Therapeutic concepts and methods for improving dental implant outcomes. Summary and consensus statements. The 4th EAO Consensus Conference 2015

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Abstract

Background: Different therapeutic concepts and methods have been proposed for improving dental implant outcomes in three specific clinical situations: (i) the fresh extraction socket with alveolar ridge preservation protocols; (ii) the posterior maxilla with limited bone height with either the placement of regular-sized implants after sinus elevation and grafting or short dental implants and; (iii) the posterior mandible with limited bone height with either vertical bone augmentation and placement of implants or short dental implants.

Materials and methods: Three systematic reviews, based on randomized and controlled clinical trials have evaluated the efficacy of these different therapeutic modalities in terms of dental implant outcomes.

Results and conclusions: Interventions aimed for alveolar ridge preservation have shown efficacy in terms of allowing the placement of dental implants and for reducing the need of further augmentation procedures at implant placement. Both therapeutic options, the placement of implants after sinus elevation and grafting or short dental implants, were valid alternatives in the treatment of the posterior maxilla with deficient bone availability, although short implants resulted in fewer complications. Similarly, the placement of implants in vertically augmented bone rendered comparable outcomes with those of short implants in the treatment of the posterior mandible, but short implants resulted in fewer complications.

The remit of this working group was to provide answers on the efficacy of these different therapeutic modalities in terms of dental implant outcomes. Specifically, three clinical situations have been discussed: the fresh extraction site after tooth extraction, the posterior maxilla with deficient bone height and the posterior mandible with deficient bone height. In each of these clinical situations, therapeutic concepts have been presented and their efficacy in regards to implant related outcomes has been analysed in light of the evidence derived from systematic reviews.

In particular, two therapeutic concepts have been indicated in situations of fresh extraction sockets: the alveolar ridge preservation concept vs. unassisted socket healing. A systematic review (Mardas et al. 2015) has evaluated the evidence based on clinical trials comparing these interventions in terms of fresh extraction sockets: the alveolar ridge preservation concept vs. unassisted socket healing. A systematic review (Mardas et al. 2015) has evaluated the evidence based on clinical trials comparing these interventions in terms of fresh extraction sockets: the alveolar ridge preservation concept vs. unassisted socket healing.
Therapeutic concepts of implant placement after tooth extraction

Alveolar ridge preservation (ARP; also referred as “socket preservation”) involves any procedure designed to eliminate or limit the negative effects of post extraction resorption, to maintain the soft and hard tissue contours of the ridge, to promote bone formation within the socket and to facilitate implant placement in a prosthetically driven position [Horváth et al. 2013].

The current evidence from systematic reviews demonstrated that in comparison to unassisted socket healing, ARP significantly reduced the post extraction dimensional changes [Vignoletti et al. 2012; Horváth et al. 2013; Avila-Ortiz et al. 2014]. However, taking into consideration that ARP is usually performed prior to implant placement, it is essential to define whether ARP would have a positive impact or added benefit/value in terms of implant related outcomes.

A number of different surgical procedures have been utilized for ARP. However, there are no clear clinical criteria [site, number of remaining socket walls, thickness and height of buccal alveolar bone] in the selection of the biomaterials or fillers used to graft the fresh extraction socket, whether a barrier membrane is needed to isolate the biomaterial or filler [guided bone regeneration (GBR)] or whether it is necessary to close the opening of the socket [socket seal].

This consensus report is based on the findings from a systematic review [Mardas et al. 2015] that included eight RCTs and two CCTs on 295 patients and 365 implants for evaluating the differences between ARP and unassisted socket healing in terms of implant related outcomes. These studies included extraction sockets with intact bone walls [either all four or at least three walls with only partial loss of the buccal wall], in all areas of the dentition [premolars being the predominant treated sites]. The feasibility to place implants was similar when comparing ARP to implants placed in unassisted socket healing. However, there is no evidence to indicate whether the implants placed were of appropriate dimensions for the specific site and/or were placed in a prosthetically driven position.

