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# Effect of Different Materials of Primary Telescopic Crowns on The Frictional Fit of Pekkton Partial Denture Frameworks in Kennedy Class I

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## Abstract

**Objectives:** This research was carried out to evaluate the friction fit (FF) of secondary telescopic crowns made of polyetherketone ketone (PEKK) in combination with primary crowns made of two different dental materials.

**Materials and methods:** It is an in-vitro study where (6) Removable partial denture frameworks together with secondary crowns were milled from polyetherketone ketone (PEKK). Afterwards, (48) primary crowns were fabricated group (A): (24) PEKK-crowns were milled from Pekkton® blank, group (B): (24) zirconia-crowns were milled from a pre-sintered zirconium-dioxide blank. Friction fit (FF) was measured in a pull-off test (6 pull-off/specimen). Maximum tensile loads needed to dislodge the framework from the cast were calculated in Newtons. The acquired data were then tabulated and statistically analysed.

**Results:** It was found that group (A) recorded statistically significant higher friction fit mean value (10.40±1.49) than group (B) (6.78±1.05) as indicated by t-test ($P \leq 0.05$).

**Conclusion:** PEKK primary crowns showed better friction fit than zirconia one in conjunction with PEKK framework in kennedy class I telescopic partial denture.

**Keywords:** CAD/CAM, conus crowns, double crowns, PEKK, telescopic crowns, zirconia.

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## Introduction:

Loss of posterior teeth may result in the loss of neuromuscular stability of the mandible, reduced masticatory efficiency, loss of vertical dimension of occlusion in addition to poor aesthetics. Prosthetic rehabilitation should aim to restore the vertical dimension, increase the occlusal contact area in the premolar/molar region and provide good esthetics. Removable partial dentures are particularly indicated in Kennedy Class I & Class II cases when there is need for a simple and economic solution.[1]

Conventional removable partial dentures (RPDs) have some limitations as the metallic color of the clasps and irritation to the gingiva of the supporting teeth.[2]

Telescopic crown attachments have been successfully used in completely and partially edentulous patients. This type of attachment provides retention, support, and stability with optimal hygiene for the removable dental prosthesis (RDP). Use of telescopic crown attachments (TCAs) for removable dental prostheses (RDPs) was first reported in the late 19th century. [3]

TCAs consisted of inner coping or a primary telescopic crown cemented to a natural tooth abutment, or a screw-retained primary telescopic abutment and an outer secondary telescopic crown attached to the removable dental prosthesis (RDP).[4]

With the emergence of CAD/CAM technology, telescopic crown attachments can be virtually designed and milled precisely to ensure a passive fit of the attachment parts and maximal function of the RDP. It is also decreases the number of visits, as well as produces accurate prosthesis. [5]

Zirconia is becoming one of the most chosen materials for dental crowns and attachments because it is highly biocompatible, as the smooth surface helps to reduce plaque accumulation. The material also promotes a healthy tissue response. [6]

Recently, a new PAEK-based polymer, polyetherketoneketone (PEKK) was introduced. It has several benefits which include low cost and lighter weight compared to conventional frameworks in RPD. Due to its mechanical strength, excellent biocompatibility, shock-absorbing ability and a wide capability of fabrication processing technologies including milling and pressing, PEKK is an attractive dental material for telescopic dentures. [7]

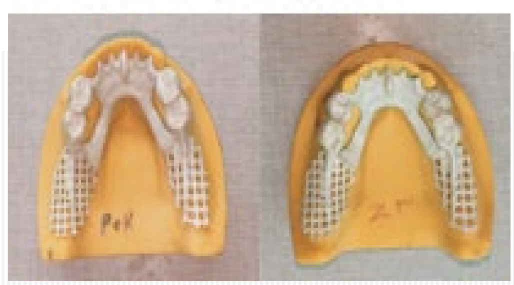
So, this study was conducted to evaluate the effect of zirconia and pekkton primary crowns on the friction fit of pekkton telescopic retained RPD.

## Materials and methods

### 1. Scanning of the educational casts:

The stone cast was coated by a scan spray (sherascan spray, Germany) and scanned with a desktop scanner (Medit Identica hybrid 3D dental Scanner, Auckland) and then a Standard Tessellation Language STL file was generated.

The STL file was imported into the 3D System CAD software (Exocad, Germany) to be modified. The cast was modified to create four beds in the first and second premolar region bilaterally. The four beds were aligned with a common path of insertion and removal and designed with 1.2 millimeters (mm) chamfer finish line and 3° taper to represent prepared abutments. Then, the STL file was sent to the additive manufacturing device (Mogassam Co., Egypt) to produce (12) identical three dimensional (3D) casts. The raw material used for printing of the 3D casts is NextDent™ resin material.



Regarding post-processing, the casts were soaked into 91% isopropyl alcohol. Then, they placed into a post-curing equipment (bre.Lux Power Unit 2, bredent, UK) for 10 minutes (min).

