

IN BRIEF

- Different areas of failure are discussed.
- Operator factors, patient factors and anatomic factors pre-disposing to failure are presented.
- Most failures can be prevented with proper treatment planning.

Failures in implant dentistry

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This article describes the many failures and complications that can occur when using implants to support restorations. Most of these failures can be prevented with proper patient selection and treatment planning. Implant failures can be largely classified into four main categories: 1) loss of integration, 2) positional failures 3) soft tissue defects, and 4) biomechanical failures. Each of these will be discussed with examples to illustrate the problem.

IMPLANTS

1. Rationale for dental implants
2. Treatment planning of implants in posterior quadrants
3. Treatment planning of implants in the aesthetic zone
4. Surgical guidelines for dental implant placement
5. Immediate implant placement: treatment planning and surgical steps for successful outcomes
6. Treatment planning of the edentulous maxilla
7. Treatment planning of the edentulous mandible
8. Impressions techniques for implant dentistry
9. Screw versus cemented implant supported restorations
10. Designing abutments for cement retained implant supported restorations
11. Connecting implants to teeth
12. Transitioning a patient from teeth to implants
13. The role of orthodontics in implant dentistry
14. Interdisciplinary approach to implant dentistry
15. Factors that affect individual tooth prognosis and choices in contemporary treatment planning
16. Maintenance and failures

LOSS OF INTEGRATION

This is an infrequent occurrence with multi centre studies and several meta-analyses indicating 93% survival rates of dental implants.^{1,2} There are indications that implants are more successful in the mandible than the maxilla.² In addition, it has also been shown that implants are more successful in host bone than grafted bone.³ Though it is disappointing for the patient and the clinician to have an implant fail to integrate, the morbidity on failure is low when cylindrical implants are employed. Often a re-attempt at implant placement with a larger diameter implant or a bone graft followed by an implant will allow successful osseointegration (Figs 1-4). This type of failure occurs mostly before loading the implant with the definitive restoration

and minimal resources have been spent on the prostheses. The major clinical problem in these situations is delay of completion of treatment and patient management. When non cylindrical implants are used, more trauma is caused on removal; this can lead to severe hard and soft tissue loss. Reconstruction of these defects may require multiple surgeries (Figs 5-8). Placement of non cylindrical implants should be avoided for this reason.

A more difficult problem to manage is when there is bone loss that occurs on an integrated implant often referred to as peri-implantitis; this often manifests after the definitive restorations have been placed. This type of bone loss is usually progressive in nature (Fig. 9). In these situations a decision has to be made as to management. Several choices are available:⁴⁻⁷ 1) culture and antibiotic therapy, 2) resective treatment and 3) removal of the implants. There is no clear evidence that any of the non surgical therapies are successful in arresting the progress of peri-implant bone loss. Removal of the implants or resection of tissue to remove pocket depth seems to be the only predictable method of managing this situation. This can lead to severe disfigurement and poor aesthetics – in aesthetic areas this type of failure is most difficult to manage.

POSITIONAL FAILURE

The most common type of failure is caused by poor treatment planning and/or poor surgical

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Fig. 1 Implant provisional in place.



Fig. 2 Occlusal view of implant with provisional restoration removed – note health of soft tissue.



Fig. 3 Impression coping attached and failing implant being removed.



Fig. 4 Implant removed and remaining wound which usually heals without incident.



Fig. 5 Failing non-cylindrical implant removed.



execution. Implant placement must be controlled and precise in order to support tooth like restorations, the restoration should guide implant placement and planning for implant placement must take into account the form and position of the restoration.⁸⁻¹⁰ The incidence of this type of failure has been estimated at 10%,¹ however, if more stringent criteria are applied it is likely to be higher. This type of failure can easily be avoided with proper treatment planning, proper site development, use of surgical guides and a good understanding of the restorative aspects of implant dentistry by the surgeon.

Malposition of the implant can lead to biomechanical problems to the screw joint or in severe situations to the implant itself due to overload (Figs 10-11).

