

REVIEW ARTICLE

Techniques of Direct Composite Build Ups in Managing Tooth Wear Cases: A Narrative Review

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ABSTRACT

Tooth wear or non-carious tooth surface loss is commonly seen in daily dental practices. This is particularly eminent with the increase of dental care awareness in an aging population who retain more of their dentition into their golden years. With the paradigm shift to adhesive dentistry, composite resin build up has shown to be one of the most predictable and minimally invasive procedure in restoring the function and aesthetic of patient's dentition. The present article reviews various techniques of additive direct composite build up, aiming to provide dental practitioners with an overview of the clinical steps in managing tooth wear. *Malaysian Journal of Medicine and Health Sciences* (2024) 20(4): 345-353. doi:10.47836/mjmhs20.4.42

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INTRODUCTION

Tooth wear or non-carious tooth surfaces loss, as the name suggests, is the loss of tooth substance due to factors other than dental caries. It can be due to attrition, erosion, abrasion and abfraction. Attrition is the loss of tooth substance or a restoration as a result of mastication or contact between occluding surfaces of approximal surfaces (1). The estimated normal physiological loss of enamel is around 20-38 micrometer per annum (2). But this may become pathological secondary to parafunctional habits, diet and medical problems (3). The definition of erosion is the loss of tooth tissue by chemical processes not involving bacteria action (4). Abrasion is defined as the physical wear caused by material other than tooth contact (5). This could be caused by excessive brushing technique, habits such as pen chewing, nail biting or pipe smoking (6). Abfraction is tooth wear located in the cervical area caused by flexural forces during function and parafunction (7), which present similarly to toothbrushing abrasion cavities, but tend to be more angular and undercut at the coronal aspect where enamel overhangs the defect. All these non-carious tooth surface loss can occur as

unifactorial, or often multifactorial in aetiology (8). However, not all severe tooth wear are considered as pathological, especially among the geriatric patients where severe wear can be considered as normal aging process (9).

With the improved dental health awareness and positive outcome of effective preventive dentistry, geriatric patients will likely retain more teeth presented with tooth wear. Other contributing factors to increased tooth wear incidence in the elderly are polypharmacy, which causes dry mouth, medical problem such as gastroesophageal reflux disease, and parafunctional habits. Youngsters are also exhibiting non carious tooth surfaces loss, mainly due to erosion, attributed to diets containing high levels of processed sugary food and acidic beverages. The occurrence of tooth wear in these group of adults have caused detrimental effects on the oral function such as mastication, speech and also aesthetic, with its consequences affecting quality of life including incapacities in socializing and low self-esteem.

Tooth wear, with different severity, affects up to 97% of the population (10). The percentage of adults presenting clinically with severe form of tooth wear increases from 3% at the age of 20 years to 17% at age of 70 years (11). The most commonly used index to measure tooth wear is Smith and Knight index (5), a comprehensive index

whereby the surfaces of tooth are scored according to clinical findings based on the level of enamel lost, level of dentine lost and change of contour of the surface. Another commonly used index is The Basic Erosive Wear Examination (BEWE) (12), a partial scoring system recording the most severely affected surface for each sextant. However, these tooth wear indices were proposed to grade the extent of tooth wear. To provide an examination protocol which is more relevant in clinical decision making, the Tooth Wear Evaluation System (TWES) combines assessment of the severity of tooth wear with evaluation of whether the tooth wear is pathological, which indicates the need of intervention (13).

RESTORATIVE TREATMENT OPTIONS IN TOTH WEAR

The prerequisite steps in successfully managing tooth wear cases are comprehensive history taking and accurate diagnosis to determine the aetiology and rate of progression of the aforementioned condition. Along with preventive measurements and patient education, restorative treatment is indicated when patient is concerned about their appearance, experiencing pain or discomfort, difficulty in eating and compromised structural integrity of tooth which might lead to other oral complications. There are, however, contraindications for fixed management of tooth wear such as presence of huge soft tissue defect, unrestorable remaining teeth, worn teeth with compromised periodontal diseases, extensive caries and time constraint, which prohibits some patients to keep up with lengthy treatments.

