

Short Mini-Dental Implants as Denture Retainers: Digital Image Correlation and 2-Year Cohort Study

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Abstract

Background: In patients with extreme alveolar ridge atrophy, where mandibular height is less than 10 mm, it is challenging to achieve stable and well functioning complete denture. In such cases it's not possible to insert standard size or even short dental implants without complicated bone augmentation procedures. Due to small width of MDIs, patients do not need demanding surgical procedures and hence are well accepted by elderly patients or those with deteriorating general health status.

Aim: Aim was to test the behavior of dental implants being both, slim and short (short MDIs) for complete overdenture (OD) retention by digital image correlation (DIC), and afterward, in clinical trial, to rehabilitate patients with less than 10 mm of mandibular height by means short MDIs OD retention.

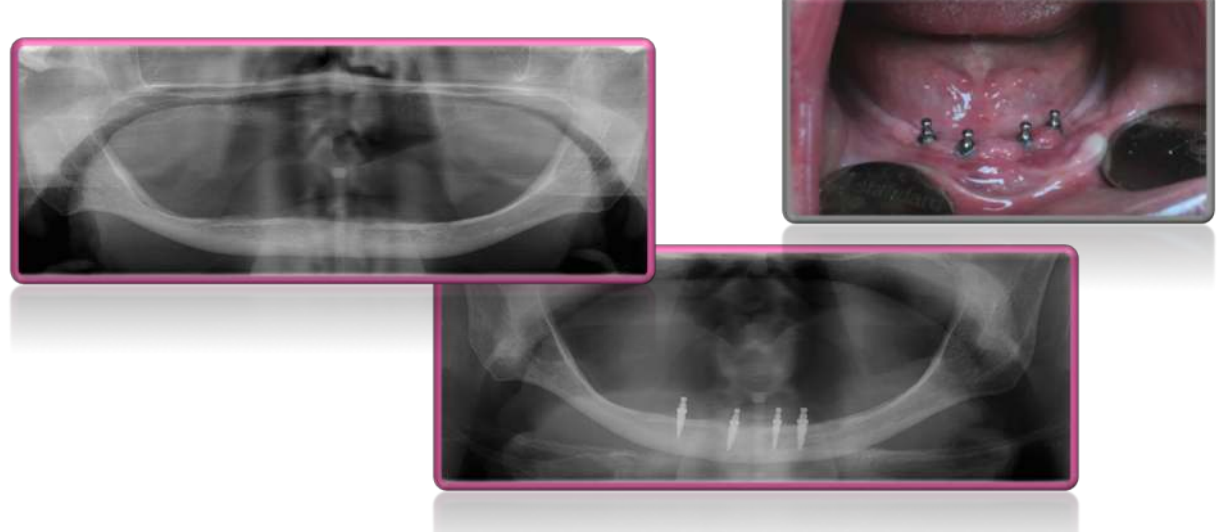
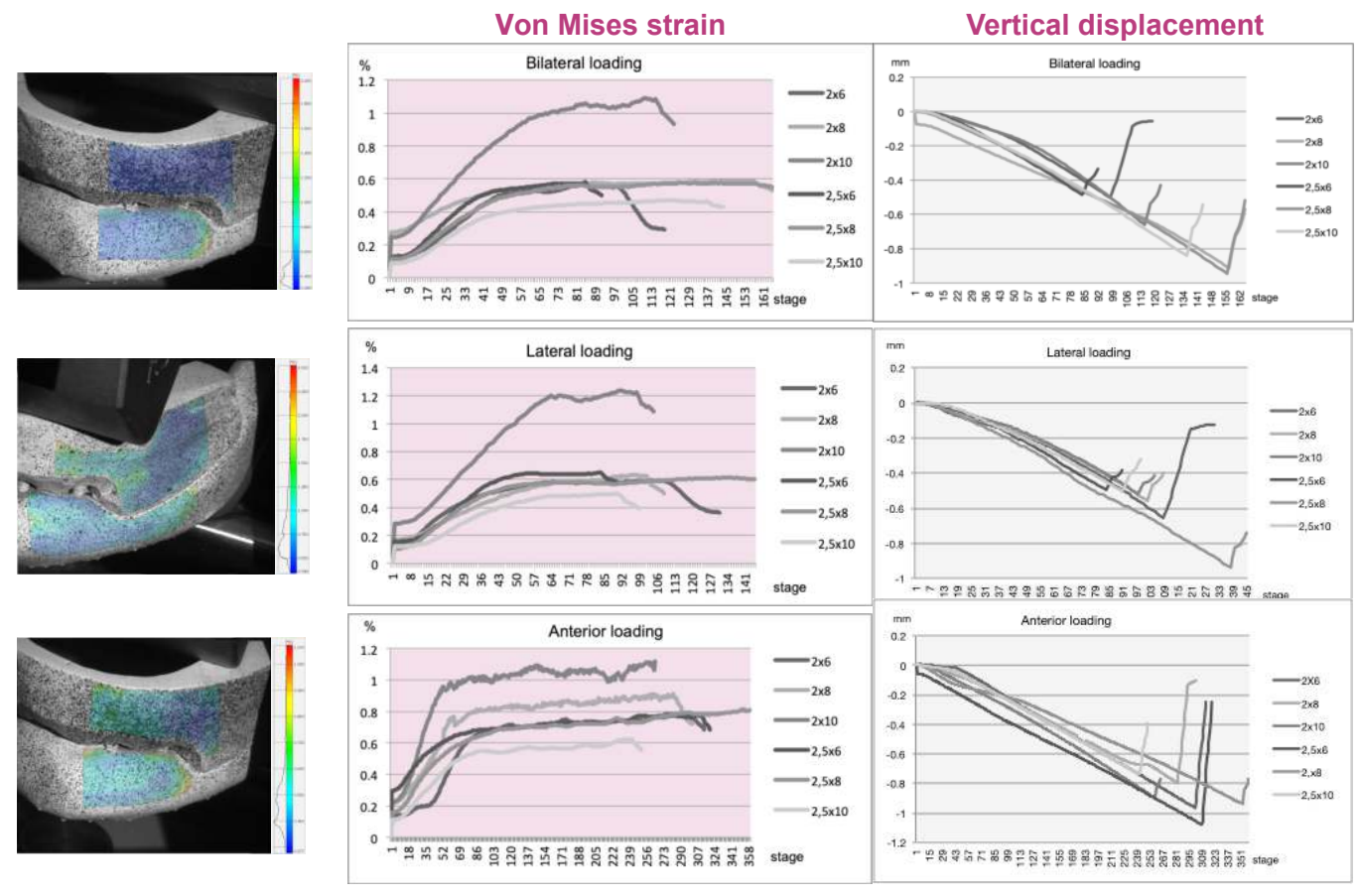
Materials and Methods: Based on CBCT scans of patients with extremely atrophied mandible (interforaminal height < 10 mm), 6 models of an average extremely atrophied mandible were virtually built and 3D printed. In each model 4 short MDIs (length 6, 8 or 10 mm, width 2 or 2.5 mm; Dentium, South Korea) were inserted interforaminally and CoCr reinforced ODs were loaded with 150 N on denture molar region bilaterally, unilaterally and the on anterior region. Precise measurement of strain and displacement was conducted using the Digital Image Correlation Method (ARAMIS software v6.2.0; GOM-Optical Measuring Techniques), which approved the protocol. Patients (D or E classification according to Leckholm and Zarb) received 4 short MDIs by a flapless surgical technique. MDIs were early loaded using matrices with O-rings mounted in mandibular ODs. Marginal bone loss (MBL), technical complications, OHIP-EDENT and the chewing function questionnaire (CFQ) were assessed prior treatment, after OD delivery and after 2-years in function.

