Freestanding and multiunit immediate loading of the expandable implant; An up-to-40-month prospective survival study

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Two hundred eighty-six immediate-load Sargon® implants were placed in 75 patients during a 40-month period. Of the 273 implants that survived, 81 were placed into fresh extraction sockets and immediately loaded, 162 were placed into healed sites and immediately loaded, and 30 were delay loaded. Some implants that had failed to remain stable after immediate loading became stable and osseointegrated after the load was removed and their expansion mechanisms were reactivated.

Purpose. The purpose of this study was to evaluate the effectiveness of an expandable implant design for immediate and delayed loading and for freestanding and multunit situations.

Material and methods. Two hundred eighty-six immediate-load Sargon® implants were placed in 75 patients during a 40-month period. Of the 273 implants that survived, 81 were placed into fresh extraction sockets and immediately loaded, 162 were placed into healed sites and immediately loaded, and 30 were delay loaded. Some implants that had failed to remain stable after immediate loading became stable and osseointegrated after the load was removed and their expansion mechanisms were reactivated.

Results. The overall survival rate during the 40-month period was 96.0% in the maxilla and 94.8% in the mandible. Implants placed in fresh extraction sockets showed a 98.9% survival rate. Healed sites showed a 93.9% survival rate. Immediate loading of 52 fresh extraction socket implants in the maxilla showed a 100% survival rate during the evaluation period. aft

Conclusion. Within the limitations of this study, it was shown that the feature of mechanical expandability may provide operators some control over implant stability during the vulnerable period after immediate loading of single, freestanding implants. (J Prosthet Dent 2001;85:148-55.)

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CLINICAL IMPLICATIONS

Enhancing the stability of immediately placed, freestanding implants by expanding the implant over a 21-day period may improve the prognosis for immediate loading.

The concept of osseointegration, as described by Branemark,1 has drastically improved the reliability of dental implants and changed the nature of clinical practice. To achieve successful osseointegration, a patient must wait 8 to 12 months for ossealination of an extraction socket, followed by healing periods of 3 to 6 months after the placement of an implant. This treatment sequence is known as the 2-stage submerged procedure.2,3 However, this procedure is no longer necessary to achieve osseointegration, because 1-stage nonsubmerged procedures9-12 and immediate-implant placements have shown good clinical results.13-25 Recently, the immediate loading of implants on placement has drawn the attention of dentists.26-36 Tarnow et al7 reported that when multiple implants were placed and splinted into a full-arch form and immediately loaded, favorable results were obtained. Branemark38 also reported a method to place multiple implants into the mandibular anterior region by using a special template to place the superstructure to perform immediate loading.

To date, there are no scientific reports to indicate predictable immediate loading on a single-tooth, freestanding implant. Predictable immediate loading can fulfill a number of requirements not currently addressed by traditional implants. First and foremost is the ability to extract a diseased tooth in the esthetic zone and immediately replace it with a provisional restoration in full function and esthetic form (provided that no orthodontic, periodontic, or endodontic corrective treatments are required within the region or on adjacent teeth). Preservation of papillary anatomy and the emergence profile could be accomplished easily if fresh extraction sockets could be implanted and immediately loaded with correctly contoured provisional restorations. Moreover, immediate loading of fresh extraction sockets could preserve dental arch integrity, occlusion, and patient satisfaction, especially in single-tooth, freestanding situations

Table I. Number of implants (total n = 286) and length of evaluation period after placement.

<table>
<thead>
<tr>
<th>Number of implants</th>
<th>Evaluation period (mo)</th>
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<tbody>
<tr>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td>50</td>
<td>16</td>
</tr>
<tr>
<td>96</td>
<td>22</td>
</tr>
<tr>
<td>28</td>
<td>28</td>
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It seems that implants will continue to evolve until a reliable, immediately loadable implant system is perfected. Variations in implant designs (in thread configurations, surface characteristics, and expandability) have been introduced to obtain immediate loadability. One manufacturer (Sargon Enterprises, Inc, Beverly Hills, Calif.) has claimed that because its implant has an expandable design, it allows immediate loading of a single-tooth implant after placement in both fresh extraction sockets and healed sites. The purpose of this study was to evaluate the effectiveness of this expandable implant under immediate- and delayed-loading conditions. Other clinical conditions, such as freestanding and multiunit cases in fresh extraction sockets and healed sites, were included.