Ideally two-stage implants should be placed with the platform of the implant 3-5 mm apical to the gingival margins of the like tooth, ie if a lateral incisor is to be replaced the contra-lateral tooth should be used to determine the depth of the implant. The implant should be placed with at least 1 mm of bone circumferentially; this will allow for the crestal bone loss which can occur around the implant (Figs 12-15). Figures 16 and 17 illustrate how a well placed implant can allow adequate aesthetics to be developed with a sufficient volume of soft tissue present around the implant. When implants are not placed in relation to teeth in aesthetic areas, poor aesthetics will ensue. Figure 18 illustrates an implant that has been placed to exit the soft tissue too apically and labially; the resulting restoration will appear much too long and out of proportion with the other dentition (Fig. 19).

The difficulty of obtaining aesthetic results increases when multiple teeth are to be replaced with implants. Positional errors occur more frequently for several reasons: 1) there is more freedom for surgeons to place implants; 2) the requirements for each implant site are as stringent for single teeth and the likelihood of multiple ideal implant recipient sites is reduced. The most common errors seen in these types of cases are implants placed in the interproximal areas and differing depth of implant placement. When implants are placed in the interproximal areas it is impossible to obtain an aesthetic result. Figures 20 and 21 illustrate how implants placed poorly in the aesthetic zone impact restorations. It will be impossible to fabricate any aesthetic restoration for implants in this position – they are placed so closely that it is impossible to develop any cervical form that will be tooth like. Skillful technicians and use of pink porcelain can help to mitigate some situations; however, it is always a compromise (Figs 22-23). Differing depths of implant placement will result in uneven exit of the implant restorations from the soft tissue, again yielding less than ideal results. In these multiple implant situations the most apically placed implant should dictate the positions of the other implants placed. If the most apically planned implant causes the other implants to be too apical, the area should

be grafted prior to implant placement of the implant site not used. Poor aesthetics as illustrated in Figure 24 are the result of the implant in the maxillary left lateral area emerging too apically, resulting in a non-symmetrical display of incisors. A silicone mask was delivered to the patient to mitigate the poor aesthetics developed (Fig. 25).

Soft tissue

The soft tissue frames the restoration – careful management of soft tissue must be considered from the time extractions take place if the tooth to be replaced is still present. Even a well placed implant will not allow good aesthetics if the soft tissue is not present or not managed well with the use of provisional restorations.^{11–15} Many authors have written about methods of increasing the volume of soft tissue.^{16–19} However, most of the articles are case reports and without sufficient follow-up. It is important to manage soft tissue from the earliest stages of implant treatment, ideally the importance of soft tissue should be considered prior to extraction of the tooth to be replaced. Figures 26 to 28 depict a patient presentation where minimal hard and soft tissue loss is seen on presentation. In Figure 26 a removable partial denture is replacing the maxillary left central incisor, minimal soft tissue loss is evidenced by the partial denture having no flange and presence of the inter-dental papilla adjacent to the missing tooth. Figure 27 illustrates a breakdown of the surgical wound and exposure of a membrane. Figure 28 shows a severe soft tissue volume loss and subsequent poor aesthetics.

Biomechanical failures

These types of failures range from loosening of screws to breakage of implant components and implants. These types of failures can be avoided with proper treatment planning, a good understanding of screw joint mechanics and knowledge of the implant system used.

Screw loosening was an often reported problem with implant supported restorations, especially with single tooth restorations.^{20,21} This was largely due to clinicians not having a good understanding of the mechanics of a screw joint and the implant manufacturers not providing components and instrumentation that would allow clinicians to maximise the retentive properties of the screw.²² In implant-restoration connections the screw acts much like a spring, the torque applied to the screw causes the threads to engage and continued torque after the components are seated causes the screw to elongate. The rebound of the stretched screw clamps the implant components together; this is known as the preload. It has also been shown that this preload is reduced after cyclic loading; therefore it is imperative that proper torque is applied to gain the maximum preload possible.²³

Today there are components that allow us to reach high preloads and devices that allow us to control torquing forces.^{24,25} Implant

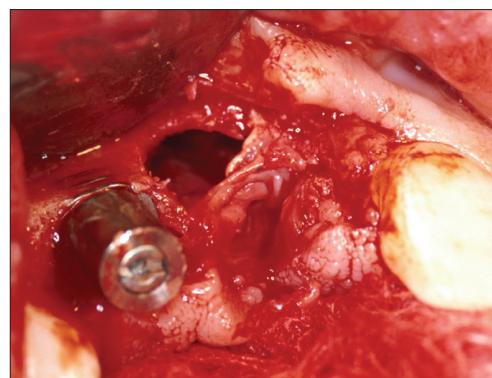


Fig. 6 Surgical wound from removal of non-cylindrical implant.



