Treatment planning for the heavily compromised tooth

Stephen Franks discusses the factors that need to be considered when assessing the current restorability and prognosis of a tooth

Aims and objectives
To examine the factors to be considered when assessing the current restorability and prognosis of a tooth. Factors include assessing the periodontal staus, defining adequate periodontal support, assessing the endodontic status and assessing the structural status.

Before the era of dental implants, the only alternatives to restoring a heavily compromised natural tooth were either dentures or a bridge. Neither of these are without their drawbacks; dentures at best are not terribly pleasant, and bridges are destructive to neighbouring teeth. Understandably, this has driven the dental profession to provide increasingly complex and, sometimes, heroic treatments in order to save teeth almost at any cost.

I would suggest that this reluctance to extract even heavily compromised teeth needs to be revised and revisited. With the advent of predictable dental implants, the ground rules need to change (Christenson, 2006). The alternatives to restoring teeth are no longer limited to removable denture or tooth-retained bridges and so the imperative for keeping heavily compromised teeth has all but disappeared. Despite this, there is still a lot of restorative dentistry being provided for no other reason than that it is possible.

As a profession we need to develop a collective shift in mindset. Rather than asking 'can this tooth be saved?', a more pertinent question would be 'can this tooth be saved predictably?' and consequently, 'should this tooth be saved?' This is a complex problem and to answer it properly we need to consider four key issues:

1. What is the likely restorability and prognosis of the tooth?
2. What alternatives exist to keeping the tooth?
3. What is the relative predictability of each option?
4. How does this tooth fit in with the overall treatment strategy for the patient?

In this article I would like to tackle the first of these issues – what factors need to be considered when assessing the current restorability and prognosis of a tooth?

Assessing the periodontal status

For there to be a predictable restorative outcome the tooth under consideration needs to fulfil the following periodontal criteria:

1. There must be adequate and stable periodontal support
2. Any proposed restoration must respect the biologic width
3. The gingival health needs to be conducive towards providing and maintaining good quality restorative dentistry.

Defining 'adequate' periodontal support

In the past, attempts have been made to give hard and fast rules to indicate the amount of loading a tooth can cope with, such as Ante's Law.

While this is a useful starting point, it can be overly simplistic. We now have a better understanding of the masticatory system's own biofeedback mechanism and of the neuromuscular adaptation to reduced periodontal support. The long-term stability of the shortened dental arch is well established and even now there is no conclusive consensus regarding the relationship between occlusal trauma and periodontal disease.

It would seem that, within reasonable limits, the central issue is lack of periodontal inflammation rather than overloading per se. In the absence of inflammation, loading can be well tolerated (Lulic et al, 2007). However in the event that the tooth has reduced periodontal attachment then axial loading is certainly preferred.

The stability of the periodontal attachment in the long-term will also be affected by the patient's level of oral hygiene and overall susceptibility towards periodontal breakdown. The latter is dependant upon a multitude of factors. These may change over time with changes in health, oral hygiene habits or smoking. With an ageing population and a widespread increase in the number of teeth retained to later life we are seeing more and more elderly patients with

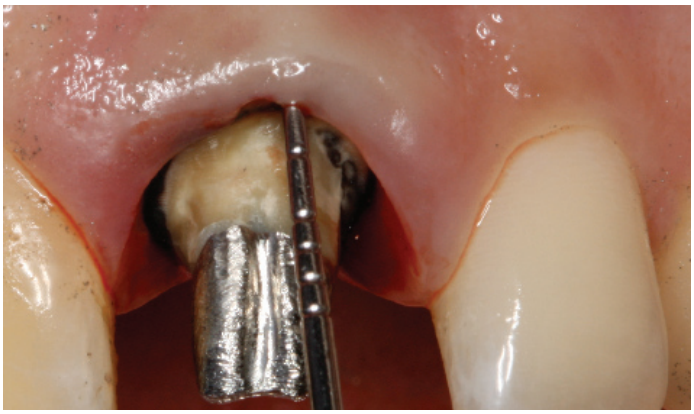


Figure 1: Assessing availability of biologic width by probing down to crestal bone under local anaesthesia

Figure 2: This subgingival palatal margin is difficult to visualise, reproduce on an impression and to isolate for bonding

Figure 3: This lone standing premolar is going to be under considerable occlusal loading, compromising the prognosis of any proposed restoration

