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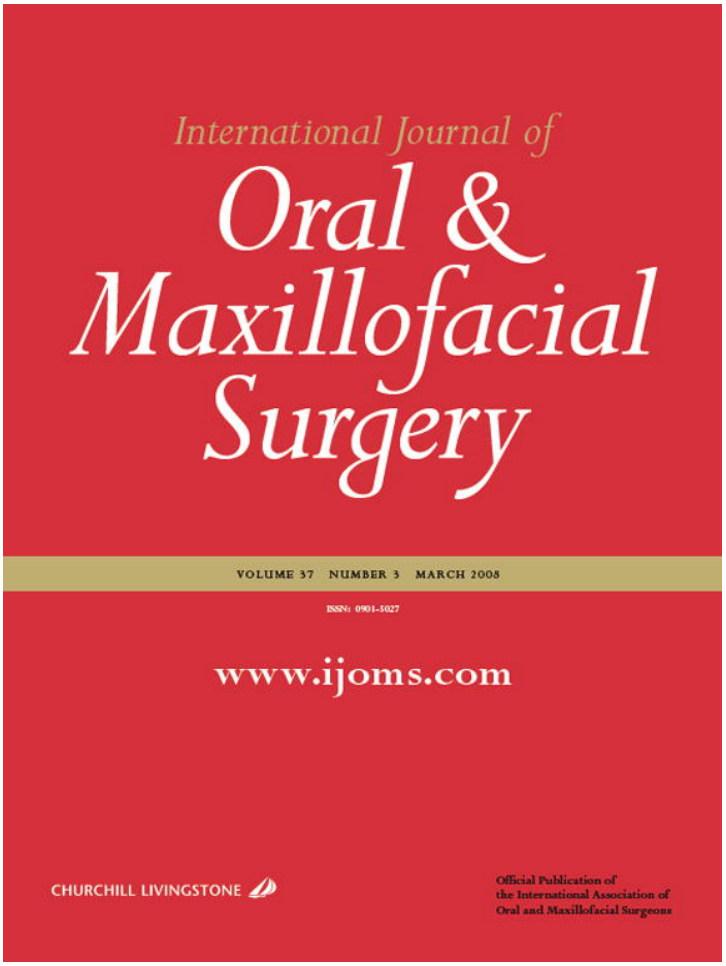

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Technical Note
Dental Implants

Immediate, non-submerged, root-analogue zirconia implant in single tooth replacement

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Abstract. This report demonstrates the successful clinical use of a modified root-analogue zirconia implant for immediate single tooth replacement. A right maxillary premolar was removed and a custom-made, root-analogue, roughened zirconia implant with macro-retentions in the interdental space was fabricated and placed into the extraction socket 4 days later. Four months after root implantation a composite crown was cemented. No complications occurred during the healing period. An excellent esthetic and functional result was achieved with the composite crown. No clinically noticeable bone resorption or soft-tissue recession was observed at 26 months follow up. Significant modifications such as macro-retentions seem to indicate that primary stability and excellent osseointegration of immediate root-analogue zirconia implants can be achieved, while preventing unesthetic bone resorption. The macro-retentions must be limited to the interdental space to avoid fracture of the thin buccal cortex. This successful case warrants further clinical research in well controlled trials.

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Replacement of lost teeth using oral implants is an accepted treatment modality with well documented, high long-term success rates of up to between 90% and 100% at 10-year follow up[10]. Originally, a healing period of 6-9 months was recommended before implant insertion (late implant placement). Later, earlier placement of implants after only 2-3 months was proposed (delayed implant placement), and more recently immediate implantation within a few days of tooth extraction has been performed clinically, but in highly selected cases only[11]. Results with shorter intervals between extraction and implantation are comparable to late implant placement. The major advantages of immediate implant placement are the decrease in treatment time with fewer surgical interventions leading to an improved quality of life and overall cost reduction, and less alveolar bone resorption and soft-tissue regression due to early functional load.

