Journal of Oral Rehabilitation

Journal of Oral Rehabilitation 2016 **43**; 145–153

Review

Survival rates of anterior composites in managing tooth wear: systematic review

K. E. AHMED & S. MURBAY *Comprehensive Dental Care Department, Prince Philip Dental Hospital, Faculty of Dentistry, University of Hong Kong, Hong Kong (SAR), China*

SUMMARY **The use of composite restorations for patients with tooth wear is considered as a more conservative treatment option. The aim of this study was to systematically review the literature investigating the survival rates of anterior composite restorations when used in managing tooth wear in patients. PubMed and MEDLINE (Ovid) databases were screened for studies from 1995 to 2015. Cross-referencing was used to further identify articles. Article selection and data extraction were performed in duplication. Languages were restricted to English. A quality appraisal of included studies was carried out using the Strength of Recommendation Taxonomy system. Six hundred and sixty-six articles were initially identified from which eight articles were full-text reviewed. Six articles involving five studies were selected for inclusion. Three studies were prospective and two retrospective. Included studies involved placement of 772 direct and indirect anterior composite restorations in 100 patients with follow-up periods between 5 months and 10 years. The survival rates of anterior composites were >90% and 50% at 2·5 and 5 years, respectively. Posterior occlusion was re-established in 91% of patients within 18 months. Meta-analysis could not be performed due to the heterogeneity of included studies. The systematic review's overall strength of recommendation was graded B. There is evidence to support the use of anterior composite restorations at an increased vertical dimension of occlusion in the short/medium-term management of tooth wear. Long-term reporting of outcomes remains limited. Further research is needed with standardised study design, detailed reporting of outcomes and long-term review.**

KEYWORDS: **review, tooth wear, composite resins, survival rate, vertical dimension of occlusion, bruxism, tooth erosion**

Accepted for publication 10 September 2015

Background

There has been a sustained decline in the prevalence of edentulism, with an expected continuation of this projection, especially in Western societies (1, 2). Consequently, as more patients retain their teeth, the treatment needs and management approach become more complex (3). This poses new challenges to the Dental Care Professional. According to the UK's 2009 Adult Dental Health Survey, only 6% of the population were edentulous. However, the survey also noted an increase of 43% in the prevalence of tooth wear, when compared to the 1998 survey findings (4, 5). Moderate tooth wear (exposing a large area of dentine) was also present in 15% of dentate adults, while 2% had severe tooth wear, either exposing the pulp or secondary dentine. Furthermore, Van't Spijker *et al.* (6) concluded in their systematic review that tooth wear is indeed associated with age, as the percentage of adults presenting with severe tooth wear increased from 3% at the age of 20 to 17% at the age of 70.

doi: 10.1111/joor.12360

Tooth wear can have detrimental effects on the dentition and the quality of life of patients, leading to issues with aesthetics, function, sensitivity, pain, pulpal exposure and even tooth loss (7–10). Additionally, tooth wear can be a sign of a serious underlying medical and/or mental disorder (11–13).

Adhesive dentistry has evolved with improvements in its materials' physical, mechanical and chemical properties (14–16). Subsequently, there has been a growing interest in using resin composites as a mean to managing tooth wear, particularly in anterior teeth (17–20). Such an approach offers a more conservative oral rehabilitation alternative that preserves the existing tooth structure, in contrast to a conventional more invasive approach. However, there is a lack of evidence regarding the long-term outcomes of various tooth wear management modalities, with anterior composite restorations being one of them (21, 22). Consequently, the absence of evidence-based guidelines and recommendations for the management of tooth wear further complicates and challenges the clinical treatment planning and decision-making process.

The purpose of this research was to systematically review the literature, from January 1995 to April 2015, with the aim of assessing the longevity of anterior composite resin restorations as a management option in tooth wear patients. This is demonstrated through the survival rates of these restorations *in vivo*. The focused question of this systematic review was, 'What are the survival rates of anterior composite restorations used to manage tooth wear in patients?'

