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Advanced restorative techniques

Leslie Howe,¹ Paul Palmer,² and Vincent Barrett,³

Great importance has already been placed on the need for very careful planning prior to embarking on implant treatment in order to try and obtain the best possible outcome. Unfortunately there are situations where a less than ideal implant position has been achieved either by design, perhaps to overcome an anatomic problem, or because of an error at the surgical stage. It is easy to blame the surgical stage for later prosthodontic problems but in the real world, even with surgeons who have a lot of experience, there are many factors which can effect the final position of the implant which cannot be identified until the time of operation. If surgeon and prosthodontist are working as a team it is essential that the surgeon has been provided with as much information as possible, such as stents, and is aware of 'second choice' implant sites if the prime site proves to be unusable. The worst possible scenario is for

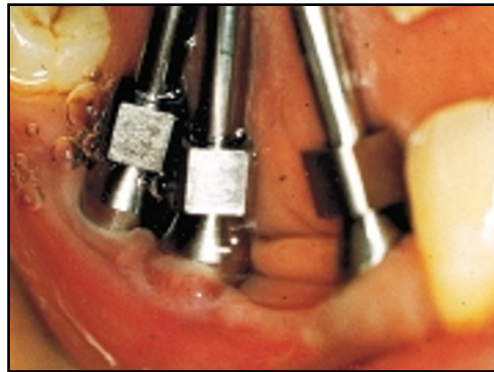


Fig. 2 Impression copings magnify any convergence of implants. Care must be taken to alter copings so that they do not touch

Many alternative techniques are available to ensure the best possible outcome for an implant restoration.



Fig. 1a Implants placed in the upper right incisor sites with healing abutments visible. Because of a large incisive canal the central incisor implant is placed too distally



Fig. 1b Crowns in place revealing an irregular gingival margin to the central incisor. The resulting interdental space will be difficult to clean

the implant to be placed in the easiest bony site without regard to the final restoration. Even movement of the implant by 1–2 mm can have a dramatic effect on outcome with restorations at the front of the mouth (fig. 1).

Patients may feel that an implant will restore them to their original appearance. They must therefore be informed that because of soft and hard tissue loss there may be an element of compromise involved.

If implants are placed in a difficult position to restore there are a multitude of alternative prosthodontic solutions available.

What are the potential problems?

Most problems can be overcome with strict attention to the guidelines given in Parts 3 and 4, such as the use of diagnostic dentures and wax-ups followed by surgical stents. Most importantly, patient expectations should be realistic with an accurate representation of them prior to treatment of what can be achieved and what the end result is likely to be.

Implant positioning

Errors in mesio-distal spacing may result in implants which are too close or distant to adjacent teeth or implants. If implants are too close it may be difficult to contour the restoration to allow for adequate oral hygiene or produce an aesthetic tooth shape. It can also be difficult to fit abutment components and take impressions as there are minimum dimensions for components (fig. 2).

Alternatively, widely spaced implants may require oversized crowns or placing narrow

In this part, we will discuss:

- What are the potential problems?
- Special techniques
- Particular problem areas

¹Consultant in Restorative Dentistry, Guy's and St Thomas' Hospitals Trust, London SE1 9RT and Specialist in Restorative Dentistry and Prosthodontics, 21 Wimpole Street, London W1M 7AD; ²Part-time Demonstrator, Guy's, Kings and St Thomas' Medical and Dental School, London SE1 9RT and Specialist in Periodontics, 21 Wimpole Street, London W1M 7AD; ³Private Practitioner, 38 Devonshire Street, London W1

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Fig. 3 Implant supported crowns have to mimic the natural curvature of the adjacent natural teeth. In this case the gingival margin of the implant crowns is high because of alveolar resorption



Fig. 4 Resorption of the upper ridge will make it difficult for a fixed implant supported bridge to have an anterior Class 1 incisor relationship. A removable implant supported overdenture should be considered



Fig. 5 Angled abutments have produced a bulky palatal contour



double pontics which may look unaesthetic. It should be remembered that different implant and abutment diameters can be selected and the particular width of the tooth to be replaced should be compatible.

Problems may result from the angulation of the implant, either in relation to other implants or to the desired position of the final restoration. This may occur because the shape of the remaining alveolar ridge has dictated the implant angulation or perhaps the patients' natural teeth have a curved contour, in particular a marked angle between crown and root (fig. 3).

