

Early bone formation around immediately placed 2-piece tissue-level zirconia implants with a modified surface. An experimental study in the miniature pig mandible

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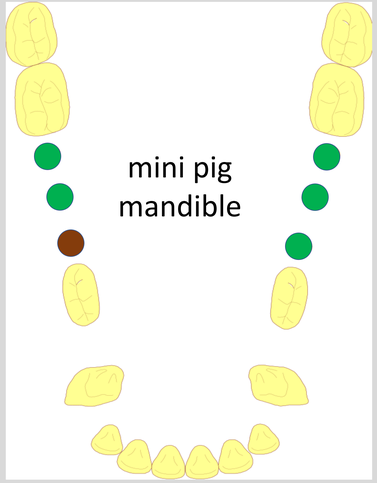
Peter Schüpbach[2], PhD
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Introduction

In clinical studies, zirconia implants have shown comparatively high rates of early osseointegration failures. The present study was conducted to histologically investigate the early bone formation around transmucosal zirconia implants using a miniature pig model. The influence of the surface characteristics on the early peri-implant bone healing was evaluated.

Methods

Immediately after extraction of 6 mandibular premolars, 20 two-piece tissue-level zirconia implants with a modified rough surface were inserted in 4 adult miniature pigs. Additionally, 4 titanium tissue-level implants, one per animal, were placed as controls.

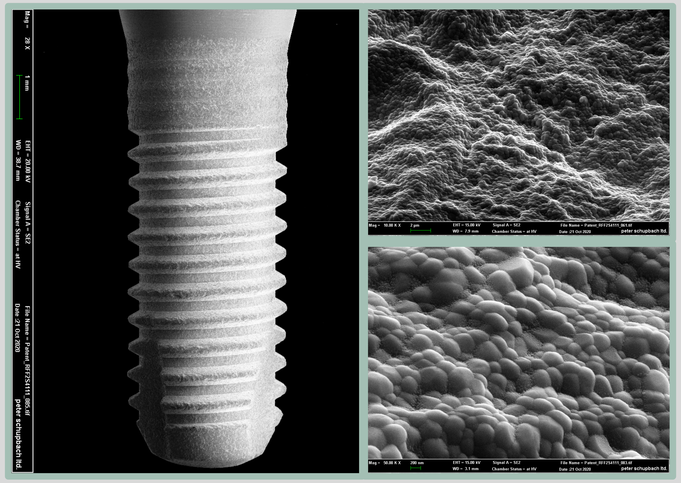




5 Test sites
Patent™ two-piece tissue-level zirconia implant with Patent™ BBS surface (blasted before sintering); R_a 5,7 µm



1 Control site
Straumann® Standard tissue-level Roxolid® implant with SLActive® surface (blasted & etched); R_a 2,2 µm



Test implant surface characteristics:
macro-, micro- & nanostructure (R_a 5,7 µm)



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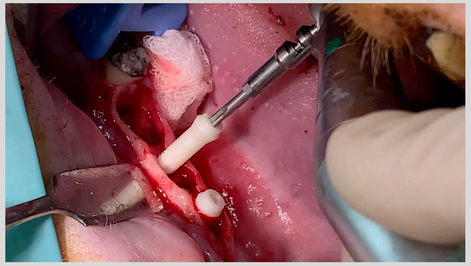
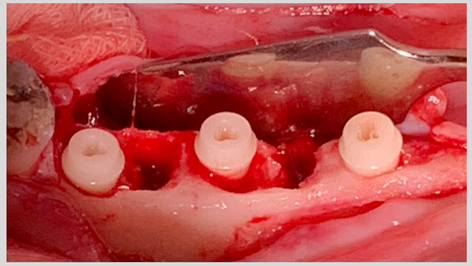
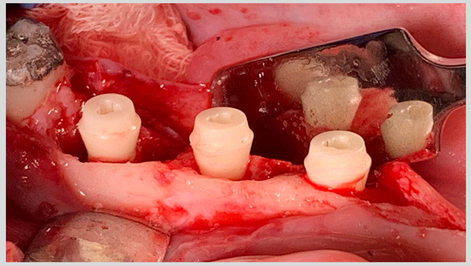
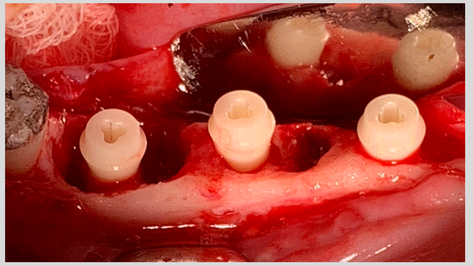
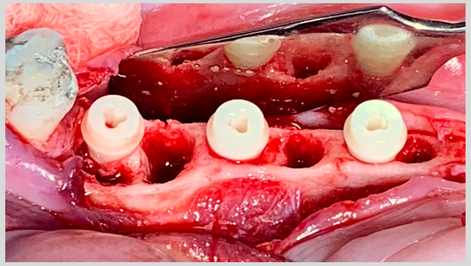
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Methods

