The Evaluation of Cantilever and Primary Stability in a Toronto Bridge Prosthesis with Mesostructure in Carbon Fiber

Riccardo Sirello[1], Mario Botti[2], Arjeta Hatia[3], Albino Eccher[4], Matteo Brunelli[5], Fabio Boscolo[6]

1- DDS, Clinical Director, Odontosalute, Peschiera del Garda (VR), Italy. 2- DDS, Clinical Director, Dentalwellness, Milano, Italy. 3- DDS, Dentalwellness, Milano, Italy. 4,5- MD, PhD, Department of Pathology and Diagnostic, Azienda Ospedaliera Universitaria Integrata di Verona, Italy. 6 - DDS, Odontosalute, Italy.

Correspondence to:
Dr.Riccardo Sirello, Via Carlo Lorenzini 17, 57124 Livorno, Italy
Contact Us : editor@ijdmr.com
Submit Manuscript : submissions@ijdmr.com
www.ijdmr.com

ABSTRACT

Goal of this research is to evaluate the benefits coming from the use of a Toronto Bridge prosthesis with mesostructure in carbon fiber and check in detail its passivation and stability, emphasizing the importance of AP spread and cantilever. The surgical technique of this case has foreseen a split crest with use of piezosurgery and insertion of self-tapping conical dental implants. The Toronto Bridge is a dental prosthesis, generally made of resin, anchored to implants previously placed and osseointegrated and that therefore remains fixed. The advantages over a removable prothesis are stability, high aesthetics and hygiene easy to implement. The aim of our work was to provide a Toronto bridge with mesostructure in carbon fiber because, in comparison with that with the mesostructure in metal, has a lower weight (only 9,7gr), greater lightness and liabilities, load resistance and modulus elasticity.

KEYWORDS: Cantilever, Carbon Fiber, Dental Implant, Toronto Bridge

INTRODUCTION

The Toronto on all four is a rehabilitation of the jaws with two mesial implants, with an axial inclination and two distals inclined at 30 degrees with bilateral distal cantilevers of 5 mm.[1]

The inclination of the implants allows a reduction of the cantilever.[2]

The prior condition for an immediate loading is that we reach an insertion superior to a torque of 35 Ncm. In fact, in a bone with a particular density and rich in cortical (D1-D2), it's simple to obtain a high torque of insertion while, in a less mineralized bone, we should make an under-preparation of the implant site, by omitting the passage of the final drill. It's only in such a way that the implant reaches a higher resistance at the time of its insertion. It's a measure detectable with both engines dedicated to implant surgery and with dynamometric ratchets. It's generally accepted that implants with a torque of at least 20 Ncm have a higher survival rate than those with a torque less than that value.[3]

In order to find the right measure of the cantilever, it's important to evaluate the relationship with the level of the anteroposterior distribution of the implants (AP spread). The voice AP spread defines the distance between the center of the anterior implant and a line joining the distal edges of the two most rear implants. A high spread generates a better distribution of masticatory strengths.[4] The length of the cantilever influences the stress distributed to the abutments.Also the length of the implants can help to increase the surface of the bone-implant contact and so to increase the primary stability.

CASE REPORT AND RESULTS

The patient is a 71 year-old woman, in good general health. She has an edentulous upper dental arch and a removable prosthesis (from 20 years). In the lower dental arch, the patient has a prosthetic implant with a mucous point of support, stabilized with two locator connections. The implants located at level 33 and 43 are pre-existing(Fig No.1).

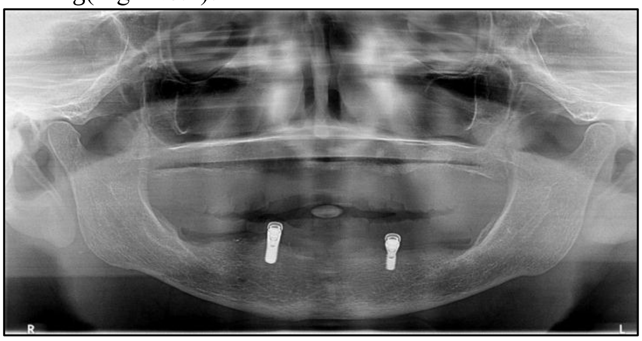

Fig.1. Preoperative orthopantomography, showing edentulous upper dental arch and two implants in the lower dental arch, at level 33 and 43

How to cite this article:
Sirello R, Botti M, Hatia A, Eccher A, Brunelli M, Boscolo F. The Evaluation of Cantilever and Primary Stability in a Toronto Bridge Prosthesis with Mesostructure in Carbon Fiber. Int J Dent Med Res 2015;1(5):69-72.

