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The osseointegration process is defined as the direct contact of living bone and a loaded implant at the microscopic level.1 This phenomenon has been shown by different animal models2-4 and in a few human histologic reports.4-10 Systemic conditions such as diabetes mellitus,11 immunosuppression,4 and cigarette smoking12 have been reported to affect the amount of implant-to-bone contact. In addition, implant surface texture has also been described as an important factor for osseointegration.3,13,14 This finding is based on the observation that roughness increases both the implant surface area and the potential for bone interlocking into the implant porosity.13,14 Porous surfaces may be obtained by subtractive methods, such as acid etching and sandblasting, or additive methods (i.e., titanium plasma spraying and hydroxyapatite coating).

Analyses of retrieved implants provide a unique opportunity to evaluate osseointegration around implants that have been in function for long periods. This case report presents a histomorphometric evaluation of one sandblasted and acid-etched implant retrieved from a male patient after having received a functional load during 40 months without any bone disturbance.

**Clinical Report**

**Implant Specimen**

A solid, commercially pure titanium screw-shaped implant (Titanium-Fix®, As Technology, São José dos Campos, São Paulo, Brazil), 3.75 mm in diameter and 10.00-mm long, was retrieved from the right first molar region of a 68-year-old man’s mandible. A single restoration had been constructed on a prosthetic post (Fig. 1A). During a period of 3 years, the patient was recalled twice a year, and no signs or symptoms of osseointegration loss were reported (Fig. 1B). Forty months after implant placement, the abutment screw fractured because of some concentration of stress resulting from a discrepancy between the implant width and the prosthetic crown size.15 The efforts made to remove the fractured screw were all unsuccessful. Therefore, the implant and the surrounding bone were removed by using a 4-mm internal diameter trephine bur (Fig. 1C). The implant specimen was rinsed and immediately fixed in 4% neutral formalin for 48 hours. A new implant (Titanium-Fix®) 5.0-mm wide and 13.00-mm long was placed after 45 days, and another crown was cemented 8 months later (Figs. 1D and 1E).

**Histologic Processing**

Undecalcified sections were prepared using the technique previously...
described by Donath and Breuner (i.e., the block was dehydrated by an ascending series of ethanol [60% to 100%], and it was embedded in glycolmethacrylate [Technovit 7200; Heraeus Kulzer GmbH, Wehrheim, Germany]). Subsequently, a ground section (20–30 μm) was obtained and stained with 1% toluidine blue. The percentage of bone-to-implant contact surfaces and the bone area formed within the limits of the threads of the implant were obtained by a computerized method for histomorphometric analysis (Image-Pro; Media Cybernetics, Silver Spring, MD).

RESULTS

The implant was completely surrounded by the new-formed bone and new-formed bone that could not be differentiated from the original alveolus (Figs. 2 and 3). The bone surrounding the implant had a lamellar appearance, but the apposition of lamellae seemed to be nonuniform, and some bone lacunae could be observed (Fig. 3A). Osteocytes could be seen in direct contact with the porous surface of the implant (Fig. 3B). There were few gaps present in the interface, and the histomorphometric analysis revealed a mean bone-to-implant contact of 74.90%, and a mean bone area of...
Histomorphometric analysis of human retrieved implants is the method available to analyze the bone-to-implant interface behavior over time. The reproduction of a human’s mouth environment in animals is tremendously difficult. Therefore, this study can contribute to the knowledge of human bone response to a dental implant under loading conditions.

Many efforts have been made by researchers and manufacturers to produce implant surfaces attractive to living cells, and, consequently, to improve quantity and quality of osseointegration. It has been reported that micro-rough topography observed in a porous implant could favorably affect angiogenesis, as well as cellular migratory events, activity, and function, resulting in a higher bone-implant contact and mechanical interlocking. Cordioli et al. experimentally showed that roughness obtained with acid-etching procedures achieved a 33% higher bone-to-implant contact and 28% higher values for removal torque than a titanium plasma spray surface. These differences may be attributed to the very small variations of surface observed in micrometer pattern. This range can elicit different cellular responses. It was concluded that the acid-etching processes may ensure adequate roughness on the implant surface.

