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ORIGINAL ARTICLE

Implementation and experience of a new method for posterior vertical bite reconstruction using direct resin composite restorations in the private practice—A survey

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Abstract

Objective. The purpose of the present survey was to evaluate the implementation and experience of a new method for posterior vertical bite reconstruction using direct resin composite restorations by private practitioners who attended a hands-on continuing education course on this technique. ***Materials and methods.*** In the years 2007 and 2008, 17 1-day continuing education courses on vertical bite reconstruction in the worn dentition by using direct resin composite restorations were attended by 310 participants. A 13-item questionnaire was posted to all course participants in April 2009 seeking information on the acceptance, implementation and experience of the presented technique in the private practice. ***Results.*** A total of 97 (31%) questionnaires were returned, whereas 67% of the respondents had used the presented technique. Analysis of the overall experience and satisfaction with the placed resin composite restorations using visual analog scale (VAS) revealed a mean VAS score of 7.2 ± 1.7 (0 = maximal unsatisfied, 10 = maximal satisfied). The direct resin composite restorations were predominantly rated 'good' within the assessed criteria surface texture, anatomical form, marginal integrity, marginal discoloration and color match. Ninety-eight percent of the private practitioners stated that they would continue to carry out vertical bite reconstructions according to this technique. The three most frequently observed clinical problems were related to marginal discolorations, bulk fractures and adhesive failures. ***Conclusion.*** The presented restoration method was well accepted by private practitioners who used this treatment approach at least once after course participation, even though some clinical problems were observed.

Key Words: *Resin composite, survey, tooth wear*

Introduction

Tooth wear, an increasing problem in developed societies, is a multi-factorial process, including abrasion, attrition and erosion [1,2]. Extensive generalized wear may manifest itself in severe loss of occlusal vertical dimension, which can result in both esthetic and functional impairments for the patient. Emphasis in a synoptic treatment approach should be on detailed diagnosis of the causative factors of the condition followed by individual preventive measures and advice to control further tooth substance loss [3]. Reconstruction of both tooth morphology and vertical dimension represents a major restorative challenge and should not be initiated until elimination of the underlying disease and arrest of the progress of wear [4,5].

Traditionally, reconstructive concepts for the severely worn dentition mainly base on highly invasive methods, such as full-crown coverage of almost all teeth in combination with elective endodontic and post-and-core treatments to provide adequate retention for the cemented restorations [6–8]. Due to improvements in adhesive techniques, more conservative approaches like all-ceramic overlays have been proposed [9]. Notwithstanding, these indirect restorations still require tooth preparation and may be unaffordable for many patients. Particularly in countries with self-pay patients, less expensive treatment modalities are of great interest and direct composite restorations would lend themselves to a valuable restorative option.

Resin composites represent a well-investigated and established material group for the restoration of

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posterior teeth, providing good and predictable clinical long-term results in load-bearing situations [10–12]. In addition to allowing for relatively economical and non-invasive techniques, resin composites offer good esthetics and simple maintenance in the form of repair. Several case reports demonstrate the successful rehabilitation of worn dentitions using directly applied resin composites [13–16]. However, there is a lack of long-term data assessing the quality of direct composite restorations covering posterior worn teeth. An up to 3-year clinical study showed high rates of fracture and loss of retention when restoring severely worn posterior teeth with microfilled resin composites [17]. The literature also suggests that, despite material-related improvements, wear of dental composites may still be a significant problem for large restorations in direct occlusal contact, especially those involving the replacement of functional cusps [18]. In addition to the fact that freehand placement of extensive composite restorations is time-consuming and clinically demanding, there might be a concern that possible interferences or complications with the gnathologic system may be provoked due to a potentially unbalanced occlusion [19].

An approach to solving this problem is the use of a vacuum-formed matrix template that is fabricated based on wax-up models to shape the directly applied resin composite, thus avoiding complex freehand build-ups and at the same time providing optimal anatomy and function. This method has been described for anterior teeth, ensuring a good intermaxillary relationship [20] and a modified technique has been introduced for posterior teeth [15,21]. A case series showed good-to-excellent clinical performance and patient acceptance of template-assisted direct composite build-ups used to restore posterior teeth with excessive occlusal wear and evaluated after a mean service time of 3 years [21].

Seventeen continuing education courses were held at nine different venues in Germany and Switzerland in the years 2007 and 2008, teaching the rehabilitation of worn dentitions with severe loss of occlusal vertical dimension by this technique. The purpose of the present survey was to assess the acceptance, implementation and experience of this new method for posterior vertical bite reconstruction among the course participants and to analyze reported problems of the restorations in clinical practice.

