# Variations in planning fixed bridgework — a group of dentists at a case-based postgraduate course

R. J. Ibbetson,[1] K. W. Hemmings,[2] and V. J. Ward,[3]

**Variations in treatment planning and prescription have been described in relation to routine restorative dentistry. This study examined dentists' decisions regarding treatment planning for fixed bridgework. Fifty five dentists who attended a Continuing Education course on fixed bridgework were given standard information about a patient in the form of study casts, photographs of radiographs and a clinical history. They were asked to design a bridge where a previous one had failed and to complete a proforma which was returned to the course organisers in advance of the event. The response rate was 65%. The data showed wide variation in identification of features of diagnostic importance. Seventy percent of respondents chose to use again as abutments teeth which were extensively damaged and had failed to retain the previous bridge: while only 30% noted features of the occlusion which if left unchanged would have precluded a successful bridge from being made. A further feature was that nearly 70% chose to use multiple abutments to support the bridge. The implications of these results were discussed with respect to current concepts of bridge design.**

Decisions made by dentists in respect of the treatment that they recommend are influenced by a number of factors. Among these are the wishes of the patient, their medical and dental condition and the costs of what is proposed. However decisions are also influenced by dentists' previous education and training, their views as moulded by their clinical experience and their participation in continuing education. Variations in treatment planning in the field of caries diagnosis and in the replacement of restorations have been documented frequently, for example Bader and Shugars,[1] but there is little information regarding diagnosis and treatment planning for crown and bridgework.

[1]*Senior Lecturer and Honorary Consultant in Restorative Dentistry* [2]*Consultant in Restorative Dentistry and Honorary Senior Lecturer* [3]*Consultant in Restorative Dentistry and Honorary Senior Lecturer, Eastman Dental Institute for Oral Health Care Science, University College of London, 256 Gray's Inn Road, London, WC1X 8LD*

REFEREED PAPER
Received 26.03.98; accepted 07.04.99



## Materials and Method

A course for general dental practitioners entitled ' Diagnosis and planning for success with fixed bridgework' was run at a site distant from the Eastman Dental Institute in July 1997. As part of the preparation for the course, each of 55 participants was sent pre-course homework. This consisted of a history sheet, a set of study casts and black and white prints of intra-oral radiographs. Participants were asked to design a fixed prosthesis to replace the missing maxillary anterior teeth. A proforma was provided to assist in framing and ordering the responses: they were returned to the organisers in advance of the course.

The main features of the case are detailed below.

### History

- A previous bridge had replaced the missing right maxillary central incisor. It had been supported on the maxillary right lateral, the left central and left lateral incisors. The bridge had failed but the roots of the incisors remained.
- The patient was a middle-aged man who had a low lip line and did not show the cervical area of the teeth when smiling.
- There was no history of parafunctional activity.
- The patient was resistant to periodontal disease.
- The patient was keen to have a fixed replacement for the missing teeth but wished to avoid implants. Treatment was not limited by cost.

### Study casts

The study casts shown in figure 1 were hand-held and showed:

- Intact dental arches apart from the missing maxillary right central incisor.
- The upper right lateral incisor had an irregular root face with subgingival margins, while the root faces of the upper left central and lateral incisors were at gingival level.
- The maxillary canines had large clinical crowns and had significant wear facets.
- The occlusion was Class II division.[2]
- The lower labial segment was over-erupted giving limited space between the lower incisors and the maxillary edentulous ridge and teeth. The lower left central and lateral incisors were nearly in contact with the palate.
- There was mild crowding of the lower incisors. These were reduced in height by about 30% and were worn.
- The posterior teeth were generally sound and the posterior occlusion stable. The occlusal form of upper left first premolar was poor.

### Radiographs

These were two periapical radiographs showing the maxillary anterior teeth with the previous bridge in place and right and left (fig. 2) bitewing radiographs.

These demonstrated:

- The root face of the upper right lateral incisor was approximately 1 mm coronal to the alveolar bone. There was a radiolucency of the root face.

