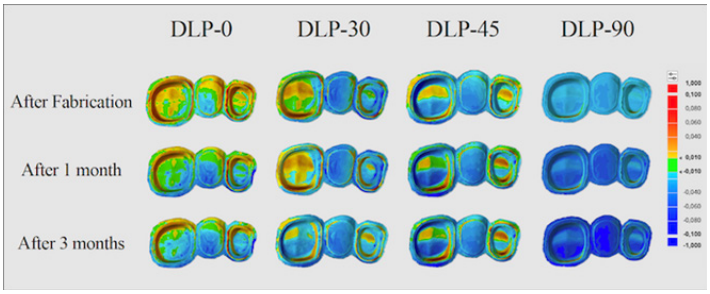

Figure 2: Representative color map of each build orientation-time point pair

A possible explanation for the significantly lower dimensional stability of DLP-90 casts may be the positioning on the build platform, which might can exacerbate the staircase effect, which refers to the loss of geometric accuracy in vertical direction (18). In addition, DLP-90 casts required the highest number of layers and thereby the longest duration for the fabrication, which might have amplified the distortions caused by printing errors and gravity, particularly considering that those casts were printed with the least number of automatically generated supports (Figure 1). Changing the build orientation may have also affected the number of overhangs in the area of interest and 0° build orientation may have improved the overlapping of successive layers and minimized the staircase effect. The gradual decrease of dimensional stability with increased build angle also supports this hypothesis. Nevertheless, the greatest mean deviation of tested casts was 134.3 µm (DLP-90, 3 months after fabrication), which is lower than the previously reported 200-µm threshold value for an additively manufactured cast to be used for prosthetic applications (23). Therefore, it can be stated that tested casts are suitable for prosthetic applications, even 3 months after fabrication.

A qualitative evaluation of the color maps would enhance the interpretation of the differences among test groups, providing insight into the measured deviations and potential clinical implications. Yellow and green were evident on DLP-0 casts, which indicate slight overcontours and acceptable deviations. However, overcontours might lead to fit issues of the restorations to be adjusted on DLP-0 casts and intaglio surface adjustments may be required. These potential adjustments might result in increased cement gap that could lead to retention-related issues. The color distribution of the remaining groups was predominantly blue, indicating undercontours that may be related to the abovementioned causes of deviation, with limited overcontours in the first molar tooth preparation of DLP-30 and DLP-45 casts. After seating fixed partial dentures on DLP-30, DLP-45, and DLP-90 casts, the pontic area may require additional veneering, given the dominant blue on all these casts at this region. However, this additional veneering might impair cleanability and result in excessive soft tissue contact if not adjusted intraorally. Regardless of the build orientation, the magnitude of blue increased with consecutive time points that may indicate dissolution. The fact that all casts were stored in light-proof boxes corroborate this interpretation as additional shrinkage caused by direct exposure to light was eliminated. However, future studies that primarily focus on this aspect are needed to substantiate this hypothesis. Nevertheless, increased undercontours would potentially require more veneering at the pontic region. In addition, the undercontoured abutment teeth might lead to perception of lower retention and cause remakes (Figure 2).

Previous studies have investigated the effect of 3D printing technologies, but few have examined print orientation as a contributing factor to the accuracy of AM casts (7,17,20,24). Maneiro Lojo et al. (16) evaluated partially edentulous maxillary casts and found that a 90-degree print orientation using a liquid crystal display (LCD)-based 3D printer resulted in the lowest accuracy. Another study using an LCD-based 3D printer showed that maxillary implant casts with a single implant in the central incisor region achieved higher accuracy with a 45-degree print orientation compared to 0-degree and 90-degree orientations (7). In addition, research on dentate casts has shown that the effect of print orientation (0 degree, 45 degree and 90 degree) varies depending on the tooth type (24). Ko et al. (17) investigated print orientation (0-degree, 30-degree, 60-degree and 90-degree) and layer thickness (20 µm, 50 µm and 100 µm) using a DLP-based 3D printer not included in the current study. They reported that casts with 0-degree print orientation and 20 µm layer thickness had lower fidelity, which they attributed to potential over-polymerization due to light bleeding through thin layers (17). Another study focused solely on removable dies when evaluating fabrication fidelity with different 3D printers (2).

Although the present study tested a well-established and widely used 3D printer, the limited number of printers was a limitation. Tested build orientations were deliberately chosen to avoid creating support structures on prepared teeth, the area of primary interest; however, different orientations could influence the results. Future research should extend the findings of this study by including other 3D printers using different technologies and model resins. In addition, future studies should evaluate the fit, occlusal contacts, interproximal contacts, and efficiency of adjustments for restorations fabricated or adjusted using these casts.

Conclusion

Within the study's limitations, the following conclusions were drawn:

1. Increased build orientation gradually decreased the dimensional stability of tested additively manufactured casts as the dimensional stability of tested casts in terms of build orientation was 0°, 30°, 45°, and 90° in decreasing order.

2. Regardless of the build orientation, the dimensional stability of tested casts decreased 1 month after fabrication and did not change 3 months after fabrication. However, the measured deviations were within previously reported thresholds regardless of the build orientation and time point.

Declarations

Author Contributions: *Conception/Design of Study- M.D., M.B.D.; Data Acquisition- M.D., A.A.D.T.; Data Analysis/Interpretation- A.A.D.T.; Drafting Manuscript- M.B.D.; Critical Revision of Manuscript- A.A.D.T., M.B.D.; Final Approval and Accountability- M.D.,*

A.A.D.T., M.B.D.; Material and Technical Support- M.D., A.A.D.T.; Supervision- M.B.D.

Conflict of Interest: *Authors declared no conflict of interest.*

Financial Disclosure: *Authors declared no financial support.*

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https://doi.org/10.62243/edr.1507278

In Vitro Investigation of the Effect of Different Surface Pretreatments, Materials, and Bonding Systems on Shear Strength in the Repair of Restorations

Didar Dilan HARTAVİ[1,2], Murat TİRYAKİ[1]

Abstract

Aim The purpose of our study is to investigate the adhesive strength of commonly used ceramics in clinics with different surface treatments and using dental materials for repairs

Material and method Our study was conducted on 16 experimental groups, each comprising 7 test specimens. The experimental group specimens consisted of restoration material, adhesive system, and repair material, resembling a restoration repair application. The Vita VMK 95 slated for repair was utilized. Surface pretreatment included roughening with a bur, application of hydrofluoric acid, and silanization process. As for the repair material, composite, flowable composite, compomer, and flowable compomer were employed. To facilitate the bonding of the repair material to the restoration material, or total-etch and self-etch systems were applied. Following the completion of restoration and repair procedures, the test specimens were affixed to a Shimadzu Autograph AG-X (Shimadzu Corp., Japan) universal testing machine to measure their shear bond strengths. The evaluation of measurement results related to Kruskal-Wallis test for inter-group comparisons and Dunn's multiple comparison test for subgroup comparisons. The results were assessed at a significance level of $P < 0.05$, with a confidence interval of 95%.

Results TAll groups prepared with hydrofluoric acid and silanization (14,996±2,756) exhibited higher shear bond strength compared to all groups prepared with bur roughening (8,378±0,795).

Conclusion In the repair of ceramic restorations, the application of hydrofluoric acid and silan to the surface should be preferred over surface roughening with a bur in terms of shear bond strength.

Keywords Ceramic repair, Hydrofluoric acid, Shear bond strengths, Silanization, Surface pretreatments

Introduction

Metal-ceramic and full-ceramic restorations are the most commonly preferred materials in fixed restorations (1). The reason for this is that among all materials used for aesthetic purposes in fixed prostheses, ceramic provides the best color match with natural teeth. Their non-absorbent nature and excellent tolerance by oral tissues are important characteristics (1-4).

However, despite the robust structure of ceramic material, breakage can occur in 18% of cases due to the following reasons:

Occlusal forces, trauma, inappropriate metal substructure design, inadequate preparation, microporosity, incompatibility of thermal expansion coefficients between ceramic and metal substructure (5-7).

Fractures may be limited to the ceramic structure or may result in exposure of the metal substructure fractures. Depending on the shape and localization of the fracture, options such as complete replacement of the restoration, removal of the restoration from the oral environment for repair in the laboratory (indirect method), or repair with in the oral cavity (direct method) are available (7). Consideration should be given to possible weakening of the ceramic structure due to additional trauma during removal of restorations for repair in the laboratory and repeated firing cycles (8).

The procedures requiring repair are listed below: Inadequate tooth preparation, inappropriate metal design, insufficient metal support, micro defects in ceramic, inappropriate thermal expansion coefficients, occlusal conflicts, excessive biting forces, trauma (10).

Advancements in adhesive technology and new composite resin materials allow for the repairing of broken pieces without removing fixed prosthetic restorations from the intraoral (9, 10). For successful repair using the direct method, proper surface pretreatment and application of a high-quality bonding system are crucial (11).

The choice of surface pretreatment method depends on the shape of the fracture and the adhesive system used. Studies examining the shear bond strengths of composites on ceramic surfaces with different surface treatments have reported that the most effective surface treatment is etching (12,13,15).

The roughening process using only HF acid is indicated

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Received: 29.06.2024 / Accepted: 07.07.2024 / Published: 30.08.2024

for feldspathic porcelains. To maximize the bonding durability to the prepared ceramic surface, the use of a silane bonding agent is inevitable. Silane provides both chemical covalent and hydrogen bonding, while also increasing the wettability of the ceramic surface (14). Acid etching is effective when the fractured surface contains only ceramic.

Another factor influencing the bonding strength of the repair material to ceramic is the structure of the restorative material used for repair and its polymerization depth. Hybrid composite resins used in intraoral repair of ceramics generally provide higher bond strength compared to microfilled resins (15).

When considering the indication for repair, it is crucial to thoroughly address the selection of the repair material, taking into account not only its aesthetic and other physical properties but also the adhesive and surface pretreatment methods that would promote better adhesion to the tooth. Additionally, careful attention should be given to the potential presence of microleakage at the interface between the old and new restorations (15).

The shear bond strength, especially between the old restoration and the repair material, holds significant importance in this regard. In our study, we aimed to comparatively evaluate which surface pretreatment and bonding system (total-etch system and self-etch system) along with which restoration material (composite, flowable composite, compomer, and flowable compomer) would yield better results.

The hypothesis of this study is that repair will be done using different surface treatments and adhesive systems and their combinations, but it is thought that the shear forces of the groups using hydrofluoric acid and silane as surface pretreatment will be higher.

Material and Methods

In our study, the minimum number of samples in each subgroup was determined as 7 using the G*Power statistical program, conducted on a total of 16 experimental groups, the experimental group samples comprised of restoration material, bonding agent, and repair material, resembling a restoration repair application, while the control group samples consisted solely of restoration material.