MATERIAL AND METHODS

A total of 286 Sargon immediate load implants (hereafter referred to as "expandable implants") were placed in 75 patients. The patient group included 42 men and 33 women ranging in age from 20 to 71 years, with a mean age of 49 years. All patients selected were in good general and oral health. None of the subjects exhibited subjective or objective complications during the surgical operation. The number of implants and the evaluation period after placement are shown in Table I.

All patients were selected solely on the basis of bone volume adequate for implant placement. None of the patients were rejected because of any pretreatment assumptions of poor bone quality or because they used tobacco. Bone quality was determined after each implant was placed and expanded by using the implant as a bone compaction device. No patients were rejected after they entered into this study, and all patients were treated consecutively.

Preoperative occlusal and radiographic evaluations were made, and any deficiencies or pathologies were corrected before surgery. This included any necessary endodontic treatment for adjacent teeth and periodontal therapy. No pretreatment orthodontic socket corrections were performed.

Expandable implants were placed under 2 different conditions: fresh extraction sockets and healed sites. All extractions were performed with an effort to avoid fracture of facial and crestal bone and to preserve the soft tissue of the crestal region.

To place the expandable implant into a fresh extraction socket, a channel was bored into the bone with a series of drills, then tapped manually. The channel was made in a trajectory that provided the greatest volume of bone around the implant. Attention was given to submerging the implant at least 5 MM23 apical to the cementoenamel junctions of the adjacent teeth with 75% of the implant's surface22 within bone.

The expandable implant used in this study has a quintapodal design in the apical half of the body, which is divided into 4 legs that can expand with the turn of a central expansion screw that becomes the fifth leg (Fig. 1). There are 3 different lengths (10, 13, and 16 mm) that can expand from the original diameter of 3.8 mm to a maximum of 5.5, 6.8, and 6.8 mm, respectively. The expansion screw is turned with a screwdriver by using only finger-wrist force until definite resistance from the surrounding bone can be felt.

When an implant was placed into a fresh extraction socket, the vertical position of the collar was approximately 1 to 2 mm below the interproximal crestal height. Neither grafting techniques nor barrier membranes were used to compensate for the gap between the cervical form of the expandable implant and the crestal walls of the extraction socket. Provisional restorations were fabricated immediately after placement of the implants and were seated within the same appointment (Figs. 2 through 6).
When bone-contacting surface areas were limited or bone quality was poor, delayed loading was used, and implant heads were covered with healing collars to preserve optimum tissue contour. Three months after implant placement, a final restoration was placed.

Fig. 2. Extraction of maxillary right central incisor.

Fig. 3. Implant placement.

Fig. 4. Provisional restoration. Note emergence profile and long axis.
This treatment sequence was called "delayed loading" as opposed to "immediate loading." In both situations, the occlusion of the restoration was carefully established. The implant was used as a bone-quality evaluation instrument to indicate loading ability (Table II).

**Table II.** Stability test outcomes and treatments for postoperative follow-ups within 3 weeks

This method was used to predict the ability to load immediately. Regardless of whether immediate or delayed loading was performed, the stability (micromobility) of the implants was examined with the postoperative protocol suggested by Lazarof et al. (Table II) at 7-day intervals for 21 days.

**Table VI.** Placed and failed (in parentheses) implants: Delayed loading in healed sites
The criteria used to test for stability were as follows: (1) percussion sounds from a metal instrument, (2) percussion and pressure sensitivity, (3) observation of mobility after application of lateral force, and (4) ability to easily turn the expansion screw clockwise. Only those implants that did not test clinically stable during the 21-day period after placement were given additional expansion.

