CLINICAL ORAL IMPLANTS RESEARCH

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Morse taper connection implants supporting "planned" maxillary and mandibular bar-retained overdentures: a 5-year prospective multicenter study

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Key words: bone quality, bone quantity, implant-supported overdentures, Morse taper connection implants, "planned" implant-supported maxillary overdentures

Abstract

Objectives: In contrast to the excellent long-term outcomes described for implant-supported mandibular overdentures, less favorable long-term survival and success rates have been reported for maxillary implants supporting overdentures. The aim of this study was to evaluate the treatment outcome of "planned" bar-retained maxillary and mandibular overdentures supported by Morse taper connection implants, investigating implant survival, peri-implant tissue health, marginal bone resorption and prosthetic complications.

Material and methods: Over a 2-year period, 60 patients were enrolled in this study, in four different clinical centers. The overdentures (maxilla 38, mandible 34) were planned with support from four implants anchored on a bar. A total of 288 Morse taper connection implants (Leone Implant System®) were inserted (152 maxilla, 136 mandible). Implants were evaluated 5 years after insertion. Success criteria included the absence of pain, suppuration or clinical mobility, the distance between implant shoulder and first crestal bone–implant contact (DIB) <2 mm and no exudate history.

Results: The overall 5-year implant survival rate was 98% (maxilla 97.4%, mandible 98.6%), with 282 implants still in function. Among these surviving implants, 278 (98.6%) were classified in the success group. At the 5-year examination, the mean DIB was 0.7 mm ($\pm$ 0.53). Few prosthetic complications were reported.

Conclusions: With "planned" bar-retained maxillary and mandibular overdentures supported by Morse taper connection implants, satisfactory survival and success rate can be achieved.

Edentulous patients often experience problems with their complete conventional dentures such as insufficient stability and pain during mastication, especially with regard to the mandibular denture (Feine et al. 2002; Mau et al. 2003). *Implant-supported overdentures* represent a good clinical alternative to conventional dentures in the edentulous jaws (Andreiotelli et al. 2010; Slot et al. 2010). Many of the problems reported by conventional complete denture wearers can be eliminated when implants are used to support removable dentures (Nahri et al. 2001). An implant overdenture provides stability of the prosthesis, and patients are able to reproduce a determined centric occlusion. The objective chewing ability with an overdenture is improved by 25% when compared with a complete denture (Bakke et al. 2002). Moreover, the maximum occlusal force of a denture patient may improve 300% with an implant-supported prosthesis (Sposetti et al. 1986).

Clinical follow-up studies have reported good and predictable mid-term and long-term treatment outcomes with implant-supported mandibular overdentures (van Steenberghe et al. 2001; Behneke et al. 2002; Heckmann et al. 2004; Zechner et al. 2004; Meijer et al. 2009; Andreiotelli et al. 2010; Vercruyssen et al. 2010). Although removable implant-supported prostheses in the mandible have been used with excellent long-term results, less favorable mid-term and long-term survival and success rates have been originally reported for maxillary implants supporting overdentures (Engquist et al. 1988; Jemt et al. 1996). Maxillary implants supporting an overdenture often show proportions of late failures of 5–15% (Smedberg et al. 1999; Kiener et al. 2001; Nahri et al. 2001; Mericske-Stern et al. 2002; Andreiotelli et al. 2010; Slot et al. 2010) or more (Widbom et al. 2005). The issue of complications with overdenture therapy was addressed in a retrospective

review bySchwartz-Arad et al. (2005), where 10-year outcomes suggested that more complications and implant failures occurred in the maxilla (83% survival) relative to the mandible (99.5% survival). These results were confirmed by a 10-year follow-up study of maxillary overdentures supported by six endosseous implants and a milled bar mesostructure, with an overall implant survival rate of 86.1% (Visser et al. 2009).

