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Fixed v's removable rehabilitation of the atrophic maxilla

Fixed rehabilitation
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Prosthetic restoration of the atrophic maxilla has been improved by the use of dental implants and fixed implant restorations have the longest documentation time1,2 and exhibit reliable and predictable success rates2,3,4. Conversely, removable restorations in the maxilla have a shorter documentation period and a greater need for repair and service over time. Anticipating and determining how much movement of a removable prosthesis will be acceptable to any patient is very difficult and often can only be determined after the prosthesis had been fabricated.

Multiple implants, usually 4 or more in number, are required support a fixed implant restoration and their positions must provide adequate support, stability and retention. The implants may be placed in the conventional vertical position or may be tilted5 as in the use of the zygoma implants6-9. The potential to place an immediate fixed prosthesis10 is a patient benefit not possible with removable prostheses. Fixed prostheses that are stable and cannot be removed, in contrast to removable prostheses, offer a strong psychological advantage to many patients.

Fixed implant restorations include: 1) the fixed hybrid restoration composed of a metal substructure, acrylic and denture teeth 2) metal-ceramic restorations with or without a metal substructure. The fixed hybrid restoration provide the most economical fixed restoration but is subject to wear or breakage of the denture teeth and degradation of the acrylic resin that adversely affect the longevity of the prosthesis. The metal ceramic restorations are typically the more expensive restorations to fabricate but provide the greatest durability and longevity and may be more cost effective over time. However, they are susceptible to fracture of the veneering ceramic. A major disadvantage of the fixed implant restoration is the inability to restore in some cases the required support of the upper lip for proper esthetics. Phonetics may also be compromised due to difficulty in managing the air stream in the maxilla with limited or minimal resorption, but in the atrophic maxilla this is usually not problematic. These limitations and potential complications are much less common than those associated with implant removable prostheses. Problems associated with denture materials, denture base adaptation to the residual alveolar ridges, retention attachments, and other maintenance issues are associated with removable implant restorations. The need to adjust, repair or replace removable prostheses over time represents a significant disadvantage. Lost of the removable prostheses may become an issue when patients are no longer able to care for themselves or are placed in living facilities unable to provide the oral hygiene and supervision. In addition, bone loss around the supporting implants may be greater when they are restored with a removable rather than a fixed prosthesis11.

In summary, fixed implant restorations are the most appropriate prosthetic restorations for the atrophic maxilla especially when compared to disadvantages associated with removable prostheses.

Removable rehabilitation
Anthony J Summerwill, Consultant in Restorative Dentistry, Birmingham Dental Hospital, UK

The primary focus of oral rehabilitation with dental implants is restoratiojn of form, funtion and ultimately the psychological well-being of the patient. The literature is awash with implant survial figures and prosthetic complilcations while often overlooking patient based criteria. It has been documented that the over-riding factor in determining the success or failure of implant based rehabilitations are patient mediated oucomes.

In the atrophic maxilla, the patterns of bone loss are consistent resulting in a jaw with both vertical and horizontal defficiency. Not only does this impact on denture retention and stability but there are also issues with loss of circum-oral form. Techniques to accommodate for these tridimensional changes include conventional denture construction utilizing a labial flange or alternatively surigcal augmentation. Onlay grafting , Le Fort osteotomies and interpositional grafting and Osteogenic distraction have all been employed and demonstrate reasonable long tem implant surival rates. However there are patient morbidity factors that need to be consiered when using grafting protocols aling with the higher incidence of implant complications in long -term follow up.

While the literature clearly demonstrates higher rates of complications in overdenture reconstructions, maintenance is clearly a cheaper and less involved process when compared to the fixed alternative.

'Conservative' fixed approaches have been advocated offering a low cost solution without the need for grafting. The so called'All on Four' concept demonstrates good implant survival rates but the literature reveals high complication rates including sinusitis, Mucositis and persistent speach issues.

Cross over studies reveal improved patient outcomes with overdenture prostheses when compared with fixed alternatives. This is particularly evident in the older patient. Functional outcomes also appear to be better in the overdenture group, notably speech.

In conclusion, the removable overdenture option offers a simpler and more predictable

Consensus
At present, there is insufficient data, including health related quality of life studies, to recommend a preference for either fixed or removable restorations in the edentulous atrpohic maxilla.