Figure 4: Multiple pulp deaths have occurred following crown and bridge work

Figure 5: Failure to respect the integrity of the biologic width has resulted in chromic suppuration of the sulcus

Figure 6: Excellent gingival health greatly enhances the ease with which restorative procedures can be executed

Figure 7: This incisor tooth has insufficient root length to both retain a post and provide an adequate apical seal

Figure 8: A well-condensed root filling and just as importantly, adequate coronal tissue, allowing a predictable coronal seal

Figure 9: A poorly-maintained dentition is not a good foundation for restorative dentistry

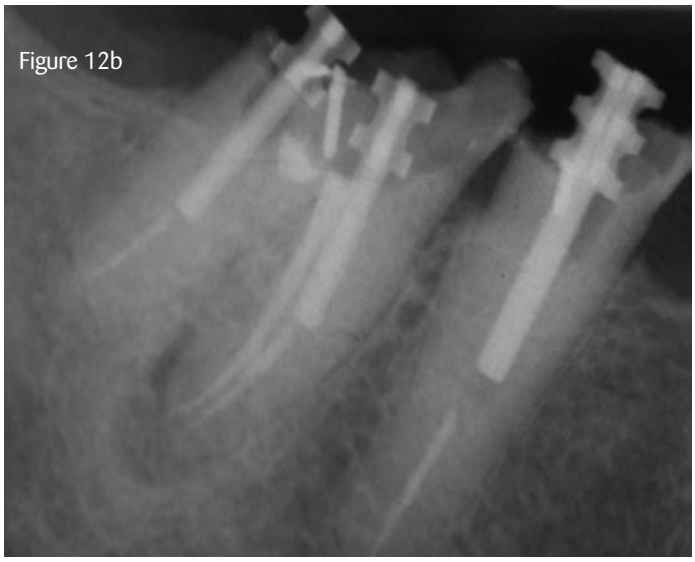
Figures 10a and 10b: The appearance of these cores (Figure 10a) can be misleading. They are retained by thin cusps (Figure 10b), and once the tooth is prepared these will be thinner and weaker still

Figure 11: Tooth surface loss has resulted in a loss of normal protective cuspal guidance, and any restoration of the lower premolar will be under considerable lateral forces

complex dentistry in their mouths, which they are finding harder to maintain as their manual dexterity deteriorates.

Biologic width is an often-overlooked factor. It is well understood that at least 3mm of space is needed above the crestal bone to provide adequate space for a normal attachment complex (including junctional epithelium, Sharpey fibres, gingival sulcus etc). If this space is not respected then inflammation and localised periodontal breakdown are a frequent result. Our analysis of each tooth must therefore include an assessment of the proposed position of our restoration margins and their relation to the crestal bone. If this is inadequate then surgical crown lengthening is indicated.

One would then need to consider the anticipated level of periodontal support in light of any resultant osteoplasty. There is no point having surgery to provide biologic width if



Figures 12a and 12b: With insufficient coronal dentine, it is down to the posts to retain the crown/core complex – with all the stress on the root that this entails

Figure 13: An adequate amount of dentine at the margin provides for a far more predictable outcome

the tooth is set for failure because of a resultant lack of alveolar bone or iatrogenic furcal involvement.

The placement of most modern dental materials is adversely affected by the presence of blood and inflammatory exudates. It is also very difficult to provide adequate visualisation with inflamed or sub gingival margins. With the advent of both in-surgery and lab-based CAD/CAM technology, the importance of readable margins on impressions is even more pertinent than ever. Every dentist will appreciate the struggle of trying to take a decent impression in the presence of inflamed gingivae.

Electro-surgery, retraction cords and, more recently, soft tissue lasers are excellent aids to impression taking but can give an unpredictable final gingival position in the presence of gingival inflammation. This can result in possible aesthetic failure, as the gingival margin moves over time exposing previously hidden margins, or in chronic inflammation, if the gingival soft tissue is resected without proper consideration of the underlying crestal bone position.

Assessing the endodontic status

From an endodontic perspective, a predictable outcome requires either the presence of a healthy pulp or an acceptably cleaned and obturated root canal space. In recent years we also have begun to appreciate that the endodontic status of the root filled tooth is also intimately related to the quality of the restoration of the tooth, and in particular the quality of the coronal seal (Begotka et al, 1996).

