

# Should we extract teeth to avoid tooth–implant combinations?

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**SUMMARY** The controversy over combining teeth and implants for support of fixed partial dentures still remains after almost three decades of debate. The aim of this review was to evaluate what support that could be found in the literature for extracting teeth in favour of implants, and to elucidate whether tooth–implant prostheses were inferior to solely implant supported constructions in terms of survival and complications. The methods for gathering relevant information entailed electronic searches on PubMed using relevant key words, as well as complementary manual searches in the retrieved publications. The results showed that there was no support for extracting teeth in favour of placing implants. On the contrary, the healthy tooth had a survival that was life-long, which is yet to be shown for the dental implant. Also the use of teeth as abutments in combination with dental implants for support of fixed dental prostheses

could be endorsed in certain situations with solid albeit limited scientific support. In a wider sense, such prostheses could be used as a reliable therapy in all regions of the jaws. However the status of the abutment teeth in terms of periodontal support, pulpal status and risk for carious lesions and bio-mechanical complications should always be considered in relation to the long-term prognosis of the prosthesis. The conclusion was that teeth should not be extracted in favour of placing dental implants without a specific indication, and that tooth–implant supported prostheses should be considered as a viable prosthetic option.

**KEYWORDS:** dental implantation, decision making, prognosis, survival, tooth-implant combination, extraction, tooth intrusion

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## Introduction

The question whether to retain teeth or to extract them in favour of replacement with dental implants has in recent years received attention. The problem has been specifically debated from the endodontic aspect, but with inconclusive result with reference to the question at hand (1–3). Certainly, at some point a tooth can sustain such damage that preservation will be contra-productive from a prognostic point of view. In those instances the tooth may be better replaced, e.g. with a dental implant. However, no clear-cut recommendation is available for when the implant supersede the tooth as the abutment of choice. Recently, the longevity of teeth and implants has been focus for review (4, 5). The conclusion is that

the dental implant does not surpass the tooth in terms of survival. Furthermore, these reviews point to the fact that even a tooth compromised by loss of vitality or loss of periodontal attachment is comparable to the dental implant in survival, provided that successful treatment has been administered. While the longevity of healthy teeth is above 99% over 50 years (4), the 10-year survival of both compromised teeth, as well as dental implants is often reported to be above 90%.

For any dentate individual it must be reassuring that teeth still are just as good as dental implants. However, available scientific reports provide little guidance to precisely when the tooth should in fact be sacrificed, and replaced with a dental implant. Of course, even less data is available on when this procedure is indicated for

avoiding fixed partial dentures (FPDs) on the combination of teeth and implants.

The Tooth-implant supported prosthesis (TISP) has for decades been called in for question because of reasons such as differences in mobility among abutments, risks for tooth intrusion as well as atrophy of the periodontal ligament (PDL), and in general a higher risk of technical complications. Therefore, the question whether to extract teeth to avoid tooth-implant combinations is possibly better answered with a review of the biomechanical aspects of prostheses on the combination of teeth and implants, and an analysis of their survival and success in relation to prostheses on implants only, rather than a scrutiny of the merits for the dental implant over the tooth.

## Materials and methods

### *Search strategy*

With help from electronic searches on PubMed, as well as complementary manual searches using key words for dental implantation, decision making, prognosis, risk factors, treatment outcome, survival, success, FPDs, tooth, implant, combination, biomechanical, risk, failure and review, relevant articles were identified to construct a review in traditional style. Among the articles, several systematic reviews addressing survival of TISP or related issues were included.

## Results and discussion

### *Implant and prosthesis survival*

In 2001, the Academy of Osseointegration appointed a committee to answer eight clinical questions by reviewing the literature with an evidence-based approach (6). One of the topics covered was the effect of implant-prosthesis type on the outcome in the partially dentate patient. In the review on this issue the authors concluded that the largest controversy in the field regarding support of FPDs probably is the combination of teeth and implants. Even though the authors of the review themselves did not find any greater risk for tooth-implant combinations, the consensus committee still expressed concerns that this form of FPDs support may lead to a higher rate of complications and failures (7). The reason for this discrepancy in opinion seems to

have been much because of the late inclusion of a report from Brägger *et al.* (8)

In another recent review by Lang *et al.* (9), the 5-year survival of implants in TISP was found to be 90.1%, and the prosthesis survival was found to be 94.1%. The corresponding figures for the 10-year survival were 82.1% for the implants and 77.8% for the prostheses. Fixed partial dentures on implants solely (i.e. implant-supported prosthesis, ISP) were analysed in another review from the same group and the 5-year survival of implants was found to be 95.4% and the prosthesis survival was found to be 95%. The corresponding figures for the 10-year survival were 92.8% and 86.7%, respectively (10).