The vertical space between the implant head and the opposing dentition may be limited and

conventional components may not fit. In addition the interalveolar relationships may create a discrepancy between implant position and desired tooth placement. For example, the Class 2 div 2 incisor relationship may call for the use of angled components or where significant alveolar resorption has occurred on one arch but natural teeth remain in the opposing jaw (fig. 4).

Patient expectations and appearance

Patients who have worn dentures with a labial flange are used to the appearance of a restored gingival and alveolar contour, and may be disappointed if this does not exist in their new restoration.

Implant treatment is complex, lengthy and expensive, and patients often become more demanding with time during their treatment and significantly more critical than they would have been with a simpler restoration provided in less time. Beware the patient who says at the start that the appearance is not important. When restoring a tooth in the upper anterior region many patients will demand a good result, not just of the tooth shade but also of the whole tooth/gingival complex, such as the gingival margin and the interdental papilla.

Function and speech

It is rare for implant supported restorations not to provide for good function even in a difficult restorative situation, however sometimes the treatment will focus problems onto existing teeth or previous restorations which may have been satisfactory before. In contrast speech can often be affected with upper anterior restorations. This is normally transitory but may be persistent if bulky components are used which overcontour the palatal surface (fig. 5).

Excessively large embrasure spaces combined with a loss of interdental papillae may result in air and saliva being expressed which upsets some patients. This may be rectified by using spoilers or removable acrylic veneers.

Presence of existing teeth

In general, it is recommended that implants should not be joined to natural teeth with a fixed restoration. However, it may be necessary or desirable to include natural teeth into an implant reconstruction, perhaps because insufficient implants could be placed and the extra support of a sound tooth could help (fig. 6). In some cases a sound tooth occupies space between edentulous areas and can be incorporated into the new restoration, although some clinicians would prefer to extract the tooth.

Retaining teeth can help aesthetics by preserving alveolar form. Teeth can be incorporated into a restoration using gold copings or precision attachments, however the degree of

What are the potential problems?

- Implant positioning
- Patient expectations and appearance
- Function and speech
- Presence of existing teeth

support provided by teeth in such a restoration is debatable. As the implants are essentially ankylosed it is likely that the teeth contribute little support which sometimes shows as infra-eruption.

Special techniques

Traditional restorative techniques for implant restorations involve choosing the abutment, placing it and then taking an impression. A gold framework can then be manufactured and the final aesthetic surface applied. This approach is fine if the case is straightforward and the implants are in the ideal place. If however there is a problem, identifying this too late can result in having to change abutments or repeating laboratory work which can be expensive and time consuming. Special techniques are therefore available to overcome this.

Implant position impressions (head of fixture impressions)

Rather than take impressions at the abutment level, most manufacturers produce impression copings that record the exact position of the implant in relation to adjacent teeth and soft tissues. Impression copings are attached to the implant using guide pins and a 'pick up' technique is employed (fig. 7).

Following attachment of an implant analogue, a model can be produced which, with a soft tissue mask, will allow the operator and technician to choose the ideal abutment and technique for the case (fig. 8).

For single teeth and short span bridges this working cast is considered accurate enough to proceed with construction of the restoration using the actual abutment screwed onto the model. With longer span bridges it may be desirable to replace the abutments in the mouth and retake further impressions in the conventional way.

Diagnostic frameworks

Following impression taking, rather than proceeding with the definitive framework which may dictate tooth position early on, it is often desirable to have a full diagnostic try-in using acrylic and wax. The simplest approach is to construct an acrylic partial denture based on the implant position. More accurately, the bridge cylinders can be linked together with acrylic or light cured composite and the tooth contours waxed on top, or denture teeth placed in wax to reproduce the possible end result (fig. 9). This also allows the clinician to check the accuracy of the cast. Any problems with fit can be rectified by sectioning the try-in and rejoining.

The trial restoration can then be tried in the mouth for the patient to see and any adjustments carried out. The agreed result can be returned to the laboratory and a putty mask



Fig. 6a Only one implant could be placed distal to the canine tooth because of resorption and the inferior dental canal. To provide the patient with two premolar teeth the implant is linked to the adjacent tooth. A gold coping is used to protect the tooth if decementation should occur



Fig. 6b The completed bridge showing a distally cantilevered pontic



Fig. 6c The bridge in place. There is also a conventional implant supported bridge on the other side of the jaw

