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COMPARATIVE STRESS ANALYSIS STUDY OF CAD/CAM MILLED PEEK AND ZIRCONIA PRIMARY COPINGS IN DOUBLE CROWN PEEK FRAMEWORK MANDIBULAR PARTIAL DENTURE AFTER 1 YEAR SIMULATED FUNCTION

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ABSTRACT

Aim of the study: The objective was to assess and compares the effect of PEEK and Zirconia primary copings in milled double crown PEEK framework. **Materials and methods:** One cast was fabricated simulating Kennedy Class I with the premolars as the last standing abutment. The primary copings were classified into two groups, milled PEEK group I and milled Zirconia group II. Two milled PEEK frameworks were used. Four strain gauges were installed bilaterally in the model. A load of 100 N was applied to the area of the first molar bilaterally. The same procedure was repeated 10 times. Cyclic loading was applied simulating 1 year of function. Strains induced on the abutments during bilateral loading were evaluated before and after chewing simulation. **Results**: The highest compressive micro-strain was recorded at channel (4) after cyclic loading for PEEK group 359.00±5.055 μm/m followed by channel (2) 356±13.293 μm/m. While the least compressive micro-strain was recorded at channel (1) before cyclic loading for the Zirconia was 150±7.817 μm/m. There was significant difference in channels (2) and (4) regarding PEEK group before and after cyclic loading. While for Zirconia group there was significance difference in channels (1) and (3) before and after cyclic loading where P value was<0.05. There was significant difference in all the channels before and after cyclic loading. **Conclusion**: PEEK and Zirconia primary copings showed different distribution of stress, as PEEK primary coping transmitted more stress to the supporting structures.

KEY WORDS: Telescopic, Partial denture, PEEK framework, Zirconia coping

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INTRODUCTION

The applied restorative concept of attaching the removable partial denture (RPD) to the remaining teeth has a significant impact on the clinical longevity of RPDs. The dentist must choose the best retainer for a long-term successful restoration based on the quantity, alignment, and periodontal health of the remaining teeth, as well as the patient's aesthetic needs and economic constraints. It has been established that telescopic or multiple crowns are an efficient way to retain RPDs.[1]

Kennedy class I is one of the most prevalent partially edentulous clinical conditions. Removable partial dentures are one of the most popular treatments utilized to address these instances. [2] Due to its exceptional retention, the transfer of occlusal pressure toward the long axis of the teeth, and the elimination of metal clasp display, double crown retained RPDs are regarded as good esthetic and biomechanical alternative approaches. [3]

Telescopic crowns were constructed from precious and non-precious metal alloys by conventional casting techniques.[4] The fabrication of telescopic crowns from these alloys needs knowledge and practical skills. [5]

Telescopic systems milled utilizing CAD/CAM provide many advantages over those constructed traditionally. Since it is simple to produce suitable retentive force by controlling different design features according to each condition, reduces working time, and minimizes technical errors and sensitivity, the CAD/CAM technique has recently been used in the fabrication of telescopic dentures to control most of these drawbacks. [6-8]

Primary copings are made from various materials, such as zirconia and PEEK, which are more aesthetically pleasing and less likely to cause vital teeth to become too sensitive or irritated by heat than metal alloys [9–11]. Due to its ductility and low hardness, which enable good adaptation and marginal fit, PEEK can be used for the fabrication of primary crowns regardless of the material used for the secondary crown .[12,13]

Zirconia-based ceramic has been introduced and used as a substitute for aluminum or titanium based alloy, giving good mechanical properties. In the ceramic classification, zirconia (ZrO2) demonstrates high strength, polycrystalline ceramic, recognized for its optimum mechanical properties, aesthetic appearance, good optical characteristics, chemical resistance and biocompatibility. In terms of biocompatibility, it has been proven that zirconia shows excellent behavior both in vitro and in vivo, reduced plaque in combination with its bioinert character and its minimum liability to degradation in the oral environment .[14]