These figures were only just updated in a new review from the same group, comparing survival and complications rates for tooth and ISP. Only small changes in prosthesis survival was reported (11). From these reports it is evident that the prosthesis survival rate after 5 years is over 90% for all types of prostheses investigated. At 10 years the tooth-supported prosthesis (TSP) is still showing a high survival on 89.2%, as well as the ISP with 86.7%. However, the TISP has dropped below 80% survival.

The dearth of long-term studies on this particular form of prosthetic therapy is evident. The 10-year result for the TSP is supported by observations of 1218 prostheses, and the ISP is supported by 219 prostheses respectively. In comparison, the long-term analysis of the TISP is based on only 60 reconstructions accounted for in three studies (Table 1). Moreover, these three studies are quite different in design. While the study by Gunne *et al.* (12) on the Brånemark implant is a randomized-controlled clinical trial (RCT), the study by Brägger *et al.* (8) on the ITI hollow Cylinder implant is defined as a prospective long-term case cohort study by the authors. The study by Steflik *et al.* (13) on the Single Crystal Sapphire implant is best classified as a prospective follow-up design. The possible importance of these differences will become evident in the following.

In the study by Gunne *et al.* (12, 14–16) the outcome of prosthetic rehabilitation in the posterior mandible, with prostheses on one implant and one tooth in a stiff combination, TISP (treatment), was compared with freestanding implant supported prostheses on two implants, ISP (control). The comparison was made intra-individually with a split-mouth design where the allocation of treatment and control was randomized to

**Table 1.** Studies with ISP or TISP with 10 years of follow-up

Study (10 years)	Study type	# FPDs	Jaw	Regio	Failures (%)
ISP					
Lekholm 1999	Prospective multicentre follow up	169	Maxilla and mandible	All	21 (12.4)
Gunne 1999	Randomized-controlled trial (RCT)	23*	Mandible	Premolar	4 (17.4)
Brägger 2005	Prospective case cohort	33	Maxilla and mandible	All	2 (6.1)
TISP					
Steflik 1995	Prospective follow up	15	Mandible	Molar	3 (20.0)
Gunne 1999	Randomized-controlled trial (RCT)	23*	Mandible	Premolar	3 (13.0)
Brägger 2005	Prospective case cohort	22	Maxilla and mandible	All	7 (31.8)

FPDs, fixed partial dentures; ISP, implant-supported prosthesis; TISP, tooth-implant supported prosthesis.

\*In the mandible of 23 patients fixed screw retained prostheses on two implants were placed on one side, while on the contralateral side prostheses on a combination of the canine and one implant were placed.

left or right side in the patients. All teeth used as prosthetic abutments were vital canines in the mandible and the residual dentition was periodontally healthy. All of the 23 patients had complete dentures in the maxilla. The dropout was 13% and accounted for in detail.

In the study by Brägger *et al.* (8), the cohort under investigation was initially recruited retrospectively from consecutive patients treated with implants at a university clinic. A report from 4 to 5 years follow-up was published in 2001 (17). However, the aim for the very first report from this cohort was to investigate the peri-implant and periodontal conditions 1 year after placement of oral implants (18). Later publications from this study have concerned the prognosis for implants in patients with and without a history of periodontitis (19), as well as association between periodontal and peri-implant conditions (20), and effects of implant design on survival of the implant (21). Possibly as a consequence of the disparity in study aims and the retrospective nature of inclusion of the patients, the designs for the TISPs were heterogeneous. In the report on the 10-year follow-up (8) it is reported that the number of abutments and pontics in the prostheses varied from 3, 4, 5 and 10 units in the 22 FPDs with 50% of the 3-unit design. The design of the 22 prostheses in the 21 patients was not described, but under the assumption that most prostheses (3–5 units) included only one implant and one tooth, the logical consequence follow that the two remaining 10-unit reconstructions should be supported by two teeth and one implant each. An unknown number of the abutment teeth were non-vital. It is mentioned in the early report by Brägger *et al.* (18) that the patients had received periodontal treatment prior to the inclusion in

