

Replacement of individual teeth with IMPLADENT implants - a 5 year study

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Dental implantology is one of the fastest developing stomatological disciplines in the Czech Republic. Thanks to the constantly evolving practice of domestic implantology, dental implants are becoming generally accepted as a part of modern stomatology. In the early 1990's there were several implantation systems developed in the Czech Republic, exemplifying further remarkable evolution¹⁷. Thanks to the wide offer of accessories, domestic implantation systems match the quality of foreign competitors, whilst still being available for reasonable prices. These implants however lack long-term clinical success rate evaluation, published in professional periodicals.

Introduction

We have so far devoted a series of articles to the IMPLADENT implant system, offered since 1992 by the Prague-based company Lasak s.r.o. (Ltd.)¹⁴. This has focussed on the shortened dental arch¹⁵, and edentulous jaws¹⁶, presenting a three-year multicentric statistical analysis of a collection of 1264 implants¹². We now aim to consider the potential of this system for the single tooth replacement.

We replace frontal teeth with dental implants far more frequently in the maxilla than in the mandible. This area is typical for high aesthetic demands concerning the quality of supraconstructions, generally limited bone availability, due to alveolar atrophy and extra-axial load on the implant. In lateral areas, we use implants in both jaws, in the area of molar teeth, mandible is predominant because the volume of alveolar bone available in maxilla is often considerably limited due to the maxillary antrum. The aesthetic aspect is much less important. The greatest problem is the risk of overloading the implant. Sometimes, it is recommended to use two implants under one crown, however, this is often impossible due to the gap length.

Material and Methodology

The analysis incorporates all IMPLADENT implants, applied from July 1993 to February 1998, concerning the indication "loss of one tooth", which were assigned for a solo crown. The data on implantations were acquired retrospectively from medical documentation. We followed the commonly specified contra-indications¹². Before applying each implant, orthopantomogram was carried out for each patient, sometimes completed with intraoral x-ray images. In order to find out the thickness of alveolus, we made use of dental CT analysis or mapping the gingiva, using a hypodermic needle with a rubber disc. Most patients were instructed on dental hygiene. Recall examinations were carried out according to the previously published scheme.

The IMPLADENT system offers seven types of fixtures. Four of them are made of titanium alloy, Ti6Al4V (ISO 5832-3), with a hydroxyapatite coating, either cylindrical (VHA) or screw-shaped (SHA). They may contain antirotary elements which ensure that abutments do not rotate in the implant (SHA-O, VHA-O). The remaining three implants are made of pure titanium (ISO 5832-2) with grit-beasted surface. The first one is screw-type (STI), complemented with a modification comprising an antirotary element (STI-O). The diameter of all the above said implants is 3.6 mm and the length ranges from 8 to 14 mm. In addition, there is a titanium self-tapping screw with an antirotary element (STI-S), diameter 2.9 mm and length 10 to 15 mm. The implants SHA, VHA and STI were available from the very beginning of the monitored period. The SHA-O modification was introduced in October 1995 and we subsequently ceased to use all previous types for the replacement of one tooth. The STI-O and STI-S modifications were made available from October and December 1997, respectively and the VHA-O modification in February 1998. We used abutments with a diameter 3.6 or 4.8 mm, either direct or angled at 15 or 25 degrees. The supraconstructions were produced using the appropriate impression and laboratory tools⁶.

Implants were left free of load and isolated from the mouth cavity for a period of at least three months (mandible) and six months (maxilla). Upon the conclusion of the healing period, the second surgery phase followed, with a two-week application of healing cylinders. We then fitted a new abutment, produced a solo crown and fixed it with cement.

We modified the success criteria according to Olsson et al⁹. An implant was classified as a failure in the case of occurrence of at least one of the following: elimination from alveolus, poor stability, signs of chronic infection, pain or any other undesired subjective feelings, or considerable mechanical damage. Non-osseo-integration during the healing period was classified as primary failure, later malfunction as secondary failure. Implants of patients who did not accept the follow-up care were excluded from our statistical analysis. We evaluated the success rate using the "input-output" method and the life-table was determined according to the Kaplan-Meier' method¹³. The second evaluation method is based on the time interval elapsed from the application of each particular implant. It gives less optimistic results, however, it is a truer expression of reality¹³.

