

Restorative Management of the Worn Dentition: 2. Localized Anterior Toothwear

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Abstract: This is the second paper in a four-part series detailing the relative merits of the treatment strategies, clinical techniques and dental materials for the restoration of health, function and aesthetics for the dentition. In this paper the management of wear in the anterior dentition is discussed, using three case studies as illustration.

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Clinical Relevance: The increasing incidence of toothwear requires clinicians to be knowledgeable in its treatment.

Epidemiological studies have shown an increase in the prevalence of toothwear,^{1–4} and numerous research papers, case reports and review articles have attempted to address this problem. Although such publications agreed on the importance of controlling the primary initiating factors for erosion, attrition, abrasion and possibly abfraction, restorative treatment options have varied greatly, mainly in:

- when restorative care should be initiated;
- which occlusal concepts could be

adopted; and

- what restorative materials could be used.

When tooth tissue loss involves the articulating surfaces, the restorative management of the worn dentition is complicated by changes in periodontal, alveolar, pulpal and coronal tissues, and occlusal relationships. Advanced toothwear can lead to biological, functional and aesthetic dental problems.

WHEN TO PROVIDE RESTORATIVE CARE

Because the longevity of restorative treatments is adversely affected by primary dental diseases, their control and prevention are imperative before extensive rehabilitation is undertaken. Dental plaque, extrinsic and intrinsic acids can demineralize sound tooth tissue around the margins of restorations, while excessive occlusal loading, as with bruxism and clenching,

has long been recognized as detrimental to restorative materials, the remaining tooth structure and supporting tissues.

Toothwear can be classified as physiological or pathological, but no universally accepted guidelines are available to differentiate the two entities:⁵ the same loss of tooth substance may be regarded as physiological in an elderly person, but pathological in a young one. The use of stone casts allows a clinician to monitor the rate of wear of a patient's dentition over a period of time if the patient is asymptomatic.

Clinical indications for restorative management are summarized in Table 1.

HOW TO PROVIDE RESTORATIVE CARE

A multidisciplinary approach may be required, and the patient's oral

Biological

- Loss of tooth substance could lead to irregular tooth surfaces, which may enhance plaque retention.
- Pulpal exposure.
- Weakening of tooth structure.

Functional

- Loss of tooth substance cannot be compensated by continuous eruption, and there is reduced masticatory efficiency because of occlusal wear.

Aesthetic

- Loss of tooth substance is aesthetically unacceptable to the patient.

Table 1. Clinical indications for restorative management.

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condition and degree of compliance to go through a possibly lengthy treatment must be evaluated before irreversible treatment is initiated. For restorative treatment planning, the patient should be assessed in terms of Periodontal, Endodontic, Coronal, Occlusal, Functional and Aesthetic (PECOFA) factors. A systematic treatment approach should be used to manage characteristic worn dentitions involving different tooth surfaces and degrees of severity. For practical reasons, the worn dentition may be classified according to location:

- localized anterior toothwear;
- localized posterior toothwear;
- generalized toothwear.

Periodontal Assessment

The gingival and periodontal tissue health should be evaluated using plaque

and gingival indices, and by measuring gingival recession, probing depths and tooth mobility. Radiographs are also required. Uncontrolled moderate or advanced periodontal disease are considered as contraindications for advanced restorative care because further periodontal breakdown may jeopardize any restorative treatment. Recession of gingival tissue margins may expose unsightly restoration margins. In addition, reduced alveolar bone support may be associated with unwanted tooth movement. When existing clinical crown length is inadequate and extracoronary restoration is required, surgical crown lengthening can be used, but the outcome relies on the existing periodontal health and architecture.⁶ In the maxillary anterior region, the distance between the roots, the presence or absence of an interdental papilla, and the proximity of the midline fraenum to the interdental

papilla must be assessed because these factors, together with loss of septal bone, may lead to excessive embrasure space.

