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Polishing Protocols Effect on The Surface Properties of Polymer Polyether Ether Ketone Prosthodontic

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ABSTRACT

Polymer Polyether Ether Ketone is a polymer and has good properties like physical, mechanical, aesthetic, and biocompatibility that why widely in dental prostheses. The present work aims to study the Polishing Protocols effect of the polymer polyether ether ketone prosthodontic properties as a function of surface roughness and microhardness for two different Polishing Protocols in a laboratory - CSA & CA technique for the aim of testing the nominated samples an experimental work designed. This study was done in Libyan polymer research Centre *to evaluate* roughness and microhardness. Twenty samples of PEEK prosthodontic polymer materials were used two various polishing protocols methods were used surface roughness and microhardness testing. The data obtained from the surface properties analysis were recorded and organized to be analyzed. The data were analyzed by using different statistical methods including mean, standard deviation, and t-test to calculate the p-value. The Microsoft Excel sheet was used to complete the statistical calculations. Means & standard deviations of surface roughness CSA polishing technique showed no significant difference and a p-value = 0.000 and CA polishing technique a p-value 0.004. For micro-hardness results CSA polishing technique showed no significant difference and a p-value = 0.000, CA polishing technique showed no significant difference and a p-value a p-value = 0.000.

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INTRODUCTION

Dentistry materials must have requirement such as high biocompatibility, good mechanical properties, withstand high temperature, low fluid absorption, flexible and resistance to chemical wear. Polyether Ether Ketone material provides all these properties so could using widely in dentistry [1]. For making prosthodontic appliances using many materials and everyone have disadvantages, acrylics have low strength so may change during processing. although metallic denture frameworks have good strength but they bad esthetic. acrylic and some metals may also cause allergic to oral mucosa and gingiva. limited abutment teeth with gingivitis must avoid to use long-span fixed porcelain-fused-to-metal prostheses because easily fracture. Recently research was focused on finding alternative materials that is not expensive and good esthetic with offering more longevity [2].

Polyether ether ketone is a widely using medicine and dentistry [3].

Polyether ether ketone is a polymer has good properties like physical, mechanical, aesthetic, and biocompatibility that why widely using for the construction implants, orthodontic wires, fixed prostheses, removable dentures and temporary prostheses. Also, peek is withstood in higher temperatures and has high resistance. Polyether ether ketone material can be incorporated with other materials such as carbon fiber, glass, and ceramics to improve the its properties [4,5]. low friction and low thermal conductivity all these benefits of peek machining it one the best materials can used in dentistry [6]. Polyether ether ketone compere to metal-based ceramics material is has better biocompatibility and is not soluble in water, low reaction with other materials, that why it may be a suitable alternative with sensitive patients to metallic materials [6]. One of the advantages of peek is easily to repair compere with ceramics this increases the using of peek as crown material and discoloration of peek low also easily for fabrications with CAD-CAM and the polish very easy so used

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widely in fixed and partial prostheses [7,8]. There are some methods for processing the PEEK such as injection, extrusion and compression molding [9].
Under high temperatures Polyether ether ketone can resist the corrosion of most chemicals' substance like nickel [10,11]. Also, can withstand great stress during operation. Polyether ether ketone is close to metallic aluminum because has good dimensional stability, rigidity is high [12]. The characteristics of peek surface is low roughness of 0.018 Nm Ra so can resist the adhesion of the bacterial plaque on its surface and doesn't irritant the soft tissue [13]. For good functionality of peek, the surface must cover with resin composites or lithium disilicate [14]. peek can be veneered with composites because of its opacity to achieve aesthetics [15].
Dental restorations should have smooth surface. below an Ra threshold of 0.2 mm should polished for surface roughness of all prostheses [16]. The surface roughness of dental materials has important role in bacterial plaque accumulation and adhesion. bacterial accumulation and adhesion are depended on the surface roughness of dental materials because of increased surface roughness can increase bacterial adhesion and low surface roughness is reduced bacterial adhesion [17,18]. By cleaning and roughening the surface of PEEK we get good adhesion with other materials like composite [18]. composite has good aesthetic so could coating the peek with it to get more an appealing finish [19]. Surface roughness should be about An Ra 0.2 mm to decrease adhesion of bacteria that why the main goals by using different polishing techniques, materials and devices is to achieve a surface roughness of under 0.2 mm and final surface roughness were depend on the polishing protocols like polisher types, kind of polishing paste and wet or dry type of dry polishing [18,19]. PEEK hard materials under many conditions of pressure [19]. In vitro study the flexural strength of Polyether ether ketone was (183 MPa) and polymethylmethacrylate was (84 MPa) that mean peek higher than PMMA [20]. The aims to study the Polishing Protocols effect of the polymer polyether ether ketone prosthodontic properties as a function of surface roughness and microhardness for two different routes of Polishing Protocols in a laboratory - CSA & CA technique for the aim of testing the nominated samples an experimental work designed**.**

METHODS

Study design

The experimental study was Polishing Protocols effect on the Polymer PEEK Prosthodontic properties as a function of surface roughness and microhardness for two different routes of Polishing Protocols in different polishing protocols a laboratory technique study. This study was conducted at the advanced medical polymer group in Libyan polymer research Center.