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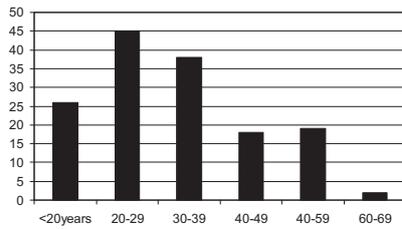


Diagram 1: Age structure of patients

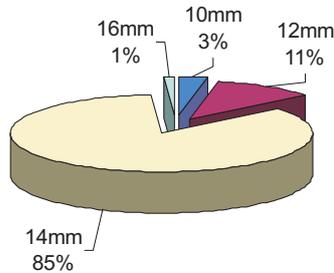


Diagram 3: Length of implants applied

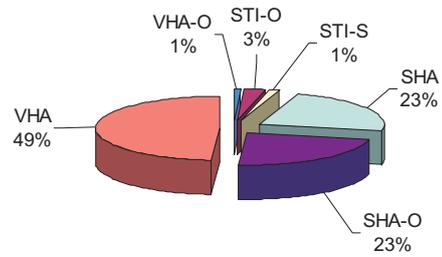


Diagram 2: Types of implants applied

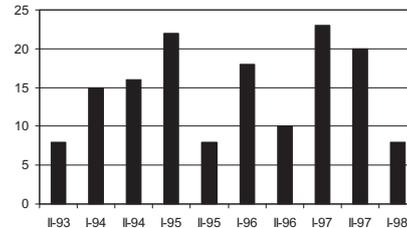


Diagram 4: Implantation frequency

Results

We inserted 1212 IMPLADENT implants between June 1993 and February 1998. We used IMPLADENT implants with 148 (12.2%) patients (75 male and 73 female patients). One hundred and twenty-four patients had one tooth replaced, nine patients had two teeth replaced and in two cases, we replaced three teeth. Our group therefore comprised 135 patients. For further basic information, see Table 1, Diagram 1 details the age structure of the group.

Almost all of the implantations we carried out were delayed at least one year following the extraction of the tooth. In three cases, we carried out immediate or delayed immediate implantation, always in the frontal area of the maxilla, which in all cases turned out to be a success. In one case we replaced a tooth # 27 with two SHA 10 mm implants, bearing a single crown. We decided upon this option in order to avoid excessive load on the short implants in a poor-quality bone density D4.

For the type and length of implants used, see Diagrams 2 and 3. Ninety-eight (66.2%) implants were made in the maxilla and fifty (33.8%) in the mandible; for the exact location, see Figure 2. For frequency, see Diagram 4.

Twenty-three patients are still in the healing phase, which was completed amongst concerning the remaining 125 implants. We encountered primary failure in three cases, in locations 24, 33 and 36. The extractions were carried out not later than during the second surgery phase. The remaining 97.6% of implants were successful. Secondary failure was reported in one implant, location 11, which was extracted nineteen months after the application of the crown. The subsequent our-patient programme was not accepted by 29 patients (19.6%), with 19 tooth replacements in the maxilla and 10 replacements in the mandible. Other implants were monitored for an average period of 25.4 months from the implantation (ranging from 3 to 53 months) and 19.3 months after the application of

the crown (from 1 to 50 months). Based on the "input-output" analysis, a total of 95.0% of implantations were successful. The result was identical for both jaws. For the life-table, see diagram 5. Towards the end of the first and second year, the success rate reached 96.8%, dropping down to 96.8% during the third year. It subsequently remained unchanged.

Discussion

Comparison of statistical results between various publications often reveals a considerable discrepancies. We therefore consider the most reliable a comparison with the previously published three-year multicentric study of 1264 IMPLADENT implants, used for all implantological indications¹³. The success of the healing phase (97.7%) was very close to our result – 97.6%. According to the "input-output" analysis, 97.7% of all implants were classified as successful after a period of thirty-six months. In our statistics, the success rate reached 95.0% after a period of fifty-six months. A more accurate result can be determined on the basis of a comparison of the life-table analyses, which take into account the actual monitoring period of individual implants. Within a three-year study¹³ the success rates after periods of one, two and three years, were 97.2%, 94.8% and 92.6% respectively. Our result was 96.8% during the first and second year, and 94.8% after the third and fourth years. We compared literature results by Malevez et al,⁸ in order to analyse the topic of a one-tooth replacement. Their evaluation focussed on 84 Branemark' implants, reporting 2.4% failure within a 5-year period, always during the first year after the implantation itself. Becker et.al.¹ evaluated 24 Brånemark' implants

Tab. 1: Basic data on patients

| number | |
|-----------------|--------------------------|
| Total | 135 |
| male patients | 68 (50.4%) |
| female patient | 67 (49.6%) |
| age | |
| Average | 31.7 years (15-63 years) |
| male patients | 31.8 years (16-53 years) |
| female patients | 31.6 years (15-61 years) |

with the same indication. After a period of one year, they achieved a success rate of 95.7%. Klemke et.al.⁷ indicate a 90.0% success rate of one-tooth replacements after 10 years, based on an analysis of 236 implants.