the study. However, there is no data on whether some of the abutment teeth had loss of periodontal attachment or not at the time of connection to the implants. In addition, three different implant-designs of the system used were incorporated in the study. In one of the reports by Karoussis *et al.* (20), the distribution of these different implant designs in the jaws is accounted for. Unfortunately, there is no information on where in the jaws the different types of prostheses on these implants were placed. In another report from Karoussis *et al.* (21), the effect of implant design on the survival and success rates was studied. In relation to pre-defined criteria, e.g. pocket probing depth, bleeding on probing, bone loss, the authors found a significantly higher incidence of biological complications at the hollow-cylinder design (29%) compared with the hollow-screw (10%). There is no data on the distribution of the three implant-designs in the different types of prostheses. Furthermore, the implant-designs used in this study have later to a large extent been abandoned in favour of other designs (22). The group of patients in the cohort that were treated with completely implant supported prostheses was not similar with the tooth-implant group in terms of number of patients, or in the design of the prostheses as 61% of these were of the 3-unit design. The dropout was reported to 30%, but was not distinguished between groups in the study.

In the study by Steflik *et al.* 18 patients were selected according to pre-defined criteria and subsequently treated with 28 implants in the posterior mandible for support of FPDs on teeth and implants in combination. The precise design of the prostheses was not accounted for. However, it is likely that also in this study the design for the TISP was heterogeneous to an extent. The vitality and periodontal status of the abutment

teeth was not given, neither was the status of the opposing occlusion accounted for. There was no control group in the study. The drop out was 13%, which was accounted for in detail.

Considering the disparate designs of these three studies and the different conditions under which the prostheses would function, it is difficult to believe that any statistical method could neutralize the confounding factors involved. Still, based on the observed differences in survival rates for implants and prostheses supported by the combination of teeth and implants versus FPDs on implants only, the authors conclude that when planning prosthetic rehabilitation with implants, FPDs on teeth or implants only should be the first choice.

As the recommendation is based on a comparison of survival rates for prostheses, with the largest dissimilarity of 8.9% in FPDs survival after 10 years (11), the question remain whether an almost 9% difference after 10 years is large enough to have an impact on clinical decision-making. In any respect, the answer would have to be heavily dependent on the quality and interpretation of the data underlying the recommendation. As mentioned in the systematic review by Pjetursson *et al.* (11), there are several shortcomings in the conduct and reporting of clinical studies in this field. However, one such inadequacy not explicitly mentioned is the effect of patient selection. Certainly, retrospective inclusion of patients in studies may predispose for this factor (23), e.g. in a retrospective study by Lindh *et al.* (24). In a recent publication (25), implants in 466 patients were analysed with respect to implant failure because of combinations of jawbone-related characteristics. The result showed that patient selection was important for increasing implant success rate. Under these circumstances, the RCT is a particularly efficient form of study design to neutralize this confounder, especially with the addition of a split-mouth design.

Two such randomized controlled trials were included in the systematic review by Lang *et al.* (9). A study by Block *et al.* with 5 years follow-up investigating differences between rigid versus non-rigid connection between teeth and implants (26). The other study was the RCT by Gunne *et al.* described earlier (9). In both studies the implants were placed in the posterior mandible. In the former study, no difference in terms of implant survival or loss of marginal bone was found depending on the type of connector between the implant and the tooth in the 3-unit prostheses. In turn,

the latter investigation found no difference in implant survival between treatment with 3-unit prostheses supported by the combination of one implant and one tooth (21/23: 91%), and in the corresponding control supported by two implants (41/46: 89%) after 5 and 10 years.