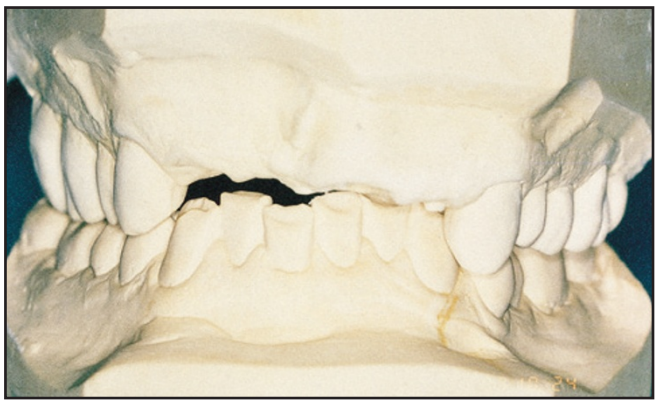

**Fig. 1 An anterior view of the study casts with the roots of 2|12 in situ**

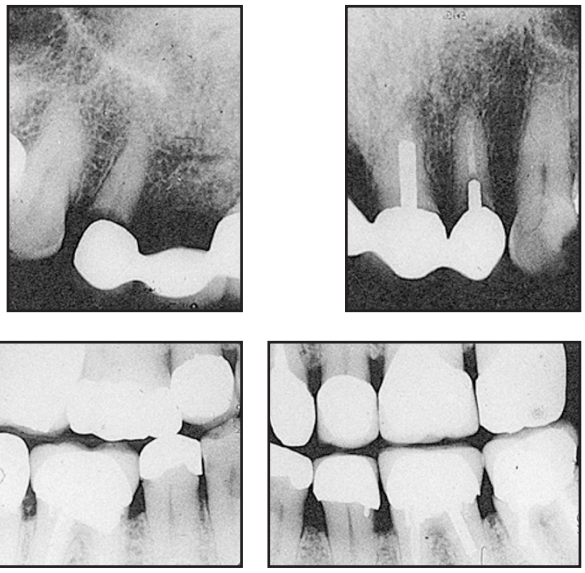

**Fig. 2 The radiographs of the teeth**

- The upper left central and lateral incisors were restored with posts and metal-ceramic retainers.
- The upper left central and lateral incisors had been root filled: the root filling in the upper left lateral appeared undercondensed but otherwise was of reasonable length, while the apical appearance was within normal limits. Approximately 1 mm remained of the root filling in the upper left central incisor; the apex of the tooth was somewhat indistinct.
- The post in the upper left lateral incisor was short and there was a radiolucency of the mesial surface of the root and root face. The upper left central incisor had a wide long post. The distal surface of the root was scalloped at a site approximately half way along its length.
- The upper left first premolar was root filled and had a crown that was poorly contoured.
- There was a large restoration distally in the upper left canine.
- The posterior teeth were heavily restored but sound with the exception of marginal defects and dental caries affecting the distal surfaces of the lower right first and second premolars. There were mesial and distal overhangs associated with the restoration in the lower left second premolar.

### Participants' Response Form

A form assisted participants in framing and ordering their responses. Nine questions were asked: there were free-form boxes in which to write the answers while participants were asked to provide a brief note to justify their responses. The questions were: a) choice of abutment teeth, b) number of pontics, c) types of retainer, d) types of connector, e) core materials, f) material for the occlusal surfaces, g) marginal design, h) opposing teeth considerations, and i) planning for the future.

## Results

Thirty-eight of the 55 participants returned their proformas prior to the course, a 64% response rate. The sections dealing with design and its justification were mostly completed comprehensively. The variety of views expressed was large as was the responses in support of the designs chosen. A few were authoritative and gave literature references to support their choice. The major observations were recorded together with the number of responses for each: Table 1 and 2 show data related to abutments and pontics, while Table 3 contains observations relating to retainers and the occlusion: Table 4 records responses related to mouth preparation prior to bridgework.