The design of the experimental groups considered the following elements:

1. Ceramic
2. Surface pretreatment and bonding system
3. Repair material

Ceramic materials repaired with the resin base surfaces of using various surface pretreatment techniques and different bonding agents (Table-1).

Ceramic material slated for repair was used in the study. Surface pretreatment included roughening with a bur, application of hydrofluoric acid, and silanization process.

Composite, flowable composite, compomer, and flowable compomer were used as repair materials. Total-etch and self-etch systems were applied to ensure bonding of the repair material to the restoration material (Table-2).

Ceramic discs were prepared using a lathe, with an inner circle of 10mm in diameter and 4mm in height made from stainless steel. Vita VMK 95 dentin ceramic was mixed with a special liquid to obtain ceramic dough. The porcelain discs were heated in a Vita Vacumat 250 ceramic furnace. After the heating process was completed, 112 ceramic discs were obtained. These discs were embedded in acrylic resin to be attached to the holder piece prepared for the testing apparatus (Figure-1).

Table 1: Ceramic Experimental Group

Expertimental Group Number	Surface Pretreatment	Bonding System	Repair Material
1	HF acid+silane	Total etch	Composite
2	HF acid+silane	Total etch	Flowable Composite
3	HF acid+silane	Total etch	Compomer
4	HF acid+silane	Total etch	Flowable Compomer
5	HF acid+silane	Self etch	Composite
6	HF acid+silane	Self etch	Flowable Composite
7	HF acid+silane	Self etch	Compomer
8	HF acid+silane	Self etch	Flowable Compomer
9	Roughening with a bur	Total etch	Composite
10	Roughening with a bur	Total etch	Flowable Composite
11	Roughening with a bur	Total etch	Compomer
12	Roughening with a bur	Total etch	Flowable Compomer
13	Roughening with a bur	Self etch	Composite
14	Roughening with a bur	Self etch	Flowable Composite
15	Roughening with a bur	Self etch	Compomer
16	Roughening with a bur	Self etch	Flowable Compomer

Following these procedures, the acrylic blocks containing the prepared ceramic discs were divided into 16 groups, with 7 samples in each group.

Two different surface pretreatment methods were applied in the study: Roughening with a bur, application of hydrofluoric acid and silan.

Figure 1: Finished leveled blocked sample

The experimental samples constituting the group of roughening with a bur were subjected to surface roughening using a coarse-grit diamond bur (6805 314 014 Komet, Lemgo-Germany) with a particle size of approximately 200μ, after being immersed in water at 37°C for 3 months.

By soaking the samples in water for 3 months, the research also aims to see the effect of short-term aging on shear forces (20,21) Before applying any bonding agent for the final surface cleaning, the surfaces were etched with 37% phosphoric acid (Uni-etch, Bisco) for 60 seconds. Following etching, the surfaces

were rinsed for 15 seconds and dried for 5 seconds. Before the repair preparation of the ceramic restoration material, hydrofluoric acid was applied to the surfaces of 8 ceramic groups after being immersed in water at 37°C for 3 months. In all groups, 5% hydrofluoric acid (IPS Ceramic, Ivoclar Vivadent) was applied. After allowing the hydrofluoric acid to left on the surface for 2 minutes, it was thoroughly rinsed with plenty of water using an air-water spray, followed by drying for 5 seconds.

Table 2: Repair Materials

Flowable composit	Filtek Supreme XT Flowable (3M ESPE, U.S.A.)	
Compomer	Dyract EXTRA (Dentsply, Germany)	
Flowable Compomer	Dyract Flow (Dentsply,Germany)	
Composite	Filtek Supreme XT (3M ESPE-,U.S.A.)	
Ceramic	Vita VMK 95 (VİTA Zahnfabrik, Bad Sackingen, GERMANY)	
Hidroflorik acid	IPS Ceramic,(Ivoclar Vivadent)	Left on the surface for 2 minutes, washed, dried for 5 seconds
Silan Bondin agent	Monobond S (Ivoclar Vivadent, Liechtenstein	It was applied to the surface with the help of a brush, remained on the surface for 60 seconds, and dried for 5 seconds with an air-water spray
Total-etch adhesive system	Adper Single Bond 2(3M ESPE-,U.S.A.)	2 coats, 20 sec were applied to the restorationAir was applied and polymerized with 10 sec LED from 1mm distance2 coats, 20 sec applied to the restorationAir was applied and polymerized with 10 sec LED from 1mm distance
Self-etch adhesive system	Clearfil SE Bond (Kuraray,Japan)	It was applied in two stages.First, the primer was applied and dried with air after 30 seconds, then the adhesive was rubbed for 20 seconds and polymerized with LED from 1mm distance.
Ultradent apparatus	(Ultradent Products Inc, SJ, Utah)	

Subsequently, a silane bonding agent, specifically Monobond S (Ivoclar Vivadent, Liechtenstein), which facilitates the bonding of ceramic to composite resin, was applied to the surfaces previously treated with acid. Standardization was achieved for these procedures using an Ultradent bonding apparatus.

The experimental specimens, after completion of restoration and repair procedures, were secured in the Shimadzu Autograph AG-X (Shimadzu Corp., Japan) universal testing machine to measure their shear bond strengths. The device was set to a speed of 0.5 mm/min, and force was applied until the samples fractured. The values at the point of fracture were recorded in Kilonewtons. The results in Kilonewtons were first converted to Newtons, and after determining the cross-sectional area, they were subsequently converted to Megapascals (MPa). Measurement results related to shear strength were evaluated using descriptive statistical methods (mean, standard deviation), as well as Kruskal-Wallis test for inter-group comparisons and Dunn's multiple comparison test for subgroup comparisons.

When the fracture types of the test specimens were examined under a stereo light microscope (Olympus SZ-61, Olympus Corporation,Japan), adhesive failure, cohesive failure in the restoration material, cohesive failure in the repair material, and mixed failure types were identified. The distribution tables of fracture types are provided below.

Results

The means and standard deviation values of the shear bond strength results obtained after immersing the repaired ceramic test specimens in distilled water at 37°C for 7 days are provided below. The highest values in terms of shear bond strength for ceramic restoration material in the experimental groups were approximately achieved in the groups repaired using a flowable composite (15 MPa), flowable compomer (14.7 MPa), compomer (13.2 MPa), and composite (13 MPa), with ceramic treated with hydrofluoric acid and silane, employing a self-etch adhesive system. The lowest value was observed in the group repaired with composite using a total-etch adhesive system on a ceramic surface roughened with a bur. In the repair groups where surface roughening was performed with a bur, shear bond strength values were below 8 MPa except for the group repaired with compomer using a total-etch adhesive (Table-3).

Table 3: Shear strength resistance values (MPa) and standard deviations in groups

Experimental group number	Surface pretreatment	The adhesive used	The repair material	Shear strength resistance (Mpa)	Standard deviation (+/-)
1	HF acid+silane	Total etch	Composite	11,189	1,914
2	HF acid+silane	Total etch	Flowable composite	10,767	1,205
3	HF acid+silane	Total etch	Compomer	11,240	2,083
4	HF acid+silane	Total etch	Flowable compomer	8,952	1,661
5	HF acid+silane	Self etch	Composite	12,950	2,406
6	HF acid+silane	Self etch	Flowable composite	14,996	2,756
7	HF acid+silane	Self etch	Compomer	13,241	1,357
8	HF acid+silane	Self etch	Flowable compomer	14,625	1,394
9	Bur for roughening	Total etch	Composite	3,566	0,705
10	Bur for roughening	Total etch	Flowable composite	4,969	0,814
11	Bur for roughening	Total etch	Compomer	8,378	0,795
12	Bur for roughening	Total etch	Flowable compomer	6,347	0,708
13	Bur for roughening	Self etch	Composite	5,627	1,307
14	Bur for roughening	Self etch	Flowable composite	7,919	0,711
15	Bur for roughening	Self etch	Compomer	7,091	1,014
16	Bur for roughening	Self etch	Flowable compomer	6,081	1,377

Statistically, there is no significant difference ($p > 0.05$) in the choice of repair material, whether composite, flowable composite, compomer, or flowable compomer, along with either total-etch or self-etch systems, following the application of hydrofluoric acid and silane to ceramic restorations.

Discussion

In today's modern dentistry concept, it may not always be the correct approach to remove and replace a restoration with a new one in every case where a defect arises and there can be some loss in clinical performance. Removing a defective restoration and replacing it with a new one can also lead to complications such as loss of tooth substance and decreased resistance or irritation of the pulp in the future (15). In such cases, utilizing today's adhesive dentistry products and application methods, it becomes relevant to consider performing a repair by only removing the defective area or secondary caries and integrating it with the existing restoration, without necessarily removing the entire restoration (15).

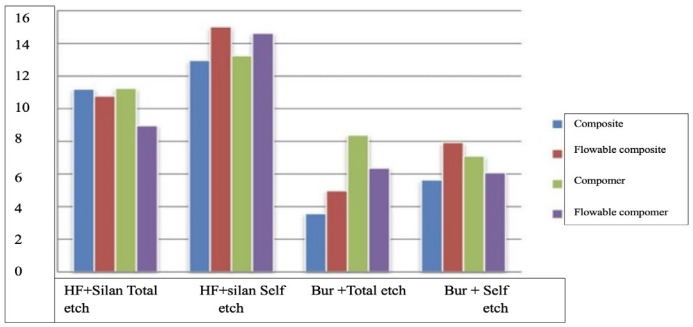

Figure 2: Graphic of shear strength resistance of repair materials grouped by different surface pretreatments and the use of different adhesives in ceramic experimental groups (MPa)

For these reasons, in cases of potential performance loss in restorations, instead of creating a new restoration, a more conservative or, using alternative terminology, a minimally invasive approach has been planned. This approach involves the removal of only the defective area and its repair using different dental materials. An in-vitro study has been designed to investigate this approach. In our study, the performance of the repair was examined in terms of shear bond strength between the bonding surfaces of old and new restoration materials. The shear bond strength of ceramic material alone is 128 MPa (16). All groups prepared with hydrofluoric acid and silane exhibited higher shear bond strength compared to all groups subjected to surface roughening with a bur. Except for the group where the surface prepared with hydrofluoric acid and silane was bonded with a total-etch adhesive and flowable compomer, all other groups yielded values above 10 MPa (Figure-2).

However, it is expected that when the repair material is bonded to the ceramic restoration, the interface between the two materials will not exhibit the same strength. What matters is the ability of the repair to withstand the shear forces that will be exerted on this area during static and dynamic occlusion in the patient's mouth. In such studies, hydrofluoric acid is commonly utilized to create retentive microporosities on the ceramic surface, whereas phosphoric acid is generally employed for surface cleaning purposes. In our study, we applied phosphoric acid as a standard surface treatment on all experimental groups where the total-etch system was used. However, following the treatment akin to hydrofluoric acid etching, we applied the silane agent, which is commonly used together in the literature.

