

Retrospective radiological analysis of peri-implant bone level and peri-implant bone density of dental implants of different lengths

Peppmeier, Sandra M¹, Henn, Paul², Neugebauer, Jörg^{1,3,4}

1. University of Cologne Faculty of Medicine and University Hospital Cologne, Department for Oral and Craniomaxillofacial and Plastic Surgery

2. Private practice Dr. Henn and colleagues Ölbronn-Dürrn, Germany

3. Private practice Dr. Bayer and colleagues Landsberg am Lech, Germany,

4. Steinbeis-University, Transfer-Institute Management of Dental and Oral Medicine, Ludwigshafen, Germany

Retrospective radiological analysis of peri-implant bone level and peri-implant bone density of dental implants of different lengths

Peppmeier, Sandra M¹, Henn, Paul², Neugebauer, Jörg^{1,3,4}

Background

Complex vertical bone augmentations are often associated with patient comorbidities^{1,2}. The prolonged healing period of the augmented bone, as well as the subsequent implant surgery, lead to a significant reduction in masticatory function³—often lasting for months or even years. Additionally, with increasing age and a higher risk profile due to pre-existing conditions, the likelihood of augmentation failure rises⁴. The surgical treatment of vertical bone defects is challenging and involves a considerable volume loss due to bone remodeling in the first few months after implantation⁵. Furthermore, there is a risk of dehiscence formation⁶. To adequately treat patients with a high risk profile, the use of shorter implants can be a viable alternative, as it eliminates the need for complex vertical augmentations^{1,7}.



Fig 1 Bone block grafting to augment vertical and horizontal bone deficiencies



Fig 2 Radiograph after bone block augmentation.

Objective

This retrospective case-control study aims to compare the vertical bone level changes and bone density development of short implants (5.2mm) versus standard-length implants (8.0–14.0 mm). The goal is to determine whether short implants are a viable alternative to extensive bone augmentation and standard implants in atrophic jaws, particularly regarding bone loss and bone density at reproducible measurement sites.

Materials and Methods

This retrospective case-control study examines 53 patients who received a total of 123 dental implants, including both standard-length (45) and short implants (78).

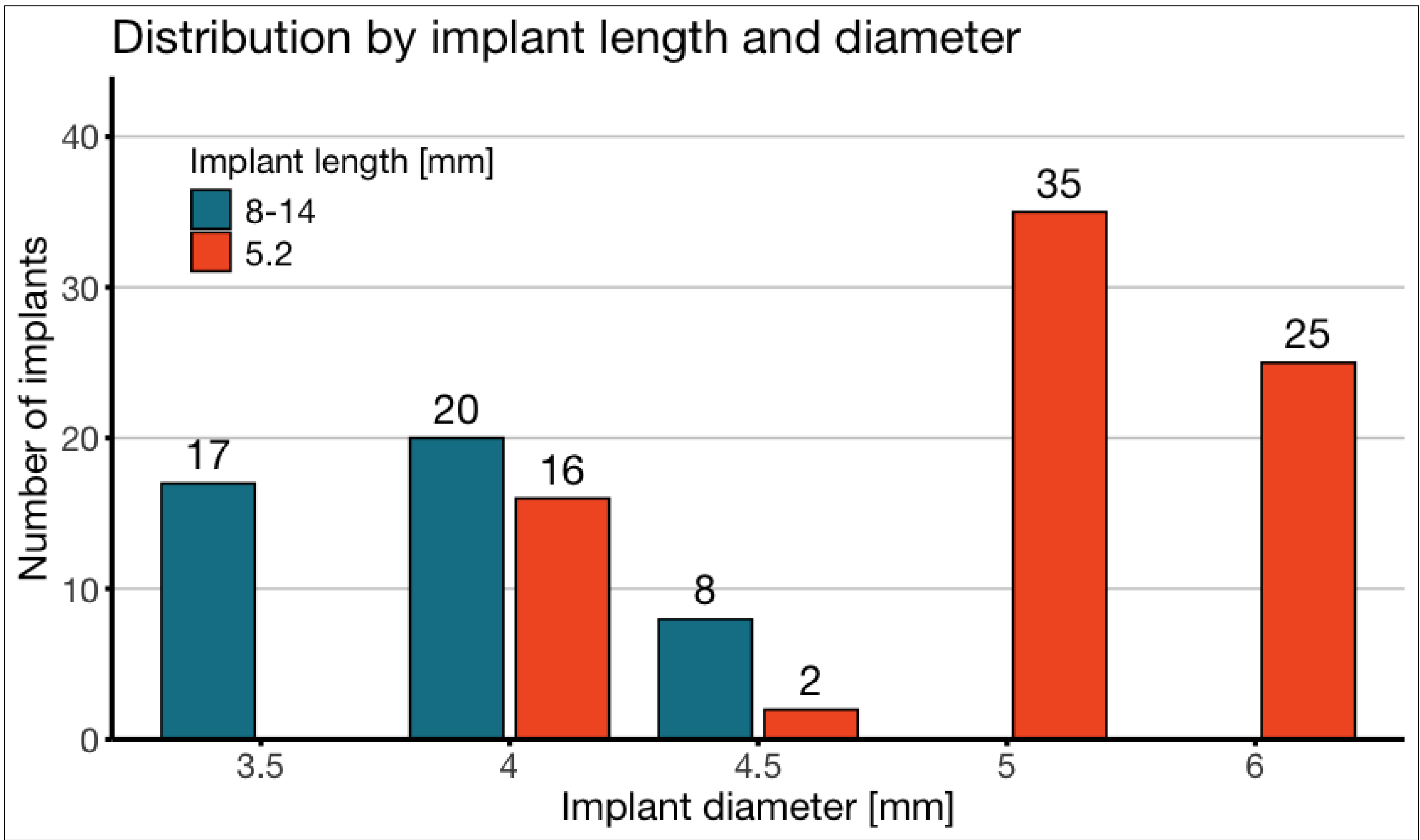


Fig 3 Implant distribution by length and diameter.