Results: Strain values on all models ranged from 0.45% to 0.92% with the highest displacement and strain values observed around MDIs and on the zone of bone-denture contact. Analysis of the major strain fields demonstrated that the strains of the mandibular bone were the result of vertical displacements of the ODs. DIC showed in all loading stages identical spreading direction with the maximum strain value within the denture-bone complex. In clinical trial 20 patients received 4 short MDIs and respective ODs. Two implants fractured during insertion and 4 failed after placement. All other implants were stable, without biological complications. MBL was 0.26 ± 0.35 mm with 95% survival rate and 8 O-ring replacements. The OHIP-EDENT and the CFQ scores significantly decreased after treatment ($p > .05$) and did not change significantly through the 2-years of observation ($p > .05$).

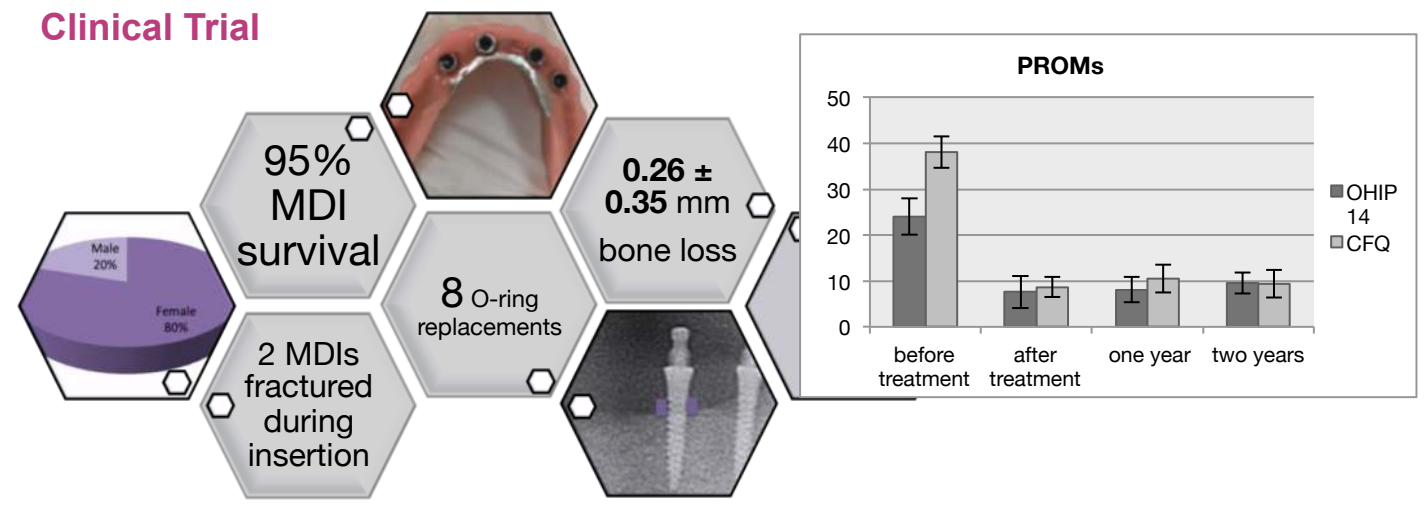
Conclusions: DIC is a novel method in dentistry providing high precision and accurate repeatability. Measurements on 3D printed models demonstrated low strain and displacement values around short MDIs and in mandible, which enabled proceeding with clinical trials. Within the limitations of this study, insertion of 4 short MDIs (length 6 or 8 mm) in extremely atrophied mandibles for retention of mandibular ODs showed encouraging results in the first two years of function.

