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The influence of implant design on primary implant stability simulating immediate placement conditions of the anterior maxilla

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Topic: Implant insertion after tooth extraction: Clinical outcomes with different approaches

Abstract

Immediate placement of dental implants requires implant design available to achieve high primary stability in non favorable conditions. The aim of this study was to compare primary stability of different implants while simulating immediate placement conditions of the anterior maxilla. Bovine rib was taken as osseous model. Stability was assessed by RFA analysis, insertion torque and duration of implantation were monitored with surgical unit. Zimmer Trabecular Metal implant exhibited highest primary stability.

Background and Aim

Immediate placement of dental implants reduces a number of surgical interventions and time required for the treatment. Ideal three dimensional positioning of implant together with preservation of bone and optimal soft tissue esthetic, as well as high esthetic outcome, can be achieved. High success rates are reported for immediately placed implants [1].
In healed extraction sockets implants are usually placed under 90 degrees angle to bone surface. When implants are placed immediately after tooth extraction they are not placed under this angle. Also, immediately placed implants in anterior maxilla often cannot be fully submerged due to lack of bony support. Described conditions for immediate implant placement result in lower primary implant stability compared to implants placed in healed sockets.
Implant design plays a significant role in immediate implantation procedures.

The objective of this study was to evaluate primary stability of Zimmer Trabecular Metal implant (3.7 x 11.5 mm), comparing it with Zimmer TSVM (3.7 x 11.5 mm) and NobelBiocare Replace Groovy (3.5 x 11.5 mm), while simulating immediate placement conditions on a bovine rib model.

Methods and Materials

CBCT image analysis

In order to simulate immediate implant placement conditions on rib model following was needed: the angle at which implant is placed in alveolar housing and available bone height to the nearest neighboring anatomical structure for implant placement (Figures 1 and 2, Table 1). 108 CBCT images were reviewed. Examined teeth were upper maxillary canines, lateral and central incisors.

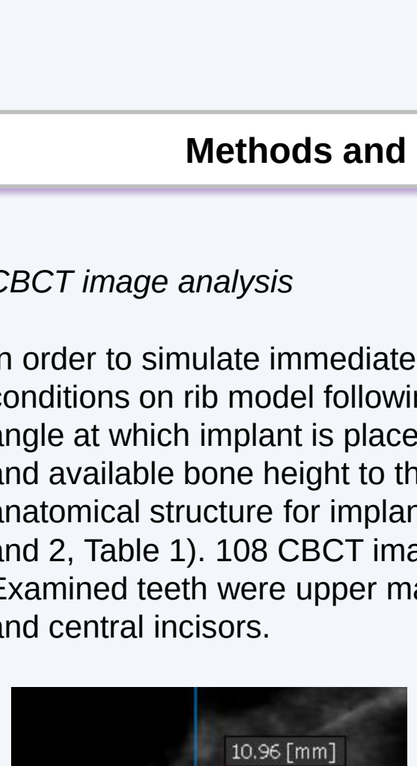


Figure 1: Ideal implant position and available bone height

Figure 2: Implant insertion angle

	Minimum	Maximum	Average
Height (mm)	5.09	15.94	10.11
Angle (°)	7.5	44.5	20.72

Table 1:Bone height and angle values

Bone specimen

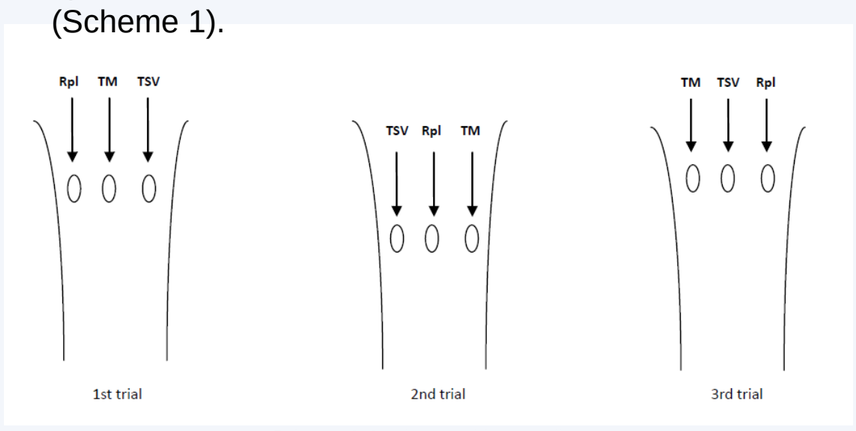
Proximal part of bovine rib was taken as osseous model in this study due to its similarity to frontal region of human maxilla [2].

