Carbon fiber frameworks and lithium disilicate crowns for implant rehabilitation: case report

[1]Oriol Canto-Naves, [2]Xavier Gimeno
[1]Department of Prosthodontics School of Dentistry, Universitat Internacional de Catalunya
[2]Private Practice. Maxillofacial Surgeon
Barcelona, Spain
Corresponding author: **Oriol Canto-Naves**, e-mail: **oriolcanto@uic.es**

ABSTRACT
A new era of materials can improve the implant rehabilitations. Different materials such as carbon fiber, PEEK, glass fiber or quartz fiber with composite, hybrid composites or lithium disilicate crowns cemented over the implants, can offer the best solution for the patients. Their occlusal impact absorbing and dissipating behavior allows to obtain a lower stress in the implant-bone-prosthesis area, reducing the risk of bone resorption of the implant when the patient has gingival inflammation. This case report discusses about a partially edentulous of 27-year-old women patient. The chief complaint of the patient was esthetic aspect; to rehabilitate her mouth with a fixed implant prosthesis. The treatment plan for the patient was a full mouth implant rehabilitation, those are as many as 18 implants (10 on the upper and 8 on the lower jaw), bilateral sinus lift, horizontal regeneration, maxillary impaction (orthognathic surgery). Both prostheses made with carbon fiber frameworks and lithium disilicate crowns cemented over them.
Keywords: occlusal impact, carbon fiber, implant rehabilitation, impact absorbing, full mouth rehabilitation
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INTRODUCTION

A full mouth rehabilitation over teeth or implants is a great challenge. Preserving all the teeth or implants and the prosthesis over time is not only an objective but also a mandatory aspect. Rehabilitating a young patient, as in this case, is more complicated, since it is not known how long these implants and the prosthesis can be maintained with correct function and esthetics. Two important aspects should be taken into account, namely the rehabilitation materials[1-21] and the patient at risk, like smoker, poor hygiene, previous periodontitis, uncontrolled diabetes, implant surface, alcohol, who will have gingival inflammation.[22-36]

Both aspects have an important relationship, namely increased stress in the implant-bone-prosthesis area can affect bone resorption, especially in patients with gingival inflammation. By using materials that absorb and/or dissipate functional and parafunctional forces, such as carbon fiber, PEEK, hybrid composite, quartz fiber, graphene, etc., the risk of the peri-implant bone resorption decreases.[1,5,6,9,11,12,15,16,19-21]

This article aims to discuss a case about a partially edentulous 27-year-old women patient that was treated with a fixed implant prosthesis.

CASE

A case is presented of a 27-year-old female (Fig.1) with chief of complaint of the patient was esthetic aspect; to rehabilitate the mouth with a fixed implant prosthesis. The patient comes to the dental clinic and shows his lower jaw was partially edentulous with hopeless remaining teeth, completely edentulous in the upper jaw, reduced intraoral space and a gingival smile (Fig.1-3).

Figure 1A Initial situation sometimes before; **B** initial situation.

Figure 2A Gingival exposure in a social smile; **B** short intraoral space in the correct vertical dimension.

Figure 3 Hopeless remaining teeth

MANAGEMENT

The treatment plan for the patient was a full mouth implant rehabilitation those are as many as 18 implants (10 on the upper and 8 on the lower jaw), bilateral sinus lift, horizontal regeneration,

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maxillary impaction (orthognathic surgery). Both prostheses made with carbon fiber frameworks and lithium disilicate crowns cemented over them.

Our objective was to recover the functional and aesthetic parameters as soon as possible, because the patient had 3 complete prostheses in the upper jaw, but it was impossible for the patient to use them again.

But in this case, according to the initial situation, to use a complete prosthesis in upper jaw or both jaws were not possible before implant placing, bilateral sinus lift and orthognathic surgery. The patient understood the situation and the team started with the treatment.

Then, the first step was to extract all the remaining teeth. After that, the implant surgery was performed 2 months later, includes bilateral sinus lift, horizontal bone regeneration and 18 implants (10 in upper and 8 in lower jaw) C1 (MIS-Dentsply, Israel) in one day under sedation (Fig.4).

