ANALYSIS OF A PYRAMIDAL IMPLANT DESIGN: INFLUENCE OF GEOMETRY AND LENGTH ON PRIMARY STABILITY. AN IN VITRO STUDY.

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Abstract

Short implant design plays a pivotal role in the achievement of the primary stability, especially in low-density bone.

Aim of the study was to evaluate the feasibility and features of a new expandable short dental implant system intended to increase primary stability.

In our study we compared 24 Pyramidion, DenTack Ltd. (Ø4.1x 5 mm-Group 1), and 24 traditional length implants (Neoss Tapered Ø4.x 11 mm-Group 2) placed on fresh pig ribs (D3 – D4 bone quality), analyzing the insertion torque, the implant stability quotient (ISQ) and removal torque.

Our data showed that both implant groups achieved sufficient values to reach primary stability; in particular it was noted an increase of ISQ values for Pyramidion after implant expansion.

In terms of primary stability, this in vitro data suggest that Pyramidion expandable short implant proves to be a valid alternative to a traditional implant for the rehabilitation of posterior maxilla and mandible zones.

Methods and Materials

Fig. 2 Pyramidion implant CBCT scan

Fig. 3 Pyramidion PIT and RFA procedures

Fig. 4 Pyramidion expansion and PRT procedures

Fig. 5 Tapered implant PIT and RFA procedures

A total of 24 Pyramidion, DenTack Ltd. (Ø4.1x 5 mm-Group 1), and 24 traditional length implants (Neoss Tapered Ø4.x 11 mm-Group 2), were placed in 8 pig ribs scanned with CBCT to select implant site (750<HU). After surgical site preparation implants were placed using the MGT-12 digital torque gauge increasing gradually the clockwise force (0.5 mm min⁻¹) recording peak of insertion torque (PIT). ISQ was determined by resonance frequency analysis (RFA) using the OSSTELL ISQ and a SmartPeg with a no contact technique. Each measurement was performed in four different directions and repeated at least twice; the highest ISQ value was taken as reference for data analysis. For the Pyramidion were performed two recording of RFA, before and after implant expansion. The apical portion expansion was performed by positioning the appropriate tool on the implant and blocking the side bracket to prevent any implant rotary movement. Both implants were unscrewed to measure the peak removal torque (PRT).

Group	Mean PIT (Ncm)	Mean RFA (ISQ)	Mean EF (Ncm)	Mean RFA (ISQ) Post-expansion	Mean PRT (Ncm)
Group 1 (Pyramidion)	35.89 ± 8.63	71.95 ± 8.37	15.18 ± 2.77	78.08 ± 4.73	41.32 ± 11.39
Group 2 (Tapered)	31.98 ± 5.44	78.95 ± 2.97	-	-	21.47 ± 6.88

Tab. 1 Mean and SD of primary stability parameters

Results

Multiple comparisons were performed using t-test setting p<0.05. Both groups achieved insertion torque values to obtain primary stability (Group 1, 35.89 ± 8.63Ncm; Group2, 31.98 ± 5.44Ncm), however PIT values were greater in group 1 (p=0.011) due to a greater underpreparation of implant site. The expansion force was analyzed after Pyramidion placement (15.18 ± 2.77Ncm); apical implant diameter changes from Ø3.1 to Ø4.5 and no higher values than 35Ncm have ever been reached. The Pyramidion not expanded registered ISQ (71.95 ± 8.37) significantly lower (p=0.00022) than group 2 (78.95 ± 2.97); a significant increase in ISQ was observed in the Pyramidion after the expansion (78.08 ± 4.73) and no differences between group 1 and group 2 in terms of ISQ values were detected. These data suggest that the expansion of the apical portion allows to reach an effective increase of ISQ. The study evidenced higher PRT values (p=0.02011) for group 1 (41.32 ± 11.39Ncm) than group 2 (21.47 ± 6.88Ncm).

Fig. 6 PYRAMIDION Resonance frequency analysis (RFA) variation

Background and Aim

The rehabilitation of the posterior maxillary zones is often a challenge for the clinician due to maxillary sinus proximity or inferior alveolar nerve nearness; the alveolar resorption causes a decrease in bone availability in order to perform a traditional implant rehabilitation.

An alternative approach to overcome jaw atrophy is the use of reduce length fixtures; short implants allow to reduce treatment times, patient morbidity and surgery cost.

The aim of this study was to analyse the mechanical properties of an innovative short implant (Pyramidion - 5 mm length) with an expandable apical portion compared to a traditional tapered implant (11 mm length) placed in bone D3 - D4 in terms of primary stability.

Conclusion

In terms of primary stability, this in vitro data suggest that Pyramidion expandable short implant proves to be a valid alternative to a traditional implant for the rehabilitation of atrophic zones. The Pyramidion seems to be a viable solution for a wide range of clinical scenarios, specially in poor bone quality areas where the expandable implant design guarantees a higher anchoring of the implant by enhancing and strengthening the bone-implant interface.

References

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