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

Dental implants are a functional and aesthetic solution to partial and total edentulism. Although the overall success rate of implant dentistry is very high, more than 90 per cent 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 utilisation 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. 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. Technical problems related to implant components include abutment screw fracture.

The abutment screw fracture presents a rare, but quite unpleasant failure and can be a serious problem, as the fragment remaining inside the implant may prevent the implant from functioning efficiently as an anchor. The primary reason for screw fracture is undetected screw loosening which can be due to bruxism, an unfavorable superstructure, overloading, or malfunction.

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 and consequently, it is advised that the repeated loosening of an abutment screw should alert the clinician to possible significant contributing causes.

However, the behaviour of the implant/abutment joint components with respect to critical bending force is still unclear. Studies show that implant abutment failure occurs when lateral forces exceed 570 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.

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. 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. Implant components are known to fracture...
A procedure for using dimples inside the abutment screw to prevent the fracturing of the prosthesis from loosening. 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, reinforcing periodic maintenance by the clinician or patient.

Fragment retrieval
The methods used to grasp the broken fragments or screw, are determined according to the location of the fracture abutment above or below the hex of the implant. If an abutment screw fractures above the head of the implant, an explorer, a straight probe or haemostats 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.

Support Racing Team at Silverstone

A team including Peter Fairbairn, the principle implant dentist at the Scarsdale Dental Clinic in Kensington, South West London was indulging in its favourite pastime with the help of DIO Implants (UK) and Biocomposites Ltd. The two companies supported the racing team which took part in the Btricar 24-hour race at Silverstone, held on Saturday and Sunday 2/3 October, 2010.

Peter has been racing in motor sport for many years although this was the first time he’d taken part in a grueling 24-hour event. Akin to the Le Mans 24-hour race, this was the fifth Btricar GP event at Silverstone and James Tucker, the event organiser, said that it was becoming more popular each year.

In addition to all the engineers and pit crew in the team, Peter was accompanied by his fellow drivers: Paul McLain who set the car up; Tony Littlejohn who was the boss for Porsche; and Mike Quinn, a seasoned racing driver whose grandfather founded luxury car manufacturer Jaguar. Each driver took it in turns to take the wheel between each pit stop (around 90 minutes), from 4:30 pm on Saturday through the night until the same time on Sunday.

The race started badly for the team with a crash in the first hour of the race; whilst heading for the pits the Porsche was hit by another car at speed, rendering the GT2 un-drivable. It was due to the skill and ingenuity of Peter’s team and their ability to work under pressure that the crippled car was launched back into the race after three hours of repairs. Despite this early setback they powered through, I really feel like a member of the team now. It was a pertinent opportunity for Dr Fairbairn’s Porsche team. “The German engineered Porsche seemed relevant to DIO and Peter Fairbairn’s relationship as DIO’s RBM-surface implants are sent to Germany for the electrochemical plating process (called Biotite-H),” Iain explained. “Peter favours using these biomechanical calcium phosphate-enhanced implants with his pioneering techniques, so there was an underlying connection to the Btricar GP collaboration, I certainly can’t wait for next year’s event!”

Over the last 22 years Peter has been on the world stage speaking about implants and synthetic graft materials and regularly contributes to dental journals. He has lectured at the Royal Academy of Cosmetic Dentistry annual forum (2005 and 2006) and the European Society of Cosmetic Dentistry Forum (2006) and is a regular speaker for the Association of Dental Implantology (ADI).

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Support Racing Team at Silverstone

Peter is a recent convert to using DIO dental implants which, he says, are ideally suited to his branch of dentistry. He has performed implant surgery for the last 20 years and has particular expertise in the use of 2nd generation synthetic materials such as Fortoss VITAL from Bio-composites which Implant surgeons worldwide are now recognising as a reliable alternative to traditional human or animal derived bone-grafts.

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Examination

A 36-year-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 5). Radiographic examination of the area showed the presence of a root-form cylindrical implant, consistent in appearance with a 15mm long, 5.75 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 internal hex. Although 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 this procedure, based upon accepted research:
- The flap incision
- Ablation of granulation tissue around the implant
- Remodelling, shaping and ablation of the bone
- Detoxification of the infected surfaces of the implant

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 scalpels, curettes, and rotary instruments.

Treatment

A dual-wave laser system with operating wavelengths of 2,940 nm and 10,600 nm (Opus Duo™ 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 20Hz. Total power: 9 Watts.
- Granulation Tissue Removal: Wavelength: 2,940nm (Er:YAG), 1,500-micron sapphire tip, in non-contact mode; 700mJ per pulse at 12Hz. Total power: 8.4Watts.
- Bone Surgery: Wavelength: 2,940nm (Er:YAG), 1,500-micron sapphire tip, in non-contact mode; 450mJ per pulse at 20Hz. Total power: 9Watts.
- Detoxification of the implant: Wavelength: 2,940nm (Er:YAG), 1,500-micron sapphire tip, in non-contact mode; 150mJ per pulse at 20Hz. Total power: 3W.
- Decortication for GBR technique: Wavelength: 2,940nm (Er:YAG), 1,500-micron sapphire tip, in non-contact mode; 500mJ per pulse at 17Hz. Total power: 8.5Watts. 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, 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). Vaporisation 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 CO2 lasers, 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.

The broken hexagon slot was straightened, using a round diamond bur and the head of the fractured screw, and a screwdriver was successfully used to unscrew the broken abutment screw (Figs 7, 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. Studies have shown that Er:YAG laser energy effects on bone include bacterial reduction. 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 protocols. 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 bi-layer membrane (Bio-Gide®, Geistlich Biomaterials), (Figs 12, 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 150mg x 50 tabs to avoid infection. He was also given Motrin 800mg x 15 tabs for pain. Instructions were given to rinse with Chlorhexidine 0.2% for two weeks x three 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 postop 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 tissue had healed over the bone and there were no bony projections observed under the soft tissue. The prognosis is excellent.

Conclusion

The use of osseointegrated 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 (2,940nm) 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 2,940nm wavelength for these procedures presents many advantages vs. conventional methods, including enhancing the surgical site and less bleed-
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