The mechanical behavior of various materials on supporting structures was investigated using a range of methodologies, but no single technique was able to fully illustrate the complex physiological interactions involved.[15] According to research, strain gauge stress analysis is a suitable method for capturing the deformation of any item under stress. [16,17]

The determination of suggested path of insertion, the instant removal of unacceptable undercuts, and the equally quick identification of desirable undercuts are the key advantages of introducing CAD/CAM in the manufacturing of RPD framework. Not only can CAD/CAM technology reduce time, but it also exhibits intrinsic repeatability, which enables reducing human error and enhancing quality control in the dental laboratory. A framework pattern can be created on a computer screen using electronic surveying of a scanned cast in accordance with the principles of removable partial denture design. [18]

In order to evaluate dental materials as closely as feasible to in vivo settings, numerous chewing simulators have recently been used. [19]

After being configured, the current simulators can accurately replicate mandibular movements in all planes and mimic all chewing movements.[20-22] Dynamic loading is used in chewing simulators to create cyclic fatigue that mimics the normal masticatory function. The chewing simulator operates in the following manner: an antagonist strikes a specimen in line with predetermined parameters. The precise weight's direct production of and transmission to the specimens of the loading force. A variety of motion patterns can be programmed when using a contemporary motion controller. To strike the specimen, the weight is mounted freely on a cross member that is lifted or lowered by a servo motor. This makes it possible to simulate chewing with accuracy and realism. [20-21]

Although, numerous studies have been conducted to evaluate the stresses induced by the double crown retained RPDs in distal extension cases. There is a lack of information about the effects of using PEEK and Zirconia as primary copings for double crown-retained PEEK framework RPDs. The null hypothesis of this study was that PEEK framework could present a similar mechanical response when supported and retained by PEEK and Zirconia primary crown materials during chewing load incidence.

MATERIALS AND METHODS

In this study two different materials were used to fabricate primary copings that retain PEEK telescopic partial dentures. Thus, two groups were established: Group I: Primary copings were fabricated from PEEK (JUVORA™, United Kingdom). Group II: Primary copings were fabricated from Zirconia (COR I-TEC 350i Loader PRO+ of a commercial Y-TZP substrate Nacera Pearl 1, Doceram,GmbH, Dortmund, Germany).

I- Model fabrication

A ready-made educational Kennedy class I stone model was used. Silicone rubber base impression (Impregum Soft, 3M™ ESPE™, St. Paul, USA) was made for the acrylic model. Tin foil, measuring 0.2 mm thick, was used to cover the roots of the acrylic first and second premolars on either side before they were placed in the impression. Using a dial gauge, the foil's thickness was determined. Using a mechanical vibrator, epoxy resin (Specifix, Stuers, Willich, Germany) was poured into the silicone rubber impression and allowed to solidify. The epoxy resin model was then freed from the acrylic teeth with tin foil spacers. All traces of tin foil was removed from their matching sockets and dried.

Before placing the premolars in their sockets in the epoxy resin model, ExpressTM 2 Light Body Flow, 3MTM ESPETM, St. Paul, USA, was injected into the cavities of the premolars. This was done to mimic the abutments' periodontal ligaments (PDL). A stone index was created over the epoxy resin model encompassing the bilateral saddle regions using Syna-Rock, a Type IV dental stone material from DFS-DIAMON in Germany. Each denture's outline was drawn on the model. A homogeneous (2 mm thickness) reduction was made from the epoxy resin surface underneath the denture base sections using a round bur. These sections were smoothed before being painted with rubber base adhesive and given a 10minutes drying period. Using the previously created stone index, an even coating of light body PVS imprint material was applied and pressed into a layer of 2 mm thickness on the reduced indicated area. After the PVS imprint material had time to solidify, the epoxy resin model was removed from the stone index.