### Bridge Design

*Combinations of Abutments*

When the designs were considered on the basis of the number of abutments to be used, there were 14 different combinations suggested. These are recorded in Table 1. The simplest design used the maxillary right lateral and left central incisors: the most extensive used the maxillary right first premolar and canine and on the left side the central and lateral incisors, canine and first premolar.

**Table 1 Abutments selected for the fixed bridge**

| Abutments selected | Number of designs |
|---|---|
| Incisors only | 7 |
| Incisors + additional abutment (s) | 19 |
| Canines only | 8 |
| Canines + premolars | 4 |
| Total | 38 |

**Table 2 The number of responses from participants for: a) the number of abutments and b) the number of pontics to be included in the bridge**

| Number | One | Two | Three | Four | Five | Six |
|---|---|---|---|---|---|---|
| Abutments | 0 | 12 | 9 | 8 | 1 | 4 |
| Pontics | 12 | 12 | 2 | 11 | 1 | 0 |

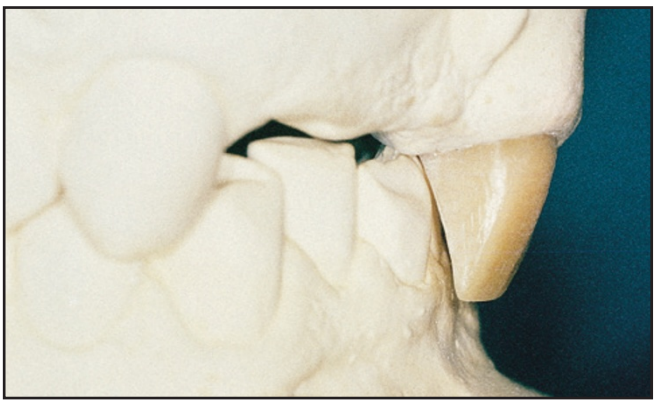

**Fig. 3 Diagnostic wax-up of the maxillary left central incisor showing the existing anterior relationship**

*Number of Abutments and Pontics*
Participants' responses giving a) the number of abutments to be used and also b) the number of pontics to be included were recorded. These are shown in Table 2.

The replies to questions f to i (f) material for the occlusal surfaces; g) marginal design of restorations; h) opposing teeth considerations; and i) planning for the future.) are recorded in Table 3 and showed the number of responses commenting on each of these particular aspects.

**Pre-restorative management**
Table 4 records the number of responses that identified particular aspects that would require management or alteration prior to provision of the bridge.

## Discussion

The case was chosen as both the abutment teeth and the occlusal relationships presented problems. The maxillary incisor teeth were extensively damaged, two had been previously root treated and the third would have required root canal treatment if it were to be retained. The lower labial segment was overerupted and would have precluded providing stable intercuspal contacts between the incisal edges of the mandibular incisor and canine teeth and either the retainers or pontics in the maxillary arch.

The information was not as complete as would have been obtained from a thorough clinical examination and radiographs rather than photographic prints. The casts could only be related in the intercuspal position as they were hand-held: this limited the information about the occlusion. However, there was no time limit for participants to examine the material and make their treatment plans. The format did not allow participants to select a prosthesis other than a fixed bridge. Inspection of the material indicated that a removable partial denture would have been a very reasonable option, while implants were also precluded by our instructions. The anterior occlusal relationship presented a deep overbite which was virtually complete to the palatal tissues.

The response rate was 64%. Participants were given considerable freedom with their answers as the response boxes were for free text. This together with the number of variables precluded the use of statistical analysis but this was a qualitative study where such analysis would have conferred no benefit.

**Quality of potential abutments**
The most interesting finding was that 26 out of the 38 respondents would have used again the already very compromised incisor teeth as abutments (Table 1) either alone or in combination with additional teeth. Examination of the data in another way, by the number of pontics to be included in the bridge (fig. 4), confirmed that just under 70% of respondents chose not to replace all four maxillary incisors. The bridge which had failed previously used the incisors as abutments, two of them had certainly been damaged further by caries. The loss of tooth structure together with all either having been root treated or requiring it made them very poor prospective abutments.