In this study, a commercially pure, titanium screw-type implant was used. It formerly received a sandblasting treatment with aluminum oxide to promote macro-deformities, and it was acid-etched to achieve microporosities. Rates of 75.40% of bone-to-implant contact and 89.30% of bone area within the limits of the implant threads were found. These findings are different from those reported by Hayakawa et al. A possible explanation can be the different surfaces used and individual characteristics of the patients, such as age, gender, habits, or systemic alteration affecting the bone quality. They also reported a similar result (76.60%) when a sandblasted, acid-etched implant was placed into the palatal bone as anchor for orthodontic treatment. Testori et al. found a similar percentage of bone-to-implant contact (64.20%) in Osseotide implants (31 –Implant innovations, Palm Beach Gardens, FL) after 2 months of healing under immediate loading. Other investigators reported similar results with different surfaces and follow-up. Piattelli et al. found similar results with titanium plasma spray implant (i.e., 60% to 70% of bone-to-implant contact). Brunel et al. reported 74% with hydroxyapatite coating in maxilla after 14 months of follow-up, and Degidi et al. found 60% after 9 months of follow-up in porous anodized implant submitted to immediate loading.

Recent clinical research showed a survival rate of 97.79% for 317 Titanium Fix® implants placed in 87 cleft patients and 98.33% in a control patient during a 5-year follow-up. This is the first time that the osseointegration event could be observed from this commercial implant retrieved from a human being, although previous animal studies had already been published, testifying satisfactory levels of osseointegrated surfaces in this commercial system of implants.

Unfavorable force conditions resulting from differences between surface crown area and standard implant area create bending and torque vectors. As a result, implants used as a single-molar replacement have a high abutment or gold screw fracture rate. In this study, these forces could have stressed the screw, resulting in the fracture. The use of wide diameter implants has been advocated to prevent these kinds of biomechanical complications. In conclusion, the histologic evidence showed a high degree of osseointegration in a threaded sand blasted and acid-etched implant retrieved from a human lower jaw after functional loading for 40 months.

Disclosure

The authors claim to have no financial interest in any company or any of the products mentioned in this paper.

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Histomorphometric Bewertung eines aus dem menschlichen Unterkiefer entnommenen Sandgestrahlten und Säuregeätzten Gewindeimplantats: eine Fallstudie


SCHLÜSSELWÖRTER: Zahnhimplantate, Knochensubstratintegration, poröse Oberfläche, Fraktur der Stützzahnschraube, Überlastung
Avaliação Histomorfométrica de um Implante Corroído por Ácido, Jateado e Rosqueado, Recuperado de Maxilar Inferior Humano: Relato de Caso

RESUMO: O propósito deste estudo foi avaliar histomorficamente o contato ossoso/implante e a área do osso em torno de um implante de titânio recuperado de um maxilar inferior humano. Um implante de titânio em forma de parafuso (jateado e corroído por ácido) foi removido de um homem de 68 anos após ter sido em funcionamento por 40 meses por causa de uma fratura do parafuso de apoio. Após a remoção do implante, obteve-se uma secção não-descalcificada. A análise histomorfométrica demonstrou uma taxa de 75,40% de contato osso/implante e 89,30% de área do osso dentro dos limites das roscas do implante. O osso circundante sarou segundo um modelo bem organizado e não poderia ser distinguido do alvéolo original. A evidência histológica mostrou um alto grau de osseointegração em um implante corroído por ácido, jateado e rosqueado, recuperado de um maxilar inferior humano após carga funcional por 40 meses.

PALAVRAS-CHAVE: implantes dentários, osseointegração, superfície porosa, fratura de parafuso de apoio, sobrecarga
AUTHOR PLEASE ANSWER ALL QUERIES

AQ1— In the sentence beginning “They also reported a similar…” is “sandblasted, acid-etched” correct?

AQ2— Please provide Solange Aranha’s title in the “Acknowledgments.”

AQ3— For Reference 20, please provide the authors and journal.