The human bone-zirconia implant interface. A histologic analysis of a clinically retrieved implant.

presented at annual meeting Phoenix 2023

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Introduction

The use of Y-TZP zirconia in dental implantology is increasing due to improved esthetics and anticipated biological advantages as compared to titanium. Several pre-clinical studies have documented that osseointegration of surface modified zirconia can be comparable to surface modified titanium implants. Irrespective of proven clinical success, little is known about the event of osseointegration and the bone-to-zirconia interface at histological level in a human environment.

Aim

The aim of this histologic study was to evaluate the human bone tissue response to a blasted before sintering (BBS) modified, rough (Ra 5,7µm), commercially available Y-TZP zirconia implant which was retrieved after 5 months of function.

Methods

Due to a sports accident, a fractured Patent™ Standard two-piece tissue-level 4,1x11mm zirconia implant, including BBS surface modification, had to be removed. It had been placed in mandibular premolar position and was in clinical function for 5 months. The implant was trephined out including some surrounding tissues and stored in formaldehyde. Histological evaluation of the bone-to-implant interface and bone formation was performed.

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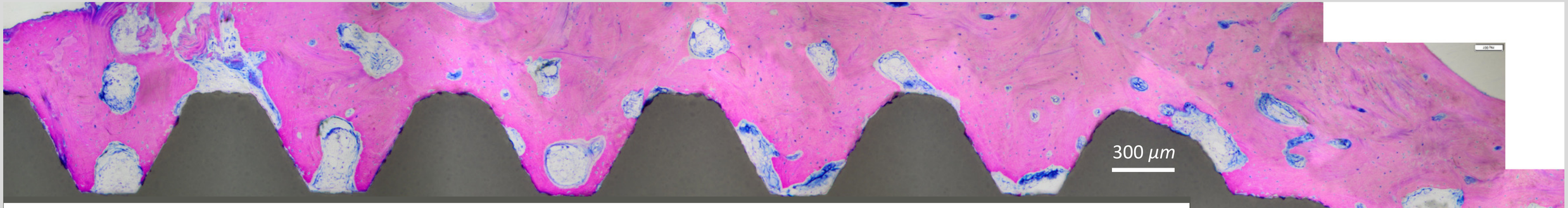

Methods

For processing, the biopsy was gradually dehydrated and subsequently infiltrated with a graded series of Ethanol/Technovit 7200 VLC embedding resin (Donath & Breuner 1982). The embedded and polymerized block was sliced using Exakt cutting and micro-grinding units down to even thickness of 80 µm. Polishing was applied with 0.1µm diamond paste (Struers DP-Paste M). Sections were stained with Sanderson's RBS (Dorn & Hart) and counter-stained with acid fuchsin (Sigma-Aldrich).

Histological evaluation of the bone-to-implant interface and bone formation was performed using both a Leica M205A stereo light microscope and a Leica DM6B light microscope. Bone-to-implant contact BIC was measured along the retrieved implant from the coronal first contact area down to the last apical contact zone. Areas of newly formed woven bone were distinguished from areas with lamellar bone by the presence of cutting cones in the latter indicating ongoing physiologic bone remodeling.

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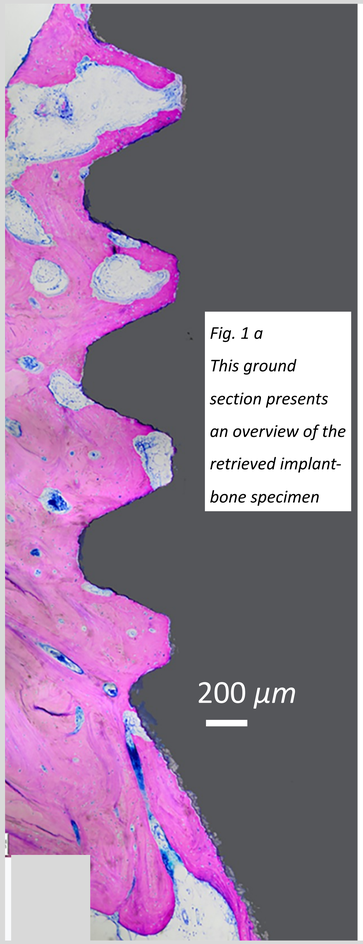