Following tooth extraction in mandibular premolar region on both sides, test and control implants were placed according to manufacturer guidelines. Flap adaptation and wound closure around the implant collar was carefully conducted.

Clinical procedure

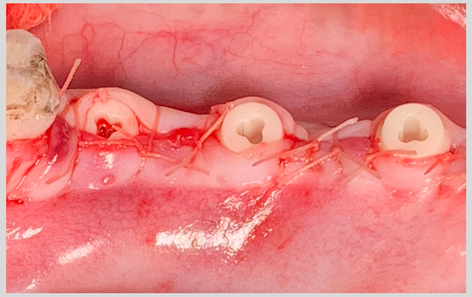
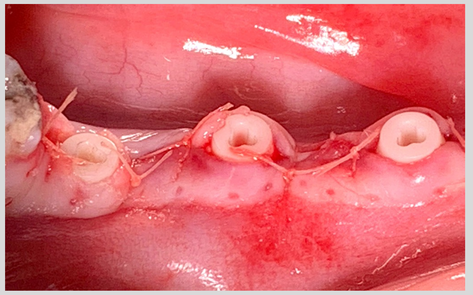
(1) tooth removal premolar region

(2) immediate implant placement

(3) 20 Patent™ implants (test) & 4 Straumann® implants (control)

(4) no bone leveling - no grafting - no membranes

(5) flap adaption & transmucosal healing for 4 or 8 weeks

MINIATURE PIG 736

Position	Implant	Torque (N-cm)
Lower jaw left	2S4111	29
	2S4111	22
	2S4111	13
Lower jaw right	2S4111	45
	2S4111	45
	SLActive	NR

MINIATURE PIG 738

Position	Implant	Torque (N-cm)
Lower jaw left	2S4111	45
	SLActive	45
	2S4111	28
Lower jaw right	2S4111	41
	2S4111	41
	2S4111	43

MINIATURE PIG 743

Position	Implant	Torque (N-cm)
Lower jaw left	2S4111	42
	SLActive	41
	2S4111	30
Lower jaw right	2S4111	45
	2S4111	45
	2S4111	31

MINIATURE PIG 744

Position	Implant	Torque (N-cm)
Lower jaw left	2S4111	37
	2S4111	45
	SLActive	28
Lower jaw right	2S4111	45
	2S4111	32
	2S4111	17

Healing was uneventful for all test and control implants. No implants were lost during the healing phase.



