NUMBER OF IMPLANTS IN THE EDENTULOUS MAXILLA

Status quo

Dr. Tobias Bensel, PD Dr. Jeremias Hey

Why read this contribution?
The aim is to provide updated information on the current state-of-the-art regarding the number of necessary implants required to properly anchor a dental prosthesis in the edentulous maxilla.

Summary: Above all for economic reasons the number of necessary implants required to properly anchor a dental prosthesis in the edentulous maxilla is continuously being discussed. For the mandible there is solid evidence that with 2 implants a long-term stable, removable prosthetic restoration can be realised. 4 implants are sufficient for a fixed dental prosthesis. At present clinical studies are investigating whether even only one implant already provides a relevant advantage. However, how about the maxilla? The article provides a brief overview of the current state-of-the-art in research to answer this question.

Keywords: Implants; edentulous maxilla; fixed dental prosthesis; removable dental prosthesis

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PROLOG
As in many fields of medicine, the following is also valid in dental implantology: „As much as necessary, but nothing more.” Despite the fact that several surveys have meanwhile been conducted with regard to realising a prosthetic restoration in the edentulous maxilla over the past more than 40 years, there is no solid evidence to date with regard to the necessary minimum number of implants not only for removable, but also for permanent prosthetic restoration [20]. Too few studies meet the high scientific requirements in this respect [14]. An example shall be given to show what is meant by that theory. Assuming that there were the issue whether a permanent prosthetic restoration in the maxilla on 6 implants a) with angulation of the distal implants without bone regeneration is equally successful as b) the axial positioning of distal implants with sinus lift and augmentation. In order to reliably react to scientific standards in this context it would be necessary to carry out a controlled and randomised study. This would initially mean that an external clinical study centre would accompany the examination.
from the beginning on and would also monitor the collection as well as evaluation of data. Moreover, the therapy option would be selected by the study centre on a purely random basis without any influence by the physician and/or decision-making of the patient. As a basic condition all patients have to fulfil the same requirements. In the example selected this means, e.g. with regard to anatomy that all patients dispose of sufficient jawbone mass to be eligible for option a) as well as for option b).

The X-ray in figure 1 shows an appropriate situation (→ fig. 1). The case shown in figure 3 would not offer sufficient bone material for therapy option b) (→ fig. 3). It would therefore not be possible to include it in the examination.

From a medical-patient-oriented viewpoint it would be comprehensible in the first case to insert distally angulated implants and in the third case to create the prerequisites for an implantation with an axial alignment by means of a sinus lift. In addition there are good arguments in the first case for not performing the therapy option b) with a sinus lift and augmentation, as without doubt this would require a two-stage procedure. If the therapy decision were made after this causality chain, the examination would no longer be randomised.

The majority of available studies was not exposed to this conflict decision. At least the survival rate and the change of bones was only evaluated in the case of one therapy option. Not only the treating dentist, but also the patient consciously decided in favour of this option.

In addition there in the edentulous maxilla there is a high variance not only with regard to the remaining height and width of bone mass, solidity of the bone, structure of the maxillary sinus, but also relating to the condition of the soft tissue. This leads to situations which may have an identifiable influence on the length as well as on the position of the implants, the surgery techniques applied and thus last but not least on the successful outcome.

It can be time-consuming, even in a multicentric procedure, to select from this diversity the cases which differ during treatment not only with regard to the number of implants. Last but not least that ultimately raises the question as to which of the many edentulous maxilla variants will be reflected by the investigation in the end (→ Fig. 1–3).

It is therefore impossible to give a generalised answer to the question regarding the number of implants required in the edentulous maxilla. The current situation of studies, however, permits a statement on the concepts which have proved to be reliable. It therefore remains at the dentist’s discretion to decide which number is deemed necessary according to the situation of the individual patient. Less scope for manoeuvre is, however, given in connection with evaluating length and diameter. The concepts presented refer to micro-

**Fig. 1:** In the maxilla there is sufficient bone mass to anchor 6 implants, insofar as the distal implants are inserted in an angulated form.

**Fig. 2:** In this example it is difficult to insert 6 implants without additional augmentative procedures at prosthetically favourable positions.

**Fig. 3:** Without augmentative procedures no 6 standard implants can be positioned in this example.
rough implants with diameters > 3.5 mm and lengths of 10 mm.

**REMOVABLE PROSTHETIC RESTORATION: 2 IMPLANTS**

The rising number of old and even more elderly people leads to the prognosis that the number of edentulous persons will rise rather than drop in future – despite all efforts to preserve the dentures [17]. The age at entry into edentulism will most probably rise together with the morbidity of the persons affected. In addition to the high treatment costs patients thus face the risks associated with surgery as the key argument against an implantation [8, 22].

