The use of the Er:YAG in laser-assisted broken abutment screw treatment

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_Abstract

Dental implants are a functional and aesthetic solution to partial and total edentulism. Although the overall success rate of implant dentistry is very high, over 90 % of the treatment modality is not free of complications and dental implants occasionally fail. The chronic loosening or fracturing of implant screws continue to be a problem in restorative practices and generally are challenging to remove. This report describes and demonstrates the management and technique used for the removal of fractured screw fragments and the successful utilization of the Er:YAG laser as an important auxiliary tool.

_Introduction—the problem

Success in implant-supported prosthetic replacement of teeth will be due to a combination of appropriate placement criteria (receptor site quality, implant stability, osseo-induction), appropriate (non-excessive) loading and prevention of bacterial contamination. The failure of dental implants is due not only to biological factors, such as unsuccessful osseo-integration or the development of peri-implantitis, but it may also result from technical complications.[1,2] Dental implant complications may be considered under the following main categories:

Early
_ Failure/inadequate surgical preparation.
_ Failure of osseo-integration.
_ Peri-surgical infection.

Late
_ Implant overloading, leading to bone loss.
_ Peri-implantitis.
_ Soft tissue complications.
_ Fracture of mechanical components and aesthetic/phonetic considerations.

Failures of implant-supported restorations result from technical problems and can be divided into two groups: those relating to implant components, and those relating to the prosthesis.[3,4,5,6,7,8,9,10,11] Technical problems related to implant components include abutment screw fracture.[8,12]

The abutment screw fracture presents a rare, but quite unpleasant failure and can be a serious problem[13,14], as the fragment remaining inside the implant may prevent the implant from functioning efficiently

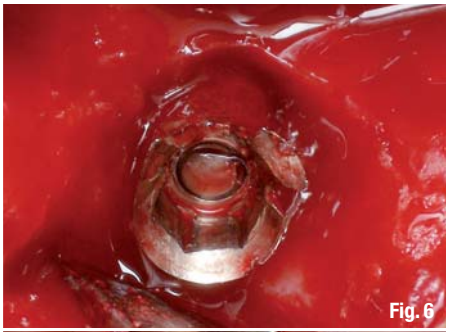

Fig. 1


Fig. 2


Fig. 3


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Fig. 5


Fig. 6

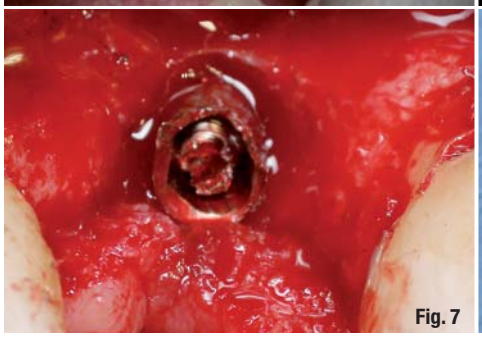

Fig. 7


Fig. 8


Fig. 9

as an anchor.[15] The primary reason for screw fracture is undetected screw loosing which can be due to bruxism, an unfavorable superstructure, overloading[16,17] or malfunction.[10,11,18,19] Fractures of the implant abutment or of the abutment screw have been observed as a consequence of screw loosening and undetected micro-movements of the abutment under functional loading[20] and consequently, it is advised that the repeated loosening of an abutment screw should alert the clinician to possible significant contributing causes.

However, the behavior of the implant/abutment joint components with respect to critical bending force is still unclear.[20,21] Studies show that implant abutment failure occurs when lateral forces exceed 370 Newtons for abutment with a joint depth of at least 2.1 mm and 530 Newtons with a joint depth of at least 5.5 mm.[7]

_Preventive recommendations

_ The number, position, dimension and design of implants, as well as the design of the prosthesis are critical factors to be considered during the treatment planning phase.[11,12,13,22,23] To withstand high bending stresses, implants should be as long and as wide as possible, used in adequate numbers, and be positioned such as to allow axial loading.[13,20,24,27] Implant components are known to fracture more frequently in the posterior region and in partially dentate patients compared to completely edentulous patients.[5,6,9,11,12,19,23,25]

_ Retightening an abutment screw ten minutes after the initial torque applications should be routinely performed, and increasing the torque value for abutment screws above 30 Newtons can be beneficial for the abutment, implant stability and to decrease the possibility of the screw becoming loose.[25]

_ Proper case selection, excellent surgical technique, placing an adequate restoration on the implant, educating the implant patient as to the importance of maintaining meticulous oral hygiene, and evaluating the implant both clinically and radio-graphically at frequent recall visits[26]; reinforcing periodic maintenance.

_ A procedure for using dimples inside the abutment screw cylinder above the screw, and filling the holes with elastomeric impression material will prevent the screw-retained prosthesis from loosening.[27]

_ Using the correct fixation screw.