Fig. 1 a
This ground section presents an overview of the retrieved implant-bone specimen

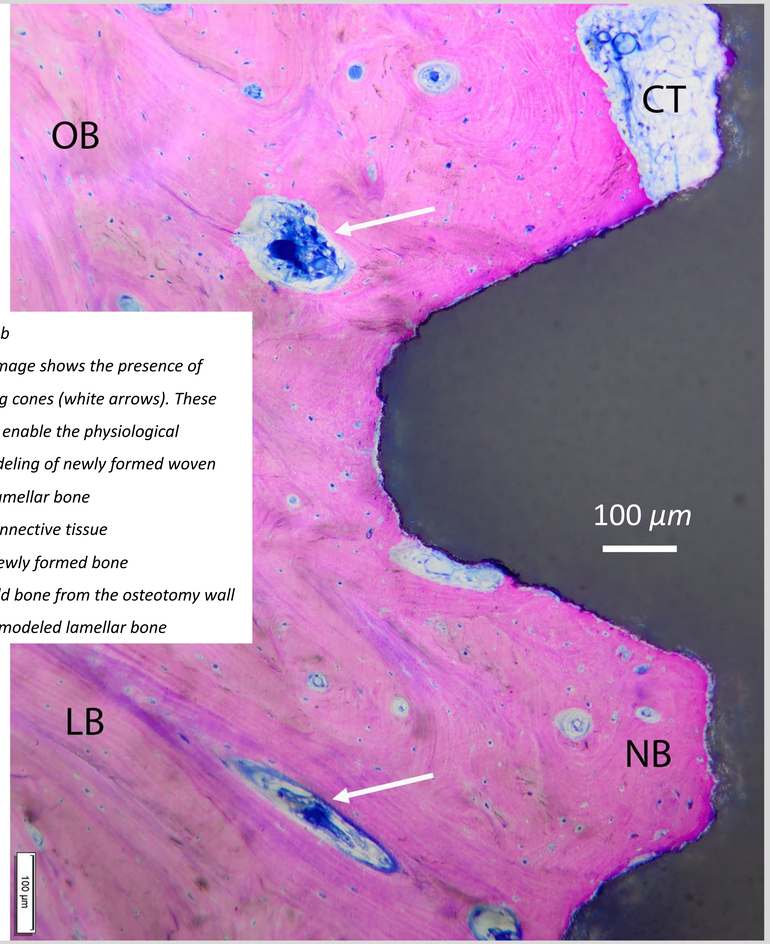

Fig. 1 b
This image shows the presence of cutting cones (white arrows). These cones enable the physiological remodeling of newly formed woven into lamellar bone
CT: connective tissue
NB: newly formed bone
OB: old bone from the osteotomy wall
LB: remodeled lamellar bone