Endodontic Assessment

Pain may be the reason that a patient seeks professional dental care. The pulpal status of the worn dentition must be assessed by heat/cold, percussion and electric pulp tests, and the periapical status by the use of radiographs. Because endodontic treatment through cemented extracoronary restorations may adversely affect the strength of the restorations, all necessary root canal treatment should be completed beforehand. Existing root canal fillings must be carefully evaluated. Retreatment should be considered if the root filling is inadequate and/or associated with periapical pathology. If a post-retained

	Nickel chromium	Gold (Type III)	Composite resin	Porcelain
Wear rate against opposing enamel: In vitro ²³ (mm ³ per 25 000 cycles) In vivo ²⁴ (mm ³ per month)	0.31 -	0.03 0.2	0.04 (Herculite XRV) 0.5 (microfill)	8.83 (Vitadur Alpha) 0.2
Tensile bond strength (MPa)²⁵	24.0 (sandblasted), 27.4 (electrolytically etched)	22.0 (sandblasted), 25.5 (tin-plated)	28.0	18.4 - 23.7
Tensile strength (MPa)²⁶	519	448	45.5 (before bonding)	24.8 (ultimate tensile strength) (feldspathic). Fragile in thin section
Appearance	Metallic	Metallic	Tooth-coloured	Tooth-coloured
Handling properties: <i>Surface treatment required</i>	Require sandblasting before bonding	May require heat treatment for oxide formation, sandblasting or tin plating before bonding	May require sandblasting before bonding	Requires hydrofluoric acid etching. If surface glaze is lost, it becomes more abrasive
<i>Marginal accuracy</i>	Accurate casting	Accurate casting	Large polymerization shrinkage	Large firing shrinkage
<i>Polishability</i>	Difficult in polishing and finishing	Easy for polishing and finishing	Easy for polishing and finishing	Difficult in polishing and finishing
<i>Repairability</i>	Not repairable	Not repairable	Repairable	Repairable with composite in some situations
Allergy	Nickel allergy	Extremely rare	Extremely rare	Extremely rare
Chemical stability	Good corrosion resistance	Good corrosion resistance	High water absorption, staining	Good

Table 2. A comparison of restorative materials for palatal veneers.

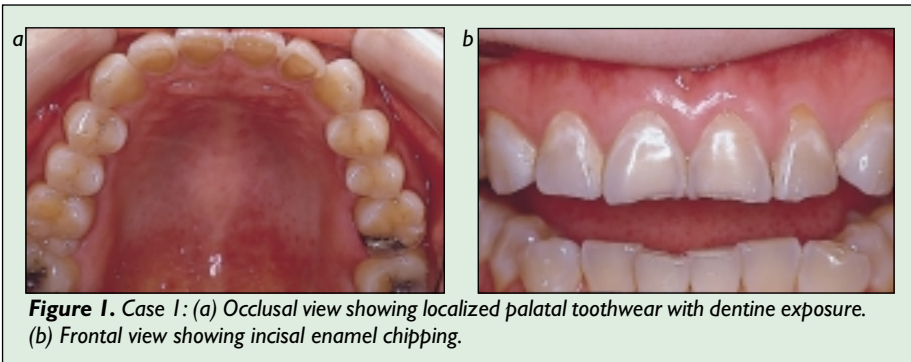


Figure 1. Case 1: (a) Occlusal view showing localized palatal toothwear with dentine exposure. (b) Frontal view showing incisal enamel chipping.

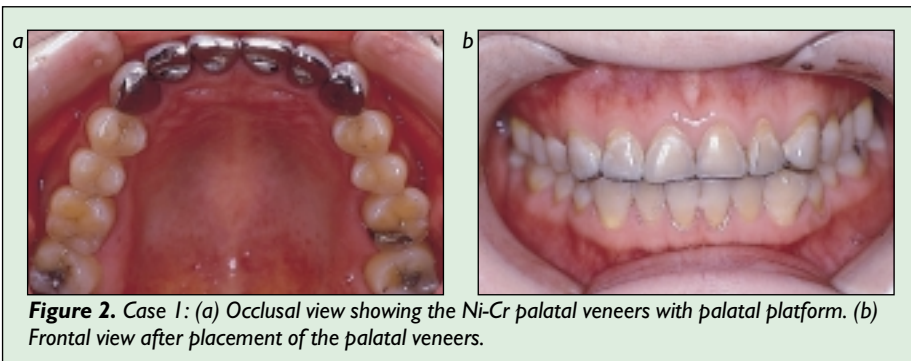


Figure 2. Case 1: (a) Occlusal view showing the Ni-Cr palatal veneers with palatal platform. (b) Frontal view after placement of the palatal veneers.

crown is contemplated, a remaining root filling of 3-4 mm is required and radicular space should be adequate to accommodate the post, which preferably should have a post:crown length ratio of more than 1:1.