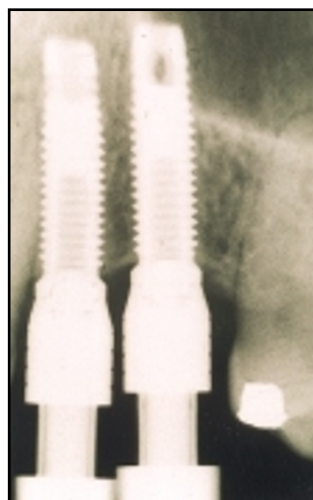


Fig. 7a Radiograph of the head of implant impression copings in place to verify seating

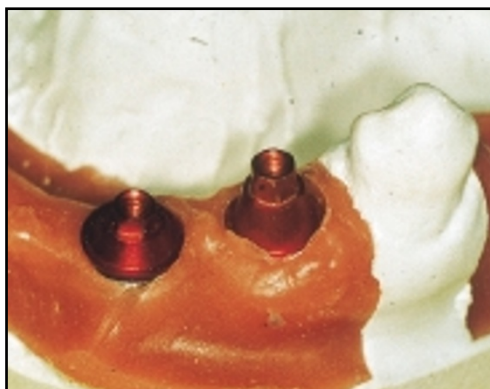


Fig. 7b The retaining pins project through a window in a stock tray for a 'pick up' impression

Fig. 8a Impression of implant heads with a soft tissue mask on the cast



Fig. 8b Analogues of suitable abutments can be tried in to ensure the correct choice is made



taken to ensure the definitive restoration copies it. The framework can be made to properly support the tooth position by cutting back from the wax teeth.

Several manufacturers now produce temporary cylinders that can be used for provisional or diagnostic restorations. These directly screw onto the implant without the need for a conventional abutment and allow even more flexibility in the decision taking until all of the potential problems have been identified. They are particularly useful in complex transitional cases.

Screwed or cemented restorations

Traditional techniques were developed to construct short or long span bridges using pre-made components that were cast together and held in place with gold screws. Conventional cemented techniques were used only in single tooth implant restorations. Although the significant advantage of easy retrievability and an excellent marginal fit of pre-made screwed components is very attractive, many operators have found the complex laboratory processes involved outweigh the advantages (Table 1). Several techniques for cemented restorations are now popular.

In the same way that conventional abutments can be chosen, preable abutments can be chosen for height, width and angulation. These can be placed on an implant position model and trimmed to mimic tooth preparations. A conventional bridge can then be made and cemented. Of particular advantage is the ability to choose abutments that correspond to the width and contour of the tooth to be replaced (fig. 10).

Although abutment preparations can be carried out in the mouth, normally only final finishing is recommended and the bulk of the work is carried out in the laboratory.

Cemented restorations

As already described, preable abutments which allow conventional crown and bridge-work can be supplied by most manufacturers and are chosen so that the gingival margin for the final restoration can be placed just subgingivally in the labial and proximal areas. A natural emergence angle can be developed and the soft tissue modified with a provisional restoration. Ideally this can be developed at the abutment connection stage by taking a

Table 1 Advantages and disadvantages of screw retained versus cemented restorations		
	Advantages	Disadvantages
Screw	Easily retrievable Machined accurate components Screw acts as fail safe component	Accurate framework required for passive fit Implant position/angulation critical Potential for screw fracture and loosening Screw-hole may spoil the appearance
Cemented	Customised abutment is highly flexible Can join teeth and implants more readily Small discrepancies in fit are filled by cement lute Comparable with 'ordinary dentistry'	Difficult to retrieve Harder laboratory technique Temporary bridge normally required Conventional impression can lead to errors in fit Potential for excess cement May encourage a lower standard of clinical and technical acceptability



Fig. 9a Plastic abutment analogues are tried in for this complex case



Fig. 9b A diagnostic wax-up of the desired tooth position in relation to the abutments can then be tried in prior to any metal castings

simple impression at first stage surgery and constructing a temporary restoration while the implant is integrating to be fitted at second stage surgery. This allows the soft tissue to heal around a more ideal contour. It also provides the patient with a good temporary restoration without the need to modify pre-existing temporary restorations to fit around healing abutments.

Some manufacturers produce preable abutments to allow an in-built angulation between implant and restoration. There is some scope for adjustment of the angulation with standard preable abutments but this is limited by the need to retain bulk around the screw hole for the abutment screw. Alternatively, fully customised abutments can be made using conventional waxing and casting techniques with burn-out or precious metal templates to fit the implant head (fig. 11).