We also scheduled a 3D tomography to evaluate the thickness of the bone in the upper dental arch and, because of a horizontal atrophy, we decided for a split crest (Fig No.2).

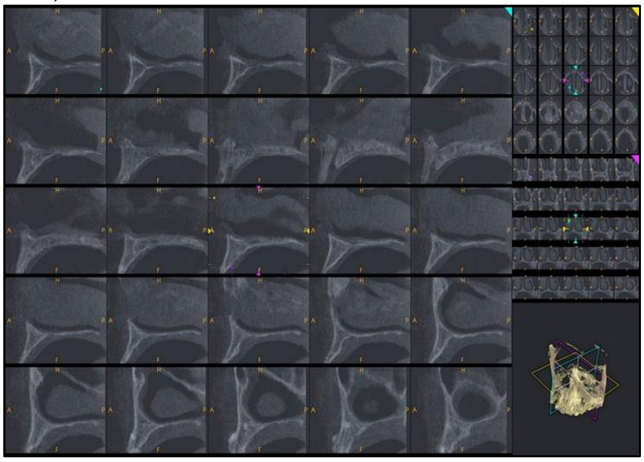

Fig. 2. Computerized axial tomography, showing atrophy of the bone in the upper dental arch

The patient underwent a preventive therapy in order to check local and systemic infections. The antibiotic therapy consisted in 1 gr. of Amoxicillin and clavulanic acid (Augmentin) every 12 hours, for six days. The therapy began the day before surgical operation.

The post surgical therapy provided, in addition to the antibiotic, also rinses with Chlorhexidine Digluconate 0.2% and Nimesulide if necessary. We suggested a soft diet and ice application.

The surgical operation was done under local anesthesia with use of Articaine Hydrochloride (Articaine with adrenaline 1/100.000, Septodont). We made a full-thickness incision and a vertical osteotomy of 12 mm with piezosurgery (Sympla S.r.l. MN, Italy). The sites receiving the implants were thus prepared: cutter with diameter of 2.0 mm and 2.8 mm and implants with 4.2 mm diameter, with a speed of 900 revolutions per minute and continuous irrigation of cold saline (engine: Aseptico Inc. Usa), to avoid necrosis of the bone. We carried out a split crest to increase the bone in a horizontal direction, and placed the implants using a dynamometric ratchet to 50 Ncm. We inserted the healing abutments. At the end, we placed suture with absorbable threads (Vicryl 4-0 by Ethicon, Inc. Somerville, New Jersey), and we make an infiltration of cortisone (4 mg) in the soft tissues (Fig No.3).

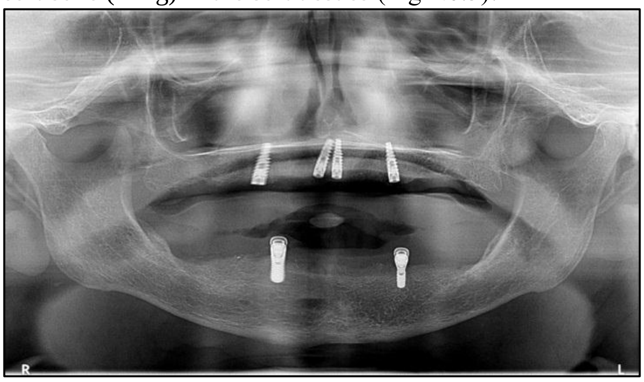

Fig.3. Postoperative orthopantomography

We used "V Edge Implant Titanium" (SigDent, Israel) with the following features: tapered self-tapping body, in length 13 mm, diameter 4.2 mm, sandblasted with aluminum bioxide and etched with citric acid. This procedure allows us to get a good primary stability.

