

The Occlusal Management of Maxillary Anterior Single-unit Implant-supported Restorations

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Abstract: This paper, with the aid of clinical examples, highlights some of the common occlusal problems that can be associated with maxillary anterior single-unit implant-supported restorations. The authors stress the importance of thorough pre-operative planning to identify any likely occlusal problems. This allows patients to be fully informed of the impact of any necessary clinical compromise and of the need for and nature of modifications to the natural dentition.

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Clinical Relevance: Ideally all single-unit implant-supported restorations should have 'reduced' occlusal contacts in maximal intercuspal position without premature excursive contacts.

The latter part of the 1990s has seen a rapid increase in the clinical use of single-unit implant-supported restorations (SIRs). Indeed, implant-supported restorations may now be the most appropriate method for many patients to replace missing teeth and maintain alveolar bone. Use of SIRs avoids the inevitable damage to abutment teeth associated with conventional fixed bridgework,¹ the potential for adhesive bridge failure and debonding² and the potential mucosal, gingival and periodontal problems reported with the wearing of removable prostheses.³

Five-year studies using criteria set by Smith and Zarb⁴ on SIRs reveal cumulative implant survival figures of 96.6% in the maxilla and 100% in the mandible.^{5,6} However, the interpretation of these figures requires caution because they ignore restorative complications

(such as screw loosening) that can occur in up to 38% of cases,⁷ although this has been reduced somewhat by the employment of a gold alloy screw for the standard 3.75 mm diameter Brånemark implant. Moreover, the introduction of the larger 5 mm diameter Brånemark implant may improve the linkage between abutment and the hex top of the implant with the ability to create a greater pre-load screw tension and a larger interfacial contact surface area. Other superstructure complications include prosthesis screw fracture, de-cementation of crown, abutment fracture, the need of abutment replacement and aesthetic problems.

It has been suggested that appropriate occlusal management can reduce unwanted functional and non-functional loads on anterior SIRs.^{8,9} Recommendations state that SIRs make 'light' occlusal contact with opposing natural teeth in the intercuspal position (ICP)¹⁰ but remain free of all excursive occlusal contacts.¹¹ However, some researchers have reported that this is difficult to achieve, with up to 20% of crowns built with excursive contact. A further 10% had a significant aesthetic

compromise¹² (problems such as the display of the metal collar, excessive clinical crown length, gingival unevenness, discoloured gingivae overlying the abutment and underlying implant associated with implant positioning and thin gingival biotypes).

In the case of canine SIRs, group function may provide protective loading.¹¹ The magnitude and stability of this 'light' occlusal contact, however, remains elusive, with no proven relationship between clinical failure and the arrangement of the occlusal scheme yet established.

The purpose of this article is to highlight the occlusal assessment and management of the maxillary anterior single-tooth implant-supported restoration.

OCCLUSAL ASSESSMENT AND DIAGNOSIS

Careful pre-operative occlusal assessment will identify the factor(s) likely to complicate the achievement of the above-mentioned occlusal goals. In addition to the clinical examination, articulated study casts mounted in intercuspal position and anatomically articulated with reference to an arbitrary or terminal hinge axis can help identify potential occlusal problems. A diagnostic wax-up can also be invaluable in planning the occlusal scheme.¹³

The following diagnostic aids are used to identify potential occlusal problems with SIRs:

- clinical and occlusal examination;
- articulated study casts;
- diagnostic wax-ups and computer-generated images.

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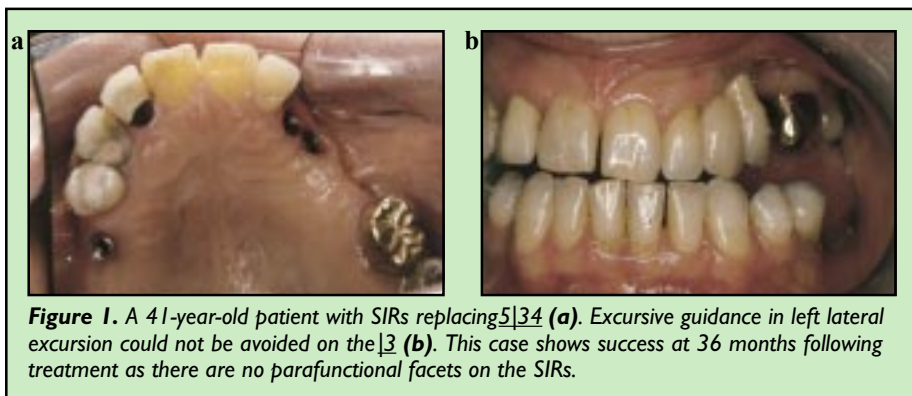


