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Evaluation of Vertical Marginal Gap of Long Span Implant Supported Fixed Dental Prostheses Fabricated with different CAD/CAM Materials.

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Abstract: Long span implant prosthetic materials capable of reducing biological or mechanical violation on the implants and supporting structures are highly required. With the introduction of high-performance polymers, this situation should be evaluated.

Aim: To evaluate the vertical marginal gap of CAD/CAM long span implant supported fixed dental prostheses fabricated from polyetherketoneketone (PEKK) compared to Polyetheretherketone (PEEK) and zirconia. **Material and methods:** Two implants with straight abutments were inserted in a metal model representing lower first premolar and second molar. Twenty-one frameworks of fourunit FDPs were milled with three materials; PEKK, PEEK and Zirconia, and divided according to type of material into three groups (n = 7). The Vertical marginal gap of cemented frameworks was measured using stereo microscope (3-MA 100 Nikon stereo microscope Japan) at 70x magnification. For each specimen; four shots were captured, then the images were transferred to an image analysis software (Omnimet Buehler USA) for vertical marginal gap evaluation. **Results:** The mean marginal gab values were [64.28 ± 17.06 µm], [66.54 ± 14.16 µm] and [58.82 ± 11.64 µm] for the PEEK, PEKK and Zirconia groups respectively. There were no statistically significant differences between the PEEK and PEKK groups while both of the two groups increase significantly than the zirconia group. **Conclusion:** The vertical marginal gap values of the long span implant supported FDPs were affected by the material type. The obtained results were all within the clinically accepted range.

Keywords- *Framework, Marginal gap, PEEK, PEKK, Zirconia,*

I. Introduction

Implant dentistry has a unique goal of restoring the patient to normal function, esthetics, speech, comfort and health regardless the condition of the stomatognathic system. With development of dental implants and advancement of CAD/CAM technology, prosthetic treatment for replacement of missing teeth has significantly improved. However, selection of prosthetic materials is a critical determining factor in long-term clinical success and stability of implant prostheses. [1, 2]. Prosthetic replacement of missing teeth has significantly improved with introduction and development of dental implants and Computer-aided designing/ computer-aided manufacturing (CAD/CAM) materials. CAD/CAM technologies are capable of providing standardized and efficient dental restorations and allow the processing of various dental materials, including ceramic, zirconia, composite, and acrylic resins.[3, 4]

Zirconia frameworks were developed as an esthetic alternative for metal ceramic implant restorations due to high chemical, mechanical, physical and optical properties, and good clinical success even in the posterior region.(5) Currently, processing is mainly conducted with pre sintered zirconia. Consequently, restorations must undergo the final sintering after the process. However, linear shrinkage by 20–25% can occur; hence, the fit of the zirconia prostheses upon completion of firing is of concern. (3, 6)

Polyaryletherketones (PAEK) are high-performance thermoplastics which have high strength, stiffness and good resistance to hydrolysis. Polyetheretherketone (PEEK) and polyetherketoneketone (PEKK) both belong to the PAEK family.(7) PEEK is a high-performance engineering plastic, which has attracted attention of dental researchers. (5, 8) It has versatile mechanical and chemical properties that are retained at high temperature. Young's modulus is (3.6-4.1 GPa), and it has a tensile strength of 90-100 MPa.(9, 10)PEEK has a glass transition temperature of around 143°C and melts around 343°C.

(11) In addition, it has a high resistance to both thermal degradation and biodegradation. From the biomedical perspective, PEEK has excellent cell biocompatibility, radiolucency, and mechanical properties similar to those of human cortical bone.(9) PEEK is being used in dentistry as abutments, removable partial denture frameworks, and FDP frameworks.(12, 13) Polyetherketoneketone (PEKK) is the latest generation of the PAEK. It displays both amorphous and crystalline material properties which acquired it unique mechanical, physical and chemical properties, up to 80% higher compressive strength than PEEK materials so, PEKK lends itself to a broader range of uses than PEEK.(7)

The success of a dental restoration is determined by 3 main factors: esthetic value, resistance to fracture, and marginal adaptation. Inadequate marginal fit leads to cement dissolution, plaque accumulation, which increases the risk of carious lesions and periodontal diseases.