The reason for these results may be that *bone quantity* and *bone quality* are often more compromised in maxillary than in mandibular sites (Smedberg et al. 1993; Jemt et al. 1996). In particular, poor bone quality is an important risk factor for implant failure, as bone density seems to be of great importance not only in primary implant stability but also in the predictability of oral implant outcome (Esposito et al. 1998; Herrmann et al. 2005). Bone quality and bone volume as well as the type, the number and position of the implants are factors that influence loading conditions and may be associated with maxillary implant success and implant prosthodontic treatment outcome (Esposito et al. 1998).

Recently, several reports have introduced a distinction between ''planned'' and ''unplanned'' maxillary overdentures and found a better survival rate for planned cases (Palmqvist et al. 1994; Widbom et al. 2005; Sanna et al. 2009). An ''unplanned'' overdenture is an emergency situation, in which the placement of an insufficient number of implants and/or previous implant failures made a fixed full dental prosthesis an unfeasible option. A ''planned'' overdenture is, instead, the result of a sophisticated treatment planning protocol, including an accurate pre-operative radiographical assessment of the residual edentolous ridges, and the use of pre-defined operative criteria such as a minimum number implants with sufficient length and diameter, inserted with the correct position/inclination (Krennmair et al. 2008; Sanna et al. 2009). Schwartz et al. (1987a, 1987b) were the first to introduce the concept of using computerized tomography (CT) scans for pre-operative assessment of dental implants candidates. With CT pre-operative assessment of dental implant candidates, cross-sectional, axial and panoramic views are provided, giving detailed information of the residual jawbones volume in three dimensions (3D) (Stoppie et al. 2006). Moreover, with the introduction of interactive 3D reconstruction software, specifically designed for implant surgery, a precise assessment of bone quality (density) can be provided (Norton & Gamble 2001). At present, in order to give specific criteria for an accurate pre-operative treatment planning, a number of authors tried to make classifications of bone based on the Hounsfield values of the CT scan of the jaw before implant insertion (Stoppie et al. 2006). Misch (1999) defined bone categories from D1 to D5 with corresponding ranges >1250, 850–1250, 350–850, 150–350 and <150 Hounsfield units (HUs). More recently, Norton & Gamble (2001) have provided an objective and quantitative method by which to measure peri-implant bone density, with a new classification based on the HUs of the bone on the CT scan, and related it to the previous classification of Lekholm & Zarb (1985). In particular, they proposed four ranges of HU values: <0, 0–500, 500–850 and a final group >850 HU (Norton & Gamble 2001).

Many years ago, the principle of Morse taper implant–abutment connection was introduced in oral implantology. Morse taper implant–abutment connection is based on the principle of ''cold welding'' obtained by high contact pressure and frictional resistance between the surfaces of the implant and the abutment (Merz & Hunenbart 2000). The connection is called ''self-locking'' if the taper angle is <5°. Recent studies have clearly demonstrated that the Morse taper implant–abutment connection can resist eccentric loading complexes and bending moments, ensuring an absolute mechanical stability and significantly reducing the incidence of prosthetic complications at the implant–abutment interface (Merz & Hunenbart 2000; Bozkaya & Muftu 2003; Hansson 2003; Cehreli et al. 2004). Several clinical studies have indicated that the use of Morse taper connection implants represents a successful procedure for the rehabilitation of partially and completely edentulous arches, with excellent survival and success rates (Mangano & Bartolucci 2001; Doring et al. 2004; Weigl 2004; Mangano et al. 2009, 2010).

At present, stud and bar attachments are the two main systems for retention in implant-supported overdentures (Karabuda et al. 2008). The use of four implants connected with a bar seems to be the first choice in the maxilla, while the use of two to four splinted or unsplinted implants has been reported to be a feasible option in the mandible (Naert et al. 2004; Karabuda et al. 2008).

The aim of this 5-year multicenter prospective clinical study was to evaluate the treatment outcome of ''planned'' bar-supported maxillary and mandibular overdentures, investigating implant survival, peri-implant tissue health, marginal bone resorption and prosthetic complications.

