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Implant Failure: Regional versus Cumulative Evaluation

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A B S T R A C T

In this paper the success rate of implant therapy in various bone regions is discussed. The objective is to determine whether differences existed in success rates of cylinder implants placed in different areas in the both maxilla and mandible. Forty four patients have been treated and reviewed five years after the placement of the fixed prosthetic restoration. The patients were provided with a total of 92 implants. Results from this study show very low survival rate for implants placed in anterior region of maxilla (55.6%) after five years. It is concluded that simple cumulative follow up studies do not entirely correspond to actual situations, positioning the implants has an important role in the planning of the implant therapy and that important factor for force compensation is not only the surrounding bone density, but also the region of the jaw where the implants are placed.

Introduction

In this paper we discuss the success rate of implant therapy in various regions of the jaw. It is evident that osseointegration is a guarantee for long–term success in the anchorage of dental prostheses, which is particularly advantageous when there is insufficient bone for conventional dentures[1]. Osseointegration is one of the most important conditions for successful dental implantology and can only be achieved and maintained by precise indication, appropriate implant choice, careful surgical installation technique, long healing time and proper stress distribution when in function[2]. During healing as well as while in function, it is necessary to prevent occlusive overloading which is obtained more easily in the partial dentoulus than in edentulous jaw[3]. Despite variations in integration patterns, stress is highest towards the bone crest (cortical bone) and relatively

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low towards the implant apex[4]. Large compression stresses occurred in a small part of the bone at the coronal portion of the mandibular ridge, while the majority of the loading occurred in the cortical region of the mandible[5]. Since different regions of the maxilla and mandible differ in bone structure and physiological loading, we expect that the success of implant therapy is also determined by the specific region of placement.

Both main types of implants (cylinder and screw shaped) are equal in survival success and can be placed in all regions. The objective of this report is to determine the differences in these regions which means the most successful/unsuccessful position for the survival of (cylinder) implants by testing different areas in both the maxilla and the mandible.

Material and Methods

Forty four patients (29 women, 15 men) with the mean age of 47 years (min. 21, max. 65) have been treated and reviewed five years after the placement of fixed prosthetic restoration. In sum, the patients were provided with a total of 92 titanium, two stage cylinder shaped, IMZ system (Intra Mobile Cylinder) implants. Special features included a transmucosal implant extension and the intramobile element IME, which was used to mimic the resiliency of the periodontal ligament. This system is indicated to splint natural teeth, as well as freestanding fixed partial dentures and clip bar prostheses for edentulous patients. The specific positions of the implants are indicated in Table 1.

Before implantation, the anamnesis was taken and special attention was drawn to diseases and drug consumption. A clinical analysis focussed on width and height of the alveolar process and the relationship between mobile and immobile mucosa in the region of planned surgery. A radiological examination included orthopantomograph and standard and/or bite dental x-ray images which were later used to determine cortical thickness and spongiosal density.

The surgical procedure was carried out in accordance with the rules of two-phase surgical treatment that is required for IMZ. After the operation, the patients were advised to put cold packs in the first 24 hours, to use the antiseptic chlorhexidine twice a day within the first two weeks and to take analgesics if needed. After the placement of the prosthetic restoration, the patients were scheduled for medical supervision in one year intervals.

Results

The 92 implants have been integrated and not a single one had to be actively removed after the surgical procedure. Table 1 shows the number and the percentage of implant loss compared to the total of implants after five years. On average, 16.3 percent out of all implants had been lost. The implants placed in the anterior region of the maxilla showed with 55.6% the lowest survival rate, whereas the implants of the other regions showed survival rates around 85%. This fact is neither reflected in the cumulative success rate for both jaws (83.7%) nor in the survival probability for the maxilla implants (71.4%) nor in the one for the mandible implants (87.3%).

Discussion

After five years, the highest percentage of implant loss was found in the anterior region of the maxilla. The implant survival rate in the other regions was considerably higher. These results strongly support Hass' findings[6].

Dental implant failure has led to continuous innovations of various implant systems and to different interceptive

TABLE 1
LOST IMPLANTS COMPARED TO TOTAL IMPLANTS IN DIFFERENT REGIONS AFTER A PERIOD OF FIVE YEARS

Position	N	%
Maxilla		
Anterior	04 / 09	44.4
Posterior	02 / 12	16.7
Subtotal	06 / 21	28.6
Mandible		
Anterior	02 / 13	15.4
Posterior	07 / 58	12.1
Subtotal	09 / 71	12.7
Total	15 / 92	16.3

TABLE 2
TYPE IV LOSSES COMPARED TO TOTAL LOSSES OF IMPLANTS IN DIFFERENT REGIONS AFTER A PERIOD OF FIVE YEARS[8]

Position	N	%
Maxilla	23 / 37	62%
Posterior Mandible	11 / 21	52%
Anterior Mandible to Mental Foramina	2 / 7	29%
Total	36 / 65	55%

treatment modalities. These concerns also led to a selection of implant designs suiting best to various types of bone[7]. Branemark[8] described four classes: Type I is homogeneous cortical bone which is perfect for implant therapy. Type II (thick cortical bone with marrow cavity) and Type III (thin cortical bone with dense trabecular bone of good strength) have enough cortex to stabilize the implant and sufficient strength to hold the integrated implant in function. However, Type IV is very thin cortical with low density trabecular bone of poor strength and has minimal internal strength. A five year analysis of excessive loss of Branemark fixture in Type IV bone was published by Jaffin and Berman 1991[8]. In Types I, II, and III, the total fixture failure rate was 3% and in Type IV bone 35. Several studies revealed a success rate of 70–80% for implants placed in the maxilla and over 90% in the mandible[1,9,10]. Babbush and Shimura[11] reported a very favorable five year survival rate of 92% for a group of 467 IMZ implants, and Fugazzotto et al.[1] reported a cumulative success rate of 92.9% on 991 maxillary IMZ implants. In the study that reports the results of placing implants in 34 patients with diabetes who were treated with 227 Branemark implants, at the time of second-stage surgery, 214 of the implants had been osseointegrated and showed a survival rate of 94.3%. Only one failure was identified among the 177 implants followed through final restoration[13].