Materials and methods

Course concept, theory and technical background

In the years 2007 and 2008, 17 1-day continuing education courses on vertical bite reconstruction in the worn dentition by using direct adhesive composite restorations were given at nine different German and Swiss venues to a total of 310 participants (Table I). The courses comprised lectures, hands-on trainings and periods for discussion. Attendance at the courses ranged between 9–30 participants and a favorable participant-to-tutor ratio not exceeding 5:1 was ensured during the practical sessions. In the initial theoretical part of the courses, the etiology of erosion, abrasion and attrition was described and preventive strategies were explained. Thereafter, pre-requisites and physiological principles of vertical dimension alterations were depicted. The following lectures gave an overview of the current state of adhesive techniques and resin composites suitable in load-bearing posterior segments and introduced a new method for vertical bite reconstruction using template-assisted direct resin composite build-ups. The methodology is described elsewhere in detail [15,21].

In brief, in the first step of this build-up technique, a dental technician mounts the patient's diagnostic casts on a semi-adjustable articulator and confects a diagnostic wax-up in a balanced occlusion scheme, mimicking exactly the desired shape and size of all

Table I. Information of the course venues and the survey.

Course venue	No. of courses	No. of participants	No. of returned questionnaires	Response rate (%)
Berlin (DE)	2	40	13	33
Freiburg (DE)	2	40	15	38
Düsseldorf (DE)	1	17	5	29
Hamburg (DE)	3	44	6	14
Hanover (DE)	1	12	2	17
Magdeburg (DE)	2	40	12	30
Münster (DE)	1	9	3	33
Stuttgart (DE)	2	32	10	31
Zurich (CH)	3	76	31	41
Total	17	310	97	31

DE = Germany; CH = Switzerland.

teeth to be restored. The wax-up model is duplicated and a vacuum-formed matrix template is produced. As an important feature of this device, the front teeth and the most distally located tooth are supported by the worn dentition in order to stabilize the template. After placing a full-arch rubber dam and cleaning the teeth, the template is proofed to fit accurately. The hollow space of the template represents the future composite material that would build up the worn teeth and copy the wax-up. The template is removed and the enamel is etched for 45 s with 35% phosphoric acid. The dentin areas are etched for 15 s and an adhesive system (proposed: Syntac Classic; Ivoclar Vivadent, Schaan, Liechtenstein) is applied according to the manufacturer's instructions. When intact composite restorations are present, they are Al_2O_3-sandblasted and silanated. During the restorative build-up phase, every second tooth to be restored is conditioned as described above. The neighboring teeth of the first to be reconstructed ones are insulated with Teflon tape in order to avoid interproximal blocking with resin composite. The template is filled with resin composite material (proposed: Ceram X mono; Dentsply DeTrey, Konstanz, Germany) and then repositioned on the tooth arch. Subsequently, the resin composite is light-cured for 2–3 s to 'freeze' the material. The template is carefully removed, along with any excess material and the material is thereafter completely cured by irradiation from the occlusal, buccal and oral direction. After finishing and polishing, the remaining teeth are restored accordingly.

At the end of the courses, each participant received a course script including a step-by-step guide to the presented restoration technique, the lecture slides and a selection of published articles.

Practical exercise

In the hands-on sessions of the courses the participants practiced the above-described technique for vertical bite reconstruction on typodont models mounted in dental phantom heads. They were instructed to re-build up the occlusal aspects of three teeth in one quadrant, which had been reduced in height before. The template had been produced by a technician prior to the course based on the typodont model with unprepared teeth. Figure 1 shows both a prepared typodont model and template as well as the final resin composite restorations placed by one of the course participants.

Survey, non-response analysis and data analysis

In April 2009, a 13-item questionnaire containing both multiple-choice questions and questions requiring provision of specific information (Table II) was designed and posted to the course participants either directly (participants of the courses held at Zurich) or via the local dental organizations (participants of the courses held in Germany). The questionnaire was reviewed by two experts to establish content validity and pilot tested at the Center for Dental Medicine (University of Zurich) by staff dentists prior to its distribution to the course participants. The participants were asked to return the completed questionnaires anonymously by mail or fax within 6 weeks.

