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Dental Implants: What Have We Learnt from Long-term Follow-up?

Abstract: At dental hospitals and general dental practices across the UK there are increasing numbers of patients attending with problems related to their dental implants. Many of the most challenging to deal with are those where implants were placed many years previously. With more evidence now available from long-term studies, this paper will look at the causes and incidence of implant and prosthesis complications, and suggest practical methods of management in these cases. The impact of obsolete implant systems on patient treatment will be considered, and how age-related patient factors can alter the management of these cases.

CPD/Clinical Relevance: To explore the needs and treatment burden of patients with implant-retained restorations and consider important factors in the care and management of these patients over time.

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Dental implants are increasingly common, with more patients and practitioners embracing this technique for supporting fixed or removable prostheses. As with all forms of dentistry, planning for maintenance and failure is important and can be assisted by incorporating elements that will make replacement and revision easier for dentists and patients.

At dental hospitals and specialist centres across the UK, there are increasing numbers of patients attending with problems related to their dental implants. Many of the most challenging to deal with can be those where implants were placed many years previously. With a scarcity of evidence for the management of implants and implant prostheses beyond 15 years, this paper aims to look at the challenges that occur in this cohort of patients and make suggestions as to how cases can be managed and maintained.

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Prosthesis problems

Removable prostheses

A 2002 systematic review identified that the incidence of complications occurring in overdenture superstructures was approximately 4–10 times higher with implants used in overdenture therapy compared with implant fixed prostheses.[1]

Goodacre *et al* in 2003 showed that loss of retention was the most frequently reported mechanical complication in overdentures at 30%.[2] The need for overdenture relines (19%), overdenture clip/attachment fracture (17%), opposing prosthesis fracture (12%) and acrylic resin base fracture (7%) were further mechanical complications which were noted. Retentive elements will wear over time due to cycles of friction or flexion associated with their function. There have been differences noted between findings from *in vitro* and *in vivo* studies on matrix and patrix wear, which may be due to the complexity of replicating the masticatory forces that the prosthetic components experience.

Overdentures may be retained using a number of systems which include a variation of o-rings, clips and magnets. Locators® (Zest Anchors Inc, Escondido, CA, USA) are an overdenture device which can be used in conjunction with a large range of implant systems. They comprise a small gold-coloured stud attachment on the implant and a metal housing in the denture base with a nylon insert (Figure 1). The inserts are colour-coded with respect to retentive force and can be changed easily using a specially designed tool. This makes maintenance of Locators® simple and relatively inexpensive.

Ball abutments are another commonly used overdenture retainer (Figure 2). The maintenance of these can be slightly more time consuming because the plastic insert in the housing often has to be drilled out prior to changing. This also risks damaging the metal housing. These plastic inserts are now no longer available for some systems (eg Clix ball attachment system, Dentsply Implants

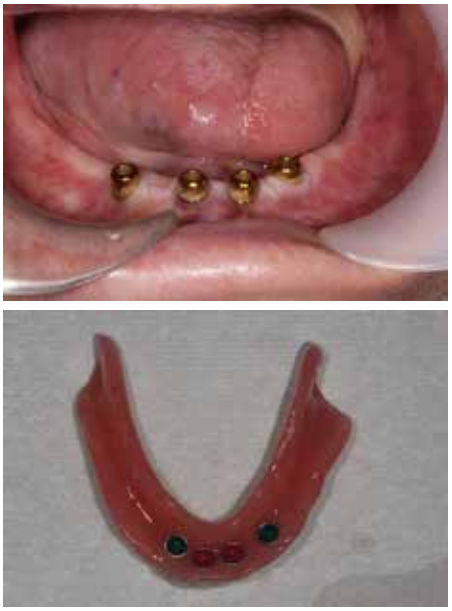

Figure 1. **(a)** Locator® abutments in the mouth and **(b)** fitting surface of a denture with different nylon inserts *in situ*.

Figure 2. Ball abutment in the mandible for retention of a lower overdenture.

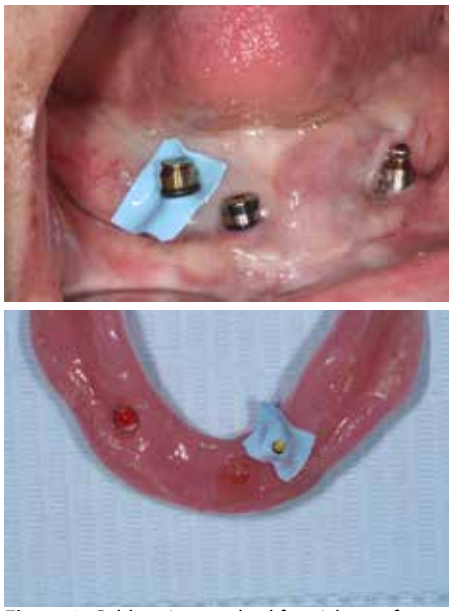

Figure 3. Cold-curing method for pick-up of Clix housing. **(a)** Rubber dam is used around the abutment to act as a barrier, minimizing the risk of cold-cure acrylic dispersing into undercut areas. **(b)** Housing securely fixed into the denture fitting surface.

Ltd, UK). Alternatively, gold or metal clips can retain with ball abutments. Although the leaves of these can be reactivated to help maintain their retention, at the end of their useful life it will be necessary to remove the entire component and replace it. Similarly, magnets have to be completely replaced at the end of their use. Use of implant-retained, ovoid, circular or milled bars requires the use of clips, which can be made of plastic or metal. The metal clips can be reactivated, but replacement of the clips may require the prosthesis to be sent to the dental laboratory and, as a consequence, patients will have some time without their prostheses.