Figure 1. A 41-year-old patient with SIRs replacing 5|34 (a). Excursive guidance in left lateral excursion could not be avoided on the 3 (b). This case shows success at 36 months following treatment as there are no parafunctional facets on the SIRs.

Both the static and dynamic occlusal relationships should be assessed. The static relationship will reveal the availability of inter-occlusal space; whereas the dynamic mandibular movements will highlight potential excursive interferences with the SIR.

In protrusive (intra-border) and lateral (border) excursive mandibular movements guidance should ideally not solely involve the SIR; however, this might not always be achievable, due to positioning of the opposing mandibular teeth. In patients without parafunctional activity, sole excursive guidance on the SIR may be acceptable provided that the patient is adequately informed of the potential risk of failure (Figure 1 a and b). Parafunctional habits (e.g. attrition, pen biting) may influence both implant and crown survival (Figure 2 a-d), and any such habits should be carefully recorded. It is important, therefore, that the aesthetic implications of measures taken to avoid excursive interference(s) (such as reduction of incisal height, uneven incisal edge of the prosthesis) are taken into consideration and carefully explained to the patient.

COMMON OCCLUSAL CONSIDERATIONS

Over-eruption of Opposing Teeth

Over-erupted opposing teeth can compromise the interocclusal space available and complicate excursive occlusal relationships.

Malaligned Opposing Teeth

Imbricated and malpositioned teeth can also create occlusal difficulties. For example, a labially placed lower incisor,

if ignored, can lead to unfavourable localized excursive contact with the SIR.

Appropriate pre-operative assessment can be used to identify such problems. The options available for such circumstances are:

- Leave the tooth alone and accept the occlusal limitations.
- Tooth reduction.
- Use the Dahl principle to create inter-occlusal room by a combination of intrusion of the overerupted tooth and extrusion of the neighbouring teeth.¹⁴ The authors prefer to attempt tooth movement using Dahl principles in preference to orthodontic treatment if controlled labio-lingual tooth

