EVALUATION OF POLISHING PROTOCOLS ON THE SURFACE ROUGHNESS OF POLYETHERETHERKETONE(PEEK) TO IDENTIFY AN EFFECTIVE POLISHING METHOD FOR DENTAL PROSTHESIS CHAIRSIDE

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ABSTRACT

INTRODUCTION: PEEK is a biocompatible material with excellent mechanical, thermal, and chemical properties, making it suitable for various dental applications.In dentistry, PEEK is commonly used as a substitute for metal materials due to its lightweight nature, high strength, and durability. It offers several advantages over traditional dental materials, making it a preferred choice for both clinicians and patients.Therefore as a restoration if it can be polished chairside, then that will be a great boon to clinicians and patients, saving up on laboratory time.

MATERIALS AND METHOD: The PEEK samples were prepared as disks of 10mm diameter and 10 mm height.The samples were machine milled. Sample size was obtained through calculations from G power and key articles. The samples were then polished on one side with first coarse and then fine silicone rubber . The surface roughness of both the sides were checked with the Stylus Profilometer and results were obtained by doing Chi Square test. **DISCUSSION:** Polishing of dental prosthesis is a crucial step for the longevity of the restoration and for the good health of the patient due to accumulation of plaque on rough surfaces. **CONCLUSION:** Polishing with Silicone bur is a good chairside option.

KEYWORDS: polyetheretherketone, surface roughness, polishing

INTRODUCTION

Polyetheretherketone (PEEK) has emerged as a prominent material in the realm of engineering due to its exceptional mechanical properties, high thermal stability, and biocompatibility (Kemmish, 1995; Kurtz, 2011). As industries increasingly turn to PEEK for diverse applications, understanding and enhancing its surface characteristics become paramount. PEEK is employed in dentistry to create frameworks for detachable dentures, implant bodies,

superstructures, crowns, and fixed partial dentures (Lee *et al.*, 2023; Parate *et al.*, 2023). Rising precious metal prices and worries about dental metal allergies are projected to drive up demand for PEEK dental prostheses(Singh, Maiti and Shenoy, 2024).

The surface roughness of PEEK plays a pivotal role in determining its functional properties, especially in applications where friction, wear, and biocompatibility are crucial considerations. As we delve into the intricacies of surface engineering, we pave the way for advancements that not only optimise material performance but also broaden the scope of PEEK's applicability in cutting-edge technologies and medical innovations (Akkan, 2013; Almogbel *et al.*, 2023; Pryjmaková *et al.*, 2023). By investigating and refining polishing protocols, we aim to achieve a comprehensive understanding of how these treatments influence the topography and properties of PEEK surfaces. This exploration is not only relevant for industrial applications but also holds significance in the medical field, where PEEK is widely used in orthopaedic and dental implants(Shenoy *et al.*, 2023)(Maiti *et al.*, 2024).

The methodologies employed in polishing PEEK surfaces vary, encompassing mechanical, chemical, and thermal approaches(Alqahtani, 2023; Mittal and Lee, 2023). Each protocol brings forth its unique set of challenges and advantages. Striking the right balance between enhanced surface finish and maintaining the material's integrity is pivotal for unlocking the full potential of PEEK in diverse engineering and medical applications. In many cases, the prosthesis surface requires additional polishing at the chairside following adjustment, even if it is adequately polished at the laboratory side(Lin and Wang, 2003). The final polished prosthesis's surface roughness shouldn't be greater than 0.2 μm, as this is the threshold value that allows dental plaque adhesion (Almogbel *et al.*, 2023) (Khurshid *et al.*, 2019). It has been claimed that humans can distinguish differences in roughness values of at least 0.5 μm. Furthermore, the influence of abrasive wear is increased when an occlusal surface that is rougher has a smaller occlusal contact area, also known as the mating surface or true contact area(Yoshioka *et al.*, 2001; 'Factors affecting enamel and ceramic wear: A literature review', 2002).The investigation into polishing protocols on the surface roughness of PEEK is a multidimensional exploration with far-reaching implications. This study aims to scrutinize these protocols, identifying optimal conditions that result in improved surface smoothness without compromising the inherent properties of PEEK. This research contributes to the ongoing dialogue surrounding materials science, providing insights that can shape the future of PEEK-based technologies.