In general, fixed restorative treatment options can be divided into direct or indirect restorations, whereby removable options are such as occlusal splint, onlay or overlay denture. Choice of restoration depends on numerous factors such as the patient's age, amount and quality of remaining tooth structure, restorative space available, location of the tooth wear, size of the pulp chamber and presence of parafunctional habit (14). Versatility of materials used for indirect restorations including metal fused ceramic, full ceramics, zirconia and metals. As discussed in European Statement on the management guidelines, it is advisable to practice "additive" or direct technique since it is minimal invasive, preserves tooth structure and vitality of teeth. In comparison to "subtractive" technique which subject the worn down teeth to the end of restoration cycle, leading to claustrophobic failure when the restorations fail (15). In term of management of tooth wear cases, the Dahl concept was introduced 30 years ago to increase the interocclusal space by placing removable Dahl appliances on the palatal surface of upper anterior teeth. Poor patient compliance with removable appliances is the primary cause of the space creation failure by Dahl appliance. Followed by the advancement in adhesive dentistry, composite resins have been suggested to be used as fixed Dahl appliance as it is reversible and not

expensive (16). In the present paper, it is the authors' main focus to elaborate on the different methods of direct composite build up techniques in treating tooth wear cases.

DENTAL COMPOSITE RESINS

Composite resins are polymer-based tooth coloured dental restorative materials which set through addition polymerization. The compositions of composite resins include an organic resin matrix, inorganic filler particles, a silane coupling agent and an initiator for polymerization (17). This restoration made its introduction in dentistry over 60 years ago to improve the aesthetic quality of dental restorations. They can be further classified based on the size of filler particle used.

Based on the size of the filler particles, composite resins can be classified into macrofilled, microfilled, hybrid, nanohybrid and nanofilled (17). Macrofilled composites were the first generation of composites introduced in the late 1950s and generally contained 70% to 80% filler content by weight. Due to the large filler particle size (10–100 μm), although exhibiting stronger physical properties, poor polishability with rough surface upon polishing were noted. Hence, this material is no longer widely used in clinic now. In an attempt to improve this, microfilled composites with smaller particles (0.2–0.04 μm), consist of 50% to 60% filler content by weight were introduced in late 1970s. This composite with colloidal silica particles produced a high polishability and smooth surface finished restoration. However, as microfilled composites exhibit inferior physical properties compared to other types of composites, this material is not indicated for stress bearing area, only used selectively for anterior restoration. In order to combine both advantages of microfilled and macrofilled composites, hybrid composites were subsequently introduced in early 1980s. It consists of broad range of particles size and combined the physical properties of both macrofilled and microfilled composites. With the advancement of nanotechnology in early 2000s, nanohybrid composites which contained a combination of micro and nano sized filler with a diameter of 0.3–1 μm and 0.02–0.05 μm were introduced. The latest generation of composite is nanofilled composites with the size of nano particles which varies from 5–75 nm (18) and contain content up to 79.5% by weight. This leads to lesser polymerisation shrinkage, increased polishability and improved physical properties. In short, hybrid, nanohybrid and nanofilled composites are among preferred choices for clinicians at present. Besides the size of the filter, incremental layering technique was advocated to reduce shrinkage stress and increase the degree of conversion. However, this technique is time consuming and may lead to failure if there are gaps between the layers. These challenges have paved the way for the development of bulk-fill composite which may be applied in layers of thickness of 4–5 mm, making the process of placing large composite

restorations simpler and quicker without compromising the micromechanical properties (19). An in-vitro study showed that the wear and surface roughness of bulk-fill composite is comparable to conventional composite in attrition, erosion and abrasion (20). The clinical outcome of bulk filled composite is deemed similar to the conventional incrementally layered composite within a review interval of 6 months to 10 years (21). Hence, bulk fill composite can be used as a viable option for treating tooth- wear cases.

Physical and Mechanical Properties of Composite Resin in relation to the Restoration of Worn Teeth

