Restorative Management of the Worn Dentition: 4. Generalized Toothwear

FREDERICK C.S. CHU, ADAM S.C. SIU, PHILIP R.H. NEWSOME, TAK W. CHOW AND ROGER J. SMALES

Abstract: **This is the final paper of a four part series on the management of worn dentition. The factors affecting the selection of restorative techniques for generalized toothwear, such as pulpal vitality, jaw relationship and occlusal guidance are discussed. The practical steps of oral rehabilitation using fixed prostheses are illustrated with two clinical cases.**

***Dent Update* 2002; 29: 318–324**

Clinical Relevance: **Generalized toothwear requiring complex rehabilitation should be managed by a systematic step-by-step approach.**

Although 'full-mouth reconstruction' is a treatment option for generalized toothwear, it is not always necessary because a dentition may still function adequately for mastication and speech, and patients may accept the appearance of their teeth.

A 'conformative' occlusal approach may be used for management of generalized toothwear when the coronal tissues are moderately worn, and if only a few teeth require restorative treatment. Placement of a small number of intra-/extracoronal restorations in a moderately worn dentition with a satisfactory existing occlusal vertical dimension (OVD) and stable occlusal relationships not only simplifies the treatment procedures but also reduces the costs involved. The major drawbacks are the need to sacrifice the tooth substance of the already shortened clinical crown, and a more subgingival placement of preparation margins for retention of extra-coronal restorations.

If multiple restorations are required it is important to decide whether a 'reorganized' occlusal scheme should be used for the management of the moderately worn dentition, even though the OVD may still be satisfactory.

- The reorganized approach with an increased OVD is appropriate when the worn teeth still have an adequate amount of crown height because there is virtually no need to reduce further occlusal tooth substance for adhesive or conventional castings.
- When the worn teeth are short and require restorations, an increase in OVD is frequently combined with surgical crown lengthening. This approach may allow more supragingival placement of margins, reduce the risk of pulpal exposure during tooth reduction, and create tooth preparation with better retention and resistance forms.
- In cases where there is no stable occlusal relationship because the existing dentition is severely damaged or the patient is partially edentulous, the need for a reorganized approach is obvious.

With extensively broken teeth, pulpal vitality must also be determined before restorative treatment is carried out.

Non-vital Teeth

For non-vital teeth endodontic treatment can be carried out with the root canal space prepared for subsequent crowns and the support of removable partial dentures. Removable partial dentures may also be used to increase the OVD and to protect the worn teeth as an onlay denture, an overlay denture or an overdenture[1] (Figure 1).

- An onlay denture extends over the incisal or occlusal surfaces of worn abutment teeth with tooth-coloured acrylic resin, and forms a 'butt joint' on the labial or buccal surfaces. Use of an onlay denture is not recommended if the resin/tooth junction is visible.
- An overlay denture 'laminates' the labial surfaces of the worn teeth with tooth-coloured acrylic resin, which is usually supported by a metal framework or polymeric denture base material.
- An overdenture with fully extended flanges may be constructed if a border seal is required for retention of the prosthesis. Retention of the

***Frederick C.S. Chu**, BDS(Hons), MSc, FRACDS, MRDRCS, FADM, Assistant Professor, **Adam S.C. Siu**, BDS, Postgraduate Student, **Philip R.H. Newsome**, BChD(Hons), MBA, PhD, FDS RCS(Edin.), MRDRCS(Edin.), Associate Professor, **Tak W. Chow**, BDS, MSc, PhD, FRACDS, FDSRCS, DRDRCS, Associate Professor, Faculty of Dentistry, The University of Hong Kong, and **Roger J. Smales**, MDS(Hons), DDSc, FDSRCS, FADM, Visiting Research Fellow, Dental School, Adelaide University, Australia.*

