Implant Complications and Failures: The Single-tooth Restoration

C.J. Watson, D. Tinsley and S. Sharma

Abstract: The single-tooth implant restoration appears to be an ideal method of replacing missing natural teeth in a healthy dentition. Most follow-up studies report a high success rate. The restoration is seen by many clinicians as a relatively straightforward technique easily adapted to general dental practice and popular with patients, although it is not without complications. The purpose of this paper is to look at common problems following the placement of root-formed endosseous dental implants. A number of implant systems are reviewed and the results of the authors' clinical experiences reported.

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Clinical Relevance: The pitfalls of implant treatment are rarely discussed. Implant position and design, the emergence profile and inadequacies of the soft and hard tissues can all create post-insertion restorative complications. The overall success of treatment requires careful planning at all stages.

For the replacement of single missing teeth in certain situations implants have distinct advantages over conventional treatment modalities. The use of implants has increased as dentists have recognized the predictability and long-term success of modern dental implants.[1] Implants avoid the need for preparation of adjacent healthy teeth, are particularly useful where diastemas are present, reduce the psychological impact of tooth loss, and can avoid the social embarrassment of wearing dentures.

Implant treatment has been followed up for more than 15 years.[2] However, most of these long-term studies relate to edentulous patients. The follow-up period for the single-tooth implant is shorter, but studies have shown a high degree of success. Table 1 shows both success and survival rates for some recently published studies. *Success* is usually defined as an implant which is functional, symptom free, and with no obvious clinical pathology. Smith and Zarb[11] state that cervical bone loss should not exceed 0.2 mm per year after the first year of function. *Survival* can be defined as a retained non-mobile implant capable of supporting a crown. However, some surviving implants may demonstrate significant cervical bone loss or have associated soft-tissue problems.

Although most single-tooth implants are predictable and successful, there are some well recognized post-insertion complications. These can be frustrating for the dentist and the patient, costing both time and money to put right. The purpose of this paper is to discuss some common complications found at follow-up of patients treated or referred, with various dental implant systems, at the Leeds Dental Institute. For convenience, complications have been divided into two distinct groups:

- implant positional problems; and
- restorative complications.

COMPLICATIONS RESULTING FROM POOR IMPLANT PLACEMENT

Positioning of the single-tooth implant is

C.J. Watson, BDS, FDS RCS, PhD, Senior Lecturer/Honorary Consultant in Restorative Dentistry, D. Tinsley, BDS, MDSc, Lecturer in Restorative Dentistry, and S. Sharma, BDS, FDS RCS, Staff Grade in Restorative Dentistry, Leeds Dental Institute.

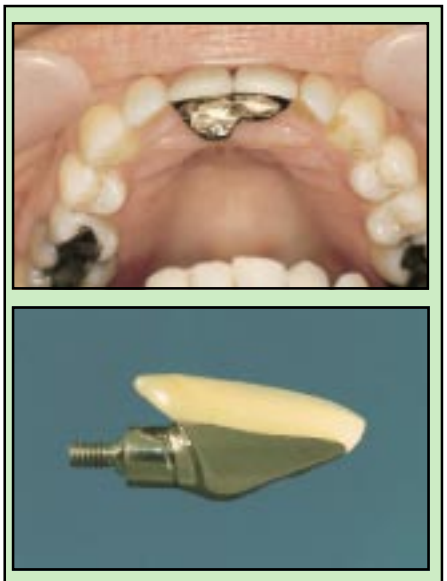

***Figure 1. (a)** A palatally positioned implant 11 resulting in occlusal problems requiring significant adjustment of the crown. **(b)** A ridge-lapped crown.*

Implant system	Authors	Duration of study (years)	Success rate (%)	Survival rate (%)
Nobel Biocare	Henry *et al.*[3]	5	96.6	
	Schmitt and Zarb[4]	1-6		100
	Laney *et al.*[5]	3	97.2	
	Scheller *et al.*[6]	5	95.9	
Frialit-2	Gomez-Roman and d'Hoedt[7]	5	96	
Calcitek	Watson *et al.*[8]	4	58	100
Astra	Kemppainen *et al.*[9]	1		97.8
	Palmer *et al.*[10]	2	100	

Table 1. *Survival/success rates for single-tooth implants.*

critical: minute deviations may compromise the emergence profile and aesthetics and lead to functional problems. The residual ridge morphology dictates the implant position. An example of this is when there is a combination of labial bone resorption with a predisposing concavity related to the labial aspect of the maxilla; this requires the implant to be positioned palatally to avoid a labial perforation. Ridge augmentation before, or at the time of, implant placement may help to resolve some of these complications. Several common placement problems are now described.