MATERIAL AND METHODOLOGY

1.Sample Preparation

The PEEK samples were milled as disks of 10mm diameter*10mm height as seen in Image 1. The samples were machine milled in the institute itself. 10 samples were used , the number was obtained using Gpower and key articles. 10 disks were first checked for surface roughness and then with the help of stylus profilometer and then the same disks were used for further

experiment. The disks were washed with distil water before further experiment. The disks were marked on one side to differentiate the surface of the two groups.

Image 1

2.Coatings

The disks were polished on one side with first coarse and then fine silicone rubber bur unidirectional for 60 seconds and the surface roughness was checked as seen in Image 2.

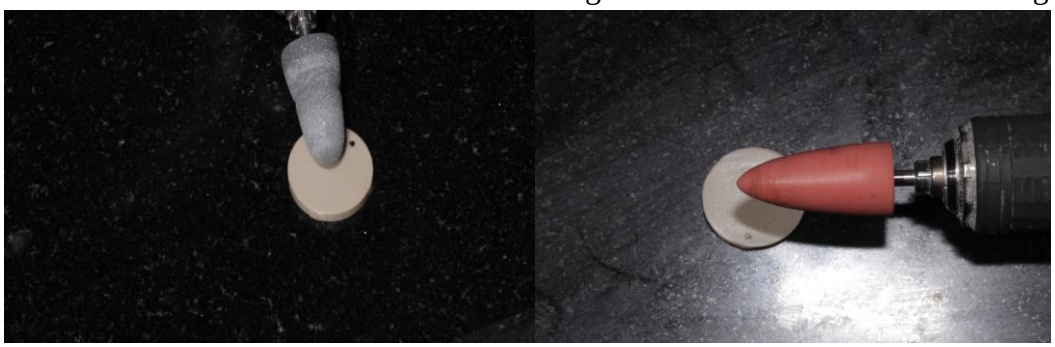

Image 2 & 3

3.Surface roughness measurement

The surface roughness of both sides were obtained by using Stylus profilometer as seen in image 4 and 5. The Ra, Rq and Rz were obtained with the pre roughness as the control.

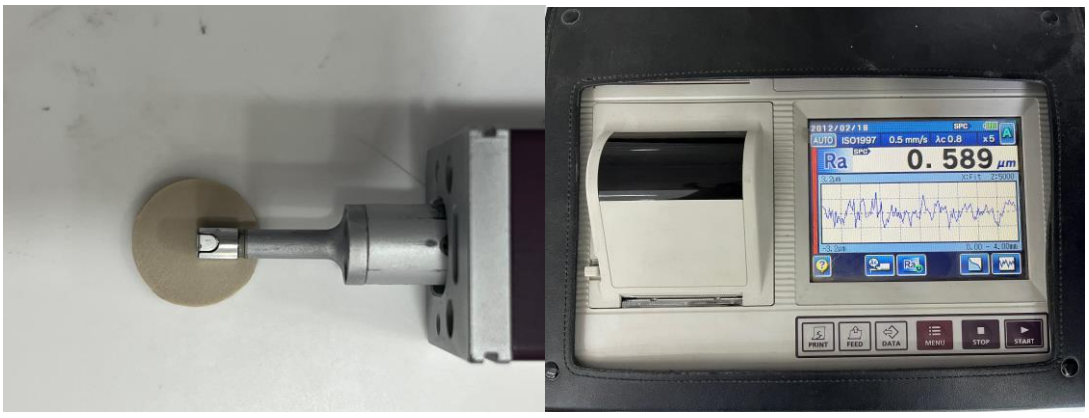

Image 4 and 5

4.The surface roughness was then analysed and significance was found output using IBM SPSS software 23 and paired t test was done to compare the means.