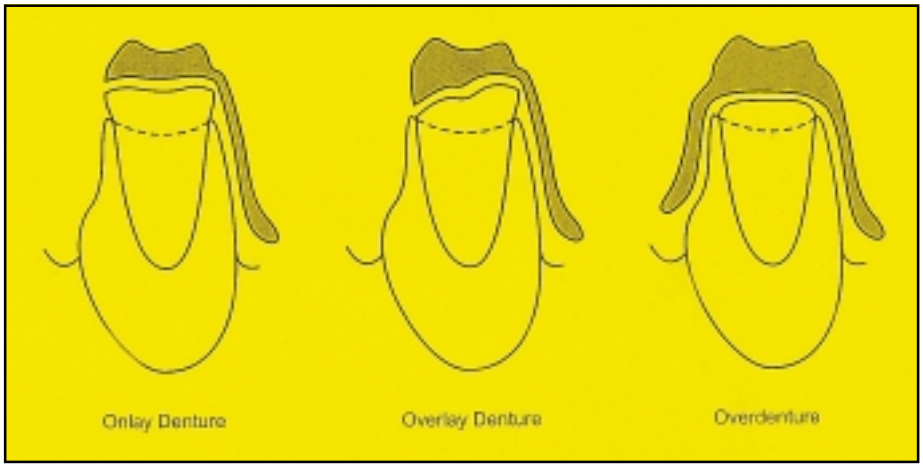

Figure 1. *Worn dentition and denture designs.*

overdenture may be further improved by incorporation of magnets, precision attachments on natural roots or implants.

Irrespective of the denture design selected, oral health measures are imperative to maintain the periodontal health, pulp vitality, and caries-free crown/root surfaces of denture abutments.

Vital Teeth

With the deposition of secondary dentine, it is not unusual to find severely worn teeth with vital pulps. A combination of periodontal surgery and core build-up techniques may be considered to preserve the pulp vitality before elective devitalization. Increasing the OVD using post crowns may increase the risk of longitudinal root fracture unless adequate full-mouth contacts at the increased OVD can be established and maintained.

VERTICAL DIMENSION

In dentate patients presenting with generalized toothwear, interocclusal clearance can be provided with an increase of OVD. The amount of OVD increase required depends on:

- whether one or both arches have to be restored;
- the chosen restorative technique;
- the properties of the restorative material; and
- the patient's ability to adapt.

An appropriate OVD for treatment should allow adequate space available for restorations and maintain contacts between the restored anterior teeth. If toothwear is not compensated for by dentoalveolar growth, then restoration of OVD would be well tolerated.

A decision on whether dentoalveolar growth has compensated for toothwear relies on the crude clinical assessment of the relationship between resting vertical dimension (RVD), freeway space (FWS) and OVD. Theoretically, if the RVD and OVD are reduced, and FWS is normal, restoration of the OVD and RVD are straightforward. With a normal RVD, reduced OVD, and an increased FWS, restoration of the OVD with a reduction of FWS is also generally acceptable (Figure 2). If dentoalveolar growth has successfully compensated for the wear rate the patient will present with normal RVD, FWS and OVD.

Many authors have been concerned that further increase of the OVD may jeopardize the balanced activities of masticatory muscles, which may lead to tooth mobility, repeated failure of restorations, clenching, and even myofascial pain.[2,3] In dentate patients, in contrast to edentulous patients, an increase of OVD and a 'change' of FWS appear well tolerated. Electromyographic studies have shown that the muscles of mastication are able to adapt to an increased OVD when there are stable occlusal contacts:[4] as OVD is increased the mandible adopts a new resting (postural) position, with a decrease in activity of the elevator muscles and an increase in activity of the depressor muscles;[5–7] the FWS will thus be re-established. Such re-establishment of FWS has also been reported in patients with temporomandibular dysfunction who were treated with occlusal splints.[8]

The difference between edentulous and dentate patients may be explained by the mechanoreceptors in the periodontal ligaments, which are responsible for input of changes to the nervous system for generating adaptation.