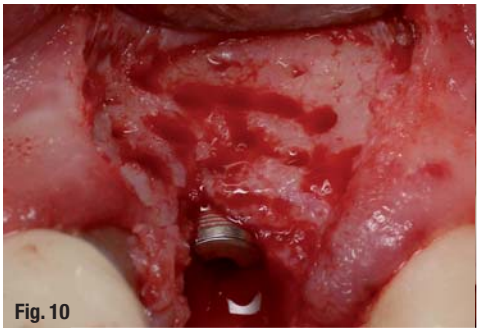
_ Replacing loose screws instead of retightening them.

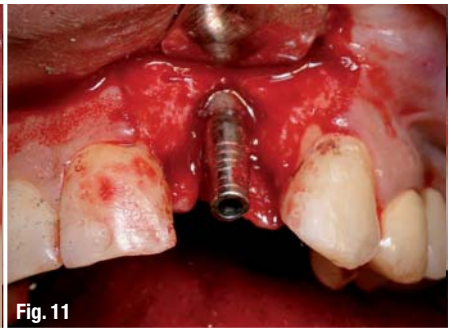
_ Immediate investigation; looseness of the prosthesis is detected by the clinician or patient.[28,29]

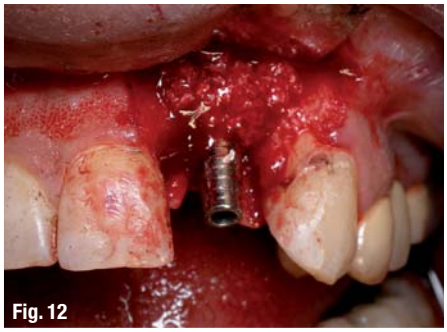
_Fragment retrieval methodology

The methods employed to grasp the broken fragments or screw are determined according to the location of the fracture abutment—above or below the head of the implant. If an abutment screw fractures above the head of the implant, an explorer, a straight probe or haemostats[30] might be successful. The tip of the instrument is moved carefully in a counter-clockwise direction over the surface of the screw segment until it loosens.[1] If the screw fracture occurs below the head of the implant, other methods are required. There are several available implant repair kits:

_ ITI® Dental Implant System (Institut Straumann AG, Switzerland), consists of drills, two drill guides and six manual tapping instruments.[8]


Fig. 10


Fig. 11


Fig. 12

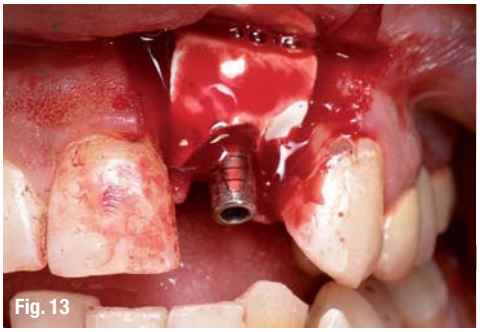

Fig. 13


Fig. 14


Fig. 15


Fig. 16

_ IMZ® TwinPlus Implant System[1] (DENTSPLY Friadent, Germany)
_ Screw Removal Kit Replace (Nobel Biocare™, Yorba Linda, California, USA)
_ Certain®-Screw Removal Kit (Biomet *3i*™, Florida, USA[31])

The application of these systems is to permit a hole to be drilled into the centre of the broken screw and drive a removal wedge into the hole that engages the broken screw when reverse torque is applied by removing the instrument.

If no thread damage has occurred and the screw has not "bottomed out" or torqued into a seating stop, then the force necessary to remove the screw may be minimal.[8] If none of these systems is available, another method for broken screw retrieval involves the following procedure: after the prosthesis or abutment is removed, the screw hole is vigorously flushed with an air/water spray from a 3-way syringe. Pressurized air is applied to dry the screw hole, and a drop of mineral oil (delivered on the tip of an explorer) is introduced into the screw hole. A sharp 1/4-round bur in a high-speed handpiece is activated and lightly applied to the exposed side of the fractured screw. The objective is to have the spinning bur's blades contact the metal surface of the screw so that the screw will spin itself out of the hole. When repeated several times, the screw can be backed out and retrieved easily with forceps.[8]

If this technique fails, a slot can be created using a surgical drill, on the head of the fractured screw, and then a screwdriver is used to back out the broken abutment screw. Sometimes just a gentle touch with the drill to the head of the broken screw will be enough to back it out. If the hexagonal head of the screw is stripped, it should be filed away completely using a round carbide bur or heatless stone, the head of the implant should be straightened, and a new abutment may be rotated into the implant.

_Case study

This clinical report describes a situation in which a fractured implant abutment screw was successfully retrieved by using the Er:YAG laser as an auxiliary tool, and the advantages of this 2,940 nm wavelength versus conventional methods.

