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Clinical Technique/Case Report

Three-year Evaluation of Posterior Vertical Bite Reconstruction Using Direct Resin Composite– A Case Series

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Clinical Relevance

The occlusion of extensively worn teeth can be restored using direct resin composite materials. The quality over a mean observation period of three years is good. The proposed method, using a wax-up-based template, can help the clinician to restore the occlusal anatomy and function.

SUMMARY

The use of resin composite materials to restore the complete occlusion of worn teeth is controversial and data are scarce. In this case series, the authors report on seven cases of progressive mixed erosive/abrasive worn dentition (85 posterior teeth) that have been reconstructed with direct resin composite restorations.

In all patients, either one or both tooth arches was completely restored using direct resin composite restorations. All patients were treated with standardized materials and protocols. In five patients, a wax-up-based template was used to avoid freehand build-up techniques and to ensure optimal anatomy and function. All patients were re-assessed after a mean service time of three years (mean 35 ± 5 months) using USPHS criteria. Subjective patient satisfaction was measured using visual analogue scales (VAS).

The overall quality of the restorations was good, with predominantly determined "Alpha"-scores. Only the marginal quality showed small deteriorations, with "Beta" scores of 37% and 45% for marginal discoloration and integrity, respec-

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tively. In general, the composite showed signs of wear facets that resulted in 46% "Beta" scores within the anatomy scores. Small restoration fractures were only seen in two restorations, which were reparable. Two teeth were excluded from the evaluation, as they have been previously repaired due to fracture after biting on a nut.

The results were very favorable, and the patients were satisfied with this non-invasive and economic treatment option, which still has the characteristic of a medium-term rehabilitation. The outcomes were comparable to other direct composite restorations successfully applied in adhesive dentistry.

INTRODUCTION

Resin composite materials represent a well-investigated and established material group for the restoration of posterior teeth. Based on the poor wear characteristic and marginal behavior of early developed materials, resin composites were primarily restricted to small-to medium-sized intra-coronal restorations in posterior teeth.[1] Currently, material-related and technical improvements provide good and predictable clinical long-term results and lead to a considerable shift in this paradigm, even in load-bearing posterior areas.[2-4]

The restoration of dental wear caused by erosion and abrasion processes represents a major restorative challenge in contemporary dentistry. Therapy focuses primarily on the reconstruction of lost tooth structure, while providing good long-term stability, function and aesthetics.[5] Thereby, most importantly, adequate diagnosis, prevention and maintenance are inevitable aspects of a synoptic treatment approach.[6] Traditionally reconstructive concepts mainly include methods, such as porcelain-fused-to-metal crowns or ceramic overlays. This treatment is not only invasive, but also time-consuming and expensive. Particularly in countries with self-pay patients, less expensive treatment modalities would be of great interest, and direct composite restorations would lend themselves for a valuable restorative option. The use of directly applied resin composite to restore worn teeth was first described by Bevenius and others.[7] In 1994, these authors realized that composites are unique, aesthetically pleasing materials that allow for relatively economical and non-invasive techniques. Thus, they were successfully used to cover worn tooth areas, including enamel and dentin. A limited amount of long-term data assessing the quality of direct restorations, covering posterior worn teeth, has been found in the literature. This limited interest and acceptance of such an approach is mainly based on the fact that the required freehand build-up technique is time-consuming and clinically demanding. The literature also suggests that failure rates are higher for larger restorations and wear may still be a significant problem.[8] In addition, there might also be a concern that possible interferences or complications with the gnathologic system may be provoked due to a potentially unbalanced occlusion.[9]

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 demanding freehand build-ups. This method has been described for anterior teeth, ensuring a good inter-maxillary relationship, and a modified technique has been described for posterior teeth.[10-11]

Findings of a recently published study, however, showed very unfavorable results when treating a worn dentition with microfilled direct and indirect composite restorations that were placed in load-bearing posterior segments and evaluated after three years. The authors concluded that resin composite used to restore worn posterior teeth was contraindicated.[12]

In the years 2004 and 2005, seven patients with combined erosion/abrasion have been treated in our clinic according to our clinical protocol. It was the aim of this investigation to present the results of these cases, assessed by USPHS criteria. In addition, patient-related objectives regarding patient satisfaction using visual analogue scale (VAS) measurements are reported.