Fig.4. Postoperative orthopantomography with mesostructure in carbon fiber

In the months before the positioning of the prosthesis, the patient continued to use her mobile prosthesis appropriately adjusted with tissutar conditioner. After five months, we unscrewed the healing abutments and screwed the Multi Unit Abutments at 30 Ncm (MUA). Before the impression, replicas were connected with pattern resin. We got the impression with the replicas using monophasic silicone (Impregum Penta, Italy). So we prepared a Toronto carbon fiber mesostructure and we screwed it with a torque of 25 Ncm. For the realization of the mesostructure in carbon fiber we used seven sheets with a high modulus fiber, consisting of 1000 strands/mm^2. The polymerization was done at 90° for 135 minutes. Then, we checked the functionality of the mobile prosthesis. The

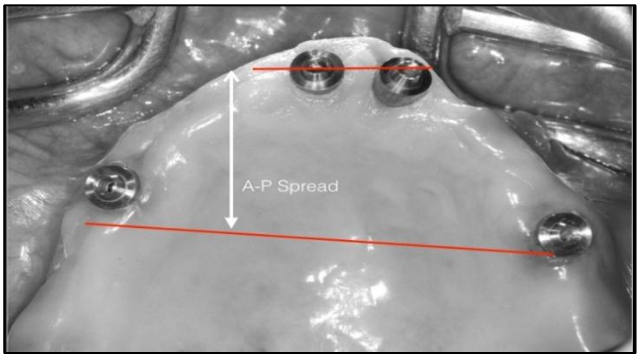

Fig.5. AP spread, distance between the center of the anterior implant and a line joining the distal edges of the two most rear implants

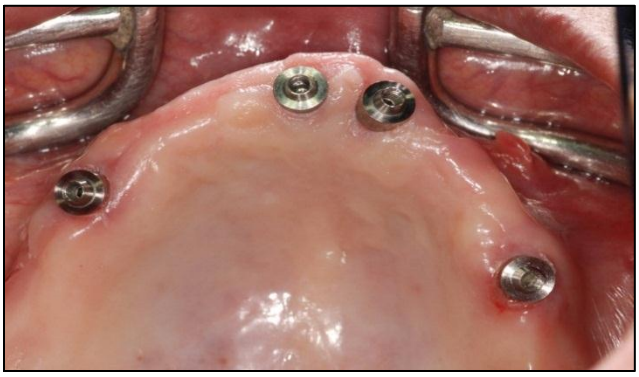

Fig.6. Occlusal view of four transmucosal MUA (Multi Unit Abutment)

Toronto carbon fiber has a total weight of 9.7 gr. So we got an excellent passivation, lightness and strength.

Fig.7. Occlusal view of Toronto Bridge in carbon fiber

Fig. 8. The Toronto weight

Fig. 9. Finished case after tightening, functionalization and balance in occlusion

Fig. 10. The result in situ

DISCUSSION

The surface topography plays a key role in the healing of the bone. It influences the degree of agglomeration of the red blood cells and its wrinkledness influences the number and degree of activation of platelets.[5-6]

A bigger micro topography of the surface implies a larger implant area with a bigger absorption of fibrinogen and, as final result, a wider platelet adhesion.[5]

Platelets activated on rough surfaces attract and stimulate neutrophils in a better way, if compared to platelets activated on smooth surfaces.[7]

From a surgical, prosthetic and biomechanics point of view, the rehabilitation based on the All-on-4 concept has shown its efficacy and safety, ensuring comfort and aesthetics to the patient.

In the Toronto it's important to consider the length of the cantilever. According to Misch the length must not exceed 2.5 times the AP spreads, without neglecting the bone density and the physical condition of the patient.[8]

Following the Skalak model, the length of the cantilever must not exceed 1.8 times the AP spread.[9]

The AP spread is influenced by the shape of the dental arch: a triangular or V shape has a very favorable AP spread (even 8 mm), while a square geometry or U shape is usually unfavorable (2-5 mm).

In our case, the AP spread is 22 mm and the length of the cantilever is 15 mm to the right side and 9 mm to the left. So we have complied with both laws of Misch and McAlarney.

In our research, the mesostructure of the Toronto Bridge is in carbon fiber. This way it's possible to reconstruct a prosthetic arch that meets the weights as in nature, improving comfort for the patient, integrating biological and propriocetive properties.