II-Digital design and fabrication of primary copings

The abutments on both sides were prepared with a 6 degree taper per wall using a paralleling device (Frasgerat AF30, Nouvag AG, Swizerland), a 1mm deep Chamfer finish line, and a 2.5mm occlusal reduction[23]. The model, the dies, and the mucosa simulator were all sprayed with a scan spray (SCANTIST 3D Dental SCAN-SPRAY, scantist3d, Recklinghausen, Germany) and scanned using the desktop scanner. Using Exocad software (Exocad DentalCAD 2.4 Plovdiv, Exocad GMBH, Darmstadt, Germany), the primary copings were designed with a common path of insertion.

All primary crowns were designed with a zero-degree taper at the cervical third, while the rest of the tooth was tapered to 4 degrees. The thickness of the copings was kept at the minimum thickness, which is 1 mm, with a 1 mm finish line and gap distance set at 0.05 mm.[24]

This design was sent to the CAM software (CORITEC ICAM V5 SMART, imes-icore® GmbH, Eiterfeld, Germany) and was prepared for milling PEEK primary coping,and primary copings from zirconia were milled using COR I-TEC 350i Loader PRO. (Figure 1)

Cementation of the primary copings to the abutment teeth was done using temporary cement.

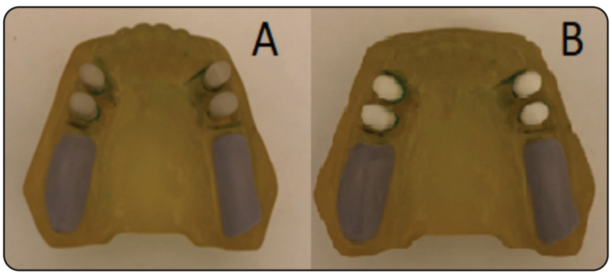

Fig. (1) A primary telescopic crown from PEEK,B primary telescopic crown from zirconia

III- Fabrication of PEEK partial denture

The models (with and without mucosa simulator), the dies, and the mucosa simulator were sprayed with the scanner spray and scanned with the desktop scanner. Using Exocad software, secondary crowns were designed with a common path of insertion, and the RPDs frameworks were designed by blocking out undesirable undercuts, drawing denture base meshwork's and major and minor connectors, installing an external finish line, and smoothening the design at last.

The virtual designs were sent to the CAM software for nesting and preparation for milling from PEEK (JUVORA™ , United Kingdom).Two identical frameworks were fabricated.

The double crown-retained RPDs were seated on their models to check their fit and accuracy. The secondary copings were veneered with a high-impact polymer composite (Novo.lign Veeners, Bredent, Senden, Germany).

Waxing-up of dentures and complete setting-up of teeth was done on duplicate casts constructed from the original models. Heat- cured acrylic resin (Vertex Rapid Simplified, Vertex Dental, Soesterberg, Netherlands) was used to process the denture bases following an accurate long polymerization cycle, then finished and polished. (Figure 2)