Furthermore, even though the survival rates between the groups were similarly high (100% ARP vs. 95% unassisted socket healing) these data are based on implants with a follow-up of 12 months post-loading, what limits these conclusions.

From these studies, six were included in the meta-analysis comparing ARP with unassisted socket healing and reported significant differences in the additional ridge augmentation needed at the time of implant placement (7/111 vs. 50/103), what resulted in a relative risk of 0.15 (0.07–0.3). However, these studies did not always indicate the criteria for the decision to carry out the additional ridge augmentation procedure.

The provided evidence suggests that the crestal bone level changes around followed up implants were comparable between ARP and unassisted socket healing. Currently there is no available literature to suggest that implants placed in ARP sites are more susceptible to peri-implant diseases than implants placed in sites following unassisted healing, however these data are based on short follow-up periods (12 months) post-loading. Irrespective from of the ARP procedure, the clinician should control any risk factors related to peri-implant diseases and implement stringent individually based maintenance programmes.

Different surgical protocols have been tested for ARP, being the most common:

- Guided bone regeneration using a socket filler/graft to fill the socket covered with a resorbable barrier membrane and combined with a flap.
- Using a socket filler/graft to fill the socket (filler).
- Using a socket filler/graft to fill the socket and a soft tissue graft/substitute to seal the opening of the socket (seal).

This systematic review [Mardas et al. 2015] evaluated the evidence on the possible impact of these three surgical protocols on 21 RCTs, 7 CCTs and two case series (12 studies compared GBR to unassisted socket healing or to another GBR procedure, 14 comparing a filler to unassisted socket healing or to different fillers, two studies compared socket seal to unassisted socket healing and two studies compared GBR to a filler). These studies involved 582 patients [280 with GBR, 242 with filler and 60 with socket seal]. These different surgical protocols resulted in comparable implant related outcomes and similar need for further ridge augmentation.

Even though there is no clear evidence to favour one specific surgical protocol in regards to implant related outcomes, historical outcomes from experimental preclinical studies have shown more favourable ridge preservation outcomes with the use of xenografts [Hammerle et al. 2012] and recent systematic reviews have identified a possible additional benefit of using a barrier membrane in limiting post extraction dimensional changes [Vignoletti et al. 2012; Avila-Ortiz et al. 2014].

Clinical recommendations

Alveolar ridge preservation is a valid therapeutic concept since it significantly reduces the post-extraction ridge dimensional changes, which may improve the feasibility of implant placement in a prosthetically driven position. Furthermore, there is evidence that ARP decreases the clinical need for ridge augmentation during implant placement. These potential advantages, however, have not resulted in improved implant related outcomes when compared to unassisted socket healing and therefore, the clinician’s decision should be based on accurate diagnosis of local and patient related factors (i.e. tooth location, reason for extraction, treatment duration, healing time, cost benefit and patient expectations and preferences).

There is no evidence to indicate a preferred time point for implant placement following the use of different biomaterials and surgical protocols for ARP.

Recommendations for future research

There is a clear need for further research in these specific areas:
- Carry out well-designed clinical trials to compare ARP protocols with other implant placement protocols.
- Carry out well-designed clinical trials to compare different surgical interventions [biomaterials, sealers] for alveolar ridge preservation.
- Evaluate the outcomes of ARP protocols with accurate and reproducible non-invasive outcome measurements to evaluate soft and hard tissue changes.
- Evaluate the outcomes of ARP protocols with validated aesthetic indexes, patient-reported outcome measures [PROMs] and cost benefit indicators.
Therapeutic options for the posterior maxilla with deficient bone height

Following tooth extraction in the posterior maxilla, bone resorption will often occur as a combination of increased sinus pneumatization and/or ridge atrophy resulting in a vertically and/or horizontally deficient ridge dimension, what may impair the feasibility to place a regular sized dental implant (>8 mm) in a prosthetically driven position.