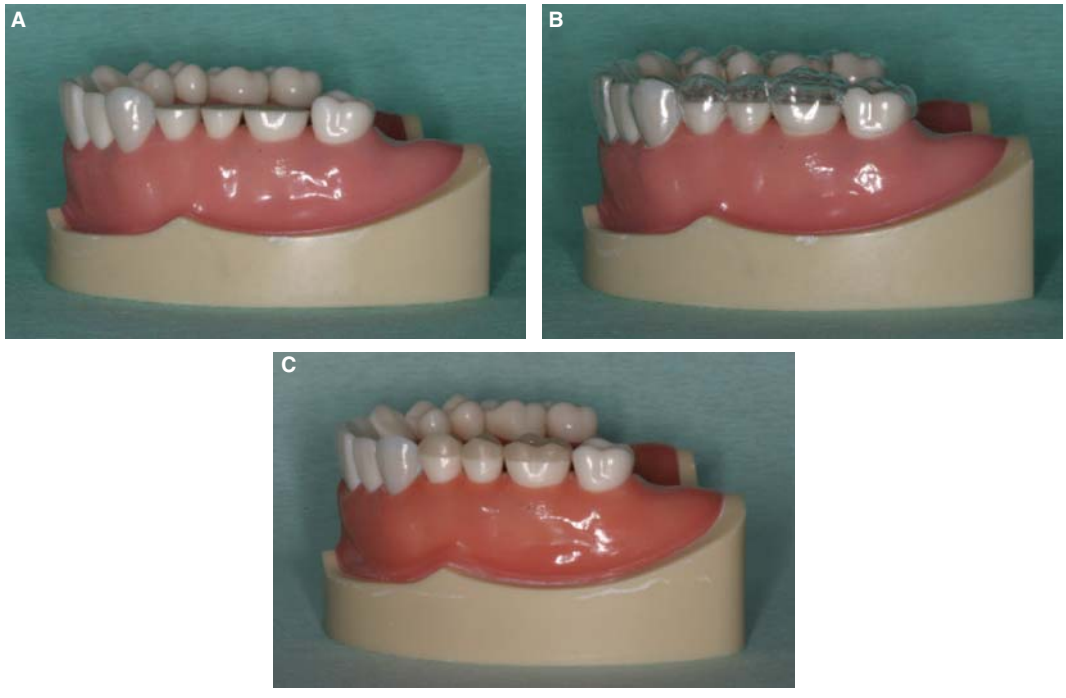

Figure 1. Typodont model with ground teeth 14–16 (A), positioned matrix template (B) and final resin composite restorations (C).

Table II. Questionnaire.

1. After course participation did you carry out vertical bite reconstructions using direct resin composite restorations according to the presented technique? (Yes; no)
2. If yes, how many patients did you treat in this way?
3. What was the cause of the loss of occlusal vertical dimension?* (Erosion; abrasion; attrition; trauma; other . . .)
4. By how many millimeters did you increase the occlusal vertical dimension?* (<2; 2–4; >4)
5. Which jaw(s) were treated?* (Only maxilla; only mandible; maxilla and mandible)
6. How many teeth were treated per case?* (<9; 9–16; >16)
7. Which adhesive system did you use?*
8. Which resin composite material did you use?*
9. How many hours did you need on average to build up eight posterior teeth by means of the presented technique?
10. How do you rate the direct resin composite restorations regarding surface texture, anatomical form, marginal integrity, marginal discoloration, color match? (Good; acceptable; bad)
11. Did the following problems occur in at least one case: marginal discoloration, debonding, fracture in the resin composite material, fracture in the tooth, loss of tooth vitality, recurrent caries, gingivitis? (Yes; no)
12. Overall, how satisfied are you with the direct resin composite restorations?**
13. Will you continue to carry out vertical bite reconstructions using direct resin composite restorations according to the presented technique? (Yes, because . . .; no, because . . .)

Possible answers are given in brackets.
* Multiple answers possible; ** Visual analogue scale (VAS).

A cover letter stated the instructions, rationale and purpose of the survey. Non-respondents were not reminded due to the anonymous survey character.

A non-response analysis was carried out by telephone interview in July 2009 to assess the proportion of non-respondents that had performed vertical bite reconstructions according to the presented technique after course participation. The non-response analysis was solely conducted on the participants of the courses held at Zurich, since contact details of the participants of the German courses were not provided by the local dental organizations. Due to the anonymous survey character, all participants of the three Zurich courses were contacted by telephone in order to identify potential non-respondents.