Hodosh and colleagues were the first to use custom-made root-analogue implants placed into the extraction socket, reducing bone and soft-tissue trauma[3]. Experimental studies with root-identical titanium implants yielded extremely favourable results with clear evidence of osseointegration and clinical stability[5,7]. The ensuing clinical trial resulted in 100% primary stability at insertion and 1-month follow up. Due to the high failure rate of 48% over the short time period of 9 months, this particular implant system was not recommended for clinical use[6].

The present authors selected root-identical implants with significant modifications by 1) using zirconia for its excellent biocompatibility and improved esthetic

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results; 2) adding micro-retentions to the entire root surface and macro-retentions strictly limited to the interdental space to get beyond primary stability and improve osseointegration; 3) reducing the diameter of the implant next to the thin cortical bone to avoid fracture and pressure-induced bone loss; and 4) choosing a single-stage implantation resulting in immediate, albeit limited, functional load via the crown stump for prevention of bone resorption.

Surgical method

A 63-year-old patient presented with a non-vital first maxillary right premolar with deep root caries and chronic apical paradontitis. Due to the extent of the root caries it was decided to remove the tooth and replace it with a custom-made root-identical zirconium implant. After informed consent was obtained, the first maxillary right premolar was carefully extracted under local anesthesia (Ultracain DS Forte, Aventis), avoiding any damage to the socket and soft tissue (Fig. 1a and b). The extraction socket and the area of the apical paradontitis were cleaned by means of curettage, and an iodoform-soaked cotton gaze was placed in the socket.

The root was laser scanned and macro-retentions were designed according to the study protocol, i.e. strictly limited to the interdental space only, sparing the buccal and lingual face, to prevent fractures at the time point of insertion of the thin cortical bone layer. In addition a crown stump was designed for later connection to the crown.

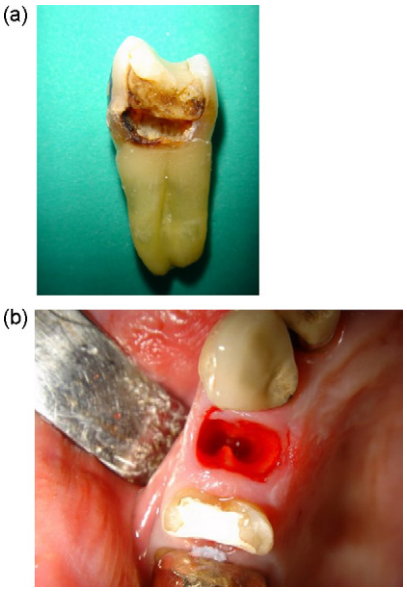

Fig. 1. (a) Extracted avital tooth with distal root caries. (1b) Extraction socket.

Fig. 2. Implant before insertion, and a copy of the extracted tooth with macro-retentions.

Fig. 3. Situation 4 months after implant placement, before crown reconstruction: buccal view.

The implant was then milled from a zirconium dioxide block (specifically, yttria-stabilized tetragonal zirconia polycrystal), and the surface roughened by sandblast and sintered for 8 h to achieve the desired mechanical properties (Fig. 2). Then the implant was cleaned in an ultrasonic bath containing 96% ethanol for 10 min, packaged and sterilized in a steam sterilizer.

On day 4 the iodoform cotton gaze was removed, and the alveolar socket again curetted and flushed with sterile physiologic saline solution. The custom-made individualized implant was then placed into the socket under finger pressure and subsequent gentle tapping with a hammer and a mallet (Fig. 3). Primary stability was achieved as checked by palpation and percussion. The patient received postoperative analgesics (Parkemed 500 mg, Pfizer) on demand and antibiotic medication (Augmentin 625 mg, GlaxoSmithKline) for 4 days. He was instructed to chew predominantly on the contralateral side and avoid hard food.

