Prospective clinical evaluation of 1920 Morse taper connection implants: results after 4 years of functional loading

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Key words: endosseous implants, implant–abutment connection, microgap, Morse taper connection implants

Abstract
Purpose: This study evaluated the survival rate and the clinical, radiographic and prosthetic success of 1920 Morse taper connection implants.

Material and methods: One thousand nine hundred and twenty Morse taper connection implants were inserted in 689 consecutive patients, from January 2003 until December 2006. Implants were clinically and radiographically evaluated at 12, 24, 36 and 48 months after insertion (mean follow-up per implant: 25.42 months). Modified plaque index (mPI), modified sulcus bleeding index, probing depth (PD) and the distance between implant shoulder and first crestal bone–implant contact (DIB) were measured in mm. Success criteria included the absence of suppuration and clinically detectable implant mobility, PD \( \leq 5 \) mm, DIB \( \leq 1.5 \) mm after 12 months of functional loading and not exceeding 0.2 mm for each following year, the absence of recurrent prosthetic complications at the implant–abutment interface. Prosthetic restorations were fixed partial prostheses (364 units), single crowns (SCs: 307 units), fixed full-arch prostheses (53 units) and overdentures (67 units).

Results: The overall cumulative implant survival rate was 97.56% (96.12% in the maxilla and 98.91% in the mandible). The cumulative implant success rate was 96.61% (95.25% in the maxilla and 98.64% in the mandible). Only a few prosthetic complications were reported (0.65% of loosening at implant–abutment interface in SCs).

Conclusion: The use of Morse taper connection implants represents a successful procedure for the rehabilitation of partially and completely edentulous arches. The absence of an implant–abutment interface (microgap) is associated with minimal crestal bone loss. The high mechanical stability significantly reduces prosthetic complications.

Implant dentistry is a valid and predictable treatment option for the rehabilitation of partially and completely edentulous arches. More than 30 years of evidence involving the clinical use of endosseous implants has shown excellent long-term results [Albrektsson 1988]. Implants have been shown to have a predictable success in both maxillary arches, in conjunction with full-arch, partial-arch and single-tooth restorations [Adell et al. 1990; Creugers et al. 2000; Naert et al. 2001]. The success of the implant treatment depends on many factors affecting the bone–implant, implant–abutment and abutment–prosthesis interfaces [Geng et al. 2001]. While the high rate of success of dental implants is an accepted clinical reality, many reports of a high incidence of mechanical complications, such as abutment and occlusal screw loosening, have been published [Kallus & Bessing 1994; Binon 1995; Balshi et al. 2000].
A major difference between implant systems is the type of implant–abutment connection [Bozkaya & Muftu 2003]. At present, the most commonly used methods for securing the abutment to the implant involve screw type connections. In these systems, the connection between the implant and the abutment depends on the screw preload, which is generated by applying a predetermined amount of torque during installation. When occlusal loads exceed the preload, mechanical complications such as screw loosening or creep deformation at the screw–implant interface can occur [Merz & Hunenbart 2000]. Implants featuring external hexagon at the connection with the abutment seem to be especially prone to screw loosening, because all the external force components are concentrated mainly on the abutment screw. Typically, a high incidence screw loosening of up to 40% was found for this type of abutment connection in the posterior areas of the mandible [Jemt et al. 1991; Becker & Becker 1995]. Walton reported a screw-loosening rate of 27% for fixed prosthesis and 32% for mobile prosthesis [Walton & MacEntee 1997]. In a 5-year study, Behr et al. 1998 evidenced a high percentage of screw loosening using external hexagon at implant-abutment connection. In a 3-year study on single-tooth implant supported restorations, Ekfeldt et al. [1994] showed a high percentage of abutment screw loosening (43%). Higher percentage of prosthetic complications generally affect single-tooth restorations, in particular in the posterior regions of both maxillary, for this reason, screw-loosening percentages have been described in the literature between 6% and 48% (Schwarz 2000). These complications represent a significant problem for both clinicians and patients and result in additional costs. Implant manufacturers have attempted to overcome these mechanical problems by incorporating different systems, using internal hexagons and octagons, combination of screws and frictional systems such as tapered interference fit (also called Morse taper). The tapered interference fit relies on the large contact pressure and frictional resistance in the region of the implant abutment interface, to provide a secure connection. Levine et al. [1999] reported a lower rate of abutment loosening (3.6–5.3%) with conical implant–abutment connections, restoring single-tooth replacements with cemented crowns. Sutter et al. [1993] proposed a taper connection, between implant and abutment as an optimal combination of predictable vertical positioning and self-locking characteristics. Similar results were reported by Norton [1999] and Felton [1999], who showed that the incorporation of conical connections between implant and abutment dramatically enhanced the ability of the system to resist bending forces. To date, experiences published by Muftu & Chapman [1998] and Morgan & Chapman [1999] seem to confirm that, when the tapered interference fits are used, the abutment loosening is a lesser problem.

