This study aimed to histologically analyze the bony tissue formed around dental implants after osseointegration. A 58-year-old patient presented with pain and discomfort caused by two dental implants in her maxilla placed 8 months earlier. At clinical and radiographic analysis, the implants appeared well osseointegrated but tilted buccally, emerging in nonkeratinized mucosa. For this reason, the discomfort began right after the prosthetic load, 4 months after implant placement, and the patient felt pain when wearing the implant-supported removable prosthesis. Both implants were made of titanium, airborne-particle abraded with zirconium oxide, and etched with mineral acids. The implants were removed, preserving the bone around the implant threads, and replaced with two new implants, inserted in a prosthetically guided, correct position. The removed implants were histologically observed. Histologic analysis showed good bone-to-implant contact, mature bone with few marrow spaces, presence of direct connecting bridges between the peri-implant bone trabeculae and the implant surface, and no inflammatory cells nor connective fibrous tissue ingrowth. This study showed that dental implants coated with a rough surface were properly osseointegrated, with no inflammatory signs nor connective fibrous tissue ingrowth, 8 months after placement. Int J Periodontics Restorative Dent 2021;41:121–125. doi: 10.11607/prd.5102

Dental implants are accepted as the treatment of choice for the replacement of missing teeth, and there has been rapid growth in the number of implants being placed and restored. Retrieval of clinically stable and osseointegrated dental implants can occur due to prosthetic restoration issues, fracture, dysesthesia, or aesthetic reasons.1,2

Osseointegration is a clinical term, based mostly on the stability of the implant and defined as a “direct rigid fixation of the implant into jawbones”3 or as “osseous contact to the surface of a dental implant.”4 Osseointegration properties have been defined as such: “The osseous formation engages the microscopically rough surface of the dental implant much like a Velcro connection, thereby making movement of the implant unlikely without a large dislodging force,”4 underlining the importance of histologic confirmation of the process.

Information from evaluation of retrieved human dental implants could be useful to analyze the bone-implant interface behavior over time,5 as the evaluation of surface morphologies, surface coatings, loading timings, and different bone qualities performed in vitro or in experimental studies on animals can be significant but not as relevant as the same evaluations performed in a human study.6 Analysis of implants...
retrieved from humans is probably the most valuable tool for evaluating implant success and failures; specimens could contain important information concerning host biologic reaction and bone remodeling effects when in contact with an implant.  

It is possible to find in the literature histologic cases of retrieved implants after several time periods, and observing the continuous bone remodeling could permit an evaluation of how osseointegration reacts to different implant surfaces, geometries, and loads.

This is a histologic analysis of the peri-implant tissue reactions in the bone-implant interface of two titanium dental implants retrieved from the maxilla of the same patient 8 months after placement.

Materials and Methods

A 58-year-old patient presented with pain and discomfort caused by two dental implants in the maxillary canine sites placed 8 months earlier. Analysis of the radiographic computed tomography scan showed the two implants apparently well osseointegrated but placed with a strong buccal tilt (Fig 1). Clinical observation showed that both implants emerged in nonkeratinized mucosa, causing patient discomfort immediately after the prosthetic load (4 months after implant placement). Moreover, the patient was rehabilitated with a provisional removable prosthesis, as it was not possible to realize an implant-supported fixed definitive prosthesis due to the incorrect positioning of the implants. The patient explained difficulties with performing adequate oral hygiene and achieving stability of the removable prosthesis.

The screw-shaped implants (Kohno, Sweden & Martina) were made of pure titanium, airborne-particle abraded with zirconium oxide, and etched with mineral acids.

With patient consent, both implants were harvested, preserving the bone around implant threads, and replaced with two new dental implants (Prama, Sweden & Martina), placed in a prosthetically guided, correct position. The first removal attempt was made using a dedicated screw-remover kit, which broke and failed to unscrew the implants. The removed implants and the bone surrounding the threads were processed for histologic analysis.