The amount of tooth structure can have a profound effect on the ability of an abutment to function satisfactorily for a reasonable period of time. Enamel supported by reasonable amounts of dentine is necessary to support adhesive bridgework. For conventional bridgework, the quantity of remaining dentine is likely to influence the long-term performance of retainers. Root treated teeth often represent the most extreme examples of extensively damaged teeth and dentists have long been cautioned about their limitations in fixed bridgework. Roberts[2] was the first to record the increased level of failure where root treated teeth were used as abutments. Later both Cheung[3] and Palmqvist and Soderfelt[4] found that root treated teeth gave a higher incidence of failure compared with their vital counterparts. Some of the studies have indicated a primary endodontic cause of failure[5,6] while factors related to the post were implicated in others.[7,8]

However, there is little evidence that supports the commonly-held clinical concept that root treated teeth are more brittle than their counterparts with vital pulps.[9] The most powerful factor in the tendency of root treated teeth to undergo structural failure is related to the very significant decrease in the amount of dentine. The use of a post does nothing to strengthen the remaining tooth structure and may result in a less favourable outcome if the tooth fractures.[10,11] Gold collars for the retainers were recommended by over 75%

**Table 3 Responses to questions g) to i)**

| The Retainers: the Occlusion | No. of responses |
|---|---|
| Metal for the occlusal surfaces | 28 |
| Metal margins for crowns/retainers | 25 |
| Gold copings/collars with post crowns | 10 |
| Wear of the opposing teeth | 15 |
| Reduction of the lower incisors with or without crowns being provided | 10 |
| Deep overbite | 10 |

**Table 4 Pre- restorative treatment**

| Mouth preparation prior to bridgework | No. of responses |
|---|---|
| Surgical crown lengthening | 10 |
| Orthodontic treatment/ Dahl appliance | 2 |
| Root extrusion | 1 |
| Ridge augmentation | 1 |

**Fig. 4 Diagnostic wax-up of the maxillary left central incisor followingdepression of the mandibular incisor teeth**

of people. This was encouraging as these may be protective of the remaining tooth structure.[12] However, this percentage was surprisingly high when casual clinical observation indicates that such metal margins are rarely used.

It was disappointing that 68% of the dentists produced designs that would carry a very high risk of failure. The prognosis for the remaining maxillary incisor teeth was very poor and a fixed prosthesis that used these teeth was considered to provide an unacceptable risk of failure. These teeth would have been better extracted and replaced by a more extensive bridge.

### Number of abutments

Multiple abutments were selected as appropriate by 60% of participants. Many current textbooks of fixed bridgework still recommend multiple abutments as a means of 'tying-in' the prosthesis, while they may also be recommended at times by those who adhere to Ante's 'Law'.[13] Double abutments are also described as a means of increasing retention but their use on these grounds is mistaken. Fixed prostheses are much more at risk from failure due to inadequate resistance, ie being twisted or torqued off the teeth. Double abutments increase retention but decrease resistance thereby increasing the risk of failure of the bridge through loss of cementation of the secondary retainer as the primary abutment becomes a fulcrum. There is also no evidence indicating that the use of a second abutment will protect a weakened one.

The decision by just over 10% of people (four responses) to use both the maxillary canines and first premolar teeth as abutments is understandable in view of its continuing to be described in the literature. However, it would appear to be an outdated concept. There has been a major shift in thinking as to what constitutes adequate support for a bridge. Ante[14] recommended that the periodontal support of the abutments should be equal to or greater than that of the teeth to be replaced. It was suggested when the causes of periodontal disease were largely unknown and occlusal understanding was based around concepts derived from complete denture prosthetics. In the light of current knowledge it is overly cautious. There is no set level of attachment below which the use of a tooth as an abutment becomes contra-indicated, however what support remains must be healthy.