Coronal Assessment

The upper anterior teeth are most commonly involved in localized toothwear, particularly when erosion is the primary aetiological factor. A toothwear index serves as a useful tool for epidemiological study and identification of different toothwear patterns.^{7,8} For practical restorative care, the extent of tooth substance loss of anterior teeth can be broadly classified into three categories:

1. Toothwear limited to the palatal side only.
2. Toothwear affecting both the incisal and palatal surfaces, with reduced clinical crown height.
3. Toothwear limited to labial surfaces only.

Retention of the final restorations depends on the quality and quantity

of remaining tooth tissue. Adhesive techniques with minimal tooth preparation should be employed if only the palatal tooth surfaces are affected. It is difficult to construct a crown on a shortened tooth without clinical crown lengthening surgery or subgingival placement of the crown margins. Unfortunately, both techniques require the crown margins to be placed on a narrower root surface. This necessitates a greater reduction of tooth substances and risks endangering the pulp.

Occlusal Assessment

As a result of compensatory tooth

eruption and alveolar bone growth, loss of occlusal tooth substance may not reduce the normal occlusal vertical dimension (OVD).⁹ Therefore, several methods are used to create the interocclusal space needed for the management of localized toothwear, before cementation of final restorations.¹⁰⁻¹² These include:

- fixed or removable anterior bite planes (Dahl appliance) – for selective intrusion of the localized worn teeth and their opposing teeth, and continuous eruption of those unaffected teeth, usually the posterior segments (relative axial tooth movement);¹³⁻¹⁶
- straight-wire orthodontic appliance – to create space by the intrusion of worn teeth or their opposing counterparts, and/or by proclination of anterior teeth;
- tooth preparation at existing intercuspal position – to create space by reducing the articulating surfaces of the teeth requiring restoration;
- occlusal adjustment – to move the occlusion from the existing intercuspal position (ICP) to a more ‘retruded’ position, usually the retruded contact position (RCP), when there is a horizontal difference present between the two.

Irrespective of technique selected, any pre-existing occlusal interferences must be eliminated by movement and/or adjustment of teeth, and temporomandibular joint dysfunctions satisfactorily managed.

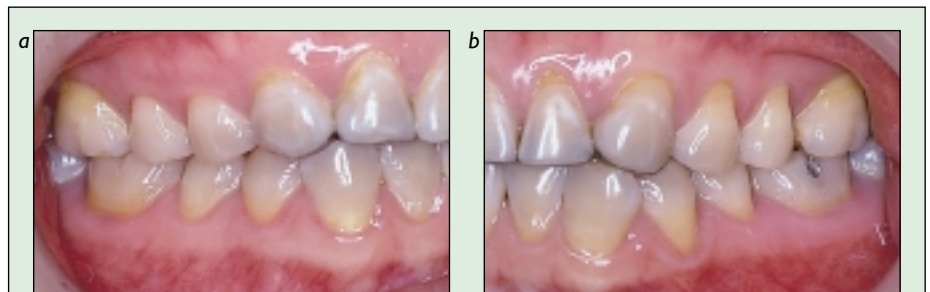


Figure 3. Case 1: (a) Right buccal view, showing the posterior segment in occlusion. (b) Left buccal view: the posterior segment is in occlusion.