Materials and methods

Review protocol

The review aimed to systematically retrieve and analyse clinical studies investigating the longevity of anterior direct and indirect composite resin restorations in managing tooth wear patients. The protocol was developed and agreed upon by both investigators prior to commencement of the study. The PICO principle was used in formulating the research question (23). Patient cohort investigated was tooth wear patients. The intervention was anterior composite restorations in the management of tooth wear. No control or comparison was selected. The outcome reviewed was the survival rates/longevity. Consequently, the review question formulated was, 'What are the survival rates of anterior composite restorations used in managing tooth wear in patients?' The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines where consulted whenever applicable (24).

Search strategy

A database literature search in PubMed and MEDLINE was performed to identify studies for inclusion. Both investigators (K.A. and S.M.) independently searched and reviewed the titles and abstracts of retrieved studies, using the agreed search strategy (Table 1). The investigators were not blinded to journal names or article authors.

Study selection

It was agreed to include randomised and non-randomised, controlled, prospective and retrospective studies. Selected articles had to involve the sole use of anterior direct and indirect composite resin restorations for managing tooth wear in patients. The restorations' follow-up period had to be at least 5 months. Studies that involve the use of other restorative interventions (removable partial dentures, ceramic restorations, gold crowns, etc.) used concurrently with anterior composite restorations, as part of the tooth wear management approach, were excluded. The selected studies were limited to those in English language, published in the past 20 years (from 01 January 1995 to 01 April 2015), and conducted on humans. Case studies and case series were also excluded. Study inclusion and data extraction was achieved through discussion and agreement between investigators. Selected citations were independently full-text screened by investigators. Citation mining was also performed via cross-referencing and checking all reference lists of included articles.

Table 1. Search strategy used for PubMed

1	Search (((TOOTH WEAR) OR NON CARIOUS TOOTH SURFACE LOSS)) OR TOOTH SURFACE LOSS) NOT NON CARIOUS CERVICAL LESIONS
2	Search ((((COMPOSITE) OR DIRECT COMPOSITE) OR INDIRECT COMPOSITE) OR COMPOSITE BUILD UP) OR COMPOSITE RESIN
3	Search ((#1 and #2)) Filters: Publication date from 1995/01/01 to 2015/04/01

Data extraction

Unpublished data were not sought from included studies' authors or obtained from other sources. Extracted data were reviewed and analysed according to the following:

1. Study type (prospective/retrospective)
2. Number and age of participants
3. Follow-up period
4. Identified tooth wear aetiology (attrition/erosion/abrasion/multifactorial)
5. Pre-operative incisal relationship (Kennedy class I, II or III)
6. Location of intervention (maxillary/mandibular arch)
7. Type of intervention (direct/indirect composite restorations and materials)
8. Mode of intervention (tooth preparation or no preparation, and number of operators)
9. Increase in overall vertical dimension (OVD), amount of increase and time of re-establishment of posterior occlusion
10. Assessment of intervention at follow-up (criteria used, number of assessors and their calibration)
11. Definition of intervention failure
12. Survival rate/longevity

Data extraction and grouping according to the aforementioned categories would also assist in assessing any potential bias present in included studies. A meta-analysis was also planned, if feasible.

Quality assessment

The quality of the individual studies and the overall strength of recommendation of the systematic review were graded according to the Strength of Recommendation Taxonomy (SORT) grading system (25). Strength of Recommendation Taxonomy addresses three key elements in research: quantity of evidence, quality of evidence and consistency of evidence. The clinical strength of recommendation derived from the systematic review was accordingly graded as either: A = strong, B = moderate or C = weak.