A healthy pulp needs a healthy blood supply. This is impossible to directly measure in any practical way so instead the clinician must make an assessment based upon the history, clinical signs and radiographic appearance of the tooth. Pulpal insult, be it mechanical, chemical or thermal, has a cumulative effect over the lifetime of the tooth and one needs to consider the history of any pulpal insult from previous caries, fillings or crowns when making a clinical judgement. Irreversible pulpal inflammation and eventual necrosis is a well-recognised complication of repeated trauma from dental treatment. It always needs to be borne in mind that the proposed treatment may be one procedure too many for the pulp, and it is often quoted that anything from one in 20 to one in 10 pulps die as a result of crown preparation. Although it is impossible to predict the teeth that will not recover with total accuracy, we still need to make a reasonable assessment to minimise the risk to the patient of unexpected endodontic problems.

If a de-novo root treatment is deemed necessary – either because of irreversible pulpal inflammation, carious exposure or necrosis, or for elective reasons – then the dentist needs to assess the likelihood of this being provided to an adequate standard. One must also consider the likelihood of restoring

Figure 14: These short clinical crowns would result in poor retention should the teeth $\overline{65}$ be prepared for full coverage without crown lengthening or increasing the OVD first

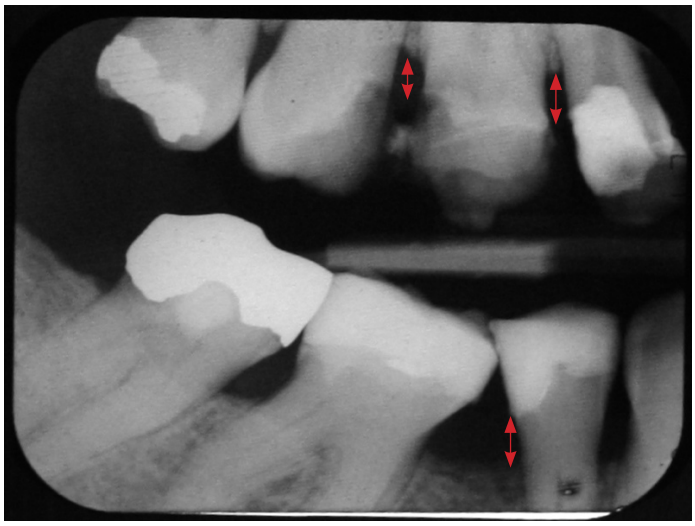


Figure 15: Bitewing radiographs are ideal for assessing biologic width. Ideally there needs to be 3-4mm of space between then crestal bone and the proposed restoration

the tooth adequately afterwards, both to provide a coronal seal and from the perspective of the tooth's structural integrity once it has been further weakened by the access cavity. The American Endodontic Association (www.aae.org) has published guidance as to the anticipated difficulty of endodontic treatment, including factors such as access, root curvature, complexity of the anatomy and canal patency. Given that root canal treatment is commonly provided to a poor standard, the practitioner would be wise to only provide such treatment within his or her ability.

If the tooth is already root-treated then it is important to assess the quality of the existing root filling and its current restoration. If this is not acceptable then one must consider the chances of success second time around. Have the canals become ledged or blocked? Does a bulky post need to be removed, risking root fracture? Is re-root treating the tooth possible but not worth the damage that will need to be done to the tooth to achieve an acceptable result?

We have all seen X-rays of very poor root fillings that have been stable for years, and the temptation is often to leave these be when replacing old crowns. However, this stability can easily be disturbed by removing the existing restoration. Oxygen and nutrients gain access to previously dormant bacteria in the poorly cleaned root canal system and the tooth flares up; the current dentist receives the blame for the patient's distress, when in reality the seeds of failure were sown many years ago by the dentist who provided the existing poor root filling.

We have also seen radiographs of seemingly excellent root fillings that have failed. The radiograph only shows part of the story, and it doesn't tell us if there was adequate isolation or irrigation at the time of the procedure.

Lastly, the presence of radiolucency does not necessarily indicate active disease. It needs to be compared to older radiographs and could well be a healing lesion.

Assessing the structural status

To provide a predictable result a tooth needs to have sufficient structural integrity, firstly to retain the proposed restoration, and secondly to withstand any mechanical stresses.

Structural integrity also impacts on other disciplines, such as the quality of coronal seal when providing root canal therapy, and the issue of biologic width in regards to periodontal health.

