CASE REPORT

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Application of polyether ether ketone in obturator telescopic prosthesis fabrication: a case report

Primena polieter-eter-ketona u izradi opturator teleskop proteza

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Abstract

Introduction. The retention, stability, and plaque resistance of the obturator prosthesis significantly impact the improvement of the patient's quality of life. The aim of this paper was to draw attention to the benefits of telescopic obturator prostheses made of polyether ether ketone (PEEK). **Case report**. We present an approach to the telescopic obturator fabrication using PEEK as the material of choice for the primary and secondary telescopic crowns, which are an integral part of the framework, in a 65-year-old patient with partial maxillectomy. The positioning of the teeth was made with a silicone key, and the featuring of the gingival part of the prosthesis was performed by a composite. **Conclusion.** PEEK is a polymer with good mechanical and chemical properties besides being biocompatible. An obturator prosthesis made of this material does not incur enormous fabrication costs, and its satisfactory functionality contributes to the improvement of patients' lives.

Key words:
crowns; dental prosthesis; polyetheretherketone; polymers.

Apstrakt

Uvod. Retencija, stabilnost i neprijemčivost za plak opturator proteza ima značajan uticaj na poboljšanje kvaliteta života pacijenata. Cilj rada bio je da se ukaže na prednosti teleskop opturator proteza izrađenih od polieter-eter-ketona (PEEK). **Prikaz bolesnika.** Prikazujemo način izrade teleskop opturator proteze od PEEK-a, kao izabranog materijala, kako za primarne tako i za sekundarne teleskop krune, koje su sastavni deo skeleta proteze, kod 65-godišnjeg muškarca sa parcijalnom maksilektomijom. Postava zuba urađena je pomoću silikonskog ključa, a ostatak proteze izveden je kompozitom. **Zaključak.** Pored biokompatibilnosti, PEEK je polimer koga odlikuju dobra mehanička i hemijska svojstva. Opturator proteze izrađene od tog materijala ne poskupljuju u velikoj meri proces izrade, a njihova zadovoljavajuća funkcionalnost doprinosi poboljšanju kvaliteta života pacijenata.

Ključne reči:
krune; zubna proteza; polieter-eter-ketoni; polimeri.

Introduction

Surgical treatments of oral cancers often result in changed anatomy of the oral cavity structures, thus changing the patient's normal functioning. Postoperative radiation therapy additionally impedes the functioning of the orofacial system due to a decreased salivary secretion rate; difficulties in taking food, swallowing, and speech impediments may also occur. Under such changed conditions in the oral cavity, the fabrication of the final prosthetic dental rehabilitation is more challenging. Due to maxillary defects, the retention and the stability of the obturator prosthesis (OP) are affected, and postoperative radiation therapy additionally reduces the load-bearing ability of natural and reconstructed tissues [1].

Regardless of the increasing number of publications in which the benefits of surgical reconstruction are discussed, the fabrication of OP to repair maxillary defects is still a widely applied method [2]. The advantages of this method are the following: a quick closure of the defect and dental rehabilitation, restoration of the normal functioning of the orofacial system, and easy monitoring of wound healing and recurrence [3]. Retention may be achieved by the remaining teeth or by osseointegrated implants in an edentulous jaw. Weaknesses of the OP are as follows: inadequate leaning of the pros

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thesis against the adjacent structures, insufficient retention, and stability due to the missing load-bearing tissue [4].

The surgical obturator may be fabricated postoperatively before radiation therapy, so the patient may speak, swallow, and/or eat normally. The necessary period for making the final OP is six months after radiation therapy so that the tissues may join and stabilize after the maxillectomy and radiotherapy [5]. The stability of the OP size is affected by the defect and the position of the remaining teeth. Besides the retention of the prosthesis on the remaining teeth, the base of the prosthesis must be extended as much as possible to the remaining structures in the oral cavity. The maximum extension of the OP ensures the transfer of chewing forces to the remaining part of the palatal and the alveolar ridge, thus reducing pressure on the adjacent tissue [6]. One of the main problems of OP is retention and stability. Telescope prostheses ensure good retention, and another positive characteristic of this material is that telescope crowns could be made from it, in combination with various conventional materials or with the same material [7]. Another equally important problem of acrylic OP is the accumulation of bacteria on the surface, causing infections. The nonadhesive surface made of this material reduces the binding potential of cells and proteins on it, thus indirectly reducing the accumulation of the bacteria and the potential for an infection to occur [8].