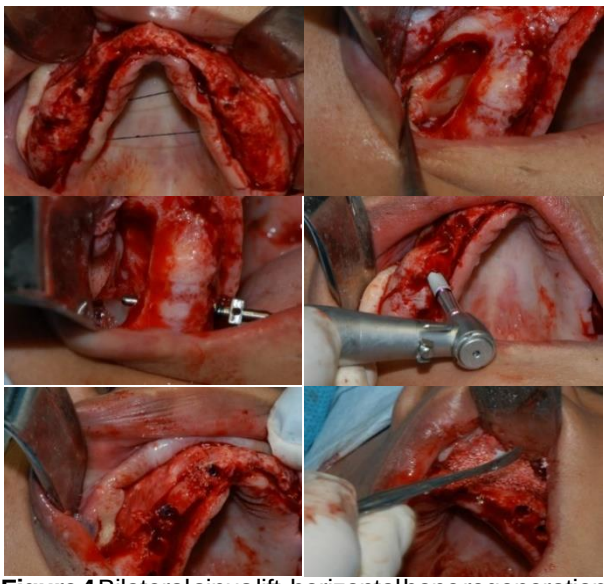

Figure 4 Bilateral sinus lift, horizontal bone regeneration and implant placing.

After that surgery, the patient goes without provisional prosthesis. We needed to get more space and a correct maxillary relationship before placing them. During surgical wound healing, we started to prepare the provisional prostheses to place them the day of the maxillary impaction (Fig.5).

It was observed the lack of space for teeth and the excessive exposure of them in rest and social smile. This is the reason the patient went without prosthesis during this healing time.

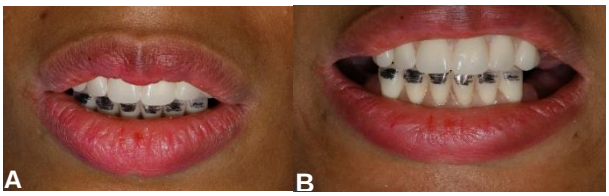

Figure 5A Teeth try in in rest position; **B** teeth try in in a social smile.

In the second step, four months later, provisional prostheses in both arches were screwed (Fig.6A) guiding us the correct position the day of the orthognathic surgery (maxillary impaction) under general anesthesia (Fig.6B and Fig.7).

Figure 6A Both provisional prostheses were screwed in mouth guiding us the maxillary impaction; **B,C** different aspect of the maxillary impaction.

Figure 7A The orthognathic surgery was finished; see the new teeth exposure with the provisional prosthesis; **B** 15 days post-surgery; observe the final aspect of the patient.

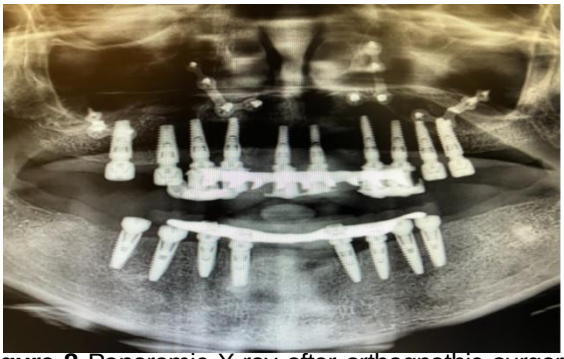

Figure 8 Panoramic X-ray after orthognathic surgery. The provisional upper and lower prostheses have been screwed.

Figure 9 Both full arches made with carbon fiber milled from carbon fiber discs.

For 4 months, the occlusion, VD, esthetic, and functional parameters were found. Final prostheses were performed according to the provisional parameters, both esthetics and functional. The final prostheses were both screwed milled carbon fiber

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frameworks from a disc Bio Carbon Tablet (Micromedica srl, Italy) (Fig.9) designed with CAD system (Fig.10A), with titanium abutment cemented to the frameworks, and pressed lithium disilicate crowns IPS Emax Press (Ivoclar-Vivadent, Liechenstein) (Fig.10B) cemented over them (Fig.11A, 11B).

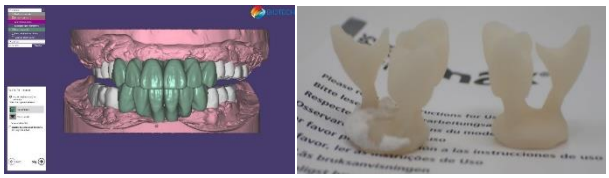

Figure 10A CAD design of the framework and single lithium disilicate crowns; **B** lithium disilicate crowns made from a pressed block.

Figure 11A Upper final prosthesis; the lithium disilicate crowns cemented over carbon fiber frameworks; **B** the gingiva was made with composite.

Figure 12 Final result after implant rehabilitation.