All implantations were completed prior to the study, and routine radiographic imaging was performed to document the peri-implant bone level and its density. The average observation period was 38 months, with a maximum of 64 months.

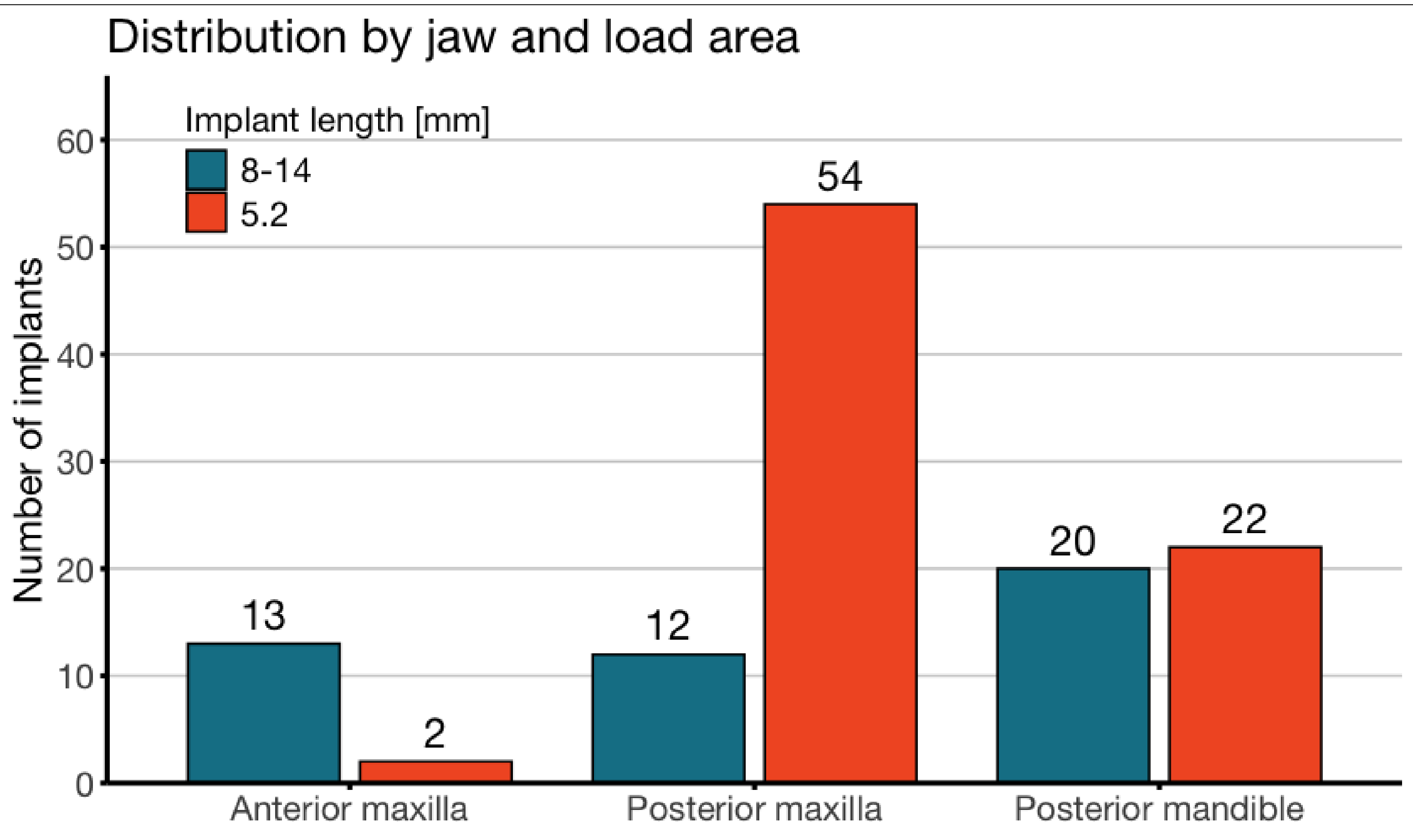


Fig 4 Implant distribution by jaw and load area.

The mean marginal bone level was assessed by measuring the distance from the implant shoulder to the first bone-to-implant contact on the mesial and distal sides in Fiji. To ensure accuracy, the radiograph was calibrated using the known length of the implant. (Fig 5)



Retrospective radiological analysis of peri-implant bone level and peri-implant bone density of dental implants of different lengths

Peppmeier, Sandra M¹, Henn, Paul², Neugebauer, Jörg^{1,3,4}



Fig 5 Radiographic images of the MBL of a short implant using Fiji[®]. (a) Initial measurement. (b) Calibration of the initial measurement using the set scale tool to match the known implant length. (c) Exact measurement of the MBL mesially and distally of the implant after calibration. Results of the measure tool should be carefully validated, with mathematical signs adjusted as necessary.