Results

Outcome of search

In sum, electronic screening of PubMed and MEDLINE identified 666 articles (Fig. 1). Forty-four titles and their abstracts were assessed for eligibility. A total of eight articles were full-text reviewed. The study by Smales and Berekally (26) was excluded because 14 patients, of 17 included in the study, had 20 removable partial dentures made as part of their treatment plans. The study by Hamburger (27) was also excluded from the review because patients' treatment plan involved restoring both anterior and posterior teeth, in addition to the use of full gold and metal ceramic crowns. Consequently, only six articles, involving five studies (Table 2), were selected for inclusion in the systematic review (28–33).

Sample size and study characteristics

Three studies were prospective and two were retrospective, with post-operative follow-up periods ranging between 2 and 10 years (2). The sample size ranged between 12 patients/75 composite restorations (29) and 31 patients/225 restorations (30). Age of patients ranged between 15 and 80. Class I incisal relationship was present in 37 patients, class II

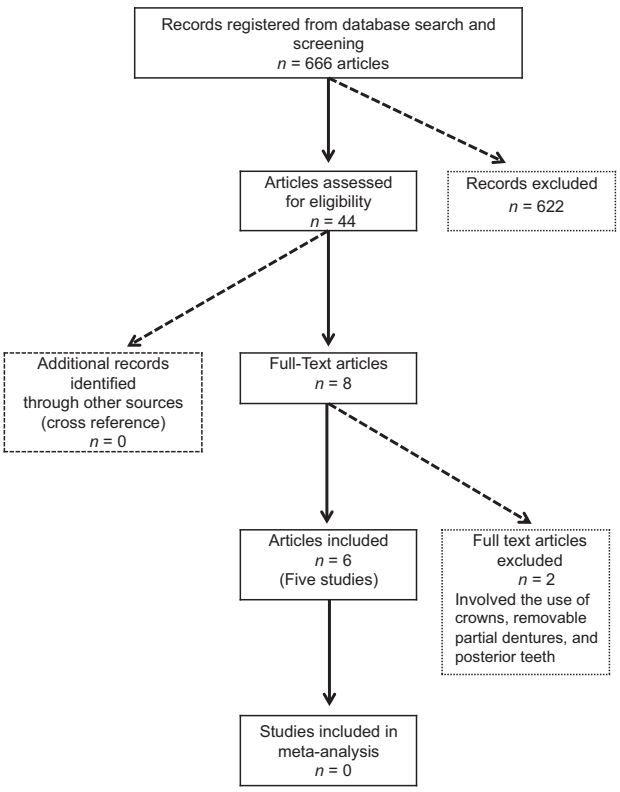

Fig. 1. Flow chart of the selection of studies for the systematic review of the survival rates of anterior composite restorations used in managing tooth wear in patients.

Table 2. Selected studies for inclusion in systematic review

Study	Year	Type of study	Patients	No. of composite restorations	Follow-up period	Journal
Hemmings (28)	2000	Prospective	16 patients (19–54 y/o)	104 direct (microfilled and micro hybrid) restorations	2·5 years	J Prosthet Dent
Gow and Hemmings (29)	2002	Prospective	12 patients (17–61 y/o)	75 indirect (ceromer) restorations	2 years	Eur J Prostho Rest Dent
Redman (30)	2003	Retrospective	31 patients (15–70 y/o)	225 restorations. Direct, *n* = 134/225 (37 microfilled and 97 microhybrid) + Indirect, *n* = 91/225 (18 microhybrid and 73 ceromer)	5 months – 6 years	BDJ
Gulamali (32)	2011	Retrospective	26 patients (28–80 y/o)	283 restorations. Direct (*n* = 190/283) + Indirect (*n* = 63/283) + Combined (*n* = 30/283)	10 years	BDJ
Poyser (31), and Al-Khayatt (33)	2007 and 2013	Prospective	14 patients at 2·5 years (31–75 y/o) and 15 patients at 7 years (38–78 y/o)	*n* = 77 direct (microhybrid) at 2·5 years and *n* = 85 direct (microhybrid) at 7 years	2·5 and 7 years	J Oral Rehab

division 2 in 22 patients, class II division 1 in 16 patients and class III in 16 patients. One study did not clarify the incisal relationship of patients (29). Dental erosion was identified as the main aetiology in 36 patients, followed by a multifactorial aetiology in 31 patients, and attrition and abrasion in six and two patients, respectively. Two studies did not mention the main diagnosed aetiology of presented tooth wear (28, 29).