Aging is used in many repair procedures. In our study, we kept them in distilled water for 3 months, and in many studies, when the samples were aged and the shear forces were examined, it was observed that there was a decrease compared to the control group (20,21). Our hypothesis is that the groups with chemical surface treatment (hydrofluoric acid and silane) will give superior bond strength than the groups with mechanical surface treatment (roughening by bur) and our hypothesis has been accepted. Researchers investigated the effect of different surface treatments on the shear bond strength of polymer infiltrated ceramic material. According to the findings of the study, the best surface treatment for polymer infiltrated ceramic material was reported to be application of HF acid followed by adhesive application. The baseline results showed that the mean SBS values for etching and hydrofluoric acid showed higher SBS than HF +Ultradent porcelain repair and grinding with diamond bur ($p<0.05$) (17). Fracture types are shown in the chart (Figure-3).

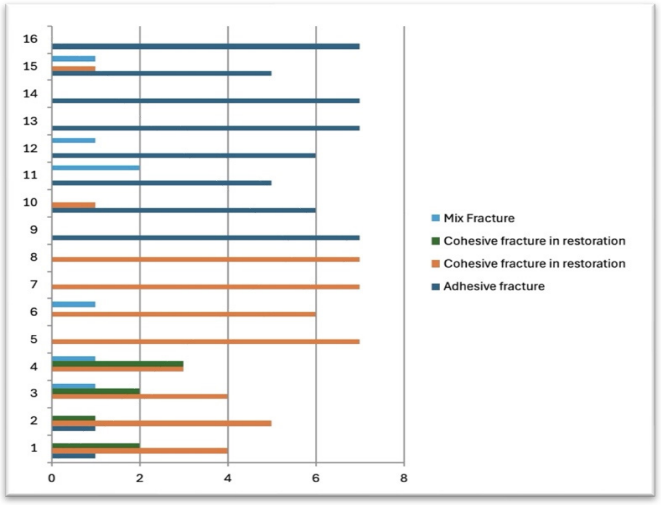

Figure 3: Distribution according to fracture types

In a study, the bonding mechanism between resin composites and polymer infiltrated ceramic material was investigated. It was reported that HF acid application increased shear bond strength, but post-acid etching silane application significantly further increased shear bond strength values. It was concluded that the chemical bonding between silicate and silane could be responsible for this increase (18). In our research, unlike other studies focusing on repair procedures, we also incorporated the use of compomer material. When ceramic restorations are repaired with surface pretreatment using hydrofluoric acid and silane, the use of compomer with a self-etch adhesive system yields high values in terms of shear bond strength within its own category. The highest value found in the repair of ceramic material was 15 MPa. Therefore, it is advisable not to perform repairs on ceramic restorations in areas where the repair is subjected to the stresses of occlusal forces. Additionally, regular monitoring of the clinical performance of the restoration at specific intervals is beneficial. In our study, we used HF+silane and bur roughening methods as surface treatment, but surface treatments such as air abrasion and laser roughening, which are frequently preferred by researchers, can be performed and long-term bond strengths can be examined by aging with thermal cycles.

Conclusion

There was no significant difference in terms of bonding strength among materials after applying surface treatment to ceramic material and restoring it with different materials (p>0.05). In the groups where HF + silane and self-etch were used, the resistance to shear force gave higher values. The lowest values were obtained in the groups where bur roughening and total etch system were used. After the pretreatment of the ceramic with hydrofluoric acid and silane, there was no significant difference in terms of the resistance of the use of different adhesive systems to shear forces.

Declarations

Author Contributions: *Conception/Design of Study- D.D.H.; Data Acquisition- D.D.H.; Data Analysis/Interpretation- D.D.H.; Drafting Manuscript- D.D.H.; Critical Revision of Manuscript- M.T.; Final Approval and Accountability- D.D.H.; Material and Technical Support- D.D.H.; Supervision- M.T.*

Conflict of Interest: *Authors declared no conflict of interest.*

Financial Disclosure: *Authors declared no financial support.*

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https://doi.org/10.62243/edr.1494530

The Prevalence of Peg-shaped Maxillary Permanent Lateral Incisors in the Turkish Population

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Abstract

Aim The development of human dentition is influenced by a complex interplay of diverse factors spanning epigenetic, environmental, physical, chemical, biological, and genetic realms. Variations in the morphology and dimensions of upper lateral incisors have been documented, commonly resulting in a reduction in mesiodistal size, a phenomenon often referred to as "peg-shaped laterals". This study aimed to explore the prevalence of peg-shaped maxillary permanent lateral incisors while investigating potential correlations with gender and laterality.

Material and method The study comprised 1076 Turkish individuals, aged between 18 and 75, who sought treatment at the Istanbul University Restorative Dentistry Clinic. Prior to examination, participants provided voluntary consent by completing consent forms. To ensure precision and consistency, all examinations were conducted by a single clinician with a minimum of twenty years of clinical experience. Patient selection adhered to predefined inclusion and exclusion criteria. Anamnestic data, encompassing age, gender, past dental history, general health status, and intraoral examination findings, were documented. Examinations focused on the anterior region, specifically between the maxillary canine teeth.

Results Peg-shaped incisors were noted in 7.2% of cases (n=77), with 54 cases being unilateral and 23 bilateral. Among the cases, 7.4% (n=52) were observed in females and 6.7% (n=25) in males. A total of 97 peg-shaped incisors were identified in both left and right maxillary lateral incisors.

Conclusion The research took place in Istanbul, Türkiye, a cosmopolitan metropolis. Expanding such investigations to various regions within Türkiye would yield a richer and more comprehensive dataset, enhancing the study's significance.

Keywords Anatomical shape, Dental anomaly, Maxillary lateral incisors, Peg-shaped laterals, Prevalence study

Introduction

A smile is considered significant all over the world, especially for young adolescent patients, for whom having teeth that are different from their peers might cause them to become embarrassed. Having a peg lateral at the eruption stage, may result in imperfection and smaller size compared to other anterior teeth, which might cause anxiety and disappointment in the patient. Human dentition is affected by multilevel, diverse and multidimensional interferences, which are epigenetic, peripheral such as physical, chemical, and biological or genetic, stemming from metabolic factors, inheritance and mutations. A combination of peripheral and genetic agents causes these malformations in some cases (1). Morpho-differentiation phase begins in utero or the first year of life. If endocrine disturbances occur during this phase, they affect the size and form of the crown of teeth. Disturbances in morpho-differentiation may affect the form of the tooth in terms of size and shape without any obstruction of the activity of ameloblasts and odontoblasts, and the function of the tooth, resulting in a normal structure but a peg-shaped or malformed tooth with dentine and enamel (2,3).

Alterations in the morphology and dimensions of upper lateral incisors have been documented, with a prevalent observation being a decrease in the mesiodistal dimension (2). This often results in the characterization of such teeth as "peg-shaped laterals" or simply "peg laterals" (3). Graham defined a peg-shaped tooth presenting as the cervical span of the suit crown being longer than the incisal mesiodistal breadth, and which is usually a maxillary adult lateral incisor (4). There is a diastema between adjacent teeth in mesial and digital surfaces because of a peg-shaped crown whose form is converged incisally. Because of the peg-shaped laterals, the central incisors drift distally into malposition, and this causes the presence of a diastema to shift to the midline region of central incisors (5). Mesiodistal width of a lateral is a lot smaller in some compared to average width and does not present the characteristic pointed peg form, in which case they are plainly called “small lateral incisors” (3). This difference in width leads to periodontal, orthodontic and aesthetic problems for the patients (3).

According to some studies, transposed teeth, taurodontism, peg-shaped incisors and supernumerary teeth may occur in subjects with tooth agenesis (6-10). On the other hand, some studies assert that the formation of peg laterals is related to ge-

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Received: 02.06.2024 / Accepted: 24.06.2024 / Published: 30.08.2024

netic mechanisms. These studies claim that the flawed gene can be expressed divergently through indistinct teeth (11,12). According to Granat and Chapelle, a tooth decreases in volume and changes into a conic shape before disappearing due to the evolution within a species (13). Brooke says that distinct dental anomalies are the result of any inconsistency between the cellular and molecular components during tooth development (14). These dental anomalies may also be observed as morphological and structural changes or alterations in the number of teeth. Different dental anomalies, like over retained deciduous teeth, poly-diastema and canine transposition may result in peg laterals (15).

Many researchers have reported different frequencies of peg-shaped lateral incisors. They varied dramatically from 0.6% (16) to 9.9% (17). The incoherence in their results could be attributed to variations in original races of populations and ethnic groups, and the differences in sampling methodologies (18-20). Peg-shaped lateral teeth are usually smaller than healthy teeth. The occurrence frequency of peg-shaped maxillary lateral incisors has been observed to be higher than the occurrence frequency of other developmental malformations of teeth (17). Studies reported that the existence of maxillary peg-shaped lateral incisors was on either the left or right side of the jaw. Bilateral presence of peg-shaped lateral incisors is a rare case (21,22).

The occurrence frequency of developmental dental anomalies in the Turkish population has been studied several times (23-28) by different researchers. However, there was not a study directly aimed at the investigation of the prevalence of peg-shaped lateral incisors in the Turkish population. Therefore, this study was conducted with the purpose of investigating the prevalence of peg-shaped maxillary permanent lateral incisors and possible associations with race, sidedness, and sex.

Material and Methods

Approval for the clinical trial was obtained from the Istanbul University Faculty of Dentistry Ethics Committee (protocol number: 2016/16). The study was conducted in full accordance with the World Medical Association Declaration of Helsinki. 1076 Turkish patients aged 18 to 75, who were admitted to Istanbul University Restorative Dentistry Clinic between May and October 2016, were included in this study. Each patient provided informed written consent, and the patients signed the Ethics Committee form at the beginning of the study. A general and systemic anamnesis was obtained from the patients. The details pertaining to age, gender, past dental records, overall health status, and intraoral examination findings of the participants were meticulous,sly recorded on dedicated anamnesis papers. In order to guarantee the attainment of precise and uniform outcomes, all patients underwent examination conducted by a solitary clinician possessing a minimum of two decades of clinical expertise (O.Y.). Participants fitting the exclusion criteria listed below were exempted from the study.

The examination process for each patient was carried out in the same unit with the help of a hand mirror and a probe under the dental chair light. The anterior region spanning between the right and left canine teeth on maxillary was examined. In order to facilitate the diagnosis of the presence of the anomaly, the acquired data were supported by intraoral periapical and panoramic radiographic images, which were taken before the examination. During the examination of each patient's mouth, the peg-shaped size was marked as "1" and normal shaped sizes were marked as "0". Digital calipers were used to accurately measure crown widths.

The peg-shaped qualities of the incisors were determined based on the following inclusion criteria (29): 1) Peg-shaped crown: the teeth take a convergent shape towards the margin of incisal. The crown feature is outside the standards for crown length from mesial to distal, and the morphology is distorted. 2) Curtailed crown size: although the size of the crown distal from the mesial is less than 5.5 millimeters, normal morphology is observed.