Superstructure retention - screw v's cement

Screw retention
Henny Meijer, Professor in Implant Prosthodontics, University of Groningen

Implant-supported restorations can either be screw-retained or cement-retained. Usually both options are available in implant dentistry for the partially dentate patient. Literature reveals no difference between screw-retained and cement-retained implant-supported restorations with respect to radiographic bone changes. However, peri-implant infections are mentioned due to excess of cement. And the deeper the margin of the restoration, the more difficult to remove all cement remnants. It is obvious that the access hole of the screw must not be visible in the esthetic region and that the access hole must not endanger the strength of the restoration, but in many times this is not the case. It seems that personal preference of the restorative dentist determines the selection for screw-retained or cement-retained. In favour of the choice for screw-retained speaks:

- no extra margin which could irritate the peri-implant mucosa
- no risk of excess of cement
- the possibility to remove the restoration without destroying it

Cement retention
Alvin G Wee, Associate Professor, Creighton University, Nebraska

The use of either cement- or screw-retained implant supra-structures does not impact implant survival rates. However, there are advantages and disadvantages in? the prosthodontics component of the rehabilitation for both supra-structures that clinicians need to be aware of. Knowing this will allow clinicians to provide the most appropriate care and match the treatment desire of their patients. The advantages and disadvantages of cement-retained supra-structures are listed below:

The advantages of cement- compared to screw-retained implant supra-structures include: (1) Flexibility in implant position; (2) Easier to technically fabricate and 1.5 to 2 times less costly; (3) Super-structure fits passive over fitting abutments because of the cement grout; (4) Securely retained over rigid abutments with cement as compared to use of small screws in screw-retained supra-structures; (5) The whole occlusal table / lingual surface is available for better control of the occlusion; (6) Provide an esthetically pleasing occlusal table than can be done with screw-retained implant supra-structures; (7) Easier to technically deliver the restorations with regards to adjusting proximal contacts and working in the posterior segment; and (8) Has a lower prosthetic complication rate.

The disadvantages of cement- compared to screw-retained implant supra-structures include: (1) Greater inter-occlusal space is required for these restorations; (2) A potential for clinicians to leave a cement residue that can cause periodontal problems; and (3) Difficulty of retrievability even by varying the type of cement used.

Consensus
At present, there is insufficient scientific data, including health related quality of life studies, to recommend a preference for either removable or fixed prostheses for the edentulous maxilla.

Inferior versus superior border onlay technique for class VI mandibular augmentation

Lower border onlay technique
Dr Rik Soehardi, Radboud University Nijmegen Medical Centre

The results were presented on a lower border grafting technique, limited to the symphyseal area, in preparation to implant insertion, in extremely resorbed edentulous mandibles (Cawood & Howell Class VI, sympheseal bone height < 10mm). This technique allows for maximum sized implants, followed by prosthetic rehabilitation. Sixteen patients were followed for a period of six months to four years. They were all free of nerve dysaesthesia. All patients received a removable overdenture and were satisfied with the result, measured by a VAS. The main advantage of this method is the minimal risk of damage to the mental nerve, while they can wear their conventional denture immediately postoperative. There is also no risk of mucosal dehiscence's and it is assumed that this way less bone resorption can be expected.
The disadvantages includes a submental scar and accentuated chin, while no reduction of the intermaxillary distance is achieved.

Long term treatment outcome of reconstruction of the extremely atrophied mandible with onlay bone grafts followed by insertion of endosteal implants.
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Rehabilitation of the extremely resorbed edentulous mandible (Cawood, Class VI, bone height <7 mm) is still a challenge in implant dentistry.
The aim of this retrospective study was to assess the long term treatment outcome (5-12 years) of implant-retained lower dentures on two endosteal Straumann implants placed in a severely atrophied mandible that was reconstructed with bone grafts from the iliac crest.
Materials and methods:
In 2012, all consecutive patients (n=40) who had been treated with iliac crest bone grafts, two implants and a lower denture between 2000 and 2007 were recalled. Clinical and radiographic parameters, patients' satisfaction and chewing ability were scored. Differences between evaluation periods were tested with a paired Student's t-test. In all tests, a significance level of $p<0.05$ was chosen.
Results:
Implant survival rate was 99% (one implant was lost after 5.5 years). Surgical complications related to the iliac crest donor site were seroma (n=1), hematoma (n=2) and sensible disturbance of the femolaris cutaneous lateralis (n=1) directly after augmentation. All these complaints had resolved before insertion of the implants. Furthermore, 11 patients had reported postsurgical sensory disturbances of the mental nerve (objectively and subjectively). Five of them still had a sensory disturbance in the region at the last recall visit, but the region had diminished in size over time. Mean scores of the indices for plaque, calculus, gingival, and bleeding were very low. Patients' satisfaction and chewing ability were high.
Conclusion:
Iliac crest bone onlay augmentation of the extremely resorbed mandibule followed by placement of two implants after three months provides a solid basis for a bar-retained mandibular overdenture. The results show that also on the long run patients are well satisfied with treatment Peri-implant parameters, chewing ability and patients' satisfaction were as high as reported in earlier studies.