If any stability tests were positive, the expansion mechanism within the implant was reactivated until firm bony resistance was observed, after which loading was continued. For immediately loaded implants that exhibited positive testing more than 2 times during the 3-week testing period, all loads were removed for 16 to 18 weeks, after which the provisional restorations were placed back onto the implant.

Table VII. Placed and failed (in parentheses) single-tooth, freestanding implants

<table>
<thead>
<tr>
<th></th>
<th>Maxilla</th>
<th>Mandible</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mm</td>
<td>4 (3)</td>
<td>3 (1)</td>
</tr>
<tr>
<td>13 mm</td>
<td>16 (0)</td>
<td>4 (0)</td>
</tr>
<tr>
<td>16 mm</td>
<td>5 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Total</td>
<td>25 (3)</td>
<td>7 (1)</td>
</tr>
</tbody>
</table>

Table VIII. Placed and failed (in parentheses) implants according to the number of implants in the multiunit situation

<table>
<thead>
<tr>
<th></th>
<th>Fresh extraction socket</th>
<th>Healed site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate loading</td>
<td>29 (0)</td>
<td>36 (3)</td>
</tr>
<tr>
<td>Delayed loading</td>
<td>4 (0)</td>
<td>4 (1)</td>
</tr>
<tr>
<td>Total</td>
<td>33 (0)</td>
<td>40 (4)</td>
</tr>
</tbody>
</table>

The postoperative protocol for expandable implants suggests additional expansion for reestablishing intimate bone contact. The number of implants that received additional expansion was 208. The loss of stability after loading may suggest insufficient expansion during initial implant placement. Complications such as fistula formation and crestal bone loss, structural problems such as bacterial leakage at the abutment-implant interface, and mobility may contribute to implant instability. Four categories of complications and their distributions are shown in Table IX.
In this investigation, a total of 13 implants failed because of such complications and/or additional, unknown factors.

**Table IX.** Complications relative to the expandable implant

<table>
<thead>
<tr>
<th>Incidents</th>
<th>Number of occurrences</th>
<th>Number of recoveries</th>
<th>Number of failures</th>
</tr>
</thead>
</table>

http://www.sargondentalimplants.com/home/index2.php?option=com_content&task=view...  1/30/2008
Freestanding and multiunit immediate loading of the expandable implant: An up-to-40-m... Page 7 of 10

<table>
<thead>
<tr>
<th>Fistula formation</th>
<th>10</th>
<th>10</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crestal bone loss</td>
<td>35</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Mobility</td>
<td>17</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>Bacterial contamination</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

Table X. Survival rate based on loading

<table>
<thead>
<tr>
<th></th>
<th>Maxilla</th>
<th>Mandible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate load Fresh extraction socket</td>
<td>100%</td>
<td>96.7%</td>
</tr>
<tr>
<td>Healed site</td>
<td>95.5%</td>
<td>94.8%</td>
</tr>
<tr>
<td>Delayed load Fresh extraction socket</td>
<td>100%</td>
<td>---</td>
</tr>
<tr>
<td>Healed site</td>
<td>88%</td>
<td>85.7%</td>
</tr>
</tbody>
</table>

Ten fistulas, apparently caused by residual cysts and root remnants, were found in this study. These were resolved after removal of the pathosis. Among these, 2 fistulas were associated with leakage, and it was necessary to seal the central abutment channel and remove pathologic agents to resolve them. Thirty-five implants exhibited crestal bone loss. Among these, 2 implants showed mild bone loss limited above the first or second thread (Fig. 7). However, 6 implants showed severe, crater-like bone resorption that extended to the furcation area (Fig. 8). In all 6 cases, the implants were fully expanded, which suggested type IV bone quality. Among these, 4 failed and 2 were salvaged by removing the load for 16 to 18 weeks.