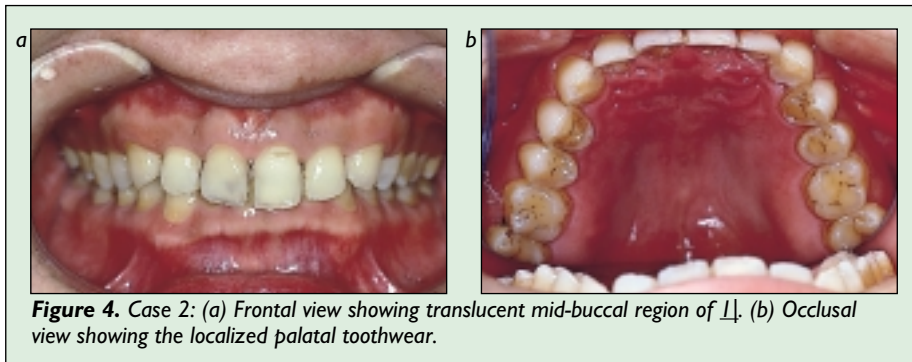


Figure 4. Case 2: (a) Frontal view showing translucent mid-buccal region of I1. (b) Occlusal view showing the localized palatal toothwear.

In addition to these methods, provisional or permanent restorations can be placed at an increased OVD. These supra-occluding restorations are used as ‘individual Dahl appliances’ for the intrusion of the worn teeth and their opposing counterparts and separation of the remaining dentition. With the Dahl appliance or individual supra-occluding restorations placed at an increased OVD, a palatal platform should be present as an ‘ICP stop’ to dissipate occlusal forces more axially. The anterior guidance must not be too steep (to minimize loading), but must be adequate for posterior disclusion. If there is an edentulous space in the posterior region, disengagement of the



Figure 5. Case 2: An upper hard acrylic occlusal splint at increased occlusal vertical dimension.



Figure 6. Case 2: The fixed Dahl appliance cemented in place.

occlusion may result in further tooth drifting or tilting in addition to over-eruption; therefore the use of a fixed orthodontic appliance may be preferable to the Dahl appliance.

Functional Assessment

It is not clear whether the loss of teeth will increase wear of the remaining dentition. Stable posterior tooth support is believed to be necessary for the success of anterior restorations, as the anterior teeth may experience unfavourable masticatory loading if many posterior teeth are missing. The shortened dental arch concept is a good reference when planning restorative treatment. It is desirable to have at least two pairs of premolars or the equivalent present on both sides of the mouth.

Aesthetic Assessment

Appearance is a major concern to the patient when the anterior teeth are affected by toothwear. Preoperative assessment should include:

- severity of tooth damage;
- location of lip line; and
- location of gingival margin.

The severity of tooth damage ranges from incisal enamel chipping to clinical crown shortening. If only the palatal surfaces are worn, then palatal veneers are preferred over conventional full crowns, which require a large amount of tooth reduction.¹⁷

If existing crown height is satisfactory but the remaining labial

surface is minimally affected, extension of the resin composite/ porcelain palatal veneer beyond the existing crown length can be considered. If a metal veneer is used, such extension can be masked by opaque porcelain and resin composite to achieve an aesthetic result. However, if the labial surface requires aesthetic improvement (e.g. there is discoloration, an existing restoration is present, loss of contour), double veneers have been proposed, with porcelain bonded labially and metal bonded palatally to the tooth surface.¹⁸⁻¹⁹ However, although such a technique involves less labial and interproximal reduction, porcelain bonding to cervical dentine has been reported as causing more microleakage than bonding to enamel, and care must be taken not to expose dentine during veneer preparation.

SELECTION OF RESTORATIVE MATERIAL

The ideal restorative material is:

- as wear resistant as the opposing



Figure 7. Case 2: The right buccal view shows the amount of posterior separation achieved immediately after cementation of the Dahl appliance.



Figure 8. Case 2: The posterior teeth were in contact again 3 months after initial treatment.



Figure 9. Case 2: Space was created between the upper and lower incisors after decementation of the Dahl appliance.



Figure 10. Case 2: Six gold palatal veneers were cemented (321|123).

- tooth tissues or restorative materials;
- physically strong in thin sections (have high flexural strength);
- repairable in the mouth; and
- economical to use.

If the incisal tooth edges require repair, the materials used should ideally be tooth-coloured. When multiple restorations are needed, the relative ease of establishing occlusal contacts in the laboratory and chairside adjustment of the selected restorative materials are especially important, in order to avoid lengthy clinical time. If erosion is the primary cause of the toothwear, then the restorative material must be chemically stable in an acidic environment.