Material and methods

Patient selection

Between December 2002 and December 2004, a total of 62 patients (40 males and 22 females) were selected to take part in this prospective clinical study, in four different clinical centers. Inclusion criteria were as follows: patients had to be edentulous in the maxilla or/and mandible with sufficient maxillary or/and mandibular bone volume to place implants at least 3.3 mm in diameter and 8 mm in length. In addition, patients had to be available for the entire duration of the study. The exclusion criteria were grafted or irradiated jaws, any systemic (such as uncontrolled diabetes) or neurological diseases that could potentially compromise implant surgery, and a heavy (more than 15 cigarettes per day) smoking habit. With regard to these criteria, 60 patients (38 males and 22 females, aged between 57 and 79 years, average 63.6 years) fulfilled the inclusion criteria, presenting no conditions listed in the exclusion criteria, and all these patients were enrolled in the study. Twenty-two of the patients were edentulous in the mandible, 26 patients were edentulous in the maxilla and 12 were fully edentulous (maxilla and mandible). All patients signed an informed consent form.

Surgical protocol

A complete examination of the oral hard and soft tissues was carried out for each patient. Pre-operative work-ups included an assessment of the edentulous ridges using casts and diagnostic wax-up. Panoramic radiographs formed the basis for the primary investigation. CT scans were used as the final investigation. CT datasets were transferred to a specific implant navigation software (Simplant®, Materialise, Leuven, Belgium), to perform a 3D reconstruction of the maxillary bones (Figs 1 and 2). Through this navigation software, it was possible to correctly assess the bone height and width at each implant site, the thickness of the cortical plates and the cancellous bone, as well as the ridge angulation; finally, in order to obtain a complete and reliable description of pre-operative jawbone condition, bone density was assessed by the amount of compact bone and dense trabecular bone, in accordance with Norton & Gamble (2001). Local anesthesia was obtained by infiltrating articaine 4% containing 1 : 100 adrenaline (Ubistesin®, 3M Espe, St. Paul, MN, USA). An extended crestal incision was made, with or without releasing incisions, and full-thickness flaps were elevated exposing the alveolar ridge. Four implants (Leone Implant System®, Sesto Fiorentino, Italy) were placed in each edentulous mandible and maxilla, amounting to a total of 288 implants inserted in a 2-year period (December 2002–December 2004) in four different clinical centers. The implant system used in this study (Leone Implant System®) is characterized by a self-locking connection between the fixture and the abutment due to a 1.5° angle Morse taper and an internal positional

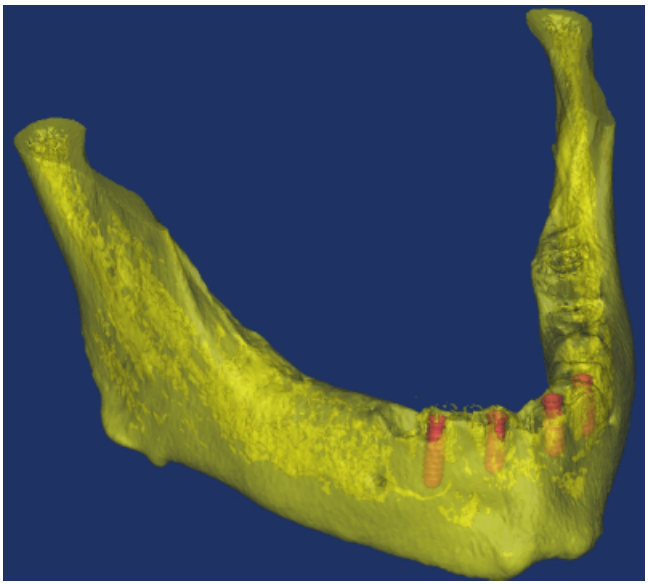

Fig. 1. Three-dimensional reconstruction of the mandible with virtual planning of implant placement.

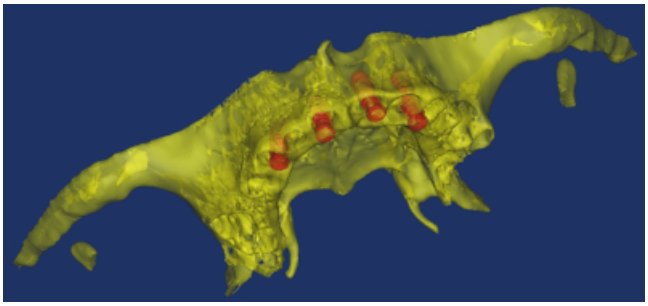

Fig. 2. Three-dimensional reconstruction of the maxilla with virtual planning of implant placement.