Data were transferred to a computer and analyzed with descriptive statistics including frequency distributions by use of the SPSS 14.0 software for Windows (SPSS, Chicago, IL, USA).

Results

A total of 97 questionnaires were returned from the 310 course participants, representing a response rate of 31% (Table I). The mean time between course participation and returning the questionnaire was 15 ± 6 months. Sixty-five (67%) of the 97 responding course participants reported that after course participation they performed vertical bite reconstructions using direct resin composite restorations according to the presented technique. These 65 participants did not answer all of the following questions addressed to them and, consequently, the number of respondents per question varied between 53–65, yielding a response rate per question between 82–100%.

The non-response analysis revealed that none of the identified 31 (from a total of 45) non-respondents of the Zurich courses had as yet used the presented restoration technique in the private practice. This fact lowers the proportion of participants that have implemented the technique after course attendance in Zurich from 51.6 to 25.8%.

On average the respondents treated three patients with loss of occlusal vertical dimension according to the presented build-up technique (minimum: one patient, maximum: 15 patients). Thirty (46%) of the respondents named erosion as cause of the loss of occlusal vertical dimension, 53 (82%) named abrasion, 18 (28%) named attrition and one (2%) named trauma. Eight (12%) marked 'other' and indicated 'insufficient restorations', 'caries', 'dental tipping' and 'extractions' as cause. Twenty-one (32%) of the respondents increased the occlusal vertical dimension by less than 2 mm, 52 (80%) by 2–4 mm and five (8%) by more than 4 mm. Forty-three (67%) of the respondents reported that the vertical bite reconstruction was performed by treating both jaws, whereas eight (13%) only treated the maxilla and 19 (30%) only treated the mandible. Twenty-seven (42%) of the respondents reported that the vertical bite reconstruction involved treatment of less than nine teeth, 28 (43%) treated between nine and 16 teeth per case and 17 (26%) treated more than 16 teeth per case.

The respondents used 17 different adhesive systems, but only three systems were used by at least five

respondents. These three most frequently used systems are presented in Table III. Four-step, 3-step and 2-step etch-and-rinse systems were used by 26 (43%), nine (15%) and eight (13%) of the respondents, respectively. Eleven (18%) of the respondents used 2-step self-etch systems and nine (15%) used 1-step self-etch systems. Fifteen different resin composite materials were used, but only four were used by at least five respondents. These four most frequently used resin composite materials are presented in Table IV. Forty-seven (89%) of the respondents used hybrid resin composites, two (4%) used the submicron-filled composite material Estelite Sigma (Tokuyama, Tokyo, Japan) and four (8%) used the nanofilled composite material Filtek Supreme XT (3M ESPE, St. Paul, MN, USA). Microfilled composite materials were not used.

On average the respondents needed 3.4 ± 1.7 h (minimum: 1 h, maximum: 7.5 h) to build up eight posterior teeth by means of the presented technique. Table V shows the rating of the resin composite restorations by the practitioners regarding surface texture, anatomical form, marginal integrity, marginal discoloration and color match. The percentage of 'good' ratings ranged from 86% for color match to 51% for marginal discoloration. The direct resin composite build-ups were never rated 'bad', except in one case, where the surface texture was criticized. Problems observed by the private practitioners after placement of the resin composite restorations in a total of 168 patients are presented in Table VI.

Analysis of the overall satisfaction with the direct resin composite restorations using a visual analog scale (VAS) (0–10-scale, 0 = maximal unsatisfied, 10 = maximal satisfied) revealed a mean VAS score of 7.2 ± 1.7. Almost all of the respondents (98%) stated that they would continue to carry out vertical bite reconstructions according to the presented technique. The four most frequently mentioned reasons for using this technique are listed in Table VII. Along with the completed questionnaire, one course participant sent photographs of a case in which the vertical dimension was reconstructed with direct resin composite restorations according to the presented build-up technique. This case is shown in Figure 2.

Table III. The three most frequently used adhesive systems.

Adhesive system	Classification	No. (%) of respondents (n = 60)
Syntac Classic (Ivoclar Vivadent, Schaan, Liechtenstein)	4-step etch-and-rinse	26 (43)
Optibond FL (Kerr, Orange, CA, USA)	3-step etch-and-rinse	8 (13)
Clearfil SE Bond (Kuraray, Tokyo, Japan)	2-step self-etch	5 (8)

Table IV. The four most frequently used resin composite materials.