Although *in vitro* studies demonstrate that high bond strengths can be achieved between enamel/dentine and nickel-chromium, gold, resin composite and porcelain, only a few clinical studies have compared the clinical performance of these materials as palatal veneers.²⁰⁻²² A comparison of the restorative materials for palatal veneers is summarized in Table 2.

The following case studies illustrate

how localized toothwear can be managed using different approaches.

CASE STUDY I

A 27-year-old woman attended, complaining of mild pain and sensitivity around her front teeth, which had been present for about 2 years. Her dental condition had been stable during the past 12 months. Her medical history revealed no conditions predisposing to gastric illness, but the patient had a stressful job in an airline company and she consumed a large volume of citrus juices.

The patient had excellent plaque control and good gingival health. Tooth sensitivity was associated with dentine exposure on the palatal surfaces of her upper anterior teeth. Enamel chipping of 1|1 was also visible (Figure 1), with minimal involvement of the labial surfaces of other anterior teeth. Occlusal relationships were analysed at the chairside with the study casts articulated in the retruded contact position (RCP). There was little discrepancy between RCP and the intercuspal position (ICP). The overjet and overbite were minimal, and the



Figure 11. Case 2: Postoperative frontal view.

patient had canine guidance in left and right lateral excursions.

A soft vinyl occlusal splint was made to protect the teeth and to reduce dentine sensitivity by home-use fluoride gel application. After dietary advice and a 6-month monitoring period, the incisal edges of 1|1 were repaired with resin composite (Spectrum TPH, Dentsply, Milford, DE19963-0359, USA) and the palatal surfaces were restored with nickel-chromium veneers at an increased OVD (0.5 mm between upper and lower central incisors) (Figure 2). The posterior teeth were separated and occlusal contacts were re-established after 4 weeks (Figure 3). A 'long' monitoring period before definitive

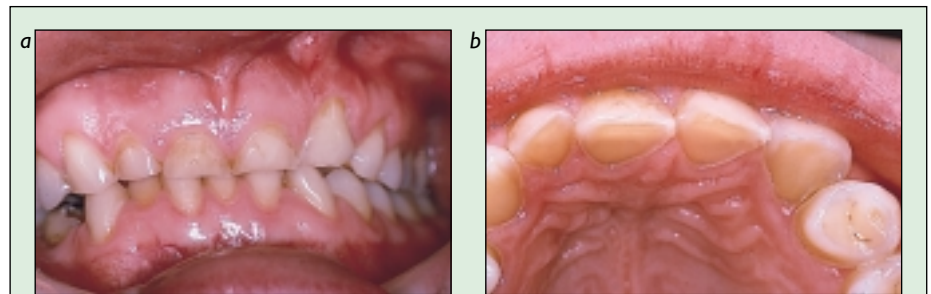


Figure 12. Case 3: (a) The worn upper anterior teeth with shortened clinical crowns. (b) Occlusal view, showing the amount of dentine exposure of incisors and canines.

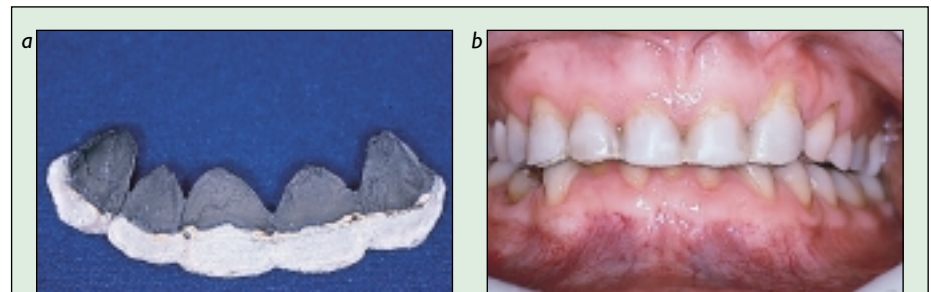


Figure 13. Case 3: (a) The fitting surface of a fixed Dahl appliance with opaque porcelain added. (b) The anterior teeth with fixed Dahl appliance and addition of labial composite.



