Demonstration of synergy between an innovative implant design and a novel biomaterial

Implant and alloplast synergy in the anterior mandible

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Intraoral host bone regeneration within the labial portion of the anterior mandible can be unpredictable, affected by many factors including host healing, the bony envelope dimensions labial to the implant shoulder, surgical technique and patient compliance pre, peri and post operatively. This case study demonstrates the first use of a novel implant design together with a ß-tricalcium phosphate (ß-TCP) particulate alloplast graft material in the anterior mandible with immediate placement and loading.

Case report

A 76-year-old male patient, non-smoker, with a non-contributary medical history presented with a painful lower left central incisor tooth 31, the lower right central incisor 41, being removed in childhood. A reduced incisal dimension between the lower canines was present with no diastemata. The symptomatic tooth had become tender to biting pressure and had previously been orthograde root treated with a subsequent apicectomy using amalgam as a retrograde filling material (Figs. 1 to 4). At presentation, the tooth was tender to percussion with grade 1 mobility. No increased probing depth or suppuration was noted, either on the affected tooth 31, or elsewhere in the mouth. A diagnosis of chronic apical periodontitis secondary to suboptimal orthograde and retrograde root treatment was made for tooth 31 and the tooth was given a hopeless prognosis.

An immediate placement/loading implant treatment plan was proposed. The initial treatment plan involved the fabrication of a PMMA Shell provisional crown designed based on the approved digital 3D-printed diagnostic wax-up for immediate loading; a pre-extraction small field, sectional CBCT scan on the lower anterior mandible; an atraumatic extraction of tooth 31 with meticulous degranulation and curettage; and an immediate implant placement using a novel implant with internal angle correction.

1 I Initial situation – periapical radiograph shows tooth 31 with apicectomised root, extruded anterograde root filling material, amalgam retrograde root filling, post crown with off-centre post positioning.

2 I Initial presentation shows thick biotype with stippled keratinised attached mucosa, a vertical linear scar visible at site of historically extracted tooth 41 and a composite labial repair to the cervical margin of the 31, post-crown.

3 I Initial presentation occlusal view shows loss of ridge with associated with linear gingival scar at site 41, mild imbrication of remaining lower incisors and mild tooth surface loss with a major attrition component on the incisal edges of the lower anterior teeth.

4 I Sectional CBCT showing very thin labial plate and labio-lingual morphology of the bony ridge at tooth 31

5 I Prior to mechanical degranulation of the socket 31

6 I Full thickness muco-periosteal flap with papillae sparing release incisions distal to canines. Granulation tissue visible within vertical bony cleft associated with extracted tooth 41

7 I During further mechanical degranulation showing a reduction in granulation tissue

A simultaneous bone grafting with an in-situ hardening synthetic resorbable bone substitute was then used, composed of ß-TCP and calcium sulphate (CS), according to Fairbairn and Leventis [1–4] and simultaneous loading of the implant with the PMMA provisional crown which is modified at chairside.

Antibiotic prophylaxis with 3 g amoxycillin was given one hour prior to surgery, with chlorhexidine mouthwash used for two minutes at the time of surgery. Under local anaesthesia, atraumatic flapless tooth extraction was performed using both elevators (Helmut Zepf Medizintechnik, Germany), and extraction forceps (Devemed GmbH, Germany) trying to avoid plastic flexing of the labial and lingual plates of intact bone. Immediately post extraction the socket was debrided of granulation tissue using both Lucas curettes (Hu-Friedy Group, USA), and degranulation burs (EthOss EK Strauss Degranulation Bur Kit, EthOss Regeneration Ltd, UK) (Fig. 5).

After completion of degranulation, the socket was evaluated and a dehiscence was detected labially. A full thickness muco-periosteal flap with mid crest mandibular and papillae sparing incisions distal to both canines was raised using microsurgical instrumentation (SM69 & SM67 blades, Swann Morton, UK), with periosteal release to mobilise the flap using microsurgical instrumentation (SM65 blade, Swann Morton, UK) (Fig. 6). Further meticulous curettage followed with both hand instruments and degranulation burs.