The loss of the last teeth at a high age often involves a complicated adaptation to the dental prosthesis. Despite the fact that experience has shown that it is possible to ensure optimum adhesion of a total prosthesis in the maxilla well, a reduced alveolar process and/or distinct dryness of the mouth can massively reduce its fixative properties [25].

The afore-mentioned factors enhance the temptation to improve the stability of a dental prosthesis even with only two implants in the maxilla contrary to all clinical practice guidelines and consensus conferences. It is uncertain to what extent this is already practised in day-to-day treatments. The number of publications in any case is restricted to a few reports and studies on a by-case basis [2, 3, 7]. In a current clinical assessment the implants were positioned in the eye-tooth region and anchoring by means of ball abutments was selected (→ Fig. 4) [26]. The one-year survival rate for the implants was at 97.3 % and the mean bone deterioration was 0.7 mm with a standard deviation of 1.1 mm. In comparison thereto an examination was published in 2007 with regard to a survival rate of 82.1 % after about 2 years [23] and only 39 % after 5 years [18]. In this case there was a rigid coupling by telescopes. The authors of the more recent study assumed that the anchoring they selected with the lower force coupling might have a positive effect on the survival of the implant. In-vitro examinations support this theory [11]. The stress load for the marginal bone with quasi tight anchoring in the case of only 2 implants achieves critical values in the tests.

With the exception of the survival rate there are further aspects that should be taken into account. The eye-tooth region ultimately comes into question as target position for 2 implants in the maxilla above all due to the bone material offer. This results in a transversal connecting line through the base of the prosthesis in the scope of anchoring by means of ball abutments. In the event of soft, resilient hyperplastic mucosal tissue a rotation around this axis may occur when biting with the front teeth. This would then lift dorsally. The lacking resilience of the implants can have the effect similar to that of a hypomochlion. A tilting prosthesis would otherwise be the consequence.

Nevertheless it can be assumed that in future more examinations with this reduced number of implants will be carried out. It will be interesting, above all, to see to what extent the performance of prosthetic work, i.e. coupling, type of occlusion and extension of the base, will have a decisive influence on the survival of the implants. In the solid practical daily routine, however, the 2-implantat-concept should – for the time being – have no place. In this case it is imperative to wait until further results from clinical studies are available.

**4 IMPLANTS**

Anchoring a removable dental prosthesis on implants which are primarily blocked by means of four bars is considered to be a valid treatment concept. In this context items 2 and 4 are classically aimed at. In order to avoid the high dentistry costs and/or to improve the sanitisation of the peri-implant region, the dental prosthesis is also coupled by confectioned hybrid attachments or telescopes. For these options there is no comparable long-term experience which is comparable with that of the bar prosthesis. In a clinical prospective survey there are no noteworthy differences in the comparison of the three options with regard to the implant survival [27]. Not only the cost-benefit factor, but also the peri-implant plaque-free environment in the locator-anchored hybrid prosthesis were, however, the most favourable (→ fig. 5, 6).

**ARE 6 IMPLANTS REALLY MUCH BETTER THAN 4?**

Evidence in this context is extremely scarce. According to meta-analyses there are no real differences between bar prosthesis with 4 as against 6 implants after a one-year review period [19]. With regard to the clinically-prospectively obtained data from Slot et al. this will not alter after 5 years eit-
her [21]. It is, however, comprehensively documented in the study that 6 implants lead to higher maintenance efforts. It is furthermore interesting that the implants were inserted at positions 1–3 and/or 1–3–5 in order to avoid a costly bone augmentation. In this context the aim is to remind dental specialists of the fact that 2 densely positioned implants in the front tooth range would complicate the production of a bar prosthesis. A narrow distance makes cleaning difficult and prevents a confectioned bar attachment from being positioned. Under circumstances it may furthermore negatively impair the positioning of the front teeth from aesthetical viewpoints. If attention is paid to these aspects, 4 implants could even be better than 6.

Even in the case of an optimum positioning under static viewpoints, in any case of doubt by additional augmentative procedures, no clinical advantage of 6 (→ Fig. 7) or more implants vis-à-vis 4 was identified [10]. With regard to the peri-implant mucous membrane the telescoping anchoring vis-à-vis the bar proved to be advantageous [28]. It should, however, be taken into account that the telescopic implants have to be inserted into the centre of the planned tooth position with a maximum degree of accuracy in order to guarantee an aesthetic design. This aspect gains greater significance with a reduced expansion of the prosthesis base (→ Fig. 7, 8).