Figure 14. Case 3: The posterior teeth were in contact again 3 months after cementation of the Dahl appliance.



Figure 15. Case 3: Gingival recession apparent 4 weeks after clinical crown lengthening surgery.

restorative treatment was preferred for this patient because the presenting symptoms and signs were not extremely severe, and the patient may need more time to identify any other sources of acid attack.

CASE STUDY 2

A 36-year-old man was referred by his physician for the management of toothwear as a result of bruxism and gastric reflux. On examination, the patient presented with a non-vital $\underline{1}$, with the pulp having been exposed as a result of localized palatal toothwear. The upper anterior and premolar teeth had smooth palatal surfaces, and the mid-buccal region of $\underline{1}$ was particularly translucent, but the clinical crown heights were still satisfactory (Figure 4). The patient had a Class II division 2 incisal relationship, and a 10 mm overbite.

Once endodontic treatment of $\underline{1}$ was completed, a hard acrylic resin removable maxillary occlusal splint was constructed for the patient, to prevent further damage of the teeth from bruxism, and to evaluate the patient's

ability to tolerate an increased OVD (Figure 5). After 3 months of monitoring, a fixed Dahl appliance (Figure 6) was cemented with glass ionomer cement (Ketac-Cem, ESPE, Norristown, PA19904-0111, USA) to create an inter-occlusal space between $\underline{321|123}$ and their opposing teeth (Figure 7).

The patient was seen 1 week after appliance cementation, and reviewed monthly thereafter. The posterior teeth were in contact again after 3 months (Figure 8) with space created anteriorly (Figure 9). Six type III gold palatal veneers ($\underline{321|123}$) were constructed to create anterior guidance for immediate posterior disclusion in mandibular protrusion, and canine guidance in lateral excursions (Figures 10 and 11). A nightguard of hard acrylic resin was made to protect the restorations and other teeth.

CASE STUDY 3

A 30-year-old woman was referred to a dental hospital by her dental practitioner because she was suffering from dentine sensitivity and poor appearance from a worn dentition. The patient stated that she had bulimia nervosa for about 12 years, but the habit had stopped during the past year.

She had very good gingival health and a minimal amount of plaque. Dentine sensitivity was associated with the vital and worn upper anterior teeth. Tooth $\underline{2}$ was congenitally missing and $\underline{3}$ had erupted mesially in contact with $\underline{1}$. The five upper anterior teeth had reduced clinical crown heights, and their palatal surfaces had dentine

exposure surrounded by only a thin rim of enamel (Figure 12). The patient had a Class II division 2 incisal relationship, and little horizontal difference between ICP and RCP. In ICP, there was no interocclusal space between the upper and lower anterior teeth.

A hard acrylic occlusal splint was prescribed to prevent further toothwear, and to assess the patient's ability to tolerate an increase in OVD and changes in occlusal guidance. Interocclusal space between the anterior teeth was created by a fixed Dahl appliance cemented with glass ionomer cement (Figure 13).

Four months later, all the posterior teeth had re-established occlusal contacts (Figure 14). Surgical crown lengthening was performed to increase the clinical crown heights of the five upper anterior teeth by about 2 mm (Figure 15) and the worn upper anterior teeth were finally restored with full coverage ceramometal crowns (Figure 16).

SUMMARY

Ideally, a preventive and restorative treatment plan for the localized worn anterior dentition should be compatible with periodontal and pulpal health, minimally invasive to the remaining coronal tooth tissues, occlusally stable, functional and aesthetic. A comprehensive treatment plan must be established with clear objectives and understanding of the patient's expectations, including an assessment of the patient's ability to adapt to the changes at the beginning. A multidisciplinary approach may be