When considering a heavily restored tooth it is useful to remember that it may well end up with a series of components. This may include a root filling, some form of retentive aid (be it a post or similar), a core and, lastly, a crown. Rather than just assessing the tooth, we also need to consider the entire restorative complex. Each of these components only contributes one link in the chain and each must be able to do its part. For example, a retentive preparation and a well-cemented crown are not going to be of any use if they are let down by a poorly-retained core. The weakest link in the chain needs to be identified and assessed.

Retention and fracture resistance can be greatly enhanced by the ferrule effect (Stankiewicz et al, 2007). The greatest focus of stress commonly occurs at the cervical margin, so the greater the bulk of tooth at this level the better. If there is insufficient tooth structure at the critical cervical region then we are relying on the core to resist any loading, which will in turn stress the core-tooth interface. Having a good bulk of supragingival tooth structure also enhances accessibility for margin preparation and impression taking, the ability to provide isolation when bonding, and the quality of the coronal seal.

The level of loading that a tooth experiences can vary widely, and will be affected by a multitude of factors. These include the number of other teeth in function to share the occlusal load, the presence or absence of posterior support

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and anterior guidance, and the position of the tooth in the arch (with biting forces increasing as we approach the TMJ). The nature of the opposing dentition (natural, denture, or implant) is also important, as is the presence of any parafunction habits.

As well as having different levels of loading, restorations in different parts of the mouth will also be subjected to different directions of loading. Restorations of posterior teeth are subject mainly to compressive loading, while those of anterior teeth are mainly subject to tensile loading. This tensile loading of anterior teeth will act in a labial direction and may dislodge any restoration present. The critical area in resisting this dislodging force is the palatal surface of upper incisors. Without sound dentine at this palatogingival margin, resistance to tensile forces will be poor and lost restorations and failed cores will be a common outcome.

Posts are a frequent aid to retention but are also a common origin of failure. Teeth with posts often fail because of de-bonding of the post or root fracture.

Unfortunately, the factors that improve post retention can cause decreased fracture resistance and vice versa. Posts are best retained when they are long, parallel sided and large enough to provide a good surface area, whereas roots are least likely to fracture when the post tapers to match the shape of the root, is narrow enough to leave a good bulk of dentine, and short enough so that it is away from the delicate apical region. A good bulk of coronal tissue acts to considerably enhance the retention of posts, focusing stress on sound and bulky cervical dentine instead of at the post/root interface.

Before the advent of adhesive dentistry the retention of restorations was entirely mechanical. Cements retain restorations by virtue of the ability of the hard cement lute to stop two closely-fitting surfaces from sliding past one another. Adhesives differ from cements in that they provide a bond between the tooth and restoration, which can often compensate for a lack of retentive features of the preparation. In theory, this allows us to be much more conservative, having no need to remove tissue to provide parallel surfaces and other retentive features, and being able to retain poorly supported tissue knowing that there will be reinforcement from bonding. On the flip side however, adhesives differ greatly from traditional mechanical retention in respect of their reliance on excellent moisture control and technique.

Whereas in the past gingival health and margin position were only important in respect to the ability to visualise, prepare and record the margin on an impression, nowadays we also need to assess the margin from the perspective of our ability to isolate from moisture at the time of fitting, and to provide an adequate surface area of sound tooth tissue to bond to.

PESH and SHEEP scoring

A useful aide memoire to guiding an analysis is the PESH or SHEEP score. This gives the dentist a useful way of quickly going through all of the key issues in his or her mind and also of presenting these to the patient.

PESH stands for 'perio, endo, structure and history'. SHEEP has an added 'E' for experience – namely, the experience of the practitioner with this type of treatment, patient or scenario.

History would include such factors as the medical and social history of the patient, as well as an assessment of his/her attitudes and level of motivation. It may also include a consideration of the symptoms and treatment history of the tooth in question, and the success (or otherwise) of similar treatments on the patient's other teeth.

Conclusion

I have provided a brief overview of all those factors that contribute towards and detract from the successful restoration of a single tooth.

This article started with a suggestion that perhaps the era of complex and often unpredictable restorative dentistry is nearing an end with the advent of predictable dental implants. With such an excellent alternative becoming more readily available, the restorative dentist needs to be far more discerning in his or her decision to restore a heavily compromised tooth. Approaching this difficult decision with a systematic approach can help simplify a sometimes complex issue.

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