Consensus

When considering treating a patient with a Class VI edentulous mandible and with a symphyseal bone height of less than 10mm, a 3-D examination is mandatory to properly assess both height and width of the residual mandible.

When treating these patients with fixed implant-retained prostheses, over time, some bone apposition in the posterior region of the mandible may be expected.

When considering bone augmentation, an intra-oral or submental approach for onlay grafting techiques may be chosen. Both techniques have advantages and disadvantages.

Biomechanical analyses relating to fractures of "thin" mandibles treated with implants

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Senior Research Engineer

Aims: Recent reports have raised concerns about fractures of "thin" mandibles treated with dental implants. For instance, Soehardi et al.'s (2011) review of such fractures noted that they typically occurred through the implant osteotomy site in mandibles having heights of between 5 and 10 mm. Moreover, in a survey of clinicians' precautions about the "minimal bone height needed for implant placement", Soehardi et al. reported that the majority of survey respondents "considered a bone height of less than 8 mm as unsuitable." Against this backdrop, the present biomechanical study (presented at the 2012 meeting of the IAOFR in Tampa, FL) sought to identify biomechanical factors that could be contributing to the fracture incidence of "thin" edentulous mandibles treated with implants.
Methods: All analyses involved 3-dimensional finite element (FE) computer simulations (using Comsol Multiphysics 4.3a) of mandibular structures. The first set of simulations included a series of idealized mandibular models comprised of solid or hollow tubes bent into a 180-degree arc, with 5 non-threaded cylindrical 3.75 x 10 mm implants installed in the anterior region to support a 4 mm-thick hybrid-type titanium prosthesis loaded bilaterally in the distal cantilever region with 100 N (downward), e.g., Figure 1.

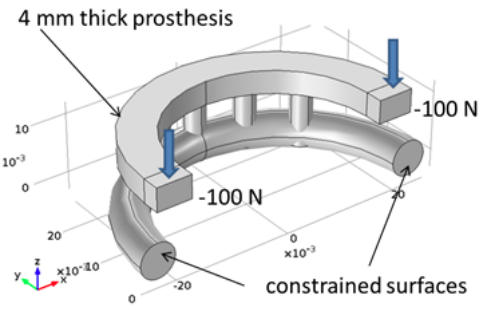

Figure 1 FE model of an idealized 5 mmthick mandible with 5 implants and prosthesis

In these idealized mandibles we varied a) the mandibular height (e.g., 5 to 10 mm) and b) the cross-sectional structure, e.g., a solid vs. "hollow" structure, the latter having a cortical shell and cancellous marrow). Cortical and cancellous bone were assumed to be linearly isotropic; for cortical bone, the modulus E = 10 GPa and Poisson's ratio ν = 0.33, while for cancellous bone E = 100 MPa and ν = 0.33. The second set of FE simulations (e.g., Figure 2) involved solid models constructed from a CT dataset from one patient with a "thin" mandible treated with implants. (This patient was from Dr. Kenji W. Higuchi's clinic in Spokane, WA. There was no history of fracture in this case.) The mandible was obtained using thresholding and smoothing operations in Analyze and Geomagics software. This mandible was analyzed with five (5) 3.75 mm-diam. Brånemark implants placed in the anterior to support a titanium framework loaded bilaterally with 100 N as in the case of the idealized mandibles. In the biomechanical analyses of both the idealized cases and the actual human mandible, the aim was to identify locations of high strain (and related stress) that could relate to potential bone fracture. As an approximate indicator of the threshold for dangerous strain magnitudes in bone, we used a value of 0.4% (0.004, or 4,000 microstrain) of tensile principal strain, since fatigue literature on cortical bone indicates that fatigue failure is likely in about 1000 cycles under a tensile strain range of about 0.4%(e.g., Keaveny and Hayes, 1993).