The density evaluation of the radiographs was performed according to Sahrman et al. by marking five areas of interest on each radiograph⁸. One AOI was placed mesially and one distally at the midpoint of the endosseous part of the implant, and one centrally apical to the implant. The remaining two AOIs were placed in structures expected to remain unchanged over time, such as metal, dentin, or fillings, for calibration purposes. (Fig 6)

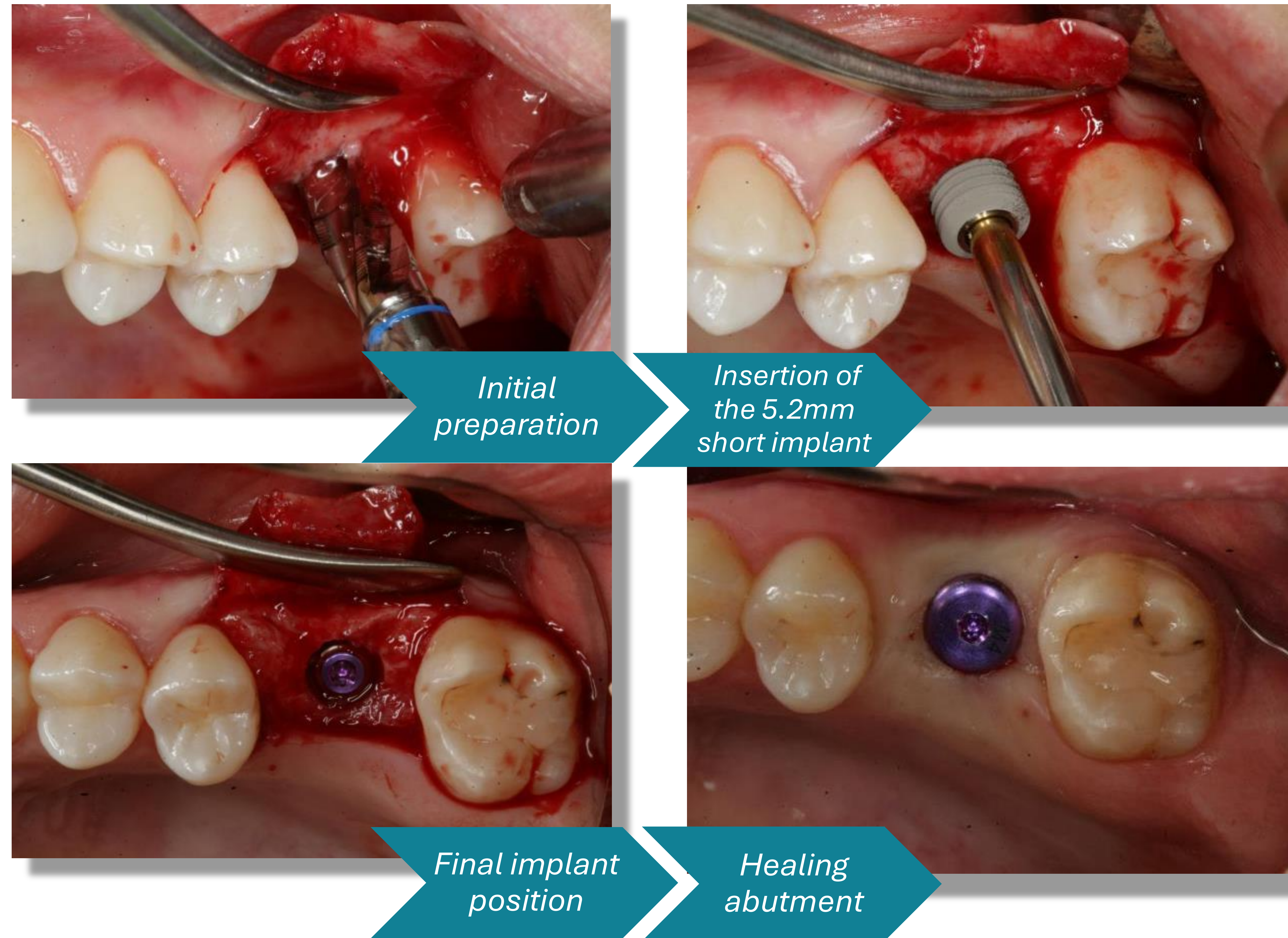
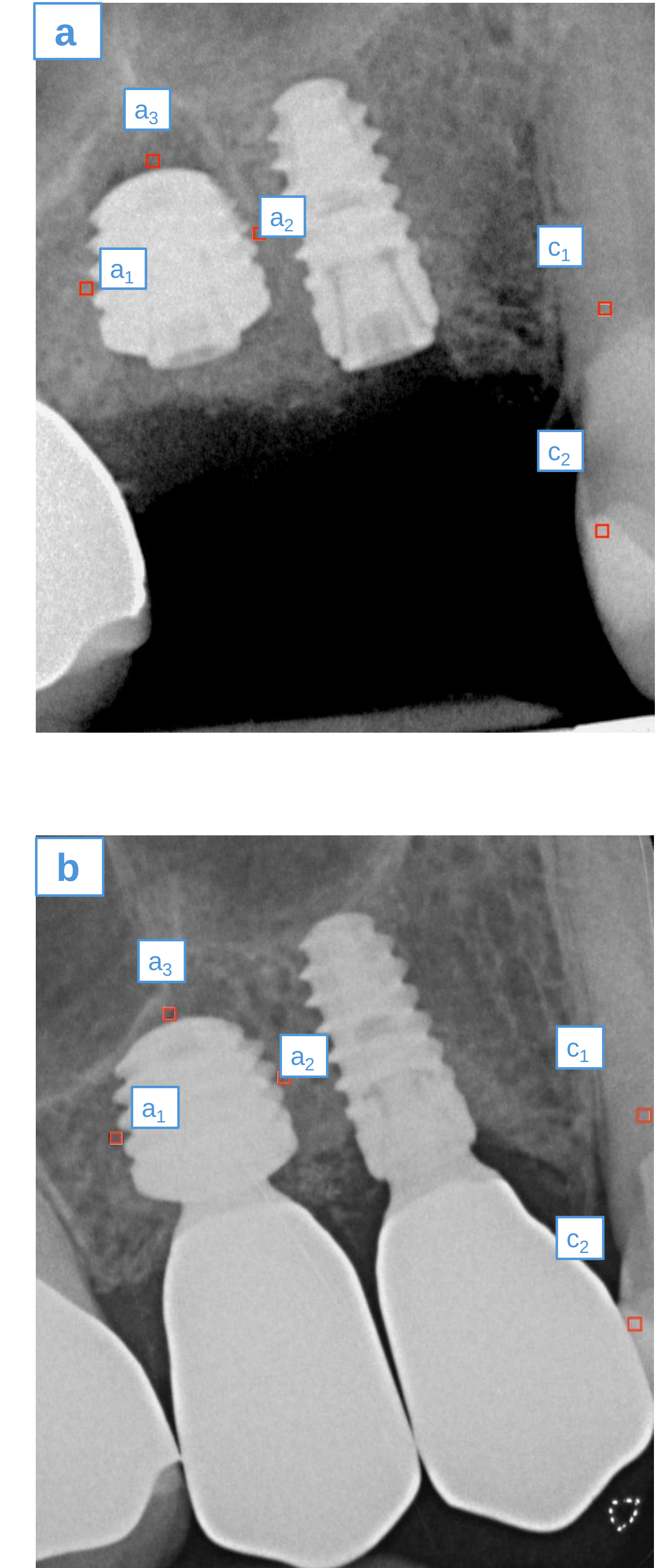
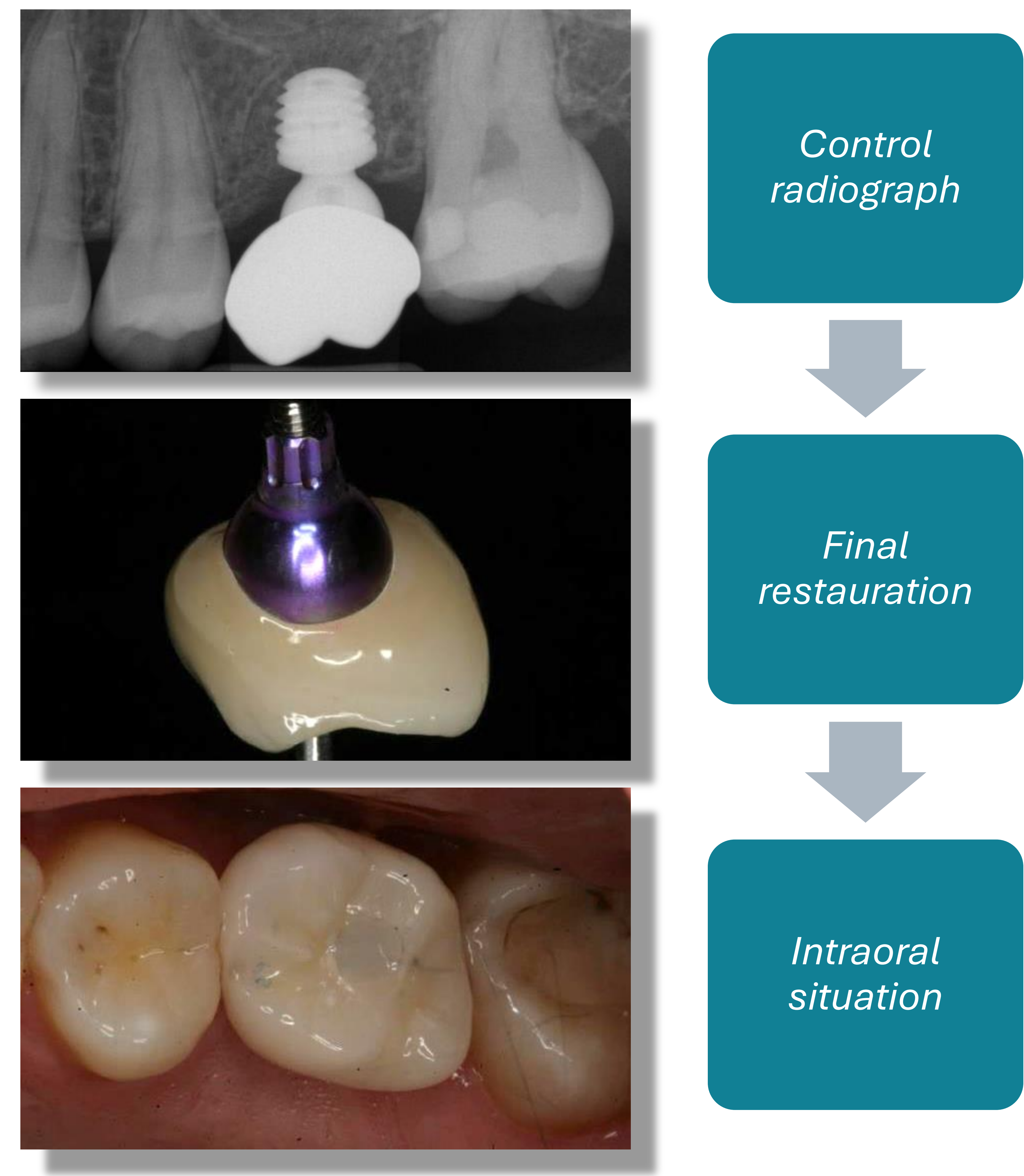