Some retentive housings can be replaced chairside (Figure 3). During chairside replacements of retentive housings in denture bases using cold-cure acrylic, it is imperative that all undercuts are blocked out around the patient's implants. The cold-cure acrylic needs to be left to set completely before removal from the mouth for trimming in order to ensure that the retentive housing is held in the denture base. Some manufacturers provide pre-made components that sit around implants and ensure that the undercut is blocked out, for example, the white washer spacers that are provided with Locator® abutments. Alternatively, there is a range of dental materials that can be used to block out undercut around the implant abutment. This includes ribbon wax, rubber dam and caulking (such as Oraseal®, Ultradent Products Inc, South Jordan, UT, USA) and soft temporary restorative materials such as Telio® Inlay (Ivoclar Vivadent AG, Schaan, Liechtenstein) or *Clip F* (VOCO GmbH, Cuxhaven, Germany). Should these precautions fail and cold cure locks into the undercut, it is important that the denture is not forced out of the mouth. There have been cases of this resulting in inadvertent removal of compromised dental implants when too great a force has been applied. If there are concerns that there is extension of cold-cure acrylic around the implant abutment, cutting the denture out is the best course of action.

Components are designed so that the retentive element in the denture wears preferentially to the implant abutment. Nonetheless, titanium ball abutments (Figure 4) have been shown to experience most of their wear within the first 3 years, with between 19 and 22 µm of wear noted.[3] Ceramic ball abutments have been shown to experience less wear, but they have a 30% incidence of fracture in one year and are therefore not recommended for clinical use.[4] When there is clinical loss of retention that cannot be satisfactorily resolved by replacement of the matrix insert in the denture, then replacement of the ball abutments is indicated.

Fixed prostheses

Patients who have had implant-retained fixed prostheses for many years may experience failure and complications. Prosthodontic complications of screw loosening and fracture, porcelain or acrylic fracture and cement failure are the most commonly encountered problems with fixed implant prostheses.[5,6]

Loss of retention

Screw loosening can be a result of failure to torque screws at prostheses insertion effectively ('settling effect'), overloading of the superstructure due to poor design or parafunction, or malfunction of the component.[7,8] There is more screw loosening noted with cantilever designs of bridges, potentially caused by loading forces applied away from the long axis of the implant resulting in higher torsional forces.[7,9] There is also more experience of failure of implant components in the posterior regions (where occlusal forces are greater than anteriorly) and in patients who are partially edentulous when compared to edentulous patients.[8,10,11] Extreme mechanical forces may also result in screw fracture, either from over-torquing of the screws, unfavourable or excessive occlusal loading, mechanical trauma or gradual fatigue of the screw.

For cement-retained restorations, even the management of a relatively simple complication, such as a loose screw, can be more complicated to manage, often resulting

Figure 4. Ball abutments which demonstrate wear.

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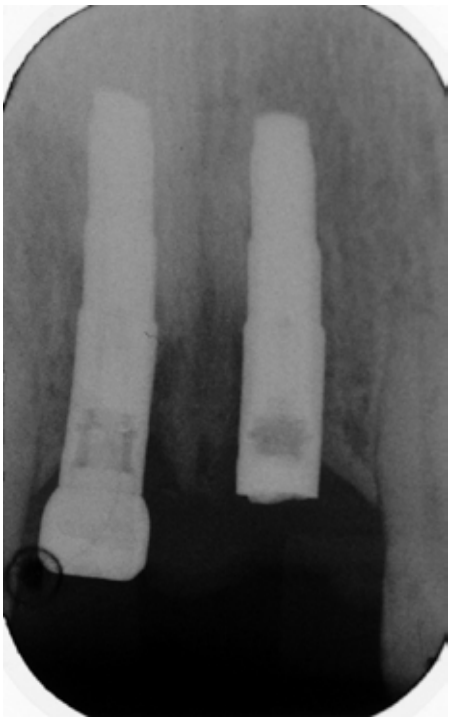

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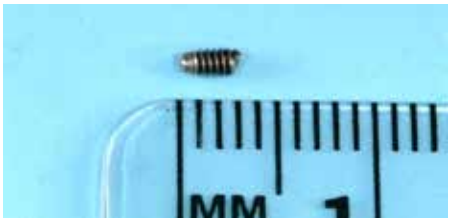

Figure 5. (a) Radiograph of two implants (UR1 and UL1) with healing abutment *in situ* on UR1 and screw fragment evident in UL1. **(b)** Retrieved apical fragment of fractured screw from UL1 implant.

in the need to drill through the prosthesis should it not be possible to remove it from the loose abutment mechanically.

Undetected screw loosening is one of the primary causative factors of screw fracture.[8] The incidence of combined abutment screw fracture in single crowns has been noted at 5-year follow-up as being 0.35%,[5] with higher incidence noted for implant-supported fixed dental prostheses (FDPs) (1.5%).[12] Conversely, 12.7% of single crowns have screw loosening at 5 years compared to 5.8% of FPDs.[5] It may be that the clearer presentation of loosening of screws in single crowns means that they are managed better and in a more timely manner than with FPDs. Implant type appears to have an impact on the risk for screw fracture; Behr noted that ITI implants (Straumann, Switzerland) had an incidence of 3.1% screw fracture compared with 7.7% screw fracture in IMZ implants (Friatec, Germany), with a mean follow-up of 3.5 years.[13] There is some evidence of higher fracture rates of prosthetic screws (4%) when compared to abutment screws (2%).[2]

Screw fracture often presents with loss of the prosthesis. There may be a history of trauma or of loosening of the prosthesis. Clinically, the implant will be firm and, if the patient has retained the prosthesis, the fractured screw will be evident. Radiographically, the retained screw fragment will be visible inside the implant (Figure 5). There are a number of methods of screw retrieval. The first technique to employ to remove the fractured portion is to unscrew it with a sharp probe. Moving the probe in an anti-clockwise movement can catch on the fractured surface and back out the screw. If the screw is too tight to be removed using this method then a fine bur is required to drill out the fractured screw or create a groove within it to aid removal. Care is required when drilling is necessary to avoid damage to the internal screw threads of the fixture. Some manufacturers now make screw retrieval instruments for retrieving fractured screws and, if necessary, rethreading the internal threads of the implant (eg Dentsply screw retrieval kit, Dentsply, UK). Should screw removal fail, the successful restoration of the patient will be compromised, with some implants rendered non-functional due to irretrievable screws or an irreversibly damaged implant head during the attempt to retrieve the fractured screw.