The aim of this study was to evaluate the survival and the clinical, radiographic and prosthetic success of a new implant system (Leone Implant System®) with a Morse taper implant–abutment connection, in different clinical applications, such as fixed partial prostheses (FFPs), single crowns (SCs), fixed full-arch prostheses (FFAs) and bar-supported overdentures (ODs).

Material and methods

Patient selection

Between January 2003 and December 2006, a total of 705 patients, 386 males and 319 females, were subsequently taken into consideration, in six different clinical centres, to take part in our prospective clinical study. Inclusion criteria were adequate bone height and width, to place an implant of at least 3.3 mm in diameter and 8 mm in length. Exclusion criteria consisted of poor oral hygiene, active periodontal infections, uncontrolled diabetes, bruxism, heavy smoking habit (more than 10 cigarettes/day). With regard to all these criteria, 16 patients could not take part in the study (four for inadequate bone height and width, four for poor oral hygiene, four for active periodontal infections, one for bruxism, three for heavy smoking habit). Six hundred and eighty-nine patients (376 males and 313 females, aged between 25 and 76 years; average: 51.4 years), on the contrary, fulfilled the inclusion criteria, presenting no conditions listed in the exclusion criteria. For this reason, all these patients were enrolled in this prospective clinical study, in six different centers, and were treated with 1920 implants (Leone Implant System®, Florence, Italy). The most frequent indication was the restoration of partially edentulous patients (921 implants), while the least frequent indication was the treatment of single-tooth gaps (307 implants). A total of 692 implants were inserted to restore fully edentulous patients. Twenty-four patients had multiple indications for implant therapy, such as single-tooth gap on one side and multiple gap on the contralateral side. All the patients signed an informed consent form.

Pre-operative work-up

A complete examination of the oral hard and soft tissues was carried out for each patient. Panoramic radiographs formed the basis for the primary investigation. Pre-operative work-ups included an assessment of the edentulous ridges using casts and diagnostic wax-up. Where necessary, computed tomography (CT) scans were used as the final investigation. CT datasets were acquired using a modern cone beam scanner (i-Cat®, Imaging Sciences International, Hartfield, PA, USA) and then transferred in the DICOM format to a specific implant navigation software (Simplant®, Materialise, Leuven, Belgium) to perform a three-dimensional reconstruction of the maxillary bones. With this navigation software, it was possible to correctly assess the width of each implant site, the thickness and the density of the cortical plates and the cancellous bone, as well as the ridge angulation. On the basis of these informations, surgical templates (Surgiguide®, Materialise) were manufactured.

Implant placement

Local anaesthesia was obtained by infiltrating articaine 4% containing 1:100,000 adrenaline (Ubistesin®, 3M Espe, St Paul, MN, USA). A midcrestal incision was made at the sites of implant placement. The mesial and the distal aspects of the crestal incision were connected to two releasing incisions. Full-thickness flaps were reflected exposing the alveolar ridge, and preparation of implant sites was carried out with spiral drills of 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. A total of 822 implants (42.81%) were inserted in the maxilla, while 1098 implants (57.18%) were inserted in the mandible. Two hundred sixty-six implants (13.85%) were placed in the maxillary anterior region, 556 implants (28.95%) were placed in the maxillary posterior region, 259 (13.48%) implants were placed in the mandibular anterior region and 839 (43.69%) in the mandibular posterior region. The distribution of implants by length and diameter was in accordance with Table 1. The most frequently used implant diameter was 4.1 mm, with 898 implants (45.2%), followed by 4.8 mm, with 620 implants (34.89%), and 3.3 mm, with 402 implants (19.91%). Despite the implant diameter, the most frequently inserted implants were 12 mm long (697), 10 mm long (532) and 14 mm long (502), while 8-mm-long (199) implants were the least used. Finally, sutures were performed [SupramidR; Novaxa Spa, Milan, Italy].