Fig. 7 Implants in Figure 5 in place.



Fig. 8 Ridge contour following hard and soft tissue loss after removal of failed non-cylindrical implants.



Fig. 9 Intra-oral view of implants with progressive bone loss.



Fig. 10 Malpositioned implants with implant axis tilted severely lingually.

Fig. 11 Occlusal view of implants in Figure 10.



Fig. 12 Frontal view of two stage implant analogue in ideal position with provisional restoration allowing proper mesial-distal transition to proper contours.



Fig. 13 Lateral view of implant analogue and provisional restoration in Figure 12 showing transition to proper labial contours.

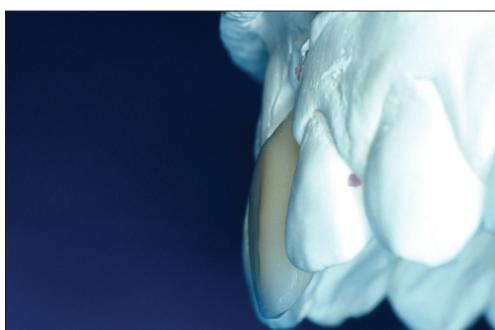


Fig. 14 Occlusal view of implant analogue and abutment in Figure 12 with soft tissue cast in place showing sub-mucosal contours developed with provisional restoration.

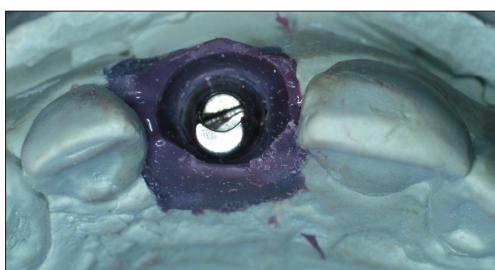
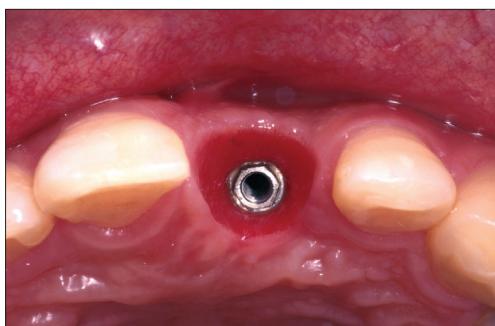


Fig. 15 Clinical view of implant and abutment in Figure 12 from occlusal perspective showing soft tissue contours identical to soft tissue contour developed on cast.



Fig. 16 Occlusal view of an implant placed in the ideal restorative position.



manufacturers have also designed different connections between implant components and implants, for example early implants were designed with external hexagons and components were made to connect to this feature. Today there are implants made with an internal connection which are much more resistant to screw loosening.²⁶

Other types of biomechanical failure involve fracture and breakage of prostheses. Many of the materials used to restore implants are derived from conventional restorative dentistry, for example denture base resins. Complete denture wearers develop relatively little bite force compared to force generated with implant supported restorations. Breakage is a common failure of overdenture restorations (Figs 29-30).

Metal fatigue of restorative materials can also lead to breakage – the rigid connection of implants to the bone demands that attention is paid to the size of connectors (Fig. 31).

Breakage of implants and implant components can also occur;²⁷ often this is due to poor treatment planning and exposing implants to excessive forces. The implants in Figures 10 and 11 were eventually restored and after about four years and repeated episodes of screw loosening, the restoration and implants failed (Figs 32-33). Similarly the implant in Figures 34 and 35 was treatment planned as a single implant in an incomplete dentition and a terminal tooth. The implant was connected to the tooth causing decay on the tooth, and eventually the implant to fracture under the load.