Advantages of milling include elimination of porosities resulted from human error and elimination of casting errors by precise milling of frameworks.(14) The coping (framework) mainly determines the overall adaptation of final restoration .(15-17) The previous studies recommended 3.0 mm to be minimal occluso-cervical dimension for premolars prepared with the recommended 10º to 20º total occlusal convergence angle. (18, 19)

Marginal fit is considered one of the most important criteria used in the evaluation of fixed dental prostheses (FDPs). Good marginal fit is one of the most significant prerequisites for the long-term success of ceramic restorations. The larger the marginal discrepancy, the more the luting material is exposed to the oral environment, and is also associated with a higher plaque index and loss of attachment(20, 21) Vertical marginal discrepancy is the least liable to correction after crown fabrication, as indicated by Holmes et al(22) Horizontal discrepancies, such as overhangs, can be adjusted to some degrees intraoral. However, a vertical marginal gap can only be closed with luting cement, which is prone to dissolution.(23) The number of measurements in different studies varied from 4 (24, 25) to 8,(26) 12,(27) 54,(26) or more than 100(28) locations per crown. Groten et al(29) proposed that 50 locations, and no less than 20 to 25, were ideal to obtain clinically relevant information. Furthermore, sample sizes have varied from 5 to 10 specimens for each crown system. (24, 28) (30) Marginal gap was measured by direct view technique which was used by several studies. Direct viewing with external measurements has the advantage of not being invasive and therefore applicable to clinical practice. (17, 21, 31) (32) Christensen(33) reported that the clinically acceptable sub-gingival marginal opening range from 34 to 119µm; while the acceptable supra-gingival marginal opening range from 2 to 51 µm. However; most investigators continue to use the criteria established by McLean and Von Fraunhofer(34), after 5-years clinical study of 1000 restorations, in which they concluded that 120 µm was the maximum acceptable marginal opening. However the most acceptable marginal gap range is between 50 to 100 µm for CAD/CAM restorations. (35) For PEEK, CIGU et al (36) reported mean gap value of 66µm Makky M. R. et al (37) reported mean gap value of 69 µm. Abdullah et al(38) reported a mean gap value of 46 µm, Attia and Shokry(39) reported mean gap value of 45 µm and Emad M. et al.(40) reported mean gap value of 49 µm. For PEKK, Park et al (41) reported mean gap value of 66 µm and Bae et al.[3] reported mean gap value of 62 µm. The mean marginal gap values for Zirconia ranged from 57 to 71µm.(42) (43)

The null hypothesis that tested in this study was that the material type will not affect the vertical marginal gap of the long span implant supported FDPs .

II. METHODOLOGY:

Materials used in this study:

The materials used in in this study indexed in table (1) .

Table (1): Materials used in this study:

Material	Product	Lot No.	Manufacturer
Implants: -Size (Ø 4.3mm, L 13mm) -Size (Ø 5mm, L 13mm)	JD Evolution® Plus+	02-08-20-5520 05-07-18-3318	JDentalCare srl Via del Tirassegno 41/N41122 Modena Italy
PEEK Milling blank	BreCAM.BioHPP	484123	Bredent GmbH&Co.KG Weissenhorner Str. 2, 89250 Senden - Germany
PEKK Milling blank	Pekkton® ivory	0000359831	Cendres+Métaux SA Rue de Boujean 122 CH-2501 Biel/Bienne, Switzerland
Low translucent zirconia	Ceramill ZI White	1802002	Amann Girrbach AG
			Herrschaftswiesen 16842 Koblach | Austria

Sample size:

A power analysis of the data was designed based on previous study[44] , sample size of 7 in each group has an 80% power to detect a difference between means of 169.87 with a significance level (alpha) of 0.05 (two-tailed) at 95% confidence intervals. In 80% (the power) of those experiments, the P value was less than 0.05 (two-tailed) so the results were statistically significant. In the remaining 20% of the experiments, the difference between means was statistically non-significant (Report created by GraphPad StatMate 2.00).

Preparation of bridge specimens:

Specimens grouping:

A total of twenty-one frameworks of fourunit FDPs were divided according to type of material into three groups (n = 7). Group PEEK, Group PEKK and Group Zirconia.