### Occlusal analysis

It was disappointing to note from Table 3. that less than 30% of respondents recorded the depth of the overbite as being of concern. Figure 3 shows the problems that this would create with pontic and retainer design. Stability of the position of the mandibular anterior teeth and control over excursive contacts could not be achieved with the lower incisors in their present position. This would require alteration prior to treatment. Approximately the same percentage (30%) indicated that the lower incisors would require reduction or restoration. Neither of these options is really feasible, reducing the quite markedly worn teeth was contra-indicated while crowning them would have demanded 2 mm of reduction incisally. This would have left a number of these teeth with very little crown height unless previous crown lengthening had been undertaken or space created incisally by some other means.

The need to make alterations in the anterior relationship of the teeth and to evaluate clinical crown height in the maxillary and mandibular arches indicated that some preparation of the mouth prior to provision of bridgework was required. However, this was considered by only 30% of our respondents (Table 4). The existence of an anterior relationship that would have precluded the construction of a successful bridge was not recorded by 48% of the participants.

The overeruption of the mandibular anterior teeth would have been best treated by use of an appliance designed using Dahl's principles[15] to reverse the changes in the position of the teeth that had taken place. Figure 4 shows the effect that changing the position of the teeth would have had on the anterior relationship and the consequent improvement in the occlusal contacts between the lower anterior teeth and the pontics. Contact between the lower incisal edges and a flat area on the cingulum of the pontics would have provided stability on closure and control over the anterior guidance. Without this the contacts would have been between the labial aspects of the mandibular incisors and the palatal surfaces of the maxillary incisor pontics. This would not have produced stability. There would be the continued danger of further eruption of the mandibular incisors, effectively increasing their length and producing interferences on the bridge on mandibular movements.

### The optimal bridge design

A bridge made to replace the four maxillary incisors would have best been supported solely on the maxillary canines as long as the upper left canine proved not to be too damaged by the existing distal restoration. Crown height was inadequate and the prosthesis would have benefited from a surgical crown lengthening procedure for the canine teeth prior to restoration. Torsion and bending of fixed prostheses were detailed by Smyd:[16] rigidity to minimise flexure remains important in prevention of failure of the cement lute. This is developed by height in components and is decreased by length of span, thus the need for adequate crown height becomes a significant consideration in treatment planning.

The three remaining maxillary incisor roots would have best been extracted. They were not suitable for use as abutments for the bridge due to the small amounts of tooth structure that remained. It could be argued if they were retained

without being restored that they would help preserve alveolar bone in the area, which would be useful if implants were required subsequently. However, making pontics which fit surfaces that would be in close proximity to the root faces would compromise both the form of the pontics and plaque control procedures.

The prosthesis of choice was probably an adhesive bridge that would have used only the canines as retainers. The use of a Dahl appliance would have created sufficient space for the retainers and other components of the bridge to have sufficient thickness and height to resist distortion. An adhesive bridge could have combined the replacement of the incisors with the functions of a Dahl appliance which would have simplified treatment. If the dentist or patient had wished, this could have been replaced with a conventionally-retained bridge. However if the adhesive bridge proved successful as might be expected, there would be little indication to do so. This length of span is not a contra-indication for an adhesive bridge. The more teeth that it replaces, the greater the demands for rigidity in the components which is no different from a bridge using crowns as retainers. The retainers, cast in nickel-chromium, should provide maximal coverage of the palatal surfaces of the canines from close to the gingival margin up to the incisal edges of the abutments. The framework should be extended onto the mesial approximal areas of these teeth to give some 'wrap-around' of the framework to increase resistance form. This approximal extension also allows full development of height in the connectors. The retainers should be of the order of 0.7–0.8 mm thick in order to enhance rigidity in the bridge. There was a deep distal restoration in the maxillary left canine tooth. This would have needed investigation and replacement with new composite before the bridge was made.

### The course

Those attending the course were all general dental practitioners. They showed a broad spread of age and hence experience: there were however a few vocational dental practitioners. Many people had travelled long distances to attend and had also given up part of their weekend. No analysis was made of their time since graduation or their dental school of origin as this seemed inappropriate for a day being spent in voluntary continuing education. However, the majority were neither very recent graduates nor those who had been qualified for extended periods and were therefore viewed as being a random sample of general practitioners.

