

Denti-System Ltd., Szentes\* Department of Oro-Maxillofacial Surgery and Stomatology, Semmelweis University, Budapest\*\*

## Reviewing the literature on the experience with the use of short implants

DR. ISTVÁN VAJDOVICH\*, DR. MIHÁLY OROSZ\*\*

Short implants are more and more frequently used in the dental practice, and it is also reflected in the literature. The number of international publications on this subject has significantly increased in the recent years. Since there are many controversial issues related to its application, the authors set themselves the objective to present the most important experience of publications to dentists who are involved in dental implantology. Based on the results of the 33 reviewed publications (9 Review articles and 24 clinical studies), the authors recommend the use of short implants in the daily dental practice.

Key words: short implant, indication, contraindication, principles of application

During the last thirty years of the history of dental implantology, several basic principles were seen to be failed which had often been honored as doctrines. Consider the questions of immediate, early, or delayed loading. The application of sufficiently long (min. 10 mm long, standard size) large-surface implants, which were broad enough in diameter (about 4 mm), was deemed to be an equally important key rule concerning long-term success, not to mention the prosthodontically important ratio between the implant body and the abutment. The implant/crown length ratio has to be at least 1 in order the loading on the implant by chewing forces to be sufficient in the long term.

Tempora mutantur – times change, and we change with them, and our principles related to the application of dental implantology are constantly changing based on more and more recent study results. This phenomenon can be seen in the case of short implants as well. The growing number of the results of scientific studies and long-term clinical trials disprove our previous concept, since data from literature show that short implants are used more and more frequently in the daily dental practice, too.

We consider that it is important to present the results and principles related to short implants used in dental implantology. In this review article, results that are scientifically sufficiently well-founded and proven by long-term clinical trials are summarized based on international scientific literature related to short implants.

### Materials and methods

The studied English-language publications were selected from MEDLINE (PUB MED and Ovid) and Cochrane databases on 22 September 2014. The following search words were used: “short dental implant success” (209 results), “short dental review” (195 results), and “short dental clinical study” (357 results). After the selection, we studied 33 publications of which 9 were Review articles and 24 were clinical studies. The criteria for selection were the duration of the follow-up study; the number of study participants; the impact-factor of the journal; and if any other (for example, histological, microbiological) test results are given in the paper.

In each article, the length of the implants was maximum 10 mm or less. In addition, we considered it as a criterion that in the posterior region of the jaw due to the atrophy of the alveolar crest an implant longer than 10 mm could not have been implanted without an additional surgical intervention. In most publications the authors described implants with body length from 5 to 10 mm as short implants [3, 20]. Others considered an implant short only under the length of 8 mm [26, 30].

#### **1. Overall assessment based on the publications**

The first short implant (7 mm) was applied by the Brånemark School in 1977 [31].

The acceptance of using short implants has emerged in the past few years. In previous years, the low success rate and the unpredictable implant retention time were criticized when assessing short implants. We used to accept as a fundamental law that only longer (standard) implants can lead to successfully long-lasting results.

There are many reports about the statistically proven low success rate of using short implants from this time period [21, 33] Conversely, in current years there is an increasing number of publications reporting remarkably successful results achieved with short implants [3, 16, 17, 18, 19, 25, 28].

Short implants are primarily designed for creating fixed dentures in edentulous areas of the mandible replacing premolar/molar teeth or several teeth at the same time.

Prior to the implantation of short implants, the authors consider the followings necessary for preparing the management plan [18, 31]:

The implant is indicated:

- over the age of 18 years
- appropriate general state of health and degree of oral hygiene of the patient
- there is no inflammation in the periodontal region
- the suspected cause of teeth loss (chronic or aggressive periodontitis, caries, etc.)
- there is no parafunction
- due to the degradation of the alveolar crest in the given situation, only an implant up to 8 mm can be implanted
- at least 6 weeks have passed since the last extraction
- in the antagonist denture, the occlusion surface is retained.

The most common reasons for the exclusion of short implants:

- incomplete or poor oral hygiene
- acute or aggressive periodontitis or other inflammatory diseases
- insufficient amount of bone at the desired location of the implant, i.e., there is not enough bone supply for an implant with 8 mm of body length.
- at the location of the implant previous bone grafting occurred

Table 1

Features of using short implants and their success rate in the international literature

Authors	Number of implants	Size of implants	Duration of the study (after the loading)	Cumulative success rate	Type and number of publications
Mangano FC et al. [18]	215	3.3–4, 1–4.8 x 8 mm	1–10 years	95.9%	study
Tutak M et al. [31]	5643	5–10 mm	1–8 years	83.7–100%	study (13) review (6)
Balevi B [4]	2223	7 < 10 mm	1 year	97.5–98.7%	study (14) review (40)
Lops D et al. [16]	257	8 mm	10–20 years	92.3%	study
Annibali S et al [3]	6193	< 10 mm	3.2 years	99.1%	study (2) review (14)
Urdaneta RA et al. [32]	410	5 x 5.05 x 6.0–5.0 x 8.0 mm	20 months	97.5%	study
Rossi F et al. [27]	40	4.1–4.8 x 6 mm	2	95%	study
Tellemann G et al. [30]	2611	5–9.5 mm	1980–2009	93.1–98.6%	review study (29)
Malo P et al. [17]	408	7–8.5 mm	1–9 years	96.2–97.1%	study
Misch CE et al. [19]	745	< 10 mm	6 years	98.9%	study

- uncontrolled diabetes mellitus
- systemic autoimmune diseases
- smoking.