DISCUSSION

The implant rehabilitation is the usual care for our patient, but different treatments can be considered before starting. On this case, a prosthesis made with carbon fiber was chosen for both frameworks. The reason to choose that material is, such other materials as PEEK, glass fiber or quartz fiber, it can absorb and dissipate the occlusal impact (functional or parafunctional), then it can reduce the stress in implant neck-bone-prosthesis area.[1-20] All the literature explains us that stress and gingival inflammation, together leads to bone resorption around the implant, that is peri-implantitis.[1,19-36] Using these kinds of materials, the risk of peri-implantitis can be decreased,[1,4-7,9,12,19,20] and when treating young patients, perhaps, this option can help us to improve implant survival keeping the prosthesis in the mouth longer; and lithium disilicate gives dentists and patients the correct aesthetic aspect all along (Fig.12).

This type of implant rehabilitation material is used to maintain the functional and aesthetic parameters for the patient for a long time, and preserve not only the implant, but also the prosthesis.

Conflict of interest

The case report is not funded and there is no potential conflict of interest.

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REFERENCES

1. Castorina G. Carbon-fiber framework for full-arch implant-supported fixed dental prostheses supporting resin-based composite and lithium disilicate ceramic crowns: case report and description of features. Int J Periodont Resto Dent 2017.
2. Baldissara P, Katsinas G, Scotti R. Use of carbon-epoxy frameworks for reinforcing provisional fixed partial dentures. J Prosthet Dent 2004; 91(1):89-92.
3. Conserva E, Menini M, Tealdo T, Bevilacqua M, Ravera G, Pera F, et al. The use of a masticatory robot to analyze the shock absorption capacity of different restorative materials for prosthetic implants: a preliminary report. Int J Prosthodont 2009;22(1):53-5.
4. di Franco A. Full arch frameworks: lithium silicate meets carbon fiber. eLABORATE 2018;4:26-8.
5. Erkmen E, Meric G, Kurt A, Tunc Y, Eser A. Biomechanical comparison of implant retained fixed partial dentures with fiber reinforced composite versus conventional metal frameworks: a 3D FEA study. J Mech Behav Biomed Mater 2011;4(1):107-16.
6. Gracis SE, Nicholls JI, Chalupnik JD, Yuodelis RA. Shock-absorbing behavior of five restorative materials used on implants. Int J Prosthodont 1991;4(3):282-91.
7. Magne P, Silva M, Oderich E, Boff LL, Enciso R. Damping behavior of implant-supported restorations. Clin Oral Implants Res 2013;24(2):143-8.
8. Menini M, Conserva E, Tealdo T, Bevilacqua M, Pera F, Signori A, et al. Shock absorption capacity of restorative materials for dental implant prostheses: an in vitro study. Int J Prosthodont 2013;26(6):549-56.
9. Menini M, Pesce P, Pera F, Barberis F, Lagazzo A, Bertola L, et al. Biological and mechanical characterization of carbon fiber frameworks for dental implant applications. Mater Sci Eng C Mater Biol Appl 2017;70(1):646-55
10. Muhsin SA, Hatton PV, Johnson A, Sereno N, Wood DJ. Determination of Polyetheretherketone (PEEK) mechanical properties as a denture material. Saudi Dent J 2019 Jul;31(3):382-91.