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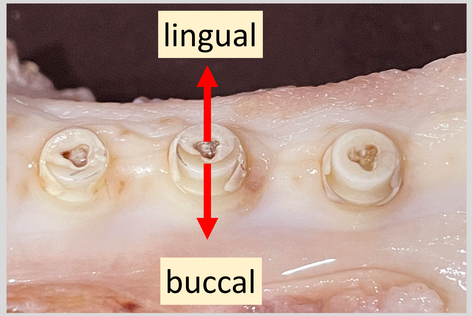
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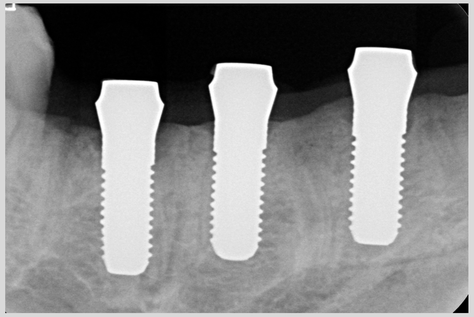
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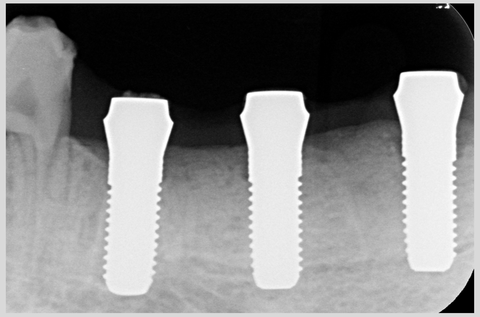
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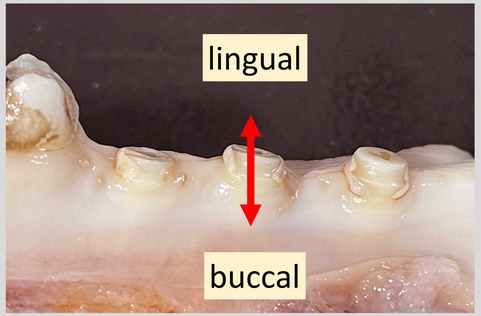
Methods

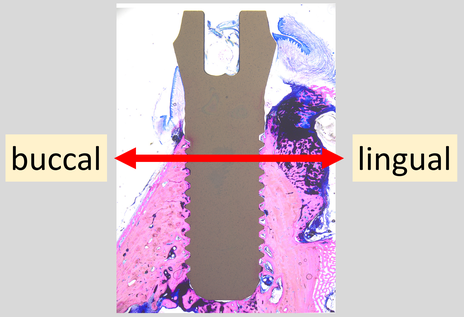
After 4 and 8 weeks of transmucosal healing, two animals at a time were sacrificed and block sections were harvested.





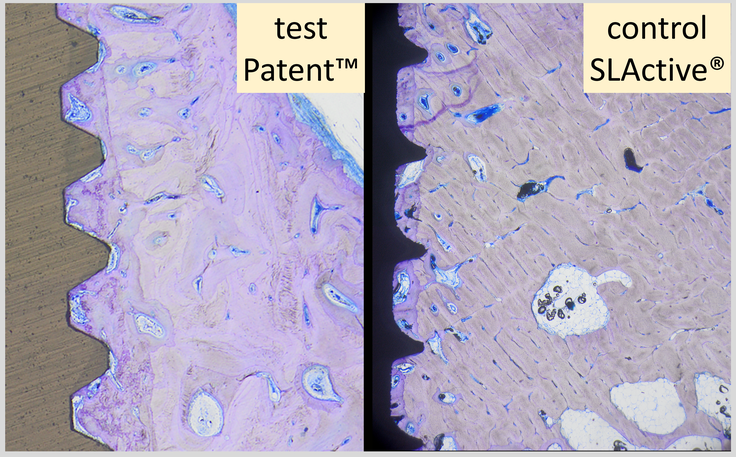






Methods

Specimens were gradually dehydrated and subsequently infiltrated with a graded series of Ehtanol/Technovit 7200 VLC embedding resin (Donath & Breuner 1982). Embedded and polymerized blocks were sliced using an Exakt cutting and micro-grinding unit down to even thickness of 60-120 µm. Sections were stained with Sanderson's RBS (Dorn & Hart) and counter-stained with acid fuchsin (Sigma-Aldrich). Analysis was performed in bucco-lingual direction. Histological evaluation of the bone-to-implant contact BIC and on early bone formation was performed using a light and a stereo light microscope.