A deep narrow bony defect was noted labially with a smaller deep cleft coronally associated with the previous extracted tooth 41 (Fig. 7). An osteotomy was created using a sharp Inverta spade drill followed by a 3.7 mm twist drill (Southern Implants (PTY) Ltd, South Africa), to create an undersized Osteotomy within the original bony envelope for a Southern Inverta Deep Conical Co-Axis 12° 3.5 mm–4.5 mm implant (Southern Implants (PTY) Ltd, South Africa), a novel implant design with an inverted body shift and internal angle correction.

This implant system was originally designed for placement in the maxillary anterior region, with the inverted body shift design creating a wider diameter at the apical portion of the implant to help create high primary stability, whilst the smaller diameter cylindrical coronal portion reduces the facial-crestal gap distance [5–11]. However, these benefits can also be applied to immediate place-

8 I Southern Inverta Deep Conical 12° Co-Axis implant in its carrier prior to placement

9 I Implant position showing large buccal dehiscence with thread exposure but implant within original bony envelope

10 I Initial EthOss 0.5 cc placement prior to shaping

11 I EthOss shaped to cover exposed implant threads and adjacent bony defect. Note: not overbuilt

12 I Provisional crown fitted at 20 ncm to implant and flap repositioned tension free using 5.0 PTFE sutures (Omnia)

13 I Lingual screw channel occluded with SilverPlug (Silveraid), and Venus Flow (Kulzer)

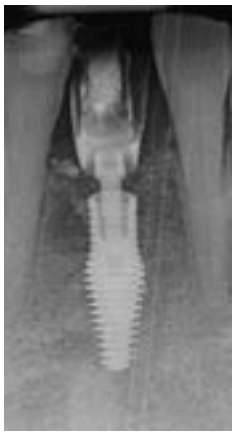
ments in the mandible, as is shown in this case (Fig. 8).

The implant was placed to the ideal position at 75 ncm, with excellent primary stability (Fig. 9). A 4 mm healing abutment was placed prior to site augmentation with a resorbable synthetic bone grafting material (Ethoss; Ethoss Regeneration Ltd, UK), a novel biphasic bone substitute consisting of ß-TCP (65 %) and calcium sulphate (CS, 35 %) (Fig. 10). 0.5 cc of the material was hydrated with 0.9 % sterile saline, mixed and partially dried, according to manufacturer's instructions and placed directly over the exposed implant threads and labial defect. Gentle pressure for 3–5 minutes with a piece of sterile gauze, "set" the material (Fig. 11). The tissue flap was repositioned and tacked with initial 5.0 PTFE sutures (Omnia S.r.l., Italy) (Fig. 12), prior to the healing abutment being removed and replaced by a Peek engaging cylinder to 20 ncm (Southern Implants (PTY) Ltd, South Africa).

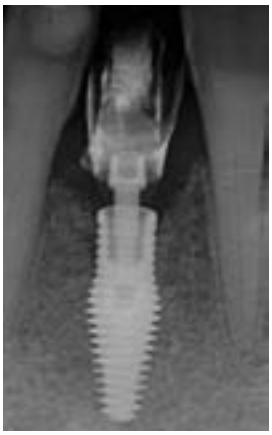
The PMMA shell provisional crown (BDT Ltd, UK), was positioned and attached to the PEEK cylinder using flowable, light curing composite resin (Venus Flow; Kulzer GmbH, Germany) (Fig. 13), followed by its removal, modification and finishing at chairside using polishing disks (Super-Snap; Shofu Dental GmbH, Germany). The healing abutment was replaced, and the patient relaxed during this procedure. The finished provisional crown was fitted to 20 ncm, with SilverPlug (Silveraid, Italy) followed by Venus Flow placed to occlude the lingual screw channel. Careful occlusal analysis ensured the crown was not in occlusion in either centric or excursive occlusal positions.

The patient followed the post-operative instructions regarding oral hygiene and a soft diet assiduously until review for suture removal at 14 days post-surgery. Excellent initial healing was observed (Fig. 14).