The participants were evaluated according to the exclusion criteria used by Guttal et al. and Albashaireh et al. (29,30): 1) Patients with a mesial-distal size of the teeth greater than 5.5 millimeters. 2) Patients having missing teeth due to congenital an unrecognized method of extraction history in the anterior region between the right and left canines on maxilla. 3) Crowned or restored incisor teeth. 4) Pediatric age group (<18 years). 5) Patients diagnosed with a syndrome such as Down syndrome, ectodermal dysplasia, etc. 6) Patients with cleft lip and palate.

All gathered data were transferred to a digital environment and prepared for analysis (Excel 2017; Microsoft Office, Microsoft corporation, USA). NCSS (Number Cruncher Statistical System) 2007 (Kaysville, Utah, USA) program was used for statistical analysis. The Mann Whitney U test was used to compare two groups of non-normal distribution variables. Pearson Chi-square and Fisher's Exact test were used to compare qualitative data. Significance was assessed at $p < 0.05$.

Results

The total of 1076 cases was made up of 702 (65.2%) females and 374 (34.8%) males (Figure 1). The participants presenting the cases consisted of patients within the age range of 18 to 75 years with an average of 33.7 ± 12.3 years (Table 1).

Table 1: Distribution of Demographic Characteristics

Age (years)	**Min-Max (Median)**	18-75 (33)
	Mean±Sd	33.70 ±12.30
Gender; n (%)	**Female**	702 (65.2)
	Male	374 (34.8)

The age of female participants ranged from 18 to 73, with an average of 33.68± 12.33 years, while the age range of the male participants was between 18 and 75, with an average of 33.74± 12.26 years. Peg-shaped incisors were observed in 7.2% of the cases (n=77). Of these cases, 54 were found to be unilateral while 23 were bilateral. Peg lateral syndrome was found in 7.4% of female cases (n=52) and 6.7% of male cases (n=25); this was not considered a statistically significant difference with respect to gender (Table 2). The number of patients that presented peg-shaped maxillary lateral incisors was 75, and two patients had maxillary canines which were peg-shaped (Table 2). In addition, peg-shaped lateral incisors were equally distributed as unilateral (22 left, 29 right; 51 teeth in total) or bilateral (34 teeth). Maxillary canines diagnosed as peg-shaped were bilateral in one case and unilateral in the other (Firgure-2). The

percentages of observed peg shaped incisors were 0.2% (n=2) in left maxillary canines, 4.2% (n=45) in left maxillary lateral incisors, 4.8% (n=52) in right maxillary lateral incisors, and 0.1% (n=1) in right maxillary canines, whereas peg-shaped incisors were not detected in the maxillary central incisors (Table 2).

Table 2: Evaluation of the Presence of Peg Lateral Syndrome in the Anterior Teeth by Gender

		Gender		Total (n=1076)	p
		Female (n=702)	Male (n=374)		
Peg Lateral Syndrome	13	1 (0.1)	1 (0.3)	2 (0.2)	[a]1.000
	12	30 (4.3)	15 (4.0)	45 (4.2)	[b]0.838
	11	0 (0)	0 (0)	0 (0)	-
	21	0 (0)	0 (0)	0 (0)	-
	22	33 (4.7)	19 (5.1)	52 (4.8)	[b]0.782
	23	1 (0.1)	0 (0)	1 (0.1)	[a]1.000
Total Peg lateral syndrome status	No	650 (92.6)	349 (93.3)	999 (92.8)	[b]0.661
	Yes	52 (7.4)	25 (6.7)	77 (7.2)	
Frequency of Peg Lateral syndrome	Min-Max (Median)	0-2 (0)	0-2 (0)	-	[c]0.695
	Mean±Sd	0.09±0.35	0.09±0.37	-	

[a]Fisher's Exact Test, [b]Pearson Chi-Square Test, [c]Mann Whitney U Test

Discussion

Developmental dental anomalies are relatively common. A lot of genetic factors such as specific syndromes and environmental factors such as cancer therapy, cytotoxic medications, traumatic dental injuries, radiation and dioxin might affect and arrest tooth development (31,32). Several kinds of issues ranging from ectodermal and mesenchymal factors may cause the initiation, the morphogenesis and the differentiation. The initiations may present in the number and region of teeth. The morphogenesis may occur as size, type, and shape of teeth, including dimensions and cusp number. The differentiation may be observed in tooth structure in the dentine, and enamel mineralization and formation (14).

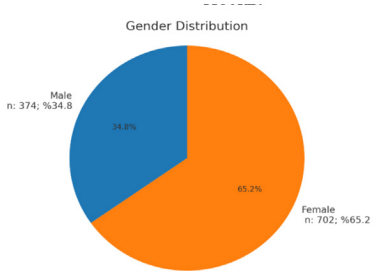


Figure 1: Gender distribution

The locution microdontia (microdentism, microdontism) designates the condition displaying abnormally small teeth (33). Microdontia is chiefly divided into three types (35,36): 1) True generalized microdontia: all of the teeth are smaller than normal. 2) Relative generalized microdontia: normal teeth exist on an abnormally large jaw. 3) Localized microdontia: involving only a single tooth.

Microdontia can include different tooth morphologies and contours. The most mentioned example of localized microdontia is a maxillary lateral incisor which is called "peg lateral". The characteristic peg-shape is explained as a crown diameter that decreases markedly from cervical margin to incisal edge at the anterior teeth in the primary or permanent dentition. The average mesio-distal width of maxillary lateral incisor is 6.6 millimeters, ranging between 5 and 9 millimeters (32). It is usually about 2 millimeters narrower mesio-distally and two millimeters shorter cervico-incisally than the central incisor (3). The average mesio-distal width of peg-shaped lateral is less than 5.5 millimeters (3).

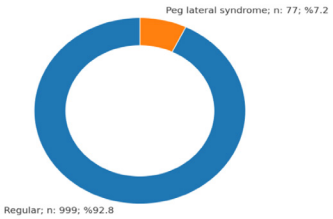
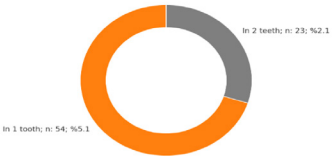


Figure 2: Total Peg Lateral Syndrome status



The sample size of prevalence studies is significant in determining the real score. In previous studies, the sample sizes were dramatically different, either relatively small or too large (34,35). Having a too small sample size might have compromised the representativeness of the underlying population. Contrarily, if the sample size was too large (over 10,000), it might have caused the possibility of overlooking affected subjects, and thus, underestimating the prevalence rates.

Several investigators have reported different frequencies of peg-shaped lateral incisors 18 to 20. In this study, the prevalence of peg-shaped lateral incisors was found in 7.2% of the cases. According to the meta-analysis conducted, the prevalence of peg laterals worldwide is 1.8%, which translates to nearly one in every 55 people (36). According to previous studies, the prevalence of peg laterals is 5.1% in China (37), 3.1% in Mongoloid people (36), 1.5% in black people and 1.3 in white people (36, 38). Hua et al. say that the prevalence for white people in Europe (1.2%) was also slightly higher than the North American white people (0.9%) (38). In this study, the prevalence of peg-shaped lateral is 7.2%, which is higher than white people in Europe. However, another study by Celikoglu reported a much higher percentage (20.2%) for the frequency of peg laterals in a Turkish population (7). Most researchers think that this variation could stem from a specific difference among ethnic groups. The difference may also be attributed to genetic variations.

In a previous study by Gupta SK et al., 1123 individuals were examined. A total of 11 male and 18 female subjects (2.58%) had unilateral or bilateral peg-shaped teeth (39). The number of individual subjects included in their study was nearly the same as this study, where 52 females and 25 males were observed to have peg laterals. This represents a higher frequency of peg laterals then the one observed by Gupta SK et al. (38).

The reported prevalence of the sidedness characteristic of peg-shaped teeth also varied in the literature. In the present study, 54 of the peg-shaped laterals were unilateral (5.1%), and 23 of them were bilateral (2.1%), which is incompatible with the results acquired in

the study conducted by Amin (3). This rate is higher than the findings of Gupta SK et al. and Hua et al. (38,39). Even though unilateral peg laterals were more common in most studies (17,39), bilateral peg shaped teeth were more common in several others (40,41). Celikoglu found that unilateral peg laterals had a higher frequency of occurrence than bilateral in the Turkish population (7).

In contrast to the data gathered in our study, Hrdlicka (42) found that there was a slight propensity for left sided peg laterals, similarly Meskin and Gorlin (41) identified a 2-to-1 ratio favoring left sided peg-shaped teeth. According to the findings achieved in this study, the occurrence frequency of left sided peg laterals (4.4%) did not present a statistically significant difference from the frequency of right sided peg laterals (4.2%). The nearly equal expression of bilateral and unilateral peg laterals, as well as the tendency to occur on the left side, is not fully understood yet.

According to this study, the presence of peg laterals present a slightly higher frequency in females (7.4%) than in males (6.7%), which does not reflect a statistical meaningful difference. The results reported by several other studies concluded that the frequency of peg laterals was higher in females than in males (3-7). On the other hand, another study also reported that there was not a significant difference between the genders in terms of the frequency of peg laterals (11). Such results may have been impacted by the differences among the study sample and socio-demographic variables. In a previous study, the authors have stated that microdontia displays a strong correlation with hypodontia (43). Additionally, Antunes et al. suggested that tooth agenesis and peg-shaped lateral incisors could perchance have the same genetic background (44). In the present study, none of the patients presented hypodontia. Studies of a wider range may contribute different results to this issue. The results achieved in this study were not similar to the results of other studies conducted in Türkiye (23-28), and some differences were observed in certain aspects which could have been due to genetic differences and the differences in the methods, place, sample selection procedures in the study and racial factors.
In terms of limitations, the focus was exclusively on peg-shaped teeth in the maxillary anterior region. Other dental anomalies in different jaws, regions, or teeth could have been examined as well. Enlarging the sample size of the study by including different cities in Türkiye is recommended to support and confirm the data indicating the prevalence of peg-shaped lateral incisors.

Conclusion

In conclusion, peg-shaped lateral teeth were identified in 7.2% of the patients, and it was determined that this anomaly is more frequently observed in females compared to males. This study elucidates the prevalence of peg-shaped lateral incisors within the Turkish population and serves as a means to raise clinicians' awareness in better understanding the frequency of this dental anomaly.

Declarations

Author Contributions: *Conception/Design of Study- O.Y., M.Y.U., M.D.; Data Acquisition- O.Y.; Data Analysis/Interpretation- O.Y., M.Y.U.; Drafting Manuscript- O.Y., M.Y.U.; Critical Revision of Manuscript- O.Y., M.Y.U., M.D.; Final Approval and Accountability- O.Y., M.Y.U., M.D.; Material and Technical Support- O.Y., M.Y.U., M.D.; Supervision- M.D.*

Conflict of Interest: *Authors declared no conflict of interest.*

Financial Disclosure: *Authors declared no financial support.*

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Preparedness and Anxiety of Dental Students in the Transition from Preclinical to Clinical Practice

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Abstract

Aim This study aimed to investigate the preparedness and anxiety levels of dental students transitioning to clinical practice and to examine the effects of sex, university, and observations.