There is no firm clinical recommendation available for clinicians to determine if an increased OVD will be adapted. With extensive restorative treatment, it seems prudent to use an occlusal splint as a reversible means of

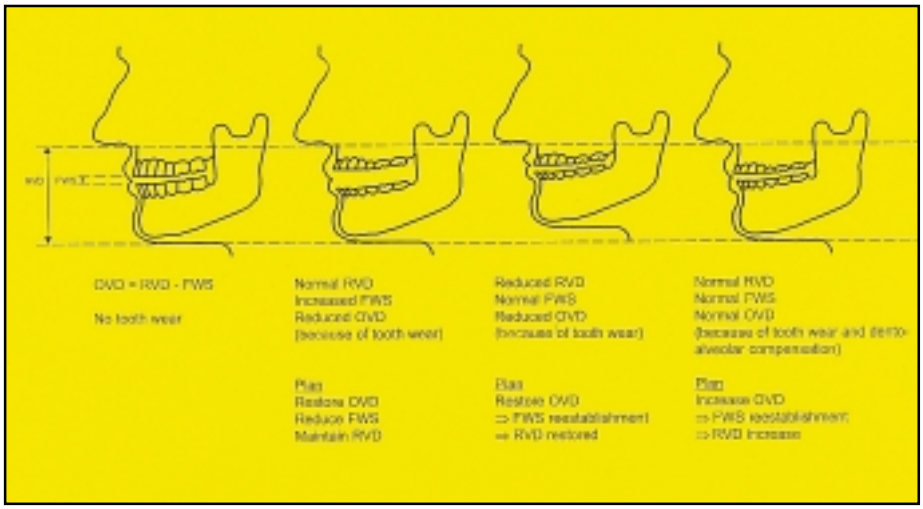

Figure 2. *Consideration of the vertical dimension.*

Figure 3. *Case 1: generalized occlusal toothwear of the lower dentition (occlusal view).*

assessing the patient's acceptance of increased OVD.

ANTEROPOSTERIOR JAW RELATIONSHIP

Although an increased OVD can instantly create interocclusal clearance for restorations, the existing occlusal relationship will be lost. Therefore a new occlusal scheme has to be planned and tested before any irreversible changes are made. The differences between, and the advantages of, various occlusal schemes have been summarized elsewhere.[9] For restorative dentistry, different occlusal schemes have different requirements for anteroposterior jaw relationship between retruded contact position (RCP) and intercuspal position (ICP), and occlusal guidance.

The anteroposterior jaw relationship affects the relationship between maxillary and mandibular teeth. Extensive occlusal restoration should not even be contemplated until the desired jaw relationship has been established. For practical purposes, it is generally accepted that the RCP is reproducible, and the retruded axis of rotation of the mandible can be used as a reference for extensive rehabilitation to make the anteroposterior jaw relationship of a new ICP coincident with that of RCP. When there is a large horizontal and small vertical difference between RCP and original ICP, it is very difficult to achieve occlusal contacts in the case of a small amount of protrusive jaw movement.

Once the new OVD and the axis of mandibular rotation have been determined, a static jaw relationship becomes available between the maxilla and mandible for re-establishment of occlusal scheme.

OCCLUSAL GUIDANCE

Definitions

'Anterior occlusal guidance' can be defined as the effects of the articulating surfaces of anterior teeth on the mandibular movements, and 'posterior occlusal guidance' as the effects of posterior teeth. For patients with severe Class II division 1 and Class III incisal relationships, the occlusal guidance will rely on posterior teeth only.

'Posterior determinant' can be broadly defined as the effects of temporomandibular joints on mandibular movements. 'Anterior determinant' refers to effects of dental articulation including both anterior and posterior teeth.

Mandibular Protrusion

The selected anterior occlusal guidance should be aesthetically and physiologically acceptable to the patient, and convenient for the dentist and technician to prepare.

In mandibular protrusion, the concept of posterior disclusion by anterior occlusal guidance is recognized as the basis for physiological desirability: posterior disclusion/elimination of posterior contacts in mandibular protrusion, rather than canine contacts alone, reduces the elevating activity of temporal and masseter muscles.[10] Posterior disclusion may be 'immediate' if there is contact between anterior teeth in ICP or 'delayed' if there is no contact between anterior teeth in ICP, such as with Class II division 1 malocclusion. Delayed disclusion may occur when a small amount of protrusive jaw movement (or 'long centric' movement) is required before anterior teeth contact and cause disclusion of posterior teeth.

Regardless of the timing for disclusion, it is desirable to have all anterior teeth sharing the guidance, except when a tooth is heavily restored or periodontally compromised. At ICP, 'palatal platforms' may be incorporated in upper anterior restorations to allow occlusal forces to dissipate more along the long axes of the teeth. These platforms may also reduce the risk of over-eruption and labial drifting of the upper anterior teeth.