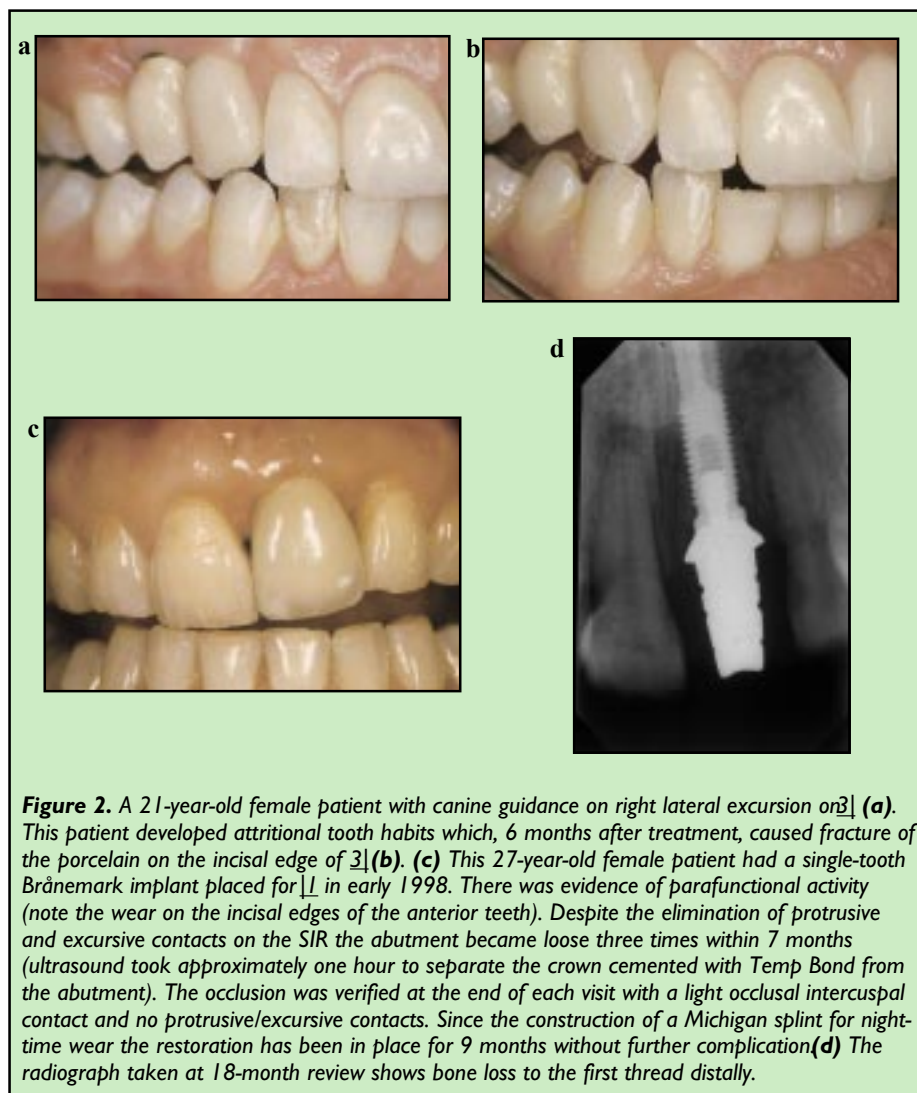


Figure 2. A 21-year-old female patient with canine guidance on right lateral excursion on 2| (a). This patient developed attritional tooth habits which, 6 months after treatment, caused fracture of the porcelain on the incisal edge of 2| (b). (c) This 27-year-old female patient had a single-tooth Brånemark implant placed for 1| in early 1998. There was evidence of parafunctional activity (note the wear on the incisal edges of the anterior teeth). Despite the elimination of protrusive and excursive contacts on the SIR the abutment became loose three times within 7 months (ultrasound took approximately one hour to separate the crown cemented with Temp Bond from the abutment). The occlusion was verified at the end of each visit with a light occlusal intercuspal contact and no protrusive/excursive contacts. Since the construction of a Michigan splint for night-time wear the restoration has been in place for 9 months without further complication (d) The radiograph taken at 18-month review shows bone loss to the first thread distally.