Fig. 3. Drawing of the Morse taper implant–abutment connection of the implant system (Leone Implant System®) used in this study.

hexagon (Fig. 3). The preparation of implant sites was carried out with spiral drills of an increasing diameter (2.8 mm to place an implant with 3.3 mm diameter; 2.8 and 3.5 mm to place an implant with 4.1 mm diameter; an additional 4.2 mm drill was used to prepare the site for 4.8 mm diameter implants), under constant irrigation. Implants were positioned at the bone crest level. In the mandible, 136 implants (34 patients) were inserted, in the mandibular lateral incisor and in the first premolar area. In the maxilla, 152 implants (38 patients) were inserted, in the maxillary lateral incisor and in the first premolar area. The most frequently used implant diameter was 4.1 mm (191 implants: 66.3%), followed, respectively, by 4.8 mm (67 implants: 23.2%) and 3.3 mm (30 implants: 10.5%). Implant length was 8 mm (six implants: 2%), 10 mm (64 implants: 22.2%), 12 mm (142 implants: 49.4%) and 14 mm (76 implants: 26.4%). The distribution of the implants by length and diameter was as shown in Table 1. The flaps were repositioned to cover the implants completely and were secured in position by interrupted sutures (Supramid®, Novaxa Spa., Milan, Italy). All patients received oral antibiotics, 2 g each day for 6 days (Augmentin®, Glaxo-Smithkline Beecham, Brentford, UK). Postoperative pain was controlled by administering 100 mg of Nimesulide (Aulin®, Roche Pharmaceutical, Basel, Switzerland) every

Table 1. **Implants distribution by length and diameter**

	8 mm	10 mm	12 mm	14 mm	
Maxilla					
3.3 mm	0	3	4	2	9
4.1 mm	2	24	64	15	105
4.8 mm	2	11	16	9	38
					152
Mandible					
3.3 mm	0	5	8	8	21
4.1 mm	2	13	42	29	86
4.8 mm	0	8	8	13	29
					136
Overall					
3.3 mm	0	8	12	10	30
4.1 mm	4	37	106	44	191
4.8 mm	2	19	24	22	67
	6	64	142	76	288

12 h for 2 days. Detailed oral hygiene instructions were provided, with mouth rinses with 0.12% chlorexidine (Chlorexidine®, OralB, Boston, MA, USA) administered for 7 days. Suture removal was performed at 8–10 days.

Healing period

A two-stage technique was used to place the implants. Implants were left submerged with a healing time of 3 months in the lower jaw and 4 months in the upper jaw. At the location of the submerged implants, ample space was left to allow for a partial relining with a tissue conditioner (Soft liner, GC Corporation, Tokyo, Japan), in order not to disturb the process of osseointegration of the implants. The patients wore their provisional complete dentures before returning for second-stage surgery. Second-stage surgery was conducted to gain access to the underlying implants. A mesio-distal crestal incision, limited to the implant site, was placed and the ridge mucosa was elevated to uncover the implant, and the healing abutment was inserted. The mucosal flap was adjusted to the healing abutment and then sutured in position. Again, a partial relining with a tissue conditioner (Soft liner, GC Corporation) was performed. Two weeks following second-stage surgery, the healing abutments were removed and pick-up impression posts were placed at the implant level. An impression was taken with a rigid impression material (Impregum, 3M Espe, Seefeld, Germany). From this impression, a master cast was poured, and a rigid gold bar was fabricated. The time lag between implant surgery and the delivery of the overdenture varied between 4 (mandible) and 5 (maxilla) months.