Lateral Excursion

Occlusal guidance is also responsible for lateral excursion contacts.

- Canine guidance occurs when only the canine on the working side contacts in lateral mandibular movement.
- Group function occurs when two or more pairs of teeth on the working side contact and provide disclusion of the non-working side.

There is little evidence to support one occlusal scheme over another but, irrespective of the occlusal guidance selected, there must be disclusion of the non-working side. Achievement of group function is technically demanding and usually requires intra-oral adjustments, using only a semi-

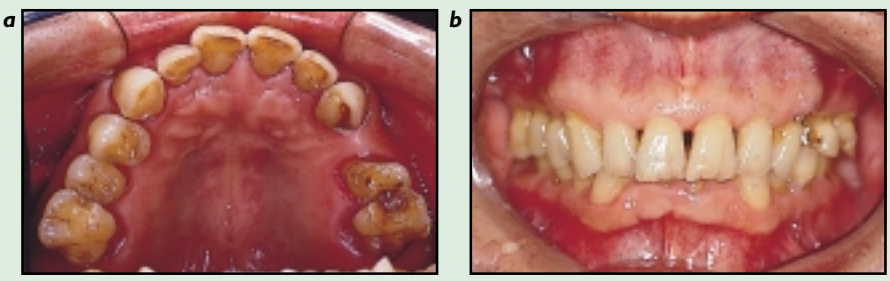

Figure 4. *Case 1: **(a)** Occlusal view showing generalized occlusal toothwear of the upper dentition. **(b)** Frontal view of occlusion at original OVD.*

Figure 5. *Case 1: right buccal view demonstrating the amount of increase in OVD.*

adjustable articulator. However, with canine guidance, consideration must still be given to the contacts that may develop should wear occur on the canine surfaces.

Disclusion of the non-working side can be 'immediate' or 'delayed' in lateral excursion. A 'delayed' disclusion of the non-working side (or 'wide centric') occurs when a small amount of lateral jaw movement is needed to enable the guiding teeth, such as the canines, to contact and provide disclusion in lateral excursion.

PRACTICAL CONSIDERATIONS OF ORAL REHABILITATION

Before irreversible fixed prostheses are provided it is advisable to use a reversible device, such as a hard maxillary occlusal splint or removable overlay denture, to evaluate a patient's adaptive ability to the new occlusal scheme and protect the remaining tooth tissues. However, quite how an asymptomatic patient with worn dentition should be monitored with splint wearing before the definitive restorative treatment is provided is open to question. For examination of the occlusion in RCP recommendations for splint wear have varied from 24 hours to as much of the day and night as possible for 3 weeks.[11,12]

Once the patient has adapted to the new occlusion, a sequential posterior-anterior-posterior approach (PAP) can be adopted for full mouth reconstruction.[13] The first 'P' refers to establishment of posterior stability/support by temporary restorations, which is a pre-requisite for the introduction of anterior guidance (represented by 'A') using temporary or permanent restorations. With temporary restorations, anterior guidance can be further evaluated before its transfer to permanent restorations, using a custom-made incisal guidance table. The second 'P' refers to the provision of posterior stability/support by permanent restorations.

The following cases illustrate how generalized toothwear could be managed with fixed and removable prostheses.

CASE STUDIES

Case 1

A healthy 67-year-old man presented with severe pain from $\overline{6}|$. On examination, exposure of secondary dentine and the root canals of $\overline{6}|$ could be seen clinically as a result of severe occlusal wear (Figure 3). Dentine sensitivity, especially to contact with cold water, was associated with teeth showing generalized toothwear (Figure 4). There was minimal difference between ICP and RCP. The upper and lower central incisors were responsible for mandibular protrusion, while the canines and all posterior teeth were involved in lateral excursions.