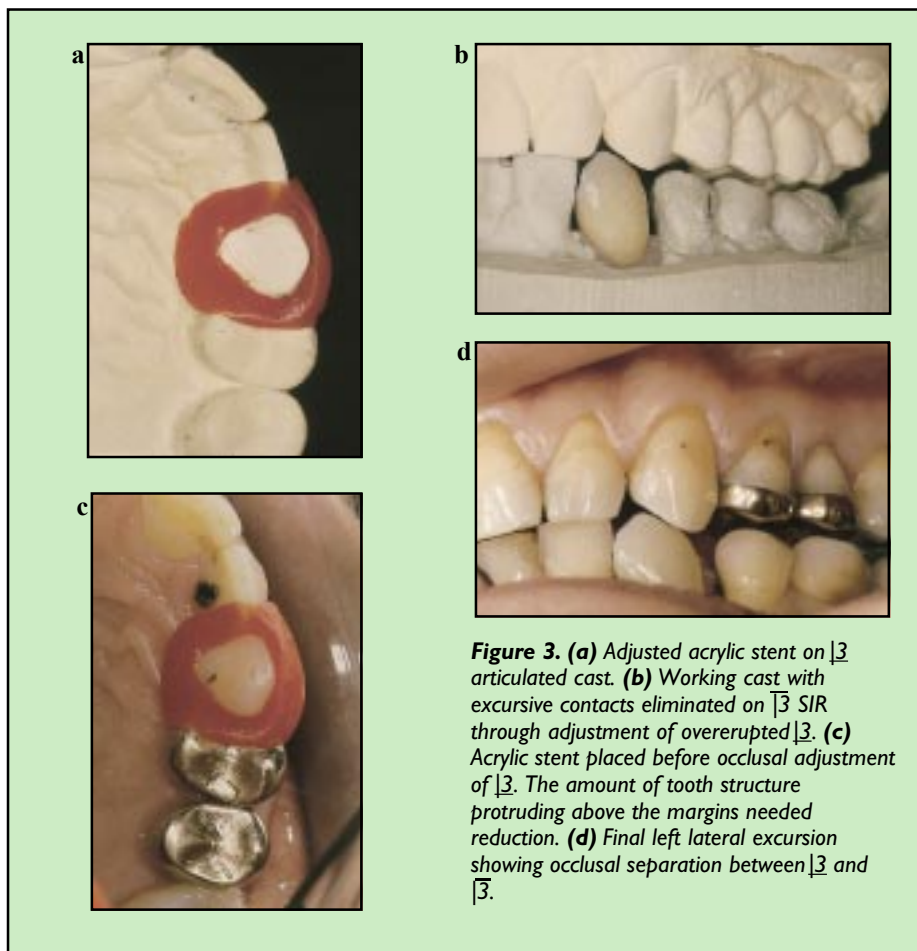


Figure 3. (a) Adjusted acrylic stent on articulated cast. (b) Working cast with excursive contacts eliminated on SIR through adjustment of overerupted. (c) Acrylic stent placed before occlusal adjustment of. The amount of tooth structure protruding above the margins needed reduction. (d) Final left lateral excursion showing occlusal separation between and.

movement is not required.

- Undertake tooth extraction with or without orthodontic tooth realignment.

Incisal Relationships

Class 2 division 1 incisal relationships can make it difficult or impossible to achieve a desirable occlusion with an ICP occlusal contact on the palatal aspect of a maxillary SIR. Indeed, with some severe occlusal derangements the lower incisors may impinge on the palatal mucosa. Care, however, should be taken to assess wider mandibular excursions to avoid sole contact with the SIR. It may be necessary to reduce the length of the restoration to avoid such an arrangement. Alternatively, the guidance could be increased by bonding restorative material to the neighbouring teeth, thus allowing excursive freedom of the SIR. Finally placing the SIR more

labially can avoid such interferences.

Class 2 division 2 incisal relationships with deep overbites can present with inadequate inter-occlusal space and unavoidable excursive contacts. The placement of SIRs in such patients can be difficult¹⁵ and may be contraindicated.¹⁶ Patients with a severe Class 2 division 2 type occlusion use extremely limited anterior guidance in function and may be described as having a 'locked' occlusion

in protrusive and lateral excursions. In such cases excursive contacts on SIR may be non-existent and thus not a problem as far as obtaining the stated ideal occlusal goals is concerned. Cautious and meticulous planning is still necessary for such patients to secure the exact position of the implant. However, potential parafunctional loads may place shear loads on the crown, abutment, abutment screw and the implant and could be argued as a contraindication to implant placement.

MODIFICATION OF THE ANTERIOR OCCLUSION BEFORE PLACEMENT OF THE SIR

To avoid sole excursive contact with the SIR it is often necessary to modify existing occlusal relationships. This can be done by:

1. Planned adjustment of the opposing dentition.
2. Alteration of excursive tooth contacts with the addition of restorative materials to natural teeth.
3. Compromise to the length, shape or position of the SIR.
4. Orthodontic tooth realignment.

1. Alteration to Natural Teeth

In order to limit excursive occlusal contacts to natural teeth it may be necessary to make adjustments to opposing overerupted or malpositioned teeth. Any adjustment should first be carefully planned on articulated study

Material	Advantages	Disadvantages
Composite (can be used either directly or indirectly)	Aesthetic, adhesion to tooth, command set, ease of use, ease of repair	Shrinkage on cure, stain accumulation, wear on opposing teeth, coefficient of thermal expansion
Adhesive ceramic materials	Aesthetics, ease of placement, can bond to tooth	Wear on opposing teeth, greater costs, brittle
Cast non-precious or precious metals	Adhesion to enamel, good wear properties, rigid in thin section	Discoloration of underlying tooth, greater costs

Table 1. Materials available for alteration of tooth-to-tooth contacts.

casts. A laboratory-made acrylic stent, through which adjustments are made, can help the clinician relay the required amount of tooth reduction. Dentine bonding agent should then be applied to exposed dentine and a topical fluoride to enamel.

