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Short (5 and 7 mm long) porous implants in the posterior atrophic mandible: a 5-year report of a prospective study

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Purpose: The aim of this ongoing prospective study was to determine the 5-year survival rate of short porous implants in the posterior atrophic mandible.
Materials and methods: In 40 partially edentulous patients, 55 short porous implants were placed. The implants used were of two lengths (5 and 7 mm) and two different diameters (4.1 and 5 mm) and were chosen according to the available crestal height and width. The unloaded healing period was 4 months. Twenty-one implants were restored with single crowns, 32 were splinted to the adjacent implant, 2 were used with an overdenture and were followed for 5 years. Outcome measures were prosthesis failures, implant failures and complications.
Results: No patients dropped out. Nine implants were removed: 1 implant at uncovering and 8 after prosthetic loading. Eight patients lost 1 implant and 1 patient lost 2 implants. Four crowns failed. No complications occurred during the healing period. In 2 patients severe peri-implantitis occurred after loading and the implants had to be removed. At the end of the follow-up period the survival rate was 84% at implant level and 80% at patient level.
Conclusions: The use of short porous implants showed an acceptable clinical outcome in the treatment of the posterior mandible in this interim 5-year report. These preliminary results must be confirmed by longer follow-ups.

Conflict-of-interest statement: *The authors declare no conflict of interest.*

Introduction

The use of dental implants is often the treatment of choice to replace missing teeth in partially edentulous patients[1], with good long-term results and predictability[2].

The bone in posterior mandibles can be resorbed, especially when periodontally involved teeth have been previously extracted or the patient has been edentulous for a long time. Available bone height over the mandibular canal, the position of lingual mandibular undercuts or the position of the mental foramen are often important limiting factors determining implant length. A radiographic study of partially edentulous subjects revealed that posterior available bone height is at least 6 mm in only 50% of the mandibles examined[3].

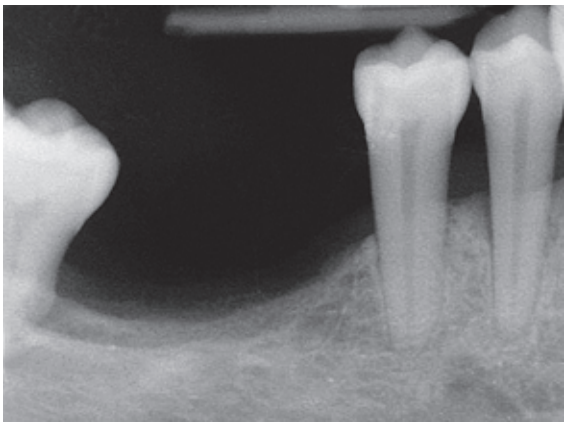

Fig 1 Case 1: partially edentulous right mandible in a periodontitis patient. Note the bone loss and proximity of the neurovascular bundle.

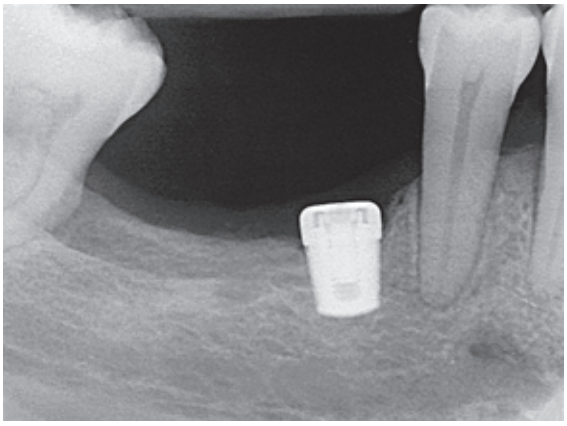

Fig 2 Case 1: a press-fit porous surface implant 5 × 5 mm is positioned and left to heal submerged.

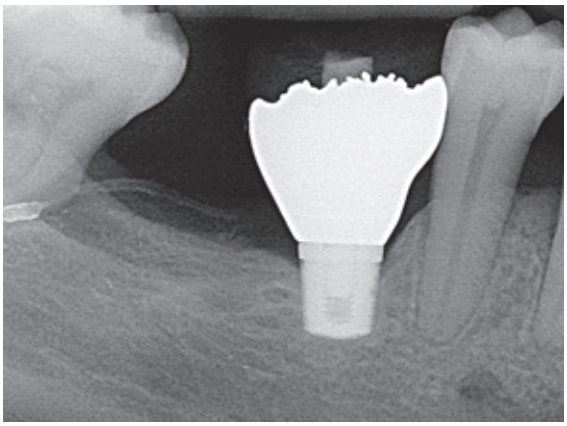

Fig 3 Case 1: radiograph at 5 years. The implant has been restored with a screw-retained crown. Crestal bone remodelling does not exceed the smooth collar of 1 mm.