Description of intervention

In total, 772 composite restorations were placed in 100 patients. The majority of restorations placed were direct composite restorations (*n* = 513/772), followed by indirect composite restorations (*n* = 229/772), and a combination of direct and indirect composite restorations (*n* = 30/772). The materials used were as follows: microfilled Durafill composite* , microhybrid Herculite XRV composite† and ceromer Artglass®*. When it came to bonding techniques, two studies used Optibond®† in conjunction with the Herculite XRV composite (28, 31, 33), one study used 2bond2 resin cement* with Artglass®, and two studies did not mention their bonding techniques (30, 32). Details of tooth preparation prior to placement of restorations were not clear in three studies (29, 30, 32). Hemmings' study mentioned that minimal tooth preparation was carried out to reduce sharp enamel edges (28). Only two studies mentioned the state of the opposing dentition (31, 32). All studies involved an increase in OVD, with three studies detailing the amount of increase to be between 0·5 and 5 mm (28, 29, 31, 33). Posterior occlusion was restored within 18 months of placement of anterior composite restorations in 91 patients. The number of operators was mentioned in three studies, which ranged from one to three experienced operators (28, 30, 31), one study mentioned that the operators were senior clinical staff and postgraduate students (32), and one study did not present any operator details (29).

Assessment of intervention

The majority of included studies used modifications of the United States Public Health Services (USPHS) criteria to assess the restorations, with a Charlie (C) grade indicating that a restoration was clinically unacceptable and hence requiring replacement (29–33). However, Poyser and Al-Khayatt in their study clearly defined restoration failure as: complete bulk failure with no remaining composite (31) and survival as: a restoration that had not been lost, replaced or repaired (33). Hemmings also defined restoration

*Heraeus Kulzer, Hanau, Germany.

†Kerr, Orange, CA, USA.

failure as: loss, fracture, marginal discolouration, loss of marginal integrity, noticeable wear, pain or sensitivity, endodontic failure and aesthetic failure.

When it came to assessing the restorations, three studies used calibrated assessors (30–33), while two did not detail their assessor calibration process. Two studies had one calibrated assessor (30, 32) and the third had five calibrated assessors at their 2·5-year follow-up (31) and six assessors at their 7-year follow-up.

Survival rates

There was a noted inconsistency in the reporting of restoration survival rates amongst included studies. The two retrospective studies used the Kaplan–Meier survival function to report their findings (30, 32), two of the prospective studies simply reported the survival rate at the end of follow-up period (29, 31, 33), and one prospective study reported findings using both approaches (28). Consequently, data extraction and comparison of studies' findings was challenging.

At 2 years, Gow and Hemmings (29) reported a 100% survival rate when using indirect composite restorations. There was a slight decline in survival rate at 2·5 years when using direct composite restorations, with Hemmings (28) and Poyser (31) reporting similar rates of 93% and 94%, respectively. At 7 years, the reported survival rate of direct composite restorations was 85% (33). At 10 years, Gulamali (32) reported that only 29% of direct and indirect composite restorations survived, exhibiting no major modes of failures.

Kaplan–Meier-calculated median survival rates for direct and indirect composite restorations was 7 years, when only major failures were considered (32). However, when all types of failure were considered, the survival rate dropped to 4 years and 9 months (30).

Patients who were class I incisal relationship were at higher risk of restoration failure according to one study (32), class II div 2 relationship in another (30) and class III edge-to-edge relationship in a third study (28).