Attachment system

For all patients, the splinting suprastructures for the implants consisted of an egg-shaped Dolder gold bar (Cendres Metaux, Biel, Switzerland),

with or without extensions. All these bars were supported by four fixtures. After the fabrication of the bar, the implants were elongated with prefabricated titanium abutments, to the top of which gold copings were screwed. All overdentures had a horseshoe design and were fabricated with acrylic resin with a metal framework. Retention of the superstructure was ensured by several prefabricated gold clips (Cendres Metaux) (Figs 4 and 5). The same laboratory with technicians dedicated to this project, fabricated the bars and the overdentures (Fig. 6). All overdentures were carefully evaluated for proper occlusion and protrusion and laterotrusion were assessed on the articulator, and intraorally, to secure a balanced occlusion in centric relation without anterior tooth contact.

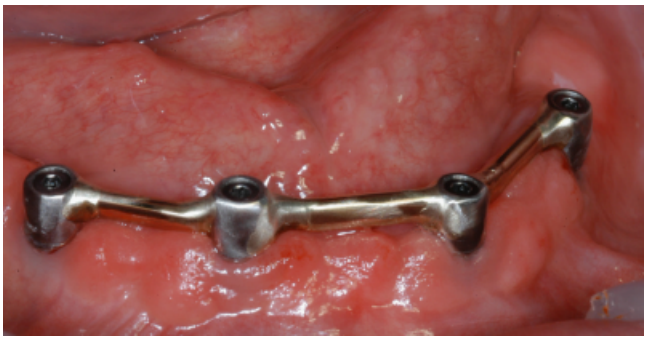

Fig. 4. The mandibular bars after application.

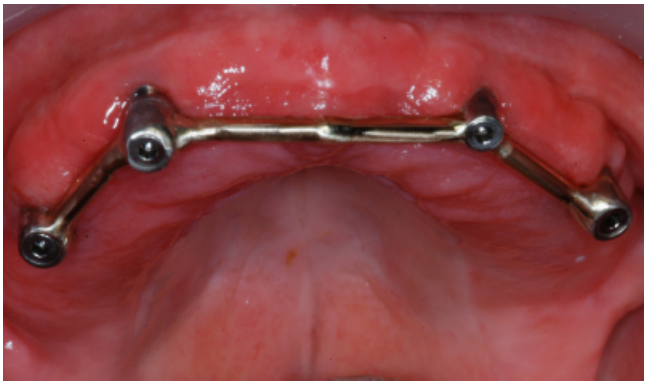

Fig. 5. The maxillary bars after application.

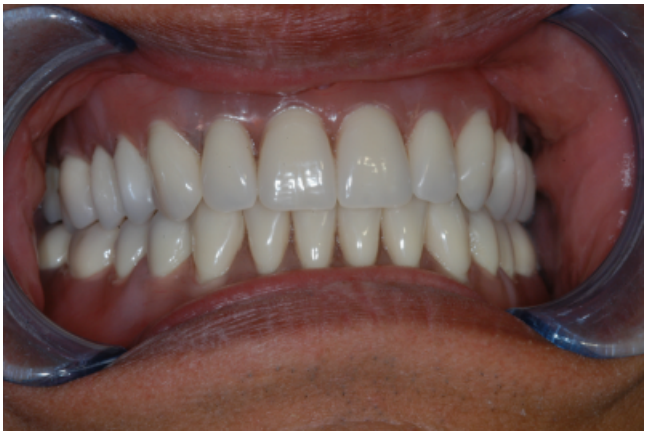

Fig. 6. The maxillary and mandibular bar-retained overdentures.

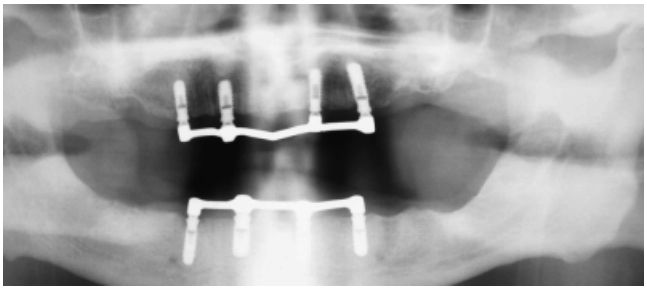

Fig. 7. The panoramic radiograph taken at the 5-year follow-up session.