In case of reduced bone availability two therapeutic options exist to increase the ridge height in the posterior maxilla depending on the anatomical conditions: either through vertical bone augmentation in a caudal direction (Simion et al. 2004) or by elevating the sinus floor in a cranial direction using either a trans-alveolar or a lateral window approach (Boyne & James 1980, Summers 1994). The SFE procedure through a lateral window approach has demonstrated high implant survival rates. In general, this procedure requires bone grafting and may be associated with a relatively high number of intra-operative complications, patient morbidity and treatment costs. To overcome these drawbacks and limitations, the use of shorter dental implants may be a therapeutic alternative.

Shorter dental implants have been defined as implants with an intra-bony length of 8 mm or less (Renouard & Nisand 2006). The clinical efficacy of short dental implants with moderate rough surfaces has been evaluated in several systematic reviews reporting similar survival rates compared with longer implants (Sun et al. 2011; Telleman et al. 2011; Annibali et al. 2012; Atieh et al. 2012; Srinivasan et al. 2013). When selecting this therapeutic option in the treatment of the posterior maxilla with deficient bone height, clinicians may be concerned on potential complications, patient morbidity and treatment costs. To overcome these drawbacks and limitations, the use of shorter dental implants may be a therapeutic alternative.

Therapeutic options for the posterior mandible with limited bone height

The bone available for implant placement in the posterior mandible (premolar and molar area) is limited between the crest of the alveolar ridge and the inferior alveolar nerve. In clinical situations of partial or full edentulism, bone resorption may result in limited bone availability and therefore limit the feasibility of placing dental implants.

This systematic review reported different prosthetic restorative solutions [splinted and single unit] providing no data on their relative outcome, although in general the reported short-term survival rates of the prosthetic restorations (up to 1 year) were high in both groups [100 vs. 98%, respectively].

Clinical recommendations

Sinus floor elevation together with bone grafting is the preferred therapeutic option to place implants in the posterior maxilla when the available bone is <5 mm. When the bone availability is between 5 and 8 mm the short implant option is a valid alternative. The choice of either therapeutic concept should be mainly based on the local anatomy and/or pathology of the sinus and on other patient’s factors, mainly the general health condition of the subjects, their lifestyle (smoking, oral hygiene) and their preferences, which may advise the short implant option, due to the more demanding surgery and morbidity associated with SFE.

Recommendations for future research

When comparing these therapeutic concepts for the treatment of the posterior maxilla with deficient bone height, there is a clear need for further research in these specific areas:

- Evaluate long-term (>5 years) outcomes in well-designed clinical trials.
- Validate and standardize PROMs.
- Compare different types of prosthetic reconstructions.
- Evaluate the incidence of intra- and post-operative complications with the different therapeutic options.
- Evaluate the incidence and impact of periimplant diseases.

Therapeutic options for the posterior mandible with limited bone height

The bone available for implant placement in the posterior mandible (premolar and molar area) is limited between the crest of the alveolar ridge and the inferior alveolar nerve. In clinical situations of partial or full edentulism, bone resorption may result in limited bone availability and therefore limit the feasibility of placing dental implants.
When the availability of crestal bone ranges between 5 and 8 mm, the therapeutic options for placing implants are either to carry out a vertical ridge augmentation procedure prior or in conjunction to implant placement or to place short dental implants within the available bone bed.

In this context, vertical ridge augmentation is defined as the surgical attempt to increase the bone height and volume to allow the insertion of dental implants ≥8 mm long. This surgical intervention also aims to allow a prosthetic reconstruction with natural contours that would facilitate oral hygiene and maintenance. Vertical ridge augmentation has been achieved by means of different surgical approaches: GBR, on-lay bone grafts, distraction osteogenesis, inter-positional bone grafts and combinations.

This consensus report is based on a systematic review [Nisand et al. 2015] summarizing the results from four RCTs comparing the efficacy of longer implants in vertically augmented bone by means inter-positional grafts, vs. short implants in the treatment of fully and partially edentulous posterior mandible. These studies with follow-ups ranging between 1 and 5 years reported similar high implant survival rates (95.1% vs. 96.2%, respectively). Similarly in terms of prosthetic survival, there were no differences between the treatments. This evidence, however, should be interpreted with caution since it is derived from four RCTs with limited samples sizes (ranging between 15 and 30 patients per group) and all studies were performed by the same research group. Furthermore, the quality assessment of this evidence was ranked as high risk of bias.