Specimens were immediately fixed in 10% buffered formalin solution (Sigma-Aldrich) at 4°C for 24 hours. The specimens were rinsed, dehydrated in an ascending series of alcohols, and embedded in London white resin (LR White Acrylic Resin, Sigma-Aldrich). After resin polymerization, specimens were sectioned along their longitudinal axes using a high-precision diamond disk (Micromet, Remet) at 150 µm and ground to approximately 50 µm with a specially designed grinding machine (Micromet). Sections were stained with acid fuchsin and toluidine blue and were observed under normal transmitted light using an optical microscope (Nikon Eclipse E800, Nikon). Histomorphometric analysis was performed using the light microscope.
connected to a high-resolution video camera, and the images were expanded and evaluated using ImageJ software (National Institutes of Health). The tested variables in the histomorphometric analysis were newly formed bone, mature bone, and marrow spaces. Presence of the mentioned factors were expressed in percentage.

Results

Histologic analysis revealed proper osseointegration of the implants after 8 months. The histologic biopsy samples showed good bone-to-implant contact from the coronal side to the apical implant section (Fig 2). Compact, mature lamellar bone, with a few small marrow spaces, was present around the implants (Fig 3).

The presence of direct connecting bridges between the peri-implant bone trabeculae and the implant surface was recorded (Fig 4).

Many remodeling areas were detected in both implants, showing ongoing bone apposition and resorption phenomena between the threads (Fig 5). At higher magnification, many osteocytes were observed in the peri-implant bone, close to the implant surface (Fig 6).

No foreign-body reaction cells, connective fibrous tissue, or epithelial growth was observed at the bone-implant interface around the retrieved implants; no inflammatory cells, bacterial aggregates, or calculus were detected on the entire length of the implants.

The histomorphometric analysis showed high percentages of ma-
ture bone in the first and second retrieved implants (36.5% and 47.5%, respectively), as well as presence of newly formed bone (31.7% and 24.9%, respectively) and marrow spaces (31.8% and 27.6%, respectively).

Discussion

Causes of implant removal are various and can occur immediately after implant placement or even months and years later due to wrong placement, intrasurgical contraindications, implant fracture, prosthetic failure, or esthetic issues.\textsuperscript{1,2,6,7,11,12}

The quality of retrieved human specimens can vary, and it is possible that due to problems in the insertion process or to the issues during the retrieval procedure, only few tissue fragments can be present at the interface.\textsuperscript{2} In some cases, bone could be totally lost, some threads could be cut, or there could be a lack of a whole implant section, making a complete analysis of the bone-implant interface impossible. Unfortunately, due to the present study’s small sample size and problems in the retrieval procedure, the bone-implant interface was partially damaged. It was therefore decided to perform histologic evaluations only around the parts with bone between the implant threads.

Implant surface roughness plays a key role in influencing cell activity; roughness influences cell proliferation, production of collagen and osteocalcin, and the cells’ ability to respond to signaling molecules.\textsuperscript{13} Since the early 1990s, it has been shown that significantly high levels of cellular attachment in osteoblast-like cells are found on rough, airborne particle–abraded surfaces with irregular morphologies.\textsuperscript{14}

In the present study, implant surfaces with an airborne particle–abrasion treatment (to promote macroadeformities) and acid-etching (to achieve microporosities) were evaluated. In both implants, almost all threads were filled with a thin layer of bone or by compact mature bone; this could underline the osteoconductive action of the implant surface. Tight contact between bone and implant was very common, with no important variations between the coronal and apical parts. Bone remodeling areas were frequently observed, and it has been shown that remodeling cycles are mandatory in order to obtain a high level of peri-implant bone organization that shows good mechanical properties.\textsuperscript{9}

In a recent case series, the authors histologically analyzed 17 osseointegrated implants retrieved due to traumatic reasons (fracture of the implant or prosthesis).\textsuperscript{12} All implants appeared well-integrated in the surrounding mineralized bone, and all of them showed adequate bone in contact with the implant. Bone remodeling areas were observed mostly in the most coronal portion of the implants, probably due to stresses in the peri-crestal bone before the traumatic event.\textsuperscript{12}

In different peri-implant locations of the two specimens in the present study, areas of new bone formation with wide lacunae are evident. In agreement with other reports with a much higher loading period,\textsuperscript{1,12} this could attest that, 8 months after implant placement, bone was still undergoing resorption and formation.

Conclusions

This case report clearly showed that, 8 months after implant placement, the rough-surface, airborne particle–abraded, etched implants were properly osseointegrated, with good bone-to-implant contact along their entire surface, and with no inflammatory signs nor connective fibrous tissue ingrowth.

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