### Post-operative treatment

All the patients received oral antibiotics, 2 g each day for 6 days [AugmentinR; Glaxo-Smithkline Beecham, Brentford, UK]. Post-operative pain was controlled by administering 100 mg nimesulide (Au-UK). Post-operative pain was controlled by administering 100 mg nimesulide (AugmentinR; Glaxo-Smithkline Beecham, Brentford, UK). Healing period

A two-stage technique was used to place the implants [Branemark et al. 1969]. The healing time was 3 months in the lower jaw and 5 months in the upper jaw. All the patients were requested not to wear their partial or complete dentures for 2 weeks post-surgery, after which the dentures were modified and lined with a tissue conditioner over the implant site. Second-stage surgery was conducted to gain access to the underlying implants and healing abutments were placed. Acrylic resin provisional restorations were used to monitor implant stability under a progressive load and to obtain good soft tissue healing around the implant before fabrication of the definitive restorations. The temporary restorations remained in situ for 3 months, and after this period, definitive restorations were placed. The prosthetic restorations comprised 364 FPPs, 307 SCs, 53 FFAs and 67 bar supported ODs. SCs, FPPs and full-arch prostheses were ceramo-metallic; the ODs were fabricated with acrylic resin with a metal framework. The ODs were fabricated with bone retention systems, and were supported by four implants. SCs, fixed partial and full-arch prostheses were cemented with zinc oxyphosphate cement or zinc–eugenol oxide cement.

### Implant evaluation

At the follow-up sessions, scheduled for 12, 24, 36 and 48 months after implant insertion, the following clinical parameters (primary and secondary endpoints of the study) were investigated.

**Primary endpoints:**

- the presence or absence of pain or suppuration [Buser et al. 1990b];
- the presence or absence of implant mobility tested manually using the handles of two dental mirrors [Weber et al. 2000];
- probing depth (PD) in mm, measured using a periodontal probe [PGF-GFSR];
- Hu-Friedy, Chicago, IL, USA] at the same surfaces. For each implant, the PD value was calculated based on the average of the four obtained values [Buser et al. 1990a];
- the distance between the implant shoulder and the first visible bone contact (DIB) in millimeters [Smith & Zarb 1989]. To perform this evaluation, introral periapical radiographs were taken for each implant, using a Rinn alignment system [RinnR; Dentsply, Elgin, IL, USA] with a rigid film-object X-ray source being coupled to a beam-aiming device in order to achieve reproducible exposure geometry, at the baseline [immediately after implant insertion] and at the follow-up sessions (12, 24, 36 and 48 months after implant insertion). With these values, crestal bone level changes were registered as modifications in the distance from the implant shoulder to the bone level on the mesial and distal implant side. In order to correct dimensional distortion, the apparent dimension of each implant was measured on the radiograph and then compared with the real implant length [Weber et al. 1996].

The radiographs were also analyzed for:

- the presence or absence of continuous peri-implant radiolucencies.

**Secondary endpoints:**

- modified plaque index (mPI), determined on the mesial, distal, buccal and palatal surface of the implants. For each implant, the mPI value was calculated based on the average of the four obtained values. The following scores were assigned on the basis of the amount of plaque: score 0, no plaque detected; score 1, plaque only recognized by running a probe across the marginal surface of the implant; score 2, plaque visible with the naked eye; score 3, abundance of soft matter [Mombelli & Lang 1994];
- modified bleeding index (mBI), assessed at the same surfaces, as an indicator of the existence and severity of peri-implant gingivitis. For each implant, the mBI value was calculated based on the average of the four obtained values: score 0, no bleeding running a periodontal probe along the gingival margin adjacent to the implant; score 1, isolated bleeding spots evidenced; score 2, blood forming a confluent line on the mucosal margin; score 3, profuse bleeding [Heckmann et al. 2004].

