LONG-TERM SURVIVAL RATE OF IMPLANT-SUPPORTED OVERTURE DENTURES WITH VARIOUS ATTACHMENT SYSTEMS: A 20-YEAR RETROSPECTIVE STUDY

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KEYWORDS
attachment; implant-supported overdenture; survival rate

Abstract Background/purpose: The aim of the present study is to review the survival rate of dental implants with overdenture rehabilitation within the past 20 years. Materials and methods: Patients (n = 187) treated with implant-supported overdentures from November 1993 to October 2013 were studied. Oral rehabilitations were completed and followed-up over average of 103 ± 21 months (range, 6–240 months). There were of 131 males and 56 females (mean age 64.2 years; range, 37–87 years) who received 32 dentures with 149 implants (22%) in maxillae and 161 dentures with 533 implants (78%) in mandibles. Most of the patients (n = 136) were routinely followed up every 6 months, for the others, information for data collection on implant survival was performed by telephone (n = 51).
Results: In total, 650 implants (95.3%) survived, and 32 implants (4.7%) failed. The 32 failed implants included 28 Steri-Oss implants (20.9%), one F-2 (0.8%), two Xive (1.6%), and one Nobel Biocare implant (2.3%). According to the attachment systems, eight failed implants combined with O-ring (22.9%), 11 with ball attachment (11.6%), seven with bar-clip (20.6%), one with milled-bar (0.2%), and one implant with locator (1.2%). Conclusion: The overall survival rate of dental implants with overdenture rehabilitation was 95.3% (91.3% in maxillae vs. 96.4% in mandibles) within the past 20 years. With careful
treatment planning, implant-supported overdenture is an interesting treatment alternative with better esthetic, retention, stability, and good hygienic maintenance for patients with severe ridge resorption.

Introduction

Long-term prognosis and predictability of implant-supported prostheses have been well documented.\(^1\)\(^-\)\(^6\) Fully edentulous patients with severely resorbed ridges combined with unfavorable jaw relations often experience problem with their conventional prostheses, due to an impaired load-bearing capacity. Thus, patients have to change food preparation in order to accommodate their insufficient masticatory function. Implant-supported overdenture is an optional treatment for the patients who undergo moderate to severe ridge resorption, which offers better esthetics, retention, and stability of the prosthesis and also have some advantages over full arch fixed implant prostheses, such as fewer implants required and lower cost.\(^7\)\(^-\)\(^9\) However, the survival rate of implant-supported overdenture still reveals an unclear tendency. A systematic review of implants with a minimal 5 years of loading reported higher failure rates for implant-supported overdenture than fixed implant-supported prostheses.\(^10\) Besides, the attachment of an overdenture plays a very important role on both stability and retention of the prostheses. A randomized clinical trial of mandibular long-bar implant-supported overdenture showed similar patient satisfaction as with a fixed implant prostheses.\(^11\) The objective of the present study is to review the survival rate of dental implants with overdenture rehabilitation combined with different attachment designs in our clinical experience in the past 20 years.

Materials and methods

The patients (\(n = 187\)) have been treated with implant-supported overdentures (implant, 682; denture, 193) at the Implant Center of Kaohsiung Veterans General Hospital, Taiwan from November 1993 to October 2013 were studied (Fig. 1). Oral rehabilitations were completed and followed over an average of 103 ± 21 months (range, 6–240 months). The patients included 131 males and 56 females (mean age 64.2 years; range, 37–87 years) who received 32 dentures with 149 implants (22%) in maxilla and 161 dentures with 533 implants (78%) in mandible (Table 1). Most of the patients (\(n = 136\)) were routinely followed up every 6 months; for the others, information for data collection on implant survival was gathered by telephone (\(n = 51\)). Fifteen patients (70 implants) were excluded due to death during the follow-up period and four sleep implants were classified in the failed group. Orthopantographic assessments were routinely carried out and cone-beam computer tomographic examinations were supplemented in severely atrophied areas in maxillae and mandibles. Nine different implant systems and six attachment systems were involved in the present study, implant system and number were: (1) Steri-Oss (Sterioss, Yorba Linda, California, USA), 134 implants (19.6%); (2) F-2 (FRIADENT GmbH, Mannheim, Germany); 119 implants (17.4%); (3) Xive (FRIADENT GmbH, Mannheim, Germany), 122 implants (17.9%); (4) Straumann (Straumann AG, Basel, Switzerland), 187 implants (27.4%); (5) Nobel Biocare (Nobel Biocare, Göteborg, Sweden), 44 implants (6.4%); (6) Lifecore (LifeCore Biomedical, Chaska MN, USA), 41 implants (6.0%); (7) Anthogyr (Anthogyr, Sallanches, France), 18 implants (2.6%); (8) Swiss plus (Zimmer Dental Inc, Carlsbad CA, USA), 14 implants (2.1%); and (9) 3i (BIOMET 3i, Palm Beach Gardens, FL), 3 implants (0.4%; Fig. 2). Attachment system and involved implant number were: (1) ball attachment, 95 implants (13.9%); (2) O-ring, 35 implants (5.1%); (3) bar-clip, 34 implants (5.0%); (4) milled-bar, 417 implants (61.1%); (5) magnet, nine implants (1.3%); (6) locator, 86 implants (12.6%); and (7) support, six implants (0.9%; Fig. 3). Descriptive analysis was applied to the patients, implant systems, and types of attachment. Retrograde assessment of the jaw bone with failed implants was based on an evaluation of the bone morphology according to Lekholm and Zarb.\(^2\) An implant still in function in the oral cavity, without any clearly uncomfortable symptoms and signs (pain, mobility), was considered to have survived.
Results