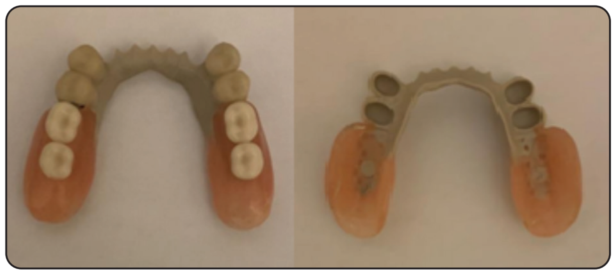

Fig. (2) PEEK framework

IV- Stain gauge installation

The strain gauges used in this study were supplied with a fully encapsulated grid and attached wires. The strain gauges (kyowa strain gauges, Japan) used in this study had dimensions of 1 mm in length, 2.4 mm in width, and 120 Ohm in nominal resistance. Lead wires of 100 cm in length were attached to strain gauges. With a thin coating of cyanoacrylate adhesive, all strain gauges were adhered to the epoxy resin model in their final positions. The model's base was cut out with grooves, and the strain gauge wires were inserted into these grooves and secured with adhesive. (CC-33A, EP-34B; Kyowa Electronic Instruments Co., Ltd.). The loading points were subjected to vertical static loads ranging from 0 to 100 Newton using the loading device universal testing machine (LLOYD Universal Testing Machine, U.K.). The base, frame, model fixture, and loading point make up the loading device. The model made of epoxy resin had four strain gauges mounted in vertical grooves. 1 mm mesial and 1 mm distal, on the right and left sides, respectively, to the sockets of the first and second premolars; channels 1, 2, and 3,4. (Figure 3). The telescopic primary copings for each of the tested materials were first cemented to the relevant abutments before being set on the lower metal plate of the universal testing apparatus. Each active strain gauge's lead wire was attached to the strain meter. Before applying a load, all of the attached gauges were examined to make sure they were all functional. The testing apparatus's T-shaped load applicator bar was placed against the denture's first molar teeth. The load was applied bilaterally. The applied static load started from zero up to 100 N. Spot grinding with articulating paper was used to provide uniform contacts between the bar and the prosthetic teeth on both sides for the application of a bilateral load. The strains formed at the mesial wall of the socket of the first premolar and the distal one of the second premolar, bilaterally, were measured using the micro-strains of the four strain gauges. The four-channel strain-meters translated the micro strain measurements to micro strain units. The resilient construction was given enough time (about 15 minutes) to fully rebound between each pair of subsequent measures.

Fig. (3) Strain gauge installation

V- Chewing simulation

A cylindrical acrylic projection was made at the center of the base of the cast to match specimen holder of chewing simulator. The geometric center of the partial denture was located on the cast by drawing four lines on the cast and extending them to the cast base in the following manner: Line (1) joining the centers of the Retromolar pad. Line (2) passing through the incisal edge of lower central incisors of the anterior ridge and parallel to the line (1). Line (3) represent the mid line of the cast and perpendicular to both lines (1) and (2). On line 3, the midpoint between line (1) and (2) was identified and marked, (point a), which is the geographic center of the lower partial denture. Line (4) passes through point (a) and it runs parallel to lines (1) and (2).Then, A trough was drilled at (point a) using round surgical bur.A horizontal metal plate with a central hole was centrally placed and fixed to the removable partial denture using a cold cured acrylic between the second premolar and first molar.

The Chewing Simulator was used to give a dynamic cyclic loading through a stylus falling at the center of the metal plate. Each group was examined under the same conditions load settings of 50 N. The software parameters were set at 60 mm/sec speed, 3 mm vertical path, 0.7 mm horizontal path and 1.6 Hz frequency. And each was subjected to bi-axial cyclic loading for a total of 240,000 cycles

After placing the mold into the chewing simulator, partial denture was fixed on the specimen chamber that was adjusted anteroposteriorly and medio-laterally to make sure that load was in the center of the horizontal metal plate then work was placed again on universal testing machine for new measurements after loading.

Data from the two groups were collected, arranged using Microsoft Excel (version 365).

RESULTS

Statistical analysis was performed with SPSS (v 20, IBM Corporation, Armonk, NY, USA) for Windows. Data for micro-strain gauge analysis are presented as mean and standard deviation (SD) values. Data was explored for normality using D'Agostino-Pearson test. Micro-strains (μm/m) showed normal distribution. Paired t-test was used for intra group comparison while student T test was used to compare between the two studied primary copings materials before and after 240,000 cycles of simulated function. The significance level was set at P ≤ 0.05.

The mean values of the recorded micro strains for both groups and their level of significance are presented in Table 1. The data obtained from table 1 revealed that for both group I and II there was increase in the recorded microstrains for all channels after 240,000 cycles of simulated function. The highest compressive micro-strain was recorded at channel (4) after cyclic loading for PEEK group 359.00±5.055 μm/m followed by channel (2) 356±13.293 μm/m. While the least compressive micro-strain was recorded at channel (1) before cyclic loading for the Zirconia was 150±7.817μm/m

There was significant difference in channels (2) and (4) regarding PEEK group before and after cyclic loading. While for Zirconia group there was significance difference in channels (1) and (3) before and after cyclic loading, where P value was<0,05

Comparing the two studied materials the data obtained from table II, revealed that there was significant difference in all the channels before and after cyclic loading. There was highly significant increase for the micro strains in channel (2) and (4) distal aspect of the abutments.