Much has been written in the literature about the need for a passive fit for any casting that is screw retained. It would seem that this is an ideal that is rarely attained and its importance has possibly been over emphasised. Introducing a cement lute allows for small discrepancies in fit to be insignificant. Normally the final restoration is only cemented with a weak cement which allows the possibility for removal if necessary. Small lateral grub screws or a single conventional screwed abutment can be incorporated into the design to give the patient security that the bridge will not be suddenly displaced. Fortunately, decementation of implant restorations does not result in caries! Natural teeth incorporated into any cemented structure should ideally have a permanently cemented

gold coping under the bridge structure so that subsequent bridge removal or debonding will not result in damage to the tooth.

Screw retained restorations

Many clinicians still prefer the simplicity and retrievability of screw retention and patients who have experienced the problems of failing conventional bridge work often appreciate the advantages. Implant positioning is however critical if the screw access hole is to be non-visible and in the ideal site.

On occasions it may be necessary to correct the position of the screw hole by selecting an angled abutment (which are available in a variety of angles). Selection is made easier using a head of implant impression and analogues tried in the laboratory. The final restoration is either based on standard abutment gold cylinders or customised superstructures. Ideally, with any screw retained restoration, fully machined and prefabricated components are preferred to ensure an accurate fit under screw tightening. With angled abutments aesthetics can be a problem unless the implant has been placed quite deeply as the abutment collar can show on the labial aspect.

Angled abutments can also create phonetic

Special techniques

- Implant position impressions (head of fixture impressions)
- Diagnostic frameworks
- Screwed or cemented restorations

Particular problem areas

- Single teeth restorations
- Short spans
- Full arch bridges



Fig. 10a Missing upper lateral incisors where the width of the spaces is only 5 mm



Fig. 10b Narrow width preable abutments can be produced



Fig. 10c Crowns immediately after cementation



Fig. 11a Surgical placement of these implants in the thin ridge has resulted in a labial angulation. With a screw retained bridge the access holes for the screws would be visible. A customised cemented bridge is therefore indicated



Fig. 11b A jig is used to locate the abutments to one another to ensure their correct relationship



Fig. 11c Customised cast gold abutments in place



Fig. 11d Completed bridge

Fig. 12a The head of implant impression shows that the mesial implant is quite superficial and any metal abutment would show. The distal abutment is in a conventional position

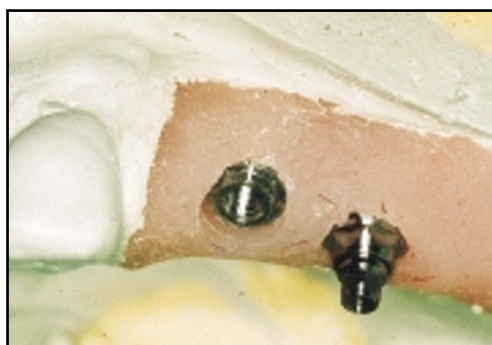
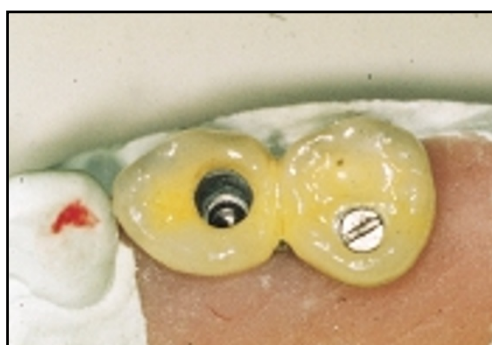


Fig. 12b A bridge is constructed combining the abutment into the bridge to allow the porcelain to be extended down to the implant head. The result is a larger access hole on the occlusal surface for the abutment screw



and oral hygiene difficulties because of the increased bulk of abutment. Difficulties can arise in correctly placing the abutments into the mouth as they need to seat in the desired position on the anti-rotational element of the implant. A locating jig can be made to facilitate this (fig. 11b).

Although abutments are available in a variety of collar heights, problems can arise when there is minimal occlusal height available, for example, under 7 mm for a Branemark implant, as there is little room to place an aesthetic plug into the access hole to cover the screw. Shorter abutments (minimum profile abutments) are available which allow restorations with a 5 mm occlusal space.

Superficially placed implants where there is little occlusal space and where the collar of the head of the implant is near the surface can present major aesthetic problems if the metal collar of the abutment is visible. Abutments are available for the Branemark implant to allow the abutment and restoration to be incorporated into one unit, the UCLA abutment. This allows the restoration (porcelain) margin to extend down to the head of the implant. The disadvantage of this approach is the need for a larger screw access hole to allow for the abutment screw (fig. 12).