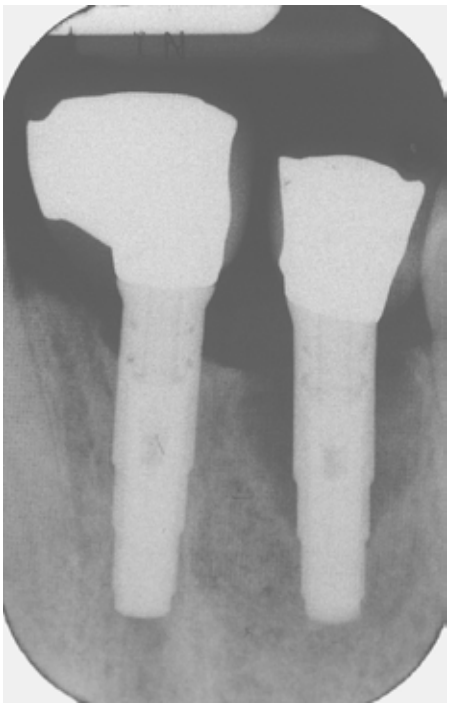

Figure 6. Radiograph demonstrating loss of supporting bone due to peri-implantitis.

Fixed prosthesis wear

Acrylic, composite and porcelain are used as veneering material for fixed implant-retained prostheses. Rates of wear and fracture can differ, dependent on the type of material and whether the prosthesis replaces one or multiple units. Available evidence for the incidence of ceramic fracture suggests that it continues to increase over time; a 20-year prospective study identified ceramic chipping in 28% of cases,[14] in comparison to a 26-month study, which identified ceramic fracture in only 1.1% of cases.[9]

Ceramic or acrylic fractures soon after fit can be caused by a non-passive framework. As years pass, such fractures may be caused by occlusal discrepancies that have developed with time. Differential wear of the bridge veneering material compared to neighbouring teeth or restorations can cause undesirable loads to be placed on the implant restoration. Similarly, further tooth loss can result in excessive or undesirable forces being placed through the implant restoration.

Jung *et al* identified that fracture of the veneering material was the third most common technical complication for implant-retained single crowns of 4.5% at 5 years.[5] A 2007 systematic review identified that fracture of veneer material was the most common technical complication in implant-supported FPDs, with a 5-year complication rate of 11.9%.[15] In comparison, tooth-supported FPDs

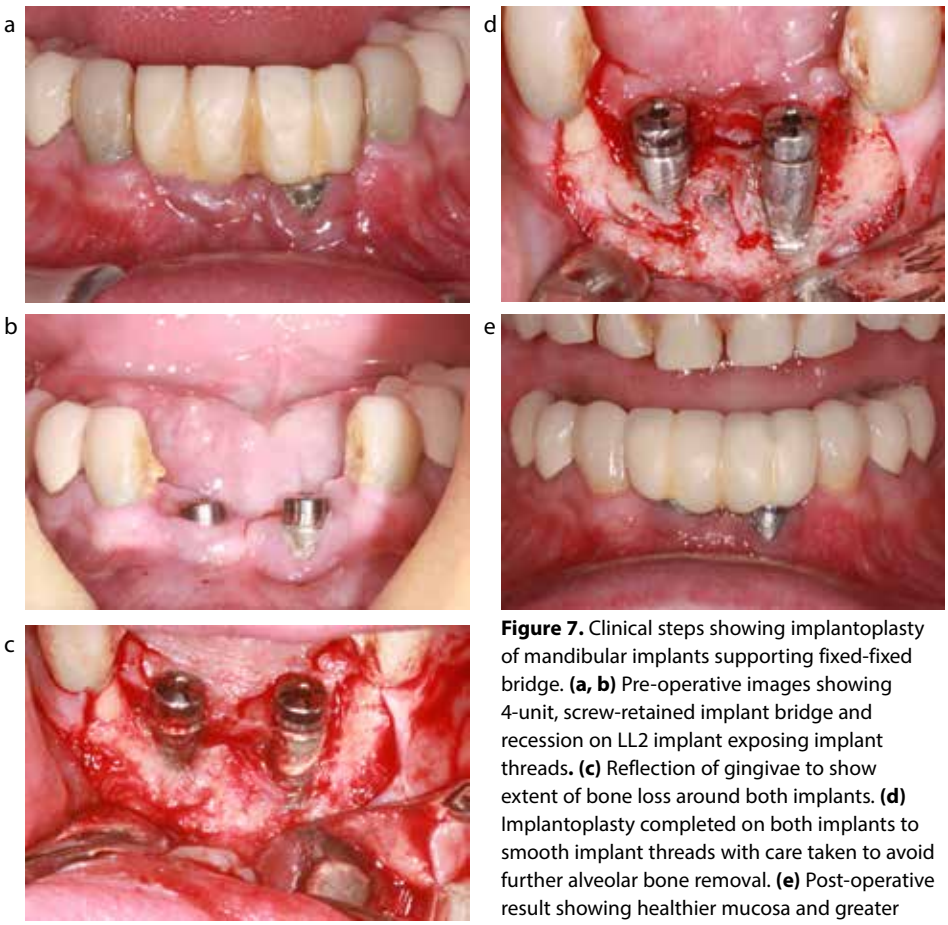

Figure 7. Clinical steps showing implantoplasty of mandibular implants supporting fixed-fixed bridge. **(a, b)** Pre-operative images showing 4-unit, screw-retained implant bridge and recession on LL2 implant exposing implant threads**. (c)** Reflection of gingivae to show extent of bone loss around both implants. **(d)** Implantoplasty completed on both implants to smooth implant threads with care taken to avoid further alveolar bone removal. **(e)** Post-operative result showing healthier mucosa and greater cleansability of the area.

have a significantly lower incidence of ceramic fracture chipping of 2.8% at 5 years.

Veneering materials have different rates of complications. Pjetursson *et al* identified that the ceramic fracture rate for implant-retained, metal-ceramic prostheses is lower for both FPDs and single crowns than the combined rate of fracture of both gold-resin and metal ceramic prostheses.[15] This is supported by another review which showed incidence of fracture of 22% in resin/gold implant-supported FPDs in comparison to 14% in porcelain-veneered, implant-supported FPD.[2] Acrylic resin displays an additional complication of severe wear after 10 years.[16]

Mechanical complications can result in the need to remove the implant-retained prosthesis to allow repair and remaking. Understandably, this is more complex with fixed implant-retained prostheses but the removal of cement-retained prostheses can be particularly difficult.