### Prosthesis function

To test prosthesis function, static and dynamic occlusion was evaluated, using standard occluding papers (Bausch Articulating Paper)3; Bausch Inc., Nashua, NH, USA). Prosthesis function represented a primary endpoint of this study. Any recurrent prosthetic complication, related to the implant–abutment connection, such as

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**Table 1. Number of implants by diameter and length**

<table>
<thead>
<tr>
<th>Dia (mm)</th>
<th>8 mm</th>
<th>10 mm</th>
<th>12 mm</th>
<th>14 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3 mm</td>
<td>73</td>
<td>217</td>
<td>112</td>
<td>402</td>
</tr>
<tr>
<td>4.1 mm</td>
<td>116</td>
<td>212</td>
<td>270</td>
<td>300</td>
</tr>
<tr>
<td>4.8 mm</td>
<td>83</td>
<td>237</td>
<td>210</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>199</td>
<td>522</td>
<td>697</td>
<td>502</td>
</tr>
</tbody>
</table>
abutment loosening or abutment fracture, was registered.

Criteria of implant survival and implant success

Cumulative survival rate: An implant has been classified as a ‘survival implant’ when it was still in function, at the end of this study. Implant losses were all failure categories. The conditions for which implant removal could be indicated included peri-implant infections with persistent pain, or implant loss due to mechanical overload.

Cumulative success rate: An implant has been classified as a ‘successful implant’ when it fulfilled all the following success criteria:

- the absence of pain and suppuration;
- the absence of clinically detectable implant mobility;
- the absence of peri-implant radiolucency;
- PD < 5 mm (for each implant);
- DIB < 1.5 mm after 12 months of functional loading, and not exceeding 0.2 mm for each following year (Albrektsson & Isidor 1994);
- the absence of recurrent prosthetic complications (abutment loosening or abutment fracture).

Statistical analysis was carried out with the life table analysis described by Cutler & Ederer [1958].

Results

Implant survival

At the end of the study, the overall cumulative implant survival rate was 97.56%, with 1884 implants still in function [Table 2]. Thirty-six implants failed and had to be removed. In the maxilla, the cumulative survival rate was 96.12%, with 26 implants failed and removed [Table 3]. In the mandible, the survival rate was 98.91%, with 10 implants failed and removed [Table 4]. With regard to the position of the failed implants, 18 were in the posterior maxilla, eight in the anterior maxilla and 10 in the posterior mandible. Twenty-eight implants were classified as ‘early failures,’ showing clinical and radiographic signs of recurrent peri-implant infection, or implant mobility before the time of abutment connection. Eight implants were classified as ‘late failures,’ as after the abutment connection, four showed untreatable recurrent peri-implant infections, and four failed because of progressive bone loss due to mechanical overloading, without clinical signs of peri-implant infection [Table 5].

Table 2. Overall life-table analysis for implant survival

<table>
<thead>
<tr>
<th>Time interval (months)</th>
<th>Implants at the start of the interval</th>
<th>Dropouts during the interval</th>
<th>Implants under risk</th>
<th>Failures during the interval</th>
<th>Survival rate within the period (%)</th>
<th>Cumulative survival rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–12</td>
<td>1920</td>
<td>4</td>
<td>1916</td>
<td>30</td>
<td>98.43</td>
<td>98.43</td>
</tr>
<tr>
<td>12–24</td>
<td>1216</td>
<td>2</td>
<td>1214</td>
<td>4</td>
<td>99.67</td>
<td>98.10</td>
</tr>
<tr>
<td>24–36</td>
<td>676</td>
<td>5</td>
<td>671</td>
<td>1</td>
<td>99.85</td>
<td>97.95</td>
</tr>
<tr>
<td>36–48</td>
<td>256</td>
<td>4</td>
<td>252</td>
<td>1</td>
<td>99.60</td>
<td>97.56</td>
</tr>
</tbody>
</table>