Surprisingly, the results from the treatment and from the control in the same patients from the RCT were used separately in two different reviews by Pjetursson, Lang *et al.* The 23 ISPs was included in a review of FPDs on implants only by Pjetursson *et al.* (10), while the 23 TISPs was referred to in the review by Lang *et al.* (9). The review-authoring group commented upon the fact that the 5-year implant survival rate (86.3%) was substantially below the expected 95.4% found by Pjetursson *et al.* (10). The very point of an intra-individual RCT is overlooked though, when the results are dismantled in this manner by separating the types of prostheses.

One of the three aims for the RCT by Gunne *et al.* (12, 14–16) was to elucidate whether implants could in fact be placed in the posterior region of the partially edentulous mandible. The other two goals was to investigate the implant survival rate of such implants and to make intra-individual comparisons between prostheses supported by implants only and those supported by the combination of teeth and implants. It should be acknowledged that the outcome of implant therapy in these areas of the mandible was largely unknown at the time for initiation of this study in the mid 1980s. Since then, it has been established that lower implant survival is to be expected in some regions of the jaws because of aspects such as bone volume and quality, as well as implant length (25). Fifty-four per cent of the implants in the RCT by Gunne *et al.* was 7 mm in length and 42% was 10 mm long. In reference to this, the authors made a comment on the negative influence of small bone volume and soft bone in the areas used for implant anchorage. Also in the report from the 5-year follow-up (16), it was recognized that some of the patients included in the RCT in the 1980s would probably have received other forms of treatment a decade later because of development of new treatment options, e.g. nerve transposition, bone grafting or guided tissue regeneration.

With this background the advantage of the randomization process in the RCT becomes clear. By randomly assigning the implants for support of freestanding prostheses or TISP on either side in the same patient

after the implants were placed, any bias in site selection was neutralized. This detail is very important to understand when later interpreting the results.

The absence of difference in implant survival rates reported by Gunne *et al.* were also depreciated in the review (9), commenting on the RCT for having to low power to detect: '...smaller but clinically relevant differences of the proportion of lost implants.' Certainly, the number of implants in the study by Gunne *et al.* was small. In that context it is impossible with a dichotomous variable to attain the necessary statistical power to determine if the absence of difference in implant losses between ISP and TISP is 'true' or just haphazard. However, as mentioned by Pjetursson *et al.* (11), to reach a statistical power of 80% on a significance level of 5% for detecting a 1% difference of loss of reconstructions, a two-arm study would need to randomize >1000 patients. The likelihood of such a study to be initiated must be considered as low (27).

While the loss of an implant is the true endpoint in many investigations on implants and implant supported prostheses, the use of surrogate variables can be valuable when larger studies are difficult to realize. One such variable used is the loss of marginal bone over time (28). In a study with similar design to the study by Gunne *et al.* 1999, the survival and success of TISP compared with ISP in posterior maxilla was investigated (29). Marginal bone loss was utilized for computing the number of patients needed to determine a 'true' difference of peri-implant bone loss between implants supporting the two different prosthesis designs. In order to detect such a true difference with a 90% power at the  $\alpha$ -level of 5% (two-tailed) with a s.d. set to 0.5 mm, 17 patients were needed. The study included 26 patients. Two years after loading a statistically significant loss of marginal bone at the posterior implants in ISP had developed. Incidentally, the factual implant survival in this study was the same as the one reported by Gunne *et al.* 1999, i.e. 88%, with no difference attributable to the type of prosthesis. If the reasoning regarding marginal bone loss as being representative of outcome in terms of implant survival is accepted, the conclusion must be that the implant function and survival is similar regardless if the implants are connected to teeth or not. The same reasoning should then be applicable on the study by Gunne *et al.* as the parameters were quite the same.

With the above in mind it must be concluded that there is no reason to entertain a general belief that fixed

dental prostheses on the combination of implants and teeth should represent an inferior alternative to prostheses on implants only in terms of prosthesis survival.