Fabrication of master models:

Aluminum model (Length= 50mm Width=30mm Thickness=20mm) was cut from aluminum bar. Two holes were drilled in the model to receive the pre-determined implants.The two implants were fixed in the holes using auto-polymerizing acrylic resin (Size (Ø 4.3mm, L 13mm) representing lower 1st premolar; tooth No, 34 and Size (Ø 5mm, L 13mm) representing lower 2nd molar; tooth No, 37). The distance between the apices were 23 mm[45] , corresponding to the average distance between a first premolar and a second molar. To adjust parallism and distance, A special paralling device was designed to hold the two implants parallel to each other. A dental surveyor (Paraskop®M, Bego, Bremer, Germany) was used to control the horizontal and axial orientation of the inserted implants and to centralize them within the resin material in the holes placed in the model. Each Abutment was reduced by the aid of milling machine to create 4 mm height, 16º total occlusal convergence and radial shoulder finish line with (0.8mm) thickness. The abutments were then adapted over their implants and tightened precisely. All frameworks were directly fabricated on this model. “Fig. 1”

Framework fabrication:

<u>Scanning the master model:</u>

Before scanning, the master model was sprayed using (D-Scan) Spray (Dentify GmbH Germany) and ensured to form a single continuous layer, then mounted to the base of the scanner. Optical impression was then taken using lab scanner (CS.Neo - 3D Dental Scanner(CAD star Technology GmbH Austria)). The model was fixed to the base of the scanner, then the scan was initiated. The scanned 3D model was generated directly through (CS.Core dental scan application version 2.0.15 (CAD star Technology GmbH Austria)). The scanning process produced a 3D model that was ready for design.

<u>Framework designing (CAD):</u>

The framework was designed using EXOCAD software (Exocad (exocad GmbH) Germany). The constructed 3D model was transferred to the program to start the designing process. Only one design was used with all materials in this study. Path of insertion detection, teeth selection, the material thickness was set to (0.8mm), connector size was set to (14mm) and cement gap was set to 80μm, as observed in the diagram “Fig. 2”

<u>Milling of the frameworks (CAM):</u>

The designed framework was then set up in the milling blank using MILL BOX software (CIMsystem, Via Monfalcone,(MI) Italy). The material was selected and then 7 frameworks for each group were set up within the corresponding blank and then milling was done by five axis milling machine (COREiTEC 250i Series (imess-icore GmbH, Germany))

<u>PEEK & PEKK Groups milling:</u>

The same steps were followed in the process of milling PEEK and PEKKTON blanks started from opening the MillBox software, then selection of material, selection of blank, nesting and then milling were done.

Zirconia group milling:

The same steps used with PEEK and PEKK were followed with the zirconia group, but differ here by adding shrinkage factor recommnded by the maniufacturer to the nesting process.All the milled zirconia frameworks were then placed on the firing tray on their occlusal surfaces and away from the margins and then sintered in (TABEO-1/M/ZIRKON-100 (MIHM-VOGT GmbH & Co. KG, Germany)) sintering furnace.The sintering program was set according to manufacturer instructions for long span bridges 10h with an average rise in temperature of (8^0C/min) and peak temperature of

(1450^0C) with a holding time of (2h) and slow cooling rate of (-5^0C/min). The finished frameworks showed in "Fig. 3"

Vertical marginal gap evaluation:

Each framework was temporary cemented(46-49) to the corresponding abutments on the master model using NETC (Non-Eugenol Temporary Cement (META BIOMED CO., LTD, SOUTH KOREA)). Separating medium was applied on the abutments before cementation to ease removal of each specimen and cleaning the abutment surface after vertical marginal gap evaluation. To prevent framework movement and maintain accurate positioning, a customized loading device with pre-determined torque was designed to apply a uniform load of 49 N for 10 minutes along with the long axis of the implants" Fig.4". The excess cement was removed with sharp explorer. Four points were marked on both buccal and lingual surface of each abutment 1 mm apical to the finish line using diamond rotary instrument and were used as a reference for measurement all over the whole specimens. The cemented framework was then positioned on the stereo microscope (3-MA 100 Nikon

stereo microscope Japan) at 70x magnification. For each specimen; four shots were captured, then the images were transferred to an image analysis software (Omnimet Buehler USA). Within the OmniMet software; all limits, sizes, frames and measured parameters were expressed in pixels. Therefore, system calibration was done to convert the pixels into absolute real-world units. Calibration was made by comparing an object of known size (a ruler in this study) with a scale generated by the software "Fig.5". The vertical marginal gap between the cervical margin of each retainer and the outer end of the finish line of the corresponding abutment was measured for each shot at predetermined landmarks. Measurement at each point was repeated three times then the average recorded. Then the obtained data were collected and tabulated using Microsoft Excel (Microsoft Office 2019). The mean vertical marginal gap for each specimen was calculated and then subjected to statistical analysis.

Statistical analysis of the data:

Statistical analysis of the data was fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) The Kolmogorov-Smirnov test was used to verify the normality of distribution Quantitative data were described using range (minimum and maximum), mean, standard deviation, and median. The significance of the obtained results was judged at the 5% level.

