The tooth replacement concept: a case study

Josep Oliva-Ochoa, Xavi Oliva-Ochoa and Andrea Roig-Araujo discuss a case report using the tooth replacement concept with Ceraroot ceramic implants

Traditionally, metals have been used in implant dentistry to produce both implants and prosthetic frameworks (Kasemo, Lausmaa, 1988; 1993). Metal dental implant designs have not changed much since their first use in dentistry.

In general, the configuration consisted of multiple parts: a titanium bone fixture, a transmucosal abutment, a fixation screw, and the crown or bridge. This approach has been used to restore most partially edentulous patients in the past.

Some drawbacks of this is the presence of multiple connecting parts in subgingival spaces that are colonised by bacteria and may induce an inflammatory reaction, and bone remodelling around the implant with the subsequent loss of papilla height. This aspect is especially important in patients with a thin biotype that are more susceptible to have gum recessions, as well as the gum discolouration coming from the metal shining through the thin mucosa. Screw and abutment loosening is often another complication that may induce inflammatory reaction around the implants as well as halitosis.

The tooth replacement concept, developed by Ceraroot, was conceived to provide a more natural, biologic and aesthetic solution in implant dentistry. The rationale for such a new design was conceived from the following questions: why should the dental implant have multiple components if the natural tooth is a one body unit? Why should the dental implants look like airplane or car metal screws with hexagons or octagons etc?

The seven implant models of the

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Dr Josep Oliva-Ochoa
Josep is a periodontist and specialises in ceramic dental implants. Together with his brother Xavi, they developed the Ceraroot ceramic implant system that has been in the market since 2004. He lectures internationally and is involved with various scientific committees across the world, including the European Academy of Esthetic Dentistry. He is a founding member of the Leading Dental Centers of the World.

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Ceraroot system were designed specifically for the different tooth anatomy of a natural dentition. The teeth were carefully studied to finally draw new ceramic implant models with a diameter and emergence profile very similar to the natural one.

Moreover, the zirconia ceramic was chosen as the best available material in terms of biocompatibility, strength and aesthetics to produce such one-piece ceramic implants. The one-piece ceramic implant includes the endosseous part, the transmucosal part, and the abutment, where the customised ceramic crown will be cemented when the implant is osseointegrated.

Several authors have studied the biocompatibility and osseointegration of zirconia with great success both in vivo and in vitro, in animals and humans, and today its success is beyond any doubt (Heydecke, Kohal, Glaser, 1999; Wohler, Studer, Schärer, 1996; Silva, Lameiras, Lobato, 2002; Schulte, D’Hoedt, 1984; Schulte, D’Hoedt, 1988; De Wijs et al, 1994; Marx, 1993; Picconi et al, 1998; Stevens, 2000; Marx, Jungwirth, Walter, 2004; Albrektsson, Hansson, Ivarsson, 1985; Akagawa et al, 1993; Akagawa et al, 1998; Ichikawa et al, 1992; Kohal et al, 2002; Kohal et al, 2004; Kohal et al, 1997; Senerby et al, 2005; Andreiotedi, 2006; Kohal, Klaus, 2004; Wennerberg, 1996; Oliva, Oliva, Oliva, 2007). The Ceraroot implant system has reported a success rate of 98% after five years of function (Oliva, Oliva, 2010), and the acid-etched surface (ICE) is key for such success, as it has been shown a great osseointegration potential in a histologic study (Oliva, Oliva, 2013).

Initial exam

First, she had the crown restored with a composite, and a few months later the nerve got infected and she received a root canal treatment.

At the age of 18, a fistula appeared in the facial aspect of the tooth with an apical granuloma. Then the patient received an apical surgery to eliminate the granuloma and perform an apicoectomy together with a bone graft to fill the granuloma bone defect. With the years, the tooth became discoloured and the patient was really unsatisfied with her smile. The patient experienced regular episodes of pain around UR1, and attended our practice to find an aesthetic solution for her tooth and smile. She was very concerned about metals and asked for a metal-free tooth replacement solution.

The interproximal bone height was well preserved. Aesthetically, the tooth discoloration came from the endodontic root and coronally into the crown. Moreover, the different composite restorations that the patient had received over the years for the fractured crown was very visible (Kasemo, Lausmaa, 1988, 1993).

The patient smile line was high and the discoloured crown was very obvious even at rest position of the lips.