#### *Marginal bone response*

In a recent publication occlusal loads were measured *in vivo* on implants and teeth combined for support of 3-units FPDs in the premolar and molar area (30). The results showed statistically significant higher loads on the implants compared with the teeth. The level of the marginal bone at the implants was followed with repeated radiographs over a 24 months period. A slight apposition of marginal bone was noted at the end of the 2 years with statistically significant more apposition of bone towards the mesial aspect of the implant. The stability of the marginal bone over time is in accordance with similar findings in other studies (12, 24, 31). In contrast, loss of marginal bone is usually reported. In a study with follow up ranging from 1.5 up to 15 years of loading time (32) the authors compared freestanding FPDs on implants with tooth-implant connected FPDs of three different designs and found a statistical significant difference in marginal bone loss between the freestanding and the tooth-implant connected FPDs. Regression analysis was used to determine the rate of bone loss. Both types of prostheses showed an ongoing reduction of marginal bone over the 15-year period. However, the rate of bone loss was slow in both groups, in fact smaller than a tenth of a millimetre per year for the implants in the TISPs, and even less for the implants in the freestanding group. A conspicuous find in the investigation was the higher rate of bone loss at implants rigidly connected to teeth compared with implants with a non-rigid connector. The authors contributed this difference to biomechanical consequences from the configuration of the TISP, which with reference to *in vitro* studies of finite element analyses give rise to high bending moments on the implant (33–35).

In the report by Acka *et al.* (30) the authors argued that the apparent discrepancy between the report by Naert *et al.* and their own results could be explained in a better way by later studies with finite element analysis (33). Regardless of explanatory biomechanical model, the time dependency of bone loss must also be considered. The results by Acka *et al.* is in accordance with the abovementioned clinical trial by Lindh *et al.* (29). In the latter study, the marginal bone level after

2 years of loading was not statistically different from baseline values for the implants supporting the prostheses on implants combined with teeth. However, another feature still in common for these two studies, and in contrast to the investigation by Naert *et al.* is the relatively short follow-up time.

As with teeth (36), it seems reasonable to expect some minor loss of marginal bone for implants in greater length of service without this necessarily being prognostic for failure.

#### *Technical complications*

In general, low annual rates of technical complications in implant-supported prostheses were reported in a review by Pjetursson *et al.* (11). There was little difference between the completely implant supported FPDs, and the ones supported by both implants and teeth. Typically the cumulative rates at 5 years would be below 10% for most complications, e.g. loose implant abutments or screws, loss of retention and ceramic chipping. More serious complications such as implant fracture, or fracture of the framework was below 2% at 5 years. The most common complication was however fracturing of the veneer material. The incidence of this complication was for ISP 11.9% at 5 years. The corresponding figure for the TISP was 7.2%. If the complications rates for implant-supported prostheses were compared with that of prostheses on teeth only, the results were in favour of TSP, e.g. a statistically significant lower rate of chipping or fracture of ceramic veneers. The TSP also showed lower incidence of loss of retention, 3.3% versus 5.7% for implant supported and 7.3% for TISP.

It seems, as the risk for technical complications is low over a 5-year period. However, in another recent systematic review from the same group (9), much higher incidences of loss of retention are cited from two studies with 10-year follow-up. In the study by Bragger *et al.* 2005 (8), loss of retention to four natural abutments was noted. These retention-failures later led to development of secondary carious lesions, and eventually the loss of the prostheses (19% failure over 10 years). The four abutment teeth were all endodontically treated and fitted with posts and cores, and were combined with an implant for support of a fixed prosthesis.

In contrast, in the RCT by Gunne *et al.* 1999, one abutment tooth of 23 (4.3%) was reported with loss of

retention in the follow-up of 10 years. This tooth was later lost as a consequence of subsequent carious development and endodontic complication and the TISP had to be revised. The incidence of retention-loss for the completely implant supported prostheses was similar (1/23), but did not lead to loss of the prosthesis. In another RCT of similar design, but in the maxilla and with only 2-year follow-up, the incidence of retention-failures was higher (7.7%). However, there was no difference between prosthesis designs (29). In two long-term follow-up studies where prosthesis design on teeth and implants was accounted for in detail, no loss of retention was reported and in general low number of other biomechanical complications (31, 37).

A reasonable conclusion could be that the risk for technical complications in implant therapy in the partially dentate patient is relatively low, and does not differ between implants in different types of prostheses. However, in addition to complications correlated to the implant, the TISP always run the risk of tooth-related complications such as carious lesions, loss of vitality and periodontal disease.