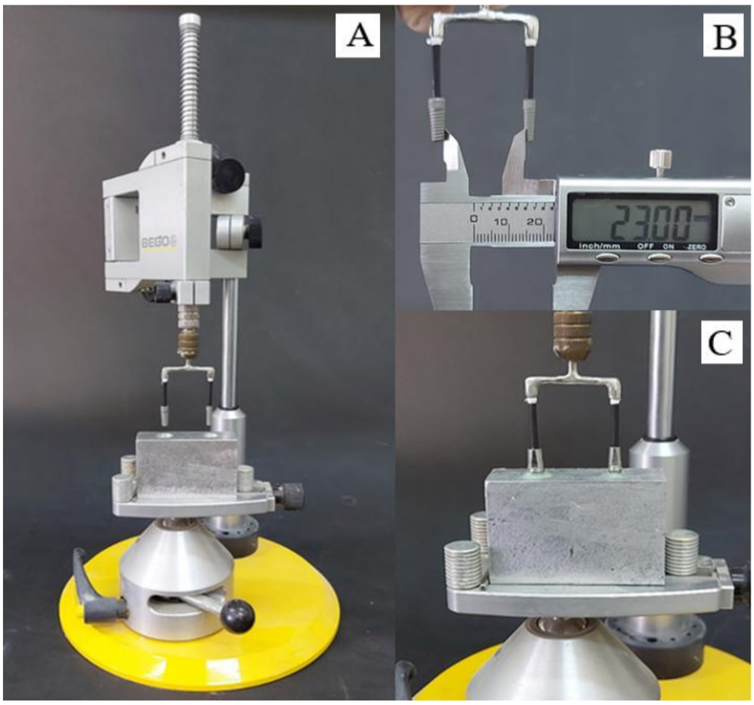

Figure 1: A. Master model in place on the surveyor (fixture placement), B. Confirmed 23mm apical distance, C. Abutments in place and confirmed parallism.