Due to the COVID-19 pandemic and UK lockdown restrictions, the patient was unable to attend for a further review for thirteen months. Via telephone consultation he reported no problems and at thirteen-month review the provisional implant restoration had assimilated well into the oral scheme and the patient was masticating his normal diet with normal function. A periapical radiograph showed no bone loss around the implant (Fig. 15). Probing depths were measured at ≤ 2 mm around the implant at tooth 31. Supra-gingival calculus was noted (Fig. 16), and oral-hygiene instruction and supra-gingival debridement was performed (Figs. 17 and 18) prior to the impression for the definitive screw-retained crown being scheduled.



14 I Periapical radiograph immediately post implant placement



15 I At thirteen-month review. Periapical radiograph showing no bone loss on the implant

16 I Minimal changes to attached gingivae associated with implant at tooth position 31, or repositioned flap

17 I Improved ridge width with minimal evidence of preoperative vertical gingival cleft at site 41 tooth

18 I After removal of supra-gingival calculus and oral hygiene instruction

At sixteen months post implant placement the impression was taken using a custom tray open at the 31, with a modified impression coping and machine mixed one-stage addition cured silicone impression material (Flexitime light and Flexitime Dynamix putty base, Kulzer GmbH, Germany). A custom screw retained crown abutment (Atlantis Crown Abutment, Dentsply Sirona, USA), was bonded at the laboratory with a monolythic zirconia crown, which was delivered to the mouth and fitted to 35 ncm. SilverPlug (Silveraid), and Venus Flow (Kulzer), were used to occlude the lingually placed screw channel (Figs. 19 to 23). A post fit periapical radiograph shows a well-fitting restoration with an ideal emergence profile (Fig. 24).

Discussion

This is the first example of this novel implant design being used in the anterior mandible and the case presents its use with a bioactive alloplastic ß-TCP and CS material, in an immediate placement and loading implant protocol.

The premise of the novel implant design features include that the innovative body-shift inverted morphology allows enhanced apical bone engagement for immediate loading, whilst the narrower coronal portion allows a chamber for the formation of endosteal bone labially by increasing both the jump gap distance and the space between the coronal labial implant shoulder and the labial cortical plate position.

The bioactive ß-TCP and CS combination produces a grafting substrate that self-hardens, with the CS having a barrier function, preventing soft-tissue ingress during the early phases of bone regeneration. The CS resorbs in a three-to-six-week window dependent of individual patient physiology, and as it resorbs, it creates interlinked porosities within the ß-TCP scaffold for angiogenesis.

The ß-TCP component resorbs over a 6–12 month period due to a combination of phagocytosis, hydrolysis and enzymic action. As both it and the CS are fully resorbable bone augmentation materials, host bone is regenerated without the presence of residual graft particles.

This case study shows amendments from the published protocol [2] where these materials are used in a delayed immediate procedure. Here, immediate placement and loading are used with simultaneous grafting for improved preservation of host hard tissue along with up-regulated host-regeneration [1].

19 I Immediately on removal of provisional crown showing healthy mature gingival collar and preservation of optimal soft tissue and ridge form

20 I From the labial showing the papillae

21 I The impression coping screwed into the implant

22 I The definitive crown, occlusal view

23 I The definitive crown, labial view

24 I Check periapical radiograph showing well-fitting restoration and the stable bone level sixteen months after implant placement and augmentation

The ß-TCP graft constituent shows both osteo-conductive, but also, osteo-inductive potential, which enhances host bone regeneration during the healing period. The self-hardening nature of the material meant graft stability whilst in contact with the host periosteum. The narrow chimney portion of the novel implant design with its internal angle correction allowed increased graft volume within the original bony envelope, facilitating ideal screw channel position for a screw-retained restoration without the use of ASCs with their associated deficits, or having to use a cement-retained solution with its associated issues.

For further reading regarding the science specific to bioactive calcium phosphates and their clinical applications, the readers may refer to papers published in previous issues of the EDI Journal and other international journals [1–4, 12–16].

To conclude, the use of this novel implant design in conjunction with immediate placement and loading and the use of a fully resorbable bioactive alloplastic graft material may have provided a synergistic result here, with a very successful outcome for this patient. It is essential that clinicians are well versed in the surgical procedures they employ and understand the specific properties and handling characteristics of the grafting protocols that they elect to use, so that they can optimise the biological mechanisms of host regeneration in each individual implant procedure, and improve both predictability and long-term success of their implant practice.

The references are available at www.teamwork-media.de/literatur

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