Iatrogenic failures also occur. Care must be taken when threading screws into implants; when screws are cross threaded, damage to the implant can occur and when too much force is applied, breakage of the screw can occur. When screws are cross threaded and broken they are difficult to remove and can render the implant unusable (Fig. 36).

CONCLUSION

With proper patient selection and treatment planning, using dental implants to support restorations replacing missing teeth can provide long lasting functional and aesthetic restorations. However, when poorly executed, many problems can arise. It is often said in jest 'An implant in the wrong position will always integrate'. Unfortunately there is much truth to this statement. Failure to integrate is usually not as difficult to manage as an improperly positioned implant. This article could also be titled 'treatment planning for dental implants'; most of the failures described, except for the first section describing loss of integration, can be prevented by proper treatment planning and a sound understanding of restorative aspects of dental implants, screw joint mechanics and forces placed on implant restorations and components. The key to preventing these types of failures is proper treatment planning.



Fig. 17 (left) Restoration on implant in Figure 16. Good aesthetics are possible when the implant is placed in good restorative position.



Fig. 19 (left) Good aesthetics are not possible with poor implant position.



Fig. 21 (left) Anterior view of provisional restoration placed on implants in Figure 20. Due to the poor mesio-distal position of the implants, good aesthetics in the cervical area of the restorations is impossible to achieve.



Fig. 23 (left) Implant restoration of implants in Figure 22 with pink porcelain to mask poor implant position.



Fig. 24 (right) Anterior view of implant restoration with uneven gingival contours. Implant in the position of the right lateral incisor is exiting too far apically resulting in a long clinical crown for the restoration.



Fig. 25 (left) Anterior view of implant restoration in Figure 24 with silicone mask in place.

Fig. 26 (right) Pre-operative view of patient who is having implant placed to restore maxillary left central incisor. Note minimal hard and soft tissue loss, provisional removable partial denture has no flange.

Fig. 27 (left) Intra-oral view of patient in Figure 26 showing wound breakdown post-implant placement surgery.

Fig. 28 (right) Restoration of implant in Figure 27, note the severe loss of soft tissue and use of pink porcelain on the restoration resulting in an aesthetic failure.

Fig. 29 (left) Teeth broken off an overdenture prosthesis. Forces generated on implant prostheses are greater than conventional removable partial dentures, however many of the same materials are used.



Fig. 30 (right) Fractured overdentures are a common failure due to increased forces and thinning of acrylic bases to accommodate implant components and tissue bars.



Fig. 31 (left) Intra-oral view of fractured implant tissue bar. The cantilevered attachment has fractured.



Fig. 32 (right) Occlusal view of implants in Figure 11. Note the buccal and mesial cantilever of the restoration.



Fig. 33 (left) The restoration eventually fails together with the implants due to high biomechanical stress.



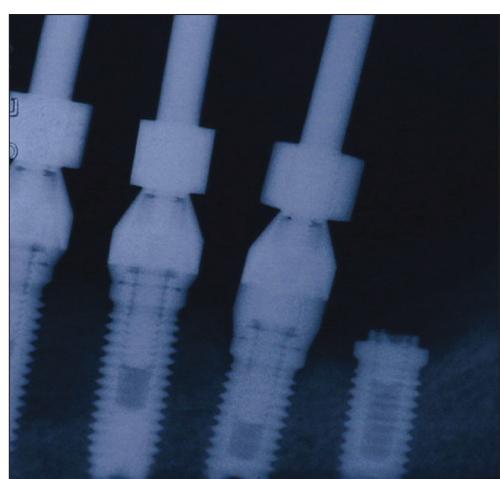
Fig. 34 (right) Implant restoration together with fractured implant component.



Fig. 35 (left) Radiograph of implant supporting restoration in Figure 34. Note that the implant has broken and the rest seat on the restoration has caused decay on the adjacent tooth.



Fig. 36 (right) Radiograph of abutment screw that was cross threaded and broken off, it could not be removed from the implant.



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