DOI: 10.46934/ijp.v3i1.133

11. Pera F, Pesce P, Solimano F, Tealdo T, Pera P, Menini M. Carbon Fiber vs metal framework in full-arch immediate loading rehabilitations of the maxilla-a cohort clinical study. J Oral Rehabil 2017;44(5):392-7.
12. Rahmani H, Najafi S, Saffarzadeh-Matin S, Ashori A. Mechanical properties of carbon fiber/epoxy composites: effects of number of plies, fiber contents, and angle-ply layers. Polym Engineer & Sci 2014;54(11):2676–82.
13. Schwitalla AD, Spintig T, Kallage I, Muller WD. Flexural behavior of PEEK materials for dental application. Dent Mater 2015;31(11):1377-84.
14. Schwitalla AD, Spintig T, Kallage I, Muller WD. Pressure behavior of different PEEK materials for dental implants. J Mech Behav Biomed Mater 2016;54:295-304.
15. Segerstrom S, Sandborgh-Englund G, Ruyter EI. Biological and physicochemical properties of carbon-graphite fibre-reinforced polymers intended for implant suprastructures. Eur J Oral Sci 2011;119(3):246-52.
16. Stawarczyk B, Egli R, Roos M, Ozcan M, Hammerle CH. The impact of in vitro aging on the mechanical and optical properties of indirect veneering composite resins. J Prosthet Dent 2011;106(6):386-98.
17. Steinberg EL, Rath E, Shlaifer A, Chechik O, Maman E, Salai M. Carbon fiber reinforced PEEK Optima-a composite material biomechanical properties and wear/debris characteristics of CF-PEEK composites for orthopedic trauma implants. J Mech Behav Biomed Mater 2013;17:221-8.
18. Canto-Naves O, Medina-Galvez R, Marimon X, Ferrer M, Figueras-Alvarez O, Cabratosa-Termes J. A 3D finite element analysis model of single implant-supported prosthesis under dynamic impact loading for evaluation of stress in the crown, abutment and cortical bone using different rehabilitation materials. Mater 2021; 24;14(13)
19. Medina-Galvez R, Canto-Naves O, Marimon X, Cerrolaza M, Ferrer M, Cabratosa-Termes J. Bone stress evaluation with and without cortical bone using several dental restorative materials subjected to impact load: a fully 3d transient finite-element study. Mater 2021; 4;14(19)
20. Bacchi A, Consani RL, Mesquita MF, dos Santos MB. Stress distribution in fixed-partial prosthesis and periimplant bone tissue with different framework materials and vertical misfit levels: a three-dimensional finite element analysis. J Oral Sci 2013;55(3):239-44.
21. Derks J, Tomasi C. Peri-implant health and disease. A systematic review of current epidemiology. J Clin Periodontol 2015;42 Suppl 16:S158-71.
22. Duyck J, Vandamme K. The effect of loading on peri-implant bone: a critical review of the literature. J Oral Rehabil 2014;41(10):783-94.
23. Insua A, Monje A, Wang HL, Miron RJ. Basis of bone metabolism around dental implants during osseointegration and peri-implant bone loss. J Biomed Mater Res A 2017;105(7):2075-89.
24. Klinge B, Meyle J, Working Group 2. Peri-implant tissue destruction. The third EAO consensus conference 2012. Clin Oral Implants Res 2012;23 Suppl 6:108-10.
25. Lindhe J, Meyle J, Group D of European Workshop on Periodontology. Peri-implant diseases: Consensus Report of the Sixth European Workshop on Periodontology. J Clin Periodontol 2008;35(8 Suppl):282-5.
26. Mazel A, Belkacemi S, Tavitian P, Stephan G, Tardivo D, Catherine JH, et al. Peri-implantitis risk factors: A prospective evaluation. J Investig Clin Dent 2019;10(2)
27. Mombelli A, van Oosten MA, Schurch E,Jr, Land NP. The microbiota associated with successful or failing osseointegrated titanium implants. Oral Microbiol Immunol 1987;2(4):145-51.
28. Naert I, Duyck J, Vandamme K. Occlusal overload and bone/implant loss. Clin Oral Implants Res 2012;23 Suppl 6:95-107.
29. Ramseier CA, Warnakulasuriya S, Needleman IG, Gallagher JE, Lahtinen A, Ainamo A, et al. Consensus Report: 2nd European Workshop on Tobacco Use Prevention and Cessation for Oral Health Professionals. Int Dent J 2010;60(1):3-6.
30. Sanz M, Lang NP, Kinane DF, Berglundh T, Chapple I, Tonetti MS. Seventh European Workshop on Periodontology of the European Academy of Periodontology at the Parador at la Granja, Segovia, Spain. J Clin Periodontol 2011;38 Suppl 11:1-2.
31. Afrashtehfar KI, Afrashtehfar CD. Lack of association between overload and peri-implant tissue loss in healthy conditions. Evid Based Dent 2016;17(3):92-3.
32. Chang M, Chronopoulos V, Mattheos N. Impact of excessive occlusal load on successfully-osseointegrated dental implants: a literature review. J Investig Clin Dent 2013;4(3):142-50.
33. Favot LM, Berry-Kromer V, Haboussi M, Thiebaud F, Ben Zineb T. Numerical study of the influence of material parameters on the mechanical behaviour of a rehabilitated edentulous mandible. J Dent 2014;42(3):287-97.
34. Mattheos N, Collier S, Walmsley AD. Specialists' management decisions and attitudes towards mucositis and peri-implantitis. Br Dent J 2012;212(1):E1.
35. Pesce P, Canullo L, Grusovin MG, de Bruyn H, Cosyn J, Pera P. Systematic review of some prosthetic risk factors for periimplantitis. J Prosthet Dent 2015;114(3):346-50.

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