Case report

A male patient aged 65 had a partial maxillectomy on the left side due to maxillary carcinoma. Six months after the radiation therapy, the postoperative defect of the maxilla was detected at a clinical examination in the premolar and molar regions on the left. The maxillary defect, classified as Class II by the Armani classification system, reached the medium section of the palate (Figure 1). The treatment plan was to fabricate a partial OP due to the presence of the teeth at the front, on both sides, left and right. The retention was secured by the telescope crowns on the first molar on the right side – 16, and on the canine tooth on the left side – 23. For the fabrication of the partial OP, a material based on polyether ether ketone (PEEK) (Biological High-Performance Polymer BioHPP, Bredent GmbH & Co.KG) was used. Primary and secondary telescope crowns were made of PEEK, including the framework of the prosthesis. At Stage I, the impression was made by a standard tray and alginate, with the prior protection of the obturator section by Vaseline™ gauze for making the individual tray. After grinding teeth 16 and 23, impressions were done by adding silicone for the primary telescope crown creation. Then, temporary acrylic crowns were made and cemented, and the surgical obturator was returned. At Stage II, primary telescope crowns were placed on teeth 16 and 23; the impression was taken by the individual tray with the light body addition silicone, with the prior protection of the obturator section with Vaseline™ gauze (Figure 2). At Stage III, jaw relationships with the primary telescope crowns were determined within wax patterns (Figure 3). At Stage IV, the trial positioning of the teeth was performed. After the trial positioning of the teeth, a silicone key was made in the laboratory (Figure 4), and after that, the framework of the prosthesis started, forming secondary telescope crowns. After pressing the framework made of BioHPP, composite facets were placed in accordance with the previously created silicone key (Figure 5). Then, the featuring of the gingival portion and the polishing of the very prosthesis were performed (Figure 6). At Stage V, the delivery

Fig. 1 – The maxillary defect.

Fig. 2 – Individual tray.

Fig. 3 – Wax patterns with primary telescope crowns.

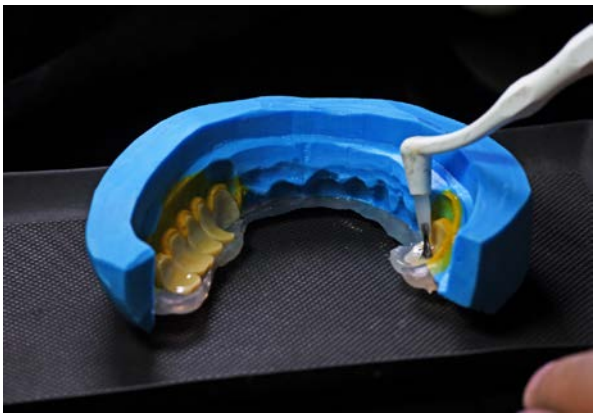

Fig. 4 – Silicone key.

Fig. 5 – Positioning of the composite facets according to the silicone key.

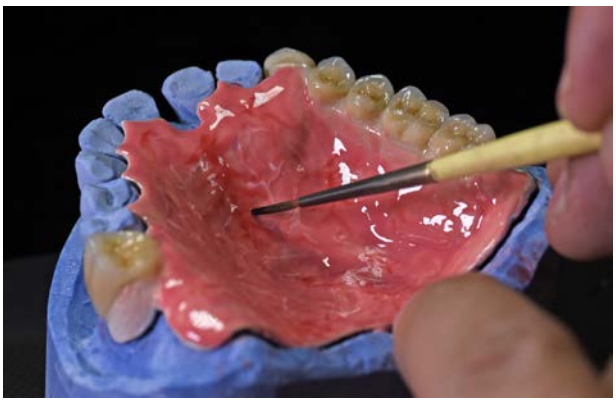

Fig. 6 – Gum and teeth characterization.

Fig. 7 – Telescope obturator prosthesis.

Fig. 8 – Telescope obturator prosthesis weight.

of the telescopic prosthesis, identical to the delivery of the conventionally combined prosthetic dental rehabilitation, was performed (Figure 7). Before cementing the primary telescope crowns, it was necessary to protect the space between the primary and the secondary telescope crowns from unwanted penetration of definitive cement for primary crowns fixation. The precise obturation of the space between these two crowns may be ensured by wax or light body addition silicones. Dual composite cement (Multilink Automix, Ivoclar Vivadent) was used to cement the primary telescope crowns. After cementing, the surplus cement was removed, and the delivery of the OP was performed. The decreased weight of the telescope OP was noticed (Figure 8).

Discussion

The fabrication of the OP has still been widely applied in repairing maxillary defects after maxillectomy. Besides the aesthetic aspect, the restoration of the normal functioning of the orofacial system is necessary for patients' quality of life. The purpose of the OP is to repair defects that have occurred due to maxillectomy [9].