One of the major advantages of composite resins is its ability to bond to tooth structure, thus allowing an additive approach in direct restoration as a viable restoration option (22, 23). This approach is more conservative and ideal in restoring worn teeth, particularly in short, worn teeth that are unsuitable for conventional crowning owing to the lack of retention and resistance form. In addition, direct restoration is relatively inexpensive with superior aesthetics. Besides, composite resins have a comparable wear rate to the rate of enamel attrition and thus do not result in excessive tooth wear on the opposing teeth (24). When compared with indirect treatment options such as glass ceramic, composite resins cause lesser tooth wear to opposing teeth as well (25). In general, more follow up appointments are anticipated for composite restoration as it is more easily worn down compared to indirect restoration materials (26). However, over long term the advantages of composite resins outweigh their flaws as they can be easily repaired compared to other restorations such as ceramics. Effective mechanical bonding between enamel and adhesive can be achieved by acid-etching, but bonding of composite resin to exposed dentine which is commonly seen in tooth wear cases has proven to be difficult due to the weak adhesive-dentine bond (27). Frequent exposure of acids increases activity of proteolytic enzymes, leading to degradation of non-infiltrated collagen and hybrid layer over time (28), significantly impairing adhesion to eroded dentine (29). Studies have shown that surface pretreatment such as application of riboflavin, silver diamine fluoride which aims to remove or stabilize the demineralized collagen layer, helps in promoting better bonding strength of etch and rinse or self-etch adhesives on eroded dentine (30). Another technique to improve bonding of eroded dentine including usage of methacryloyloxydecyl dihydrogen phosphate (MDP) containing universal adhesives which showed less degradation over long term observation (28).

Survival Rate of Composite Resins in Treating Tooth Wear Case

The longevity of the restorations is one of the crucial factors in selection of restoration technique, particularly the success and survival rate of composite resins in treating tooth wear cases. A 7 year randomized controlled

trial reported that direct placement of composite restorations at an increased occlusal vertical dimension is a predictable process with acceptable aesthetics and good long term survival (31). According to a study done by Rodolpho and colleagues (32), the success rate of composite resins was determined by the number of restorations that did not require any intervention while the survival rate of composite resins was determined by the number of restorations being repaired and still functional (33). It was reported that the success rate and survival rate of direct composite resin restorations as full mouth rehabilitation patients with severe tooth wear are 94.8 % and 99.3% at 3.5 years (33). This was further supported by the findings of Milosevic and colleagues, where the failure rate over a mean of 33.8 months was 5.4% in cases with severe attrition and erosion (23). Hemmings et al. showed survival rate of 89.4% for direct composite restorations in treating tooth wear case at an increased vertical dimension with follow up period up to 30 months (34). Gulamali and colleagues documented 10-year survival of anterior maxillary composite restorations placed in tooth wear cases. A median survival of 5.8 years were reported, with over 90 percent of the restorations displayed signs of major or minor failure, usually due to wear, fracture and marginal discoloration (35). Studies have consistently shown that composite resins are the material of choice when rehabilitating worn dentition in direct approach.

FACTORS AFFECTING SURVIVAL RATE OF COMPOSITE RESINS

The survival rate of composite resins build-up in tooth wear cases is dependent on various factors such as occlusion, types of teeth, types of material, curing protocols and clinical skill of the clinician.

Occlusion Factor

Incisor relationship is an important occlusion factor in determining good restoration outcome. Composite restorations in cases with Class II division two incisor relationship have been shown to have a significantly lower survival rate. This is thought to be due to the unfavourable and higher tensile force the restorations are subject to. On the other hand, similar restorations in those with Class III incisor relationships have higher survival rates as compared to Class I and II incisors (35). Parafunctional habits, particularly bruxism will negatively impact the success rate of treatment with the high occlusal load.

The presence of posterior support is particularly important for the longevity of composite resins. The lack of posterior support occurred when there are missing six or more posterior teeth (premolars and/or molars). Milosevic and colleagues observed that lack of posterior support resulted in reduced mean survival time of composite resin restorations in anterior region due to a higher occlusal load exerted on the anterior

teeth (23). In an attempt to increase the longevity of anterior restorations, patients with anterior tooth wear are therefore recommended to have their posterior teeth replaced with prosthesis prior to restoration.

Types of Teeth

According to a retrospective study done by Kanzow and colleagues, the ten years mean annual failure rate of composite resins for posterior restoration were reported higher compared to anterior restoration (36). Posterior teeth (molars and premolars) typically experience higher occlusal force during chewing compared to anterior teeth. This increased occlusal load can lead to higher stress on posterior restorations, potentially contributing to their failure. When it comes to posterior restoration, which are premolars and molars, there is a greater chance of failure for molars restoration when compared to premolars (37). This is because molars are positioned at a closer distance to the temporo-mandibular joint, resulting in higher occlusal load, with the mandible functioning as a class II lever (38).