Quality appraisal of the studies

Retrospective design studies assessing survival of restorations rely on the patient reporting and/or the patient's recollection of problems with the restorations, as well as the quality of records (34). If this reporting is not done immediately with detailed recording present, an accurate calculation of longevity might not be possible. The use of multiple operators, with varying experience and seniority, might also affect the performance of the restorations and their survival. Calibration of assessors was only mentioned/performed in three of five of the included studies, which could affect the outcome of assessment. Furthermore, Poyser *et al.* (31) argued that the USPHS criteria are a subjective, clinician-oriented grading system, which do not account for patients' needs and expectations. Consequently, the definition of restoration failure and its assessment varied between the included studies.

The five included studies demonstrated a considerable level of heterogeneity in their study design, follow-up periods, assessment criteria, and definition and reporting of restoration failure (Appendix 1). As a result, a meta-analysis comparing survival rates across included studies was not possible.

All studies were graded as level two evidence, according to the SORT grading system (31, 33). Grading was reached after discussion and agreement between authors.

Given the inconsistencies between studies and the limited quality of presented evidence, it was agreed that the overall clinical strength of recommendation of the current systematic review was moderate, and hence, graded as a 'B' according to the SORT grading system.

Discussion

The current systematic review aimed to investigate the survival rate of anterior composite resin restorations used in managing tooth wear in patients. Three prospective and two retrospective studies were identified involving the placement of 772 direct and indirect anterior composite restorations in 100 patients, with a follow-up period between 5 months to 10 years.

The results of included studies do support the use of anterior composites as a management modality for tooth wear patients with favourable short/medium-term survival rates of over 90% at two and a half years and over 50% at 5 years. However, the level of evidence remains limited, especially long-term survival, given the relatively small patient sample size and heterogeneity present between studies. In comparison, a study investigating 127 375 composite resin restorations placed in adults, in England and Wales, reported similar survival rates of 87% and 58% at 1 and

5 years, respectively (35). Moreover, one of the studies excluded from this review involved the use of anterior and posterior composites, ceramo-metal crowns and full gold crowns in managing tooth wear in 17 patients (26). The restorations in this retrospective case series study demonstrated an age of 2–8 years for direct restorations and 3·3–8·5 years for indirect restorations, with 14 patients wearing 20 removable partial dentures as part of the treatment. There was also no statistically significant difference in the cumulative survival rates between direct and indirect restorations over a 10-year follow-up period. The second excluded retrospective study involved the use of 332 anterior and posterior composites in 18 patients, with a observation period between 6 months to 12 years (27). Bulk fractures or restoration loss was reported in eight restorations, while secondary caries was present in four restorations. When all minor and major failures were included, the calculated average probability failure of the composite restorations was 2·2% per year.

A recent systematic review investigating the clinical effectiveness of class IV composite restorations demonstrated that their median success rate after 10 years of service was 90% (36). Furthermore, the review identified bulk fractures as the main reason for failure, which occurred significantly more in microfilled composites than with hybrid and macrofilled composites. The review further concluded that bevelling of the enamel had no influence on the clinical outcome of the restoration. It is also worth noting that Al-Khayatt demonstrated that restorations that required longer time to prepare (over 11 min) were statistically less likely to survive for 7 years (33). Furthermore, the study found no statistical differences in survival rates between preparing and not preparing teeth, prior to placement of restorations.

Certain confounding factors that could have affected the survival rates of composites were not clearly mentioned in the included studies. These factors include the use of adjuncts such as: use of ICP or centric relation in treatment planning, sandblasting with/out silane-coupling, type of bonding techniques (total etch or self-etch) and the use of protective appliances post-treatment.