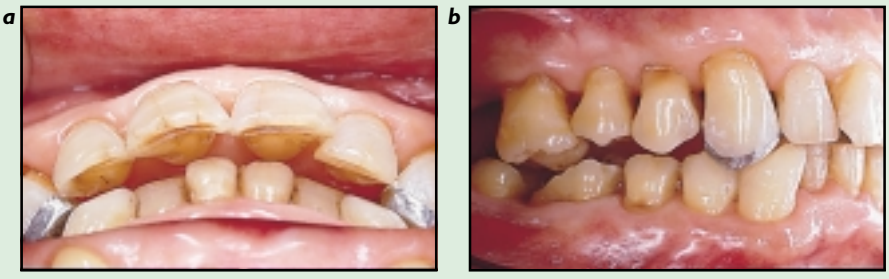

Figure 6. *Case 1:* ***(a)*** *occlusal view showing the amount of anterior space created by palatal veneers bonded on upper canines.* ***(b)*** *The amount of posterior separation is visible on the right buccal view.*

Figure 7. *Case 1: right buccal view showing resin composite build-up for posterior stability.*

Figure 8. *Case 1: the restored upper dentition (occlusal view).*

Figure 9. *Case 1: left buccal view showing the space after debonding palatal veneer on canine.*

Treatment

After completion of endodontic treatment of $\overline{6}|$, an upper acrylic occlusal splint was constructed at a 4 mm increase of OVD to protect the worn dentition, and to assess the adaptation of the patient to a reorganized occlusal scheme (Figure 5). A 'mutually protected' occlusal scheme was used. Canine guidance was used for lateral excursions, while anterior guidance was shared among all the anterior teeth.

After the patient had adapted to the new occlusal scheme, temporary nickel-chromium palatal veneers were constructed on $\underline{3}|$ and $|\underline{3}$ according to an incisal guidance table fabricated with the

Figure 10. *Case 1: frontal view of the restored dentition at increased OVD.*

occlusal splint. The palatal veneers established an accurate increase in OVD, and provided occlusal guidance (Figure 6). Initial posterior support and restoration of the worn posterior teeth were achieved using a posterior resin composite (SureFil, Dentsply, Milford, DE 19963-0359, USA) (Figure 7). Anterior guidance was re-established with gold palatal veneers on 21|12, labial porcelain veneers on $\overline{1|1}$ and incisal resin-composite restorations on $\overline{2|2}$ (Figure 8).

One month after anterior guidance was re-established the premolars and molars on both sides were prepared in two visits. Full-arch impressions were taken for the construction of adhesive gold onlays on 654|6 and $|\overline{56}$, full gold crowns on $\overline{76|}$ and a cantilever conventional ceramometal bridge to replace a missing first premolar.

Figure 11. *Case 2: worn lower anterior teeth, frontal view.*

Figure 12. *Case 2: overlay denture at increased OVD in place.*

After cementation of all posterior restorations with a resin cement (Panavia F, Kuraray, Osaka 530, Japan) the palatal veneers on 3|3 were debonded (Figure 9) and it was confirmed that group function could be achieved in the absence of canine guidance. The incisal edges of the lower canines were then restored with resin composite, and two gold palatal veneers without incisal overlap were cemented on 3|3 (Figure 10).

Case 2

A 50-year-old woman was referred because of generalized worn dentition. The patient's periodontal health was excellent, but endodontic treatment was performed for 4|, |7 and $\overline{7|}$. All of the posterior teeth had been extensively and repeatedly restored with amalgam because of caries and toothwear. The upper anterior teeth had been previously restored with porcelain jacket crowns, which accelerated the wear of the lower anterior teeth (Figure 11). Little difference was found between the RPC and ICP. There was Class II division 2 incisal malocclusion, with mandibular protrusion guided by the lower incisors against the coarse porcelain surfaces of upper crowns. Group function was present for lateral excursions on both sides. From the articulated study casts, unstable contacts between the heavily restored upper and lower posterior teeth in ICP were noted.

Treatment

To evaluate the patient's ability to adapt to an increased OVD and a new reorganized occlusal scheme, a lower overlay denture was constructed to cover $\overline{321|123}$. An upper onlay denture was also used to provide even bilateral posterior support (Figure 12). The use of two separate partial dentures maintained posterior support while the anterior teeth were undergoing reconstruction. The lower onlay denture also temporarily restored the appearance of the worn teeth.