Seventeen implants exhibited mobility. Among these, with additional expansion and removal of the load for 16 to 18 weeks, 4 implants recovered. The remaining 13 implants failed. Four of them had mobility with severe, crater-like bone resorption. Three implants showed a 2 to 3 mm radiolucency around the furcation area (Fig. 9). This may be attributable to bacterial leakage from a defective expansion screw mechanism. After sealing the tip of the expansion screw with the delrin sealing cap and a composite resin luting cement, all radiolucencies disappeared, and the implants recovered.

The survival rates of the 286 implants were surveyed under loading conditions of immediate loading and delayed loading (Table X). An example of delayed loading of a mandibular fresh extraction socket was not performed. The overall survival rate of the expandable implants up to a 40-month period was 96.0% in the maxilla and 94.8% in the mandible.

DISCUSSION

Contemporary trends for the immediate loading of individual, freestanding implants suggest that ideal conditions of bone and patient cooperation are vital. This study indicates that these parameters may be expanded. Delayed loading was performed only in type IV bone. It was found that fresh extraction sockets exhibited results superior to those of healed sites. Contrary to reports in the dental literature involving traditional implants, results in the maxilla were more favorable than in the mandible. Although the 286 implants used in this study were assumed to be an adequate sample, the evaluation period of up to 40 months is not long enough to derive a general conclusion. Other studies now in progress involving the expandable implant may offer more information to support the results of this study.

The survival rates of immediately loaded and delayed loaded implants were 96.3% and 90%, respectively. The more favorable result for immediate loading is assumed to be due to the strong anchoring effect, which occurs with expansion of the implant. Brunske stated that micromotion of more than 100 μm must be avoided to achieve successful osseointegration. Apparently, the compaction of the quintapodal legs into bone by apical expansion effectively prevented micromotion of the implant. With apical expansion, a compressive force is produced that causes a microfracturing of the periapical trabecular bone. It may be that, with immediate loading, an intermittent stimulus occurs during function. Either of these 2 factors might be effective in inducing bone formation and thus responsible for the favorable results produced by immediate loading.

The implants placed in fresh extraction sockets showed a survival rate of 98.9%, whereas those placed in healed sites had a survival rate of 93.9%. Fresh extraction sockets exhibited slightly superior results in these patients. Because most fresh extraction sockets are classified into type II bone, they are suitable for placing implants. It is known that metabolism is more active in the bone of fresh extraction sockets than in the bone of healed sites. This factor may have contributed to the favorable results obtained in this study. Moreover, in the orthodontically correct fresh extraction socket, the implant can be placed within the original dental arch, and occlusal forces can be transmitted in the direction of the long axis of the implant. The traditional sequence of therapy calls for tooth extraction and healing to occur before implant placement. This method permits the alveolar ridge to collapse and bone quantity and quality to diminish, through disease, to such a point that it may not be possible to place implants without the additional time and expense of grafting procedures. For this reason, it would seem more desirable for implants to be placed in fresh extraction sockets rather than in healed sites.

Single-tooth freestanding conditions and multiunit conditions were compared. The survival rate of single-
Freestanding and multiunit immediate loading of the expandable implant: An up-to-40-m... Page 8 of 10

tooth, freestanding implants was 94.5%, whereas the survival rate of multiunit cases was 96.9%. This result suggests that the single-tooth, freestanding condition was quite promising, particularly in fresh extraction sockets in the maxilla, where the survival rate was 100%. In the past, immediate loading was possible only when multiple implants were placed and splinted. This study indicates that the immediately loaded, single-tooth, freestanding implant has a high survival rate when the expandable implant is used. The fact that implant placement into fresh extraction sockets showed a result superior to that reported by traditional implants is an indication that additional studies that make use of the expandable implant are needed. Treatment planning concepts for esthetic implants, as they pertain to the timing of tooth extractions and placement of implants, may need to be altered.

Of the 286 implants placed, 208 recorded a positive response to the stability test and underwent additional expansion. A positive response indicated the occurrence of micromotion, which was eliminated by additional expansion. Seventy-five implants exhibited complications.