Results

Digital Image Correlation



Clinical Trial



Background and Aim

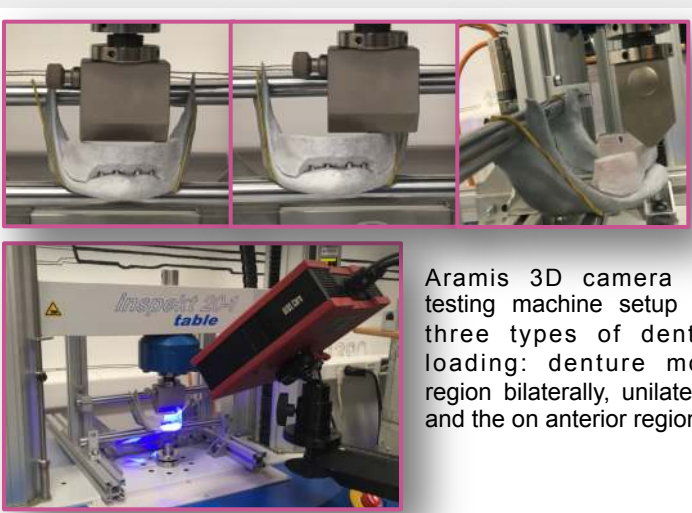
Extreme alveolar ridge atrophy is a result of a long period of edentulism. It is aggravated by poor bone quality, osteoporosis or inadequate and unstable removable denture. In rare cases, mandibular ridge atrophy may sometimes be so advanced that interforaminal mandibular height is less than 10 mm, accompanied with a reduced bucco-lingual width. Dental implants provide considerable benefits to patients with mandibular overdentures, such as increased denture stability, functional efficiency, comfort and increased quality of life. Due to extreme ridge atrophy, only slim MDIs (diameter < 2.9 mm, length 6 or 8 mm) could be inserted without previous demanding surgical procedures of bone augmentation and soft tissue modelation.

Aim of this study was to test the behavior of dental implants being both, slim and short (short MDIs) for complete overdenture (OD) retention by digital image correlation (DIC), and afterward, in clinical trial, to rehabilitate patients with less than 10 mm of mandibular height by means short MDIs OD retention.

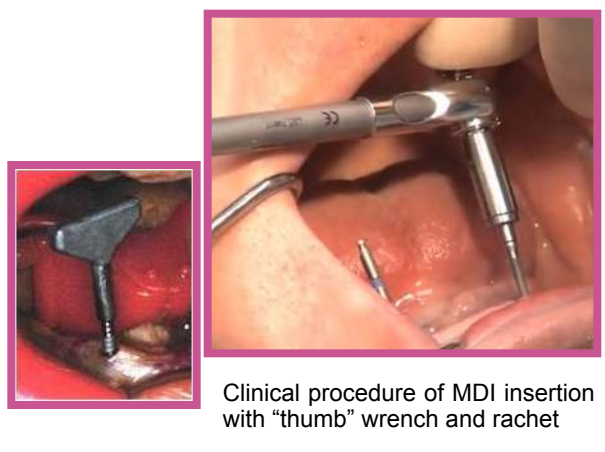
Conclusion

- Measurements on 3D printed models demonstrated low strain and displacement values around short MDIs and in mandible
- Insertion of 4 short MDIs (length 6 or 8 mm) in extremely atrophied mandibles for retention of mandibular ODs showed improvement in patients' oral health related quality of life
- Short MDIs for OD retention had 95 % survival rate after two years in function
- Marginal bone loss after two years in function was 0.26 ± 0.35 mm
- Insertion of 4 short MDIs (length 6 or 8 mm) in extremely atrophied mandibles for retention of mandibular ODs showed encouraging results in the first two years of function

Methods and Materials



Aramis 3D camera and testing machine setup with three types of denture loading: denture molar region bilaterally, unilaterally and the on anterior region



Clinical procedure of MDI insertion with "thumb" wrench and rachet

References

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