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Experimental research on the relationship between fit accuracy and fracture resistance of zirconia abutments

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ABSTRACT

Objective: The purpose of the study was to investigate the correlation between fit accuracy and fracture resistance of zirconia abutments, as well as their feasibility for clinical applications.

Methods: Twenty self-made zirconia abutments were tested with 30 Osstem GSII implants. Firstly, 10 Osstem GSII implants were cut into two parts along the long axis and assembled with the zirconia abutments. The microgaps between the implants and the zirconia abutments were measured under scanning electron microscope. Secondly, the zirconia abutments were assembled with 20 un-cut implants and photographed before and after being fixed with a central screw of 30-N cm torque. The dental films were measured by Digora for windows 2.6 software. Then the fracture resistance of zirconia abutments were measured using the universal testing machine at 90°. All results were analyzed using SPSS 13.0 software.

Results: The average internal-hexagon microgaps between the implants and zirconia abutments were 19.38 ± 1.34 μm; The average Morse taper microgap in the implant–abutment interface was 17.55 ± 1.68 μm; The dental film showed that the Morse taper gap in the implant–abutment interface disappeared after being fixed with a central screw of 30-N cm torque and the average moving distance of the zirconia abutments to the implants was 0.19 ± 0.02 mm; The average fracture resistance of zirconia abutments was 282.93 ± 17.28 N; The internal-hexagon microgap between the implants and zirconia abutments was negatively related to the fracture resistance of the abutments ($r_1 = -0.97$, $p < 0.01$); The Morse taper microgap in the implant–abutment interface was negatively related to the fracture resistance of the abutments ($r_2 = -0.84$, $p < 0.01$).

Conclusion: The microgap between implant and abutment was negatively related to the fracture resistance of the abutment. While the internal-hexagon microgap has better correlation than the Morse taper microgap. The fracture resistance of zirconia abutments can satisfy the clinical application.

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1. Introduction

With the increasing of living standards and aesthetic demand, the implant dentures in anterior area are more than a biological requirement. The conventional and widely used titanium abutment shows undesirable metalcolour through thin gingival tissue. In recent years, due to its perfect aesthetic effect, excellent biological and mechanical performance, zirconia abutment has become a research focus. Our previous study has found that zirconia abutments fabricated with injection moulding technique showed sufficient resistance required for the clinical application under loadings with different angles.[1] The existence of microgap between implant and abutment has been described in many studies. Microgap could be colonized by bacteria, which may influence the remodelling of the peri-implant bone and the long-term health of the peri-implant tissues. In the present study, zirconia abutments were made with injection moulding technique. The microgaps between the zirconia abutments and the titanium implants were measured under scanning electron microscope. The changes of joint interface between the zirconia abutments and the implants before and after the central screw fixation were observed with dental film. The fracture resistance of the zirconia abutments were measured with Universal Test Machine. The relationship between fit accuracy and fracture resistance of the zirconia abutments was analyzed.

2. Materials and methods

2.1. Materials and instruments

Zirconia powder (TZ-3YB-E) was purchased from Tosoh Company (Japan). Thirty titanium implant were from Osstem Implant Company (Osstem GS II system, 4.5 mm × 10 mm, Korea). Other equipments included laser three dimensional gage (LPX-250, Japan), banbury mixer (XSN-15, Giding Co., Ltd., Taichung City, Taiwan), injection shaper (XSN-15, Shapers' Deutschland GmbH, Gladenbach, Germany), sintering apparatus (KSX-5–14, ChangZhou Xing Guang Kilns Co., Ltd., Jiangsu, China), mill (XSM-LC, Beijing, China), universal test machine (AGS-J, Japan), and intraoral dental X-ray (FIN-00031 SOREDEX, Finland).

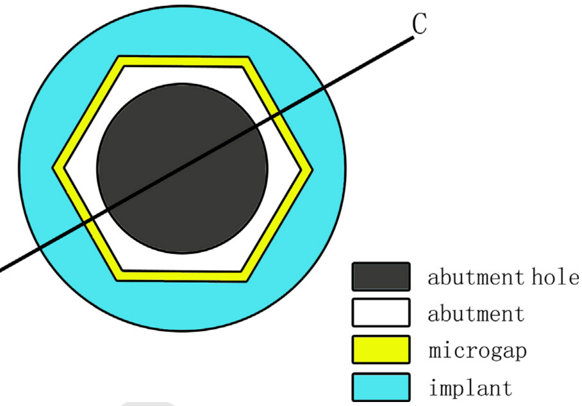

Fig. 2 – The cross section of internal-hexagon in abutment–implant interface.

2.2. Zirconia abutment fabrication

The fabrication of zirconia abutment was described as in Yang et al. Briefly, three dimensional scanning on the titanium abutment and the connecting portion with the implant (the portion of hexagon and Morse taper) was measured by laser gauge. The zirconia abutment draft was drawn according to the liner shrinkage of zirconia materials. The abutments were fabricated following the procedures (including mixing, injection moulding, degreasing, sintering, and refinement, Fig. 1).

2.3. Analysis of adaptation at implant–abutment and interface

The interface adaptation was assessed by calculating the microgap between the zirconia abutment and the tititum implant, as shown in Figs. 2 and 3. Ten implants (Osstem-GS II) were randomly selected and fixed to the self-made zirconia abutments, which then were placed on a test stand of wire cut electrical discharge machining (Fig. 4). The cutting wires were

Fig. 1 – The side view and bottom view of zirconia abutment.

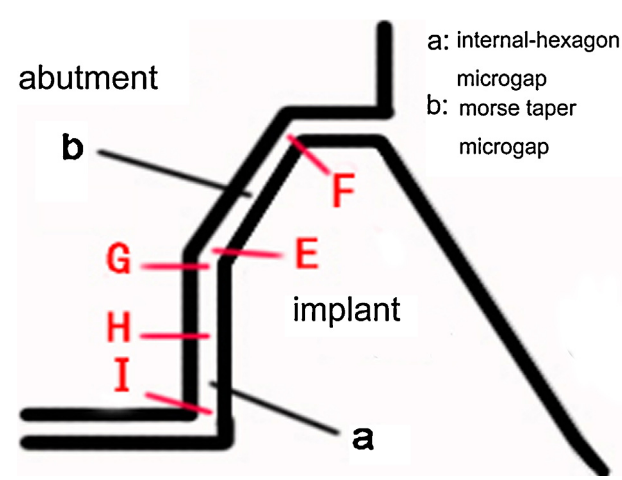

Fig. 3 – The diagram of microgap between zirconia abutment and tititum implant.

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