The patient’s bite was good with a normal occlusal relationship of the jaws and good alignment of teeth in both arches.

The Ceraroot 21 ceramic implant (Figure 5) was selected (Ceraroot). As seen in Figure 5, the Ceraroot 21 implant has a transmucosal part with a scalloped design to support the interproximal tissues.

Additionally, the design of the implant’s abutment is such that there is no need to prepare it for the provisional or final restoration, provided that the implant is together with a bone fenestration of the cortical plate in the apical third of the root. Moreover, the bone graft particles from past surgeries were evident.

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**MATERIALS AND METHODS**

- A 25-year-old female presented with a discoloured central incisor that needed to be replaced
- A Ceraroot 21 ceramic implant with an acid-etched surface was used to immediately replace the extracted tooth
- Injectable platelet rich-fibrin and a bone graft was used to preserve the volume and help with the wound healing
- An immediate vacuum-formed removable temporary restoration was placed for a period of two months until the implant was osseointegrated
- A PMMA-fixed temporary crown was used to contour the gingival profile, and finally the zirconia ceramic crown was cemented three months after surgery
- A zirconia crown was cemented.
placed in the correct 3D position.

**Surgical treatment**

Systemic antibiotics were given for one day before surgery and seven days after surgery. The surgical treatment started with an atraumatic tooth extraction, using scalpels and forceps. After this, the extraction socket was debrided and the chronic peripapical cyst was extracted together with some bone graft particles that had been placed in past surgeries, and finally a thorough irrigation was done with saline solution. Special care was taken to avoid the damage of the buccal cortical bone plate, especially in the apical third of the root where a fenestration was detected.

Then the drilling sequence started with a sharp pilot drill that was positioned in the palatal aspect of the apical third of the extraction socket, followed by twist drills (2.2, 2.8, 3.5mm). Special attention was put to give the drills the appropriate inclination in order to follow the incisal edge of the neighbouring teeth. The authors call this ‘the closed mouth technique’ (Figure 7), where the initial drill and, later, the twist drills, are used one by one to check the correct osteotomy inclination by making the patient bite with the drill in the osteotomy and confirming the proper inclination. If the drill interferes with the bite, then the osteotomy has to be modified a bit to the buccal, and if the drill is too much to the buccal, then the pilot drill has to be changed into a more palatal inclination.

By doing the closed mouth technique every time we use the next drill, the final implant position will be in an ideal inclination and the implant abutment will not have to be modified to correct a possible misplacement of the implant.

Finally, a profile drill was used to finalise the shape of the implant site, taking care to add pressure in the palatal aspect to avoid damaging the thin buccal cortical plate. This is especially important in immediate extraction implants where the palatal bone is much thicker and can push the implant towards the facial aspect when inserting it into the osteotomy, if we have not previously prepared the palatal cortical plate considerably.

Before the implantation of the CeraRoot 21, the implant was placed into a sterile blood tube together with i-PRF (injectable platelet-rich-fibrin) and left for five minutes for it to clot (Figure 9).

The implant was inserted with the contra-angle using a special transporter key (Figure 10). The implant buccal shoulder was left 1.5mm apically to the gingival margin of the central incisor UL1 (Figure 11). An optimal primer stability (>35 N) of the implant was achieved at surgery.

After the implantation a-PRF (advanced platelet-rich-fibrin) mixed with bone graft (Endobone, Biomet3i) was used to fill the spaces around the implant and the extraction site, to avoid the collapse of the soft tissues around the implant and to help with the initial phase of wound healing (Figures 12 and 13). The panoramic X-ray on the day of surgery confirmed the good position of the implant in the upper jaw (Figure 14).

**Immediate removable temporary restoration**

Before the tooth extraction was done, alginate impressions were made and the stone models were prepared to produce an immediate temporary restoration with a thermoplastic vacuum-formed appliance, and a composite veneer in the facial aspect of tooth UR1.

Special attention was taken to avoid contact between the vacuum appliance and the implant abutment to bypass any loading during the first two months as well as any pressure at the gingival area of tooth UR1 for the soft tissue regeneration.

**Two-month follow-up**

The healing phase was uneventful, and two months after surgery the soft tissue was very well healed and there was a gain in papilla height, as well as the gingival margin in the facial aspect of the implant.

The soft tissue had grown all around the implant considerably, both horizontally and vertically (Figures 15 and 16). The fixed immediate temporary crown alternative is never the first choice, since it interferes with the soft tissue augmentation potential because it blocks the space. Moreover, the temporary cement may interfere with the wound healing.