## 2. Detailed assessment of the publications

The authors examined the success of the implants under the criteria of Albrektsson and Zarb (1998) [2].

Comprehensive review articles can be categorized into two main groups:

1. presentation of treatment results (reviews)
2. description of factors influencing success (studies).

### **2.1. A detailed description of the results of short implants based on some of the major publications.**

Balevi B [4] has evaluated and compared the success rate of short and standard sized implants after being worn for 1 year by the methods of meta-analysis based on 54 publications. The results of 14,158 standard and 2,223 short implants have been assessed. After the beginning of the loading, the short implants showed statistically better results at the end of the first year than the standard implants.

Based on subgroup analyses, statistically poorer success was found in case of short implants placed into the posterior region of the maxilla compared to standard implants; however, there was no difference between the success rate of implants implanted into the posterior region of the mandible and the anterior region of the maxilla. No relation has been found between the diameter and the lack of success of implants with microporous surface.

In the review of Tutak M et al. [31], the results of 5643 short implants can be found from 32 publications. Short implants were mainly suggested to be implanted into the posterior regions of the lower and the upper jaws. In the publications, the success rate of the implants ranged from 83.7 % to 100%. In 13 publications, it has exceeded 95%.

Deporter et al. [10] have reported the lowest rate of success in patients with 5 mm long implants with porous surface in the posterior regions of the maxilla. The results showed that the size of these implants was critical concerning the long-term success; thus, their use is not recommended.

Lops D et al. [16] followed up 127 patients with 257 implants (108 short and 149 standard implants) for 10–20 years. After 20 years of follow-up, the cumulative survival rates were proven to be 92.3% and 95.9%, while the cumulative success rates were 78.3% and 81.4%, respectively. The difference was not significant statistically. Besides, it was also demonstrated that the probability of the success of short implants implanted into the posterior and the anterior regions of the mandible is the same. During the 20 years of follow-up, peri-implant bone resorption had an average value of 1.8 mm in case of short implants, while it was 1.9 mm for the standard implants. During periodontal probing, the measured values were larger than 3 mm in short implants in 4 cases and in 5 cases in the standard ones.

Mangano FG et al. [18] have implanted 215 short implants into 194 patients with short (1 or 2 missing teeth) interline edentulous areas in the posterior region of their jaws. During the 10 years of clinical follow-up, the implants with single crown showed a cumulative survival rate of 98.5%. However, the success rate was proved to be 95.9% in the same time period. Implants with 8 mm body length and different diameters were used in the implantations. After the implantation, they waited for the bony fixation for 3 months in the mandible and 4–6 months in maxilla, and the dental prosthesis was prepared only after that. The implantations were prepared in a two-stage surgical procedure. It is not recommended to use a screw-tap for creating the implant nest.

According to Annibali S et al. [3], using short implants in the prosthetic rehabilitation of the posterior parts of the jaw has several benefits for the patients and for the dentists as well. The need for bone grafting is reducing, there is also a reduction in the risk of sinus elevation surgery, the risk of inferior alveolar nerve paresthesia is lower, and there is also a decrease in the usual risks of surgical interventions [3, 20, 30]. The strength of that paper is the large number of implantations, and its weakness is the relatively short follow-up period.

### **2.2. The most important factors of the effectiveness of short implants based on the publications.**

According to the investigations of Lops D et al. [16] and in agreement with several authors, the quality of the bone, the surgical technique, the microstructure of the implant's surface, the bone surface–implant distance, the parafunction, and the primary stability of the implant appear to be the factors having an impact on the long-term success of short implants [5, 12, 14, 19].

Jaffin RA and Berman CL [12] think that the length of the implant has a direct effect on the success rate. According to other authors [1, 24], using implants of 8 mm body length is the ideal choice. Several authors have implanted short implants of 6 mm body length, but they cannot be assessed validly considering the long-term success [27, 30, 31]. We also consider short implants 'standard' with the body length of 8 mm and the appropriate diameter. The quality of the jaw bone affects the success of the therapy [22] and the long-term prognosis. In the posterior area of the maxilla, the bone quality is type III or IV, due to which the success of the implantation is significantly lower [6]. Other researchers have come to conflicting results in retrospective studies supporting the idea that similar success can be achieved with the use of short implants in the posterior region of both the upper and the lower jaws [16, 17]. Mangano FG et al. [18] have found in their 1–10 year retrospective study that implants with microporous surface and locking-taper (conically-closing interface) design are better in many aspects than the standard > 10 mm size implants with microporous surface.