_Examination

A 36-years-old male presented for treatment, reporting the detachment of an implant-supported crown in the region of the upper left central incisor. The patient stated that the implant and crown had been placed four years earlier and that looseness of the crown had occurred on two occasions during this period. On both occasions, the screw had been retightened with no further investigation.

Clinical examination of the patient revealed a missing tooth at the location of #9 with no sign of an implant (Fig. 1). The patient brought the abutment, crown and broken screw with him (Fig. 3). Radiographic examination of the area showed the presence of a root-form cylindrical implant, consistent in appearance with a 13 mm long, 3.75 mm diameter abutment with an internal hex. The apical part of the screw remained threaded into the implant, but had fractured at the level of the hexagonal lock. Although

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the implant was osseointegrated, there were radiographic signs of peri-implantitis with some crestal bone loss having occurred (Fig. 2).

_Treatment options

The treatment options available were: 1) retrieve the fractured screw, or 2) remove the old implant and insert a new implant in one sitting. Following discussion with the patient and evaluation of the possibilities for success, it was decided to try and retrieve the fractured screw. Treatment would involve the use of the Er:YAG laser to perform the following, based upon accepted research:

_ The flap incision.[31,32,33]
_ Ablation of granulation tissue around the implant.[34,35,36]
_ Remodelling, shaping and ablating of the bone.[32,34,37,38]
_ Detoxification of the infected surfaces of the implant.[36,39,40,41,42]
_ An associated osteogenic (GBR) procedure to prevent soft tissue in-growth and maintain the form of the alveolus treatment alternatives, using a more conventional approach, would include the use of traditional scalpel, curettage, and rotary instruments.

_Treatment

A dual-wave laser system with operating wavelengths of 2,940 nm and 10,600 nm (OpusDuo™ AquaLite™, Lumenis, Ltd. Yokneam, Israel) was employed for this procedure. The laser operating parameters employed for the various surgical stages were as follows:

_ Flap Access: Wavelength: 2,940 nm (Er:YAG), 200-micron sapphire tip, in contact mode; 450 mJ per pulse at 20 Hz. Total power: 9 Watts.
_ Granulation Tissue Removal: Wavelength: 2,940 nm (Er:YAG), 1,300-micron sapphire tip, in non-contact mode; 700 mJ per pulse at 12 Hz. Total power: 8.4 Watts.
_ Bone Surgery: Wavelength: 2,940 nm (Er:YAG), 1,300-micron sapphire tip, in non-contact mode; 450 mJ per pulse at 20 Hz. Total power: 9 Watts.
_ Detoxification of the implant: Wavelength: 2,940 nm (Er:YAG), 1,300-micron sapphire tip, in non-contact mode; 150 mJ per pulse at 20 Hz. Total power: 3 W.
_ Decortication for GBR technique: Wavelength: 2,940 nm (Er:YAG), 1,300-micron sapphire tip, in non-contact mode; 500 mJ per pulse at 17 Hz. Total power: 8.5 Watts.

A "V" shape incision was made with the Er:YAG laser. An intrasulcular incision was made (after anaesthesia) at the buccal and palatal side of the implant, together with two vertical relieving incisions: one at the mesial side of tooth # 8 and the second at the mesial side of tooth # 11 (Figs. 4 and 5).

The buccal and palatal flaps were lifted and the area explored (Fig. 6); there was granulation tissue around the neck of the implant. The granulation tissue was ablated using the laser (Fig. 9). Vaporization of granulation tissue (if any exists) after raising a flap is efficient with the Er:YAG laser, offering a lower risk of overheating the bone than that posed by the current diode or CO_2 lasers.[43] And often obviates the need for hand instruments. Results from both controlled clinical and basic studies have pointed to the high potential of the Er:YAG laser and its excellent ability to effectively ablate soft tissue without producing major thermal side-effects to adjacent tissue has been demonstrated in numerous studies.[35,36,37]

The broken hexagon slot was straightened, using a round diamond bur and the head of the implant was rendered smooth. A slot was created with a surgical drill on the head of the fractured screw, and a screwdriver was successfully used to unscrew the broken abutment screw (Figs. 7 and 8). The Er:YAG laser was aimed at the surface of the exposed implant for the purpose of decontaminating the infected exposed surfaces, without damaging them.[36,40,41,42,43] Studies have shown that Er:YAG laser energy effects on bone include bacterial reduction.[43,44] Following this, all accessible bone surfaces were exposed to laser energy to ablate necrotic bone and to shape and remodel the surface, in accordance with established clinical proto-