The systemic review reported fewer surgical complications when using short dental implants. In fact, in three of four clinical trials, these differences were statistically significant. These data highlights the risk of operative complications associated with the vertical ridge augmentation procedure, mainly temporary nerve paresthesia (56%). However, the use of short implants may also pose some surgical risk, since the reported incidence of temporary nerve paresthesia occurred in 17% of the subjects. In regards to the complications associated with the graft, the evidence of this systematic review is restricted to inter-positional xenografts, reporting complete [6/85] or partial [5/85] graft failures (defined as being able to place either short implants or implants longer than the short implant group). Other reported complications were soft tissue dehiscence and block graft fractures.

Even though the available evidence is limited, some prospective and retrospective case series [Simion et al. 2001] using different vertical bone augmentation approaches have reported clinical success in restoring the bone volume and providing implant-supported reconstructions with natural contours and emergence profiles. These series of cases, however, were performed by a limited number of specialists and highly skilled clinicians, what should not underscore the fact that these surgical interventions are very complex, require high surgical skills and may lead themselves to post surgical complications. Similarly, the placement of short implants in the posterior mandible may be surgically challenging due to the anatomic characteristics and the frequent problems of accessibility in this location.

The evidence from the systemic review reported similar crestal bone level changes when comparing implants in vertically augmented bone with short implants [1.51 vs. 1.23 mm respectively]. However, the only study with longer follow-up [5 years] reported significantly higher crestal bone loss in around the implants in vertically augmented bone [2.34 vs. 1.49 mm, respectively].

There was no evidence on the incidence of peri-implant diseases in either treatment group, probably due to the short follow-up nature of these clinical trials. However, the possible incidence of peri-implantitis may have important clinical implications, mainly in the short implant group. Moreover, the frequent lack of attached and keratinised mucosa in this anatomical area [posterior mandible] may pose a higher risk for the maintenance of healthy peri-implant tissues and crestal bone levels.

**Clinical recommendations**

Vertical ridge augmentation is the preferable option to place implants when the available bone is less than the available implant length. When the bone availability is between 5 and 8 mm, both the placement of short implant vertical or longer implants in vertically augmented bone may be the valid therapeutic options, although the latter requires the presence of a favourable anatomical site. The choice of either therapeutic concept should be based on both the anatomical conditions of the site [bone availability and shape, surgically access conditions, patient’s mouth aperture, etc.] as well as the patient factors, mainly the general health condition of the subjects, their lifestyle [smoking, oral hygiene] and their preferences, which may advise the short implant option, due to the more demanding surgery and morbidity associated with vertical ridge augmentation. In the patient with limited height of bone available in the anterior jaws, the choice of therapy may be also guided by aesthetic and restorative considerations and due to these, the placement of implants in vertically augmented bone may be the choice of therapy.

The possible impact of the design of the implant-supported restoration (individual units vs. splinted restorations) was not reported in the systematic review. There are, however, case series using short implants restoring single unit restorations in the posterior mandible reporting high survival rates and maintenance of crestal bone levels up to 5 years follow-up.

**Recommendations for future research**

When comparing these therapeutic concepts for the treatment of the posterior mandible with deficient bone height, there is a clear need for further research in these specific areas:

- Redefine the concept of short implants and establish the minimal lengths for predictable long-term implant survival.
- Develop and test reproducible regenerative approaches, focusing on bio-engineering therapeutic alternatives.
- Develop and test soft tissue augmentation procedures to assure proper tissue coverage during augmentation procedures and adequate quality of the mucosa around implants.
- Evaluate the appropriate number of implants and prosthetic designs for improving of success of short implants.
- Carry out well-designed clinical trials to properly compare the long-term (>5 years) success of these therapeutic concepts.

**Conflict of interest and source of funding statement**

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References