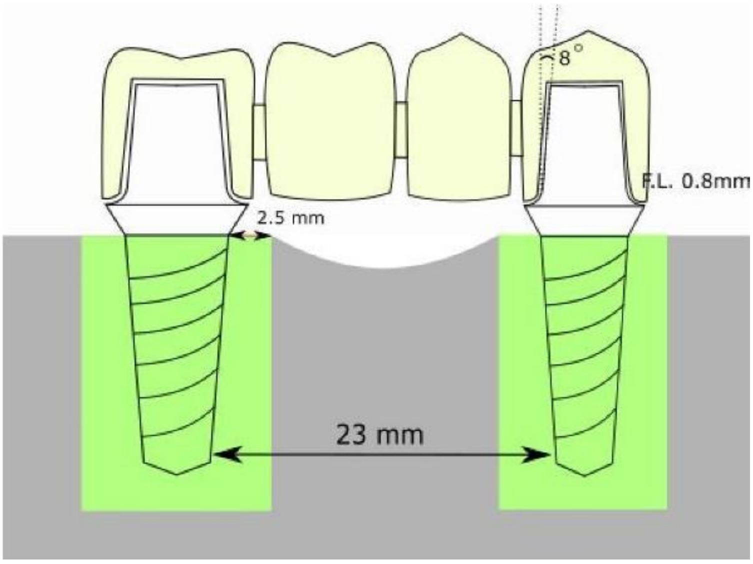

Figure 2: Diagram showing master model with the framework design

Figure 3: The completed frameworks (A)PEEK, (B)PEKK, (C) Sintered Zirconia

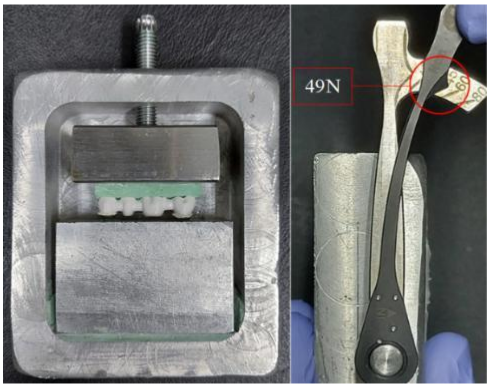

Figure 4: device for load application during cementation

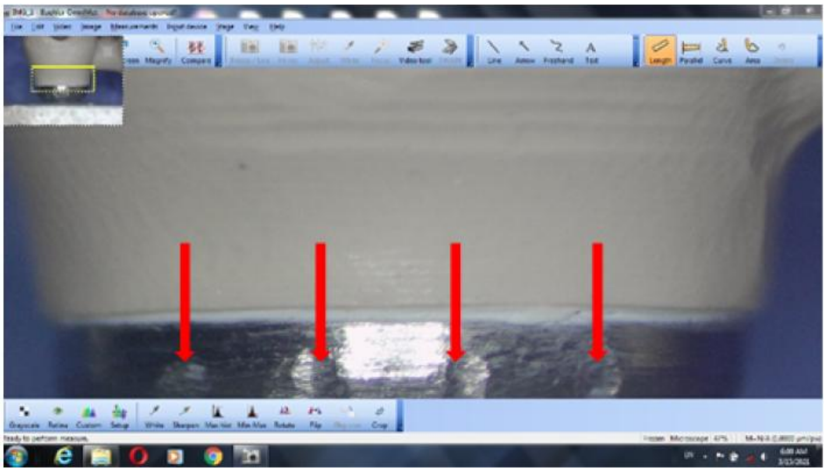

Figure 5: Captured image in OmniMet software (Note the four reference points marked on the abutment

III. RESULTS

Different materials and abutments (premolar versus molar) tested showed a significant effect on the marginal gap values (p=0.02 and p<0.00, respectively). On the other hand, Different abutment aspect (restoration aspect) showed non-significant effect on the marginal gap values (p=0.273).

Table 1: Mean and standard deviation of marginal gap for different tested materials.

		PEEK		PEKK		Zirconia		p-value
		Mean	SD	Mean	SD	Mean	SD	
Buccal	Premolar	54.18[a]	3.63	62.84[a]	4.44	51.95[a]	9.18	0.121 NS
	Molar	80.36[a]	16.88	73.03[ab]	15.69	64.37[b]	8.27	0.019*
Lingual	Premolar	59.06[a]	12.79	63.04[a]	9.20	57.26[a]	7.20	0.566 NS
	Molar	63.49[a]	7.04	67.24[a]	12.78	61.71[a]	7.11	0.596 NS

**=Significant. NS=Non-significant*

Different letter within each row indicates significant difference

The mean marginal gap values for the buccal surface of the molar abutments were [54.18 ± 3.63 µm],

[62.84 ± 4.44 µm] and [51.95 ± 9. 18 µm] and for the lingual surface were [59 .06 ± 12.79 µm],

[63.04 ± 9.20 µm] and [57.26 ± 7.20 µm] for the PEEK, PEKK and Zirconia groups respectively.

For the molar apartment the values for the buccal surface were [80.36 ± 16.88 µm], [73.03 ± 15.69 µm] and [64.37 ± 8 point 27 µm] and for the lingual surfaces the values were [63.49 ± 7.04 µm], [67 .24 ± 12.78 µm] and [61.71 ± 7.11 µm] for the PEEK, PEKK and Zirconia groups respectively.

The differences between the vertical marginal gap values between the tested materials were statistically non-significant except for;

Significant differences between PEEK and Zirconia groups at the buccal surfaces of the molar abutments.

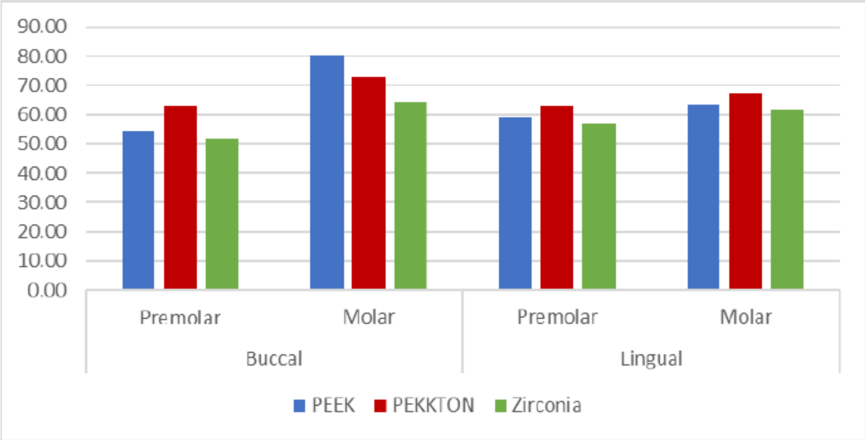

Figure 3: Bar chart showing the mean marginal gap for different tested materials.

Table 2: Mean and standard deviation of total marginal gap for different abutments.