Screw-retained prostheses are intentionally designed to be easy to remove. However, it is possible for screw-retained prostheses to be difficult to remove, depending on the design. Implants with a tapered internal connection, where the prosthesis is screwed direct to the implant, can resist removal. In this regard, if multiple implants are restored with a fixed bridge that connects direct to the implant head (as opposed to having an intervening multi-unit or uni-abutment), then even very subtle divergence in the alignment of the fixtures can lead to the superstructure being locked into the implants, even when all the retention screws have been removed. For this reason, it is worth considering the use of an intervening abutment rather than restoring direct to the implant head when linking three or more implants with a fixed prosthesis, in order to retain retrievability.

Implant problems

Criteria for implant success were described in 1986 by Albrektsson *et al*,[17] with failure due to bone loss being described as crestal bone height loss of greater than 0.2 mm per year after the first year. When this criterion is included in studies, it should be noted that this definition of success is markedly different from implant 'survival.' For example, Da Silva *et al* reported on 920 implants placed in general dental practice with an average follow-up of 4.2 years.[18] A 93% survival rate was reported, but when excessive bone loss, as described by Albrektsson *et al*, was included in their analysis, the success rate dropped to 81.3%. Implant failure was linked to a number of factors; history of severe periodontal disease, pre-existing inflammation in the implant site, type IV bone, immediate implant placement and placement in the incisor or canine region.[18]

Peri-implantitis

Peri-implantitis is the loss of supporting bone and soft tissue around an osseointegrated implant as a result of inflammation (Figure 6). An incidence of between 5–13% has been noted, with higher incidences of up to and over 30% in groups which are periodontally compromised prior to implant placement.[19] Periodontally-compromised patients may have twice the risk of developing peri-implantitis, with significantly more incidences of increased pocketing, bone loss and suppuration.[20,21] There is also an increased risk of implant loss in these patients.[20,22] Higher incidences of peri-implantitis are also associated with factors such as smoking, poor oral hygiene, uncontrolled systemic diseases such as diabetes mellitus, occlusal overloading and excessive cement which is not removed.[23-25]

Implants that have been present for an increased length of time are more likely to encounter biological complications. Chappuis *et al* described that, at 20 years, 92% of patients had only minimal bone changes, but that 8% showed moderate bone loss (defined as between 1 and 1.8 mm), with smokers more affected than non-smokers.[14] Bone level changes have been shown to occur predominantly within the first 5 years, with minimal changes between 5 and 15 years.[16] However, the number of implants affected by high levels of bone loss (defined as 3 mm or more) increased over time, with 8.7% of implants affected at one year increasing to

Figure 8. Surgical exploration confirming implant fracture following clinical history of crown loosening

14% at 15 years.[16] The average bone losses are in the region of 0.5–0.6 mm cumulatively between 5 and 15 years, compared to that seen on natural teeth over 10 years of follow-up at 0.4 mm.[26] This is supported by a 2008 systematic review comparing natural teeth and implants where bone loss of natural teeth was 0.2–0.8 mm over 10 years compared to 0.7–1.3 mm over 10 years for implants.[27] This suggests that most implants will follow a similar course of gradual bone loss as that seen around natural teeth in well-maintained mouths.

At present, treatment of peri-implantitis is difficult and there is no real evidence base to guide clinicians. Strategies include mechanical and chemical debridement, as well as implantoplasty and guided bone regeneration (GBR). It is accepted that non-surgical methods of treating peri-implantitis are unpredictable in their success at controlling the progressive hard tissue loss, although there is evidence for settling of the mucosal inflammation.[28] Implantoplasty is the careful removal of implant threads using either diamond or carbide burs to create an implant surface that is smooth and more manageable for debridement (Figure 7). This may be combined with an apically repositioned flap to aid cleansibility of the region. This seems to result in slower bone loss, although it does not appear to favour further tissue attachment.[29] In walled defects, GBR is an alternative therapy, although at present there is little evidence to show how effective this is around implants.[30,31] For implants that are severely affected by bone loss, removal of the implant may be the only treatment option.

Implant loss

Implant loss is inevitably of concern when considering maintenance of implants over decades, and multiple groups have given estimates for the longevity of implants in different clinical circumstances. There are several systematic reviews which give 5-, 10- and 15-year longevity of dental implants. Implant survival at 5 years when supporting single crowns (SCs) is reported to be 94.5%.[5] Implants supporting fixed-partial dentures (FPDs) have a reported 5-year survival of 95.4% and a 10-year survival of 92.8%.[12] These numbers may be skewed by implants that are lost prior to loading, which range between 2.16% and 2.53% for those intended to support overdentures and 0.76% for those intended for single crowns.[1] The evidence for these numbers also comes from lower levels of evidence due to a lack of controlled trials.

Given the changes in implant systems over the past decade, it is difficult to discern how applicable some of the older trials are to modern implant systems. Rates of survival for rough-surface implants versus machined implants, when used in sinus grafts, had respective survival rates of 96.7% and 86.3%,[32] which demonstrates that survival data for one implant system cannot be accurately used to predict the survival of another type of implant.

The earliest study groups have now started to publish 20-year data for implant success and survival. A cohort of 67 patients with 95 implants demonstrated a success rate of 75.8% at 20 years, with 89.5% of the original implants still present.[14] These long-term results can enable us to improve the information provided to patients when discussing risks, but more data is required before we can be sure of the survival rates at extended periods of time.

Implant fracture

Implant fracture is a rare complication, with an incidence of around 1%.[1,2] Higher incidence of implant fracture has been found associated with fixed partial dentures when compared with other forms of restoration, with single crowns having the lowest recorded incidence.[1,15] Rates of implant fracture seem to increase with time. A systematic review recorded a cumulative incidence of implant fracture of 0.4% at 5 years and 1.8% after 10 years.[12] During 20-year follow-up, Chappuis *et al* recorded an incidence of 3.2% implant fracture, most often occurring between 15–16 years of function.[14]

Implant fracture appears to be clinically associated with a number of factors, including smaller implant diameter, cantilever designs, non-passive seating of the superstructure, bone loss, increasing probing depths and overloading due to parafunctional habits.[33-35] *In vitro* studies suggest fractures are associated with metal fatigue due to bending forces applied to implants.[35,36]

Signs alerting to implant metal fracture include screw loosening, torsion or fracture of the prosthetic screws and ceramic fracture of the prosthesis.[35] Implant fracture may present as increased mobility and pocket depth with spontaneous bleeding[33] (Figure 8). Radiographically, separation of fragments and bone loss will be seen.