RESULTS

The two surfaces were measured for surface roughness. Ra value of the two surfaces were compared by using paired t-tests, and significance was 0.047. Hence since the P<0.05, the values are found to be statistically significant. Between milled and polished surfaces, the mean and standard deviation was less of the polished surface. Rq value significance between milled and polished surface is P=0.012, hence showing statistical significance in the parameter. Similarly, Rz was also found to be statistically significant with P value got as 0.018. The mean with standard deviation was found to less for the polished surface in Ra , Rq and Rz. There was statistical significance in all three parameters when means were compared.

DISCUSSION

A crucial part of dental operations is chairside polishing of PEEK (Polyether Ether Ketone) material, especially in prosthodontics where PEEK is frequently used to fabricate dental prostheses like crowns and bridges(Tekin *et al.*, 2018)(Düzgün *et al.*, 2024). PEEK is a high-performance polymer that has strength, durability, and biocompatibility. In order to achieve a clean, visually appealing finish and preserve the structural integrity of the PEEK restoration, chairside polishing is essential(Heimer *et al.*, 2017). The null hypothesis of this study was that the examined material and its chairside polishing protocols would not affect the surface roughness. The null hypothesis was rejected for this parameter. The current work concentrated on polishing techniques for PEEK, which can be conveniently made available at the chairside(Heimer *et al.*, 2017).In this study we have milled PEEK disks and measured the surface roughness pre and post polishing the disks.The polishing effect is influenced by the hardness of the PEEK, which is nearly equal to or slightly higher than that of acrylic resin, as well as the polishing materials. The researchers hypothesize that polishing reduces the surface imperfections of PEEK due to the cutting effect of the diamond particles in the rubber tip. In a study by Kosuke Kurahashi et al,stated that the surface roughness of the six polished groups of PEEK in his study was lower than that reported in earlier works, the researchers conclude that the surface qualities of PEEK are superior to those of other thermoplastic resins. It has also been noted that the Ra values of resin composites used as restorative materials in the oral cavity that need to be polished range between 0.1 and 0.3 m and between 0.13 and 0.23 m, respectively. The conclusions and findings of his investigation indicate that PEEK can be polished into a suitably smooth surface for use as a dental prosthesis. Our Study we have tried to use basic chairside polishing protocols, to measure the difference in surface roughness between the untouched milled surface and polished surface. 3 parameters of surface roughness were evaluated, Ra, Ra and Rz(Incesu and Yanikoglu, 2020). Ra being the Ra is the average roughness of a surface. Rz is the difference between the tallest "peak" and the deepest "valley"in the surface and Ra is Root mean square roughness (Rq) is the square root of the sum of the squares of the individual heights and depths from the mean line. As seen from the results there is statistical significance in the surface roughness parameters between the 2 surfaces and the it is seen the chairside polishing actually may be reducing the surface roughness. Although a multiple-step polishing treatment can produce a smoother surface, a single-step polishing

protocol at the chairside is recommended to save time and money. The following measures are also required during the polishing procedure: reducing frictional resistance and minimizing change in temperature of the material surface during polishing, avoiding splashing the polishing agent, and ensuring that the polishing agent can be easily washed away after polishing to avoid bacterial adherence. Furthermore, polishing should preferably be done while adding a soluble paste, such as "aqua blue paste," at regular intervals. As a result, the silicone bur is a good start for the polishing routine. More materials should be studied for future investigations, and a larger sample size should be used.

CONCLUSION

The study concluded that there was statistical significance between the milled and polished surface on comparing their means. Chairside polishing seemed to be an effective method but larger sample size needs to be used for further experiments. Various other chair side polishing materials should also be used for the studies.

AUTHOR CONTRIBUTION:

First author (Dr. Bhavini Nahata) performed the analysis and interpretation and wrote the manuscript. Second author (Dr. Nabeel Ahmed) contributed to conception, data design, analysis, interpretation and third author (Dr. Vaishnavi Rajaraman) critically revised the manuscript. All authors have discussed results and revised the manuscript.

CONFLICT OF INTEREST: The authors declare no conflict of interest, financial or otherwise.

FUNDING SOURCE:

We thank Saveetha Dental College and Hospitals for allowing us to conduct this study at the prestigious Blue lab. The study was funded by Vaibhav Veneers but no conflicts of interest were reported.

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