METHODS AND MATERIALS

Patients and Pre-treatment

Seven patients were evaluated in this case-series (Table 1) and 87 teeth with massive occlusal wear were treated. The mean observation time of the restorations was 35 ± 5 months (minimum: 28 months, maximum 41 months). Six men and one woman were treated. The age was 36 ± 6 years. The reason for the tooth wear was assessed based on anamnestic case history and clinical observations. In all cases, tooth wear was caused by mixed erosion/abrasion processes, with a background of extrinsic and/or intrinsic acid attack.

After baseline clinical and radiographic examinations, a diagnosis was made, and the reason for tooth wear was individually investigated by anamnestic interviews and diet reports. Cases with systemic underlying disease, that is, bulimia or gastroesophageal reflux disease, were assigned to adequate medical and psychological treatment. In cases with extrinsic erosive background, that is, acidic nutrition at high frequency levels, a diet control was administered. In general, abolishment of the underlying disease was determined before treatment and erosion status was clinically reassessed.

All subjects received individual oral hygiene instructions. Baseline was documented with photographs, and full-arch impressions were made. Two sets of casts were

Table 1: *Patients and Teeth Involved in the Current Study*

	Gender	Patient Age (years)	Etiology of Tooth Wear	Teeth Treated (tooth #)	Observation Period (months)
1	Male	31	Erosion/Abrasion	17,16,15,14,25,26,37,36,35,34,44,45,46,47	41
2	Male	27	Erosion/Abrasion	37,36,35,34,44,45,46,47	41
3	Female	44	Erosion/Abrasion	37,36,35,34,44,45,46,47	36
4	Male	32	Erosion/Abrasion	17,16,15,14,24,25,26,27,35,34,44,45,47	28
5	Male	34	Erosion/Abrasion	17,16,15,14,24,25,26,27,37,36,35,34,44,45,47	29
6	Male	41	Erosion/Abrasion	16,15,14,24,25,26,27,37,36,35,34,44,45,46	36
7	Male	42	Erosion/Abrasion	17,16,15,14,24,25,27,36,35,34,44,45,46	39
		36 ± 6		**N = 85**	**36 ± 5**

poured. One set served to document the baseline situation and the other was mounted on an articulator. A dental technician confected a diagnostic wax-up in a balanced occlusion scheme, mimicking exactly the desired shape and size of all teeth to be restored. Based on these cast models, a stabilization splint was fabricated in the lower arch. This removable device was worn for four-to-six months to simulate the new bite situation and vertical dimension and any possible influences on the temporomandibular joint at an early stage.[13-14] Only when this phase was well tolerated by the patients, no clinical signs of any form of temporomandibular disorder could be detected and signs of active erosive processes vanished, was the restorative treatment performed. All patients gave their informed consent.

Restorative Treatment

Before restoring the vertical dimension, all metallic restorations (amalgam or gold) were replaced with composite restorations (Syntac Classic and Tetric, Ivoclar Vivadent, Schaan, Liechtenstein) according to the manufacturer's instructions. Tooth-colored restorations with secondary caries or primary caries were treated accordingly.

A duplicate was made of the wax-up model and a vacuum-formed matrix template was provided for five patients. As an important feature of this device, the front teeth and the most distally located tooth were supported by the worn dentition to stabilize the template and support it. Under local anesthesia, a full-arch rubber dam was placed (Figure 1a), the teeth were cleaned with fluoride-free prophylaxis paste (Cleanic, Hawe Neos, Bioggio, Switzerland) and small metal matrices were interproximally placed to avoid blocking the teeth with resin composite. The template was then proofed to fit accurately (Figure 1b). The hollow space of the template represented the future composite material that would build-up the worn tooth and copy the wax-up (Figure 1c).

The template was removed and the enamel was etched for 120 seconds with 35% phosphoric acid (Ultraetch, Ultradent, South Jordan, UT, USA). The dentin areas were conditioned with a three-step adhesive system (Syntac, Ivoclar Vivadent, Schaan, Liechtenstein) according to the manufacturer's instructions. When composite restorations were present, they were sandblasted (Microetcher II, Danville