Implant fracture does not always result in the removal of the implant. Other options, after considering surgical, prosthetic and patient factors, include that the fractured implant may be left 'sleeping' (removing the coronal portion whilst leaving the apical portion integrated to the bone) (Figure 9) or, if the fracture is very coronal and sufficient internal threads left, restoration of the implant can be attempted once more.[1,33]

Traditionally, implant removal was with the use of trephines to perform an osteotomy around the fixture. This can be difficult with close proximity of adjacent teeth. Recently, atraumatic implant removers have been pioneered, such as the BIOMET 3i™ implant removal system (NeoBiotech, Seoul, Rep of Korea), which uses mechanical forces applied directly to the implant (Figure 10). Forces above 200 Ncm should be avoided to avoid bone fractures or breakage of the implant removal tool. For implants with total bone loss, forceps extractions are an option, although this technique depends on the ability to grasp the implant firmly and the knowledge that even a small amount of remaining osseointegration can make this method more difficult.

Implant failure can have a significant impact on prosthodontic retention. In one study with a 20-year follow-up, nine out of 75 prostheses (12%) were removed due to implant failure.[14] Alteration of prostheses to be supported by fewer implants and assessing the suitability of the patient for further implant placement are treatment options that can be considered. Again, cement-retained prostheses can be difficult or impossible to retain the original prosthesis, as removal of the prosthesis without major damage can be clinically challenging. For some patients, the

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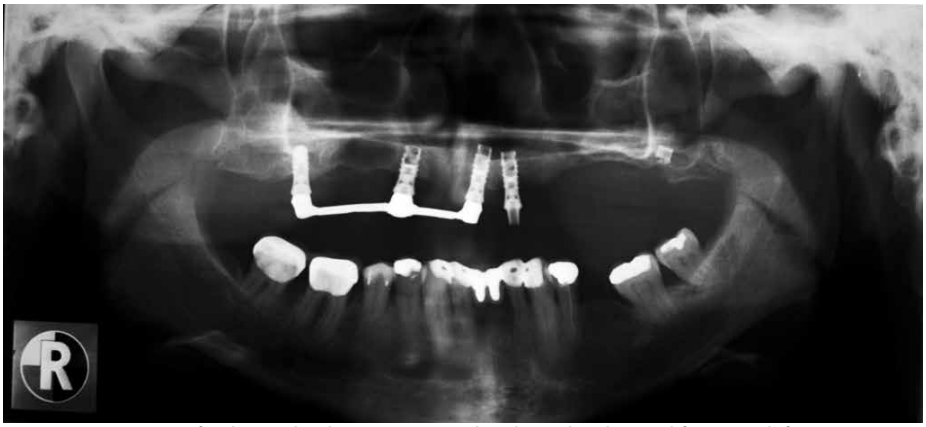

Figure 9. Sequence of radiographs showing UL7 implant buried with apical fragment left *in situ*.

most successful option may be moving from a fixed to removable prosthesis.

Implant system loss

A significant problem when attempting to deal with restoring older implants and implant prostheses can be identifying the existing implant system *in situ*. Some implant systems have ceased production of specific components for that implant system. This may be due to the closure of the company that produced the patient's implant or due to manufacturers creating new lines of implants and implant systems, whilst ceasing to support older ones. An advantage of using one of the larger implant companies is that they have lifetime warranties to provide components for restoring the implants, even if the implant line is no longer in common production.

There are companies that will offer the custom manufacture of implant abutments. For example, Atlantis™ (Dentsply Implants, Mannheim, Germany) will provide custom abutments and corresponding screws for many major systems of implants. Some dental laboratories have started to specialize in tracking down rare and obsolete implant components. There are also companies, such as Southern Implants® (Irene, South Africa), that will provide custom-made screwdrivers and other components, but there is often a higher financial cost for these custom components, as well as delay inherent in their manufacture. This means that, after several decades with their implants, patients' expected 1.2 and 2 maintenance visits per year[6] may start to become more costly and frequent due to problems sourcing components for treatment.

An example of this problem is the implant systems Calcitek® (Calcitek, Inc, San Diego, California) and Integral® (Calcitek Inc, Carlsbad, CA), which are now obsolete, but were used for many patients in the 1980s and 1990s. Components for these implants are now difficult to track down and so refurbishing patients' prostheses with diminishing available components is becoming an increasing issue (Figure 11).

It is recommended that patients are made aware of their implant and prosthesis details to ensure that any new practitioner has the appropriate information to order equipment and components to replace restorations, as necessary. Appropriate information to give patients is summarized in the Technique Tip paper by Coleman, Webb and Nixon.[37]

Should this information not be available, identification of the implant can be very difficult and often requires an experienced clinician. There are a number of steps that can be taken to aid identification of the implant system. Initially, radiographic assessment can help, and there are a number of websites that have been set up to help with using this method of identification, such as **www.whatimplantisthat.com** and **www.osseosource.com**. A second method to identify an implant system, should access to the implant head be possible, is to look at the interface, which is often unique to a single company.

Some patients have more than one implant system present after having multiple stages of implant placement following tooth loss over time (Figure 9). The operator should be careful that they do not rely on only using one implant to identify the system for multiple implants supporting a fixed prosthesis; manufacturers now have the technology to incorporate multiple implant types to support an overlying framework, so each individual implant requires assessment and identification.

Even within a single implant system there are different screws that can be used, for example angled versus straight prosthetic screws. It is important to identify such details as a different driver is required for each (Figure 12).

Identifying unfamiliar implant systems is a skill that develops with experience, and sometimes the best option is to ask the patient to return to the dentist that placed the implant, if that is possible, to request the details of the implant system. Dependent on the implant system previously used, the patient may find that he/she has to attend a particular practice for refurbishment of the implants.