Because 6 implants combined more than 1 complication, the actual number of complications was 69, none of which were the result of mechanical failure (fracture) of the implants. Among these, 13 implants failed. They were removed by simply reversing the expansion mechanism and allowing the implant to collapse. The majority of the complications were problems common to all implants (for example, failure to integrate possibly because of frequent tobacco use, biomechanics, and systemic conditions).

The 2- to 3-mm-wide radiolucencies in the furcation area on 3 of the implants completely resolved after cementation of the delrin seal cap for the internal screw head located at the bottom of the abutmentscrew channel. This reversal strongly indicates that bacteria-laden oral fluids were able to pass through the seal mechanism of some of these implants and into the bone, causing the lesions. Possible causes of the leakage include insufficient expansion-screw tightening on placement of the implant and manufacturing defects.

The ability to rescue an implant that has developed micromotion by performing additional expansion is a beneficial feature of the expandable implant. Without this feature, the results of this study would not have been as favorable.

CONCLUSIONS

On the basis of this evaluation of 286 expandable, immediate load implants placed into 75 patients during a 40-month period, the following conclusions were drawn.

1. Survival rates of 100% in the maxilla and 95.7% in the mandible were obtained by immediate loading in fresh extraction sockets.
2. Survival rates of 95.5% in the maxilla and 94.8% in the mandible were obtained by immediate loading in healed sites.
3. The overall survival rates were 96.0% in the maxilla and 94.6% in the mandible.
4. The results suggest that, even if instability occurs after initial loading, removal of the occlusal load for 16 to 18 weeks and additional expansion can restabilize the implant.
5. Because this was a 40-month serial case study, the results are limited and should be viewed with reservation until a 60-month (or longer) evaluation is performed.

REFERENCES


http://www.sargondentalimplants.com/home/index2.php?option=com_content&task=view... 1/30/2008
Freestanding and multiunit immediate loading of the expandable implant; An up-to-40-m... Page 9 of 10


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Noteworthy
Abstracts Current
Literature

Swedish dentists' decisions on preparation techniques and restorative materials


Purpose. The aim of this study was to identify variables among Swedish dentists in their choice of preparation techniques and restorative materials for the restoration of primary approximal and occlusal carious lesions in permanent teeth in an

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adolescent population.

**Material and methods.** A precoded questionnaire that included illustrations of different approximal and occlusal carious lesions was sent to a random sample of 923 Swedish dentists. The sample was drawn from the register of authorized dentists and included only those dentists who were 65 years of age or younger. Of the 520 respondents, 52% were employed by the public dental health service, and 48% were in private practice. Precoded alternatives were given for both preparation type and restorative material. The responses were anonymous. The results were subject to statistical analyses. Regression analysis (ANOVA) was used to analyze the relationship between dentist age and the dependent variables of restorative techniques and choice of dental materials.

**Results.** To restore primary approximal caries in a 20-year-old patient with low caries activity and good oral hygiene, 48% of surveyed dentists chose a tunnel preparation, 32% chose a saucer-shaped preparation, and 20% chose a traditional class II preparation. To restore occlusal caries, 74% of the respondents chose removal of the caries part only. For a mandibular second molar with a minor occlusal carious lesion combined with a suspected dentin lesion judged radiographically, 50% of the respondents chose to restore only the carious part, and 27% chose to seal the rest of the fissure system as well. For a similar lesion with no obvious dental radiolucency, equal numbers of respondents chose one of the following: a "no treatment" alternative, a fluoride treatment, or fissure sealing or other techniques. Resin composite was the most chosen and amalgam the least chosen material for both approximal and occlusal carious lesions.

**Conclusions.** On the basis of the results of this survey, it seems that Swedish dentists replace traditional class II preparations with more tooth-conserving preparations. For occlusal restoration, tooth-saving techniques appear to be widely practiced, implying removal of only carious parts of the fissure system. Resin composite is the material of choice for restoration of these teeth. 23 References. -RP Renner