Advantages are reflected in the following: simple repair of the defect and dental rehabilitation, restoration of the oropharyngeal function, and easier monitoring of both the epithelialization of the wound inflicted by the surgery and the occurrence of a recidivation [10]. Patients often experience difficulties with chewing, swallowing, nasal speech, and overall appearance, all resulting in the patients' dissatisfaction [11].

Depprich et al. [6] have mentioned acrylic materials for the fabrication of OP (polymethyl methacrylate), silicones, and titanium. The weaknesses of acrylate and silicone are the porousness and roughness of their surfaces. The physical features of these materials support microbial growth on the surface and in the interior of the obturator, from the oral and nasal cavity, which makes maintaining hygiene more difficult. Depending on the general physical condition of the patient and the pathogenicity of microorganisms, local or systemic infections might occur. The advantages of hot polymerized compared to self-polymerized acrylates are that their surface polishes better, which facilitates hygiene maintenance and reduces microbial growth. Due to hypersensitivity of the mucous membranes after radiation therapy, the obturator may also be made of soft acrylate, but in that case, hygiene maintenance is affected because of the porousness of the material. Titanium has good biomechanical properties – it is biocompatible, resistant to corrosion, has little weight, does not cause allergies, and may be easily polished. The weak point of titanium is that it is hardly adapted to the soft tissue structures in the oral cavity, and the cost of such prosthetic work is significantly higher [6]. The weight of the OP may also present a fundamental problem, especially in the case of toothless patients and patients suffering from subtotal edentulism, when the number and the distribution of the remaining teeth do not secure adequate re-

tention [12]. PEEK is a high-performance polymer with good mechanical properties. It is resistant to chemicals and elevated temperatures. It is also applied in medicine as a biocompatible material that may be sterilized. As a material, it is suitable for the fabrication of fixed and mobile prosthetic dental rehabilitation. Prosthetic structures made of this material may sustain forces up to 1,200 N, which is more than sufficient since the maximum bite force for humans is 500 N. The main advantage of this material is its small specific weight (l.32 g/cm^3) which allows the fabrication of lighter prosthetic structures [7]. The elasticity of this material is like a human bone (4,000 MPa), which, contrary to metal alloys and other materials used in dental prosthetics, significantly reduces occlusal pressure. That is particularly important in implant-bearing prosthetic reconstructions due to lesser pressure on the dental implants [13]. It is resistant to wearing and tearing, as well as to breaking, and there is a weak degradation of the material after longer periods of utilization. It may be easily processed mechanically and highly polished [7]. The material is biocompatible, resistant to plaque, insoluble in water and bodily fluids, may be sterilized, is radiotransparent, does not reflect rays during radiation therapy, and is acceptable from the aesthetic point of view since it is white. Another positive thing about this material is that telescope crowns could be made of it, in combination with various conventional materials or with the same material [7]. One of the main problems of OP is retention and stability. Telescope prostheses ensure good retention, thus resulting in increasing the patient's confidence [14]. Another equally important problem of acrylic OP is the accumulation of bacteria on the surface and infections. A certain number of investigations reveal a substantial accumulation of bacteria and fungi on the surface of an acrylic obturator, which is the source of infection. Infections occur because of bacterial adhesion on the very surface of the material and their multiplication [15, 16]. The nonadhesive surface made of BioHPP reduces the binding potential of cells and proteins on it, thus indirectly reducing the accumulation of the bacteria and the potential for the occurrence of an infection [16]. Recent research shows that the use of this material is suitable for reconstructing the defect of the craniofacial region. Compatible properties and good characteristics of this material show that its application, combined with new 3D printing technologies, will be increasingly used in primary and secondary reconstructive procedures [17–19]. This case report of the patient who had the partial OP based on PEEK, as well as our experience, has revealed a vast number of benefits of this prosthesis in comparison to conventional materials. The advantages are primarily reflected in its functionality due to the decreased weight, good closure and positioning of the prosthesis along the rims, stabilization and retention, satisfactory phonation, and the restoration of the oropharyngeal function. Besides that, the advantages are also reflected in the simpler use and the fact that patients get accustomed more easily to the partial OP and can maintain oral hygiene more easily and effectively.

Conclusion

With the fabrication of the telescopic partial OP out of PEEK, good retention and stability may be achieved, which will have positive effects on the patient's confidence and comfort. Due to its chemical stability, biocompatibility, and good mechanical properties, oral hygiene maintenance is easier, reducing the potential for secondary infection. The simplicity of the procedure and the relatively low cost of its fabrication ensure functionality, which significantly contributes to the improvement of the patient's quality of life.

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