Case Study 1 (Figure 3)

The traumatic loss of $\bar{3}$ one year previously in this 35-year-old schoolteacher resulted in overeruption of the $\bar{3}$ by approximately 2 mm into the unopposed edentulous space. Residual spacing and intact neighbouring teeth contraindicated conventional and adhesive bridgework. An SIR was considered once it was determined that adequate bone was available for fixture placement. When assessment indicated that lateral excursive tooth contact with the SIR could be eliminated and maintain correct anatomical form of the prosthesis, the patient's consent was achieved for fixture placement. An acrylic stent, through which adjustments were made in the laboratory, was then used by the clinician to relay the extent of tooth reduction of the overerupted tooth required to achieve the ideal goals (Figure 3c). Figure 3d shows the disclusion of the SIR in lateral excursive movement. The all-ceramic restoration cemented with Temp Bond onto a CeraOne™ abutment has been in place for 3 years without clinical problems.

2. Addition to Natural Teeth

Excursive tooth contacts can be altered by the addition of restorative materials to the guiding surfaces of the natural teeth. Non-precious alloys have been used for the re-establishment of canine guidance on excessively worn teeth.¹⁷ However, with their improved physical properties and the ability for greater clinical control, composite resins can be added directly to the guiding surfaces of anterior or posterior teeth to steepen excursive jaw movements and allow avoidance of the SIR. First premolar teeth can also be used to take

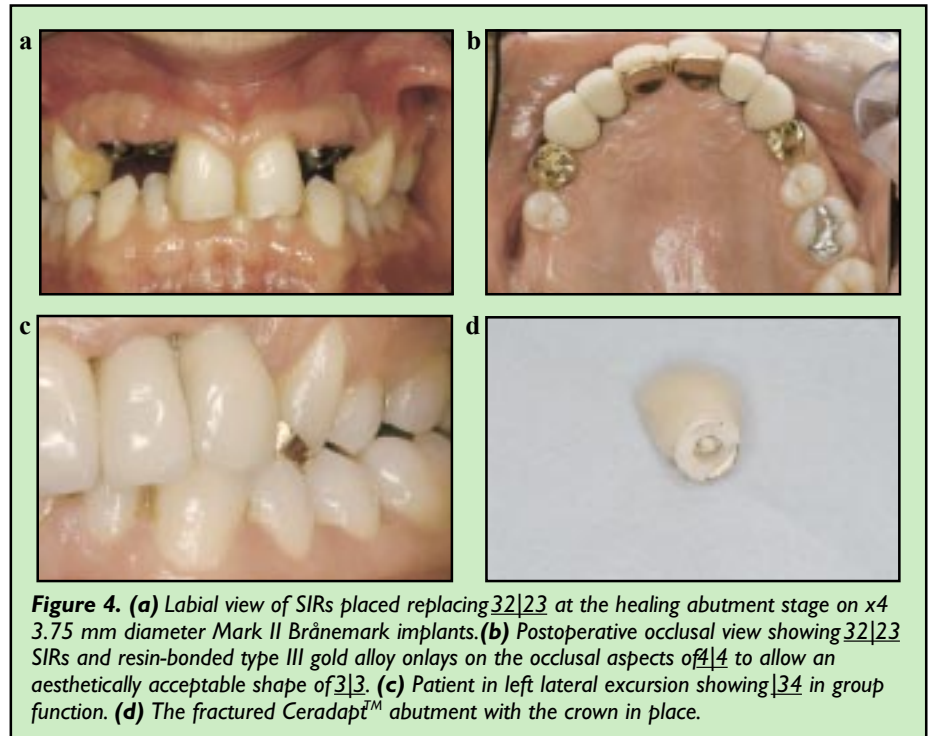


Figure 4. (a) Labial view of SIRs placed replacing $\bar{3}2|\bar{2}3$ at the healing abutment stage on $\times 4$ 3.75 mm diameter Mark II Brånemark implants. (b) Postoperative occlusal view showing $\bar{3}2|\bar{2}3$ SIRs and resin-bonded type III gold alloy onlays on the occlusal aspects of $\bar{4}|\bar{4}$ to allow an aesthetically acceptable shape of $\bar{3}|\bar{3}$. (c) Patient in left lateral excursion showing $\bar{3}|\bar{4}$ in group function. (d) The fractured Ceradapt™ abutment with the crown in place.

up lateral excursive jaw movements in the place of canines, where the latter are to be replaced with SIRs. It is usually not necessary to change ICP relationship. A list of suitable materials for alteration of tooth-to-tooth contacts is given in Table 1.