Fig. 17

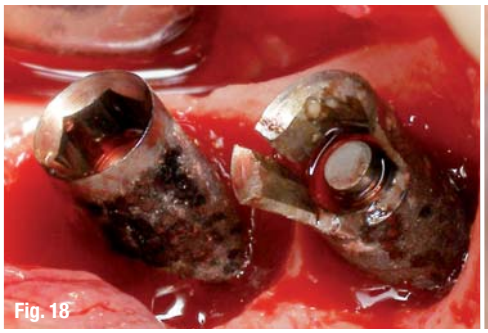
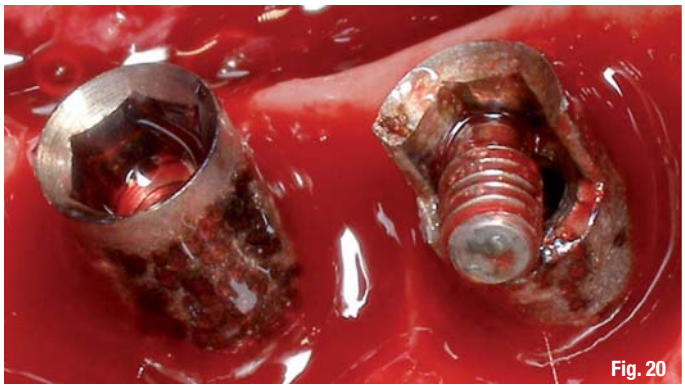
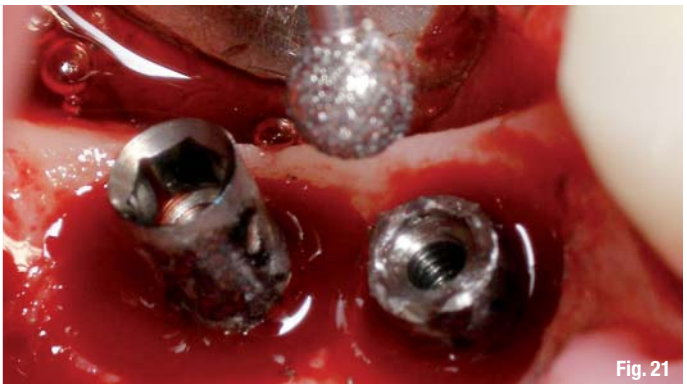

Fig. 18


Fig.19


Fig. 20


Fig. 21

cols.[32,34,38,39] Decortication of the buccal bone was then performed (Fig. 10). The purpose of decortication is to encourage bleeding, providing progenitor cells to the site. A new abutment was then inserted into the implant (Fig. 11). All spaces between implant and existing osteotomy site were filled with a xenograft bone substitute (Bio-Oss®, Geistlich Biomaterials) and covered with an absorbent bilayer membrane (Bio-Gide®, Geistlich Biomaterials), (Figs. 12 and 13). The mucoperiosteal flap was re-positioned and sutured with silk 3-0, paying particular attention to primary closure of the flap (Fig. 14).

_Post-operative instructions

The patient was prescribed Clindamycin 150 mg x 50 tabs to avoid infection. He was also given Motrin 800 mg x 15 tabs for pain. Instructions were given to rinse with Chlorhexidine 0.2 %, starting the next day for 2 weeks x 3 per day.

_Management of complications and follow-up care

The following day the patient reported moderate pain and moderate swelling. There was no tissue bleeding and the site was closed. The flap was showing signs of attachment and was healing nicely. At ten days post-op the patient returned for inspection and removal of sutures. The swelling had resolved, there were no signs of fistula and healing was progressing well. After five months the soft tissue was completely healed without complications (Figs. 16 & 17). The soft issue had healed over the bone and there were no bony projections observed under the soft tissue. The prognosis is excellent.

_Conclusion

The use of osseo-integrated implant-supported prostheses in the replacement of missing natural teeth has become an accepted clinical protocol in dentistry. Success in this area is enhanced through correct diagnosis, treatment planning and maintenance; however, complications often occur, which may be significant and compromise the long-term success of the implant abutment and associated prosthesis. The management of such complications has given rise to several techniques to address failings, such as component fracture and bacterial contamination.

The Er:YAG (2,940 nm) laser can be employed as an auxiliary tool for the purpose of decontamination of infected implant surfaces and it has been shown to be effective and safe. The use of the 2,940 nm wavelength for these procedures presents many advantages vs. conventional methods, including enhancing the surgical site and less bleeding during the operation, providing the practitioner a better field of visibility and reducing patient discomfort during its use. In addition, anecdotal claims have been made that post-operative effects such as pain and swelling are less pronounced. A summary of possible serious complications associated with implant placement has been given, together with a report of a clinical case in which the use of the Er:YAG laser has been shown to be beneficial in the management of the consequences of a fractured abutment screw._

Editorial note: The literature list can be requested from the Editorial Office.

_contact laser

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