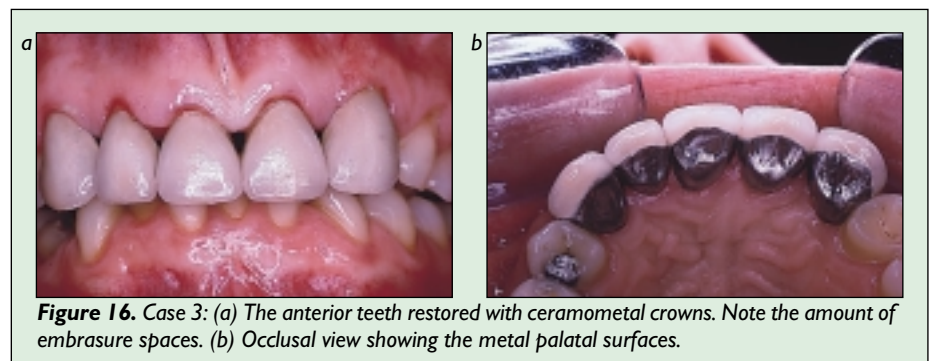


Figure 16. Case 3: (a) The anterior teeth restored with ceramometal crowns. Note the amount of embrasure spaces. (b) Occlusal view showing the metal palatal surfaces.

required for complex cases (see Figure 17). A suitable recall programme is also necessary to maintain successful outcomes.

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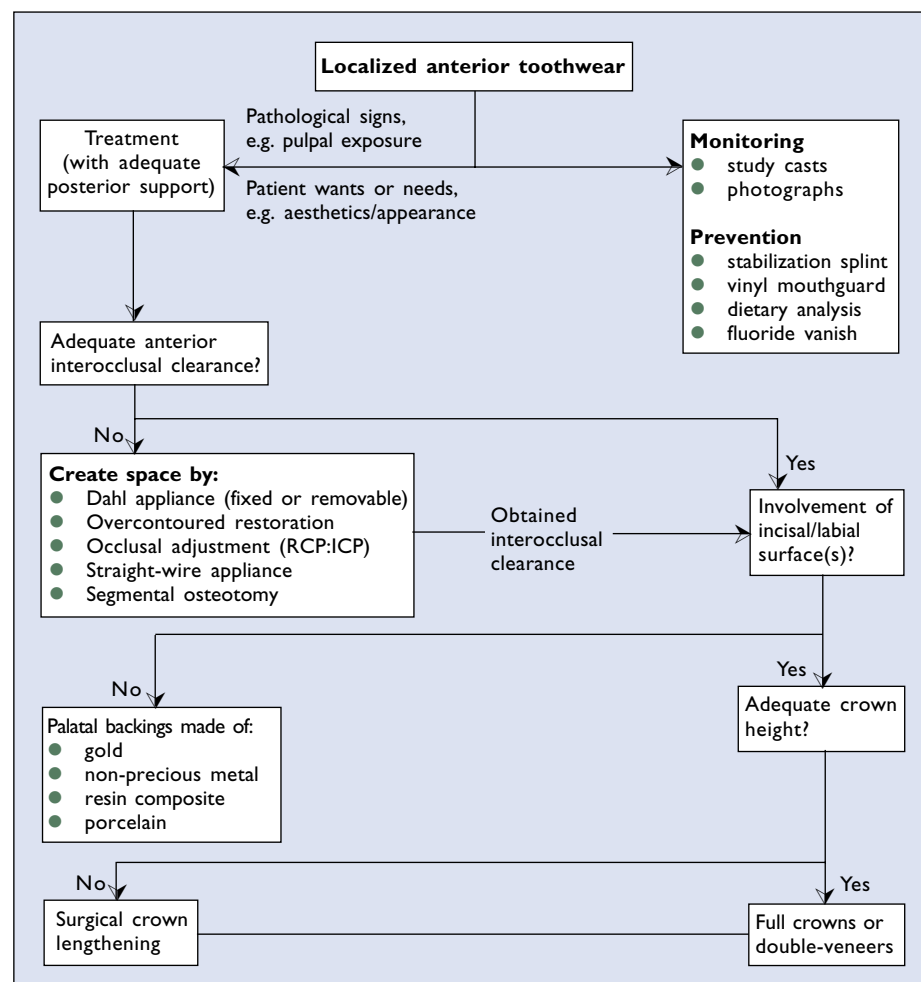


Figure 17. Flowchart of management of localized anterior toothwear.