After 2 months, pin-retained core build ups were placed on the worn lower anterior teeth $\overline{1|12}$ at an increased OVD, using a cermet material (Ketac Silver, ESPE, D-82229 Seefeld, Germany) (Figure 13). Ceramometal crowns were used as

Figure 13. *Case 2: prepared lower anterior teeth after core build-up using a cermet cement.*

final restorations for all anterior teeth except |2, for which a pontic with cervical pink porcelain was used. The posterior teeth were then prepared in four sextants for ceramometal and gold crowns (Figures 14 and 15).

SUMMARY

In addition to fixed adhesive and conventional castings, removable partial dentures, or a combination of both fixed and removable prostheses, may be considered in the management of generalized toothwear.

It is very uncommon for the severity of toothwear to be the same in different parts of the dentition, even in patients with 'generalized' toothwear, and patients with generalized toothwear

Figure 14. *Case 2: frontal view showing the finished restorations.*

Figure 15. *Case 2: left buccal view, showing posterior separation in mandibular protrusion.*

should be regarded as having predominantly anterior or posterior toothwear. Our treatment philosophy is to restore function and aesthetics by preserving and protecting the remaining tooth tissue, with minimal alteration of the supporting structures and occlusal relationships. Extraction of the worn teeth and their replacement with partial or complete dentures without first thoroughly exploring the possibility of more conservative approaches is unacceptable: extraction should be used only in the last resort if the existing teeth are unsalvageable, or if replacement of such teeth is not essential. It may be more appropriate to accept a sub-optimal aesthetic outcome based on the existing worn teeth, such as partial restoration of the crown length of the worn incisors with resin composite or onlay denture, rather than an 'optimal' aesthetic appearance with acrylic denture teeth replacements.

Successful management of different degrees of toothwear requires early diagnosis of the problem and an understanding of the different treatment strategies and techniques available, and of the properties of dental materials. Close co-operation with dental specialists such as orthodontists, periodontists and prosthodontists is necessary when there are opportunities for improved treatment results.

The restorative management of generalized toothwear is outlined in Figure 16. Successful maintenance requires regular recall for monitoring and preventive measures.