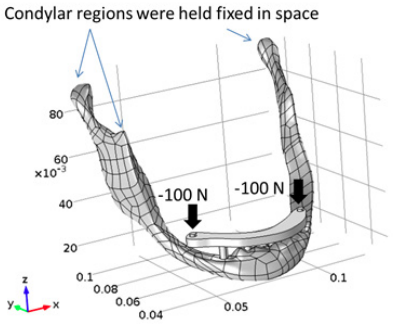

Figure 2 FE model of a mandible from a patient with 5 implants and a framework

Results: As an example of trends from the analyses of the idealized mandibles, it's useful to first look at strain magnitudes in a "worse-case scenario" of a 5 mm-thick idealized mandible (Figure 3). Here, tensile and compressive principal strains concentrated in the bone at the apices of the two most distal implants in the 5-implant distribution; note the red-orange strain contours localized near the apices of the implants as seen in Figure 3. While the magnitudes of strain in this location decreased as the mandible thickened from 5 to 10 mm, this location tended to be the high-strain locations in all of the idealized mandibles.

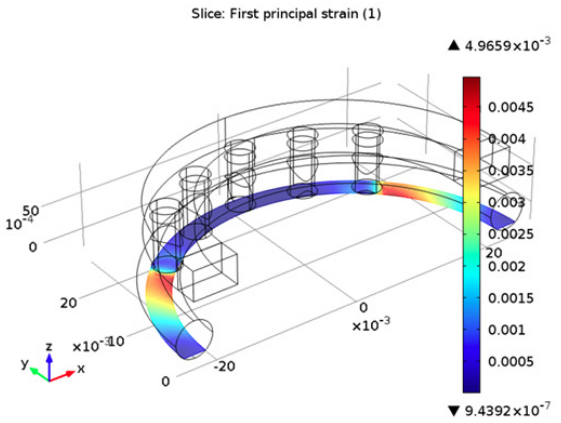

Figure 3 Contours of 1st principal (tensile) strain in a plane through a 5 mm-thick mandible at the level of the apical ends of the implants

Another point about this "worse-case" 5 mm mandible was that the tensile principal strainva magnitude in bone at the apical regions of the two distal implants exceeded the danger level of 0.004 (0.4%), e.g., in some places the strain reached 0.0045 to 0.00496. The significance of this result is that at these strain magnitudes, one would predict local fatigue failure in the bone, which, in turn, could start a crack that could propagate through the whole mandible, resulting in an overt fracture.

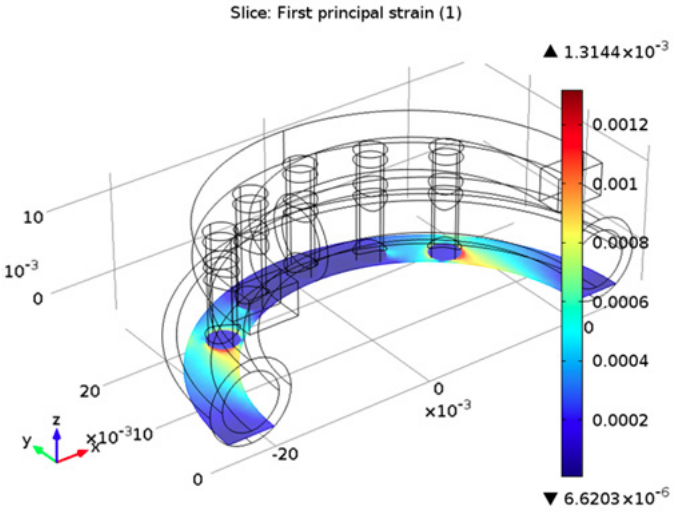

Figure 4 Contours of 1st principal (tensile) strain in a plane through a 10 mm-thick mandible at the level of the apical end of the implant

In the case of an idealized 10 mm thick mandible with cortex and cancellous marrow (Figure 4), it was still true that the tensile principal strains peaked at the apices of the two distal-most implants, but the strain magnitudes were now much smaller than in the case of the 5 mm-thick mandible, e.g., 0.0012 (0.12%) – which is considerably below the "danger" level of 0.004. In the case of the actual mandible from the CT data,we observed the same trend as seen in the idealizedmandibles, i.e., principal tensile and compressivestrain concentrated distal to the two distal mostimplants (Figure 5). However, in this actual mandible where the mandibular thickness was about 7mm in the region of peak strains near the two distal implants -- the magnitude of the peak tensile strain was relatively small, e.g., about 7.8 x 10-4, or 0.00078 (0.078%) – substantially less than what was observed in the 10 mm-thick idealized solid mandible, and also less that the strains observed in a 7 mm thick idealized mandible, where the peak tensile strain was about 0.002. The differences between strains in the idealized vs. actual mandible likely stem from differences in the shape of the mandibular cross-section as well as other factors.