Data from the literature suggests that when using implants with machined surfaces for the prosthetic rehabilitation of the posterior mandible, it is better to use at least 10 mm-long implants[4]. Various surgical techniques as well as new implant surfaces have been developed in attempts to improve the clinical outcome of short implants.

Vertical guided bone regeneration (GBR), alveolar distraction osteogenesis, onlay bone grafting, interpositional bone grafting and alveolar nerve transposition are currently used to vertically augment the posterior mandibular area[5-11]. These procedures have shown positive clinical results but are technique sensitive, associated with an increased morbidity related to complications, have higher costs and have an increased risk of infection[12-17].

Furthermore, the development of new implant surfaces offers the possibility of increasing the bone-implant contact area, providing successful long-term clinical results even with implants of reduced lengths and diameters[18]. One of these surfaces, the porous sintered implant surface (Endopore®, Innova, Toronto, Canada), encourages mechanical interlocking between the implant and the bone. This allows for three-dimensional bone interdigitation, resulting in an interface zone structure that is resistant not only to compressive and shear forces but also to interface tensile forces[19]. These implants have shown short- and long-term positive clinical results[20,21].

The objective of this prospective clinical study was to evaluate the use of short (5 and 7 mm long) porous-surface implants in the prosthetic rehabilitation of edentulous sites in the posterior mandible. The present article is reported according the STROBE GUIDELINES for observational studies (http://www.strobe-statement.org/).

■ Materials and methods

Any consecutive patient who presented with partial or total edentulism of the mandible and a residual bone height (as estimated on periapical radiographs) of at least 6 mm above the inferior alveolar canal requiring implants, who was 18 or older and able to sign and informed consent form was eligible for inclusion in this study. Forty patients took part in the study, 15 males and 25 females (a range of cases is illustrated in Figs 1–9). Patients were not admitted in the study if any of the following exclusion criteria were present:

- general contraindications to implant surgery
- subjected to irradiation in the head and neck area less than 1 year previously
- undergoing chemotherapy for a malignant tumour
- treated or under treatment with intravenous amino-bisphosphonates

- poor oral hygiene
- lack of motivation or periodontal disease
- uncontrolled diabetes
- pregnant or lactating
- substance abuse
- psychiatric problems or unrealistic expectations
- acute infection in the area intended for implant placement
- participating in other trials in which the present protocol could not be properly followed
- referred only for implant placement
- extraction sites with less than 3 months of healing.

Non-smokers and moderate smokers (less than 10 cigarettes per day) were included. Fifty-five press-fit implants (Endopore) were placed by four different surgeons. Patients were recruited and treated in 2005 in the same centre. MP and CS performed both surgical and prosthetic procedures, RA and GC performed only surgical procedures, using similar and standardised procedures.

Most of the implants were placed in the premolar/molar region of mandible. The initial measurements of the available bone height were recorded with digital radiography obtained using the paralleling technique by means of Rinn film holders. If there were any doubts, computerised tomography (CT) scans were obtained. All patients were treated under local anaesthesia using articaine with adrenaline 1:100,000. Prior to implant placement, a full thickness mucoperiosteal flap was elevated. Drills were used to prepare the osteotomies, sometimes together with a piezosurgery technique (Mectron Piezosurgery Device; Mectron, Carasco, Genoa, Italy), depending on the type of bone found. In particular, piezosurgery devices were used to initially prepare the osteomies or to correct them when working on the lateral bony walls, whereas drills were used after defining and correctly shaping the implant sites. After preparing the osteotomy, a 'trial'-fit gauge was used to verify the prepared site. Once the gauge was fully submerged with a tight-press fit, the surgeon could be certain that the implant would achieve the desired primary stability.

The implants used were of two lengths (5 mm long for crestal height 6 to 7 mm above the mandibular canal, and 7 mm long for the remaining cases) and two different diameters (4.1 and 5 mm),

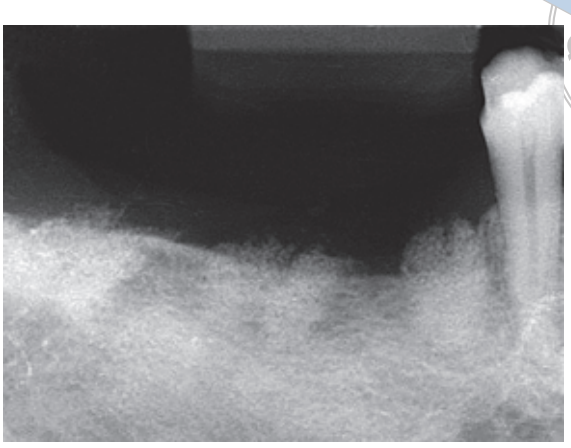

Fig 4 Case 2: preoperative radiograph. The second right premolar and both the molars have been extracted using a socket preservation technique.