Clinical and radiographic evaluation

For each single implant, at the 5-year scheduled follow-up session, the following clinical parameters were investigated:

- presence/absence of pain – sensitivity;
- presence/absence of suppuration – exudation;
- presence/absence of implant mobility, tested manually using the handles of two dental mirrors (Weber et al. 2000).

Panoramic radiographs were taken. Intraoral periapical radiographs were also taken for each implant, using a Rinn alignment system (Rinn®, Dentsply, Elgin, IL, USA) with a rigid film–object–X-ray source coupled to a beam-aiming device in order to achieve reproducible exposure geometry. Radiographs were taken at the baseline (immediately after implant insertion), at the 1-year and at the 5-year scheduled follow-up sessions (Fig. 7), for two purposes:

- to evaluate the presence/absence of continuous peri-implant radiolucencies;
- to measure the distance between the implant shoulder and the first visible bone contact (DIB) in millimeters, at the mesial and distal implant site (Smith & Zarb 1989).

For the second measurement, crestal bone-level changes were recorded as changes in the vertical dimension of the bone around the implant, so that an evaluation of peri-implant crestal bone stability was gained with time. In order to correct for dimensional distortion in the radiograph, the apparent dimension of each implant (directly measured on the radiograph) was compared (Weber et al. 2000) with the real implant length:

$$R_x \text{ implant length} : \text{Real implant length} = R_x \text{ defect} : \text{Real defect}$$

Implant survival, implant success criteria and prosthesis function

The evaluation of implant survival and implant success was performed according to modern clinical and radiographic parameters (Misch et al. 2008).

Implants were divided into two categories: ''survival'' and ''failed'' implants. An implant was classified as a ''survival implant'' when it was still in function at the last follow-up control session. Implant losses and implants presenting pain upon function or clinical mobility were all classified as failures. The conditions for which implant removal could be indicated included failure of osseointegration or infection, recurrent peri-implantitis, or implant loss due to mechanical overload.

Among ''survival'' implants, three different groups were distinguished:

Group 1: implant success (optimum health):

- absence of pain or tenderness upon function;
- absence of suppuration;
- absence of clinical mobility;
- DIB < 2 mm;
- no exudate history.

Group 2: satisfactory survival:

- absence of pain on function;
- absence of suppuration;
- absence of clinical mobility;
- DIB 2–4 mm;
- no exudates history.

Group 3: compromised survival:

- sensitivity on function;
- absence of clinical mobility;
- DIB > 4 mm;
- possible exudate history.

Finally, prosthesis function was assessed, and any prosthetic complications, such as implant/abutment loosening, bar/abutment gold screw loosening, bar fracture, retentive clips loosening or fracture, acrylic resin or tooth (denture) fracture were recorded.

Results

Implant survival

At the end of the study, the overall 5-year implant survival rate was 98%, with 282 implants still in function. Six implants failed and had to be removed. Five implants (three maxilla, two mandible) were classified as ''early failures,'' showing clinical mobility due to a lack of osseointegration or recurrent infections with pain and suppuration before the connection of the abutment. One single implant (maxilla) failed after 3 years of function. This ''late failure'' was attributed to progressive bone loss due to mechanical overloading without clinical signs of peri-implant infection. In the maxilla, the 5-year implant survival rate was 97.4%, with four fixtures removed. In the mandible, the 5-year implant survival rate was 98.6%, with two fixtures removed (Table 2).

Implant success

Two hundred and eighty-two implants were still in function at the end of the study. Among these, 278 (98.6%) were classified in the implant success group. None of these showed pain or clinical mobility, suppuration or exudation, with a DIB < 2 mm. Two implants (0.7%) placed in the maxilla were classified in the second group, among the satisfactory survival implants. These implants did not show any pain, clinical mobility, suppuration or exudation, but they had a DIB between 2 and 4 mm, associated with deep periodontal probing. Finally, two implants (0.7%) inserted in the maxilla had a history of exudation, with some sensitivity on function. These implants were placed in the third group, compromised survival.

