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To Evaluate The Hard And Soft Tissue Remodelling After Immediate Loading Of Conventional Implant With PEEK Crowns -An In-vivo Study"

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Abstract
Introduction
PEEK (Polyether Ether Ketone) crowns represent a novel alternative in dental prosthetics, known for their exceptional mechanical properties, biocompatibility, and aesthetic advantages. Despite these benefits, there is limited empirical evidence on how immediate loading with PEEK crowns influences the remodeling of hard (bone) and soft (gum) tissues around the implant. Understanding the tissue response to these crowns could lead to enhanced implant designs, material selection, and treatment protocols, ultimately benefiting patients through better functional and aesthetic outcomes. This study was done to evaluate soft and hard tissue remodelling after immediate loading of conventional implant with peek crown.
Material and method
This study was conducted at the Department of Prosthodontics, Crown and Bridge & Implantology situated within NIMS Dental College & Hospital. In this study, a total of 22 dental implants were placed in 22 patients ,in both maxillary and mandibular arches.
Result
In a study tracking dental health parameters over four months, significant improvements were observed in multiple variables. Modified Plaque Index (mPI) increased from 0.636 ± 0.727 to 0.909 ± 0.750 with a statistically significant p-value of 0.01058, as determined by the Wilcoxon Signed Rank Test. Bleeding on Probing (BOP) showed a notable rise from 0.546 ± 0.671 to 0.955 ± 0.785, also with significant changes (p=0.00102). Probing Depth (PD) escalated from a median of 1.5 to 2.04, demonstrating extreme significance with a p-value of 0.00004. Modified Gingival Index (mGI) increased from 0.318 ± 0.568 to 0.818 ± 0.795 (p=0.00078). Bone remodelling, both mesial and distal, showed slight changes with p-values of 0.00386 and 0.00338 respectively, highlighting the statistical significance in dental health improvements over the period.
Conclusion
The study's findings highlight significant yet within-normal-range disparities in peri-implant soft tissue parameters, underscoring the overall positive outcomes associated with PEEK crowns. By effectively distributing stress, PEEK crowns help maintain the integrity of surrounding bone structures, promoting the long-term stability and function of dental implants. Minimizing crestal bone loss not only enhances the longevity of the implant but also contributes to overall oral health and patient satisfaction.

Keywords
PEEK crowns, Immediate loading ,Dental implants .

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I. Introduction

Partially and fully edentulous arches' rehabilitation with dental implants is a well-established treatment, boasting a 15-year success rate of 89.7%[1] . The process of osseointegration, where implants bond predictably with the bone, has led to new and effective ways to tackle problems encountered in implant-based dental restorations.[2] The success of these treatments depends not just on how well the implant integrates with the bone but also on how the final dental prosthesis interacts with the surrounding soft and hard tissues.[3]

Dental restorations supported by implants often use materials like porcelain that's bonded to metal (also known as PFM) and entirely ceramic options. PFMs are strong and durable, which makes them a popular choice.[4,5] However, the metal part of PFM can sometimes lead to allergic reactions or change the color of the gums around the tooth. Because of these issues, dentists are increasingly choosing all-ceramic restorations over PFMs.

Polyetheretherketone, commonly known as PEEK, is a type of plastic that's known for its excellent performance qualities.[6] Dentists are now using PEEK as a substitute for metal in creating the structural part of dental work that supports restorations for teeth and dental implants. One of the key advantages of PEEK (PolyEtherEtherKetone), a synthetic, tooth-colored thermoplastic material, is its similarity in modulus of elasticity to human bone. This property makes it highly suitable for dental restoration work.Despite these benefits, there is limited empirical evidence on how immediate loading with PEEK crowns influences the remodeling of hard (bone) and soft (gum) tissues around the implant.

The study aims to fill this gap by systematically evaluating the effects of immediate loading with PEEK crowns on both hard and soft tissues. Understanding the tissue response to these crowns could lead to enhanced implant designs, material selection, and treatment protocols, ultimately benefiting patients through better functional and aesthetic outcomes.

This study was done to evaluate soft and hard tissue remodelling after immediate loading of conventional implant with peek crown.

II. Material And Method

This study was conducted at the Department of Prosthodontics, Crown and Bridge & Implantology situated within NIMS Dental College & Hospital. After obtaining the biomechanical properties of Polyetheretherketone (PEEK) crowns in the context of immediate loading. The investigation covered both hard and soft tissue aspects, using a controlled laboratory setting with fabricated PEEK crown specimens.