There were 650 implants (95.3%) that survived, and 32 implants (4.7%) failed. The 32 failed implants included 28 Steri-Oss implants (20.9%), one F-2 (0.8%), two Xive (1.6%), and one Nobel Biocare implant (2.3%; Table 2 and Fig. 2). According to the attachment systems, eight failed implants combined with O-ring (22.9%), 11 with bar-clip attachment (11.6%), seven with bar-clip (20.6%), one with milled-bar (0.2%), and one implant with locator (1.2%; Table 2, Fig. 2). Among 28 failed implants with different attachments, there were eight implants splinted (1.8%) and 20 unsplinted (8.7%). Among the failed implants, there were eight implants installed in anterior regions and five implants in posterior regions of the maxilla (13/149 = 8.7%). There were 18 implants installed in anterior regions (4 sleep implants) and one implant in posterior region of the mandible (19/533 = 3.6%; Table 2). For the failed implants, the average duration in loading function was 68 months before they were removed from the oral cavity. The overall survival rate of dental implants with overdenture rehabilitation was 95.3% (91.3% in maxillae vs. 96.4% in mandibles) within the past 20 years.

Discussion

There have been many studies on implant-supported overdentures with high survival rates, but short follow-up periods have been reported. With the limitations of retrospective study, results of the present article reveal an overall survival rate of 95.3% for dental implants with overdenture rehabilitation within the past 20 years. This survival rate is similar to a long-term retrospective study, which showed a survival rate of 95.5% after 23 years of loading.13 Within the first 8 years, we used the only one implant system (Steri-Oss) and about 20% of the installed fixtures were cylinder type with titanium plasma spray (TPS) or hydroxyapatite (HA)-coated surface. Among the 28 failed Steri-oss implants, there were 15 implants with TPS surface and 11 implants with HA coating, when two sleep implants were excluded (Table 2). The result is consistent with a 5-year clinical follow-up research, which revealed a higher failure rate of cylindrical dental implants with TPS-coated surface than HA-coated surface.14 Thirteen of the failed implants were installed in maxillae (13/149: 8.7%), which was nearly 2.5 times higher than in mandibles (19/533: 3.6%). Most of the failed implants in maxillae were unsplinted, either in anterior regions or posterior regions. Most of the failed implants in the present study were small diameter fixtures that were installed in poor bone quantitative situations without splinting, neither in maxillae nor in mandibles (Table 2). However, there is still controversy about whether splinting or not and also the selection of attachment system in some articles. Numerous studies have revealed a higher failure rate of implant-supported overdenture in maxillae than in mandibles, poor bone morphology and improper loading situations were indicated as factors that caused higher failure rates in maxillae.15–22

A systematic literature review showed that there is no difference in survival rates of implant-supported overdenture in the upper jaw between splinted and unsplinted design, but the unsplinted design needs more prosthetic maintenance and the bar-clip implant-supported overdenture has been shown to be a more successful prosthesis.23 In a systematic review of implant-supported overdenture in maxillae with at least 1 year of loading that found a higher survival rate among six implants with bar-splinted (98.2%) than four implants with bar-splinted (96.3%) or four independent implants with ball attachments (95.2%).24 The other studies also revealed that the number of implants installed in maxillae had a significant influence on survival rate, they recommend that at least four implants should be performed to support an maxillary overdenture.25–27 In the present study, six implants installed at the anterior mandible with poor bone quantity completely failed in two male patients, who are a heavy smoker and an alcohol drinker. Among the 19 failed implants in the mandible, four implants in the anterior regions were kept in sleep due to poorly lingualized angulation and

**Table 1** Overall distributions of patient, implant, denture, and location of dental implants installed in maxillae and mandibles.