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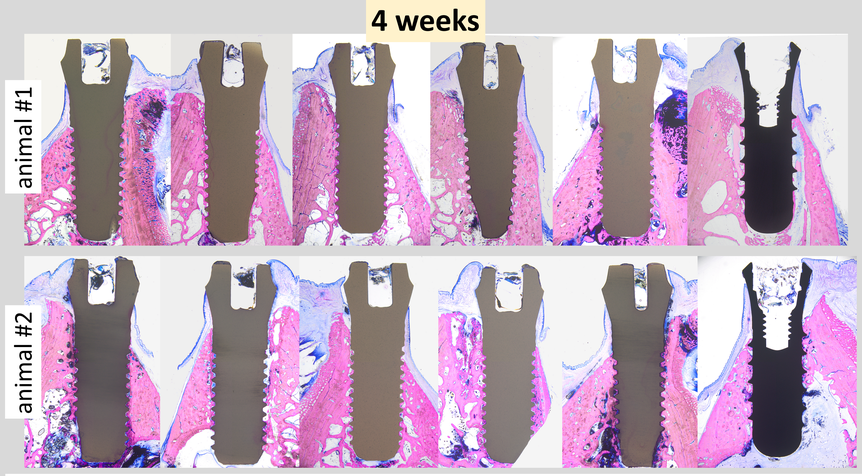
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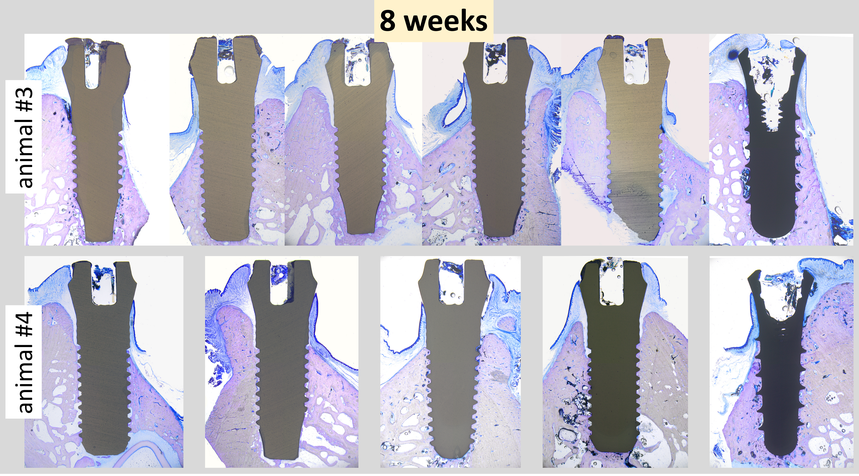
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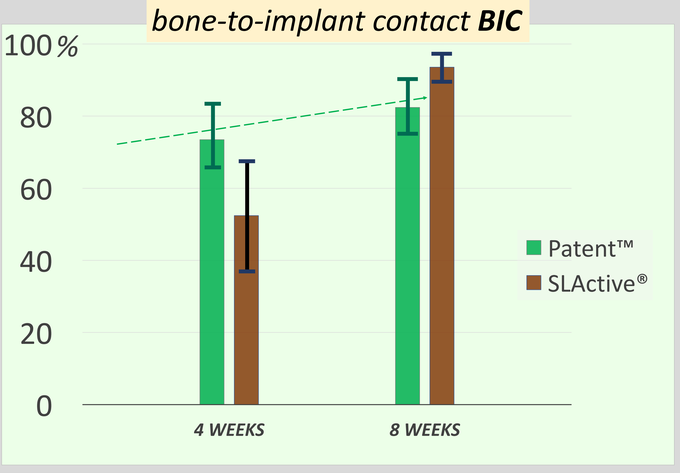
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Results

Contact osteogenesis was observed and bone was formed directly on and along the implant surface. Also distance osteogenesis was observed starting from the local bone and growing towards the implant surface. Both types of new bone formation were present at both test and control implants. At 4 weeks of healing, ongoing bone formation, indicated by the presence of a not yet mineralized collagenous osteoid lined by numerous osteoblasts, was evident. Test and control implants were completely osseointegrated after 8 weeks of healing.







Results

The mean BIC for the test implants was 73.5%(SD±18.3) after 4 weeks of healing and 82.4% (SD±16.9) after 8 weeks of healing. This shows a rapid bone formation followed by a stable maturation phase. The mean BIC for the control implants was 52.4% % (SD±31.3) after 4 weeks of healing and 93.6% (SD±9.1) after 8 weeks of healing. This indicates a slightly slower initial bone formation but a very high BIC in the matured stage.