Material Factor

The filler content in composite resins is also found to have an impact on the overall survival rate of composites. Composite resins with higher filler content performed better with increased longevity due to increased mechanical properties of the composites. The wear rate appears to increase with the particle size of the main filler. Looking at hybrid and microfilled composites, it is found that hybrid composites exhibit a higher survival rate with a lower loss of anatomical form when compared to microfilled composites (39).

Curing Factor

Strict adherence to curing protocol recommended by manufacturer is important to ensure adequate polymerisation of composite resins restoration. Studies showed that inadequate polymerisation can contribute to failure of the restoration given that adequate polymerisation optimizes the physical and mechanical properties of composite resins (40). In general, using light cure with light intensity of 400 mW/cm² for 40 second is sufficient to polymerise composite with 2mm thickness (curing depth). Incremental composite layering technique is recommended for composite resin placement to reduce the effect of polymerisation shrinkage. With the modification of the LED curing unit and the composite resins composition, the clinical time for incremental composite layering technique can be reduced with the ultra-high LED curing unit and bulk fill composite resins. The introduction of ultra-high intensity LED curing unit (4000 mW/cm²–5000 mW/cm²) has reduced the curing procedures to 1- 3 seconds. Correct curing time and technique should therefore be applied according to intensity of light source to maximise the degree of polymerisation and durability (41).

Clinical Skills Factor

The survival of composite resins is also highly dependent on the quality of the operative procedure and clinical skills of the operator. Effective moisture control, complete caries-free, adequate cavity preparation, good interproximal contact point and occlusion are vital for long term survival of composite resins especially in managing tooth wear cases. Clinical experience of the operators also affects the durability of restorations. A study showed that clinicians with lesser clinical experience had the higher number of composite resins replacement due to secondary caries compared to more experience clinicians (42).

TECHNIQUES IN DIRECT COMPOSITE BUILD-UP

By applying strict adhesive protocol, dental composite resin can be the material of choice to restore worn down dentition, particularly on aesthetic zone such as anterior teeth. Studies have shown promising survival rate of direct composite for restoration of tooth wear which is 90% in 5 years (23) and 85 % over 7 years observation period (43).

“Additive” restorations can be done with or without laboratory preparations. For uncomplicated case such as localized anterior tooth wear with sufficient restorative space, composite restoration can be carried out freehand without laboratory preparation. As dental composite resin is ‘hydrophobic’, this method can be technique sensitive as it needs to follow strict moisture control.

When treating more complicated cases, such as reorganize cases with new vertical dimension or anterior guidance, extensive wear at posterior teeth, severe wear with multiple failed restorations or demanding patient with high aesthetic demand, comprehensive clinical investigation and laboratory planning helps in providing a more controlled and predictable treatment outcome (44).

A diagnostic wax up allows planning of the shape and contour of final restorations according to the desired occlusal scheme. The design of planned composite build up can be duplicated in a stone model for fabrication of various templates which help in transferring laboratory planning into clinical procedure (45). This is also known as matrix transfer technique (46).

Diagnostic wax up can be copied using a transparent polyvinylsiloxane (PVS) material. This can be done chairside, by injecting transparent PVS material around diagnostic wax up or fabricated in the lab. Besides that, palatal putty index can also be prepared chairside by hard body PVS or putty (47). This technique which only transfers the palatal or lingual shape of the planned

information, is particularly useful for upper anterior teeth in facilitating smooth anatomical contact points and aesthetic layering technique. Mylar strips are used for the proximal surface build up to establish a good contact point and avoid composite material sticking to adjacent tooth surfaces.

When comparing the two chairside composite placement methods previously discussed, both can produce outstanding results when applied properly. Using a free-hand technique, restorations can be done in one treatment session, reducing the number of treatment visits. It is, however, very technique-sensitive, particularly in larger build-ups where numerous restoration features need to be created at the same time. On the other hand, the main benefit of the matrix transfer technique is that it provides guidance for two extremely difficult aspects of restorations: the incisal edge position and the recreation of palatal anatomy. A composite “palatal shell” made with an index makes it easier to build up and layer gradually, producing more aesthetically pleasing restorations with various shades and translucencies (48).

Apart from chairside technique, vacuum formed splint made of polyethylene material can be fabricated in the laboratory over a duplicated stone model. There are various thicknesses available, depending on the clinician’s preference. Thick vacuum formed or thermoformed plastic splint are rigid, thus reducing the chances of distortion, but they lack details as compared to silicone material and can be difficult to remove. The advantage of this technique is that composite resin can be light cured directly through the transparent material, but it incurs laboratory charges and inadequate undercut block out may lead to poor fitting matrices. If there is presence of multiple severe undercuts, it is advisable to opt for other materials and techniques. Fig. 1 demonstrates an example of composite build up in restoring generalized tooth wear by using vacuum formed splint as template (46). Fig. 2 explained another cause of direct composite build up together with removable orthodontic appliance in managing a generalized tooth wear patient.