		Premolar		Molar		p-value
		Mean	SD	Mean	SD	
PEEK	Buccal	54.18	3.63	80.36	16.88	<0.001*
	Lingual	59.06	12.79	63.49	7.04	0.425 NS
PEKKTON	Buccal	62.84	4.44	73.03	15.69	0.069 NS
	Lingual	63.04	9.20	67.24	12.78	0.449 NS
Zirconia	Buccal	51.95	9.18	64.37	8.27	0.028*
	Lingual	57.26	7.20	61.71	7.11	0.423 NS

**=Significant. NS=Non-significant*

There were no statistically significant differences between the tested abutments in the whole groups except for, statistically significant differences between the premolar and molar abutments at the PEEK group at the buccal surfaces and at the Zirconia group at the buccal surfaces.

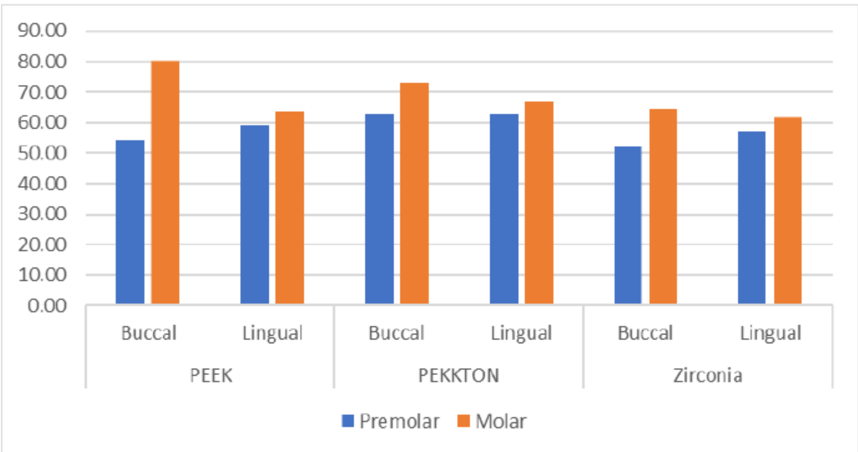

Figure 4: Bar chart showing the mean total gap for different tested tooth (abutment).

Table 3: Mean and standard deviation of marginal gap values for different abutment surfaces.

		Buccal		Lingual		p-value
		Mean	SD	Mean	SD	
Premolar	PEEK	54.18	3.63	59.06	12.79	0.380 NS
	PEKKTON	62.84	4.44	63.04	9.20	0.972 NS
	Zirconia	51.95	9.18	57.26	7.20	0.339 NS
Molar	PEEK	80.36	16.88	63.49	7.04	0.003*
	PEKKTON	73.03	15.69	67.24	12.78	0.297 NS
	Zirconia	64.37	8.27	61.71	7.11	0.632 NS

**=Significant. NS=Non-significant*

The differences between the whole surfaces were statistically non-significant for the whole groups except for, statistically significant differences between the buccal and lingual surfaces of the molar abutments in the PEEK group.

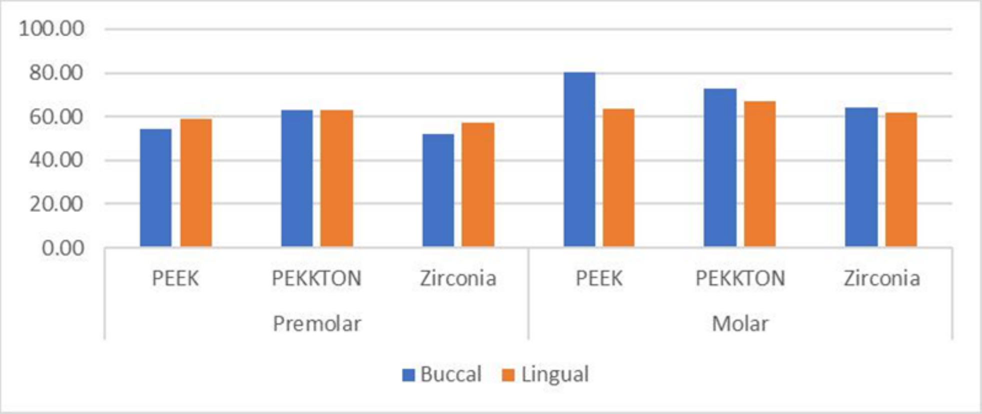

Figure 5: Bar chart showing the mean marginal gap values for different abutment surfaces.

Effect of tested materials on the vertical marginal gap (One-way ANOVA):

The mean marginal gab values were [64.28 ± 17.06 µm], [66.54 ± 14.16 µm] and [58.82 ± 11.64 µm] for the PEEK, PEKK and Zirconia groups respectively.