Replacing missing soft tissue

Soft and hard tissue grafting techniques are often the preferred way of dealing with this problem particularly in isolated defects. However, many patients are not keen to undergo further surgery and prefer to accept some level of compromise in the final appearance. The days of the traditional Branemark implant supported 'oil rig' restoration approach, particularly in the upper jaw, is no longer acceptable for most patients although the ease of maintenance of these cases is obvious. Extension of pink acrylic or porcelain can help (fig. 13), but care must be taken to ensure cleansibility. Extensions or fixed flanges (spoilers) projecting in front of abutments is a tempting solution particularly if the implant is in a poor position, but usually makes access for oral hygiene impossible. Removable flanges may not be well tolerated by patients and are difficult to maintain.

In a situation where significant amounts of tissue are missing leading to aesthetic and phonetic difficulties and the patient will not accept an implant stabilised over-denture, then a milled bar linking the implants with a (patient) removable bridge superstructure retained by locking pins can be considered. This is an elegant but complex approach with significant cost implications.

Particular problem areas

Single teeth restorations

The deeper the implant is sited the easier it is to overcome angulation and position problems and develop an ideal emergence profile. When interdental papillae are absent the crown may need to be slightly overcontoured proximally to help support and encourage development of soft tissue and close dark triangular spaces (fig. 15).

If the soft tissue overlying the abutment area is thin and a metal abutment might cause greying of the gingiva, an all porcelain abutment can be used. This is a relatively new development and long-term data are not available but initial results are very promising (fig. 16).

Short spans

The major problem with short spans is the temptation to put implants too close together leading to crowns with a poor appearance. Sometimes, if too many implants have been placed too close together, the decision has to be taken to not use one of the implants and construct a bridge using the remainder (fig. 17).

Full arch bridges

In many ways these restorations, particularly in the lower jaw where appearance is not paramount, are proving to be the easiest to provide. In the upper jaw it is often best to avoid placing



Fig. 13a A 10-year-old 'oil rig' style bridge has been removed from the mouth with its conventional abutments and is seated on a new model



Fig. 13b With shorter bridge abutments and extended acrylic work the visible metal can be eliminated



Fig. 14a A spoiler was used to disguise visible metal abutments



Fig. 14b Such a fixed restoration was impossible for the patient to clean



Fig. 15a Four missing upper incisor teeth with a resulting flat ridge. The healing abutments are in place



Fig. 15b To reduce the dark triangular spaces that would result from the lack of papillae the final crowns are overcontoured cervically



Fig 16a All porcelain abutment in place



Fig 16b All porcelain crown cemented with a tooth coloured cement



Fig 17a Four anterior crowns placed in a resorbed ridge that is now too narrow from canine to canine



Fig 17b On removal of one of the crowns, the difficulty in cleaning can be easily seen. Note the absence of healthy interdental tissue

implants in the incisor sites so that the operator/technician can place these teeth in the ideal position, not dictated by the implant position, to achieve ideal aesthetics. If the bone volume is adequate the canine and premolar sites are therefore to be preferred.

The difficulties of achieving a good fit for screw retention has led many to prefer the cemented approach for these long spans. It should be remembered that if multiple implants of sufficient length have been placed a potential long span bridge can often be split up into multiple smaller units.

Conclusion

The prefabricated components available can make the prosthodontic treatment of patients with ideally positioned implants a straightforward procedure. However, when any degree of variation from the ideal is encountered the prosthodontist can have a difficult time satisfying the patients' expectations. Implant systems should therefore be chosen with a broad range of prosthodontic components available.

In summary, start with a clear idea of the desired result and try this in the patient's mouth. By taking an impression of the implant position and relating this to the desired end result, suitable abutments can be chosen. In any complex situation it is advisable to proceed to a full try in before the superstructure is made to ensure that the abutment choice and aesthetics are correct. Above all, the surgeon should work with the prosthodontic end point in mind, to minimise the risk of an unsatisfactory aesthetic or functional restoration.

BDA Christmas opening hours

On Friday 17th December BDA headquarters and the Scottish office will close at midday and on Christmas Eve at lunchtime. Both offices will re-open between Wednesday 29th and Thursday 30th December to answer members' calls between the hours of 9.00am and 5.00pm. The Information Centre will be

open to members between the hours of 10.00am and 4.00pm. Next year, BDA headquarters will re-open on Tuesday 4th January 2000. The Scottish office will re-open on Wednesday 5th January. We wish all our members best wishes for a peaceful and prosperous new Millennium.