Material and method A total of 182 students (58 males, 124 females) transitioning from preclinic to clinic participated in the study. The survey consisted of sections covering socio-demographic data, students' opinions on their preparedness for clinical practice, anxiety levels measured by the State-Trait Anxiety Inventory (STAI), and confidence levels in various skill areas. Spearman's Rank correlation test was used for correlation analysis, while the Mann Whitney-U test for pairwise group comparisons.

Results No differences were found in preparedness between sexes, but males exhibited significantly higher confidence in various dental skills. Conversely, females reported significantly higher levels of state and trait anxiety. State university students (n=48) reported heightened workload expectations and elevated levels of state and trait anxiety. Conversely, private university students (n=134) demonstrated increased confidence and preparedness in dental practice-related knowledge and skills. Students who participated in observations (n=96) had lower preparedness and confidence levels in several dental areas, coupled with higher trait anxiety levels, compared to their peers who did not participate in observations (n=86). Finally, STAI scores were positively correlated with workload, negatively correlated with knowledge, skills, and confidence.

Conclusion Sex, school, and observation status have an impact on students' preparedness for clinical education, anxiety, and confidence in their professional abilities. Therefore, assessments and orientation programs that take these aspects into account can benefit students at this time of change.

Keywords Anxiety, Clinical competence, Dental education, Dental students, Undergraduate

Introduction

Becoming a dentist entails a long and challenging journey that requires a significant investment of time, effort, and dedication. In Turkey, a five-year dental school program combines theoretical and practical education. The first three years of the program are devoted to preclinical education while the remaining years are predominantly devoted to practical training in clinical settings. However, the practical training conducted in preclinical laboratories is insufficient to provide students with sufficient experience in patient communication, infection control, and clinical procedures. On the other hand, clinical training encompasses more than three-quarters of the dental curriculum and is designed primarily to develop the psychomotor skills necessary to perform dental procedures. At the end of this training, dental students are expected to have acquired a range of competencies, including scientific, clinical, and interpersonal skills (1, 2).

Traditionally, learning and skill development take place in learning environments including the classroom, seminar, clinic, and peer interactions. The students' manual skill development begins with simulated bench-top operations and techniques utilizing dental mannequins before the start of the clinical training (3). The purpose of preclinical dental education is to prepare students for clinical instruction (4). The competencies gained in preclinical training can affect the person's clinical performance and self-confidence. Confidence has been regarded as context-specific and as a predictor of academic success, and its definition is "freedom from doubt; belief in yourself and your abilities" (5). According to one study, clinical practice among dental students improved when their self-confidence rose (5). In order to get a better understanding of dentistry education and associated issues, it is crucial to ascertain students' self-confidence and perceptions of their preparedness throughout this transitional period. This period in dental education has been reported to be an emotionally and socially dynamic process (6). While this transition represents a significant period of personal and professional development for dental students, it can also be a source of stress and anxiety (7-9). It has been noted that students experience a marked increase in workload and a consequent lack of time for study as they enter clinical training. The sudden transition of students into this new, challenging, and exciting clinical environment can lead to feelings of uncertainty, inadequacy, and anxiety due to not knowing what to expect and

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Received: 28.07.2024 / Accepted: 02.08.2024 / Published: 30.08.2024

**This study was funded by The Scientific Technological Research Council of Türkiye (1919B012107595)*

feeling unprepared. This situation can also affect students' academic motivation levels and performance. Moreover, students may experience anxiety due to negative thoughts regarding their level of knowledge, clinical competence, ability to communicate with patients, financial resources, and interactions with clinical staff (9). Consequently, they may engage in faulty behaviors and perform inadequate treatments. Numerous studies have reported significant levels of stress and anxiety among dental students throughout their general education period, with worrisome prevalence and intensity of symptoms related to psychological morbidity, depression, and burnout (6,10,11). However, no research specifically addresses the anxiety experienced during the transition to clinical education and the impact of sex, observational status, and university on these concerns.

Observation plays a significant role in the process of learning and skill acquisition, which can have implications for the challenges encountered by students during the transition to clinical education. Previous studies have demonstrated that observation is a crucial factor in the development of cognitive and motor skills (12). Information acquired through observation can assist students in enhancing their clinical skills and feeling more prepared in a clinical setting. Additionally, it has been suggested that observation may increase students' self-confidence and alleviate anxiety associated with clinical experiences (13).

By elucidating the concerns, and anxiety levels of students during the transition from preclinical to clinical practice, valuable insights can be gained that may lead to the development of anxiety-reducing solutions.

Therefore, the objective of our study was to evaluate students' perceptions of their clinical preparedness and self-confidence, as well as their degrees of anxiety as they moved from preclinical to clinical training in dental education. Moreover, the present study aimed to examine the effect of sex, observational status, and university of the students on these evaluated parameters. To the best of our knowledge, there is no existing study conducted on this topic in Türkiye.

Material and Methods

This cross-sectional study was conducted between August 2022 and October 2022. Ethical approval was obtained from Biruni University Non-interventional Clinical Research Ethics Committee (25.02.2022 and 2022/67-09, Istanbul, Türkiye). In the absence of official statistics on the number of students completing the 3rd grade in Türkiye, a formal sample size calculation was not feasible. Therefore, the study aimed to reach the entire population of 3rd-grade students, as targeting the entire population can be a valid approach in survey studies when sample size calculation is not possible. The questionnaire was distributed to the dean offices of all public and state universities in Türkiye, with the objective of reaching all students who had completed their third year of dental school. Dental students who had completed their third year of study were invited to participate in an online or paper-based survey distributed on campus. The online version was prepared using Google Forms and distributed electronically via social media. To avoid potential biases, the online forms were designed to ensure each participant could only respond once. The survey used a forced-choice format to minimize missing data. Prior to participation, all individuals were given detailed information about the study, and only those who provided online or written informed consent in compliance with the 1964 Helsinki Declaration and its later amendments were allowed to proceed with the survey. To maintain anonymity, no personal information was collected from any participant.

The survey consisted of four sections. The first section included socio-demographic data such as the age and sex and observation status of the participants. To determine observation status, students were asked whether their training curriculum included clinical observation, and students who voluntarily observed in their own faculty or other clinics were excluded from the study. To address the disparities in the initiation of clinical practice among different faculties, the questions "Have you ever conducted procedures on patients in a clinical setting?" and “During the academic year 2022-2023, will you be studying in the fourth grade?” were employed. The students with prior clinical experience who had not finished their third year were not included in the study.

The second section of the study focused on students’ opinions about their preparation for clinical practice in five categories: professional socialization, workload, patient contact, knowledge and skills, and learning and education. The questions in this section of the survey were adapted from those used in the study by Prince et al. (4) and are presented in Table S1. Participants were asked to indicate the extent to which they agreed with each statement on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

The third section of the survey which was based on the study of Lynch et al. (10), evaluated students' confidence levels in sixteen main skill areas (Table S2). Confidence levels were rated on a 5-point Likert scale, with 0 representing no confidence and 4 representing very high confidence.

The final part of the survey consisted of the State-Trait Anxiety Inventory (STAI) developed by Spielberger et al. (11) to assess both state and trait anxiety (Cronbach’s α of 0.87). The Turkish version of the STAI was distributed to all students, who were required to have a certain level of Turkish proficiency before entering the clinic, with the permission of the author who adapted it to Turkish (14). The inventory has two separate scales, each comprising 20 items, which are rated on a 4-point Likert scale. The first scale, STAI-State (STAI-S), measures the level of state anxiety experienced at a given moment and under certain conditions. The second scale, STAI-Trait (STAI-T), measures the individuals’ overall level of anxiety in relation to their general life circumstances, regardless of specific situations or conditions.

Statistical Analysis

Number Cruncher Statistical System (NCSS) 2007 software (Kaysville, Utah, USA) was used for the statistical analyses. Descriptive statistical methods (Mean, standard deviation, median, frequency, minimum, and maximum) were used. The Shapiro-Wilk test was used to check whether a continuous variable followed a normal distribution. The Mann-Whitney U test was used for independent pairwise comparisons. Spearman's correlation analysis was used to determine the relationship between quantitative variables. A p-value <0.05 was considered statistically signifi-

cant.

Results

A total of 182 students completed the survey. Eighty-three students responded to the online version of the questionnaire, while 99 students responded to the paper version of the questionnaire. The mean age of the participants was 21.94±1.2 years. Of the participants, 68.1% were female (n=124) and 31.9% (n=58) were male.

Table 1: Opinion, Confidence and Anxiety Levels of Students According to Sexes

	Total (n=182)	Male (n=58)	Female (n=124)	p#
	Mean± SD Min-Max (Median)	Mean± SD Min-Max (Median)	Mean± SD Min-Max (Median)	
Opinions about preparation for clinical practice				
Transition and Professional Socialisation	3.4±0.34 2.33-4.5 (3.42)	3.37±0.37 2.33-4.17 (3.33)	3.41±0.32 2.58-4.5 (3.42)	0.565
Workload	3.55±0.75 1.33-5 (3.5)	3.46±0.63 2.33-5 (3.5)	3.59±0.8 1.33-5 (3.58)	0.219
Patient Contact	3.65±0.48 2.33-5 (3.67)	3.56±0.55 2.33-4.67 (3.67)	3.69±0.43 2.5-5 (3.67)	0.106
Knowledge and Skills	3.37±0.51 2.17-5 (3.33)	3.47±0.48 2.5-4.67 (3.42)	3.33±0.53 2.17-5 (3.33)	0.110
Learning and Education	4.03±0.38 2.85-5 (4.08)	4±0.41 2.85-5 (4)	4.05±0.37 2.85-4.69 (4.08)	0.227
Confidence				
Diagnosis	2.74±0.91 0-4 (3)	2.95±0.98 0-4 (3)	2.64±0.87 0-4 (3)	0.017*
Radiography	2.74±0.96 0-4 (3)	2.98±0.95 0-4 (3)	2.62±0.94 1-4 (3)	0.009**
Treatment Planning	2.69±0.99 0-4 (3)	2.83±1.03 0-4 (3)	2.63±0.97 0-4 (3)	0.136
Pain Control	2.76±1.01 0-4 (3)	2.93±0.99 0-4 (3)	2.68±1.02 0-4 (3)	0.083
Managing Dental Emergencies	2.18±1.2 0-4 (2)	2.38±1.21 0-4 (3)	2.09±1.18 0-4 (2)	0.097
Prescription of Antibiotics	1.9±1.3 0-4 (2)	2.12±1.3 0-4 (2)	1.8±1.29 0-4 (2)	0.117
Management/Understanding of Occlusion	2.5±1.22 0-4 (3)	2.74±1.24 0-4 (3)	2.39±1.2 0-4 (2)	0.055
Preventive Dentistry/ OHI	3.27±0.84 1-4 (3)	3.31±0.86 1-4 (4)	3.25±0.83 1-4 (3)	0.540
Periodontics	2.66±1.01 0-4 (3)	2.78±1.02 0-4 (3)	2.6±1.01 0-4 (2.5)	0.179
Removable Prosthodontics	2.01±1.16 0-4 (2)	2.15±1.17 0-4 (2)	1.95±1.16 0-4 (2)	0.308
Oral Surgery	2.2±1.12 0-4 (2)	2.47±1.11 0-4 (2.5)	2.08±1.1 0-4 (2)	0.022*
Patient Management	2.6±1.01 0-4 (2.71)	2.64±1.07 0-4 (2.86)	2.57±0.98 0-4 (2.57)	0.529
Restorative Dentistry	3.05±0.85 0.33-4 (3)	3.27±0.8 1-4 (3.67)	2.95±0.86 0.33-4 (3)	0.018*
Endodontics	2.8±0.99 0-4 (3)	3.22±0.84 1-4 (3.33)	2.6±1 0-4 (2.67)	0.001*
Indirect Restorations	1.88±1.22 0-4 (2)	2.19±1.24 0-4 (2)	1.74±1.19 0-4 (1.67)	0.029*
Bridgework	1.89±1.24 0-4 (2)	2.09±1.22 0-4 (2)	1.8±1.24 0-4 (2)	0.134
Anxiety				
State Anxiety	45.41±13.08 20-80 (45)	41.88±12.69 20-73 (41)	47.06±12.99 20-80 (47)	0.013*
Trait Anxiety	44.74±10.78 22-77 (44)	42.14±10.59 23-77 (42)	45.96±10.69 22-76 (45.5)	0.031*