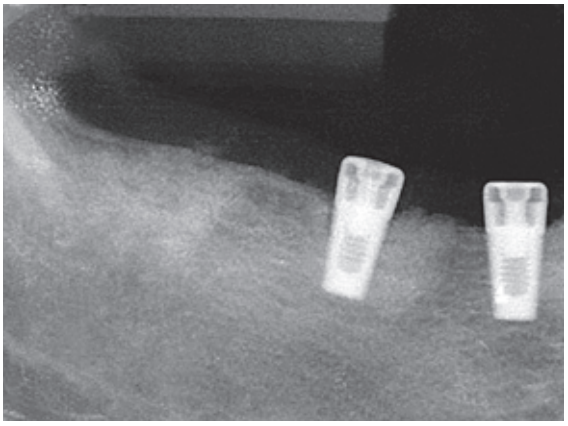

Fig 5 Case 2: radiograph at insertion of the healing caps. Two press-fit porous surface implants 4.1 × 7 mm were placed and uncovered after 4 months of submerged healing.

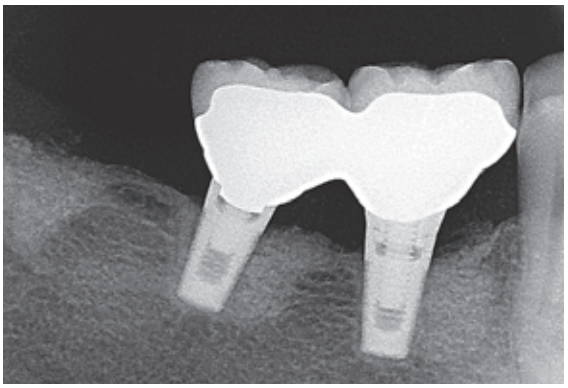

Fig 6 Case 2: radiograph at 5-year follow-up. Implants were splinted together and a definitive restoration was placed. Note the stability of the crestal bone.

Fig 7 Case 3: two implants (7 × 4.1 mm) loaded with a removable prosthesis. The distal one was affected by peri-implantitis and was removed. The prosthesis was still utilised by the patient.

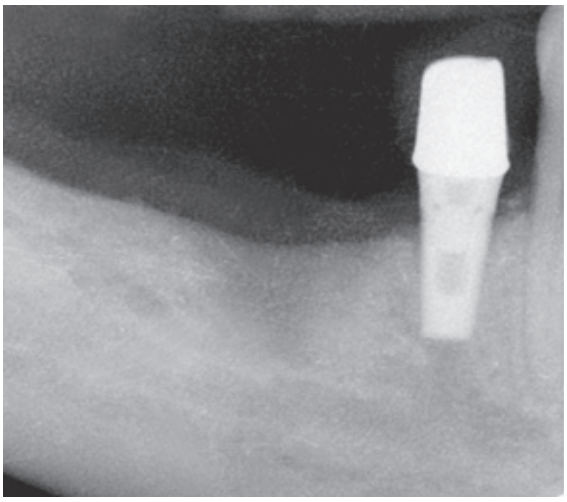

Fig 8 Case 4: post-loading radiograph. After 8 months of loading, the implant (4.1 x 7 mm) presented moderate peri-implantitis (the patient was a smoker).

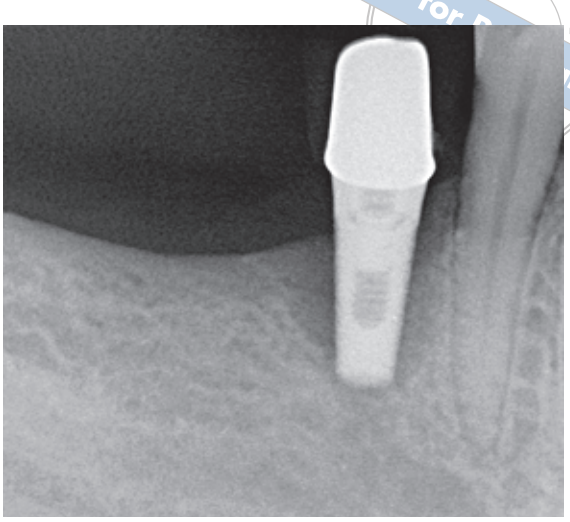

Fig 9 Case 4: after 2 years severe bone loss was present. The patient also presented infection and the implant was removed (resulting of course in prosthesis failure).