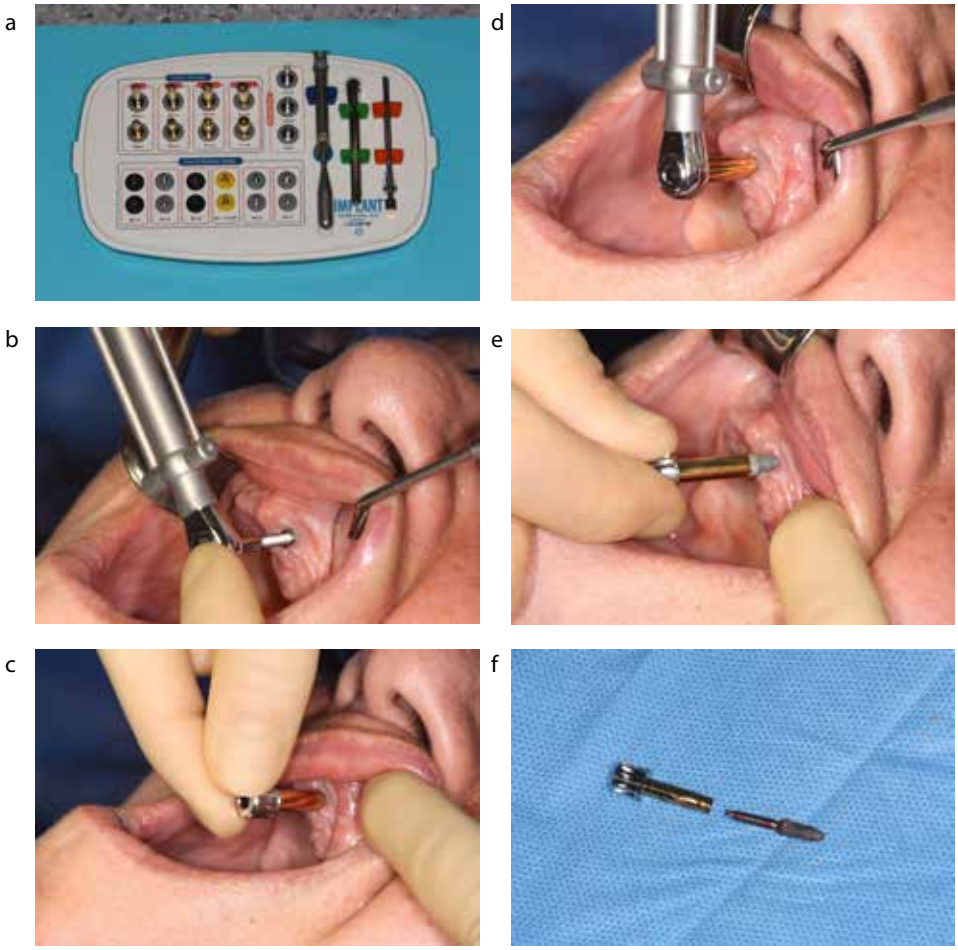

Figure 10. (a–f) Clinical steps for removal of implant using an implant removal system. **(a)** 'Implant Removal System' kit. **(b)** Fixture remover screw placed into implant and torqued into place. **(c, d)** Fixture remover secured onto fixture remover screw and torque ratchet used to commence implant removal. **(e)** Implant removal is completed using digital pressure. **(f)** Implant removal complete.

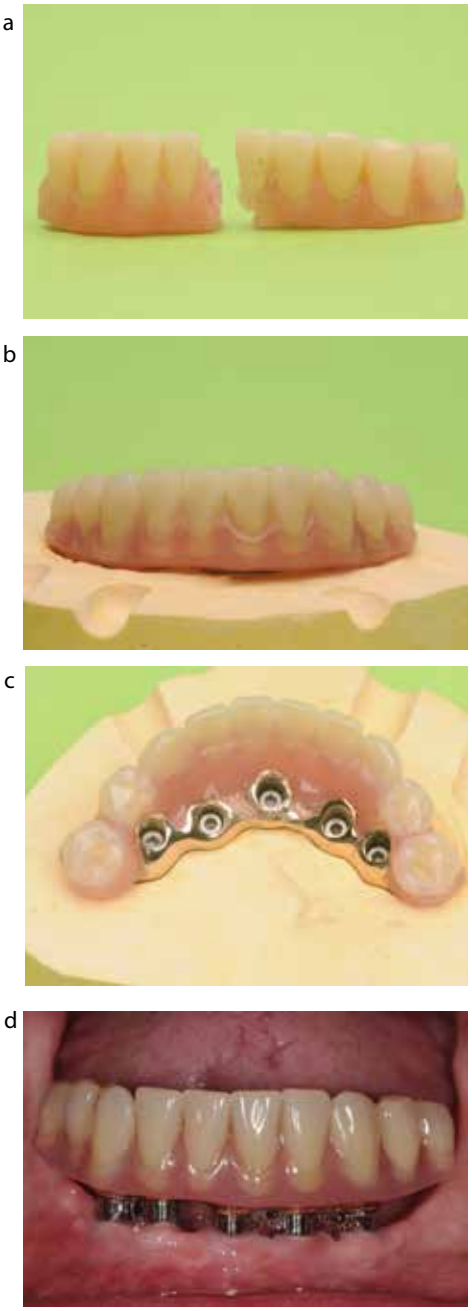

Figure 11. (a) A patient attended with acrylic/metal implant-retained bridge on five Calcitek® implants with a fracture of the acrylic. No impression copings were available for this system and no abutments could be sourced to alter the bridge design. **(b, c)** Components were salvaged from the original bridge and reused to refurbish the acrylic portion of the bridge with no change to the framework. Due to the lack of components, an interim lower denture had to be worn by the patient during the process. **(d)** Refurbished bridge *in situ*.

Patient factors

The dental management of the ageing population can be challenging; a deterioration in oral hygiene and general oral health can be evident alongside the increase in complexity of the patient's medical and physical needs. With the increasing number of implants present in an ageing population, there are ever more patient factors affecting the success of implant longevity. The maintenance of dental implants and implant-retained prostheses can be much more complex within this cohort of patients.