In regard to the success of increase in OVD in patients and re-establishment of posterior occlusion, all studies reported an OVD increase between 0·5 and 5 mm, with a restoration of posterior occlusion in 91% of cases ($n = 91/100$) within 18 months of composite resin placement. On the other hand, the use of composite restorations at an increased vertical dimension might influence the restoration's prognosis, affecting its longevity in the long-term. However, the use of a fixed Dahl appliance, in the form of composite build-ups, can be a decisive factor in the success of space creation for oral rehabilitation of tooth wear patients because it eliminates challenges associated with patient compliance (37).

There are two reviews that have previously addressed the restorative management of tooth wear in patients. Johansson *et al.* (21), in their critical review of oral rehabilitation options for the worn dentition, stated that there was a striking lack of evidence regarding the long-term outcomes of treatment methods and materials. Muts *et al.* (22) conducted a systematic review investigating tooth wear treatment options. Their selection criteria, however, excluded studies involving localised management of tooth wear. Furthermore, although the systematic review had broad inclusion criteria, but its search terms (such as tooth surface loss) and selection criteria were restricted, limiting the reproducibility of the review, as stated by the authors. As a result, the review included 11 studies, which were either case reports or case series. The authors reported that the selected studies did not present sufficient evidence to form conclusions for clinical recommendations. However, the review identified a number of management approaches that were common across the included studies. These approaches involve the following: the use of centric relation in treatment planning, composites and glass ceramics as the most commonly used restorative materials, and the use of splints or other protective appliances to preserve the restored dentition.

Composite resin restorations do offer a relatively cost-effective alternative for managing tooth wear in patients, compared to more invasive, conventional interventions. Their simple maintenance, whether through repair or replacement, presents them as a viable, short/medium-term, conservative restorative option for rehabilitation in tooth wear cases. Furthermore, there is evidence to support an improvement in tooth wear patients' quality of life post-placement of composite restorations, with two of the included studies reporting increased patient satisfaction with appearance (32, 33). However, further research is needed in the form of well-designed, randomised controlled trials with long-term follow-up periods,

appropriate calibration, and well-defined assessment criteria.

The findings of this systematic review have identified that composite restorations are a viable tooth wear management option. On the other hand, the limitations present in the included studies and previous reviews highlight the importance of a standardised approach to study design and reporting of findings in order to improve the strength of clinical recommendations derived from them. Henceforth, future studies investigating the longevity of anterior composite restorations in managing tooth wear need to involve:

1 Prospective investigation
2 Details of opposing dentition and existing incisal relationship
3 Reporting of identified tooth wear aetiology
4 Clear description detailing intervention, operator/s and their calibration
5 Clear assessment criteria (USPHS commonly used) and definitions for restoration survival, success and failure
6 Details of assessors' calibration
7 Detailed reporting of findings
8 Long-term follow-up period

Conclusion

There is evidence to support the use of anterior composite resin restorations in managing tooth wear as a short-term to midterm treatment modality. However, evidence supporting long-term survival outcomes remains limited. Increasing OVD resulted in posterior occlusion re-establishment in 91% of patients within 18 months.

Disclosure

No conflicts of interest declared. This research was carried out without funding.