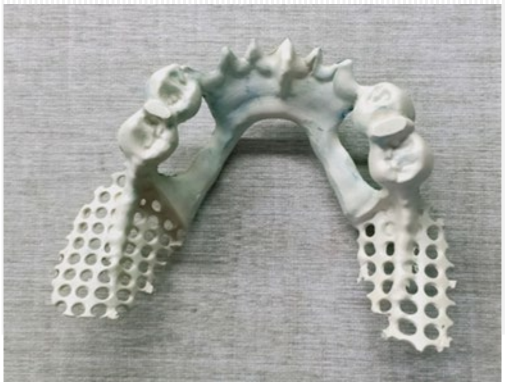
The 3D cast was powdered and scanned to generate STL file. The STL file was imported to the software to design the primary crowns with 1mm thickness and 1mm edge height from the finish line with the minimum amount of cement gap (0.4 mm). The STL file was sent to the milling machine.

- **Group (A):** The primary crowns (24) were millied from Pekkton® blank (Cendres+Metaux SA,USA) of 20 mm that was inserted in the 5 axes milling machine (K5, vhf, Germany) to fabricate the crowns. The crowns were finished, polished (Visio.link finishing kit) and seated on the cast.

- **Group (B):** The primary crowns (24) were milled from a pre-sintered zirconium-dioxide blank (Kerox ZircoStar®, HT Zirconia Disc White, K12-0188, Hunga) of 98x14 mm was used to fabricate the zirconia primary crowns applying the same construction parameters. The blanks were milled and sintered according to the manufacturer's instructions. Each zirconia crown was finished by diamond burs and polished for with the diamond polishing zirconia set (Eve Diasint set HP 321, 9077, Germany).

The 3D cast with PEKK (Pekkton®) primary crowns in place was coated with scan spray and scanned to generate an STL file. The STL file was imported to the software to design each framework including meshwork denture base, lingual plate mandibular major connector and secondary crowns. Each framework designed with three-widely separated holes at the premolars and midline areas on outer side of occlusal surface for the pull-off test.

Finally, the STL file of the framework design was sent to the milling machine to fabricate a temporary framework made from a poly methyl methacrylate (PMMA) blank (Yamahachi Dental, Japan) as a trial framework. After verification of the temporary framework on the cast, the STL file of the design was used again to mill the framework from the PEKK (Pekkton®) blank of 20 mm using the 5 axes milling machine.



## 2. Cementation of primary crowns

Pekkton primary crowns were sandblasted (Renfert Basic eco Fine sandblasting unit, German) at a pressure of 2-3 bars using 110 µm aluminium oxide. Then, they were cleaned with alcohol and a clean brush. Then, the inner surfaces of the Pekkton primary crowns were conditioned with Visio.link adhesive primer (bredent UK, Chesterfield County) and polymerized subsequently in an extra-oral light polymerization unit (Denstar Light, South Korea) for 90 seconds. Zirconia primary crowns were also sandblasted and cleaned as mentioned before. The inner surfaces of the zirconia primary crowns were conditioned by drops of MKZ Primer (bredent UK, Chesterfield County) and left to dry for approximately 30 seconds.

**For casts of both groups:** They were also sandblasted as mentioned before. Then, they were cleaned with compressed air for 15 seconds (s).The surfaces of the abutments were also wetted with light-curing Visio.link adhesive primer (bredent UK, Chesterfield County) using a brush and polymerized in an extra-oral light polymerization unit for 90 seconds. Then, self-adhesive resin cement (Theracem® automix, Bisco, Schaumburg, USA) was injected into inner surface of all the primary crowns. Then, the primary crowns were seated into their places and initially light cured for 2 seconds. The excess cement was removed and the framework was seated. Then, the polymerization was completed by the light cure for 30 seconds. The framework was removed and the crowns were exposed to the light curing for further 20 seconds and finally, allowed to continue set chemically.

For measurement of the friction fit between the primary and secondary crowns, a pull-off test setup was created. The Universal Testing machine (Lloyd LR5K, USA) was used to apply vertically dislodging forces. Three metal rings were used to attach the framework to the universal testing machine. Each ring passed through one of the holes made in the framework at midline and first premolar area bilaterally and joined together by a fourth metal ring used to attach the framework to the hook of the test machine.The occlusal plane of each cast was set parallel to the horizontal plane of the base of the testing machine. Each framework was loaded with a compressive pre-weight of 50 Newtons (N) for 20 seconds (S). The universal testing machine was controlled by a computer software (Bluehill, ITW Inc., England) to apply vertically oriented tensile loads on the metal rings until the secondary crowns separated from the primary crowns.The initial pull off test was done and maximum tensile loads needed to dislodge the framework from the cast were calculated in Newtons.