As patients become older, various medical and physical changes can affect patients' ability to care for themselves in the same manner as they did previously. There are 850,000 people with dementia in the UK, with 40,000 of these being under the age of 65.[38] This number is projected to increase over the next 10 years to over 1.0 million people.[39] Dementia can result in confusion and personality changes which may lead to a deterioration in oral hygiene and lack of attendance to dental care. Other medical conditions, such as stroke and arthritis, can affect a patient's physical ability to maintain his/her oral health, especially with fine motor controls such as those used for toothbrushing.

Polypharmacy is more common in older populations and certain drug therapies, such as antiresorptive, antiangiogenic or anticoagulant agents, can mean that dental implant provision or maintenance is more challenging. Xerostomia is a known and common consequence of taking many forms of medication, although it is not specifically seen as an age-related change. It can be

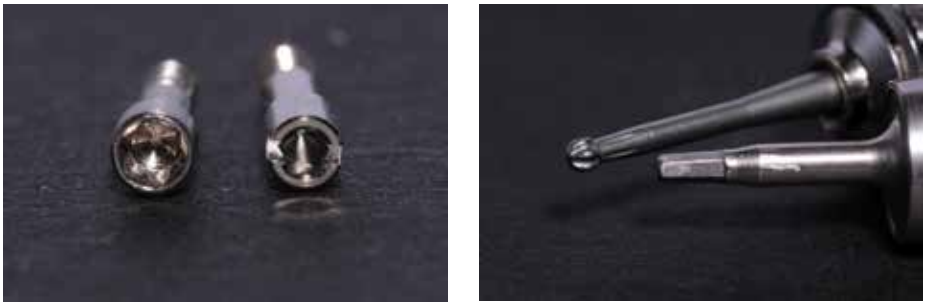

Figure 12. (a) Angled screw on the left and straight XiVE® prosthetic screw (Dentsply Friadent, Mannheim, Germany) on right. **(b)** Angled driver on left and straight 1.22 mm XiVE® driver on right.

beneficial for patients with xerostomia to have implant-retained prostheses in order to improve the retention and comfort of a prosthesis. However, excellent oral hygiene is necessary for these patients and, as discussed, this may be a challenge for patients as they become older.

Mobility decline is common in the elderly, due to reducing muscular strength, balance impairment or increasing musculoskeletal pain due to arthritis. This can diminish a patient's ability to access health services, including dental care. As patients become older, they may become reliant on a carer or live in a care home. A large survey of care homes in Wales identified that access to routine care was more difficult for care home residents than access to emergency care.[40] There was also a discrepancy noted between the need for assistance in tooth and denture cleaning and the training provided to care home staff. This will inevitably affect patients' ability to maintain their implant-related prostheses.

For a small minority of patients who are experiencing difficulties with their dental implants and/or implant-retained prostheses and who are unable to access dental care on a regular basis due to age-related changes, there may be an argument for electing to bury the implants and converting to a conventional prostheses. The National Institute for Clinical Excellence (NICE) has developed guidance for addressing oral health needs for adults in care homes which was published in July 2016.[41]

Conclusions

A customized patient information leaflet, detailing patients' implant system and prosthesis details, should help in their lifelong dental care by improving their ease of access to dental services

Screw-retained prostheses are more retrievable than cement-retained prostheses and patients may experience less peri-implantitis due to no risk of excess cement.

If more than three implants with an internal-tapered connection are linked with a fixed prosthesis, it is worth considering the use of intervening abutments to aid retrievability.

With discontinuation of certain implant systems, components may become unavailable or have to be made at special request (ie those for components no longer available) which may impact on the efficiency of patient treatment and have a significant financial impact.

Following implant treatment, patients' general health or age-related causes may mean that they become less able to maintain their implant-retained prosthesis.

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References

1. Berglundh T, Persson L, Klinge B. A systematic review of the incidence of biological and technical complications in implant dentistry reported in prospective longitudinal studies of at least 5 years. *J Clin Periodont* 2002; **29**(Suppl 3):197–212; discussion 32–33.
2. Goodacre CJ, Bernal G, Rungcharassaeng K, Kan JY. Clinical complications with implants and implant prostheses. *J Prosthet Dent* 2003; **90**: 121–132.
3. Fromentin O, Lassauzay C, Nader SA, Feine J, de Albuquerque RF Jr. Clinical wear of overdenture ball attachments after 1, 3 and 8 years. *Clin Oral Implants Res* 2011; **22**: 1270–1274.
4. Buttel AE, Luthy H, Sendi P, Marinello CP. Wear of ceramic and titanium ball attachments in subjects with an implant-retained overdenture: a controlled clinical trial. *J Prosth Dent* 2012; **107**: 109–113.
5. Jung RE, Pjetursson BE, Glauser R *et al.* A systematic review of the 5-year survival and complication rates of implant-supported single crowns. *Clin Oral Implants Res* 2008; **19**: 119–130.
6. Lang NP, Pjetursson BE, Tan K *et al.* A systematic review of the survival and complication rates of fixed partial dentures (FPDs) after an observation period of at least 5 years. II. Combined tooth-implant-supported FPDs. *Clin Oral Implants Res* 2004; **15**: 643–653.
7. Bakaeen LG, Winkler S, Neff PA. The effect of implant diameter, restoration design, and occlusal table variations on screw loosening of posterior single-tooth implant restorations. *J Oral Implant* 2001; **27**: 63–72.
8. Eckert SE, Meraw SJ, Cal E, Ow RK. Analysis of incidence and associated factors with fractured implants: a retrospective study. *Int J Oral Maxillofac Implants* 2000; **15**: 662–667.
9. Montero J, Manzano G, Beltran D *et al.* Clinical evaluation of the incidence of prosthetic complications in implant crowns constructed with UCLA castable abutments. A cohort follow-up study. *J Dent* 2012; **40**: 1081–1089.
10. Carlson B, Carlsson GE. Prosthodontic complications in osseointegrated dental implant treatment. *Int J Oral Maxillofac Implants* 1994; **9**: 90–94.
11. Nergiz I, Schmage P, Shahin R. Removal of a fractured implant abutment screw: a clinical report. *J Prosthet Dent* 2004; **91**: 513–517.
12. Pjetursson BE, Tan K, Lang NP *et al.* A systematic review of the survival and complication rates of fixed partial dentures (FPDs) after an observation period of at least 5 years. *Clin Oral Implants Res* 2004; **15**: 667–676.
13. Behr M, Lang R, Leibrock A, Rosentritt M, Handel G. Complication rate with prosthodontic reconstructions on ITI and IMZ dental implants. *Int Team fur Implantol* 1998; **9**: 51–58.
14. Chappuis V, Buser R, Bragger U *et al.* Long-term outcomes of dental implants with a titanium plasma-sprayed surface: a 20-year prospective case series study in partially edentulous patients. *Clin Implant Dent Rel Res* 2013; **15**: 780–7890.
15. Pjetursson BE, Bragger U, Lang NP, Zwahlen M. Comparison of survival and complication rates of tooth-supported fixed dental prostheses (FDPs) and implant-supported FDPs and single crowns (SCs). *Clin Oral Implants Res* 2007; **18**(Suppl 3): 97–113.
16. Jemt T, Johansson J. Implant treatment in the edentulous maxillae: a 15-year follow-up study on 76 consecutive patients provided with fixed prostheses. *Clin Implant Dent Rel Res* 2006; **8**: 61–69.
17. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. *Int J Oral Maxillofac Implants* 1986; **1**: 11–25.
18. Da Silva JD, Kazimiroff J, Papas A *et al.* Outcomes of implants and restorations placed in general dental practices: a retrospective study by the Practitioners Engaged in Applied Research and Learning (PEARL) Network. *J Am Dent Assoc* 2014; **145**: 704–713.
19. Mombelli A, Muller N, Cionca N. The