Resin composite material	Classification	No. (%) of respondents (n = 53)
Tetric EvoCeram (Ivoclar Vivadent, Schaan, Liechtenstein)	Nano-hybrid	21 (40)
Ceram X mono (Dentsply DeTrey, Konstanz, Germany)	Nano-hybrid	6 (11)
Grandio (VOCO, Cuxhaven, Germany)	Nano-hybrid	5 (9)
Tetric (Ivoclar Vivadent, Schaan, Liechtenstein)	Fine-particle hybrid	5 (9)

Discussion

A recently published review of response rates in postal surveys of healthcare professionals, including dentists, reported average response rates of 35–68% [22]. The response rate of 31% in the current study may therefore be considered low. Owing to this low response rate, a non-response analysis was carried out, which revealed that none of the identified non-respondents of the Zurich courses had as yet performed vertical bite reconstructions according to the presented technique. Based on the results of the non-response analysis on the Zurich course participants, the actual proportion of participants of the 17 continuing education courses with clinical experience in the presented direct build-up technique might be considerably less than the determined 67%. The non-response analysis also indicated that the predominant majority of course participants with clinical experience in the taught restoration technique replied the questionnaire. This was one of the main goals of the current survey in order to gain ample information on the implementation of this relatively new method for vertical bite reconstruction in the private practice.

Analysis of the VAS scores revealed high satisfaction with the directly applied resin composite restorations among the private practitioners. The fact that almost all of the practitioners (98%) stated that they would continue to carry out vertical bite reconstructions according to the presented build-up technique

Table V. Rating of the placed resin composite restorations by the practitioners.

		No. (%) of respondents		
Criterion		Good	Acceptable	Bad
Surface texture	n = 63	41 (65)	21 (33)	1 (2)
Anatomical form	n = 65	42 (65)	23 (35)	0 (0)
Marginal integrity	n = 63	39 (62)	24 (38)	0 (0)
Marginal discoloration	n = 61	31 (51)	30 (49)	0 (0)
Color match	n = 64	55 (86)	9 (14)	0 (0)

Table VI. Problems observed by the private practitioners after placing the resin composite restorations in a total of 168 patients.

Problem	No. (%) of respondents* (n = 64, each)
Marginal discoloration	36 (56)
Debonding	21 (33)
Fracture in the resin composite material	24 (38)
Fracture in the tooth	2 (3)
Loss of tooth vitality	2 (3)
Recurrent caries	5 (8)
Gingivitis	9 (14)

* Users with one observation in at least one treated tooth.

confirms the high acceptance of this technique among dentists who used this treatment approach at least once. An excellent patient acceptance of the treatment as well as a favorable clinical performance of the direct resin composite restorations after a mean service time of 3 years have also been previously shown [21].

Despite these promising results and satisfactory wear resistance of resin composite restorations in a recent 5-year clinical evaluation [23], there are still concerns regarding the general application of resin composite materials for restoring posterior worn teeth. Bartlett and Sunderam [17] investigated microfilled direct and indirect resin composite restorations placed in load-bearing posterior segments of worn dentitions over an observation period of 3 years and found high rates of fracture and loss of retention. These problems were also revealed in the present study given that about one third of the private practitioners observed adhesive failures and bulk fractures of at least one of their directly applied resin composite restorations (Table VI). Large variations in resin bond strengths to dentin have been reported among general practitioners, even after they received a detailed lecture on bonding principles [24]. A survey among 462 dentists in Denmark revealed that 23% of the respondents used their adhesive system in a manner that differed considerably from the manufacturer's instructions for use [25]. Incorrect application of adhesive systems has been shown to compromise both dentin bond strength and marginal adaptation of direct resin composites [26–28]. Consequently, application mistakes of adhesive systems provoked by complex application procedures and time constraints in many dental offices might be one possible explanation for the high proportion of private practitioners reporting adhesive failures in the current survey even though conventional adhesive systems (4-step and 3-step etch-and-rinse systems and 2-step self-etch systems) with proven good clinical performance in non-caries lesions [29,30] were primarily used (Table III) and thus chosen over less reliable and predictable simplified systems (2-step etch-and-rinse and 1-step self-etch systems) [30,31].

Table VII. The four most frequently mentioned reasons for using direct resin composite restorations for vertical bite reconstructions.