Case Study 2 (Figure 4)

This 32-year-old man had hypodontia, missing $\bar{3}2|\bar{2}3$. He was dissatisfied with his chrome partial denture and requested a fixed option. Adhesive and conventional bridgework were contraindicated owing to the short root forms of the minimally restored $\bar{1}|\bar{1}$ and unrestored $\bar{4}|\bar{4}$. Four single-unit 3.75 mm diameter Mark II Brånemark implants were placed to replace the missing $\bar{3}2|\bar{2}3$ and porcelain-fused metal restorations were cemented onto Ceradapt™ abutments. Group function with contacts on $\bar{4}3|\bar{3}4$ in excursive movements was achieved through resin-bonded type III gold alloy onlays on $\bar{4}|\bar{4}$. However, having the $\bar{3}|\bar{3}$ shorter, with excursive guidance placed on $\bar{4}|\bar{4}$ dissatisfied the patient and placing $\bar{3}|\bar{3}$ in sole canine guidance was felt to be unduly risky as there had been an element of attritional tooth wear in the

past. Despite the careful occlusal planning and the provision of a Michigan occlusal splint, there has been fracture of the $\bar{3}|\bar{3}$ Ceradapt™ abutment after 3 years. This has been replaced with a UCLA™ abutment and a composite bonded to alloy crown cemented with Temp Bond. The other restorations and implants appear to be satisfactory. This case seems to indicate that in patients exhibiting parafunction attempts to create shared occlusal loads between the SIR and a natural tooth cannot prevent failure.

3. Modification of the Implant Crown:

Occasionally, unwanted excursive contacts with the SIR cannot be eliminated by the above methods alone and alteration to the form or position of the SIR is required. The placement of a groove in the incisal edge may allow passage of the opposing natural tooth without contact on the SIR in excursion. The aesthetic effect on the prosthesis needs to be carefully discussed with the patient. Likewise, if the SIR is reduced in length or placed more labially to avoid any excursive contacts the overall

