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Review

Influences of microgap and micromotion of implant–abutment interface on marginal bone loss around implant neck

Yang Liu, Jiawei Wang*

Department of Prosthodontics, School of Stomatology, Wuhan University, Wuhan, 430079, China

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ABSTRACT

Objective: To review the influences and clinical implications of micro-gap and micro-motion of implant-abutment interface on marginal bone loss around the neck of implant.
Design: Literatures were searched based on the following Keywords: implant-abutment interface/implant-abutment connection/implant-abutment conjunction, microgap, micromotion/micromovement, microleakage, and current control methods available. The papers were then screened through titles, abstracts, and full texts.
Results: A total of 83 studies were included in the literature review. Two-piece implant systems are widely used in clinics. However, the production error and masticatory load result in the presence of microgap and micromotion between the implant and the abutment, which directly or indirectly causes microleakage and mechanical damage. Consequently, the degrees of microgap and micromotion further increase, and marginal bone absorption finally occurs. We summarize the influences of microgap and micromotion at the implant-abutment interface on marginal bone loss around the neck of the implant. We also recommend some feasible methods to reduce their effect.
Conclusions: Clinicians and patients should pay more attention to the mechanisms as well as the control methods of microgap and micromotion. To reduce the corresponding detriment to the implant marginal bone, suitable Morse taper or hybrid connection implants and platform switching abutments should be selected, as well as other potential methods.

1. Introduction

Marginal bone loss around the neck of dental implant is one of the most common complications after implantation and exerts remarkable influence on the future success and long-term stability of the implant. Generally, when the implant is placed into the alveolar bone, the resorption of marginal bone usually begins from the bone cortex (Branemark et al., 1969). Factors contributing to the loss of marginal bone include surgical trauma, peri-implantitis, occlusal overload, microleakage, biologic width, and implant anatomy on the crest area (Macedo et al., 2016; Oh, Yoon, Misch, & Wang, 2002). The phrase microleakage of the implant-abutment interface (IAI) was coined in the 1990s, and it describes a microbial leakage between the implant and the abutment, which is attributed to the microgap and micromotion of the IAI. Efforts have been exerted over the last two decades to explore the discrepancy in the microleakage level within different implant systems and the reasons behind this phenomenon. Some scholars considered the microgap responsible for the phenomenon, and others deem it as the result of micromotion. In this article, the keywords were determined as, for instance, implant-abutment interface/implant-abutment connection/implant-abutment conjunction, microgap, micromotion/micromovement, microleakage, and current control methods available. The literatures were searched based on the keywords up to February 2017. To be analyzed in the review, papers had to (i) be written in English, (ii) be published in an international peer-reviewed journal, and (iii) have a clear definition for microleakage and related keywords. The titles and abstracts for eligible papers were screened. If eligibility aspects were present in the title, the paper was selected for further reading. If none of the eligibility aspects were mentioned in the title, the abstract was read in detail and screened for suitability. After selection, full-text papers were read in detail. The search resulted in 4350 records of titles and abstracts. Screening of these titles and abstracts initially resulted in 264 articles. Based on detailed reading of full texts, 181 articles were excluded and 83 studies were identified eligible for inclusion in the literature review. The influences of microgap and micromotion existing between the implant and the abutment-interface on marginal bone loss are reviewed and clearly illustrated, and their clinical significances are discussed.

* Corresponding author at: The State Key Laboratory Breeding Base of Basic Science of Stomatology (Hubei-MOST), Key Laboratory of Oral Biomedicine Ministry of Education, School & Hospital of Stomatology, Wuhan University, 237 Luoyu Road, Wuhan 430079, China.
E-mail addresses: whulyang@hotmail.com (Y. Liu), wangjwei@hotmail.com (J. Wang).

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2. Microgap, micromotion, and microleakage

2.1. Two-piece implant system

Given the protection of implant from unwanted load during bone healing phase and the beneficial potential to adjust the prosthetic angle, the two-piece implant system is widely used in clinics. The IAI connection of the two-piece implant system includes two types: external and internal connections. In a typical external connection, the implant convex extends outside by 1–2 mm, thereby forming an external structure similar to a hexagon or an octagon, which connects to the abutment. External connection is incorporated in some systems and once commonly used worldwide during the period when two-piece implant system was initially used because of its superior antirotational mechanism and ability to orient the abutment in the implant (Davi, Golin, Bernardes, Araujo, & Neves, 2008; Gracis et al., 2012). However, the short and narrow external geometry is particularly vulnerable when off axis loads are applied, which consequently leads to the deformation of the IAI (Binon, 2000; Gracis et al., 2012).

Along with the rapid development of two-piece implant system, internal connection including but not limited to internal hex connection gradually occupies a larger share in the market. Internal connection refers to the abutment stretches of 4–6 mm into the implant cavity. Subsequently, this abutment fixes with the implant and forms a conical, octagonal, hexagonal, trilobe, or spline design. Internal connection includes taper, butt joint, and hybrid connections (Fig. 1). The taper connection originates from the concept of Morse taper in mechanical engineering and simply means a cone within another cone (Hernigou, Queinnec, & Flouzat Lachaniette, 2013; Oh et al., 2002). Therefore, this connection is also called conical connection. Butt joint connection refers to the connecting area between the implant and the abutment without a taper, and it is only retained via a retaining screw. A hybrid connection means that both Morse taper design and the regular polygonal shape of antirotational or guiding grooves are present. Compared with the external connection, internal connection remarkably lowers the rotation center and improves the mechanical stability (Sailer, Sailer, Stawarczyk, Jung, & Hammerle, 2009). Furthermore, when internal connection adopts the form of platform switching, the stress distribution of the peri-IAI bone is reduced (Alvarez-Arenal et al., 2017; Liu et al., 2014).