The most important biological factors affecting the long term success appear to be bone density and smoking [30]. The prognosis is better in the mandible than in the maxilla [25, 26, 28]. Mangano FG et al. [18] have found no significant difference in the implant survival rate in smokers (> 15 cigarettes/day) either.

From the prosthetic factors influencing the success of short implants – according to some authors – the larger implant / crown ratio (I/C ratio) does not affect the long-term success [6, 7, 32]. It is recommended to splint the abutments, since chewing pressure on each implant can be reduced this way [18, 19, 32].

After reviewing the data in literature, Jung et al. [13] have found that the error of prosthetic factors in case of the 10 mm standard implants is caused by the loosening of the head piece fixing screw in 8.8% of the cases, the loss of retention in 4.1% of the cases, and the fracture of the porcelain surface in 3.5% of the cases after 5 years of wearing. In contrast, Lops et al. [16] have described that the complications after 10 years are related to the dentures in 1.4% of the cases. The authors claim that this favorable result is mainly attributed to the locking-taper system. This self-locking fixation provides secure mechanical stability on the interface between the head and body parts of the implant, which is capable of withstanding eccentric load, too. In addition to that it is able to withstand the torque on the abutment encountered during chewing, thereby substantially reducing the vulnerability of the prosthesis [8, 18, 32].

The advantage of the morse taper implant–abutment connection is that it inhibits bacterial colonization on the interface. It is known that in the micro gaps (40–100  $\mu\text{m}$ ) next to the head fixed by screws bacterial colonies persist, and they are largely responsible for developing peri-implant inflammation and peri-implant bone destruction [9, 23].

However, on the locking taper interface the dimension of the micro gap is only 1–3  $\mu\text{m}$ , which virtually excludes bacteria harboring on the interface [11]. Mangano et al. [18] have considered that due to this technique the average DiB (Distance implant to Bone; the distance between the shoulder of the implant and the alveolar ridge, indicating the extent of bone resorption) value was only 0.62 mm after 10 years based on their 10-year prospective study in 215 pieces of short implants. Biological complications were seen in 2 cases.

For a number of clinicians – implantologists – the smaller I/C ratio than usual is not acceptable, and therefore, they do not use short implants. In contrast, Tawil et al. [29] have concluded that even if this ratio is smaller, it does not increase the biomechanical risk, that is, it does not lead to peri-implant bone destruction. Several other authors have the same opinion [6, 7]. In contrast, Bidez and Misch [5] suggest that the forces acting on the implant may increase by up to 100% if the height of the prosthesis on a short implant is between 10 and 20 mm; therefore, it is necessary to use 2 implants instead of one.

Taking into account the above mentioned mechanical factors, it is very important to adhere with the biological aspects, too, predominantly to restore the biological width [18].

### Summary and suggestions in the light of the literature

According to scientific publications and reviews on the use of short implants in the international literature, the following major findings can be established:

- Using short implants in the absence of the host bone shortens the treatment period, simplifies the surgical intervention, and reduces the more complicated peri-implant procedure. These facts not only cause less discomfort to the patient, but the cost of the procedure will also be lower.
- Short implants with at least 7 mm body length, microporous surface, and preferably widely morse taper implant–abutment fixation demonstrated a widely and scientifically proven long-term success. The preparation of prosthetic abutments requires careful consideration of all the circumstances.
- In the majority of the studied publications, short implants implanted into the posterior mandibular region have proven to be more successful than the ones implanted into the posterior area of the maxilla. Short implants with microstructured surface gave better results than raw (machine) surface implants.
- The results presented in the international literature prove that the success of short implants is substantially the same as the success of standard implants. If short implants are indicated, the application of implants with larger diameters should be pursued.

Based on these results, more and more short implants with appropriate indications will be used in the daily dental, implantology practice in Hungary. It is recommended for the professional forums (Professional College, Implantology and Prosthetic Association, etc.) to formulate detailed professional recommendations for the practicing dentists on the use of short implants considering the experience published in the international literature.

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### Experiences of application of short dental implants in literature

According to the literature short dental implants have often been used for the replacement of teeth in the daily praxis. The implantation of short dental implants raise a lot of questions. The authors's aim is to collect the most important experiences of current literature on the mentioned theme to oral implantologists. In the article 33 reviews and clinical studies have been overviewed.

The analysis of the different studies suggest that the use of short implants - taking into account of indications and contraindications - decreases the incidence of complications and the patient's discomfort as well as the cost of treatment. The use of short dental implants is proposed as an alternative method in the daily dental praxis.

Keywords: short implant, indication, contraindication, basic principles