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Mohamed Dohiem

Hebatalla Mahmoud El Afandy
Future university in Egypt, hebatalla.mahmoud@fue.edu.eg

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Mohamed Dohiem[a] , Hebatalla Mahmoud El Afandy[b]

PhD, lecturer, Department of Prosthodontics and Implantology, Faculty of Oral and Dental Medicine, Future University in Egypt, Egypt
PhD, lecturer, Department of Prosthodontics and Implantology, Faculty of Oral and Dental Medicine, Future University in Egypt, Egypt

A R T I C L E I N F O

Keywords

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A B S T R A C T

Background: Polyetheretherketone (PEEK) is a material that can be used instead of normal titanium implants. PEEK is considered inert and biocompatible, however, it has been shown to possess low surface energy and that leads to decreased osteointegration with bone, Recent researches have focused on increasing the bioactivity of PEEK by modifying the surface by chemical and physical means such as plasma treated surfaces.

The Purpose of this article to evaluate peek dental implant with cold plasma surface treatment

Materials In this case series an immediately loaded peek dental implant, treated with plasma surface activation method, was used to replace anterior teeth in maxilla , for 30 patient, and followed up for 12 months.

The results: All 30 implants placed survived the 12 month follow-up.

Conclusion: In this case series PEEK dental implant with cold plasma surface treatment showed high survival rate after using plasma treatment surface methods

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1. Introduction

Polyetheretherketone (PEEK) is one of the semi-crystalline linear polycyclic aromatic thermoplastic materials. In the 1980s, PEEK was commercialized for industrial applications, such as aircraft and turbine blades. By the late 1990s, PEEK became an important high-performance thermoplastic candidate for replacing metal implant components, especially in orthopedic and traumatic applications [1].
Since PEEK is a tooth colored polymeric material that has a non-metallic color and with sufficient mechanical properties hence it has been used in prosthodontic restoration such as removable prostheses[2]. and fixed prostheses[3].

Moreover, PEEK can also be used as esthetic orthodontic wires. According to research, it was compared to other materials, such as polyether sulfone (PES) and polyvinylidene difluoride (PVDF), PEEK materials used as orthodontic wires are able to give higher forces at the same cross-section of metallic wires such as cobalt– chromium (Co–Cr),and titanium–molybdenum (Ti–Mo)[4].

Regarding implants, PEEK has demonstrated to be a serious substitute to metallic implant components in the field of orthopedics. These findings suggest that PEEK could used instead of titanium as a material for dental endosseous implants.

However, PEEK is hydrophobic by nature, with a water-contact angle of 80–90.8 ^{o}. This hydrophobic nature leads to decreased wettability and less surface energy on its surface to overcome this major set back, it can be modified successfully by physical or chemical means. One of these physical means is the use of plasma treatment such as oxygen (O2) plasma, Other techniques include sulfonation treatment which is a type of chemical modification [5]. Also peek implants can be coated by bioactive effects like, radio-frequency (RF) magnetron sputtering, cold spray technique, spin coating techniques[6,7,8,9].

2. MATERIALS AND METHODS

This study is was done on 30 consecutive partially edentulous patients restored with PEEK dental implant[1] as 35 implant were placed The subject sample consisted of 12 females and 28 males with a mean age of 35 years (range: 21 to 45 years) the patients were treated by one implantologist in Future University in Egypt . All patients were systemically healthy, and one of the patients was a smoker from the thirty cases four cases were immediate (Figure 1) and the remaining cases was delay implant replacement (Figure 2) . The study protocol was reviewed and approved by Future University in Egypt Review Board. Initially, a careful periodontal examination including the assessment of plaque, gingivitis, probing depth and radiographic bone loss of all the remaining teeth was performed. This was followed by oral hygiene instructions and, if indicated, periodontal treatment.
Peek implant introduced from the company as single piece with 3.3 width and 14 length with zirconia cap that can correct the angulation , reinforced the implant and masking the color of the peek (Figure 3) All surgeries were performed in one stage as it is a single piece PEEK implant The osteotomy site was prepared by sequential drilling before insertion of the implant the surface was plasma treated with a piezo brush machine[2] (Figure 4) followed by implant insertion. Peek implants were inserted by press fit ,after the surgical procedure a

[1] Champion implant at win! peek champion implant GPMH , 55237 Flonhiem , Germany

[2] Reylon plasma ,GMPH Weidener Straße 1693057 Regensburg, Germany

permanent Zirconia cap[1] (Figure5) supplied by the manufacturer was cemented and stabilized over the abutment of the single piece, the temporary crown was then inserted, and occlusally modified to be out of occlusion as Centric and lateral excursive contacts of the temporary crowns were avoided.. Each patient received 1 gm curam one times per day for 7 days from the day of implant surgery. The patient was followed up for 1 week (Figure6). All peek dental implants where placed in the maxilla. The final prosthetic construction was completed 2 months after implant insertion Careful oral hygiene instructions were given to all patients at the placement of the permanent prosthetic construction and the patient were followed up till 12 month (Figure7) A cone beam CT was requested to interpret any radiolucency, not for measuring the bone changes around the implant as peek dental implants are undistinguishable from the bone in the xray (Figure8) .