## **Biomechanical considerations**

#### *Rigid versus non-rigid connection*

In the biomechanical context the question whether the fixation between the two types of abutments should be rigid or non-rigid has been debated. While theoretical (38), experimental (39–41), and clinical (42) studies suggest benefits from the use of resilient connections, other authors question their efficacy (43–45). Furthermore, in some publications it has been demonstrated, both *in vitro* and *in vivo*, that bending in the implant components is sufficient to compensate for the difference in mobility between the implant and the tooth (46–48). It has also been shown that the functional load under clinical conditions is uniformly distributed between the two types of abutments (48).

#### *Tooth intrusion*

The phenomenon of tooth intrusion in prosthetic constructions involving teeth and implants was early observed in case reports (49–52). In recent studies intrusion of abutment teeth has been reported in the range of approximately 5% (9). However, the mechanism(s) facilitating the migration of teeth in TISP is yet

not fully explained. While some interesting theories have been presented, they are based on clinical observations combined with engineering principles and remain hypothetical in lack of experimental evidence (53, 54).

Reviews of the intrusion phenomenon in the late 1990s resulted in conflicting conclusions. Schlumberger *et al.* (55) suggested that the problem could be anticipated and prevented with proper treatment planning. While on the other hand, Pesun (56) concluded that the tooth–implant type of restoration should be avoided.

In publications from clinical investigations in the new millennium some authors have continued to report on the phenomenon of tooth intrusion (24, 26, 57, 58), while others have not observed the problem (29, 31, 59). A recent experimental clinical report was published (60) giving plausibility to the theory that suggests that mechanical binding (58), also known as impaired rebound or the ratchet effect (56) could explain how teeth can be intruded under function. Clinical and experimental evidence seem to point to that rigid connections between the implant and the tooth will prevent most cases of intruded teeth.

#### *The periodontal ligament and the tactility of implants*

The PDL, at the tooth in the TISP, could functionally be classified as a ‘peri-implant tissue’. When teeth are connected to implants via prostheses, the load from occlusion and mastication on the tooth will presumably be mitigated by the implant. Thus the PDL could be directly affected by the connection, despite not being immediately adjacent to the implant. It has been speculated whether such a connection could lead to disuse atrophy of the PDL because of insufficient loading (61).

No findings have been presented to support the hypothesis of PDL-disuse atrophy. On the contrary, data from animal studies where teeth and implants have been connected has shown that the PDL remain unaltered and fully functional also after 24 months of rigid connection to implants (62, 63). This conclusion is supported by long-term studies in man, e.g. Gunne *et al.* (12).

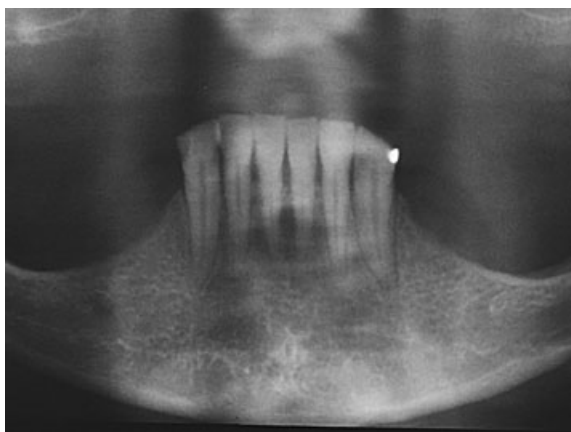
The conception of osseoperception defined as: ‘The conscious perception of external stimuli transmitted via a bone-anchored prosthesis by activation of neural endings and/or receptors in the peri-implant environ-