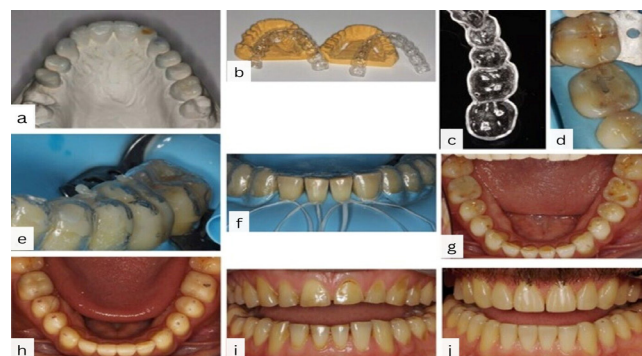


Figure 1: A case of composite build up in restoring generalized tooth wear (a) Study model with diagnostic wax up. (b) Fabrication of rigid vacuum formed splint from duplicated study model. (c) A closed-up view of the vacuum formed splint, venting holes were prepared to facilitate composite placement. (d) Retention grooves prepared on existing restoration at tooth 46. (e) Heated composite placed on the teeth by using the splint fabricated. (f) Composite build up done at the posterior teeth then followed by anterior teeth. (g) Intraoral occlusal view of mandibular teeth before composite build up. (h) Intraoral occlusal view of mandibular teeth after composite build up. (i) Pre-operative intraoral photograph. (j) Post-operative intraoral photograph.

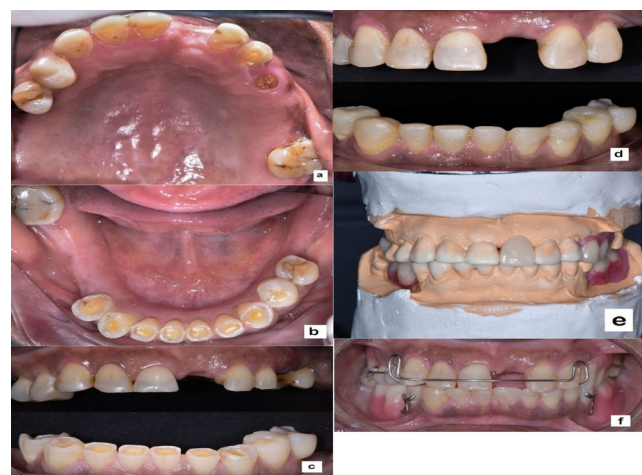


Figure 2: A case of generalized tooth wear treated with composite build up and removable prosthesis. (a) Pre-operative Intraoral photograph of the maxillary arch occlusal view. (b) Pre-operative intraoral photograph of the mandibular arch occlusal view. (c) Anterior view of both arches before composite build ups. (d) Anterior view of both arches after composite build ups. (e) Diagnostic wax up on study cast as a reference for composite build up. (f) Anterior view of patient wearing removable prosthesis after direct composite build up done using template fabricated from diagnostic wax up.

In an attempt to overcome the disadvantages of vacuum formed splint and template fabricated with clear polyvinylsiloxane, matrix transfer technique combining two materials have been reported as shown in Fig. 3 (49). With the clear polyvinylsiloxane material at the working side and rigid vacuum formed splint extending to adjacent teeth, acting like a casing, this technique provides a stable guide, facilitating accurate transfer of details from wax up to restoration and easy placement and removal of the template (49). To improve the outcome of the restorations, highly filled flowable composite should be carefully selected. Apart from the integrity of restorations, regular follow up is advised to monitor the discoloration which commonly occurred in one year time (50).



Figure 3: Matrix transfer technique combining vacuum formed splint and clear polyvinylsiloxane. (a) Silicone index was made using clear polyvinylsiloxane (approximately two mm thickness) on the diagnostic wax up model. (b) The template for composite build up was fabricated by vacuum press one mm polyethylene covering the silicone index and adjacent teeth on the model. (c) The tip of flowable composite resin inserted into the perforation of the silicone index. (d) Light cure can be done through the transparent template. (e) Composite build up was done on alternate tooth. (f) Removal of Teflon band, excess composite was removed before restoration of other teeth.