Many studies suggested the occlusal forces to be the main factor in implant failure[14], as well as bone density, but most of them still calculate the implant

success rate cumulatively, and are not awarding failures to region of both jaws. Most authors have examined possible factors that influence the prognosis for implants without distinguishing between mandibular and maxillar implants. No appropriate conclusions can therefore be drawn from variables that might influence the prognosis of implant survival for the upper or for the lower jaw separately.

There are only few studies in which, for evaluating success of implant therapy, follow up has been investigated, taking into account the jaw region. In the analysis of Type IV bone[8], the results are not equally distributed nor between the jaws nor among different areas (Table 2). In the maxilla 62% of all implants have been lost, while in the anterior mandible the loss is only 29%[8]. This is a significant disproportion in the success rate, pointing to the importance of discriminating between these regions. In Hass'[15] study 25.2% of 1920 implants were placed in the maxilla. These maxillary implants showed a survival rate of 71.6% after 60 months and only 37.9% after 100 months, a statistically significant difference (P = .03; SD = .06). The Kaplan-Majer survival rate for implants in the maxillary incisal, canine and premolar region was 65.5% after 60 months and 31.8% after 100 months; that one of the maxillary molar region was 96.9% after both 60 and 100 months. In the mandible the Kaplan-Majer survival rates were 94.5% at 60 months and 91.3% at 100 months, for the incisal, canine, and premolar region; and 91.7% at 60 months and 87.9% at 100 months for the molar region. In these papers, the authors presented a regional approach for the evaluation of implant therapy. As mentioned, the success rate after five years was lowest in the anterior maxilla. Several other authors have also reported that the success rate of maxillary implants was clearly, sometimes even significantly, lower than those of the mandibular implants[16–18]. A possible explanation for the markedly worse results of the maxillary implants compared to the mandibular implants, might be the generally inferior cancellous bone structure of the maxilla[19]. Dietrich et al. reported similar results for the maxilla[20], describing a survival rate of 77.3% after 48 months in a random sample of 61 IMZ implants.

Although differences in implant survival probability in various regions have been repeatedly presented, and now confirmed again, this problem of actually masking the results of the regional analysis by using the cumulative analysis was never the topic in evaluation studies of therapy. Reports mainly focussed on the statement that the maxilla is the more difficult arch to restore with endosseous dental implants[21,22]. The body of data suggests that the distal regions of both the maxilla and the mandible sustain greater forces, although the bone density is poorer than in the anterior regions. Probably, it is not only the bone structure, but also the physiological load predisposition, as well as the direction of forces in function, that successfully transport most of the forces. In an effort to try to solve the problem of force distribution, most manufacturers provide implants in various lengths. The longest implants are typically inserted into the anterior regions of the mouth, where forces of less extent and superior bone quality are present[23]. Our results, as well as the ones of other workers, suggest that the risk is highest in the frontal maxillar region, probably due to unequal force distribution, determined by the apical basis and the narrow implant placement.

Conclusions

This discussion shows that traditional cumulative follow up studies were too rough to detect these more complex facts. It is evident that the positioning of the

implants plays an important role in the planning of implant therapy and it would be essential to consistently pursue the same criteria also for the analysis of the implants' success. The high failure rate in the frontal maxillar region needs to be put under closer scrutiny in future studies, and both regional and cumulative analysis should be standard when analyzing follow up studies of success rate and evaluating implant therapy.

The more detailed evaluation of the data has revealed that high success rates for implants, indicated by cumulative analyses, mask the unequal success for the different regions of maxilla and mandible. The determining factor for force compensation is not only bone density, but also the specific region of the jaw where the implants are placed.

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USPOREDBA REGIONALNE I KUMULATIVNE PROCJENE USPJEŠNOSTI IMPLANTOLOŠKE TERAPIJE

S A Ž E T A K

Ovaj rad razmatra uspješnost implantološke terapije u različitim djelovima čeljusti. Svrha rada je utvrditi postoje li razlike u uspješnosti terapije cilindričnim implantatima u pojedinim regijama maxile i mandibule. Nakon protetske terapije četrdeset i četiri pacijenta praćena su tijekom pet godina. Ukupno je ugrađeno 92 implantata. Rezultati su pokazali nizak postotak uspješnosti u prednjoj maksilarnoj regiji (55,6%) nakon pet godina praćenja. Zaključeno je da kumulativne procjene uspješnosti ne prikazuju stvarno stanje stvari, da je u planiranju terapije bitno područje čeljust u koji će implantati biti postavljeni i da otpornost na opterećenje nije determinirano samo gustoćom kosti već i regijom čeljusti.