Table 3. Cumulative survival rate in the maxilla

<table>
<thead>
<tr>
<th>Time interval (months)</th>
<th>Implants at the start of the interval</th>
<th>Dropouts during the interval</th>
<th>Implants under risk</th>
<th>Failures during the interval</th>
<th>Survival rate within the period (%)</th>
<th>Cumulative survival rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–12</td>
<td>822</td>
<td>2</td>
<td>820</td>
<td>22</td>
<td>97.31</td>
<td>97.31</td>
</tr>
<tr>
<td>12–24</td>
<td>655</td>
<td>1</td>
<td>654</td>
<td>2</td>
<td>99.69</td>
<td>97.01</td>
</tr>
<tr>
<td>24–36</td>
<td>315</td>
<td>3</td>
<td>312</td>
<td>1</td>
<td>99.68</td>
<td>96.69</td>
</tr>
<tr>
<td>36–48</td>
<td>178</td>
<td>2</td>
<td>176</td>
<td>1</td>
<td>99.43</td>
<td>96.12</td>
</tr>
</tbody>
</table>

Table 4. Cumulative survival rate in the mandible

<table>
<thead>
<tr>
<th>Time interval (months)</th>
<th>Implants at the start of the interval</th>
<th>Dropouts during the interval</th>
<th>Implants under risk</th>
<th>Failures during the interval</th>
<th>Survival rate within the period (%)</th>
<th>Cumulative survival rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–12</td>
<td>1098</td>
<td>2</td>
<td>1096</td>
<td>8</td>
<td>99.27</td>
<td>99.27</td>
</tr>
<tr>
<td>12–24</td>
<td>561</td>
<td>1</td>
<td>560</td>
<td>2</td>
<td>99.64</td>
<td>98.91</td>
</tr>
<tr>
<td>24–36</td>
<td>361</td>
<td>2</td>
<td>359</td>
<td>0</td>
<td>100.00</td>
<td>98.91</td>
</tr>
<tr>
<td>36–48</td>
<td>78</td>
<td>2</td>
<td>76</td>
<td>0</td>
<td>100.00</td>
<td>98.91</td>
</tr>
</tbody>
</table>
success criteria. The radiographic evaluation of the implants revealed a mean distance from the implant shoulder to the first crestal bone to the implant contact (DIB) of, respectively, 0.928, 0.953 and 1.072 mm at 12, 24 and 36 months after implant insertion. At the 4-year examination, the bone level of the fixture was situated 1.161 mm from the reference point (Table 6). Minimal changes were evidenced in the bone level between the 1- and 4-year examinations. With regard to all these data and to the established success criteria, the overall implant success rate was 96.61% (1877 implants completely fulfilled success criteria) (Table 7). In the maxilla, the cumulative success rate was 95.25% (791 implants completely fulfilled success criteria) (Table 8). In the mandible, implant success rate was 98.64% (1086 implants completely fulfilled success criteria) (Table 9).

### Prosthetic complications

Two prosthetic abutments became loose, during the first year of loading, in two SCs sited in the posterior area of the mandible. These abutments were reinerted and no further loosenings were observed in the period of this study. The incidence of abutment loosening was 0.65% for single-tooth replacement. No recurrent complications, however, were observed at the implant–abutment connection of SCs, FPPs and FFAs. No abutment fractures were evidenced as well. The incidence of prosthetic complications was greater for ODs than for any other type of prostheses. These problems were, however, related to the weakness of the anchorage components used for connecting the implants to the prosthetic framework. Five patients with maxillary ODs (7.46%) showed clip fractures or loosening, in three of these patients, gold-bar fracture occurred.