3. Result

The survival rate of all the implants was 100% ,without any implant loss except for one implant with gingival inflammation due to incorrect implant position. No clinical changes were observed

4. Discussion

Dental implants are mandatory to ensure the quality of life for many patients with tooth loss [10]. And the most used implants are based on titanium and titanium alloys.

Some notable problems have been addressed with the use of titanium such as hypersensitivity to titanium, also the problem of the difference in the modulus of elasticity between titanium endosseous implant and bone, that may cause stress transfer to bone during load [11].and eventually may lead to periimplant bone loss.

Another problem with titanium dental implants are the esthetic problems due to its lack of light transmission. As an alternative to titanium, ceramic implants were proposed. However, clinicians and manufacturers encountered problems due to their brittleness. The rise of the PEEK implant possessed the advantage of an ideal modulus of the elasticity of 3.6 GPa, that is closer to that of bone [11].

As PEEK implants are hydrophobic the physical modification used in this article was implemented to increase the surface energy of that peek implant. Plasmas are ionized gases that can be produced in a closed reactor system containing a low pressure gas mixture by excitation with electro-magnetic waves [12]. This treatment generates reactive particles that can interact with the surface of the bone around the implant without affecting physical and chemical surface properties.

In this article the survival rate was chosen to be the outcome as it difficult to measure the bone changes around peek dental implant as they are undistinguishable from the bone in the xray.

5. Conclusion

In this case series PEEK dental implant with cold plasma surface treatment showed high survival rate.

Reference .

[1]. Rigby, R.B. *Engineering Thermoplastics Properties and Applications*; Marcel Dekker: New York, NY, USA, 1985; p. 15.

[2]. Costa-Palau S, Torrents-Nicolas J, Brufau-de Barbera` M, Cabratosa-Termes J. Use of polyetheretherketone in the fabrication of a maxillary obturator

[1] Zirconia cap for win! peek champion implant GPMH , 55237Flonhiem , Germany

prosthesis: a clinical report. J Prosthet Dent 2014;112:680–2.
[3]. Kern M, Lehmann F. Influence of surface conditioning on bonding to polyetheretherketon (PEEK). Dental Mater 2012;28:1280–3.
[4]. Maekawa M, Kanno Z, Wada T, Hongo T, Doi H, Hanawa T, et al. Mechanical properties of orthodontic wires made of super engineering plastic. Dent Mater J 2015;34:114–9.
[5]. Zhao M, An M, Wang Q, Liu X, Lai W, Zhao X, et al. Quantitative proteomic analysis of human osteoblast-like MG-63 cells in response to bioinert implant material titanium and polyetheretherketone. J Proteomics 2012;75:3560–73.
[6]. Kurtz, S.M.; Devine, J.N. PEEK biomaterials in trauma, orthopedic, and spinal implants.*Biomaterials* **2007**;*28*: 4845–4869.
[7]. Jiya, T.; Smit, T.; Deddens, J. Posterior lumbar interbody fusion using nonresorbable polyetheretherketone *vs.* resorbable Poly-L-Lactide-Co-D,L-lactide fusion devices. *Spine* **2009**;*34*:233–237.
[8]. Khoury, J.; Kirkpatrick, S.R.; Maxwell, M.; Cherian, R.E.; Kirkpatrick, A.; Svrluga, R.C. Neutral atom beam technique enhances bioactivity of PEEK. *Nucl. Instrum. Meth. B* **2013**;*307*:630–634.
[9]. Kirkpatrick, A.; Kirkpatrick, S.; Walsh, M.; Chau, S.; Mack, M.; Harrison, S.; Svrluga, R.; Khoury, J. Investigation of accelerated neutral atom beams created from gas cluster ion beams. *Nucl. Instrum. Meth. B* **2013**;*307*:281–289.
[10].Buser D,Mericske-Stern R, Bernard JP, et al. Long-term evaluation of non-submerged ITI implants.Part 1: 8-year life table analysis of a prospective multi-center study with 2359 implants.Clin Oral Implants Res 1997;8:161–172.
[11].Karoussis IK, Bragger U, Salvi GE,Burgin W, Lang NP.Effect of implant design on survival and success rates of titanium oral implants: A 10-year prospective cohort study of the ITI Dental Implant System.Clin Oral Implants Res 2004;15:8–17.
[12].Sarot JR, Contar CM, Cruz AC, de Souza Magini R. Evaluation of the stress distribution in CFR-PEEK dental implants by the three-dimensional finite element method. J Mater Sci Mater Med. 2010;21:2079–2085.
[13].Toth JM, Wang M, Estes BT, et al. Polyetheretherketone as a biomaterial for spinal applications. *Biomaterials.* 2006;27:324-334
[14].Awaja, F.; Bax, D.V.; Zhang, S.; James, N.; McKenzie, D.R. Cell adhesion to PEEK treated by plasma immersion ion implantation and deposition for active medical implants. Plasma Proc. Polym. 2012;9: 355–362.
[15].Chen, M., Zhang, Y., Sky Driver, M., *et al.*: 'Surface modification of several dental substrates by non-thermal, atmospheric plasma brush', *Dental Mater.*, 2013;8 :871–880
[16].Yoshida, S., Hagiwara, K., Hasebe, T., *et al.*: 'Surface modification of polymers by plasma treatments for the enhancement of biocompatibility and controlled drug release', *Surf. Coat. Technol.*, 2013;**233**: 99–107