**SUMMARY OF THE REMOVABLE DENTAL PROSTHESIS**

Based on current scientific data it is possible to reliably anchor a removable dental prosthesis in the long term in many cases on 4 standard implants. More implants do not necessarily mean an added value for the patient. The most comprehensive data base is available for the bar prosthesis. In consideration of the cleanability the bar is, however, deemed to be inferior in comparison with telescopes or confectioned attachments. To what extent this aspect will affect the durability cannot be assessed at this point in time. For a minimum concept with only 2 implants there are interesting approaches, however, no reliable data. The type of prosthetic coupling and/or design of the prosthesis could have a great influence as against the option with 4 or more implants.

**PERMANENT DENTAL PROSTHESIS**

Per-Ingvar Brånemark, the founding father of modern implantation, deemed 6 implants to be appropriate for a permanent dental prosthesis in the edentulous jaw. The implants should be positioned in the anterior jaw region [4]. An extended freestanding bridge, the so-called “Toronto Bridge” was screwed onto the implants up to the first molar teeth. The base construction consisted of a basal polished metal frame with confectioned prosthetic teeth, lined with tooth-coloured PMMA. To improve cleanability a larger distance was set between the base of the bridge and the oral mucosa. For that reason the term „Hochwasserbrücke“ (high-water bridge) was also used in the German context. Whether this construction does justice to the aesthetical zeitgeist, is an individual decision. The reliability of the classic is, however, beyond all doubt [1]. Special significance is attributed to this aspect if you take into account that machined implant surfaces were used in the past. The standard for a fixed and completely blocked bridge has therefore been 6 implants to date.

Why should now 8 to 10 or more implants be required? Merited dentists such as Gunnar Carlsson do not see any justified claim therein [6]. If, however, divided bridge constructions are selected and if highly aesthetic ceramics are to be used an increased number of implants makes sense. In the case of 8 implants concepts allow for segments with the positions 6–4, 3–1, 1–3 and 4–6. An increased number of implants requires a more exact positioning. The position of the top central incisors must be seen as particularly critical. An asymmetric localisation at this position can hardly be compensated for from a dental perspective (→ Fig. 9).

**IS IT ALSO POSSIBLE TO WORK WITH FEWER IMPLANTS?**

Dentists are far from implementing a fixed dental prosthesis on only 2 implants in the
mandible, as has been observed since 2011 in a prospective clinical study [5, 22]. With a minimum of 4 implants the dental prosthesis may function. Despite the fact that controlled, randomised examinations are lacking, the All-on-4-Concept has become increasingly popular since it was presented (in 2003 for the mandible and in 2005 for the maxilla) [12, 13]. Manufacturers of implants have identified this development and have incorporated the construction parts for highly angular abutments into their product portfolio [24]. The concept allows for the two central implants to be inserted axially and the distal implants to be angulated at the maxillary antrum. By positioning the implants in this way a sinus lift can be omitted and an extension of the projections of the dental prosthesis thus minimised.

The study results compiled in a review are as follows [15]: For 2000 inserted implants a survival rate of approx. 98 % in an observation period of up to 3 years was identified. The majority of implants were lost in the first 12 months due to lacking osseointegration. These had been primarily implanted in smokers and patients under treatment with bisphosphonate medication. In addition thereto there was no difference with regard to the number of failures between the axial and angulated implants. In so far as documented a cumulated bone loss of about 1.3 ± 0.4 mm after 3 years was identified. In all cases the implants were immediately exposed to pressure within 48 hours. The values range in the limits also published for permanent dental prostheses mounted on 6 implants.

In the Review it was criticised that extensive 5-year or rather 10-year annual results were lacking. In summer 2017 these were supplied by the active treatment group around Paulo Malo [9]. After 5 years the survival rate of the 3564 positioned maxilla implants was at 96 %. The mean bone loss was 1.14 ± 0.71 mm for the axial and 1.19 ± 0.82 mm for the angulated implants. These values speak in favour of the concept. It is, however, necessary to take into account that it is not suitable for all edentulous maxillae and only recommended in the case of surgically experienced dentists [16]. The appropriate indication and extensive experience of the treating colleagues may also have decisively contributed to the high success rates.

SUMMARY OF THE PERMANENT DENTAL PROSTHESIS

For permanent dental prostheses in the edentulous maxilla 6 implants is no doubt the most balanced option. Fewer implants are possible if the indication and experience are coherent. The same applies to 8 or more implants.
Conflicting interests: Dr. Tobias Bensel and Dr. Jeremias Hey state that there are no conflicting interests in connection with this contribution (detailed disclosure see page 78).

Literature