**Figure (3):** Pull off test.

**Figure (5)**: Lloyd LR5K Plus Universal Testing Machine

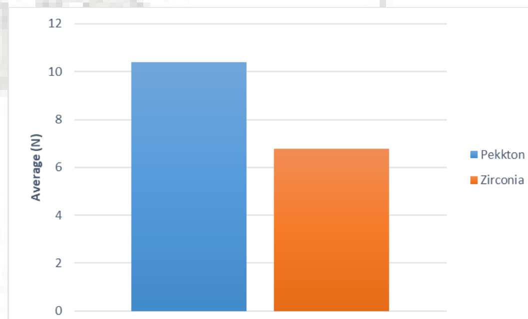
### 3. Statistical Analysis

Data were collected, tabulated and statistically analyzed. They were presented as means and standard deviation values. Statistical analysis of the resultant data was performed by using student's t-test. The significance level was set at $P \leq 0.05$.

## Results

Comparison between the two studied groups regarding the mean amount of frictional fit in the two studied groups, student t test was performed and the results are shown in figure (6).

The results show higher Value of frictional fit in group (A) Pekkton primary crowns (10.40±1.49) than in group (B) Zirconia primary crowns (6.78±1.05) and by using student T test, this difference was statistically significant (p=0.001).




## Discussion

There are a limited number of studies that investigated the friction fit of the telescopic systems that may influence the retention values. [8,9] Hence, this study was done to evaluate the friction fit of different materials of primary crowns used to retain Pekkton RPD frameworks.

This research was carried out in vitro in order to limit human variation, allow better control of variables and allow easier measurements of changes which occur. They are also very beneficial in providing valid comparative data excluding the variations. [10]

The telescopic attachment system was selected in this study due to its great advantages. It provides stability against horizontal dislodging forces. In addition, a high retentive force results from the fitting and extensive contact between the primary and secondary crown surfaces of this system. It also allows better load distribution through transferring axial occlusal loads that produce less rotational torque on the abutments.[11]

Studies have also shown that both Pekkton and zirconia can be used as an abutment and a prosthetic material because of their high mechanical properties. [12,13]

The experimental model was fabricated by utilizing the 3D printing technology that is characterized by excellent accuracy. This technology makes the creation of three-dimensional objects easier with its speed of production, high accuracy and the lowest strain values of passive fit were recorded with the stereolithography fabricated prosthesis. [14]

Five axes dry milling machine was used to fabricate partial denture frameworks due to its ability to produce complex geometries as with smooth external surfaces produced by the tangential movement of the milling bur. [15]

The primary crowns were cemented to the resin cast to mimic the situation intra-orally to achieve a one unit structure with the abutments and long term durability. Resin based luting cement was used as it provides high bond strength to restorative materials and hard dental tissues. [16] [17]

Various surface preparations, including sandblasting and application of primers were applied as they were recommended in previous studies to increase the available surface for adhesion and increase the bond strength to resin cement. [16,18]

The calcium silicate-based self-adhesive resin cement, TheraCem, was used for luting primary crowns to the resin cast as it has an alkaline pH. It also has high bond strength and stability, antimicrobial activity, as well as calcium release than other traditional self-adhesive resin cements. [19]

It is also dual cured resin that can be initiated by light or chemical reaction that compensate for the opacity of primary crowns materials that may inhibit sufficient light energy from being transmitted to the resin cement .[16]

The occlusal plane was set parallel to the horizontal plane of the base of the universal testing machine based on recommendations of several studies[20,21] to ensure that the dislodging forces are perpendicular to the occlusal plane.

The universal testing machine was set at a constant crosshead speed of 50 mm/min to approximate the clinical movement of the framework away from the edentulous ridge during mastication. [22]

50 N compressive preload was set at the machine to mimic the clinical situation as the framework is seated with a chewing force. A study [23] stated that when compressive preloads increased up to 50 N, the retention increased, but when the preloads increased above 50 N, the retentive forces did not change.

The data of this study revealed that there was higher value of frictional fit in group (A) Pekkton primary crowns than in group (B) Zirconia primary crowns and this difference was statistically significant. This may have resulted from the nature of Pekkton as one of high temperature thermoplastic polymer biomaterials which are soft and ductile materials that yield and adapt well, resulting in good marginal fit and mechanical adaptation between the primary and secondary crowns. Moreover, a strong wedging action occurs between the two crowns after functional use.[24]

Low friction fit value of group (B) can be owed to the discrepancy of marginal and internal fit of zirconia. Bea et al.,[25] explained this by the presence of the sintering process in fabrication of zirconia primary crowns that lead to inaccurate prediction of shrinkage that has negative effect on friction fit.

**Conclusions:**

Within the limitation of the results obtained from the study we could conclude that: PEKK (Pekkton) primary crowns showed better friction fit than zirconia one in conjunction with PEKK framework in Kennedy class I telescopic partial denture.

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