Fig 6 Radiographic images in Fiji[®] at (a) day of implantation, (b) most recent available radiograph of the implant. Test areas a_1 - a_3 are calibrated using the calibration areas c_1 , c_2 .

Retrospective radiological analysis of peri-implant bone level and peri-implant bone density of dental implants of different lengths

Peppmeier, Sandra M¹, Henn, Paul², Neugebauer, Jörg^{1,3,4}



Results

The mean peri-implant bone level (Δ MBL, marginal bone level) in the 5.2 mm implant group was $-0.606 \text{ mm} \pm 0.93$, while in the 8.0-14.0 mm group, it was $-1.110 \text{ mm} \pm 1.26$. Statistical analysis revealed a highly significant difference in the development of the Δ MBL between the two groups ($p < 0.01$), indicating that the shorter implants maintain a more favorable marginal bone level over time.

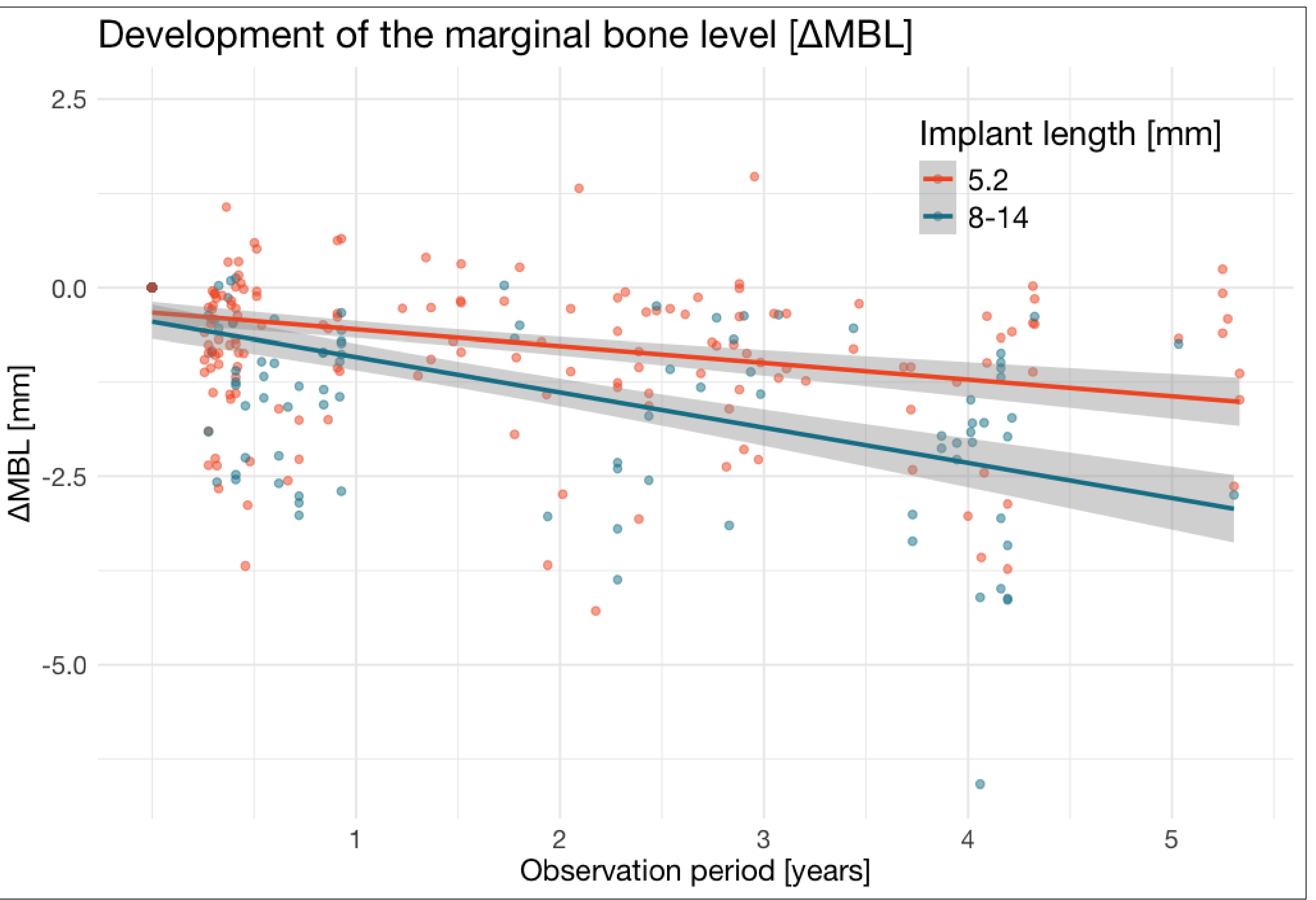


Fig 7 Development of the marginal bone level [Δ MBL]

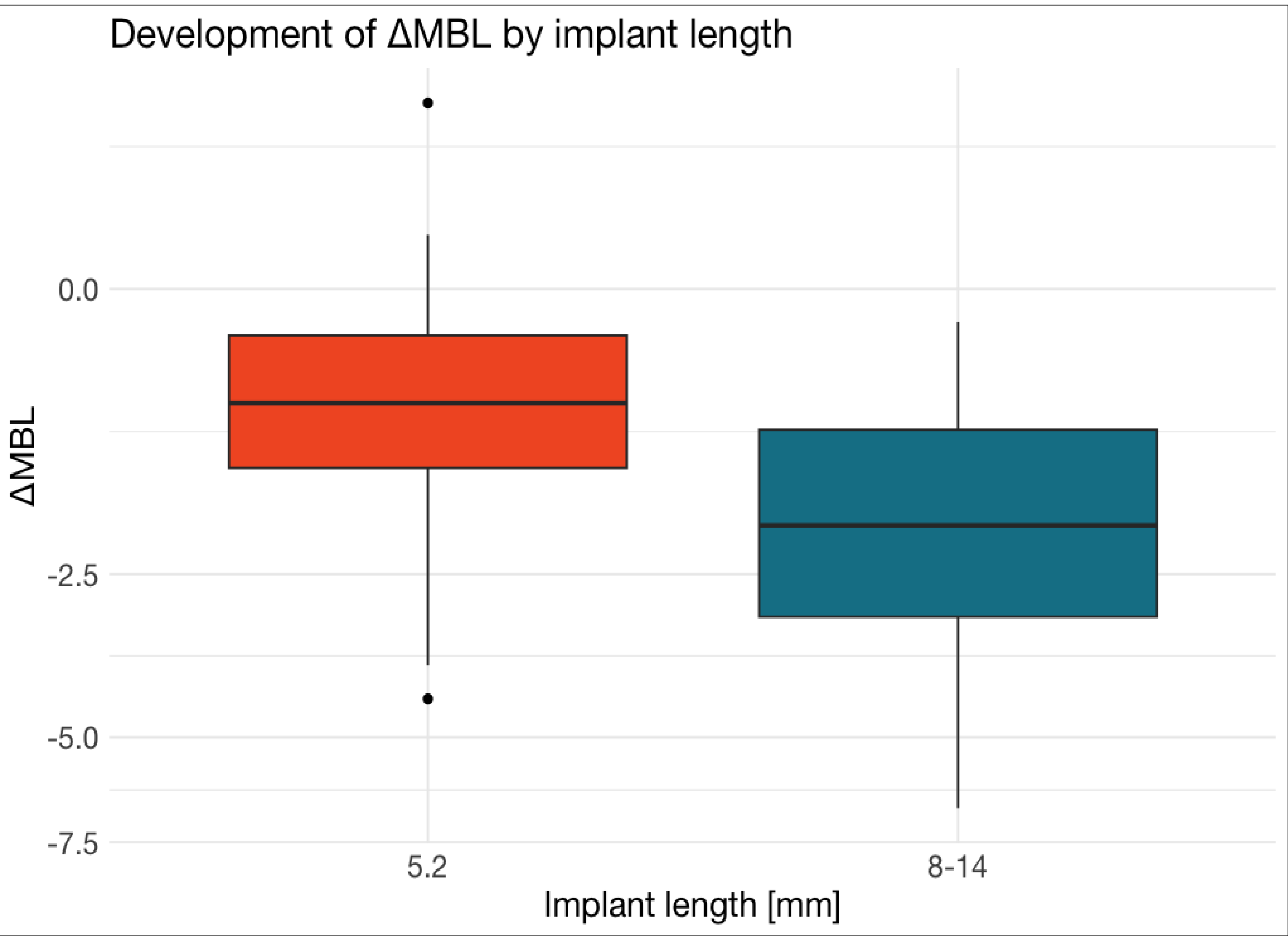


Fig 8 Development in marginal bone level by implant length

Regarding bone density (Δ GSV, grey scale value), a statistically significant difference between the 5.2mm and 8-14mm Implants was observed ($p=0.009$)

Retrospective radiological analysis of peri-implant bone level and peri-implant bone density of dental implants of different lengths