*OHI: Oral Hygiene Instructions, SD: Standart Deviation. #Mann Whhitney-U test ; *p< 0.05, **p<0.01.*

The percentage of participants studying at state universities was 26.4% (n=48; 32 females and 16 males), while the percentage of those studying at private universities was 73.6% (n=134; 92 females and 42 males). In addition, the number of students who could make observations in their schools was 96 (52.7%), and there were 86 participants who could not (47.3%).

Table 2: Opinion, Confidence and Anxiety Levels of Students According to University

	State University (n=48)	Private University (n=134)	p#
	Mean± SD Min-Max (Median)	Mean± SD Min-Max (Median)	
Opinions about preparation for clinical practice			
Transition and Professional Socialisation	3.4±0.37 2.33-4.5 (3.33)	3.4±0.33 2.5-4.42 (3.42)	0.810
Workload	3.93±0.78 2-5 (3.92)	3.41±0.69 1.33-5 (3.33)	0.001**
Patient Contact	3.67±0.48 2.33-5 (3.67)	3.65±0.47 2.5-5 (3.67)	0.831
Knowledge and Skills	3.24±0.49 2.17-4.33 (3.21)	3.42±0.51 2.25-5 (3.38)	0.048*
Learning and Education	4.09±0.38 3.15-5 (4.15)	4.01±0.38 2.85-4.69 (4.08)	0.240
Confidence			
Diagnosis	2.23±0.93 0-4 (2)	2.92±0.84 1-4 (3)	0.001**
Radiography	2.4±0.89 0-4 (2)	2.86±0.95 0-4 (3)	0.001**
Treatment Planning	2.17±1.06 0-4 (2)	2.88±0.89 1-4 (3)	0.001**
Pain Control	2.27±0.98 0-4 (2)	2.93±0.97 0-4 (3)	0.001**
Managing Dental Emergencies	1.4±1.03 0-4 (1)	2.46±1.13 0-4 (3)	0.001**
Prescriptiojn of Antibiotics	1.46±1.17 0-4 (1)	2.06±1.31 0-4 (2	0.001**
Management/Understanding of Occlusion	1.67±1.06 0-4 (2)	2.8±1.14 0-4 (3)	0.001**
Preventive Dentistry	2.85±0.9 1-4 (3)	3.42±0.77 1-4 (4)	0.001**
Periodontics	2.36±0.86 0.5-4 (2.5)	2.76±1.05 0-4 (3)	0.001**
Removable Prosthodontics	1.44±0.98 0-4 (1.25)	2.22±1.15 0-4 (2)	0.001**
Oral Surgery	1.7±0.98 0-4 (1.75)	2.38±1.11 0-4 (2.5)	0.001**
Patient Management	2±0.82 0-3.86 (2.07)	2.81±0.98 0-4 (3)	0.001**
Restorative Dentistry	2.56±0.85 0.33-4 (2.58)	3.23±0.78 0.83-4 (3.5)	0.001**
Endodontics	2.3±1.03 0-4 (2.5)	2.98±0.92 0.67-4 (3)	0.001**
Indirect Restorations	1.22±0.95 0-4 (1.33)	2.12±1.22 0-4 (2)	0.001**
Bridgework	1.13±0.94 0-4 (1)	2.17±1.22 0-4 (2)	0.001**
Anxiety			
State Anxiety	52.88±13.23 27-80 (52.5)	42.73±11.99 20-80 (42)	0.001**
Trait Anxiety	51.58±10.32 36-77 (49.5)	42.29±9.88 22-67 (42)	0.001**

*SD: Standart Deviation. # Mann Whhitney-U test ; *p< 0.05, **p<0.01.*

Table 1 demonstrates the total preparedness, confidence, and anxiety levels of students in this transition peri-

od. While students showed the highest levels of preparedness in terms of patient contact, the lowest scores were recorded regarding knowledge and skills acquisition. In terms of self-confidence, the highest scores were recorded in preventive dentistry and the lowest in indirect restorations.

Table 3: Opinion, Confidence and Anxiety Levels of Students According to Making an Observation

	Make an Observation (n=96)	Not make an observation (n=86)	p#
	Mean± SD Min-Max (Median)	Mean± SD Min-Max (Median)	
Opinions about preparation for clinical practice			
Transition and Professional Socialisation	3.4±0.36 2.33-4.5 (3.42)	3.4±0.31 2.5-4 (3.42)	0.642
Workload	3.61±0.8 1.33-5 (3.67)	3.48±0.69 1.83-5 (3.33)	0.139
Patient Contact	3.59±0.47 2.33-5 (3.5)	3.72±0.47 2.5-5 (3.83)	0.033*
Knowledge and Skills	3.36±0.51 2.25-5 (3.33)	3.39±0.53 2.17-4.67 (3.33)	0.864
Learning and Education	4.04±0.39 2.85-5 (4.15)	4.03±0.37 2.85-4.69 (4.08)	0.770
Confidence			
Diagnosis	2.57±0.99 0-4 (3)	2.92±0.79 1-4 (3)	0.024*
Radiography	2.65±0.97 0-4 (3)	2.84±0.93 0-4 (3)	0.181
Treatment Planning	2.51±1.05 0-4 (3)	2.9±0.88 1-4 (3)	0.014*
Pain Control	2.61±1.03 0-4 (3)	2.92±0.97 0-4 (3)	0.038*
Managing Dental Emergencies	1.97±1.2 0-4 (2)	2.42±1.15 0-4 (2)	0.013*
Prescriptiojn of Antibiotics	1.77±1.24 0-4 (2)	2.05±1.36 0-4 (2)	0.167
Management/Understanding of Occlusion	2.21±1.22 0-4 (2)	2.83±1.14 0-4 (3)	0.001**
Preventive Dentistry	3.13±0.89 1-4 (3)	3.43±0.76 1-4 (4)	0.015*
Periodontics	2.56±0.99 0-4 (2.5)	2.77±1.04 0-4 (3)	0.108
Removable Prosthodontics	1.88±1.14 0-4 (2)	2.16±1.16 0-4 (2)	0.071
Oral Surgery	2.12±1.08 0-4 (2)	2.29±1.16 0-4 (2.5)	0.266
Patient Management	2.37±1.06 0-4 (2.43)	2.84±0.89 0.71-4 (3)	0.002**
Restorative Dentistry	2.89±0.88 0.67-4 (2.92)	3.23±0.79 0.33-4 (3.42)	0.007**
Endodontics	2.63±0.99 0-4 (2.67)	2.98±0.97 0.33-4 (3)	0.017*
Indirect Restorations	1.7±1.2 0-4 (1.67)	2.09±1.21 0-4 (2)	0.029*
Bridgework	1.71±1.19 0-4 (2)	2.1±1.27 0-4 (2)	0.026*
Anxiety			
State Anxiety	46.99±12.78 22-80 (47)	43.64±13.27 20-80 (43.5)	0.147
Trait Anxiety	46.9±11.23 22-77 (46)	42.34±9.77 23-63 (42)	0.017*

*SD: Standart Deviation. # Mann Whhitney-U test ; *p< 0.05, **p<0.01.*

There was no difference between males and females in any of the 5 categories of their preparation for clinical practice (p>0.05). Males had statistically significantly higher levels of confidence than females in diagnosis (p=0.017), radiography (p=0.009), oral surgery (p=0.022), restorative dentistry (p=0.018), endodontics (p=0.001), and indirect restorations (p=0.029). State and trait anxiety levels were found to be statistically significantly higher in females than in males (p=0.013 and p=0.031, respectively).

Dental students from private universities had significantly higher levels of confidence in all areas than those from state universities (p<0.05). They also had statistically higher levels of preparedness in the area of knowledge application and skills (p=0.048). However, workload expectation was significantly higher in state university students (p=0.001). In addition, state university students had significantly higher levels of state and trait anxiety (p=0.001) (Table 2).

Dental students who made observations before had significantly lower preparedness in patient contact (p=0.033) and had lower self-confidence in diagnosis (p=0.024), treatment planning (p=0.014), pain control (p=0.038), managing dental emergencies (p=0.013), management/understanding occlusion (p=0.001), preventive dentistry (p=0.015), patient management (p=0.002), restorative dentistry procedures (p=0.007), endodontic procedures (p=0.017), indirect restorations (p=0.029), and bridgework (p=0.026) than the students who did not make observations. The trait anxiety level of the students who had previously performed observations was statistically significantly higher than those who had not (p=0.017) (Table 3).

The STAI-S and STAI-T were positively and significantly correlated with workload (r=0.447, p=0.000; r=0.450, p<0.001, respectively) and negatively and significantly correlated with knowledge, knowledge application and skills (r=-0.463, p<0.001;r=-0.358, p<0.001, respectively), among the 5 categories that included students' views on their preparation for clinical practice. On the other hand, the STAI-S and STAI-T were significantly negatively correlated with all categories examining students' confidence levels (p<0.05). A more detailed breakdown of these correlations is presented in Table 4.