<table>
<thead>
<tr>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>131</td>
<td>56</td>
<td>187</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Denture (n)</th>
<th>Mx (32)</th>
<th>Md (161)</th>
<th>193</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implant</td>
<td>149</td>
<td>533</td>
<td>682</td>
</tr>
<tr>
<td>Location (n)</td>
<td>Mx-a (82)</td>
<td>Mx-p (67)</td>
<td>149</td>
</tr>
<tr>
<td></td>
<td>Md-a (389)</td>
<td>Md-p (144)</td>
<td>533</td>
</tr>
</tbody>
</table>

a = anterior; Md = mandible; Mx = maxilla; p = posterior.

![Figure 2](image2.png) Distribution of survived and failed number of different implant systems. Ant = Anthogy; Lif = Lifecore; Nob = Nobel Biocare; St1 = Steri-oss; St2 = Straumann; Swi = Swiss plus; Xiv = Xive.

![Figure 3](image3.png) Distribution of survived and failed implant number with different attachment systems. Support = implant for supporting function of distal free-end removable partial denture.
too closely positioned for hygienic maintenance. According to the results of this study, description about the attachment systems and prostheses do not focus on the survival rate, but the complications, maintenance, and patient’s subjective satisfaction.

Selection of the attachments in the first 8 years was according to a series of product of the implant system (Steri-Oss; Table 2). Among the attachment systems, worn rubber ring and dislodged matrix or metal house were more common complications, especially in anterior maxillae due to improper angulation of the installed implant. More common technical procedures carried out according to the types of attachment, were exchange of the rubber ring or plastic clip and retightening of the loosening attachment in the 1st year. Within later years, a new treatment strategy was performed to minimize the vexatious complications of different types of attachment after careful patient selection and delicate treatment planning. Among the whole installed implants, 417 implants (61.1%) were restored with milled bar attachment to support the overdenture in maxillae or mandibles. The results of the milled bar implant-supported overdenture in this study are similar to a systematic literature review, which concluded that milled bar implant-supported overdentures offer the advantages of removable prostheses with the stability and retention of fixed prostheses.28 With prudent treatment planning, the milled bar implant-supported overdenture offers high survival rates either in maxillae or mandibles for patients with moderate to severe ridge resorption.

Generally, patients with severe ridge resorption often suffered from recurrent mucosal ulceration due to poor soft tissue quality and edentulous ridge loading capacity. The milled bar splinting design with adequate implants provides excellent support, stability, and retention, like fixed prostheses.29,30 This type of attachment often has fewer complications than the other types of attachments used in our clinical experience and has lower maintenance cost. However, there were still some scattered complications, such as the bar fracturing around the wall of the screw hole in the distal cantilever segments and requiring repair.

Table 2: Characteristics of the patients with implant losses in maxillae and mandibles after loading.