The Palatally Positioned Implant

Some workers feel that a bullet entry profile for the crown is the ideal but whether this can be provided depends on the relationship of the head of the implant to the mucosal cuff and labial face of the crown.[12] An implant placed too palatally results in a cantilevered, ridge-lapped clinical crown. This may cause soft tissue irritation and inflammation due to restricted access for hygiene and non-axial loading of the implant. The final crown will be bulky palatally (Figure 1), possibly causing a speech impediment or occlusal disharmony. This is compounded when inter-ridge space is limited and there is a deep overbite.

Figure 2. *Recession causing exposure of titanium abutment on the left central and lateral incisors.*

The Labially Positioned Implant

A labially placed implant will often have a deficiency of attached gingivae. This makes it difficult to manipulate the tissue to regenerate the interdental papilla. Gingival recession or thin translucent gingival tissue will cause greying out of the cervical margin and results in a poor appearance, especially for patients with a high smile line (Figure 2). A ceramic abutment may help to reduce the aesthetic impact of this problem.

Ideally the gingival margins of the implant-retained crown should be at the same height as those of the adjacent natural teeth. This is difficult to achieve when the implant has been placed labially (Figure 3) because the implant often emerges at a different level from the natural crowns. This can alter the symmetry of the arch and detract from the overall appearance.

Mesial/Distal Misplacement

When implants are placed in close proximity to adjacent teeth or other implants (Figure 4) a number of complications may result:

- Access for hygiene will be restricted.
- Development of a dental papilla will be inadequate, giving a poor emergence profile.
- The close proximity of the implants or natural teeth will limit the area available for osseointegration, which in turn may prejudice the longevity of the restoration. Use of a narrow-diameter implant may help in these situations.
- There is the potential to damage the periodontal membrane of the adjacent teeth during surgery, causing either devitalization or pocketing.[13]

Depth of Implant

To create an aesthetically acceptable emergence profile it helps to place the implant at a reasonable depth within the soft tissue. However, if it is placed too deeply, a long soft tissue pocket and high crown/root ratio will result. These two factors may compromise the longevity of the implant, particularly in the presence of occlusal problems. Deeply placed implants make seating of the transmucosal abutment difficult. When the implants are too shallow the

Figure 3. *The left central implant was positioned too labially, which compromised the final aesthetic result (note the longer appearance of the left crown).*

Figure 4. *Implants /23 positioned too closely together, resulting in a lack of interdental papilla.*

Figure 5. *Compromised aesthetics due to superficially placed implant /1.*

crowns end up being spade shaped and short (Figure 5). Owing to their shape, such crowns are difficult for the patient to maintain, and if there is any gingival recession a shadow can be seen at the cervical margin—resulting in poor aesthetics. Superficially placed implants may cause a lack of interocclusal space, which could result in excessive reduction of the abutment, leading to weakness and poor retention.

Angulation of the Implant

In our experience, mild angulation of the implant does not result in significant restorative problems, as the use of pre-angled or customized abutments can correct any difficulties. Having the retaining screw emerge from the palatal cingulum facilitates abutment and crown removal. Significant angulation of the abutment or implant will result in non-axial loading from the occlusion and may enhance alveolar bone resorption and subsequent implant failure.[14]

Figure 6. *Loss of hard and soft tissue following extraction of right canine.*

RESTORATIVE PROBLEMS

Soft-tissue Morphology

The extraction of a tooth often results in the loss of attached gingival tissue, interdental papilla and labial bone (Figure 6). The placement of an implant will not necessarily restore these defects. The regeneration of the gingival cuff around the implant plays a major role in the appearance of the completed restoration; therefore the planning and creation of the emergence profile is critical, as is its maintenance, for a good long-term result.

McMillan *et al.*[15] found that, although problems with peri-implant soft tissues occur predominantly in patients with poor plaque control, the design of the restoration may be a contributing factor to plaque retention. Ridge-lapped crowns are more likely to retain plaque than a bullet-shaped profile.

The placement of the abutment shoulder below the gingival margin does not necessarily lead to soft tissue recession in the presence of good oral hygiene.[16] However, overcontouring of the crowns may be unavoidable in certain circumstances. The cross-sectional shape of the root face is ovoid and not symmetrical, and unfortunately many implants have a more rounded and smaller diameter cross-section than the tooth (Figure 7).

To obtain an acceptable emergence profile it is necessary either to undertake soft-tissue surgery or to fabricate temporary crowns, shaped in such a way as to recontour the gingival tissues (Figure 8). This may produce an artificially deep, poorly cleansable sulcus, which may lead to bone loss or the development of a long junctional epithelium (Figure 9).

Figure 7. *The diameters of the implant and adjacent tooth can differ widely, as shown by this 4-mm diameter cylindrical implant /1 and the adjacent tooth /1.*

Figure 8. *Gingival contour around implant /1 following the use of a laboratory-constructed temporary crown to improve the emergence profile.*

Gingival recession may be a long-term complication around implants, initially resulting in a long clinical crown and greying out at the gingival margin. As recession proceeds the metal transmucosal abutment will become exposed. This will necessitate either remaking the crown (Figure 10) with modification to the titanium abutment or exchanging it for a ceramic abutment.