Reason	No. (%) of respondents (n = 60)
Inexpensive treatment	28 (47)
Substance-preserving technique	12 (20)
Good clinical results	6 (10)
Easy to repair	5 (8)

In a case series on seven patients with severe erosive/abrasive occlusal wear, the authors reconstructed a total of 85 posterior teeth using direct resin composite restorations and found no retention losses and only two bulk fractures, which were repairable, over a 3-year period [21]. In the above-mentioned study great care was taken that reconstructive treatment was not initiated until abolishment of the underlying disease and favorable clinical reassessment of the erosion status. It cannot be ensured, however, that the surveyed private practitioners equally thoroughly focused on determination and elimination of the etiological factors of the tooth wear before they placed the direct resin composite restorations, even though the importance of the management of the etiology was pointed out in the continuing education courses. Treatment approaches for patients with active erosion have been shown to vary considerably between dentists [32]. Persistent acidic conditions can lead to a degradation of dentin–adhesive interfaces [33] and might therefore have contributed to the reported adhesive failures in the current study. Especially in patients with an erosive background, which has been identified as a causative factor of the loss of occlusal vertical dimension by almost every second responding course participant, a combination of abrasion, attrition and chemical degradation can impair the physico-mechanical properties of the placed resin composite restorations [34]. The matrix can be softened and filler particles can be lost [35,36], which might have resulted in the observed bulk fractures, although hybrid resin composite materials were mainly used by the private practitioners. Hybrid resin composites placed at an increased occlusal vertical dimension showed good clinical results in previous studies [21,37]. In an attempt to reduce the number of fractures, protective Michigan or full-coverage heat-cured acrylic splints, worn at night, may be indicated, at least for patients with a clenching or grinding habit. A supportive splint therapy will therefore be recommended in future courses.

In the current survey, five (8%) of the responding private practitioners observed recurrent caries in at least one of their placed restorations, whereas previous studies with minimal evaluation periods of

Figure 2. Example of a case treated by one of the course participants (Courtesy of Dr. Milorad Mitrovic, Dietikon, Switzerland). Clinical situation before treatment (A, C, E) and after vertical bite reconstruction using template-assisted direct resin composite build-ups (B, D, F). (A, B) Frontal view, (C, D) occlusal view (maxilla), (E, F) occlusal view (mandible).

30 months recorded nearly no recurrent caries in large direct resin composite restorations [17,21,38]. Caries usually progresses slowly in posterior approximal enamel surfaces [39]. Consequently, the reported presence of clinically observable caries is surprising given that the mean time between course participation and returning the questionnaire was only 17 months for the five respondents who observed recurrent caries, which might have resulted in even considerably shorter actual observation periods of the placed resin composite restorations. It cannot be ruled out, however, that pre-existing caries were not adequately removed before placement of the resin composite restorations and that these lesions were later interpreted as recurrent caries.

Marginal discoloration is a common finding in direct resin composite restorations [11,12]. Even though in the present study more than half of the respondents observed marginal discolorations (Table VI), the placed restorations were never rated 'bad' in this criterion (Table V). This finding may indicate that the discolorations were only slight and thus removable with minimal re-finishing and re-polishing. Simple maintenance in the form of repair was among the four most frequently named reasons why course participants would continue to carry out vertical bite reconstructions using resin composite restorations (Table VII). The predominant 'good' ratings within all the criteria assessed corroborate clinical data on large cuspal-coverage resin composite restorations showing high proportions of 'Alpha' USPHS scores for surface texture, anatomical form, marginal integrity, marginal discoloration and color match [21,38].

One of the limitations of the current survey is that the questionnaire is not patient–case-related. Comparisons with controlled clinical studies should only be made with caution given that the survey design might over-estimate reported problems of the restorations. Furthermore, the fact that the questionnaires were filled out by individual practitioners and not by calibrated investigators implies some uncertainty as to the validity of the answers, especially those requiring a rating of the placed restorations. It was not intended, however, to exactly determine the objective clinical performance of the placed resin composite restorations—a task that cannot be achieved by means of a survey—but to assess general clinical experiences of the course participants with the presented build-up

technique and to analyze how these experiences influence the technique's acceptance in private practice. The developed questionnaire might have adequately addressed these purposes.

Within the limitations of the current survey, the authors conclude that the presented technique for posterior vertical bite reconstruction is well accepted by private practitioners who used this treatment approach at least once after course attendance. Even though course participants observed some clinical problems, including adhesive failures and bulk fractures, there is a high degree of satisfaction with the direct resin composite restorations representing a viable economic and substance-preserving treatment approach for the severely worn dentition that still enables the option for a more definitive restorative management at a later date.

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