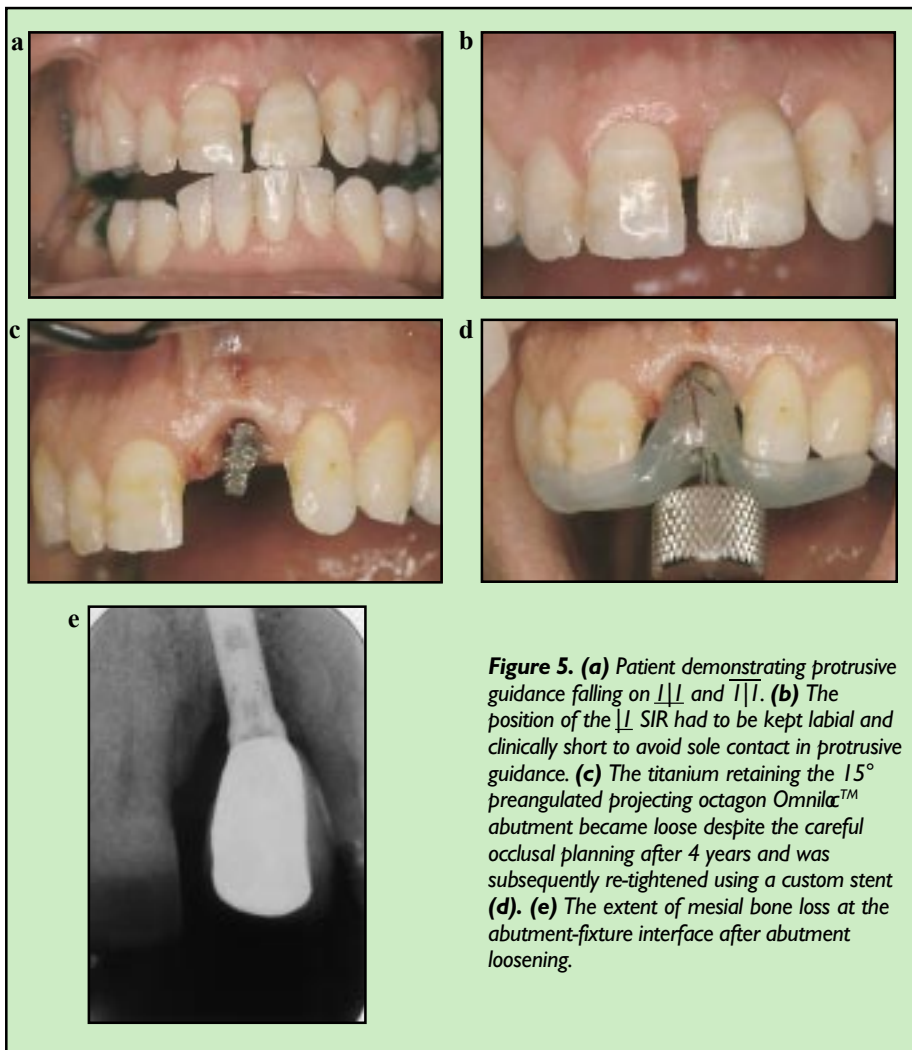


Figure 5. (a) Patient demonstrating protrusive guidance falling on $\underline{11}$ and $\overline{11}$. (b) The position of the $\underline{11}$ SIR had to be kept labial and clinically short to avoid sole contact in protrusive guidance. (c) The titanium retaining the 15° preangulated projecting octagon Omniloc™ abutment became loose despite the careful occlusal planning after 4 years and was subsequently re-tightened using a custom stent (d). (e) The extent of mesial bone loss at the abutment-implant interface after abutment loosening.

appearance of the crown in the arch needs careful planning and informed consent from the patient.

Case Report 3 (Figure 5 a-e)

This 41-year-old man lost $\underline{11}$ following a traumatic bicycle accident in 1990 and was wearing a partial acrylic denture which he found unsatisfactory. An adhesive bridge was placed; however, this repeatedly debonded. An SIR was then considered but, due to the labially placed and over-erupted $\overline{11}$, excursive contact could not be easily avoided without sole contact with the SIR. The diagnostic wax-up showed that to avoid sole protrusive contact with the SIR the restoration would have to be placed more labially and be clinically shortened. These features were

explained to the patient and his consent achieved for fixture placement. A 13 mm x 3.25 mm hydroxyapatite-coated Calcitek™ fixture was placed and after 6 months a metal-ceramic crown was cemented with TempBond onto a 15° pre-angulated projecting octagonal Omniloc™ abutment retained to the fixture with a titanium screw. Despite the careful occlusal planning, the provisional restoration became loose on two occasions and the abutment became loose after 4 years with the metal-ceramic restoration *in situ*. It was removed and re-tightened and has now been in place for 2 years without problems.

In this case a compromise to the aesthetics had to be planned for preoperatively and the excursive

contacts carefully monitored in order to avoid occlusal complications. If the aesthetic form proved to be unacceptable to the patient then it would have been impossible to avoid any excursive contact with the SIR, without considering tooth reduction of the opposing labially placed tooth, addition of restorative material to neighbouring teeth or orthodontic tooth realignment.

4. Orthodontic Tooth Movement:

Realignment of poorly placed or over-erupted teeth before implant placement can often be achieved using fixed or removable orthodontics. Careful planning with an orthodontist should be considered to confirm that the ideal objectives can be achieved, and would be stable, as this is likely to add time and cost to the overall treatment. For example, the deliberate retroclination of a labially placed lower incisor may allow the remaining natural dentition to take up protrusive guidance with disclusion of a maxillary SIR.

Case Report 4 (Figure 6 a-c)

A 22-year-old male patient was missing $\underline{22}$ due to hypodontia. The $\underline{31113}$ had encroached upon the space of the missing teeth and required fixed-appliance orthodontic tooth realignment for space creation of the lateral incisors and for the re-creation of canine guidance. This not only improved the appearance of the missing teeth but also allowed $\underline{33}$ to establish canine disclusion without contact of the $\underline{22}$ SIRs.