TABLE (1) Means and standard deviations of micro-strains (μm/m) of PEEK and Zirconia in the bilateral loading condition before and after cyclic loading

Material		Time	N	Mean	Std. Deviation	P value
PEEK	Channel 1	Before	10	167.00	9.661	0.383
		After	10	171.00	10.328	
	Channel 2	Before	10	341.50	6.687	*0.006
		After	10	356.00	13.292	
	Channel 3	Before	10	164.50	10.916	0.409
		After	10	169.50	15.175	
	Channel 4	Before	10	341.50	6.687	*0.003
		After	10	359.00	15.055	
Zirconia	Channel 1	Before	10	150.00	7.746	*0.019
		After	10	159.00	7.817	
	Channel 2	Before	10	309.50	8.644	0.176
		After	10	315.00	8.819	
	Channel 3	Before	10	153.50	7.835	*0.019
		After	10	158.00	9.189	
	Channel 4	Before	10	310.50	9.265	0.271
		After	10	315.50	10.395	

; significance between the two different materials (p<0.05)

TABLE (2) Means and standard deviations of micro-strains (μm/m) of the two different materials

Time		Material	N	Mean	Std. Deviation	P value
Before	Channel 1	PEEK	10	167.00	7.746	0.007
		Zirconia	10	150.00	9.661	
	Channel 2	PEEK	10	341.50	6.687	<0.001
		Zirconia	10	309.50	8.644	
	Channel 3	PEEK	10	164.50	7.835	0.019
		Zirconia	10	153.50	10.916	
	Channel 4	PEEK	10	341.50	6.687	<0.001
		Zirconia	10	310.50	9.265	
After	Channel 1	PEEK	10	171.00	7.817	0.001
		Zirconia	10	159.00	10.328	
	Channel 2	PEEK	10	356.00	13.292	<0.001
		Zirconia	10	315.00	8.819	
	Channel 3	PEEK	10	169.50	9.189	0.055
		Zirconia	10	158.50	15.175	
	Channel 4	PEEK	10	359.00	15.055	<0.001
		Zirconia	10	315.50	10.395	

DISCUSSION

The null hypothesis was rejected, PEEK framework could give similar mechanical response when supported by different primary crown materials during chewing load incidence. The outcomes demonstrated that the primary crown material has an impact on the telescopic attachment system's biomechanical reaction. It was discovered that the high elastic modulus of the PEEK primary crown permitted more stress to reach the abutments. Our findings are consistent with prior studies in that the principal coping material's stiffness can influence the concentration of stress during compressive loading. [25]

Over the lifetime of usage, the telescopic crowns in removable partial dentures undergo changes in surface structure due to frictional wear resulting in a loss of retention force [26,27]

Removable partial denture is the treatment of choice for partially edentulous patients. Financial issues, technical and biological conditions may contraindicate treatment with fixed prosthesis or implant supported prosthesis.[28,29]

Also, it is well documented that the use of this attachment system to retain RPD is more efficient than the usual clasps because of their capability of occlusal loading transmission to the abutment's long axis and to provide guidance, support and stability. [30,31]

This study was performed in vitro to limit variations, to allow standardization and to give more valid results. Also, in vitro studies allow better control of variables and facilitate easier measurements of changes and providing valid comparative data excluding the variations. [32-34]

The model used for this study was fabricated to simulate as much as possible the natural condition. PVS impression material was used to simulate the visco-elastic behavior of the mucous membrane covering the residual ridges under the denture bearing area. It was used for this purpose because it has the lowest values of dimensional changes and permanent deformation, and requires less time to recover the visco-elastic deformation among all rubber impression materials. Also in order to provide a stable non-movable model surface, an adhesive was used for bonding the silicone layer that simulated the oral mucosa to the underlying epoxy resin model.[35]