Peppmeier, Sandra M¹, Henn, Paul², Neugebauer, Jörg^{1,3,4}

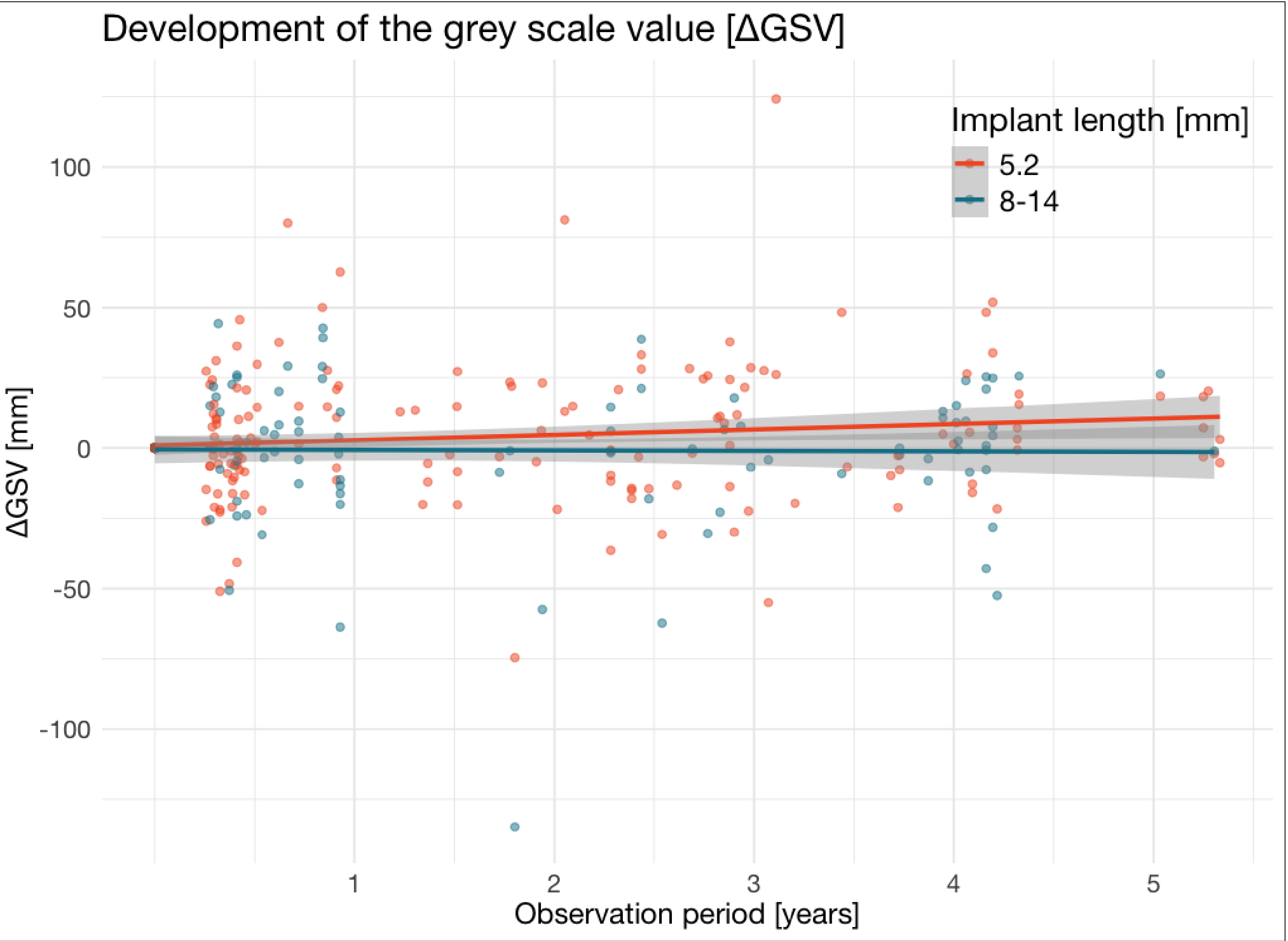


Fig 9 Change in bone density with trendline calculated by mixed model analysis

The development of the bone density around the observed implants, showed that 5.2mm Implants show a continuous increase in bone density in the lateral and apical bone, surrounding the implant. This can be shown by the linear trend line, calculated by mixed model analysis.