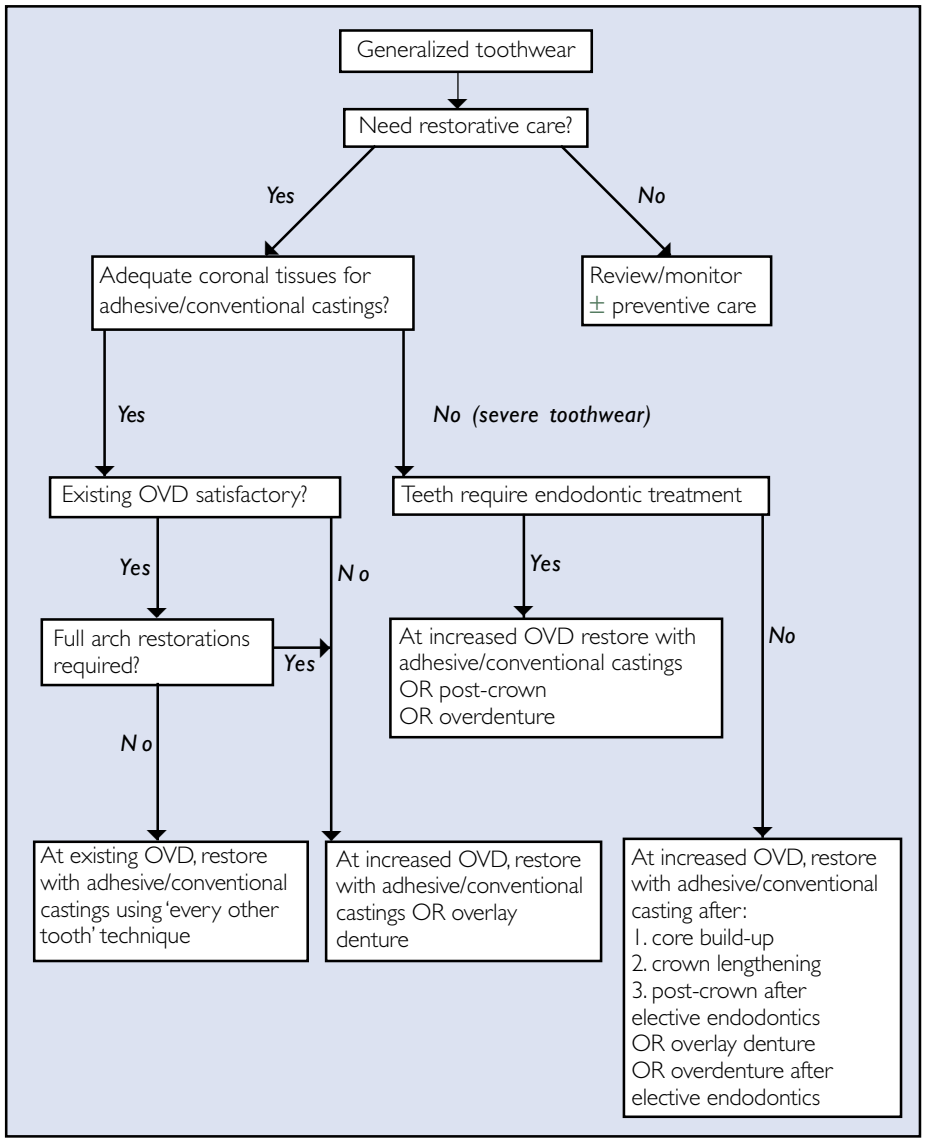

Figure 16. *Flowchart of management of generalized toothwear.*

ACKNOWLEDGEMENTS

We would like to express our gratitude to Mr Anthony C.K. Kam and Mr K.B. Wong at the Prince Philip Dental Hospital for their excellent technical support. We would also like to thank Mr Michael Nesbit of the Department of Conservative Dentistry, Eastman Dental Institute, for his assistance in laboratory work. Special thanks must be directed to Mr Raymond Leung and Mr Tat M. Yim for their help in clinical photography and professional drawings. This study was funded by the Committee on Research and Conference Grants, University of Hong Kong.

REFERENCES

1. Hemmings KW, Howlett JA, Woodley NJ, Griffiths BM. Partial dentures for patients with advanced toothwear. *Dent Update* 1995; **22:** 52–59.
2. Tench RW. Dangers in dental reconstruction involving increase in the vertical dimension of the lower third of the human face. *J Am Dent Assoc* 1938; **25:** 566–570.
3. Schyler CH. Problems associated with opening the bite which would contraindicate it as a common practice. *J Am Dent Assoc* 1939; **26:** 734–740.
4. Carlsson GE, Ingervall B, Kocak G. Effect of increasing vertical dimension on the masticatory system in subjects with natural teeth. *J Prosthet Dent* 1979; **41:** 284–289.
5. Manns A, Miralles R, Gurreo F. The changes in electrical activity of the postural muscles of the mandible upon varying the vertical dimension. *J Prosthet Dent* 1981; **45:** 438–444.
6. Carr AB, Christensen LV, Donegan ST *et al.* Postural contractile activities of human jaw muscles following use of an occlusal splint. *J Oral Rehabil* 1991; **18:** 185–191.
7. Gross MD, Ormianer Z. A preliminary study on the effect of occlusal vertical dimension increase on mandibular postural rest position. *Int J Prosthodont* 1994; **7:** 216–226.
8. Hellsing G. Functional adaptation to changes in vertical dimension. *J Prosthet Dent* 1984; **52:** 867–870.
9. Wassel RW, Steele JG, Welsh G. Considerations when planning occlusal rehabilitation: A review of the literature. *Int Dent J* 1998; **48:** 571–581.
10. Williamson EH, Lundquist DO. Anterior guidance: Its effects on electromyographic activity of the temporal and masseter muscles. *J Prosthet Dent* 1983; **49:** 816–823.
11. Calagna LJ. Influence of neuromuscular conditioning on centric relation registration. *J Prosthet Dent* 1973; **30:** 598–604.
12. Setchell DJ. Periodontal diagnosis and treatment and occlusal analysis. In: Rowe AH, Alexander AG, Johns RB, eds. *A Companion to Dental Studies.* Oxford: Blackwell Scientific, 1986; pp.497–519.
13. Wise MD. *Occlusion and Restorative Dentistry for the General Dental Practitioner.* London: British Dental Association, 1982; p.71.