epidemiology of peri-implantitis. *Clin Oral Implants Res* 2012; **23**(Suppl 6): 67–76.
20. Sgolastra F, Petrucci A, Severino M, Gatto R, Monaco A. Periodontitis, implant loss and peri-implantitis. A meta-analysis. *Clin Oral Implants Res* 2015; **26**: e8–16.
21. Roccuzzo M, Bonino L, Dalmasso P, Aglietta M. Long-term results of a three arms prospective cohort study on implants in periodontally compromised patients: 10-year data around sandblasted and acid-etched (SLA) surface. *Clin Oral Implants Res* 2014; **25**: 1105–1112.
22. Chrcanovic BR, Albrektsson T, Wennerberg A. Periodontally compromised vs. periodontally healthy patients and dental implants: a systematic review and meta-analysis. *J Dent* 2014; **42**: 1509–1527.
23. Sgolastra F, Petrucci A, Severino M, Gatto R, Monaco A. Smoking and the risk of peri-implantitis. A systematic review and meta-analysis. *Clin Oral Implants Res* 2015; **26**: e62–e67.
24. Ferreira SD, Silva GL, Cortelli JR, Costa JE, Costa FO. Prevalence and risk variables for peri-implant disease in Brazilian subjects. *J Clin Periodont* 2006; **33**: 929–935.
25. Rosen P, Celm D, Cochran D *et al.* Peri-implant mucositis and peri-implantitis: a current understanding of their diagnoses and clinical implications. *J Periodont* 2013; **84**: 436–443.
26. Paulander J, Wennstrom JL, Axelsson P, Lindhe J. Some risk factors for periodontal bone loss in 50-year-old individuals. A 10-year cohort study. *J Clin Periodont* 2004; **31**: 489–496.
27. Tomasi C, Wennstrom JL, Berglundh T. Longevity of teeth and implants – a systematic review. *J Oral Rehab* 2008; **35**(Suppl 1): 23–32.
28. Muthukuru M, Zainvi A, Esplugues EO, Flemmig TF. Non-surgical therapy for the management of peri-implantitis: a systematic review. *Clin Oral Implants Res* 2012; **23**(Suppl 6): 77–83.
29. Romeo E, Lops D, Chiapasco M, Ghisolfi M, Vogel G. Therapy of peri-implantitis with resective surgery. A 3-year clinical trial on rough screw-shaped oral implants. Part II: radiographic outcome. *Clin Oral Implants Res* 2007; **18**: 179–187.
30. Khoshkam V, Chan HL, Lin GH *et al.* Reconstructive procedures for treating peri-implantitis: a systematic review. *J Dent Res* 2013; **92**(12 Suppl): 131S–138S.
31. Alani A, Bishop K. Peri-implantitis. Part 3: current modes of management. *Br Dent J* 2014; **217**: 345–349.
32. Del Fabbro M, Rosano G, Taschieri S. Implant survival rates after maxillary sinus augmentation. *Eur J Oral Sci* 2008; **116**: 497–506.
33. Sanchez-Perez A, Moya-Villaescusa MJ, Jornet-Garcia A, Gomez S. Etiology, risk factors and management of implant fractures. *Med Oral Patol Oral Cirug Bucal* 2010; **15**: e504–e508.
34. Balshi TJ. An analysis and management of fractured implants: a clinical report. *Int J Oral Maxillofac Implants* 1996; **11**: 660–666.
35. Conrad HJ, Schulte JK, Vallee MC. Fractures related to occlusal overload with single posterior implants: a clinical report. *J Prosthet Dent* 2008; **99**: 251–256.
36. Rangert B, Krogh PH, Langer B, Van Roekel N. Bending overload and implant fracture: a retrospective clinical analysis. *Int J Oral Maxillofac Implants* 1995; **10**: 326–334.
37. Coleman A, Webb L, Nixon P. Technique Tips – Patient information for implant maintenance. *Dent Update* 2017; **44**: 680–681.
38. Alzheimer's Society. *Dementia 2014: Opportunity for change*.
39. Lewis F, Karlsberg Schaffer S, Sussex J, O'Neill P, Cockcroft L. *The Trajectory of Dementia in the UK – Making a Difference*. Office of Health Economics, 2014.
40. Monaghan N, Morgan M. Oral health policy and access to dentistry in care homes. *J Disabil Oral Hlth* 2010; **11**: 61–68.
41. National Institute for Health and Care Excellence (NICE). *Oral Health for Adults in Care Homes*. (2016) NG48.

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