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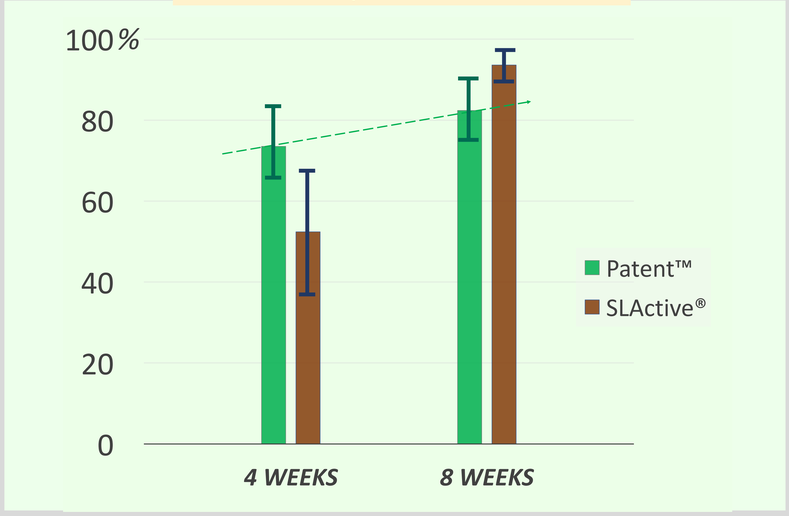
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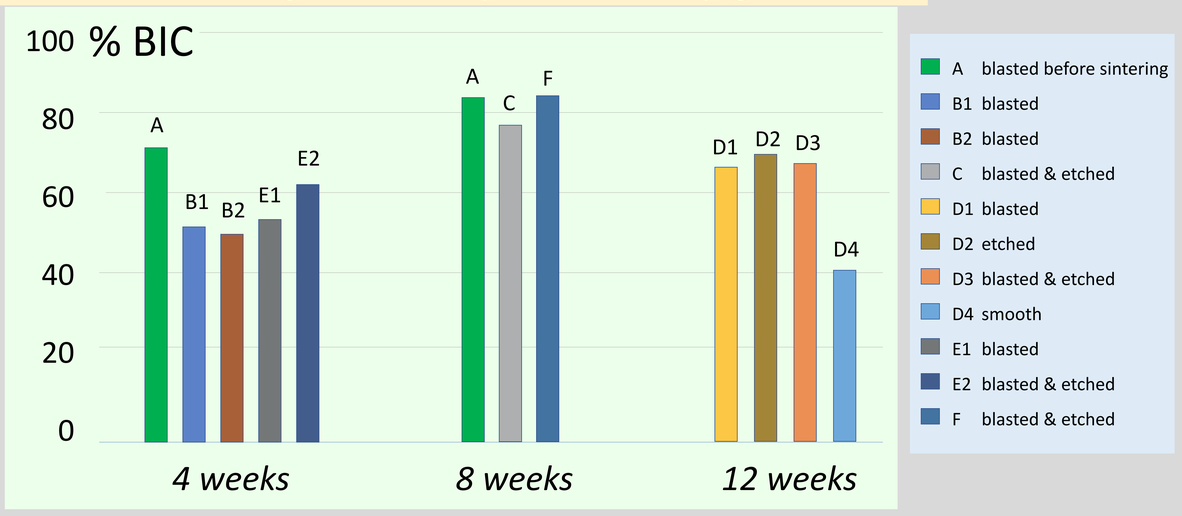
Conclusions

The results indicate a rapid and predictable osseointegration of immediately placed zirconia implants with a BBS surface. A high degree of BIC after 4 weeks of healing was maintained after 8 weeks. The results of this histologic study demonstrate a higher mean BIC on BBS surface zirconia implants compared to previous studies using zirconia implants in similar animal models.
The evaluated BBS surface can be classified as highly osseoconductive.

*bone-to-implant contact **BIC***



studies documenting zirconia implants in mini pig mandible



References

Schliephake et al. 2010 [E1, E2], Stadlinger et al. 2010 [B1, B2], Linares et al. 2016 [F], Kubasiewicz-Ross et al. 2018 [D1, D2, D3, D4], Thomé et al. 2021 [C]