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

Riccardo Sirello1, Mario Botti2, Arjeta Hatia3, Albino Eccher4, Matteo Brunelli5, Fabio Boscolo6

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 prosthesis 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).

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


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).
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).

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).

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 oxide and etched with citric acid. This procedure allows us to get a good primary stability.

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/mm². The polymerization was done at 90° for 135 minutes. Then, we checked the functionality of the mobile prosthesis. The
Toronto carbon fiber has a total weight of 9.7 gr. So we got an excellent passivation, lightness and strength.

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.\(^5\)

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 transfer by 65% compared to zirconia and 35.7% compared to ceramic on cobalt chrome.

<table>
<thead>
<tr>
<th></th>
<th>Carbon Fiber</th>
<th>Zirconia</th>
<th>Ceramic on Cobalt chrome CAD/CAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean weight</td>
<td>13 g</td>
<td>95 g</td>
<td>125 g</td>
</tr>
<tr>
<td>Shock absorption</td>
<td>13.7 kg (-65%)</td>
<td>40 kg</td>
<td>25.4 kg (-35.7%)</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th></th>
<th>Carbon Fiber</th>
<th>Gold Resin Alloy Au 51%</th>
<th>Gold Resin Alloy Au 40%</th>
<th>Reinforced Peek (carbon fiber)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load resistance</td>
<td>500 Mpa</td>
<td>440 Mpa</td>
<td>520 Mpa</td>
<td>12 Mpa</td>
</tr>
<tr>
<td>E-Module</td>
<td>66.000 Mpa</td>
<td>69.000 Mpa</td>
<td>81.000 Mpa</td>
<td>4.000 Mpa</td>
</tr>
</tbody>
</table>

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