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CASE REPORT

Immediate, Non Submerged Root Analog Zirconia Implant in Single Rooted Tooth Replacement: Case Report with 2 years Follow Up

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Abstract This report demonstrates the clinical use of a modified, truly anatomic, root analogue zirconia implant for immediate replacement of a right mandibular first premolar. A 22-year-old female patient with chronic apical periodontitis of the right mandibular first premolar was referred and the tooth was carefully extracted. A truly anatomical, root identical, roughened zirconia implant modified by macro-retentions was manufactured and placed into the extraction socket by tapping 3 days later. After 4 months a composite crown was cemented in place. No complications occurred during the healing period. A good functional and aesthetic result was achieved with minimal bone resorption and soft tissue recession at 18 months follow-up. This report describes the successful clinical use of an immediate, single stage, truly anatomical root-analogue zirconia implant for replacement of a single rooted tooth. Significant modifications such as macro-retentions yielded primary stability and excellent osseointegration. This novel approach is minimally invasive, respects the underlying anatomy and aids socket prevention. In addition the procedure saves time and cost, has good patient acceptance as there is no need for osteotomy, sinus lift or bone augmentation.

Keywords Immediate implant · Zirconia implant · Root formed implant · Zirconia as material for dental implants

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Introduction

Replacement of lost teeth using oral implants is an accepted treatment modality with well documented, long-term success rates of 90–100 % at 10-year follow up. The time between extraction and implant placement varies from a few days (immediate) to several months (late). The main advantages of immediate implant\ placement are the decrease in treatment time and the reduction in the number of surgical interventions leading to improved quality of life for the patient and overall cost reduction [8]. Irreversible alveolar bone resorption and soft tissue regression are avoided or significantly reduced, owing to early, albeit limited, functional load. Over the past 40 years, screw- or cylinder-type implants have been used in most instances with no changes of the principle and only slight changes in design. The problem associated with immediate placement of these conventional implants is their incongruence with the extraction socket, necessitating the use of a barrier membrane and/or bone augmentation to prevent down growth of connective tissue or epithelium in between the implant and the socket. The problem of incongruency was tackled by the use of custom-made root-analogue implants [8]. The root identical implants were made using zirconia. Zirconia is known for its excellent biocompatibility, diminished plaque accumulation and improved aesthetic results (by preventing dark discoloration of the gum and display of titanium roots in case of gum recession). It has high compressive strength and bending forces, fracture toughness and high electrical resistance [6]. The root surface was modified in two ways, by adding micro-retentions to the entire root surface and limiting macro-retentive elevations to the interdental space. The implant diameter was reduced next to the thin cortical bone to avoid fracture and pressure-induced bone loss. A single stage

implantation was used, resulting in immediate with reduced, functional loading [8].

Case Report

A 22 year-old woman with root canal treated right mandibular first premolar with broken crown structure was referred to us (Fig. 1). After informed consent was obtained the right mandibular first premolar was carefully extracted under local anesthesia. The extraction socket was cleaned by curettage and iodoform- cotton gauze was placed in the fresh socket [8]. The extracted tooth was modified with light cured composite material to form post to receive crown afterwards. Macro retentions were designed on the root surface only on the mesial and distal surface with light cured flowable composite material. The modified root was laser scanned and a replica was then milled by CAD CAM technology (Ivoclar Vivadent-Zenostar) from a medical grade zirconia block (Ziecon by Jyoti Ceramic GmbH) (Fig. 2). The surface of zirconia implant was roughened by sandblasting and sintered for 8 h. The implant was cleaned in an ultrasonic bath containing 96 % ethanol for 10 min, packaged and steam sterilized. On day 3rd the iodoform cotton gauze was removed, the alveolar socket was again curetted and flushed with sterile physiological saline solution. The custom-made individualized implant was placed into the socket under finger pressure and subsequent gentle tapping with a hammer and a mallet [8] (Figs. 3, 4).

Primary stability was achieved as checked by palpation and percussion. The patient was instructed to chew predominantly on the contralateral side and avoid hard food on the implant side for 8 weeks. Patient was given Amoxicillin 500 mg tid and Ibuprofen 400 mg tid for 5 days postoperatively. The patient was also given betadine mouth rinse for 2 weeks postoperatively. No postoperative pain, swelling, or bruising was reported. Over the entire follow-up period a clinically healthy marginal area was present with no bleeding on probing or wound infection. After 4 months the definitive prosthetic restoration was performed in acrylic resin. At 18 months follow-up, the patient presented with a stable implant, unchanged peri-implant marginal bone level and complete apical peri-implant ossification with no signs of peri-implantitis as