and were chosen according to the available crestal height and width. Implants were placed following a two-stage approach with the smooth collar submerged at the crestal level. After surgery, all patients received antibiotic therapy: 1 g of amoxicillin (or erythromycin 500 mg if allergic to penicillin) starting from the day of surgery, twice a day, for 5 days. Nimesulide 100 mg or ibuprofen 600 mg were prescribed to be taken twice a day for 2 or 3 days, as well as a chlorhexidine spray 3 times a day for 15 days. The submerged healing period was 4 months. The implants were then loaded with provisional acrylic resin single crowns (cemented or screw-retained) or splinted to the adjacent implant if present or loaded with an overdenture. After 6 months of loading, implants were manually tested for stability and definitive metal-ceramic restorations were placed. The stability of an individual implant was measured by applying a reverse torque of 25 Ncm at the delivery of provisional restorations (4 months after surgery) and 30 Ncm at the delivery of definitive restorations. Clinical and radiographic examinations were scheduled at 1, 6 and 12 months after crown insertion, then yearly. Patients were enrolled in an oral hygiene programme with recall visits every 4 months. The follow-up period for the implants reported in this study is 5 years after loading. Follow-up controls, data collection and analysis were performed by MP. Outcome measures were: prosthesis failures, implant failures and complications.

Table 1 Summary of the main results.

Patients	40 (25 females; 15 males)
Inserted implants	55
Drop-outs	0
Implant failures	9 (84%) (1 pre-loading) in 8 patients
Prosthesis failures	4 (single crowns)
Complications	2 (post-loading peri-implantitis)

■ Results

Forty-seven 4.1 × 7 mm, one 5 × 5 mm and seven 5 × 7 mm implants were placed. Nineteen implants were placed in the first premolar sites, 18 in second premolar sites, 24 in first molar sites and 7 implants in second molar sites. Twenty-one implants were loaded with single crowns, 29 were splinted to the adjacent implant and 4 were used to support removable prostheses.

Table 1 summarises the main results. All but one implant integrated successfully. This implant (4.1 × 7 mm) was positioned in a second premolar site and was removed at abutment connection 4 months after insertion with an uneventful healing period. Eight implants lost osseointegration after prosthetic loading and were removed. Four of them were loaded with single crowns, 3 were splinted to the adjacent

implant and 1 was used with an overdenture. In the 4 cases of single crowns, the prosthesis failed while in the remaining cases the prostheses could still be used without being replaced. One of the failed implants was 5 × 5 mm while the others were 4.1 × 7 mm. The remaining implants showed minimal crestal bone resorption, never exceeding the smooth collar of the implant (1 mm for the 5 mm-long implants, 2 mm for the 7 mm-long implants) as determined by the scheduled radiographic examinations.

No complications occurred during surgery or the healing period. Two patients presented acute infection and peri-implantitis before implant loss during the follow-up. Cumulative implant survival after 5 years was 84%. Eight patients (20%) lost 1 implant and one patient lost 2 implants.

Discussion

Various studies have shown the importance of the implant surface in achieving osseointegration and stability over time. Among various options, the sintered porous surface allows for a three-dimensional interlocking with bone[22,23], enabling resistance to the tensile and axial forces that are distributed along the implant. The bone in-growth between the pores provides more mechanical binding between implant and bone than conventional implant surfaces[24-27]. This can occur even when using 'short' implants. A recent definition for a 'short' endosseous dental implant is one that has a 'designed intrabony length' less or equal to 8 mm[18]. One of the most obvious indications for a short dental implant is the severely resorbed posterior mandible, where proximity to the mandibular neurovascular bundle may preclude the use of longer implants without more invasive and risky vertical bone augmentation or nerve lateralisation procedures.

Various randomised controlled clinical trials (RCTs) have compared implant success in augmented sites treated with 'conventional' length implants versus short implants in resorbed bone[28-32]. Considering different bone augmentation techniques, these studies showed higher failures and complications at augmented sites. In all of the patients in the present study, no vestibular or lingual implant dehiscence or episodes of paraesthesia or dysaesthesia were reported. However, it is interesting to observe that 2 implants failed due to peri-implantitis which may be more common and difficult to treat in the presence of very rough or porous surfaces[33].

The main limitation of this study is the small number of included patients. Prospective studies with more patients and longer follow-ups are needed to determine the long-term prognosis of short implants.

Conclusions

The use of short porous implants showed an acceptable clinical outcome in the treatment of the posterior mandible in this interim 5-year report. These preliminary results must be confirmed by longer follow-ups.

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