There were no statistically significant differences between the PEEK and PEKK groups while both of the two groups increase significantly than the zirconia group.

Table 11. Mean and standard deviation of the vertical marginal gap values of different tested materials

	PEEK		PEKK		Zirconia		p-value
	Mean	SD	Mean	SD	Mean	SD	
Gap	64.28^a	17.06	66.54^a	14.16	58.82^b	11.64	<0.001*

**=Significant. NS=Non-significant*

Different letter within each row indicates significant difference

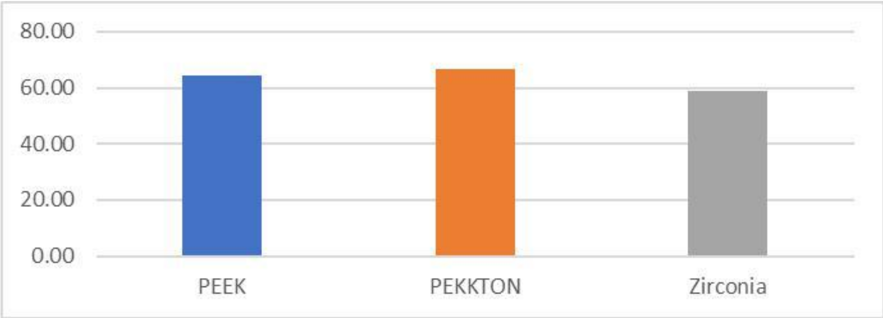

Figure 6: Bar chart showing the mean vertical marginal gap for the different tested materials.

IV.DISCUSSION

The **null hypothesis** that tested in this study, which was the material type will not affect the vertical marginal gap of the long span implant supported FDPs was rejected.

The study was designed to be in vitro. In vitro research is used for assessing new materials or techniques to be further tested in vivo. Also it offers standardized and optimized conditions in the experimental performance, which may not be achievable in vivo. [20]

Titanium implants with their abutments were used in the present study as done by several studies[5, 45]The advantages of the metal abutments are standardized preparation and wear resistance during the manufacturing processes and measurement procedures. To adjust parallism and distance, a special paralling device was designed to hold the two implants parallel to each other by the aid of dental surveyor to control the horizontal and axial orientation of the inserted implants. The distance between the apices were 23 mm[45] representing the average distance between a first premolar and a second molar. The abutments were machine-milled with 4 mm height and 16º total occlusal convergence angle like other studies as they recommended 3.0 mm to be minimal occluso-cervical dimension for premolars prepared within the recommended 10º to 20º total occlusal convergence angle. [18, 19]

Frameworks in all groups were constructed using EXOCAD software and extraoral 3D scanner (CS.Neo - 3D Dental Scanner) was used to scan the abutments. The frameworks were machine milled by using 5-axis milling machine (COREiTEC 250i Series). Advantages of milling include elimination of porosities resulted from human error and elimination of casting errors by precise milling of frameworks[14]

The marginal fit of a fixed prosthesis is one of the most important factors for successful prosthetic treatment. An ideal marginal fit maintains a healthy periodontal status and prevents cement dissolution. In addition, an excellent internal fit increases the retention of the prosthesis.[50]

Since the coping (framework) mainly determines the overall adaptation of final restoration [15-17] the marginal gap of copings in this study was measured without veneering.

Marginal gap was measured by direct view technique which was used by several studies. Direct viewing with external measurements has the advantage of not being invasive and therefore applicable to clinical practice. [17, 21, 31]

This method does not incorporate any procedures on the crown-die assembly such as sectioning or replications of the cement space before measuring the gap; hence making it cheaper and less time-consuming than other techniques and reduce the chance of error accumulation that may results from multiple procedures and ultimately impact the accuracy of results.

Some terms are necessary for marginal gap measurement on a non-sectioned specimen:[32]

- Measurements of the marginal gap must be repeated to increase reliability (the gap measurement was repeated three times for every measured point).

- The restorations must be repositioned in the identical locations on the model (the presence of two abutments solved this issue)

- The measurement points must be precise and well defined (four predetermined points were marked on each abutment 1.0 mm below the margin to orient the microscope during marginal gap measurements).

Furthermore; a special loading device was used for cementation of the frameworks in this study as recommended by Gorten et al. [28] for proper seating over the corresponding abutments with a load of 5 kg directed parallel to the longitudinal access of the implants.

The ability to directly visualize and measure marginal discrepancies by means of microscope photography provided accuracy and reproducibility. The assessment of marginal fit was performed by using USB digital microscope; all measurements were made by the same operator to avoid errors as much as possible.