References

1. Müller F, Naharro M, Carlsson GE. What are the prevalence and incidence of tooth loss in the adult and elderly population in Europe? Clin Oral Implants Res. 2007;18:2–14.
2. Slade GD, Akinkugbe AA, Sanders AE. Projections of U.S. Edentulism prevalence following 5 decades of decline. J Dent Res. 2014;93:959–65.
3. Jablonski RY, Barber MW. Restorative dentistry for the older patient cohort. Br Dent J. 2015;218:337–42.
4. Nunn J, Morris J, Pine C, Pitts NB, Bradnock G, Steele J. The condition of teeth in the UK in 1998 and implications for the future. Br Dent J. 2000;189:639–44.
5. Watt RG, Steele JG, Treasure ET, White DA, Pitts NB, Murray JJ. Adult Dental Health Survey 2009: implications of findings for clinical practice and oral health policy. Br Dent J. 2013;214:71–5.
6. Van't Spijker A, Rodriguez JM, Kreulen CM, Bronkhorst EM, Bartlett DW, Creugers NH. Prevalence of tooth wear in adults. Int J Prosthodont. 2009;22:35–42.
7. Al-Omiri MK, Lamey PJ, Clifford T. Impact of tooth wear on daily living. Int J Prosthodont. 2006;19:601–5.
8. Wazani BE, Dodd MN, Milosevic A. The signs and symptoms of tooth wear in a referred group of patients. Br Dent J. 2012;213:1–4.
9. Ahmed KE, Murray CA, Whitters CJ. A prospective survey of secondary care tooth wear referrals: demographics, reasons for concern and referral outcomes. Br Dent J. 2014; 216:1–5.
10. Sivasithamparam K, Harbrow D, Vinczer E, Young WG. Endodontic sequelae of dental erosion. Aust Dent J. 2003;48:97–101.
11. Johansson A-K, Norring C, Unell L, Johansson A. Eating disorders and oral health: a matched case–control study. Eur J Oral Sci. 2012;120:61–8.
12. Ahmed KE. The psychology of tooth wear. Spec Care Dentist. 2013;33:28–34.
13. Wieckiewicz M, Paradowska-Stolarz A, Wieckiewicz W. Psychosocial aspects of bruxism: the most paramount factor influencing teeth grinding. Biomed Res Int. 2014;2014: 469187.
14. Vaidyanathan TK, Vaidyanathan J. Recent advances in the theory and mechanism of adhesive resin bonding to dentin: a critical review. J Biomed Mater Res B Appl Biomater. 2009;88B:558–78.
15. Cramer NB, Stansbury JW, Bowman CN. Recent advances and developments in composite dental restorative materials. J Dent Res. 2011;90:402–16.
16. Vaderhobli RM. Advances in dental materials. Dent Clin North Am. 2011;55:619–25.
17. Mehta S, Banerji S, Millar B, Suarez-Feito J-M. Current concepts on the management of tooth wear: part 2. Active restorative care 1: the management of localised tooth wear. Br Dent J. 2012;212:73–82.
18. Mehta S, Banerji S, Millar B, Suarez-Feito J-M. Current concepts on the management of tooth wear: part 3. Active restorative care 2: the management of generalised tooth wear. Br Dent J. 2012;212:121–7.
19. Grütter L, Vailati F. Full-mouth adhesive rehabilitation in case of severe dental erosion, a minimally invasive approach following the 3-step technique. Eur J Esthet Dent. 2013; 8:358–75.
20. Colon P, Lussi A. Minimal intervention dentistry: part 5. Ultra-conservative approach to the treatment of erosive and abrasive lesions. Br Dent J. 2014;216:463–8.