Institutional ethical clearance was taken before conducting the study.

a) The surgical protocol- mid crestal incision was given followed by which flap was raised and Mis implant were placed in total of 22 patient such that each patient receive one implant each.

b) Prosthodontic protocol : Closed tray impressions were made using Neopure A-Silicone putty, Orikam Healthcare India Pvt Ltd. Country of Origin, India impression material and 72 hours after implant placement ,implant were restored with temporary PEEK crown (out of occlusion).

c) The outcome measures: soft tissue examination- Peri-implant soft tissue was assessed using established indices: modified plaque index (mPI), bleeding on probing (BOP), probing depth (PD), and modified gingival index (mGI).

d) Radiographic assessment- For an in-depth analysis of hard tissue remodelling, radiographs were obtained using a parallel cone technique. High-resolution radiographs were captured using a dental X-ray machine operating at 70 kV, 7 mA, and a 0.02 exposure time. Following the radiographic procedure, digital processing was facilitated by inserting the sensor into a laser scanner. Specialized software was then employed to analyse bone changes over time.

e) Inclusion Criteria- We included patient with good general health, age between 20-50 yrs, having adequate bone quality and quantity, absence of acute infection and edentulous area present between both anterior and posterior regions.

f) Exclusion criteria- we excluded patients with psychoses, TMJ disorder or any systemic disease/limiting condition that contraindicates surgery. Presence of infection or advanced periodontal disease, if received any Head and neck radiotherapy and lack of cooperation of the patient.

g) Statistical analysis- Descriptive statistics were used to summarize demographic information, providing insights into the study population. For hard tissue remodelling, paired t-test or Wilcoxon signed-rank tests compared baseline measurements with subsequent follow-up assessments. The significance level was set at 0.05, with adjustments for multiple comparisons as needed. Statistical software such as SPSS, R, or SAS was employed for robust and reliable analyses.

III. Result

Table 1: Comparing soft and hard tissue remodelling parameters at 2 months and at 4 months by using Wilcoxon signed ranked or paired t-test test

Variables	After 2 Months	After 4 months	Wilcoxon Signed rank / Paired t-test	P - Value	Significance
mPI	0.636 ± 0.727	0.909 ± 0.750	-2.806	0.01058	
BOP	0.546 ± 0.671	0.955 ± 0.785	-3.813	0.00102	
PD	1.5 (1.343-1.793)	2.04 (1.78-2.28)	**-4.107****	0.00004	
mGI	0.318 ± 0.568	0.818 ± 0.795	-3.924	0.00078	All are
Bone remodelling (Mesial)	0.36 (0.285-0.43)	0.305 (0.265-0.38)	**-2.888****	0.00386	statistically significant
Bone remodelling (Distal)	0.35 (0.285-0.418)	0.355 (0.295-0.425)	**-2.934****	0.00338	

In a study tracking dental health parameters over four months, significant improvements were observed in multiple variables. Modified Plaque Index (mPI) increased from 0.636 ± 0.727 to 0.909 ± 0.750 with a statistically significant p-value of 0.01058, as determined by the Wilcoxon Signed Rank Test. Bleeding on Probing (BOP) showed a notable rise from 0.546 ± 0.671 to 0.955 ± 0.785, also with significant changes (p=0.00102). Probing Depth (PD) escalated from a median of 1.5 to 2.04, demonstrating extreme significance with a p-value of 0.00004. Modified Gingival Index (mGI) increased from 0.318 ± 0.568 to 0.818 ± 0.795 (p=0.00078). Bone remodelling, both mesial and distal, showed slight changes with p-values of 0.00386 and 0.00338 respectively, highlighting the statistical significance in dental health improvements over the period.

IV. Discussion

PEEK is part of the PolyArylEtherKetone (PAEK) family, which is known for its strong mechanical strengths, resistance to chemicals, and compatibility with human tissues.[8] These characteristics are important because they ensure that dental implants made of PEEK can successfully integrate with both the soft and hard tissues in the mouth, which is a critical factor for the long-term success of any dental implant therapy.

In a study conducted in 2019 by Tekin, the effects of different materials on dental restorations attached to titanium implants were analyzed using a method called Finite Element Analysis (FEA). Specifically, the research focused on two types of materials: PFM (Porcelain Fused to Metal) and PEEK (Polyether Ether Ketone). The findings highlighted that when PEEK,was used, it significantly lowered the stresses that were applied to the implants.[9] This outcome indicates that by selecting various materials for the prosthetic part of the implant, it's possible to influence and modify the amount of stress the entire implant system experiences.