2.2. Microgap

The implant and the abutment cannot be accurately matched because of the precision limit during production (Alves, de Carvalho, Elias, Vedovatto, & Martinez, 2016). The IAI microgap, defined as the microscopic space between implant and corresponding abutment, exists (Scarano, Mortellaro, Mavriqi, Pecci, & Valbonetti, 2016). The microgap between the titanium abutment and the titanium implant is smaller than that between the zirconia abutment and the titanium implant. Moreover, the IAI microgaps of zirconia abutments increase significantly when torque values less than those of manufacturer-recommended values are applied (Hernigou et al., 2013; Rack, Zabler, Rack, Riesemeier, & Nelson, 2013). Concerning the manufacturing technique, the premachined abutments exhibit smaller microgaps than those of cast on and castable abutments (Harder et al., 2010; Rismanchian, Hatami, Badrian, Khalighinejad, & Goroohi, 2012).

From the perspective of IAI connection style, Morse taper connection is sealed better than butt joint connection (Khorshidi, Raoofi, Moattari, Bagheri, & Kalantari, 2016). Fixing of taper connection depends on friction. Thus, the fitting degree of IAI connection mainly relates with the taper degree and connecting area. When the taper

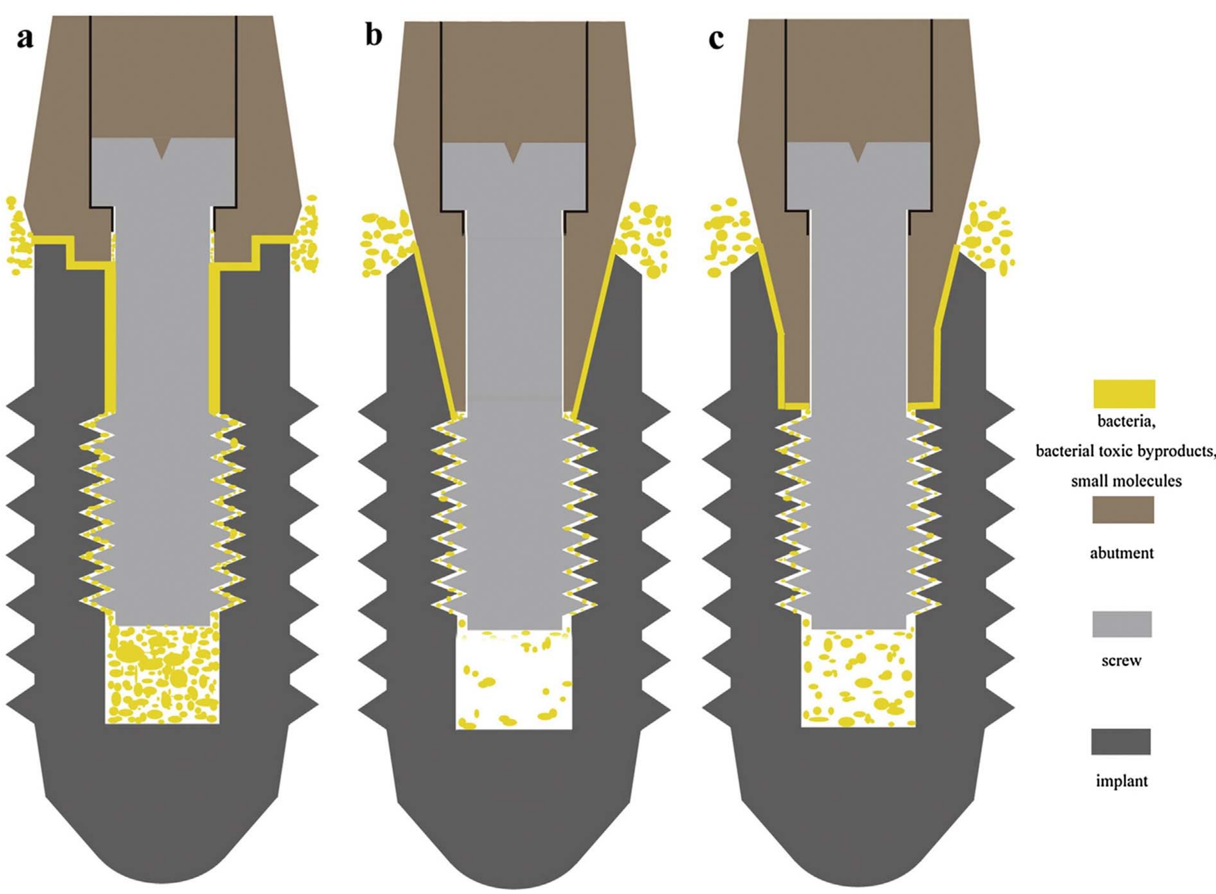

Fig. 1. (a) Butt joint connection. (b) Tapered connection. (c) Hybrid connection.