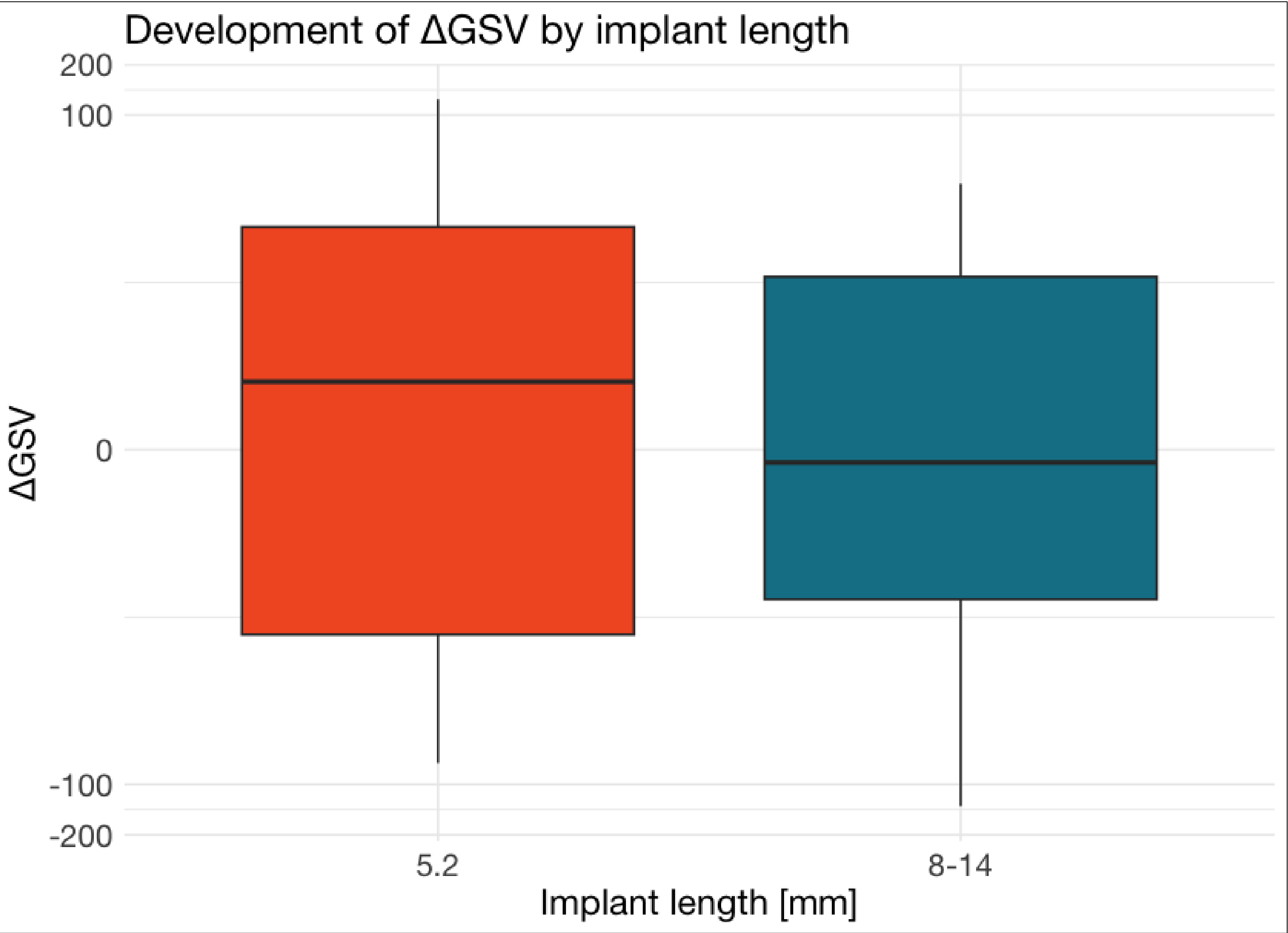


Fig 10 Development of GSV by implant length

Conclusion

Short implants are a viable option in atrophic bone, demonstrating stable peri-implant bone levels. The increased development of grey scale values in short implants compared to standard implants indicates comparable bone stability and an improved outcome

References

- Esposito M, Grusovin MG, Felice P, Karatzopoulos G, Worthington HV, Coulthard P. The efficacy of horizontal and vertical bone augmentation procedures for dental implants: a Cochrane systematic review. *Evidence-based practice: Toward optimizing clinical outcomes* 2010; 195-218.
- Heitz-Mayfield LJA, Needleman I, Salvi GE, Pjetursson BE. Consensus statements and clinical recommendations for prevention and management of biologic and technical implant complications. 2014.
- Esposito, M., Grusovin, M. G., & Kwan, S. (2008). Interventions for replacing missing teeth: Bone augmentation techniques for dental implant treatment. *Cochrane Database of Systematic Reviews*, 2008(3)
- Munakata, M., Kataoka, Y., Yamaguchi, K., & Sanda, M. (2024). Risk factors for early implant failure and selection of bone grafting materials for various bone augmentation procedures: A narrative review. *Bioengineering*, 11(2), 192.
- Dreiseidler T, Kaunisaho V, Neugebauer J, Zöller JE, Rothamel D, Kreppel M. Changes in volume during the four months' remodelling period of iliac crest grafts in reconstruction of the alveolar ridge. *British Journal of Oral and Maxillofacial Surgery* 2016; 54(7): 751-6.
- Al-Nawas B, Schiegnitz E. Augmentation procedures using bone substitute materials or autogenous bone-a systematic review and meta-analysis. *Eur J Oral Implantol* 2014; 7(Suppl 2): S219-S34.
- Berczy K, Laszlo Z, Gondocs G, Shkolnik T, Joob FA. Changes of trends in the size of the dental implants in recent years Part 1. The role of short implants in dental implantology The literature review. *Fogorv Sz* 2016; 109(4): 136-40.
- Schindelin, J., Arganda-Carreras, I., Frise, E., Kaynig, V., Longair, M., Pietzsch, T., ... Cardona, A. (2012). Fiji: an open-source platform for biological-image analysis. *Nature Methods*, 9(7), 676–682.doi:10.1038/nmeth.2019
- Sahrman P, Schoen P, Naenni N, Jung R, Attin T, Schmidlin PR. Peri-implant bone density around implants of different lengths: A 3-year follow-up of a randomized clinical trial. *Journal of clinical periodontology* 2017; 44(7): 762-8.