In 2021, Mourya conducted a study focusing on how stress is distributed around implants Made from titanium and carbon fiber reinforced PEEK (CFR-PEEK).[10] The findings from Mourya's research indicated that both the titanium and CFR-PEEK implants showed similar levels of stress distribution within the surrounding bone. However, there was a notable difference when it came to the type of crowns used. Under both oblique (angled) and vertical (straight down) pressures, the PFM crowns resulted in higher stress levels being transmitted than the PEEK crowns. Based on these observations, Mourya suggested opting for PEEK crowns over PFM crowns.[11]

The study mentioned investigated changes in peri-implant tissue status by analyzing various parameters such as modified plaque index (mPI), bleeding on probing (BOP), probing depth (PD), and modified gingival index (mGI) values at follow-up intervals of 2 and 4 months. The findings indicated statistically significant variances in all measured peri-implant soft tissue parameters over the specified time periods. These results suggest that there are notable alterations in the condition of soft tissues surrounding implants within the first four months following implantation at both follow-up points, although they remained within a normal range. These findings align with previous studies, including those by Rossi in 2015 and 2016, which also observed similar trends in peri-implant tissue parameters[12,13], Gulje´ 2019[14] Rossi, in their studies from 2015 and 2016, reported a probing depth of 2.6 mm. They suggested that maintaining a firm oral hygiene regime was essential for confirming healthy peri-implant tissues. This emphasizes the importance of diligent oral hygiene practices in maintaining optimal peri-implant health.

Research consistently indicates a direct positive correlation between the surface characteristics of dental materials. This correlation suggests that specific surface properties, such as roughness, texture, and composition, can influence various factors such as biocompatibility, adhesion, and bacterial colonization. For

example, studies have shown that smoother surfaces tend to exhibit better biocompatibility and reduced plaque accumulation compared to rougher surfaces. Additionally, surface modifications can affect the success rates and longevity of dental restorations and implants. Therefore, understanding and optimizing surface characteristics are crucial for enhancing the performance and biocompatibility of dental materials. and bacterial adhesion. Additionally, the average probing depths of 2.58 ± 0.63 mm and 2.6 ± 0.58 mm for PEEK crowns align with the findings of Mombelli in 2002[44], The concept that successful implants typically permit a probe penetration of about 3 mm, suggesting favorable peri-implant tissue response, is widely acknowledged, although attribution to a specific individual may vary.

In this study, alterations in plaque accumulation led to differences in the modified gingival index (mGI) at different time intervals, emphasizing the role of patient oral hygiene practices. The amount of plaque buildup directly influences gingival inflammation, as previously reported by various researchers Salvi 2012[15], Malo 2018 [16]AbdulAzeez 2021[17].

This finding is consistent with other studies that have highlighted the positive effects of immediate provisional restorations on reducing peri-implant bone loss and improving peri- implant soft tissue condition. These improvements are essential for maintaining bone preservation and establishing the biologic width around implants.[18,19,20]

V. Conclusion

The study's findings highlight significant yet within-normal-range disparities in peri-implant soft tissue parameters, underscoring the overall positive outcomes associated with PEEK crowns. By effectively distributing stress, PEEK crowns help maintain the integrity of surrounding bone structures, promoting the long-term stability and function of dental implants. Minimizing crestal bone loss not only enhances the longevity of the implant but also contributes to overall oral health and patient satisfaction. Furthermore, the study's observation that peri-implant soft tissue parameters remain within normal limits suggests that PEEK crowns do not induce adverse effects on the soft tissue environment surrounding the implant. This reaffirms the biocompatibility and favorable tissue response associated with PEEK materials, making them a promising choice for dental prosthetics. In conclusion, the study underscores the multifaceted benefits of PEEK crowns, emphasizing their role in promoting both structural integrity and soft tissue health in implant dentistry.