### Table 6. The radiographic distance between the implant shoulder and the first visible bone contact (DIB) in mm

<table>
<thead>
<tr>
<th>Year</th>
<th>DIB mesial site</th>
<th>DIB distal site</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.931 ± 0.252</td>
<td>0.925 ± 0.294</td>
</tr>
<tr>
<td>2</td>
<td>0.951 ± 0.242</td>
<td>0.954 ± 0.289</td>
</tr>
<tr>
<td>3</td>
<td>1.077 ± 0.245</td>
<td>1.072 ± 0.300</td>
</tr>
<tr>
<td>4</td>
<td>1.169 ± 0.250</td>
<td>1.152 ± 0.304</td>
</tr>
</tbody>
</table>

Mean values (M) and standard deviations (SD) for both mesial and distal implant sites

### Table 7. Overall life-table analysis for implant success

<table>
<thead>
<tr>
<th>Time interval (months)</th>
<th>Implants at the start of the interval</th>
<th>Dropouts during the interval</th>
<th>Implants under risk</th>
<th>Failures during the interval</th>
<th>Success rate within the period (%)</th>
<th>Cumulative success rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–12</td>
<td>1920</td>
<td>4</td>
<td>1916</td>
<td>33</td>
<td>98.27</td>
<td>98.27</td>
</tr>
<tr>
<td>12–24</td>
<td>1216</td>
<td>2</td>
<td>1214</td>
<td>5</td>
<td>99.58</td>
<td>99.58</td>
</tr>
<tr>
<td>24–36</td>
<td>676</td>
<td>5</td>
<td>671</td>
<td>3</td>
<td>99.55</td>
<td>99.55</td>
</tr>
<tr>
<td>36–48</td>
<td>256</td>
<td>4</td>
<td>252</td>
<td>2</td>
<td>99.20</td>
<td>99.20</td>
</tr>
</tbody>
</table>

### Table 8. Cumulative success rate in the maxilla

<table>
<thead>
<tr>
<th>Time interval (months)</th>
<th>Implants at the start of the interval</th>
<th>Dropouts during the interval</th>
<th>Implants under risk</th>
<th>Failures during the interval</th>
<th>Success rate within the period (%)</th>
<th>Cumulative success rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–12</td>
<td>822</td>
<td>2</td>
<td>820</td>
<td>24</td>
<td>97.07</td>
<td>97.07</td>
</tr>
<tr>
<td>12–24</td>
<td>655</td>
<td>1</td>
<td>654</td>
<td>4</td>
<td>99.38</td>
<td>99.38</td>
</tr>
<tr>
<td>24–36</td>
<td>315</td>
<td>3</td>
<td>312</td>
<td>2</td>
<td>99.35</td>
<td>99.35</td>
</tr>
<tr>
<td>36–48</td>
<td>178</td>
<td>2</td>
<td>176</td>
<td>1</td>
<td>99.43</td>
<td>99.43</td>
</tr>
</tbody>
</table>