Although the mechanical behavior of the PVS impression material, used to simulate the PDL in vitro, is different from what is expected for the PDL in-vivo, the load applied to the prosthesis in this study was not load to failure so the influence of the supporting structures, including the PDL was considered to be minor.[36]

In addition, the mucosa simulator imitates the soft tissue resiliency that may add additional load on the attachments and therefore can influence their retentive force values.[37]

In the current research, the strain gauge analysis was the adopted method to evaluate strain around abutment teeth as it provides quantitative analysis of the strain around abutment teeth supporting a distal extension, as being one of the frequent methods used for strain analysis in dentistry. [38] This is due to their miniature dimension, linearity, and minimal interference during testing procedures.[39] It is also considered to be a stable and an accurate system. It assesses strains induced into a loaded structure by changing the resistance of an electric wire, insulated by a packing material so as to be protected from humidity in order to obtain reliable recordings into strain measurement. [40-41] Moreover the use of in-vivo strain gauges comprises many shortcomings including, short circuits could not be prevented due to the difficulty in isolation of the gauges from saliva and blood, and the unavoidable patient movement resulting in motion of the wire that usually produces inaccurate results. Consequently, in-vitro strain gauge researches remain as valuable guides to the clinicians awaiting the feasibility to conduct such studies on large scale in order to have statistically concrete conclusions. [42]

The primary copings were planned to be conus in shape with a common path of insertion, the gingival cervical bands were made parallel and of 3mm height while the occlusal part was 2mm in height and was tapered to 4 degrees to enhance the retention of the telescopic system. This system is also called resilient double crown or Mardburg design. [43]

The Marburg double crown system was utilized, which has the following advantages. It provides good retention since these double crowns show continuous friction between the parallel-sided surfaces of the inner and outer crowns during the whole process of insertion and removal, it facilitates the fabrication of ceramic or metal crowns or bridges which can withstand the occlusal forces and conduct less forces to underlying bone thus, helps in decreasing the degree of bone resorption .Moreover, these system of telescopic denture appear over like fixed partial denture which display better esthetics.[44]

Nakagwa et al [45] reported that 4 degrees taper with a 50 N load was the most appropriate. It was found that at 2 and 4 degrees taper, the settling of the secondary crown demonstrated the wedging effect which brought about retentive force.

The primary copings were made with the least thickness that provides the proper mechanical properties required for function. The same was done for the secondary copings, however extra surface reduction was done to account for the esthetic visiolign veneering to mimic the final prosthesis that will be placed in the patient's mouth. [46]

A zirconia-based ceramic has been recognized by favourable mechanical properties, good optical characteristics, aesthetic appearance, and chemical resistance, combined with outstanding biocompatibility proven in many studies. As mentioned in previous studies, zirconia was also used for fabrication of telescopic crown systems either primary or secondary crown, or even both. [47]

PEEK is a proper material for primary crowns, regardless of the taper and the material of the secondary crown. PEEK is a soft and ductile material that yields and adapts well. The low elastic modulus and the ductility are reasons for the good processability of PEEK. The adaptation process was found easy, which gives a good marginal fit. [48-49]

A more flexible dental material is a viable replacement for telescopic crown systems, according to a prior study. [50] Considering that this model exhibited intermediate behavior, a study suggested that the combination of titanium and PEKK is a viable choice. However, using a Zirconia or PEKK main crown is a good choice if a metal-free procedure is intended. [51]

Milling was used for fabrication the frameworks and the primary crowns as it minimizes fabrication flaws in the dental prostheses. Milling excludes waxing, investing, and casting of the prosthesis which improve the overall precision. [52]

The use of the milling machine for preparation of the abutments of the cylindrical telescopic system gives all surfaces parallel with zero degree taper so that a piston-cylinder effect takes place. The main factor for the success of telescopic attachment systems is determining the perfect retentive force, which needs technical skill, experience and ability.[53]