CONCLUSION

Careful treatment planning is critical for the appropriate occlusal management of patients with maxillary anterior SIRs. Ideally the SIR should have a 'light' occlusal contact in maximal intercuspal position and no excursive contacts. Adjustment of the opposing dentition, placement of the SIR more labially, placement of a groove in the incisal aspects or steepening of the anterior guidance on neighbouring natural teeth

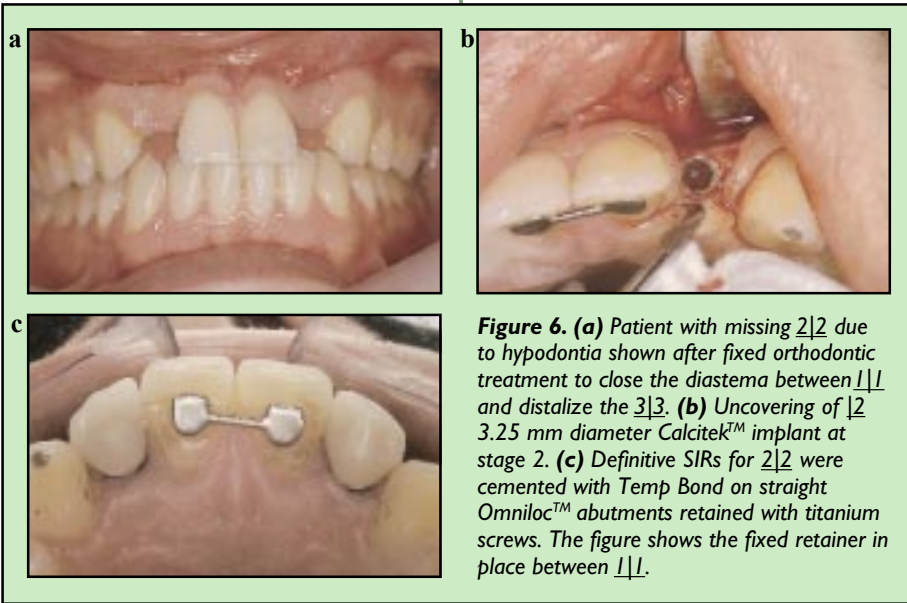


Figure 6. (a) Patient with missing 2|2 due to hypodontia shown after fixed orthodontic treatment to close the diastema between 1|1 and distalize the 3|3. (b) Uncovering of 1|2 3.25 mm diameter Calcitek™ implant at stage 2. (c) Definitive SIRs for 2|2 were cemented with Temp Bond on straight Omniloc™ abutments retained with titanium screws. The figure shows the fixed retainer in place between 1|1.

can help reduce unwanted excursive contacts on SIRs. Where this may prove to be difficult or aesthetically unacceptable the patient should be warned of the potential risk of failure. In patients exhibiting parafunction, careful occlusal planning may reduce the risk but not necessarily prevent failure and protective occlusal splints should be worn. Alternative restorative solutions should also be considered for these patients.

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BOOK REVIEW

Outline of Periodontics. By J. D. Manson and B. M. Eley. Butterworth-Heinemann, Oxford, 1999 (416pp., £29.99 p/b). ISBN 0 7236 1070 3.

Periodontology, as with the majority of dental specialties, is a fast-moving subject with a diverse and extensive amount of research moving the subject forward, almost on a daily basis. The production of new up-to-date texts are always welcome no matter which aspect of dental care you work in. This book was first published in 1983 and is now in its fourth edition, the improvements over previous editions are marked with new sections or additions in the following areas:

- increased detail on instrumentation;
- the interaction between smoking and periodontal disease;
- more detail on chemotherapeutic agents;
- updated and new information on AIDS;
- the current thoughts on genetic links to periodontal disease;
- integration of periodontology with other dental specialties.

The book consists of 27 chapters that comprehensively cover the topic, including biology and anatomy of the periodontium, epidemiology, clinical aspects (use of instruments, diagnosis, treatment planning and treatment modalities, etc.), dental implants, and the interaction between periodontology and restorative

dentistry. These chapters are well laid out and illustrated with line diagrams and black and white photographs (although I feel the use of colour photographs would have been helpful); chapters end with an extensive list of references.

In conclusion, this book is a comprehensive text on periodontology. It is clearly laid out and therefore easy to read, well illustrated and also looks at the interface between periodontology and restorative dentistry (a subject all too rare in some texts). Although this book is aimed principally at the postgraduate, I feel this would be a valuable book to have whatever stage you are at in your dental career.

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