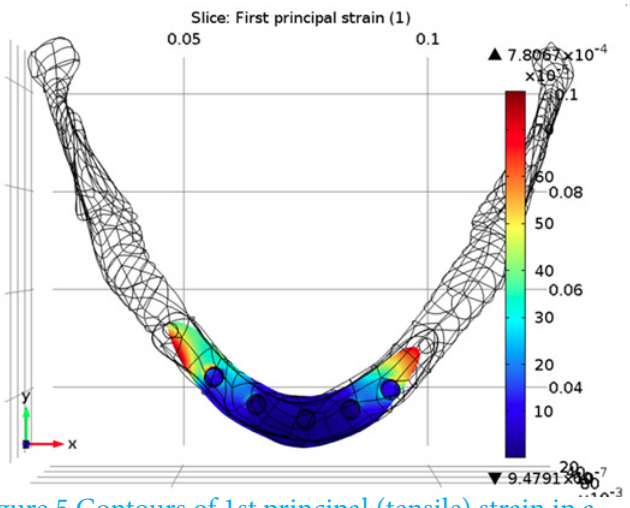

Figure 5 Contours of 1st principal (tensile) strain in a plane through a patient's mandible at the level of the apical ends of the implants (view is looking "down" from the occlusal)

Discussion and Conclusions: These biomechanical analyses shed light on possible mechanisms underlying observed mandibular fractures. First, our results show that the principal tensile and compressive strains reach peak values distal to the distal-most implants in the distribution, which is where fractures of mandibles have been observed. Second, the results indicate that when factures do occur, a fatigue failure mechanism is plausible, in view of the fact that the reported fractures were not seen immediately but rather after weeks or months post-implantation, following many cycles of in vivo loading. Also it is interesting to note that the mandible from the patient in Dr. Higuchi's practice showed relatively safe levels of strain – a finding that was consistent with the fact that no problems were seen in that case. This case represents a counterexample to the survey results in Soehardi et al., which suggested that a 7 mm mandibular height would be "unsuitable" for implant treatment.

There are a number of cautionary notes about these FE studies. First, the results do not take into account the local strain concentrating effects due to the screw threads on actual dental implants; the strains in interfacial bone would be larger if screw threads were present in the FE modeling. Second, these FE studies do not account for the existence of surgically-damaged bone right at the bone-implant interface; such bone will be weaker than normal bone and possibly more prone to fatigue and cracks. In future work, it would be valuable to do a series of analyses on a set of CT scans taken from patients with thin mandibles that did or did not go on to show fractures when treated with implants.

References:

Keaveny TM and Hayes WC (1993) "Mechanical properties of cortical and trabecular bone." Bone 7:285-344.

Soehardi A, Meijer GJ, Manders R and Stoelinga PJW (2011) "An inventory of mandibular fractures associated with implants in atrophic edentulous mandibles: a survey of Dutch oral and maxillofacial surgeons." Int J Oral Maxillofac Implants 26:1087-1093.

Immediate reconstruction of the mandible after resection for aggressive odontogenic tumours: A cohort study.
From: Simon ENM, Merkx MAW, Kalyanyama BM, Shubi FM, Stoelinga PJW.
Int J Oral Maxillofac Surg 2013;42:106-12.

The results were reported of a clinical follow-up study on 32 selected but consecutive patients with mandibular ameloblastoma, They were all treated by a segmental resection and reconstructed, using two 2.3 mm reconstruction plates and an autogenous particulate bone graft, taken from the anterior iliac crest, and platelet rich plasma. Follow-up ranged from 12 to 39 months, with an average of 27,9 months. Undisturbed healing occurred in 29 patients, whilst three had postoperative infections, but in only one case did that result in failure of the graft. Patients appreciation was measured using an adapted quality of life questionnaire. The results were compared with a similar group who did not undergo reconstruction. The eating of solid food, appearance and speech were considerably better in the reconstructed group. The conclusion is that this means of reconstruction is appropriate for patients with benign but aggressive odontogenic tumors of the mandible, particularly in the developing countries, since the expenses seem to be affordable.