At this point, the Periotest M (Medizintechnik Gulden) values (-4.2) of the implant indicated that the implant was very solid and that osseointegration was a success. For this reason, impressions were done for a fixed temporary crown.
implant and electric surgery was used for a gingivectomy to remove the excess of soft tissue that had grown into the implant-crown margin. The buccal soft tissue was left intact with the objective to remodel the gingival contour with the fixed temporary crown (Figure 17).

The design of the temporary crown was done in order to avoid any excess pressure at the soft tissue in the buccal and the interproximal aspect. To do this, a platform switch concept was done at the crown margin, making this crown smaller in diameter in the facial and interproximal (Figure 18).

The soft tissue remodelling was done gently and atraumatically to have the best soft tissue aesthetic result. The crown was produced by CAD/CAM with PMMA material (Zirkonzahn) and cemented with Fuji Temp temporary (Figure 19).

The temporary was left for one month and after this period, the crown was removed for the final impressions (Impregum, 3M ESPE). At this time, the soft tissue was well shaped around the implant with optimal papillas and volume for a successful final outcome (Figures 20 and 21).

**Final restoration**

The final crown was CAD/CAM produced with zirconia ceramic (Zirkonzahn) and a very thin layer of porcelain ceramic to maximise the final aesthetic outcome, attempting to imitate the contralateral central incisor.

The zirconia crown was cemented four months post-surgery with resin modified glass-ionomer permanent cement (GC Fujicem, GC America Inc). The excess cement was carefully removed with a dental probe and floss. Special attention was put into the occlusion to avoid excess contact in centric and protrusive displacements.

A slight infraocclusion was left to compensate with the periodontal ligament of the neighbouring teeth. The periapical X-ray confirmed that the crown margin fit precisely on the implant and that the interproximal bone was very well preserved. Considering the initial situation, the final aesthetic outcome both for the crown and soft tissues were very satisfactory for the patient.

**Three-year follow-up**

The three-year follow-up of the patient (Figures 25 and 26) demonstrated the high stability of both the bone around the implant and the gingival contour. The CBCT 3D image showed a thick buccal cortical plate of bone on the implant (Figure 31).

The tooth replacement concept with
Ceraroot 21 resulted in a new tooth that integrated perfectly within the patient’s own dentition (Figures 25-27 and 28-30). The system was able not only to restore both the aesthetic and masticatory function of the tooth, but also the soft tissue attachment into the acid-etched surface of the implant in a similar way to that of a natural dentition. This was observed clinically at this stage, when probing the implant UR1 sulcus, and found the same values of the natural tooth UL1 (PD= 2,1,2 = mesial, middle, distal). The three-year follow-up comparison with the initial situation was very satisfactory for the patient.

Discussion
When using zirconia ceramic implants to restore teeth, the latest implant research available should be taken into consideration. Ceraroot implants have been used in dentistry since 2004 and utilises ceramic implant research in its development. The rough surface of the acid-etched implant has provided a long-term success rate similar to titanium implants. The one-piece implant configuration and the anatomic design has resulted in the tooth replacement concept, meaning that the Ceraroot implant is not only a bone fixation, but also a white ceramic device that matches the natural dentition perfectly, and replaces the peri-implant soft tissue attachment into the implant’s surface just like natural teeth.

Immediate loading of the implants is a popular marketing strategy in the dental industry. Although mechanically speaking this might be a possibility, the authors do not recommend immediate loading implants because the cemented crown blocks and interferes with the soft tissue growth, and healing is necessary for the best aesthetic result. Moreover, the mechanic properties of the zirconia ceramic materials allow for a long-term successful outcome. In this sense, the proper 3D position of the implant is crucial to avoid posterior modifications of the implant abutment part to correct the inclination. For this reason, the proposed closed mouth technique (Figure 7) is recommended by the authors to be used in the upper anterior zone. Nevertheless, a surgical guide is a beneficial tool that helps the surgeon improve implant positioning to achieve a good final outcome.

Final thoughts
The tooth replacement concept with Ceraroot ceramic implants is an ideal alternative to titanium implants. The soft tissue attachment on the acid-etched one-piece ceramic implant is crucial in maintaining bacteria away from the subgingival spaces, and thus the risk of inflammatory reaction and bone remodelling is minimised.

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