The number of measurements in different studies varied from 4 [24, 25] to 8,[26] 12,[27] 54,[26] or more than 100[28] locations per crown. Groten et al[29] proposed that 50 locations, and no less than 20 to 25, were ideal to obtain clinically relevant information.

Furthermore, sample sizes have varied from 5 to 10 specimens for each crown system [24, 28] [30]. In the present study, 7 specimens and 16 measurement locations were selected for each specimen.

Pera et al used a stereomicroscope with X100 magnification for the direct observation of the marginal gap and measured the marginal gap of cemented and non-cemented crowns at four points on the dies.[26]

In the present study, the fit of frameworks was assessed based on the vertical marginal gap, the discrepancy in the vertical dimension, because this discrepancy is the least liable to correction after crown fabrication, as indicated by Holmes et al[22] Horizontal discrepancies, such as overhangs, can be adjusted to some degrees intraoral. However, a vertical marginal gap can only be closed with luting cement, which is prone to dissolution[23] For this reason, the vertical marginal gap has the most clinical relevance and should be regarded as the most critical in crown margin evaluation. Therefore; vertical cervical marginal gap measurement was selected as the most frequently used to quantify the accuracy of fit of a restoration.[31]

The frameworks were cemented using temporary cement as done by several studies[46-49]for easy removal of the frameworks between measurements without scratching the abutments.

Although there is no standard for marginal gap limit, Christensen[33] reported that the clinically acceptable sub-gingival marginal opening range from 34 to 119µm; while the acceptable supra-gingival marginal opening range from 2 to 51 µm. However; most investigators continue to use the criteria established by McLean and Von Fraunhofer[34], after 5-years clinical study of 1000 restorations, in which they concluded that 120 µm was the maximum acceptable marginal opening. However the most acceptable marginal gap range is between 50 to 100 µm for CAD/CAM restorations. [35], and that limit (100 µm) was the chosen standard set for the present study.

In the present study, the mean marginal gap values were [64.28 ± 17.06 µm], [66.54 ± 14.16 µm] and [58.82 ± 11.64 µm] for the PEEK, PEKKTON and Zirconia groups respectively.

The obtained results of the PEEK group were in accordance with those of the study by CIGU et al

- who reported mean gap value of 66µm Makky M. R. et al [37] who reported mean gap value of 69 µm.

The results were opposed by those of the study by Abdullah et al[38] who reported a mean gap value of 46 µm, Attia and Shokry[39] who reported mean gap value of 45 µm and Emad M. et al.[40] who reported mean gap value of 49 µm.

The obtained results of the PEKKTON group were in accordance with Park et al [41] who reported mean gap value of 66 µm and Bae et al.[3] who reported mean gap value of 62 µm.

The mean marginal gap values for Zirconia group were in accordance with the reported mean marginal gap values for 3Y-TZP copings fabricated by different CAD-CAM systems which ranged from 57 to 71 µm.[42]

Kayikci et al., (2021)[43] did a study to Compare the marginal and internal fit of threeunit CAD/CAM implantsupported FDP substructures fabricated from; cast cobalt chromium (Co-Cr) (control), milled Co-Cr, laser sintered Co-Cr, titanium, zirconia, and PEEK substructures. They Concluded that all substructures have marginal and internal fit within the clinical accepted limits.

When considering all criteria; the vertical marginal gap values obtained in the present study were all within the clinically most acceptable standard limit which was set to 100 µm.

There were no statistically significant differences between the PEEK and PEKK groups while both of the two groups show significant difference from the zirconia group.

These results may be attributed to the different framework design which was used in the current study.

Different findings between studies could be explained as researchers used different experimental setups and measured the marginal gaps under different conditions. Making the measurement in vivo or in vitro, before or after cementation, before or after veneering, on a chamfer or shoulder finish line, the measuring methods and possible errors in microscopic evaluation of the marginal gap, different CAD/CAM systems which are used, sample size, number of measurements per sample and even the sintering program used for zirconia specimens been found to affect the marginal gap.

Although studies on the marginal precision of PEEK and PEKK restorations are scarce, the results of this in vitro study demonstrated excellent marginal precision when compared with that of other ceramic systems. However, the long-term performance of PEEK and PEKK restorations should be evaluated.

V. CONCLUSION

Under the circumstances of this in vitro study, it can be concluded that;

- The vertical marginal gap values of the long span implant supported FDPs were affected by the material type.
- The obtained results were all within the clinically acceptable range.

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