Implant- and Tooth-Supported Fixed Prostheses Using a High-Performance Polymer (Pekkton) Framework

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The type of prosthetic restoration used in implant rehabilitation greatly contributes to the recovery of masticatory function as well as quality of life in patients. Frameworks for implant-supported prostheses are typically made by casting metal or milling either titanium or zirconia. Recently, nonmetal, polymer-type materials were suggested as framework materials. Polyetherketoneketone (PEKK), a high-performance polymer, was recently introduced in the dental field with potentially wide-ranging applications. This case history report describes implant- and tooth-supported fixed prostheses created using a new high-performance polymer (Pekkton, Cendres+Metaux) framework for a fully edentulous maxilla and partially edentulous mandible. Int J Prosthodont 2016;29:451–454. doi: 10.11607/ijp.4688

Rehabilitation of fully or partially edentulous patients greatly contributes to their recovery of masticatory function and their quality of life. Implant-supported restorations are a predictable treatment option to replace multiple teeth and present high success rates.\textsuperscript{1,2} These restorations usually consist of a framework with veneering material. A wide range of materials, such as titanium and precious and nonprecious alloys, is currently available for use in implant frameworks.\textsuperscript{3} Recently, high-performance polymers were suggested for framework fabrication where a metal-free solution is needed.

Polyaryletherketone (PAEK) is a high-performance thermoplastic polymer material valued for its high strength and rigidity within a wide temperature range. It is already widely used throughout the medical field in applications such as artificial joints and spinal implants because of its excellent biocompatibility. In the dental field, polyetheretherketone (PEEK), a member of the PAEK family, is already being used in removable dentures and temporary prostheses. Polyetherketoneketone (PEKK) was recently introduced and has an 80% greater compressive strength than PEEK.\textsuperscript{4} PEKK is useful in fabrication of the implant framework because it can be applied in both milling and pressing processes and it is lightweight and compatible with veneer.

This case report describes an implant-fixed prosthetic restoration with framework fabricated using Pekkton (Cendres+Metaux) in a patient with a fully edentulous maxilla and partially edentulous mandible. Case History Report

A 54-year-old man presented to the Department of Dentistry at Korea University Medical Center in Seoul, Korea for dental reconstruction. The patient already had six implants (IS II, Neobiotech) in the fully edentulous maxillary arch and four implants in the partially edentulous mandibular arch. Four teeth remained in the mandible, and old dentures were used as provisional dentures (Fig 1).

After comprehensively considering several conditions, fabrication of a screw-retained hybrid prosthesis for the maxilla, an 8-unit fixed prosthesis for the mandibular anterior teeth, and an implant-supported fixed prosthesis for the mandibular posterior region were planned. After preparation of abutment teeth and connection of impression copings, final impressions were taken with polyvinylsiloxane impression material (Aquasil LV, Dentsply) using customized individual trays. The occlusal plane and vertical dimension of the patient’s occlusion were determined using record bases and wax rims. The casts were then mounted with bite registration, and a full-contour wax mock-up was made. Following try-in and corrections, mock-ups were mounted on master casts for definitive fixed prostheses. Next, both master casts and mock-ups were scanned by a model scanner (Identica Blue, Medit). The scanned data

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were overlapped, and the frameworks were designed using computer-aided design/computer-assisted manufacture software (Exocad) (Fig 2).

The Pekkton frameworks were milled using a milling machine (Rainbow Mill, Dentium) and titanium cylinders (NeoBiotech, Korea) sandblasted by 50-µm particles were connected using Superbond C&B (Sun Medical). After clinical try-in (Fig 3) and minor corrections, the frameworks were veneered with resin composites (Gradia, GC). The occlusal surface was fabricated with mutually protected occlusions, and occlusal contacts were adjusted. The final prostheses were delivered, and the patient was followed up after 1 week, 1 month, and 3 months. There were no pathogenic signs or prosthetic complications. The patient was pleased with the esthetic and functional outcome of the prostheses (Fig 4).