Experimental protocol

Bone specimen was fixed in thermostat controlled water bath adjusted to temperature of 29°C simulating jaw bone temperature [3]. Inferior half of specimen was submerged in water. Acrylic guide was made in order to guide drills into the bone under 20 degrees angle (Figure 3).

Figure 3: Acrylic guide secured to a bone specimen

A total number of nine implants were used. The position of each implant with regard to the bone specimen was altered from one trial to the other (Scheme 1).



Scheme 1: Implant positions at rib

Implants were placed using W&H Elcomed surgical unit with documentation of insertion torque values and duration of implantation. Maximum insertion torque was set at 35 Ncm for all implants. Even though the obtained average bone height was 10.1 mm implants were placed to a depth of 8.5 mm. When implants are placed in anterior maxilla a minimum of 1 mm of bone should be left between the apical end of implant and the nasal cavity [4]. Safe zone of 1.5 mm was taken in order to prevent injury of nasal cavity.

Implant stability measurements

The stability of implants was assessed by Resonance Frequency Analysis (RFA). Stability of each implant was measured two times from three different directions. Osstell Mentor device with suitable SmartPeg attached to the implant was used for RFA (Figure 4).

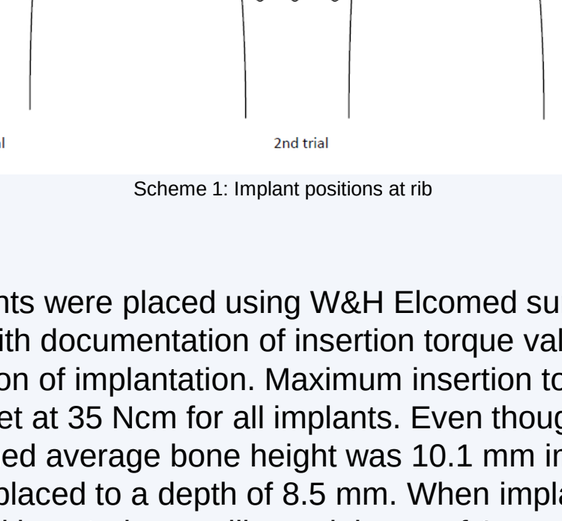


Figure 4: Implant stability measurements with Osstell Mentor device

Results

Insertion torque

The obtained maximum insertion torques for the three implant systems are listed in Table 2. Location of the implant with regard to the bone specimen had a high impact on the received values. Nobel Replace implant exhibited a higher mean value than the TSV and the TM implant.

	1st trial	2nd trial	3rd trial	Mean
TSV	16	22	15	17.66
TM	19	21	14	18
Replace	15	35	11	20.33

Table 2: Maximum insertion torque values (Ncm)

Duration of implant insertion

Time needed for implant placement is shown in Table 3. Nobel Replace showed higher values compared to Zimmer implants.

	1st trial	2nd trial	3rd trial	Mean
TSV	15	17	14	15.33
TM	16.5	17	17	16.83
Replace	33	37.5	37	35.83

Table 3: Duration of implant insertion (seconds)

Primary implant stability

Table 4 highlights the observed ISQ values for each experiment and each implant. Similar results were obtained for all three implant systems. The highest mean value was achieved for the TM implant.

	1st trial			2nd trial			3rd trial			Mean
TSV	61	62	62	61	62	69	52	52	63	60.44
TM	61	58	58	61	59	61	69	61	61	61
Replace	58	61	58	61	59	61	57	57	55	58.55

Table 4: ISQ values by implant

Implants were placed using W&H Elcomed surgical unit with documentation of insertion torque values and duration of implantation. Maximum insertion torque was set at 35 Ncm for all implants. Even though the obtained average bone height was 10.1 mm implants were placed to a depth of 8.5 mm. When implants are placed in anterior maxilla a minimum of 1 mm of bone should be left between the apical end of implant and the nasal cavity [4]. Safe zone of 1.5 mm was taken in order to prevent injury of nasal cavity.

Conclusions

Despite not having threads throughout its whole body Trabecular Metal implant showed high primary stability values. RFA showed that it had slightly higher ISQ values than competitors well known for their high primary stability. TSV and Nobel Replace are well documented implants for immediate implantation and immediate loading [5,6,7]. Mean value of 61 ISQ showed that even in unfavorable conditions like angled implantation and incomplete submerging, Trabecular Metal implant can achieve primary stability.

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