The minimum age for successful implantation is limited by the complete development of the facial skeleton³. It is quite difficult to determine such an age for a particular patient, therefore the age limit has been generally set at 18 years for boys and 16 years for girls. Although we did not strictly adhere this principle, we encountered no complications. Brungolo et al.³ present a case report in which they document the "wandering" of implants due to the growth of facial skeleton in case of implants in the maxilla frontal area, for 11.5 to 13 year olds.

Unlike a majority of our dentists and patients, we are convinced that a good quality replacement of one tooth with an implant in a visible section of the denture is one of the most demanding tasks within dental implantology, requiring much more experience and skill than the majority of other operations encountered. In case of advanced alveolus atrophy, we recommend preparation of the implant bed in parallel with the alveolus palatal lamella, i.e. disregarding the relation of the implant and abutment macrodiagonal. In case of the replacement of an upper front tooth, we consider the spacial requirements of the abutment and supraconstructions¹². Too large a location of the implant will lead to an aesthetic problem, which is hard to repair. In case of palatal localisation, the area for abutment can get blocked with the lower incisor teeth, particular during a "deep bite", and subsequently, the implant has poor effectiveness.

We consider it necessary to use implants and abutments with antirotary elements, consisting of an octagonal abutment base, which engages in the implant. The abutment is connected to the implant with a fixation screw. One of the most serious problems concerning the replacement of a frontal tooth is how to ensure a natural look in the area of marginal gingiva, and reconstruct the septal gingiva ("red aesthetics")¹¹. The fundamental prerequisite is the subgingival modification of the supraconstruction, i.e. sufficiently deeply implanted abutment step and the gingival edge of the crown^{1,4,7}. The location and configuration of marginal gingiva is based on the localisation and shape of the cut during the implantation's second surgery phase. The more palatal the cut is, the longer the vestibular lap and the transmission between the gingiva and crown shifts in the incisal

direction. We do not recommend excising the gingiva with trephine, particularly because the good-quality keratinised soft tissue is thus destroyed. Ideal model of the septal gingiva is a very demanding process. Its appearance is influenced particularly by the original conditions of the gingiva prior to implantation, an efficient cut during the first and second surgery phase and the shape of the temporal resin crown. We haven't yet carried out the newly described papilla reconstruction using a free fibrous graft².

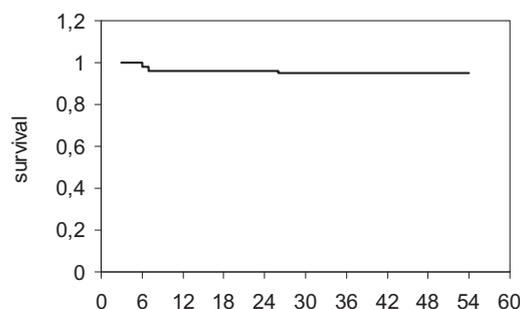


Diagram 5: Life-table according to the Kaplan-Meier's method. The timing of X-axis is expressed in months.

With respect to the submerged abutment step, the supraconstruction impression must be carried out immediately upon the abutment is fitted. Impression copings⁶ are a great advantage, since retraction of the gingival edge using other common means is not very effective. In case of angulated abutment, we make use of special impression post⁶, with which we are able to copy only the position of the implant's anti-rotary octagon. We then make the model on a titanium abutment of the same type which has been inserted in the patient's mouth. If the abutment is individually adjusted, we transfer it from the mouth to the plaster model, and replace it temporarily with a healing cylinder.

At first, we make a temporary resin crown. It adapts conveniently the gingival channel, and – as a result – the crown can be buried deep and broad. Besides, the production of the temporary crown is fast and the patient is able to specify his/her aesthetic requirements. We make imprints for the final crown after a two-week period. It is recommended to imitate the soft tissue with resilient modelling matter, which becomes part of the plaster model². The flexible gingiva model is a true reproduction of the actual mouth situation, enabling us to imitate precisely the crown's cervical section. For biological, mechanical and aesthetic ("white aesthetics") reasons, we prefer metallo-ceramics rather than crowns with plastic facet. We have not had the opportunity to make any all-ceramic crowns.