It ensures a capacity of shock absorption that can reduce the load tranfer by 65% compared to zirconia and 35.7% compared to ceramic on cobalt chrome.

	Carbon Fiber	Zirconia	Ceramic on Cobalt chrome CAD/CAM
Mean weight	13 g	95 g	125 g
Shock absorption	13.7 kg (-65%)	40 kg	25.4 kg (-35.7%)

Table 1. Capacity of shock absorption

A cytotoxicity test made on L929 fibroblast cells grown in the presence of carbon fiber indicates a total absence of phenomenon.[10]

We used Sheffield test in order to evaluate the passivation of the prosthesis. The passivation is achieved by incorporating the connections in titanium directly during the moulding of the carbon fiber. The Test of Sheffield (One Screw Test) confirms that the compliance with the Protocol of cooking and cooling gives excellent results.

An absolute quality passivation guarantees the absence of stress on the implants and provides the ideal conditions for osseointegration.

A comparison with the mechanical properties of gold alloys and carbon fiber, shows us that the load resistance and the modulus of elasticity are better in the carbon fiber.

	Carbon Fiber	Gold Resin Alloy Au 51%	Gold Resin Alloy Au 40%	Reinforced Peek (carbon fiber, glass fiber)
Load resistance	500 Mpa	440 Mpa	520 Mpa	12 Mpa
E-Module	66.000 Mpa	69.000 Mpa	81.000 Mpa	4.000 Mpa

Table 2. Load resistance

CONCLUSION

Although the carbon fiber is a new technique, thanks to its passivation and lightness, it seems to offer excellent properties in the treatment of the patient. In addition the carbon fiber has a resilience which is much better than steel.

In our case we have obtained a good primary stability, thanks to the real properties of the implants (self-tapping, sandblasted with aluminum oxide and etched with citric acid instead of orthophosphoric acid) and also thanks to the insertion torque (50 Ncm). The AP spread and the cantilever both have the ideal dimensions described by Misch and McAlarney.

REFERENCES

1. Maló P, Rangert B, Nobre M. “All-on-four” immediate function concept with Branemark system implants for completely edentulous mandible: a retrospective clinical study. Clin Implant Dent Relat Res 2003;5(Suppl1):29.
2. Bevilacqua M, Tealdo T, Menini M, Pera F, Mossolov A, Drago C, Pera P. The influence of cantilever length and implant inclination on stress distribution in maxillary implant-supported fixed dentures. J Prosthet Dent 201;105(1):5-13.
3. Brass JM, et al. Correlation between placement torque and survival of single tooth implants. Int J Oral Maxillofac Impl. 2005;20, p. 769-776.
4. Rodriguez AM, Aquilino SA, Lund PS. Cantilever and implant biomechanics: a review of the literature. J Prosthodont 1994;3(1):41-6. 1994;3(2):114-8.
5. Park JY, Davies JE. Red blood cell and platelet interactions with titanium implant surfaces. Clin Oral Imp Res 2000;11: 530-9.
6. Kanagaraja S, Lundstrom I, Nygren H, Tengvall P. Platelet binding and protein absorption to titanium and gold after short time exposure to heparinised plasma and whole blood. Biomaterial 1996;17:2225-32.
7. Davies JE. Understanding peri-implant endosseous healing. J Dent Educ 2003;67: 932-949.
8. Misch CE. Cantilever length and its relationship to biomechanical stress, In Misch Implant Institute Manual, Misch International Implant Institute, 1990, Dearbon.
9. McAlarney ME, Stavropoulos DN. Determination of cantilever length-anterior-posterior spread ratio assuming failure criteria to be the compromise of the prosthesis retaining screw prosthesis joint. Int J Oral Maxillofac Implants, 1996 May-June, 11(3):331-9.
10. Cassinelli C, Morra M, Bruzzone G, Carpi A, Di Santi G, Giardino R, Fini M. Surface chemistry effects of topographic modification of titanium dental implant surfaces: 2. In vitro experiments. Int J Oral Maxillofac Implants 2003 Jan-Feb;18(1):46-52.

Source of Support: Nil
Conflict of Interest: Nil