With the rapid development of intraoral scanner and digital software, digital dentistry is now commonly integrated into daily restorative workflow (51-52). Marta and colleagues reported a case presenting a full mouth rehabilitation performed with direct resin composites using fully digital planning as shown in Fig. 4 (53).

For both freehand restoration and direct composite restoration assisted with matrix, to facilitate proper interdental brushing after restorations, alternate tooth build up is commonly used in preventing composite resin from bonding to adjacent teeth. Materials used to separate between teeth are such as polytetrafluoroethylene (PTFE) or polyacetate strips. While monochromatic composite used for injection moulding technique which is routinely used, it shows only single shade. For patients who have high aesthetic demand, layering technique with

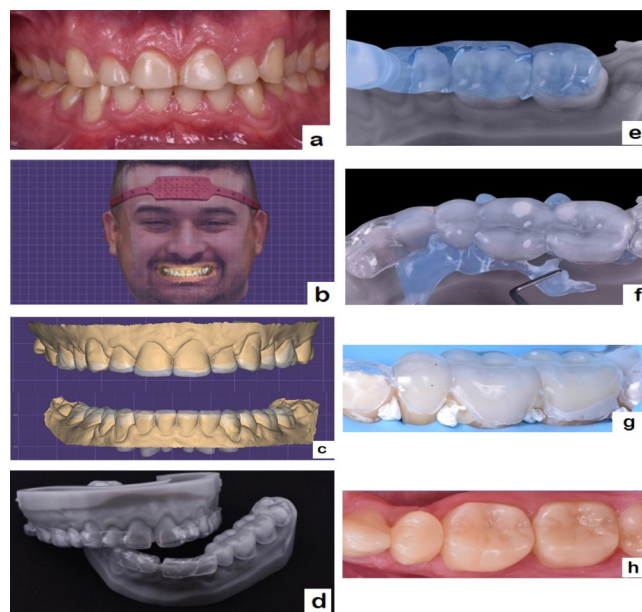


Figure 4: (a) Intraoral photograph showing shortening of teeth due to tooth wear. (b) STL file of Digital wax up integrated with 3D facial scan. (c) STL file of digital wax up. (d) Vacuum formed template was fabricated on the 3D printed diagnostic wax up models. (e) Clear PVS material was syringed on the 3D printed diagnostic wax up model. (f) Vacuum formed template was adapted on the clear PVS material until its fully set. Excess transparent silicone material was removed. (g) Template filled with preheated hybrid composite are placed in the corresponding quadrant. (h) Intraoral photograph showing the completed restoration according to the digital design.

different shades of composite is preferred. An easier way to achieve this is by using a putty index whereby build up can be done after building up the palatal shelf (54). Good fitting of stent, matrix or template is a prerequisite step in accurately transferring the diagnostic wax up to the restorations. Care should be taken to ensure good fitting of the matrix or stent, especially when clear polyvinyl silicone material is used since it is not easily visualized compared to polyethylene material. By removing the matrix which is 3mm apical to contact point, small vents are created using round bur buccally and lingually, these steps helps in reducing the excess composite restoration formed at the triangle area below contact point (55).

Multiple techniques to restore a worn dentition with direct composite build-up have been summarized in the present paper. Having knowledge and skill to carry out predictable build up in such cases are important in conducting the treatment as well as educating the patient. Apart from treatment outcome, patient satisfaction with restorative therapy is largely based on the patient's understanding and acceptance of the nature of their tooth surface loss and the role of restorations. Patients should be educated regarding the technical difficulty of placing predictable restorations in their parafunctional environment. Treatment of tooth wear cases should be conducted in phases, not merely focusing on restorations. Whilst restorations are usually placed to improve the form, function, and appearance of the worn

teeth, preventive measurement and maintenance phase too are imperative in preserving the dentition.

CONCLUSION

Various direct composite build-up techniques in restoring tooth wear or worn dentition were elaborated in this paper. There is no single best technique as clinician should evaluate the advantages and disadvantages of each technique based on the case selection, availability of materials, as well as clinician's preference. Finally, dental practitioners are required to master the fundamental knowledge on the aetiology of tooth wear, selection of materials and predictable clinical skills to treat tooth wear cases in a holistic approach.

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