At the control visit 10 days later a clinically healthy marginal area was present, and no postoperative pain or swelling was reported. There was no bleeding or wound infection. After 4 months a composite crown was cemented. At 2-year follow up the patient presented with a stable implant, unchanged peri-implant marginal bone level as monitored by radiographs and soft-tissue parameters, and no bleeding on probing (Figs. 4 and 5). Hence, as well as an excellent esthetic result there were no signs of periodontitis or bone resorption.

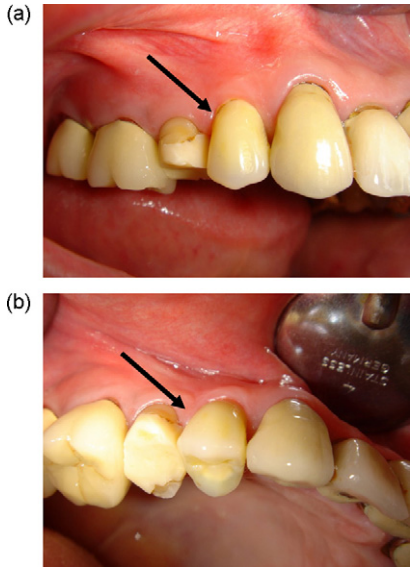

Fig. 4. Tooth replacement with crown at 2-year follow up: (a) buccal; (b) occlusal.

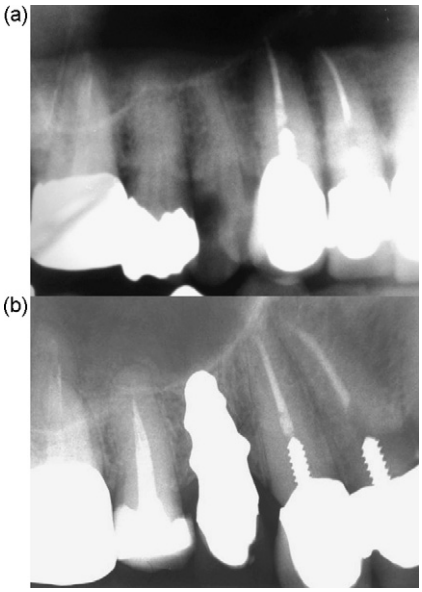

Fig. 5. (a) X-ray before extraction. (b) X-ray at 1-year follow up with the zirconium implant and crown *in situ*.

Discussion

This technical note describes successful dental root replacement with an individualized zirconia implant in a single patient.

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A tooth replica implant was reported as early as 1969, but the polymethacrylate tooth analogue was encapsulated by soft tissue rather than osseointegrated[3]. Lundgren and colleagues used titanium in an experimental model of immediate implant placement with bony integration in 88%[7]. A good fit between implant and the host bed has been described as an important factor for implant success[1,2,4]. For this reason, Kohal et al.[5] further refined the approach of root-analogue titanium implants by widening the coronal aspect of the implant to compensate for the lost periodontium and obtain good congruence between implant and extraction socket. In several instances implant insertion led to fractures of the thin buccal wall of the alveolar bone. An ensuing clinical study revealed excellent primary stability, with a highly disappointing failure rate of 48% at 9 months' follow up[6]. A perfect fit of the implant without any retentions might be responsible for the intermediate-term failure, because of the subsequent uniform pressure-induced resorption concerning the entire alveolar surface simultaneously. The present authors chose a significantly different approach, manufacturing root-analogue implants with macroretentions in the interdental space, an implant diameter reduction of 0.1 to 0.3 mm next to the buccal cortical bone, and a surface roughened by sandblast. Zirconia implants, which have been shown to osseointegrate to the same extent as titanium implants, were used to achieve better esthetic results[8,9]. The single-stage implant approach with a crown stump leads to an early functional load allowing for osseointegration while preventing bone resorption.

This case, which is part of a larger ongoing clinical trial, demonstrates that immediate placement of significantly modified, root-analogue, non-submerged zirconia implants yields excellent results superior to previously described custom-made root-analogue titanium implants with a uniform surface.

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