The overall radiographic evaluation of the implants revealed a mean distance from the implant shoulder to the first crestal bone-to-implant contact (DIB) of 0.56 ± 0.37 mm at the 1-year examination. At the 5-year examination, the bone level of the fixture was situated 0.70 ± 0.53 mm from the reference point. Minimal changes were seen in the bone level between the 1- and 5-year examinations (Table 3).

Table 2. **Distribution of the implants and related failures, *n* (%)**

Maxilla	
Implants	152
Early failures	3 (1.9%)
Late failures	1 (0.6%)
Mandible	
Implants	136
Early failures	2 (1.4%)
Late failures	0 (0%)
Overall	
Implants	288
Early failures	5 (1.7%)
Late failures	1 (0.3%)

Prosthetic complications

No implant/abutment disconnection was registered. All the prosthetic complications related to the weakness of the anchorage components used for connecting the bar to the prosthetic framework (denture). Twelve clip loosening and two clip fractures were encountered and in three patients with mandibular overdentures a fracture of an extension of the gold bar occurred; in four patients, acrylic resin or tooth fracture was recorded (Table 4).

Discussion

In contrast to the excellent long-term implant and prosthodontic survival and success rates for implant-supported mandibular overdentures (van Steenberghe et al. 2001; Behneke et al. 2002; Heckmann et al. 2004; Zechner et al. 2004; Meijer et al. 2009; Andreiotelli et al. 2010; Vercruyssen et al. 2010), several studies have described a higher number of implant failures and prosthodontic complications for implant-supported maxillary overdentures (Engquist et al. 1988; Jemt et al. 1996; Smedberg et al. 1999; Kiener et al. 2001; Nahri et al. 2001; Mericske-Stern et al. 2002; Widbom et al. 2005; Schwartz-Arad et al. 2005; Visser et al. 2009; Andreiotelli et al. 2010; Slot et al. 2010).

These results could possibly be related to poor bone quality or short implants inserted in severely resorbed maxillae (Smedberg et al. 1993; Jemt et al. 1996). Poor bone quality, low bone quantity, short implant length with reduced diameter and poor initial stability are potential problems encountered in the edentulous maxillae, and may be responsible for a higher risk of implant loss and loss of maxillary overdentures (Herrmann et al. 2005; Krennmair et al. 2008).

Table 3. **Detailed data of bone crest remodeling (DIB) of 288 implants evaluated in the study, in mm**

Year	Mean	SD	SEM	Median	CI (95%)
1	0.56	0.37	0.02	0.50	0.52–0.61
5	0.70	0.53	0.03	0.60	0.64–0.76

Table 4. **Distribution of prosthetic and technical complications**

Mechanical problems	Occurrence	No. of jaws
Clip loosening	Once	7
	Twice	1
	Three times	1
Clip fracture	Once	2
Acrylic resin fracture	Once	2
Acrylic tooth fracture	Once	2
Bar fracture	Once	3
Loose screw: gold/abutment		0
Implant/abutment loosening		0