A five axis dry milling machine was utilized since it is able to produce complicated geometries and smooth external surfaces. The smooth surface is constructed by the tangential movement of the milling bur. 5-axis machines are suitable for constructing complex shapes as partial denture frameworks. Also, dry milling was chosen in order to simplify the milling. Moreover, it allows quicker milling, decreases cutting forces, enhances tool life and gives better surface quality. [54]

The primary copings were milled from partially sintered zirconia blank then following the milling, it is sintered completely in a furnace at 1,350°C to 1,500°C to attain its final shape since they are much easier to mill than fully sintered zirconia and preserve its metastable tetragonal phase. [55]

The geometric center of the partial denture was located on the cast by drawing four lines on the cast and extending them to the cast base A trough was drilled at (point a) using round surgical bur.The bur was maintained in the trough leaving about 25 mm of its length projecting from the cast as this length was the most from which the force application could take place. [56]

The Chewing Simulator applied dynamic cyclic loading by means of a stylus falling at the center of the metal plate that was previously attached to the occlusal surface of removable partial denture. [57] The application of load of chewing simulator was at the center of the metal plate. Metal was selected instead of acrylic as it has a better stress distribution according to the previous studies. [57-58]

The load settings of the chewing simulator were adjusted at 50 N and based on the mean value of biting forces that are generated on the second premolar and first molar area during function.[59] It was showed to be optimal by Ohkawa et al. [60,61]

The software parameters were set at 60 mm/sec speed, 3 mm vertical path, and 0.7 mm horizontal path and 1.6 Hz frequency according to the setting parameters used in the previous studies. [62]The number of chewing cycles utilized in this study was 240,000 representing an average of 1 year of function. [63]

In most of the studies simulated a period of 5 years usage by performing 1.2 million loading cycles.[64] But due to high prices, the number of cycles had to be decreased to 240,000 chewing cycles in this study.In addition, the initial wear that is the most crucial feature of the cylindrical telescopic system occurs commonly in the first 5,000 cycles. So, the study was significant to imitate the initial wear plus a safety margin up to the 240,000 cycles.[65-67]

This simulator is provided with two motor-driven axles that allow two different motion patterns: the first axle moves the table on which the partial denture chamber is attached, while the second axle lifts and drops the axis with weights. When the weight contacts the partial denture teeth and a vertical load is produced, the table axle moves the partial denture in a forward and backward direction in the horizontal plane that results in a dynamic loading with both vertical and lateral components. [68]

Our findings are consistent with an earlier in vitro investigation that assessed stresses transmitted to two implants supporting a mandibular complete over denture with all ZrO2, all PEEK, and Zirconia-PEEK telescopic attachments. Their results revealed that PEEK and Zirconia combination revealed less stress in comparison with the other groups; The distinct physical characteristics of the two materials were used to explain this finding.. [24]

The higher stress values reported by all PEEK group could be attributed to less flexure strength of PEEK in comparison to Zirconia that may permit a limited movement within the attachment.[24]

The finding that the group of Zirconia primary crown recorded the least stress values can be explained by the cushioning effect offered by PEEK secondary coping in combination with the harder Zirconia.[24]

Our results agree with the result of in vitro study comparing the effect of different secondary copings against zirconia primary coping in a tooth supported telescopic overdenture. Where they found PEEK and Zirconia combination revealed the least stress.[69]

The strain values recorded distal to the abutment were higher than the mesial ones. Such a result can be explained by difference in the compressibility between the resilient mucosa and periodontal ligament of abutment teeth supporting and retaining telescopic partial denture, which causes rotational movement during load application. In addition, forces recorded mesial to abutments are shared by the neighboring teeth.[49]

The limitation of this study was that it didn't replicate the exact complex nature of the human supporting structures. Additionally, the load applied was vertical not like the masticatory one. Also, a stress analysis of the edentulous mucosa should be performed as mucosa is also affected by load application. Further clinical studies should be conducted for determining the effect of such materials on the abutment supporting structures.

CONCLUSION

Within limitations of this study, it could be concluded that PEEK and Zirconia primary copings showed different distribution of stress, as PEEK primary coping transmitted more stress to the supporting structures

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