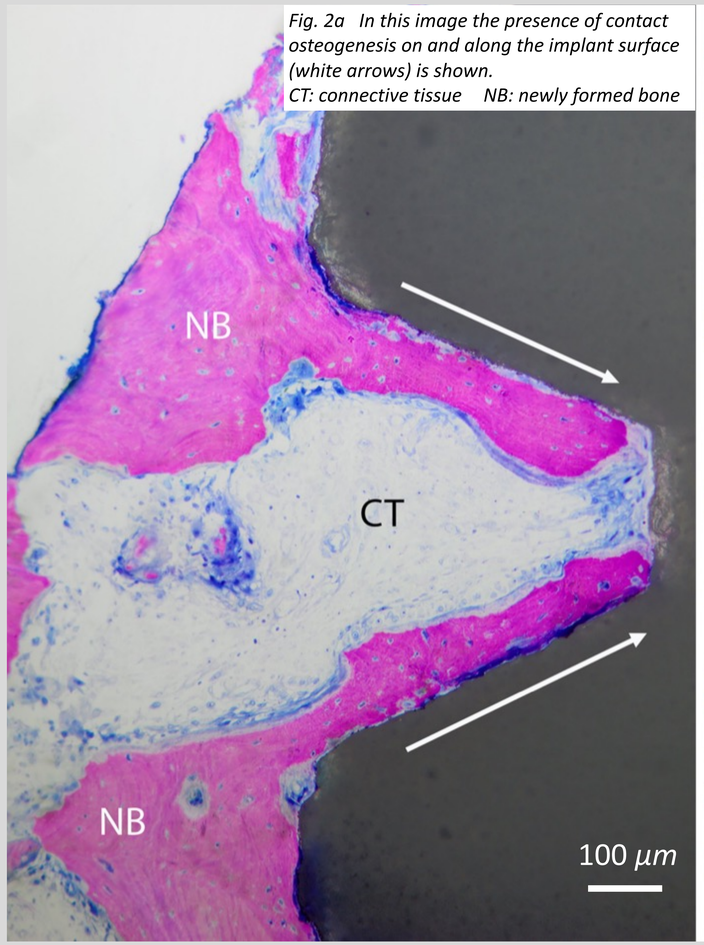

Fig. 2a In this image the presence of contact osteogenesis on and along the implant surface (white arrows) is shown.
CT: connective tissue NB: newly formed bone

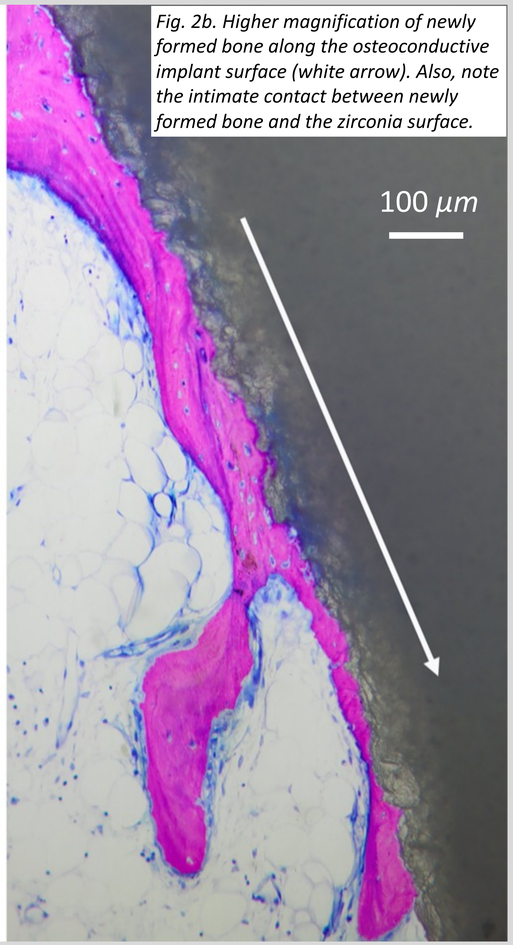

Fig. 2b. Higher magnification of newly formed bone along the osteoconductive implant surface (white arrow). Also, note the intimate contact between newly formed bone and the zirconia surface.

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Results

The retrieved implant was osseointegrated in dense lamellar bone (LB in Fig. 1a) with a high bone-to-implant contact BIC of 89.4%. Numerous cutting cones indicating ongoing physiologic remodeling were present (white arrows in Fig. 1b). The interface between bone and modified rough zirconia implant surface was characterized as a distinctly intimate contact. In general, no fibrous encapsulation was evident, and no ongoing osteoclastic bone resorption was observed (Fig. 1a & Fig. 1b). Small bands of dense bone were present directly attached to the rough zirconia surface and spreading along the surface, indicating a rapid bone formation by contact osteogenesis (white arrows in Fig. 2a and Fig. 2b).

Conclusions and clinical implications

The histologic analysis of specified human biopsy reveals an intimate bone-to-zirconia interface and well-established osseointegration. An evident high degree of BIC after 5 months of function was detected suggesting that evaluated BBS modified zirconia surface can be classified as highly osteoconductive. Furthermore, the present examination indicates that osseointegration of particular zirconia surface under clinical conditions is equal to that documented for surface-modified titanium implants (Glauser & Schüpbach 2022).

References

Donath & Breuner 1982; Glauser & Schüpbach 2022