**Discussion**

As a novel high-performance polymer, PEKK is a biocompatible material for dental prostheses. It also has good dimensional stability at high temperatures, high chemical and mechanical resistance against wear, and high tensile, fatigue, and flexural strength. Furthermore, it can easily allow detection of prosthetic complications and secondary caries due to its radiolucency. Additionally, it can be veneered with several materials, such as composite, ceramic, and acrylic resin.4,5

In screw-retained prostheses with multiple implants, the precision of the implant framework is critical for prosthetic success. Previous studies have reported that high-elastic-modulus materials such as zirconia and cobalt-chrome (Co-Cr) alloy place a high stress concentration on the framework of implant-fixed prostheses. Pekkton has a similar elastic modulus to natural tooth and bone (Table 1)6 and the present authors confirmed its elastic modulus in a laboratory. It is also effective in reducing stress. While materials with a high modulus of elasticity are more resistant to bending forces than Pekkton, they generate more intense stress at the terminal abutment of the framework. In this case, due to Pekkton's low modulus of elasticity it can easily form a passive fit with a wide framework, providing the advantages of
stress distribution and shock absorption. It is also expected to have a good biologic prognosis in terms of overload and bone resorption because it is lighter in weight than other materials. However, from an esthetic point of view, PEKK still requires veneering due to its low translucency and grayish pigmentation. Therefore, it cannot be milled to full contour. One disadvantage of this high-performance polymer in prosthetic dentistry is the difficulty of achieving adequate bond strength to composite resin materials owing to its low surface energy and resistance to surface modification by chemical treatment. To date, only one study has confirmed adequate resin bonding to PEKK. Due to limited data, the present study used a combination of silica coating, universal primer, and resin primer according to the manufacturer’s recommendation. By 3 months, no bonding failures had been observed.

There are doubts as to whether the durability of the Pekkton framework fixed partial prosthesis can be efficient. Stawarczyk et al reported a fracture load resistance for PEEK of 1,383 N, sufficient for clinical application. However, published peer-reviewed data about PEKK framework are not available to the best of the authors’ knowledge. The fracture strength of three-unit posterior unveneered bridges made of PEKK showed a value more than 1,100 N; on the other hand, veneered bridges had a value > 2,500 N. However, since these results are presented by the manufacturer, further laboratory and clinical studies are needed to determine whether this framework is suitable for oral use. Therefore, the prosthesis in the present case is to be considered a long-term temporary prosthesis and to be continuously observed regarding the durability of its application on a fixed partial prosthesis.

Conclusions

Implant- and tooth-supported fixed prostheses fabricated using a new high-performance polymer (Pekkton) framework for fully edentulous maxilla and partially edentulous mandible produced acceptable esthetic and functional results. As there are no long-term observational and clinical data for this material, further studies are needed.
Use of a High-Performance Polymer Framework in Fixed Prostheses

References


Literature Abstract

Morbidity and Mortality Rates After Maxillomandibular Advancement for Treatment of Obstructive Sleep Apnea

This retrospective cohort study compared the morbidity and mortality rates in obstructive sleep apnea (OSA) and dentofacial deformity (DFD) patients undergoing maxillomandibular advancement procedures. A group of 28 patients with OSA were compared with a control group of 26 patients with DFD. All patients underwent maxillary and mandibular osteotomies with a genioplasty or genial tubercle advancement in the Department of Oral Maxillofacial Surgery at Massachusetts General Hospital (Boston, Massachusetts, USA) between 2002 and 2011. The mean age of OSA and DFD patients was 41.9 ± 12.5 years and 21.7 ± 8.6 years, respectively. OSA patients had a higher American Society of Anesthesiologists classification, a higher body mass index and more medical comorbidities compared with DFD patients. More OSA patients experienced complications (100% vs 73%; \( P = .003 \)) than DFD patients. The total number of postoperative complications (dyesthesia, infection, hardware removal, and reoperation) was significantly higher in OSA patients (108 vs 33; \( P < .001 \)), with 13.9% in the OSA group and 3.0% in the DFD group classified as major complications The absolute risk (AR) of having a postoperative complication was 3.86 in the OSA group and 1.27 in the DFD group. The OSA group had a relative risk of complications of 3.04 when compared to the DFD group. No deaths occurred in either group. The authors concluded that the OSA group had a greater number of complications because they were older and had more comorbidities compared with the DFD group. However, this did not lead to any long-term adverse surgical outcomes or deaths. Hence, maxillomandibular advancement appears to be a safe procedure. Further studies will be required to improve patient selection methods and better predict patient response to surgery.


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