Figure 9. *Bone loss adjacent to a Frialit-2 implant.*

Figure 10. *Bone and soft tissue recession adjacent to implants 2/2.*

Occlusal Problems

Abutment screw loosening is a recognized complication of single-implant restorations and usually presents as a loose crown. The incidence of this can be as high as 43%.[3,17] There are a number of ways of securing the restoration to the implant. Most manufacturers use either an internal (Astra, Calcitek, Frialit) or external (Brånemark) anti-rotational device. An exception is the Straumann implant, which relies on the frictional fit of their 'morse' tapered joint (Figure 11). The authors have found that if the antirotational device is too shallow it can create two problems:

- during seating of components it is difficult to locate and usually requires radiographic confirmation;
- the micro-movement of the crown during function can lead to a higher incidence of disengagement and subsequent loosening of the abutment (Figure 12).

Figure 11. *The antirotational devices of five implants:* ***(a)*** *Frialit;* ***(b)*** *Straumann;* ***(c)*** *Nobel Biocare;* ***(d)*** *Astra;* ***(e)*** *Calcitek.*

The means by which these antirotational devices fail have been described by Binon.[18] It would appear that occlusal forces transferred through the crown can result in vibration and micro-movement, which eventually causes the integrity of the screw joint to fail. This situation is compounded in patients with a heavy occlusion, such as bruxists or those with a deep overbite, where there may be an unfavourable incisal guidance.

Loading the floating screw while securing the abutment to the implant generates a torque force. The recommended torque force will depend on the antirotational design used and the material from which the screw is manufactured and will be unique to each system. Generally torque values range from 20 to 35 Ncm.[19] Titanium and gold screws have been the subject of investigations by Jorneus *et al.,*[20] who found that only the gold alloy screw maintained the stability of the abutment/implant interface.

The presence of a loose abutment may lead to the formation of a fistula or sinus (Figure 13) due to colonization of the implant abutment interface with micro-organisms.[13,17] Other causes of sinus formation around implants include abutments designed with overhangs, which lead to food stagnation areas, localized delamination of coatings and fracture of the implant.

Retrieving a mobile crown can prove difficult and time consuming. The crown is usually cemented to the abutment, which in turn is secured to the implant by means of a floating screw. The orientation of the implant will determine where the screw head emerges. If the screw head can be accessed through the area of the palatal cingulum, the crown may be perforated to allow retrievability. Production of this access hole is not possible if the screw head emerges buccally. To gain access to a loose abutment screw in this situation involves sectioning of the crown (Figure 14), which makes this an expensive complication.

Figure 12. *Inaccurate seating of the transmucosal abutment on a Calcitek implant.*

The connection between implant and bone in no way replicates the periodontal membrane: the latter allows movement of the tooth under occlusal load whereas the implant is rigidly retained. Although initially the implant-retained crown can be designed to avoid occlusal contact, the occlusion can change over time due to over-eruption of the opposing dentition or natural tooth wear. This can result in higher occlusal loads being applied to the crown, particularly in lateral mandibular excursions. Long-term consequences of this are loss of integration or fracture of the abutment or porcelain facings.

Cementation Problems

The precise fit between the machined components of the implant system can lead to problems when cementing crowns.[16] As there is limited relief

Figure 13. *A sinus is associated with the implant-retained crown 11 shown here. This was due to a loose abutment.*

Figure 14. *An access hole will enable retrieval of a cement-retained crown [11].*

Figure 15. *Excess cement accumulating at the implant/crown junction when cemented on a model. This must be removed before securing the crown in the mouth.*

between these components, hydrostatic forces develop when seating the crown, causing excess cement to extrude into the gingival crevice. The extent of the problem can be seen in Figure 15, where a crown has been cemented onto an implant abutment. Clinically, the presence of cement may be difficult to diagnose and its removal may prove traumatic and difficult, particularly where there is limited space between the mucosal cuff and the new crown (perhaps caused by a poor abutment design). Figure 16 shows excess cement visible following recession of the gingiva.

SUMMARY

This paper has described a number of common complications of single-tooth implant-retained restorations. The success of such restorations depends on careful treatment planning and case selection. Accurate placement of the implant, careful management of the soft tissue at exposure and control of the emergence profile are vital.

The end result will depend on the experience and skill of the operator, and this can be developed only with a relatively high exposure to this type of work. Comprehensive training is an absolute prerequisite before embarking on implant treatment.

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Figure 16. *Excess cement found at the cervical margin after cementing an implant-retained crown [11].*

Self-Assessment Answers

1. A, C, D	6. A, B, D
2. A, B, D	7. A, C
3. A, B, C, D	8. A, B, D
4. A, B, C	9. A, B, D
5. B, D	10. A, D