<table>
<thead>
<tr>
<th>Sex/age at implant placement</th>
<th>Implant system</th>
<th>Implant surface</th>
<th>Implant D/L (mm)</th>
<th>Opposite jaw</th>
<th>Location (n)</th>
<th>Bone quality</th>
<th>Bone quantity</th>
<th>Attachment type</th>
<th>Splinted/unsplinted</th>
</tr>
</thead>
<tbody>
<tr>
<td>M/63</td>
<td>Steri-Oss</td>
<td>HA</td>
<td>3.8/12</td>
<td>RPD</td>
<td>Md-a (2slp)</td>
<td>II</td>
<td>C</td>
<td>Bar-clip</td>
<td>Splinted</td>
</tr>
<tr>
<td>M/73</td>
<td>Steri-Oss</td>
<td>HA</td>
<td>3.25/12</td>
<td>RPD</td>
<td>Mx-a (2)</td>
<td>III</td>
<td>C</td>
<td>Bar-clip</td>
<td>Splinted</td>
</tr>
<tr>
<td>M/45</td>
<td>Steri-Oss</td>
<td>HA</td>
<td>3.25/12</td>
<td>RPD</td>
<td>Mx-p (3)</td>
<td>III</td>
<td>C</td>
<td>Bar-clip</td>
<td>Splinted</td>
</tr>
<tr>
<td>M/72</td>
<td>Steri-Oss</td>
<td>TPS</td>
<td>3.8/12</td>
<td>CD</td>
<td>Md-a (1)</td>
<td>II</td>
<td>C</td>
<td>O-ring</td>
<td>Unsplinted</td>
</tr>
<tr>
<td>M/70</td>
<td>Steri-Oss</td>
<td>HA</td>
<td>3.25/12</td>
<td>CD</td>
<td>Md-a (1)</td>
<td>II</td>
<td>C</td>
<td>O-ring</td>
<td>Unsplinted</td>
</tr>
<tr>
<td>M/66</td>
<td>Steri-Oss</td>
<td>HA</td>
<td>3.25/12</td>
<td>CD</td>
<td>Mx-p (1)</td>
<td>II</td>
<td>D</td>
<td>Ball</td>
<td>Unsplinted</td>
</tr>
<tr>
<td>M/62</td>
<td>Steri-Oss</td>
<td>TPS</td>
<td>3.25/14</td>
<td>RPD</td>
<td>Mx-a (2)</td>
<td>III</td>
<td>C</td>
<td>Ball</td>
<td>Unsplinted</td>
</tr>
<tr>
<td>M/54</td>
<td>Steri-Oss</td>
<td>TPS</td>
<td>3.25/12</td>
<td>Mx-p (1)</td>
<td>III</td>
<td>C</td>
<td>Ball</td>
<td>Unsplinted</td>
<td></td>
</tr>
<tr>
<td>M/75</td>
<td>Steri-Oss</td>
<td>HA</td>
<td>3.25/16</td>
<td>CD</td>
<td>Mx-a (1)</td>
<td>II</td>
<td>C</td>
<td>Ball</td>
<td>Unsplinted</td>
</tr>
<tr>
<td>F/46</td>
<td>Steri-Oss</td>
<td>TPS</td>
<td>3.8/14</td>
<td>Dentate</td>
<td>Mx-a (3)</td>
<td>III</td>
<td>D</td>
<td>O-ring</td>
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<tr>
<td>M/54</td>
<td>Steri-Oss</td>
<td>TPS</td>
<td>3.25/12</td>
<td>CD</td>
<td>Md-a (3)</td>
<td>II</td>
<td>D</td>
<td>Ball</td>
<td>Unsplinted</td>
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<tr>
<td>M/55</td>
<td>Steri-Oss</td>
<td>TPS</td>
<td>3.8/16</td>
<td>CD</td>
<td>Md-a (3)</td>
<td>II</td>
<td>D</td>
<td>Ball</td>
<td>Unsplinted</td>
</tr>
<tr>
<td>M/58</td>
<td>Steri-Oss</td>
<td>TPS</td>
<td>3.8/14</td>
<td>RPD</td>
<td>Mx-p (1)</td>
<td>II</td>
<td>D</td>
<td>Milled-bar</td>
<td>Splinted</td>
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<tr>
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<td>TPS</td>
<td>3.8/14</td>
<td>RPD</td>
<td>Mx-a (1)</td>
<td>II</td>
<td>C</td>
<td>Ball</td>
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<tr>
<td>M/77</td>
<td>F-2</td>
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<td>3.8/15</td>
<td>CD</td>
<td>Md-a (1)</td>
<td>II</td>
<td>C</td>
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<tr>
<td>F/73</td>
<td>Xive</td>
<td>TPS</td>
<td>3.0/11</td>
<td>CD</td>
<td>Md-a (2slp)</td>
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<td>D</td>
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<tr>
<td>M/82</td>
<td>Nobel TiUnite</td>
<td>3.5/11.5</td>
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<td>Md-a (1)</td>
<td>II</td>
<td>D</td>
<td>Locator</td>
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</tr>
</tbody>
</table>

*Bone morphology according to Lekholm and Zarb.12

a = anterior; CD = complete denture; F = female; M = male; Md = mandible; Mx = maxilla; p = posterior; RPD = removable partial denture; slp = sleep.
In conclusion, no single type of attachment or prosthesis can offer completely perfect requirements to satisfy patients with compromised edentulous ridge and financial destitution. Delicate treatment planning and careful patient selection are the key factors for achieving the final success. The implant-supported overdenture is an interesting treatment alternative with better esthetics, retention, and stability and good hygiene maintenance for the patients with moderate to severe ridge resorption.

Conflicts of interest
The authors have no conflicts of interest relevant to this article.

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