Materials

Dental polymer PEEK prosthodontic are manufactured by different companies, the material is supplied in the form of the CAD\CAM is a Peek disc (peek, China) of 98 mm diameter and 18 mm height and CAD\CAM is a Peek fiber disc (Trilor, Italy) of 98,5 mm diameter and 20 mm height.

Samples preparation

These dental polymer PEEK prosthodontics were polishing protocols in two different routes (CSA and CA) according to the capabilities of dental technicians. twenty samples, were divided into foure groups based on their polishing technique the CAD\CAM is a Peek disc (peek, China) and CAD\CAM is a Peek fiber disc (Trilor, Italy), with five samples assigned to each test.We were using a roughness test fot surface properties of the samples and by lathing machine Samples were cutting like strip of (65 × 10 × 3) mm dimensions.

Polishing technique

Two PEEK surface-polishing protocols:
CSA: polished with a 400-grit silicon carbide abrasive paper under water. sandpapering using a micromotor and handpiece with mandrel was done at 5000 rpm for 90 seconds for finishing. Polishing was done by buffing with pumice slurry. Then checked dimensions by a digital calliper.
CA: Polishing 1 min at 20,000 rpm using a rubber point, using soft brush with aqua blue paste for 1 min at 10,000 rpm for polishing.
All The specimens of Polyether Ether Ketone were washed with distilled water after that All The specimens of Polyether Ether Ketone dried after every polishing step. Post-polishing of All The specimens of Polyether Ether Ketone specimens ultrasonically cleaned in 70% isopropanol for 15 min then by distilled water washed three times and then air-dried. For each group prepared five of specimens and proceeded by two step we mentioned above.

Testing procedure

Surface roughness test

Sample preparation: Five samples of uniform shape and size will be prepared from each material according to the manufacturer's instructions using (65 × 10 × 3) mm dimensions cutting. This will ensure consistency in the testing process. The SR test was done using a surface roughness meter .by (Surface Roughness tester STR-6210) determined surface roughness and with moved the drive unit on the surface of the specimen across and vertical direction.
A roughness test was done (carried out at the laboratories of the Libyan Higher Technical Center for Training and Production, Libya). The data collected and the mean of five dental polymer PEEK prosthodontics were polishing protocols in two different routes and measured samples of each group and analyzed using suitable statistical methods.

Micro-hardness Test

65x10x3) mm dimension of peek Samples had cut. Also, this dimension depends on instructions of the international standard ISO 20795-1. the surface hardness was by using tester micro-Vickers MVT-1000Z all done at the Libyan polymer research center, Libya). The data collected and the mean of five PEEK polishing Method samples of each group was measured (Peek fiber disc (Trilor, Italy), Peek disc (peek, China)), calculated and analyzed using suitable statistical method.

Data analysis

The data obtained from the surface properties analysis were recorded and organized to be analyzed. The data were analyzed by using different statistical methods including mean, standard deviation, and t-test to calculate the p-value. The Microsoft Excel sheet was used to complete the statistical calculations.

RESULTS

This was designed to the experimental study was followed to affect the surface roughness of polishing protocols polymer PEEK prosthodontic. Materials for using this type of dental prostheses raised by dentistry specialists, such as companies in China and Italy.

Surface Roughness Results

CSA polishing technique

Table 1 shows mean value for condition of the Peek fiber disc (Trilor, Italy) is 0.17, and the mean for condition of the Peek disc (peek, China) is 1.81. The standard deviation for Peek fiber disc (Trilor, Italy) is 0.020 and for Peek disc (peek, China) is 0.712. The number of cases in each condition (N) is 5 in table (1).

Table 1. Means & standard deviations of surface roughness CSA polishing technique (µm) of the tested at p = 0.000.

Material samples	mean	St. Deviation	df
Peek fiber disc (Trilor, Italy)	0.17	0.020	4
Peek disc (peek, China)	1.81	0.712	

CA polishing technique

Table 2 shows the mean value for condition of the Peek fiber disc (Trilor, Italy) is 0.13, and the mean for condition of the Peek disc (peek, China) is 1.61. The standard deviation for Peek fiber disc (Trilor, Italy) is 0.014 and for Peek disc (peek, China) is 0.592. The number of cases in each condition (N) is 5 in table (1).