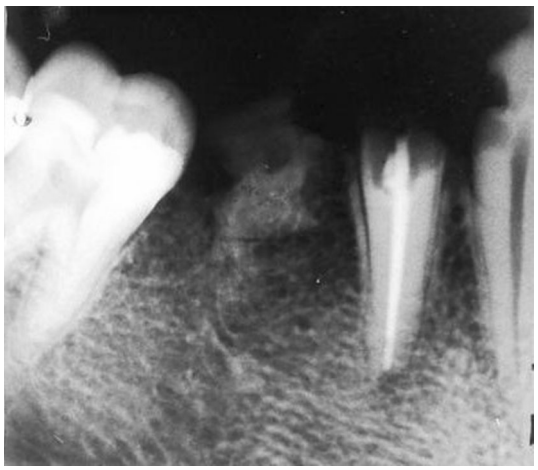

Fig. 1 Pre op radiograph

Fig. 3 Post op photograph

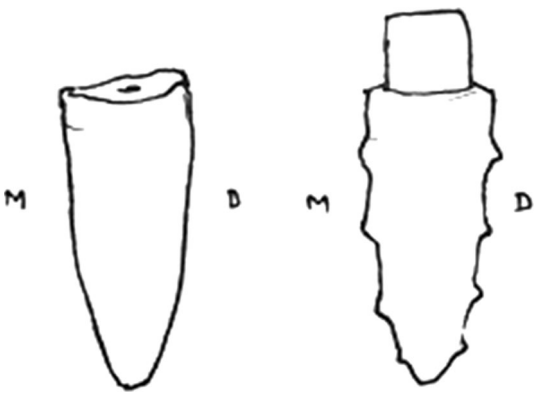

Fig. 2 Modifications made in zirconia implant

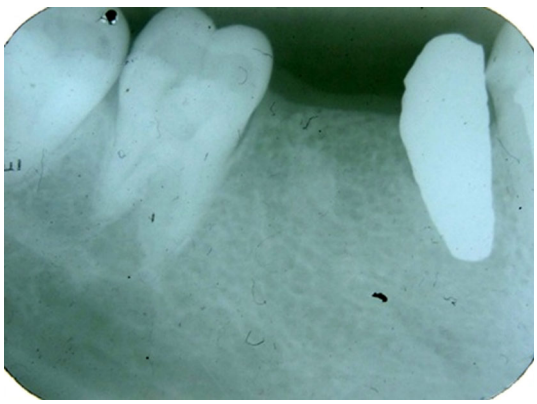

Fig. 4 Post op radiograph

Fig. 5 24 month post op photograph

monitored by radiographs and soft tissue parameters and no bleeding on probing (Fig. 5).

Discussion

The present report describes the successful immediate replacement of a single rooted tooth with an individualized single rooted zirconia implant. Significant modifications, including macro retentions limited to the interdental space and diameter reduction next to the thin cortical bone proved crucial in achieving osseointegration and stable implantation in the immediate zirconia replacement of single and multi rooted teeth [8].

The concept of replacing teeth with custom-made root-analogue implants is not new. In 1969 the use of a tooth replica implant was reported, however the auto polymerized and heat processed polymethacrylate utilized to fabricate the tooth analogue was encapsulated by soft tissue. Evidence of osseointegration was lacking [3].

Placement of dental implants has become an everyday treatment option for dental patients missing teeth. All implant systems used clinically involve screw-type threaded implants or cylindrical implants with limited resemblance to the native root.

In 1992, Lundgren et al. [7] reintroduced the idea of root-analogue implants. Titanium was utilized in an experimental model for immediate implant placement, leading to bony integration in 88 % of sites under study. A good fit between the implant and the host bed has been described as an important factor for implant success.

Kohal et al. [5] applied a refined approach to root-analogue titanium implants by widening the coronal aspect of the implant to compensate for the lost periodontium and to obtain good congruence between the implant and the extraction socket. But in several instances, implant insertion led to fractures of the thin buccal wall of the alveolar bone resulting in failures.

In recent years Zirconia has emerged as an alternative material to titanium for dental implant fabrication. Zirconia has been used to achieve better aesthetic results and has shown to have superior mechanical and chemical properties and superior plaque resistance than titanium. It has a high flexural strength and has better biocompatibility as compared to that of titanium. The osseointegration of zirconia is similar to that of titanium implants which has been demonstrated in several animal investigations [1, 6].

A rough surface topography expedites the bone integration process, so a root identical replica with a surface roughened by sandblasting was inserted by Kohal et al. They tested symmetrical sandblasted zirconia implants with titanium implants in the maxillae of 12 monkeys [4]. All implants achieved and maintained stability, and no mechanical problems were reported.

A perfect fit of the implant with no macro retentions leads to excellent primary stability, but it might be responsible for the early failure, because of the subsequent uniform pressure induced resorption of the alveolar surface. This resulted in a loosened interlock between the implant and bone. This prohibits secondary stability of a conical, root-analogue implant. For that reason, Pirker et al. [8] chose a novel approach of adding macro retentions of zirconia implants.

A cross-section of the jaws shows that there is only sufficient room for enlargements and retentions in the interdental space; the thin buccal and lingual layers do not allow for any enlargement of implants in this area. So Pirker et al. [8] manufactured root-analogue implants with macro-retentions in the interdental space (mesial and distal surfaces), an implant diameter reduction of 0.1–0.2 mm next to the thin cortical bone (labial and lingual surfaces) to avoid bone fracture. The surface was roughened by sandblasting to increase the surface area aiding bone cell attachment. A single stage implant approach with a crown stump was chosen leading to an early, reduced functional load [8]. Our results are similar to Pirker et al. [8].

There are several advantages to the approach described in the current report. The topography of the implant is similar to the topography of the root of the extracted tooth which eliminates the need for conventional bone drills and other traumatic preparatory procedures for implantation.

Zirconia is highly biocompatible and has the mechanical properties required to be a useful material for dental implants. The brittleness of zirconia, which is a problem in other applications such as bridges and crowns, is not a major problem in dental root implants because they are broad based, with a diameter well above 3 mm. Zirconia implants result in osseointegration comparable with that of titanium [2]. Taking into account the

outstanding aesthetic results with zirconia, this new biomaterial could replace titanium, especially in cases of visible dental rehabilitation. The immediate implantation of a root-analogue replica leads to instantaneous support of the soft tissue and limited functional load resulting in perfect socket prevention [8].

Conclusion

Even though the implants have to be custom-made, the costs do not exceed the expense of a conventional cylindrical implant. Zirconia is an inexpensive material and the production process can be performed by CAD/CAM technology. This novel approach could be an alternative method for replacing teeth immediately after extraction and will raise dental implantology to a new level of truly anatomic implants especially in developing countries. The successful clinical study reported here warrants further clinical research in well-controlled trials to evaluate the long-term success rate of root-analogue zirconia implants.

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