Discussion

The transition from the preclinical to the clinical phase is a pivotal point in the educational journey of dental students. However, this crucial transition is not without its challenges. The primary objective of this study was to provide a comprehensive examination of dental students' perspectives, self-confidence levels, and anxiety levels during the initial phase of their undergraduate clinical training, and to compare these parameters according to sex, observational status, and university. There have been previous studies investigating the self-confidence and anxiety of students during the transition period between preclinical and clinical training, as well as their perceptions of the gap between these stages (4, 10, 15). Our study is the first to comprehensively assess these variables collectively and to analyze their variations in relation to students' sex, university, and prior clinical observation.

In the context of dental education in Türkiye, it is common for most dental faculties to begin clinical training during the fourth year of the curriculum. In order to effectively capture students' experiences during this transitional period, our study focus-

Table 4: Correlations of evaluated parameters

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1. Age	r	1																							
2. Transition and Professional Socialisation	r	-0.092	1																						
3. Workload	r	-0.09	0.066	1																					
4. Patient Contact	r	0.052	0.274**	0.129	1																				
5. Knowledge and Skills	r	-0.074	0.365**	-0.212**	0.138	1																			
6. Learning and Education	r	0	0.358**	0.04	0.344**	0.450**	1																		
7. Diagnosis	r	-0.056	0	-0.300**	0.008	0.544**	0.183*	1																	
8. Radiography	r	-0.051	0.1	-0.310**	0.073	0.523**	0.197**	0.664**	1																
9. Treatment Planning	r	-0.065	0.025	-0.315**	0	0.605**	0.210**	0.707**	0.599**	1															
10. Pain Control	r	0.093	0.108	-0.279**	0.024	0.492**	0.184*	0.540**	0.452**	0.572**	1														
11. Managing Dental Emergencies	r	0.132	0.039	-0.271**	-0.048	0.459**	0	0.473**	0.461**	0.519**	0.692**	1													
12. Prescriptiojn of Antibiotics	r	0.05	-0.055	-0.246**	0.019	0.274**	0.006	0.318**	0.370**	0.368**	0.431**	0.435**	1												
13. Management/ Understanding of Occlusion	r	0.04	0.051	-0.335**	0.056	0.480**	0.172*	0.554**	0.533**	0.594**	0.595**	0.658**	0.537**	1											
14. Preventive Dentistry	r	-0.029	0.149*	-0.189*	0.011	0.488**	0.255**	0.510**	0.517**	0.534**	0.580**	0.558**	0.316**	0.556**	1										
15. Periodontics	r	0.021	0.160*	-0.194**	0.09	0.567**	0.237**	0.537**	0.501**	0.583**	0.512**	0.574**	0.355**	0.551**	0.546**	1									
16. Removable Prosthodontics	r	-0.026	0.066	-0.332**	-0.067	0.443**	0.103	0.449**	0.467**	0.465**	0.517**	0.549**	0.536**	0.592**	0.578**	0.545**	1								
17. Oral Surgery	r	0.083	0.083	-0.247**	0.043	0.430**	0.123	0.481**	0.435**	0.450**	0.557**	0.527**	0.568**	0.532**	0.402**	0.584**	0.552**	1							
18. Patient Management	r	-0.025	0.134	-0.329**	-0.063	0.500**	0.157*	0.566**	0.486**	0.573**	0.567**	0.637**	0.392**	0.639**	0.528**	0.607**	0.576**	0.602**	1						
19. Restorative Dentistry	r	-0.011	0.091	-0.356**	-0.024	0.553**	0.214**	0.569**	0.555**	0.660**	0.608**	0.610**	0.436**	0.658**	0.538**	0.565**	0.579**	0.604**	0.744**	1					
20 Endodontics	r	0.062	.147*	-0.293**	0.044	0.485**	0.180*	0.494**	0.513**	0.549**	0.622**	0.615**	0.432**	0.606**	0.538**	0.561**	0.598**	0.628**	0.663**	0.739**	1				
21. Indirect restorations	r	0.062	0.047	-0.349**	-0.002	0.466**	0.097	0.528**	0.524**	0.532**	0.564**	0.602**	0.606**	0.665**	0.414**	0.566**	0.738**	0.682**	0.657**	0.655**	0.657**	1			
22. Bridgework	r	0.028	0.001	-0.340**	-0.051	0.436**	0.053	0.528**	0.569**	0.535**	0.499**	0.577**	0.558**	0.626**	0.412**	0.537**	0.720**	0.648**	0.643**	0.676**	0.628**	0.834**	1		
23. State Anxiety	r	-0.112	-0.121	0.447**	-0.015	-0.463**	-0.144	-0.388**	-0.407**	-0.376**	-0.356**	-0.372**	-0.179*	-0.364**	-0.319**	-0.306**	-0.355**	-0.198**	-0.404**	-0.420**	-0.327**	-0.354**	-0.288**	1	
24. Trait Anxiety	r	-0.061	-0.124	0.450**	0.066	-0.358**	-0.026	-0.344**	-0.383**	-0.376**	-0.354**	-0.389**	-0.148*	-0.408**	-0.339**	-0.349**	-0.401**	-0.219**	-0.434**	-0.470**	-0.353**	-0.324**	-0.281**	0.761**	1

*r: Correlation coefficient. Spearman's Rank Correlation Test; *p<0.05, **p<0.001.*

es on a cohort of dental students in Türkiye who have completed their third year of school. There is currently no official comprehensive data source on the exact number of dental students enrolled in all institutions in Türkiye. Although the Higher Education Program Atlas (YOK Atlas) provides an estimate of the number of students enrolled in dental faculties at a specific point in time, its accuracy in capturing the entire student population may be limited. Variables such as students' academic underperformance, withdrawal from school, or engagement in English preparatory programs could affect the actual number of students present in dental faculties during the period under study. The findings of the study might not be fully representative of the entire population or may lack generalizability beyond the sample studied. Therefore, these factors should be considered when interpreting the results and drawing conclusions from the study.

The overall results showed that the students agreed that they had the necessary knowledge and training, would have a heavy workload, and would have no trouble making professional contacts in preparation for clinical practice. However, it was noted that students from state universities perceived a higher demand in terms of workload. In Türkiye, due to financial constraints, state universities admit a higher volume of patients compared to private universities, which may account for these observed differences. As Prince et al. (4) suggested, comprehensive orientation at the beginning of the clerkship, coupled with a gradual adjustment of workload expectations can be an effective approach to improving this phase is to provide. The highest levels of preparedness were observed in the area of patient contact. In line with these findings, Prince et al. (4) also observed that the majority of dental students transitioning to clinical practice did not experience significant challenges with patient contact.

Dental schools are considered challenging learning environments, and research has shown that dental students tend to experience higher levels of stress than the general population (16-18). In particular, clinical training can significantly affect the performance of dental students by exposing them to a variety of stressors associated with patient care (19). Alexander and Haldane (20) emphasized that the transition from preclinical to clinical education is a stressful period. This study showed that, according to medical students, this increased stress is closely related to the transition from a dependent learner to an independent decision-maker. This stress may be exacerbated by significant changes in the learning environment and teaching styles. Radcliffe and Lester (21) have shown that students may experience feelings of inadequacy due to a perceived lack of clinical knowledge and skills, ultimately leading to escalated stress levels. The STAI is a commonly used assessment tool designed to measure anxiety, which is an expression of an individual's response to stress (22). In this study, it was observed that female students exhibited elevated levels of both state and trait anxiety compared to their male counterparts. Similar to our findings, Halboub et al. (23) also found higher levels of general anxiety in female dental students compared to males, and they attributed these findings to differences in gender-specific coping mechanisms employed in response to stressful circumstances.

Dental practices are detailed procedures that require meticulous attention and extensive knowledge. Conducting pre-observation can reduce anxiety by facilitating familiarity with the clinical environment in advance. Paradoxically, however, the sight of the rigorous and disciplined work environment associated with dental procedures can also evoke disturbing feelings. This phenomenon may explain the higher trait anxiety scores observed in our study among students who had previously made an observation. However, while the difference in state anxiety scores for students who had previously observed did not reach statistical significance, the trend toward higher anxiety levels in this group was evident. This may be due to feelings of inadequacy, which can serve as a powerful catalyst for increased anxiety levels. Mishra (24) found that several significant sources of academic anxiety among dental students, including increased workload, time constraints, lower academic grades, fear of academic failure, and intense competition; notably, these stressors were equally prevalent among both state and private college students, with no statistically significant differences noted between the two groups. Our findings suggest that state faculties had students with higher levels of state and trait anxiety. This finding can be attributed to the highly competitive and demanding nature of education within state universities in Türkiye, largely due to their larger student populations. Consequently, this difference also elucidates why students attending private institutions tended to score higher on self-confidence than their counterparts in state universities. Furthermore, while private universities may offer more individualized and intense interactions between students and instructors, state universities may employ a more standardized teaching approach, which could potentially influence students' self-confidence. On the other hand, our findings suggest that making observations and being a female student may have a diminishing effect on confidence. Indeed, according to one study, female students were more confident in performing preventive resin restorations, giving oral hygiene instructions, and placing rubber dams than male students, who were more confident in performing surgical extractions, making duplicate dentures, preparing veneers, and handling orthodontic emergencies (25). Another study concurs with the current study's assessment of sex differences in confidence levels. Comparatively, male students reported more self-confidence than female students (26). In addition, another Turkish study found that male students in the Department of Oral Surgery tended to be more confident than their female counterparts (27). The reason for this general lack of self-confidence in female students may be due to their tendency to be perfectionists in their chosen profession.

At first sight, it seems unexpected that students who had previously performed clinical observations were found to be more insecure. The quality and frequency of students' observation experiences, as well as the range and diversity of practices they were able to observe, may have influenced this outcome. On the other hand, it is possible that these students were more aware of the complexities and demands of clinical practice. In this instance, increased awareness enables students to recognize their actual lack of qualifications. Students continue their theoretical education simultaneously during the transition period to clinical practice, therefore it is not an expected result that they have high self-confidence in the clinical skills. Consistent with this assumption, the total median confidence level scores in each major skill area did not exceed 3 in the present study. When examining the total confidence scores, the highest values were observed in preventive dentistry. Despite

the focus on senior students, Aldegheishem et al. (25) observed, in line with our study, that the highest level of confidence was noted in preventive dental practices, including pit and fissure sealants, preventive resin restorations, and oral hygiene instructions among students.

Dentistry is a discipline that encompasses both art and science and is involved in the processes of diagnosis, prognosis, and treatment planning. Proficiency in this field requires a combination of sound clinical skills, a comprehensive theoretical knowledge base, and practical expertise. Given the multifaceted nature of dentistry, clinicians must continually cultivate their competencies in a variety of ways. Prior to clinical training, an observation raises awareness of this, which can be intimidating for students and lower self-confidence. Such a phenomenon may provide a plausible explanation for the results observed in our study.