ment such as the bone and more likely the periosteum’ was recently reviewed and found to be still valid (64). The primary function of the periodontal receptors that osseoperception would compensate for has been demonstrated *in vivo* (65). These receptors were shown to be important for the precise direction of low biting forces. It was evident that in the completely edentulous patient, whether restored with dental implants or not, other types of mechanoreceptors could not compensate qualitatively for the loss of the receptors in the periodontium. Certainly, it would be tempting to claim an advantage to the TISP over any solely implant-supported counterpart based on the periodontal receptors of the tooth. It could be suggested that the natural abutment would function as a moderator of occlusal load, thus mediate any detrimental influence of forces on the peri-implant bone. Indeed, a positive response in the marginal peri-implant bone has been observed in clinical studies with TISP, e.g. Akca *et al.* (30), Lindh *et al.* (29). However, it is probably more reasonable to believe that the direct clinical implication of retaining tactility within prosthetic reconstructions may be of less consequence in the partly dentate patient. The residual dentition, whether vital or not, will retain the tactile ability (66), and despite reports from animal studies that have shown that occlusal load might lead to marginal bone loss, no cause–effect has been shown in clinical studies (67).

## **Conclusion**

Should tooth–implant combinations be avoided, and should in fact teeth be extracted if necessary to evade this implant-prosthetic option? There is no scientific support for a general affirmative answer in these matters. On the contrary, the few controlled studies comparing this particular prosthetic option (TISP) with prostheses supported exclusively by implants (ISP) point to incidences for survival and complications similar in both instances. Thus, no, available knowledge suggests that teeth should be extracted to avoid tooth–implant combinations.

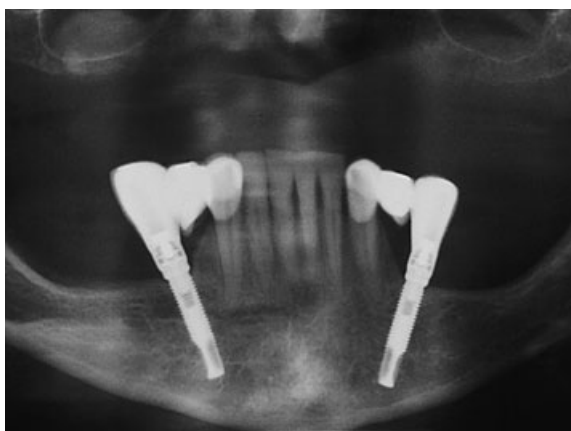
However, these few reports refer to specific indications and designs for the TISP, and especially in the premolar area of the mandible (12, 29). Therefore the results may not be possible to extend to a wider range of clinical situations. It is not uncommon however, that specific treatments are developed for equally specific situations, and that these treatments can produce quite



**Fig. 1.** A panoramic radiograph from a patient with an edentulous maxilla and a partially dentate mandible. The patient could not tolerate a removable partial denture in the mandible. For support and stability of the complete maxillary denture, occlusal surfaces distal to the residual teeth were deemed necessary.

more varying outcomes if applied outside the clinical envelope for which they are intended. Still, albeit with less scientific support, there is no available knowledge that support tooth extraction in favour of implant placement to avoid tooth-implant also in other regions of the jaws.

Patient-selection has shown to be an important factor for success with treatments like the dental implant (25). The status of the abutment tooth is also important when considering the connection to an implant. However, no available knowledge suggests that restored teeth should be routinely extracted to avoid tooth-implant combinations.



**Fig. 2.** A panoramic radiograph from the 10-year follow up after treatment with two Brånemark implants, 18 mm long, and Ø3.75 mm positioned anterior of the mental foramina, but distal to the apices of the residual canines.

The treatment under study in a RCT by Gunne *et al.* was intended for the group of patients with a healthy anterior residual dentition in the mandible, but with a need for occlusal support in the posterior areas. The therapy was tested against the established protocol with freestanding implant supported prostheses that was the accepted state of the art therapy at the time of study commencement. This therapy should be considered as the treatment of choice (Figs 1–4) as alternative solutions such as the single implant provide inadequate occlusal support, and procedures such as transposition of the inferior alveolar nerve, and bone augmentation are considered hazardous.



**Fig. 3.** A clinical photograph from the 10-year follow up of the 3-unit tooth-implant supported prosthesis in the lower left quadrant. The tooth is vital and linked to the implant via a rigid prosthesis.



**Fig. 4.** A clinical photograph from the 10-year follow up. The maxillary complete denture is supported by the bilateral 3-unit prostheses. The patient is satisfied with the aesthetics and is fully functional with this treatment.

## Conflicts of interest

The author declares no conflicts of interest.

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