The course was an enjoyable one to provide. There was strong interaction with the participants. It is hoped that they also found it a helpful day. The assessment forms carried a high return rate and the views were positive. The designs, treatment planning and restorative solutions suggested by participants did give some cause for concern. A number of important diagnostic signs were missed by the majority while there was still a very significant number of dentists who had not perceived the frailties of extensively damaged root-filled teeth and whose concepts of bridge design, particularly in relation to the number of abutments, were somewhat dated. Those attending this course were interested in the subject and had given up part of their weekend to be there. The frequently asked question, 'What about those who don't attend continuing education courses?' is worth highlighting again.

## Conclusions

Fifty-five dentists attended a course on treatment planning and bridge design. Thirty-eight (64%) participants returned proformas prior to the course in response to course material which all participants had been sent. The results showed wide variations in recognising features relevant to the final treatment plan.

Twenty-six (68%) dentists suggested designs that used the maxillary incisor teeth either alone or in combination with other teeth as abutments. These designs would have carried a very high risk of failure.

Eighteen (48%) of the participants failed to record one particular feature evident on the study casts that would have precluded a satisfactory bridge from being constructed.

The study provided an indication of the current knowledge of dentists about this topic.

1 Bader J D, Shugars D A. Agreement among dentists' recommendations for restorative treatment. *J Dent Res* 1993; **72:** 891–896.
2 Roberts D H. The failure of retainers of fixed bridge prostheses. *Br Dent J* 1970; **128:** 117–124.
3 Cheung G S. A preliminary investigation into the longevity and causes of failure of single unit extra-coronal restorations. *J Dent* 1991; **19:** 160–163.
4 Palmqvist S, Soderfelt B. Multi-variate analyses of factors influencing the longevity of fixed partial dentures, retainers and abutments. *J Prosthet Dent* 1994; **71:** 245–250.
5 Grieve A, McAndrew R. A radiographic study of post-retained crowns in patients attending a dental hospital. *Br Dent J* 1993; **174:** 197–201.
6 Valler L M. An evaluation of the longevity and causes of failure of post-retained crowns. *RADC Bulletin* 1998/99; **26:** 63–66.
7 Lewis R, Smith B G N. A clinical survey of failed post-retained crowns. *Br Dent J* 1988; **165:** 95–97.
8 Torbjorner A, Karlsson S, Odman P A. Survival rate and failure characteristics of two post designs. *J Prosthet Dent* 1995; **73:** 439–444.
9 Sedgeley C M, Messer H H. Are endodontically treated teeth more brittle? *J Endod* 1992; **18:** 332–335.
10 Guzy G E, Nicholls J I. In vitro comparison of intact endodontically treated teeth with and without endo-post reinforcement. *J Prosthet Dent* 1979; **42:** 39–44.
11 Sorensen J A, Martinoff J T. Clinically significant factors in dowel design. *J Prosthet Dent* 1984; **52:** 28–35.
12 Sorensen J A, Engelman M J. Ferrule design and fracture resistance of endodontically treated teeth. *J Prosthet Dent* 1990; **63:** 529–536.
13 Shillingburg H T, Hobo S, Whitsett L D, Jacobi R, Brackett S. *Fundamentals of Fixed Prosthodontics*. 3rd Edition. 1997; pp.91–93. Quintessence Publishing Co. Inc. Boston, USA.
14 Ante I H. The fundamental principles, design and construction of crown and bridge prosthetics. Dental Items of Interest 1928; pp. 215–232. Published in *Classic Prosthodontic articles. A Collector's Item* (1976) **1:** 271–288. American College of Prosthodontists.
15 Dahl B L, Krogstad O K, Karlsen K. An alternative treatment in cases with advanced localized attrition. *J Oral Rehab* 1975; **2:** 209–214.
16 Smyd E S. The role of torque, torsion and bending in prosthodontic failures. *J Prosthet Dent* 1961; **11:** 95–111.