The current study's correlation analyses revealed a relationship between students' perceptions of their workload, knowledge, and skills, as well as their degree of confidence, and their anxiety. According to Wang et al. (28), anxiety disorder is strongly correlated with workload. Therefore, it is expected to detect a positive correlation between workload and STAI-S and STAI-T levels in our investigation. On the other hand, lack of knowledge may lead to anxiety. Students' worries that they might be unable to complete clinic duties effectively can cause them to become extremely anxious. This condition is comparable to the finding that self-confidence lowers anxiety in clinical applications. Therefore, it is not surprising that anxiety in our study had a negative correlation with self-confidence.

It is important to note that other factors, such as psychiatric disorders and medication use, may also impact the levels of stress and anxiety measured by the STAI. The present study did not assess these factors, which constitutes a notable limitation. Future research should focus on investigating the influence of psychiatric illnesses and other possible confounding variables on stress and anxiety levels to provide a more comprehensive understanding of these phenomena.

Another limitation of the current study may be that it involved only a limited number of students from Türkiye. Future research including participants from multiple countries with a larger number of students is needed to obtain comparable results. The inclusion of open-ended questions in future research is recommended to improve our understanding of students' expectations.

Conclusion

Professional confidence has a direct impact on the quality of clinical practice, which in turn influences patient interaction, willingness to undertake more challenging treatments, job satisfaction, and ultimately career advancement. Confidence and anxiety are opinionated parameters. Feelings of preparedness, anxiety, and confidence for clinical education experienced by students can be influenced by factors such as sex, academic institution, and observation status. As a result, evaluations and orientation programs considering the effects of these factors can help students in this transition period. Given that insufficient knowledge or lack of experience is frequently the primary cause of anxiety, it is essential to educate students on clinical skills. Engaging in exercises that simulate real patient scenarios can serve as an effective method for increasing students' self-confidence in preparation for clinical practice. Moreover, acknowledging students' accomplishments and providing positive feedback can enhance their self-confidence, consequently reducing their anxiety levels.

Declarations

Author Contributions: *Conception/Design of Study- B.Y.E., BK.; Data Acquisition- O.Y.; Data Analysis/Interpretation- B.Y.E.; Drafting Manuscript- B.Y.E., A.E.S., B.K.; Critical Revision of Manuscript- B.Y.E., A.E.S.; Final Approval and Accountability- A.E.S., BK.; Material and Technical Support- B.Y.E.; Supervision- B.K.*

Conflict of Interest: *Authors declared no conflict of interest.*

Financial Disclosure: *Authors declared no financial support.*

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Bilateral Plica Fimbriata Variation of the Tongue: A Case Report

Buse ALTUN[1]

ABSTRACT

Aim This case report aims to underscore the significance of recognizing the morphological variations of the plica fimbriata (PF) and integrating thorough observations into clinical protocols for comprehensive oral care.

Case Report A 24-year-old female patient presented with bilateral PF during a routine dental examination, showing distinct morphological differences between the two sides. Clinical evaluation revealed dental caries, but no signs of irritation or contact between the PFs and teeth were observed. Treatment involved restorative procedures for dental caries and instructions on maintaining oral hygiene. The asymptomatic PFs were deemed clinically insignificant, requiring no immediate intervention.

Discussion PF, an often-overlooked anatomical structure, plays a crucial role in oral health. Recent insights suggest its association with the salivary gland system, emphasizing its potential implications beyond structural existence. PF-related issues can lead to discomfort, highlighting the importance of patient education and multidimensional management approaches.

Conclusion Recognizing the varied morphologies of PF is essential for optimal patient care. Integrating thorough observations into clinical protocols enhances diagnostic accuracy and contributes to improved oral health outcomes. This case report underscores the significance of PF in oral health and emphasizes the need for comprehensive management strategies.

Keywords Benign, CBCT, Cemento-ossifying fibroma, Mandible, Odontogenic tumor

Introduction

The plica fimbriata (PF), an often-overlooked anatomical feature beneath the tongue is positioned adjacent to the lingual frenulum within the horseshoe-shaped floor of the mouth. PF comprises raised folds facilitating saliva drainage from the sublingual and submandibular glands into the oral cavity. The PF consists of elevated crests of mucous membrane on either side of the lingual frenulum, forming the floor of the mouth. Although variations exist in its appearance among individuals, such as fringe-like processes or small triangular flaps, these structures are normal residual tissues resulting from tongue development. Functionally, the PF serves as an essential channel for saliva drainage, contributing to oral lubrication and digestion. Despite its discreet nature, disruptions to this system, such as entrapment between teeth or the formation of open sores, can lead to discomfort and potential infections, underscoring the importance of proper oral hygiene and timely intervention (1-8).

Management of conditions related to the PF, such as salivary stone formation, requires a comprehensive approach involving diagnostic imaging modalities like ultrasound or computerized tomography scans. Initial interventions may involve conservative measures such as moist heat application and anti-inflammatory medications. However, surgical intervention, including techniques like salivary sialendoscopy, may be necessary if conservative methods prove ineffective (8).

Understanding the anatomy and function of the plica fimbriata is paramount for comprehensive oral care. Despite its often-overlooked status, this anatomical landmark plays a crucial role in oral health and warrants attention in cases of discomfort or dysfunction. By recognizing its significance, healthcare providers can ensure optimal care and improved patient outcomes in managing conditions associated with the plica fimbriata. In this case report, a patient with bilateral PF is presented.

Case Report

A 24-year-old female patient presented at the dental clinic for a routine examination. She had no reported systemic diseases and did not experience any oral discomfort. The patient maintained excellent oral hygiene, with no signs of gingival or periodontal disease, and there were no significant lifestyle factors contributing to her oral health. The only dental issue was a chipped filling that required restoration. During the examination, bilateral plica fimbriata (PF) were observed, showing distinct morphological differences between the two sides. The PF on the right side displayed a tentacle-like appearance, while the left PF appeared as a small pedunculated structure (Figure 1). Interestingly, the patient was unaware of these morphological variations and did not report any associated symptoms.

Clinical evaluation further revealed dental caries on the lower right first molar and a periapical radiograph indicated an apical lesion at the mesial root of this tooth, along with caries on the lower right second molar. There were no signs indicating irritation or contact between the PFs and the teeth.

A comprehensive treatment plan was devised to address the dental issues identified. Restorative procedures were carried out to treat the dental caries on the lower right first molar and to address the apical lesion revealed by the radiograph. Additionally,

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Received: 08.04.2024 / Accepted: 03.04.2024 / Published: 30.08.2024

the broken filling mentioned previously was not present; instead, attention was directed towards managing the caries on the lower right second molar. The patient received instructions on maintaining proper oral hygiene to ensure ongoing oral health. Patient consent was obtained for both the photographs and the publication of this case report.

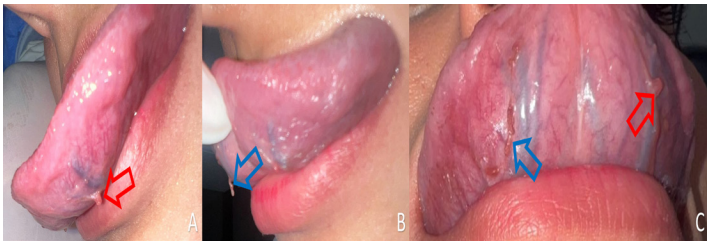

Figure 1: Bilateral plica fimbriata of the patient. A pedunculated round lesion (red arrow) and a tentacle-like lesion (blue arrow) are observed on the ventral surface of the tongue, exhibiting distinct morphologies.

Follow-up appointments were scheduled to monitor the patient's dental health and ensure successful treatment outcomes. The asymptomatic PFs on both sides were observed and deemed clinically insignificant, requiring no immediate intervention.

Discussion

PF is a relatively understudied yet significant anatomical structure situated beneath the tongue. While considered a normal feature without function, recent insights suggest its association with the salivary gland system, particularly the sublingual glands. Understanding the connection between PF and the salivary glands highlights its potential implications in oral health beyond structural existence (1-8).

Abdul Aziz and Yussif (2016) presented three case reports on nonneoplastic tongue swellings of lymphatic and lymphocytic origin. The study involved the examination and treatment of three different types of lesions: a reactive lymphoproliferative lesion, a cystic lymphoepithelial lesion, and a developmental lymphatic vessel malformation. Although the plica fimbriata is not the primary focus of the study, it is mentioned in the anatomical context of the tongue's ventral surface, where lymphatic and lymphocytic tissue can lead to various growths. These swellings, while not directly related to the plica fimbriata, illustrate the complex interplay of different tissues in the tongue, emphasizing the need for precise diagnosis and appropriate surgical intervention. The study underscores the importance of understanding the tongue's anatomy, including features like the plica fimbriata, for effective management of oral lesions (5).

Patini et al. (2023) conducted a comprehensive retrospective study on Blandin-Nuhn mucoceles (BNMs), evaluating 240 cases from two institutions. Their findings highlighted that BNMs, predominantly located on the ventral surface of the tongue, typically result from trauma and present as painless, light pink, exophytic lesions. The study noted a higher incidence in young individuals with a slight female predilection. Pathological analysis showed mucous extravasation surrounded by connective tissue in most cases. Treatment involved surgical excision with gland enucleation, leading to low recurrence and minimal complications. Additionally, the study explored the impact of prosthetic materials on BNMs, emphasizing the importance of careful prosthetic design and regular dental follow-ups to prevent irritation and inflammation associated with poorly fitted prostheses. This underscores the necessity for precise diagnosis and treatment to ensure positive outcomes in managing BNMs (7).

PF-related issues such as irritation or entrapment between teeth can lead to discomfort. This emphasizes the need for care in monitoring not just oral health concerns but also subtle anatomical changes like the PF. Combining basic oral hygiene practices and patient education regarding potential irritants can lessen such discomfort, as outlined in the supplementary article. Moreover, the possibility of PF irritation due to accidental bites or spicy foods further accentuates the need for patient awareness and management. Patients presenting with sore or swollen PF can benefit from a multidimensional approach, including gentle oral hygiene practices, saltwater rinses, and over-the-counter pain relievers. Additionally, consultation with a dental professional is crucial to rule out underlying issues and provide appropriate intervention if necessary (8).

Conclusion

In conclusion, this case report highlights the importance recognizing the varied morphologies of the PF and integrating thorough observations into clinical protocols. Healthcare providers can enhance diagnostic accuracy and contribute to improved patient care, ultimately leading to better overall oral health outcomes.

Declarations

Author Contributions: *Conception/Design of Study- B.A.; Data Acquisition- B.A.; Data Analysis/Interpretation- MB.A.; Drafting Manuscript- B.A.; Critical Revision of Manuscript- B.A.; Final Approval and Accountability- B.A.; Material and Technical Support- B.A.; Supervision- B.A.*

Conflict of Interest: *Authors declared no conflict of interest.*

Financial Disclosure: *Authors declared no financial support.*

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