Recent evidence suggests that ''planned'' implant placement for maxillary overdenture treatment has a better outcome than emergency procedures (Ferrigno et al. 2002). A recent study of ''planned'' *implant-supported maxillary overdentures* has shown a cumulative 5-year survival rate higher than 98% with four implants placed in the maxillary anterior region anchored on a milled bar (Krennmair et al. 2008). In this work, the authors have also demonstrated that implant placement in the posterior maxillary region for overdenture anchoring may guarantee an excellent survival rate even after sinus augmentation (Krennmair et al. 2008). Because of the extended bone resorption of the anterior maxillary ridge, maxillary implants can be limited with respect to length and diameter, and the anterior maxilla is often associated with the use of short implants. Widbom et al. (2005) and Mericske-Stern et al. (2002) have found a high prevalence of loosening of short maxillary anterior implants supporting maxillary overdentures. Instead of placement of short implants, with a higher risk for loosening in the anterior maxillary region, a ''planned'' placement in the augmented maxillary posterior regions could be beneficial (Krennmair et al. 2008). In another ''planned'' study, Sanna et al. (2009) showed a good outcome with four to six interconnected implants supporting an overdenture in the maxilla, with a cumulative survival rate of the supporting implants of 99.3% after 10 years of function These studies demonstrate that the use of a minimum number of four implants of sufficient length and diameter, in combination with grafting techniques, as well as a careful preoperative planning of implant placement, with an accurate study of bone quality and quantity, can result in high survival and success rates of maxillary implants supporting overdentures (Ferrigno et al. 2002; Krennmair et al. 2008). Our 5-year ''planned'' study on 288 Morse taper connection implants seems to confirm these results, and the importance of the 3D pre-operative planning of implant placement, with an overall 98% implant survival rate (97.4% maxilla, 98.6% mandible) and only six failed implants (four maxilla, two mandible). Few differences were found between the maxilla and mandible, as high implant survival rate was achieved in maxillary sites, even those with low trabecular density, if an adequate volume of bone existed to accommodate the implants. Among all the surviving implants, a 98.6% implant success rate was seen, with an excellent peri-implant tissue health, confirmed by a mean DIB of 0.56 ± 0.37 and 0.70 ± 0.53 mm from the reference point at the 1-year and at the 5-year examination, respectively. Minimal changes were seen in the bone level between the 1- and 5-year examinations. Recently, Heckmann et al. (2006) have suggested that micro-movements at the implant–abutment interface could represent a detrimental factor for bone tissue stability around implants, leading to bone resorption. This mechanism still has to be elucidated, but the use of Morse taper connection implants, due to the excellent stability of the connection between the implant and the abutment (Bozkaya & Muftu 2003; Hansson 2003), can avoid micro-movements, preventing crestal bone loss around implants. Moreover, it has been advocated that a micro-gap of variable dimensions (40–100 μm) at the implant–abutment interface with a screw-type implant–abutment connection may be associated with peri-implant inflammatory cell accumulation and peri-implant bone loss (Orsini et al. 2000; Broggini et al. 2003). In fact, this micro-gap is colonized by bacteria capable of penetrating inside the internal hollow portion of the implant (Piattelli et al. 2003) leading to the development of peri-implant inflammation and subsequent bone loss (Jansen et al. 1997). Again, if the absence of an implant–abutment micro-gap is associated with reduced peri-implant inflammation and minimal bone loss (Gross et al. 1999), the Morse taper implant–abutment connection, significantly reducing the micro-gap to 1–3 μm at the implant–abutment interface, could provide a more efficient seal against microbial penetration (Dibart et al. 2005). Moreover, with Morse taper connection implants, the abutment emergence geometry provides the advantages of platform switching (Gadhia & Holt 2003; Lazzara & Porter 2006) by increasing the distance between the micro-gap and the bone crest level. This is a very important aspect, as bacteria are more distant from the bone and it is possible to minimize bone loss (Baumgarten et al. 2005; Guirado et al. 2007; Vigolo & Givani 2009). Platform switching also guarantees excellent soft-tissue healing, with a thicker and larger, well-organized volume of peri-implant soft tissue. This transmucosal seal can protect bone crest from resorption (Rompen et al. 2006). No prosthetic complications at the implant–abutment interface (such as abutment loosening or fractures) were seen. This result is in accordance with previous studies on Morse taper connection implants (Mangano & Bartolucci 2001; Doring et al. 2004; Weigl 2004; Mangano et al. 2009, 2010) where the excellent stability of the connection between the implant and the abutment contributed to a very limited number of complications, all related to the suprastructure and to the retention system.

Conclusions

Because of the complexity of overdenture therapy, careful treatment planning is mandatory to improve treatment outcome. An accurate study of bone quantity and quality, as well as the use of pre-defined criteria (such as minimum implant number, length and diameter) are key factors for achieving successful outcomes in a ''planned'' overdenture protocol. In this study on Morse taper connection implants, with a ''planned'' overdenture treatment protocol, minimal differences in the survival rate were found between maxillary (97.4%) and mandibular (98.6%) implants, in a 5-year period after implant placement. Based on these results and within the limits of this study, it can be concluded that, with a ''planned'' treatment protocol, the predictability of overdenture treatment can be satisfactory both in the maxilla and in the mandible.

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