21. Johansson A, Johansson AK, Omar R, Carlsson GE. Rehabilitation of the worn dentition. J Oral Rehabil. 2008;35: 548–66.
22. Muts E-J, van Pelt H, Edelhoff D, Krejci I, Cune M. Tooth wear: a systematic review of treatment options. J Prosthet Dent. 2014;112:752–9.
23. Sayers A. Tips and tricks in performing a systematic review. Br J Gen Pract. 2008;58:136.
24. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. J Clin Epidemiol. 2009;62:1006–12.
25. Ebell MH, Siwek J, Weiss BD, Woolf SH, Susman J, Ewigman B *et al.* Strength of recommendation taxonomy (SORT): a patient-centered approach to grading evidence in the medical literature. J Am Board Fam Pract. 2004;17:59–67.
26. Smales RJ, Berekally TL. Long-term survival of direct and indirect restorations placed for the treatment of advanced tooth wear. Eur J Prosthodont Restor Dent. 2007;15:2–6.
27. Hamburger JT, Opdam NJ, Bronkhorst EM, Kreulen CM, Roeters JJ, Huysmans MC. Clinical performance of direct composite restorations for treatment of severe tooth wear. J Adhes Dent. 2011;13:585–93.
28. Hemmings KW, Darbar UR, Vaughan S. Tooth wear treated with direct composite restorations at an increased vertical dimension: results at 30 months. J Prosthet Dent. 2000;83:287–93.
29. Gow A, Hemmings K. The treatment of localised anterior tooth wear with indirect Artglass restorations at an increased occlusal vertical dimension. Results after two years. Eur J Prosthodont Restor Dent. 2002;10:101–5.
30. Redman C, Hemmings K, Good J. The survival and clinical performance of resin–based composite restorations used to treat localised anterior tooth wear. Br Dent J. 2003;194: 566–72.
31. Poyser N, Briggs P, Chana H, Kelleher M, Porter R, Patel M. The evaluation of direct composite restorations for the worn mandibular anterior dentition–clinical performance and patient satisfaction. J Oral Rehabil. 2007;34:361–76.
32. Gulamali A, Hemmings K, Tredwin C, Petrie A. Survival analysis of composite Dahl restorations provided to manage localised anterior tooth wear (ten year follow-up). Br Dent J. 2011;211:1–8.
33. Al-Khayatt A, Ray-Chaudhuri A, Poyser N, Briggs P, Porter R, Kelleher M *et al.* Direct composite restorations for the worn mandibular anterior dentition: a 7-year follow-up of a prospective randomised controlled split-mouth clinical trial. J Oral Rehabil. 2013;40:389–401.
34. Levin KA. Study design IV: cohort studies. Evid Based Dent. 2003;7:51–2.
35. Lucarotti PSK, Holder RL, Burke FJT. Outcome of direct restorations placed within the general dental services in England and Wales (Part 1): variation by type of restoration and re-intervention. J Dent. 2005;33:805–15.
36. Heintze SD, Rousson V, Hickel R. Clinical effectiveness of direct anterior restorations – a meta-analysis. Dent Mater. 2015;31:481–95.
37. Poyser N, Porter R, Briggs P, Chana H, Kelleher M. The Dahl Concept: past, present and future. Br Dent J. 2005;198:669–76.

Correspondence: Khaled E. Ahmed, Comprehensive Dental Care Department, Prince Philip Dental Hospital, Faculty of Dentistry, 34 Hospital Road, University of Hong Kong, Hong Kong (SAR), China. E-mail: khaledahmed@outlook.com

Appendix 1. Overview of study comparison

Study	Tooth preparation	Amount of OVD increase	Occlusion re-established	Assessment criteria	Definition of failure	Survival rate
Hemmings (28)	Yes, minimal to reduce sharp enamel edges	1·5–2 mm	1–11 months (mean 4·6) in 15/16 patients	Unclear	Loss, fracture, marginal discoloration, loss of marginal integrity, noticeable wear, pain or sensitivity, endodontic failure, and aesthetic failure	93% (97/104) at 2·5 years
Gow and Hemmings (29)	Unclear	1–4 mm	6–12 months (mean 9) in 10/12 patients	Modified USPHS	USPHS score 3	100% at 2 years
Redman (30)	Unclear	Unclear	2–18 months (mean 7) in all patients	Modified USPHS	USPHS score 3	Median survival rate: 4 years 9 months, when all types of failure considered
Gulamali (32)	Unclear	Unclear	2–18 months (mean 7) in 21/26 patients	Modified USPHS	USPHS score 3	29% (n = 81/283) – exhibited no major failures at 10 years. Median survival rate: 7 years
Poyser (31), Al-Khayatt (33)	Compared preparation and no preparation	0·5–5 mm	3–13 months (mean 6·2) in 14/15 patients	Modified USPHS	Complete bulk failure with no remaining composite. Restoration not lost or repaired	94% at 2·5 years (n = 72/77), 85% (n = 85/89) at 7 years