In the frontal area, we prefer abutments with a diameter 3.6 mm⁶, while in lateral areas, we consider the 4.8 mm diameter⁶ to be more convenient. We try to avoid temporary solo crowns. Even the top-quality foreign implantation systems suffer from frequent complications caused by thin fixation screws¹.

Crowns of distal teeth reach the gingival or slightly supragingival level. On one hand, we thus deviate from the optimal supraconstruction shape. However, patients find their oral hygiene much easier. We opt for an anatomic shape of the crown with implanted gingival edge only upon a request of the patient. This is also possible only in case that adequately high soft tissue is available, allowing such implantation. In foreign literature, we come across implantation of crown steps in the molar area much more often, based on growing aesthetic requirements.

In any case, molar crowns must be reduced vestibule-orally, in order to reduce the load on the implant. When replacing a last tooth in a row, we apply the so-called moral pre-molarisation. The cervical parts of pre-molar and molar teeth are modelled in order to enable the use of an interdental toothbrush. One of the most critical requirements is to carefully articulate the supraconstruction on both the working and balancing side, in order to ensure smooth transmission between the centric relation and the habitual occlusion (the so-called long centric)¹⁰. The contact between a supraconstruction and the antagonist should be as light as possible. This is due to the risks of excessive load and exclusion of an implant subject to excessive chewing pressure.

In case of a replacement of one-tooth, we can always opt for one of the traditional alternatives. It is possible to make use of the classic fixed bridge, temporary prosthesis, orthodontic gap cover or adhesive bridge¹². Dental implants are without any doubt the truest imitation of the original anatomic situation – a crown that is isolated from adjacent teeth and supported by its own radix. The largest advantage, i.e. protection of the intact hard dental tissue, is opposed by the considerable financial cost, anatomic and hygienic requirements concerning the situation within the mouth cavity, time demands and the imminent risk of failure.

The fears of major surgery are unsubstantiated, as the invasiveness of the operation is minimal and there is a surprisingly low rate of postoperative complications. All patients have their own choice; we only recommend what we consider to be the best solution. If they opt for dental implants, we can assure excellent results, from the perspective of both function and appearance (see also Figures 2, 3, and 4). Our medium term study reveals that the IMPLADENT system is convenient and reliable.

Conclusion

The study focuses on the topic of single tooth replacements using IMPLADENT dental implants. It references previous publications dealing with this implantation system. The authors draw our attention to specific problems of this particular procedure and present solutions based on the IMPLADENT system. Within the statistical section, the study presents 148 implants inserted over a period of 56 months. Implants were monitored during an average period of 25.4 months. Osseointegration was successful for 97.6% of all implants, based on the final "input-output" evaluation, 95.0 % of all implants were successful. There was no considerable statistical difference between implants applied in the maxilla and the mandible. According to the Kaplan-Meier's analysis, the success rate reached 96.8% after the first and second year, dropping down to 94.8% during the third year, without any further changes. The results are comparable to similar reports of foreign authors involved in the application of prestigious implantation systems. The authors conclude that replacement of single teeth using dental implants is one of the most complex and difficult tasks in stomatology. The IMPLADENT system exhibited adequate reliability over a medium time horizon, and convenient for the patient under consideration.



Fig. 1: Implant localisation

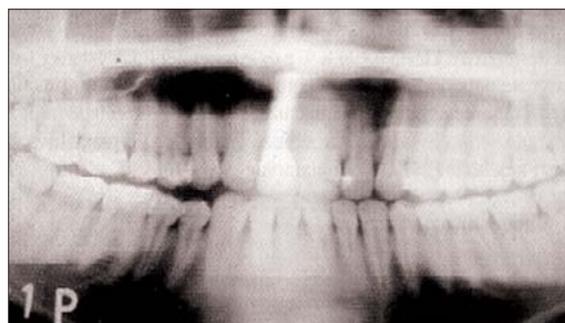


Fig. 2: Panoramic X-ray after a replacement of tooth # 11 of a seventeen-year old girl.



Fig. 3: Patient from Fig. 3, viewed from the perspective of "white aesthetics" ...



Fig. 4: ... and from the perspective of "red aesthetics" much more demanding for the implantologist.

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