Table 2. Means & standard deviations of surface roughness CA polishing technique (µm) of the tested at p = 0.004.

Material samples	mean	St. Deviation	df
Peek fiber disc (Trilor, Italy)	0.13	0.014	4
Peek disc (peek, China)	1.61	0.592	

Micro-Hardness Results

CSA polishing technique

The mean value for condition of the Peek fiber disc (Trilor, Italy) is 14.932, and the mean for condition of the Peek disc (peek, China) is 9.914. The standard deviation for Peek fiber disc (Trilor, Italy) is 1.060 and for Peek disc (peek, China) is 1.016. The number of cases in each condition (N) is 5 in table (3).

Table 3. Means & standard deviations of micro-hardness CSA polishing technique (µm) of the tested at p = 0.000.

Material samples	mean	St. Deviation	df
Peek fiber disc (Trilor, Italy)	14.932	1.060	4
Peek disc (peek, China)	9.914	0.016	

CA polishing technique

The mean value for condition of the Peek fiber disc (Trilor, Italy) is 19.700, and the mean for condition of the Peek disc (peek, China) is 16.420. The standard deviation for Peek fiber disc (Trilor, Italy) is 1.982 and for Peek disc (peek, China) is 0.704. The number of cases in each condition (N) is 5 in table (4).

Table 4. Means & standard deviations of surface roughness CA polishing technique (µm) of the tested at p = 0.000.

Material samples	mean	St. Deviation	df
Peek fiber disc (Trilor, Italy)	19.700	1.982	4
Peek disc (peek, China)	16.420	0.704	

DISCUSSION

Since the 1990 PEEK is using in medical applications and one of the most popular polymers because has high. By using different surface cleaning protocol, the surface roughness PEEK has been investigated. Finishing and polishing protocol of dental restoration control the long life, esthetics and biocompatibility [20].

PEEK surface roughness with polishing paste shows lowest R_a values. After grinding the peek with 1000 grid silicon carbide abrasive paper the PEEK material shows about 0.277 µm and when polishied by paste the R_a value decreased to be an average of 0.073 µm [20].

Determined of polishing procedures and protocol type of Polymer Polyether Ether Ketone surface not to high have done before [19,20]. Surface of the specimens get polished on three side have less roughness compere to the specimens get polished

on two side in the same time the specimens polished in chairside have less then polished by laboratory methods [18,20].

Despite there was not statistically different in this study, the surface roughness of groups A less than the surface roughness of groups B. We think may from using the bounce paste on the surface and both polishing protocol with applied rubber burs.

Surface properties of materials may change from aggressive procedures. morphology and surface roughness of peek can change by surface treatments [17,19,20].

Until now not too many examinations had don on properties of PEEK surface to see what kind of materials can affect its surface. Adhesion rate of bacteria or plaque on dental prothesis depend on roughness of material that the surface made from also its properties. For reducing caries for the teeth must decrease value of adhesion and accumulation on the teeth surface and around teeth also on dental prothesis [18,19,20].

For the microhardness, the results showed that peek by CA polishing technique for two types had a relatively higher hardness compared to CSA polishing technique. When comparing the mean values for the two materials with different using polishing technique it was found that there were no statistically significant differences.

For CSA polishing technique the mean value for condition of the Peek fiber disc (Trilor, Italy) is 14.932, and the mean for condition of the Peek disc (peek, China) is 9.914. The standard deviation for Peek fiber disc (Trilor, Italy) is 1.060 and for Peek disc (peek, China) is 1.016 and For CA polishing technique The mean value for condition of the Peek fiber disc (Trilor, Italy) is 19.700, and the mean for condition of the Peek disc (peek, China) is 16.420. The standard deviation for Peek fiber disc (Trilor, Italy) is 1.982 and for Peek disc (peek, China) is 0.704.

The study shows no statistically significant differences despite the Peek fiber disc (Trilor, Italy) (CA polishing technique) group had harder data than the (Trilor, Italy) CSA polishing technique and Peek disc (CA polishing technique) (peek, China) group had harder data than the Peek disc CSA polishing technique (peek, China) group.

Mechanical properties of peek hard and similar to that found in cortical bone and PEEK's flexural strength was high [19,20]. PEEK materials have high elastic modulus this make it one of good options for dental implant because need high elastic modulus abutments and superstructures. Nowadays is mixed the PEEK with fibers or ceramics for good functionality of peek, the surface must cover with resin composites or lithium disilicate [18,19,20]. PEEK can be veneered with composites because of its opacity to achieve aesthetics [10,19,20].

CONCLUSION

PEEK has good microhardness and roughness and types of polishing protocols can increase or decrease them. And in this study the result did not show statistically significant differences in the surface roughness and microhardness.

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