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References

[1]. Albrektsson T, Branemark PI, Hansson HA, Lindstrom J. Osseointegrated titanium implants: requirements for ensuring a long-lasting, direct bone-to-implant anchorage in man. Acta Orthop Scand. 1981;52:155–170.
[2]. Lops D, Bressan E, Chiapasco M, Rossi A, Romeo E. Zirconia and Titanium Implant Abutments for Single-Tooth Implant Prostheses After 5 Years of Function in Posterior Regions. Int J Oral Maxillofac Implants. 2013;28(1):281–7.
[3]. Pjetursson BE, Asgeirsson AG, Zwahlen M, Sailer I. Improvements in implant dentistry over the last decade: comparison of survival and complication rates in older and newer publications. Int J Oral Maxillofac Implants. 2014 Jan;29(Supplement):308–24.
[4]. Goldberg P V., Higginbottom FL, Wilson TG. Periodontal considerations in restorative and implant therapy. Periodontol 2000. 2001;25(1):100–9.
[5]. Araujo MG, Lindhe J. Peri-implant health. J Clin Periodontol. 2018;45(August 2017):S230- -S236.
[6]. Kaleli N, Sarac D, Külünk S, Öztürk Ö. Effect of different restorative crown and customized abutment materials on stress distribution in single implants and peripheral bone: A three dimensional finite element analysis study. J Prosthet Dent. 2018;119(3):437
[7]. Soliman TA, Tamam RA, Yousief SA, El-Anwar MI. Assessment of stress distribution around implant fixture with three different crown materials. Tanta Dent J. 2015;12(4):249– 58.
[8]. Papathanasiou I, Kamposiora P, Papavasiliou G, Ferrari M. The use of PEEK in digital prosthodontics: A narrative review. Vol. 20, BMC Oral Health. BioMed Central Ltd; 2020.
[9]. Tekin S, Değer Y, Demirci F. Evaluation of the use of PEEK material in implant supported fixed restorations by finite element analysis. Niger J Clin Pract. 2019 Sep 1;22(9):1252.
[10]. Mourya A, Nahar R, Mishra SK, Chowdhary R. Stress distribution around different abutments on titanium and CFR-PEEK implant with different prosthetic crowns under parafunctional loading: A 3D FEA study. J Oral Biol Craniofacial Res. 2021;11(2):313–20.
[11]. Lemos CAA, Verri FR, Gomes JM de L, de Souza Batista VE, Cruz RS, Oliveira HFF e., et al. Ceramic versus metal-ceramic implant-supported prostheses: A systematic review and meta-analysis. J Prosthet Dent. 2019;121(6):879-886.e4.
[12]. Rossi F, Lang NP, Ricci E, Ferraioli L, Marchetti C, Botticelli D. Early loading of 6- mmshort implants with a moderately rough surface supporting single crowns - a prospective 5- year cohort study. Clin Oral Implants Res. 2015 Apr;26(4):471–7.
[13]. Rossi F, Botticelli D, Cesaretti G, De Santis E, Storelli S, Lang NP. Use of short implants (6 mm) in a single-tooth replacement: A 5-year follow-up prospective randomized controlled multicenter clinical study. Clin Oral Implants Res. 2016 Apr;27(4):458–64.
[14]. Guljé FL, Raghoebar GM, Vissink A, Meijer HJA. Single crown restorations supported by 6-mm implants in the resorbed posterior mandible: A five-year prospective case series. Clin Implant Dent Relat Res. 2019;21(5):1017–22.
[15]. Salvi GE, Aglietta M, Eick S, Sculean A, Lang NP, Ramseier CA. Reversibility of experimental peri-implant mucositis compared with experimental gingivitis in humans. Clin Oral Implants Res. 2012 Feb;23(2):182–90.
[16]. Maló P, de Araújo Nobre M, Moura Guedes C, Almeida R, Silva A, Sereno N, et al.
[17]. Shortterm report of an ongoing prospective cohort study evaluating the outcome of full arch implant-supported fixed hybrid polyetheretherketone-acrylic resin prostheses and the Allon-Four concept. Clin Implant Dent Relat Res. 2018;20(5):692–702.

[18]. AbdulAzeez AR, Alkinani AA. The Crucial Role of Plaque Control in Peri-Implant Mucositis Initiation as Opposed to the Role of Systemic Health Condition: A CrossSectional Study. Clin Cosmet Investig Dent. 2021 Jun;Volume 13:257–68.
[19]. Suárez-López Del Amo F, Lin GH, Monje A, et al. Influence of soft tissue thickness on peri-implant marginal bone loss: A systematic review and meta-analysis. J Periodontol 2016; 87:690–699.
[20]. Galindo-Moreno P, León-Cano A, Ortega-Oller I, et al. Prosthetic abut- ment height is a key factor in peri-implant marginal bone loss. J Dent Res 2014; 93:80–85.
[21]. Vervaeke S, Dierens M, Besseler J, et al. The influence of initial soft tissue thickness on peri-implant bone remodeling. Clin Implant Dent Related Res 2014; 16:238-47.

Figure 1 implant placement

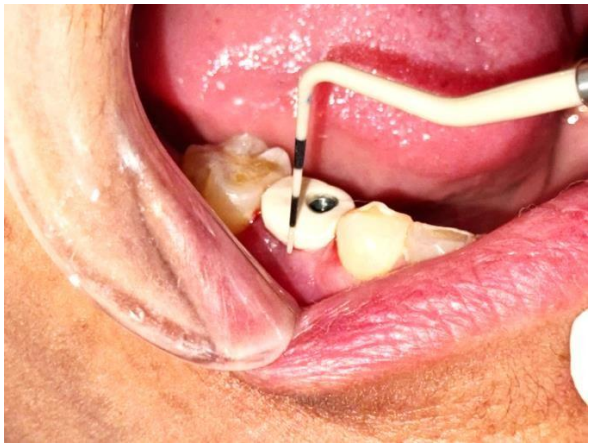

Figure2- Isolated Bleeding on probing.

Figure 3- Probing depth measured around the implant supported PEEK crown

Figure4- Base line reading

Figure 5- Reading At 2 months

Figure 6- Reading at 4 months