### Table 9. Cumulative success rate in the mandible

<table>
<thead>
<tr>
<th>Time interval (months)</th>
<th>Implants at the start of the interval</th>
<th>Dropouts during the interval</th>
<th>Implants under risk</th>
<th>Failures during the interval</th>
<th>Success rate within the period (%)</th>
<th>Cumulative success rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–12</td>
<td>1098</td>
<td>2</td>
<td>1096</td>
<td>9</td>
<td>99.17</td>
<td>99.17</td>
</tr>
<tr>
<td>12–24</td>
<td>561</td>
<td>1</td>
<td>560</td>
<td>3</td>
<td>99.46</td>
<td>99.46</td>
</tr>
<tr>
<td>24–36</td>
<td>361</td>
<td>2</td>
<td>359</td>
<td>0</td>
<td>100.00</td>
<td>100.00</td>
</tr>
<tr>
<td>36–48</td>
<td>78</td>
<td>2</td>
<td>76</td>
<td>0</td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>
able to induce a self-locking mating between the parts. In the present study, with 307 implant supporting single-tooth restorations, only two prosthetic abutments became loose (0.65%), over a period of 4 years, in two SCs located in the posterior area of the mandible. Moreover, no complications occurred at the implant–abutment connection of FPPs and FFAs. This study has pointed out that the Morse taper connection can provide a very low incidence of failures and biomechanical complications, especially in the posterior regions of both maxillary arches. The high mechanical stability of this type of connection allows the cementation of the crowns or bridges without the risk of abutment loosening [Weigl 2004]. Moreover, fabrication of the final restoration is easier and the prostheses more aesthetic, without occlusal screws. Some authors have reported [Heckmann et al. 2006] that micro-movements at the implant abutment interface could finally lead to bone resorption. Although this mechanism is certainly still to be elucidated, the Morse taper connection implants can avoid micro-movements, preventing crestal bone loss around implants. In the conventional submerged technique, the top of an implant is placed at the level of the bone crest, and abutment connection 3–6 months later creates an interface (implant–abutment connection) at the bone level. In recent years, clinicians have performed abutment connection to conventionally submerged implants during initial surgery, in order to avoid a second surgical procedure [Ericsson et al. 1997]. Regardless of the surgical technique, it has been widely described in the literature that the marginal bone crest level around two-piece dental implants, with screw type implant–abutment connection, is generally located 1.5–2 mm below the implant abutment connection after the first year of functional loading [Hermann et al. 2001a]. The precise mechanisms of bone loss around dental implants are still poorly understood [Oh et al. 2002]. Recent studies, however, have evidenced that peri-implant soft tissues of two-piece implants develop a considerable cellular infiltrate (mainly represented by neutrophilic polymorphonuclear leucocytes) in connective tissue below the gingival epithelium [Orsini et al. 2000; Broggi et al. 2003]. As this kind of infiltrate is mainly concentrated at the level of the implant–abutment interface and appeared to decrease gradually toward either bone or gingival epithelium, it has been advocated that a microgap at the implant abutment interface should be associated with peri-implant inflammatory cell accumulation and peri-implant bone loss [Hermann et al. 2001b; Todescan et al. 2002]. This microgap of variable dimensions (40–100 µm), in fact, is colonized by bacteria capable to penetrate inside the internal hollow portion of the implant [Keith et al. 1999]. The bacterial leakage and persistent colonization of the microgap at the implant–abutment interface [Piatelli et al. 2003] are responsible for generating a chemotactic stimulus which initiates and sustains recruitment of inflammatory cells. This finally results in the development of peri-implant inflammatory cell accumulation and bone loss [Quirynen et al. 1994; Jansen et al. 1997]. If the absence of an implant–abutment microgap should be associated with reduced peri-implant inflammation and minimal bone loss [Gross et al. 1999], the Morse taper implant–abutment connection could provide an efficient seal against microbial penetration. The tapered interference fit significantly reduces microgap dimensions (1–3 µm) at the implant–abutment interface, providing an adequate biological seal, avoiding any kind of bacterial leakage [Dibart et al. 2003]. This contributes to minimal level of peri-implant soft tissues inflammation, and can guarantee adequate bone crest stability. Furthermore, it has been demonstrated that the vertical height of bone around an implant depends largely on the formation of the biological width at the abutment–implant interface, to provide space for the connective tissue [Cochran et al. 1997]. With tapered interference fit, the abutment emergence geometry leads to the platform switching advantages [Gadhia & Holt 2003; Lazzara & Porter 2006] increasing the distance between the microgap 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 [Chou et al. 2004; Baumgartner et al. 2005; Guirado et al. 2007]. Moreover, another consequence is excellent soft tissue healing, with a thicker and larger, well organized amount of peri-implant soft tissues. This transmucosal seal can protect bone crest from resorption [Abrahamsson et al. 1997; Rompen et al. 2006]. In the present study, minimal changes have been evidenced between the 1- and 4-year examinations, with the bone level of the fixture situated 0.928 and 1.161 mm from the reference point after the first and the fourth year of functional loading, respectively. Good soft tissue healing was present, and 1744 implants (90.83%) did not exhibit any sign of gingival inflammation (mBI score value comprised between 0 and 1). These data were confirmed by PD values, with only seven implants (0.36%) unable to fulfill success criteria [PD value > 5 mm].

Conclusion

Within the limits of this work, the cumulative implant survival rate (97.56%) and the cumulative implant success rate (96.61%) obtained in a 4-year period was in agreement with other Morse taper connection implant studies. The lower incidence of mechanical and prosthetic complications observed during the loading period revealed the high mechanical stability of the implant–abutment connection; the bacteria-proof seal of the locking taper probably prevented a possible peri-implant soft tissue inflammation that could be responsible for the crestal bone loss around implants.

References


Mangano et al. Prospective clinical evaluation of 1920 Morse taper connection implants


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