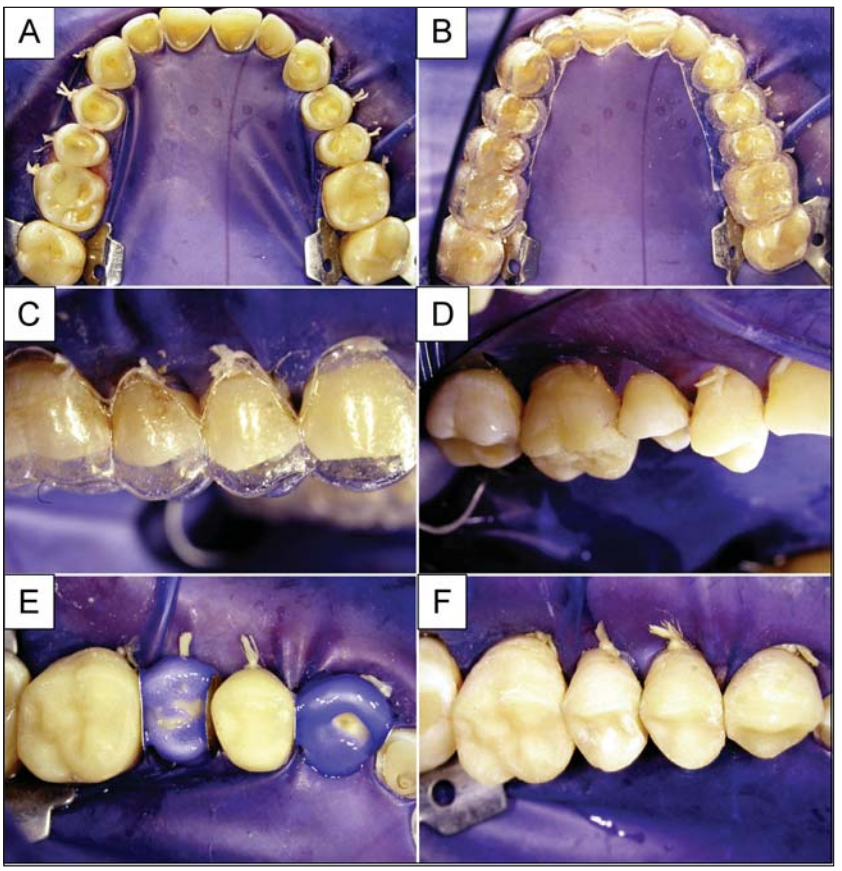

Figure 1. *Direct composite build-up of an upper arch using a vacuum-formed matrix template. The clinical steps (A-F) are documented step-by-step in the Methods and Materials section.*

Engineering, San Ramon, CA, USA) and silane (Monobond S, Ivoclar Vivadent) was applied for 60 seconds.

During the restorative build-up phase, every second tooth to be restored was conditioned as described above. The template was insulated (Insulating Gel, Haereaus Kulzer, Hanau, Germany) and the restorative fine-hybrid resin composite material was filled in the template (Tetric Ceram, Ivoclar Vivadent). The latter was then repositioned on the tooth arch. The resin composite material was light-cured (Optilux 500, Demetron Inc, Danbury, CT, USA) for three-to-four seconds to freeze the material. The template was carefully removed, along with any excess material. The material was then cured for 60 seconds per tooth (Figure 1d). After gross finishing and polishing, the remaining tooth areas were treated according to the method described above (Figures 1e and 1f). Distal teeth, which served as stabilization and support of the template, were treated with the freehand build-up technique. The occlusion was carefully controlled and adjusted, if necessary. Two patients received a freehand build-up according to the adhesive procedures described above.

After treatment, all patients received recalls based on an individual periodontal and cariologic risk assessment with a maximum period of six months. Five patients received Michigan or full-coverage heat-cured acrylic resin splints to protect the restorations.

Clinical Evaluation

Three investigators evaluated the restorations independently. The restorations were pre-calibrated at 85% reliability. Disagreement was resolved with a consensus. The restorations were evaluated using modified USPHS criteria (Table 2).[15]

RESULTS

The results of the clinical examination, based on USPHS criteria, are presented in Table 3. A representative example of a typical case is given in Figure 2.

Only one restoration showed radiographic signs of secondary caries formation. All other restorations were rated "Alpha," based on clinical and radiographic examinations. Surface texture and restoration color stability were rated "alpha" for all patients who showed the silky gloss appearance typical of hybrid composite materials. Regarding color match, all restorations were rated "Bravo" in one patient; whereas, all other patients were rated "Alpha." For most of the restorations, the anatomic form was rated "Alpha." "Bravo" ratings, however, were frequently rated due to visible loss of material as a result of attrition. Only two restorations had small defects extending to the tooth surface. These defects were rated as "Charlie." One defect was a small bulk fracture, the other was due to excessive occlusal wear. Four patients did not wear the protective splint on a regular basis. In all cases, marginal integrity was rated "Alpha" or "Bravo;" only one restoration had a score of "Charlie." These results were reflected in the marginal discoloration scorings. One restoration, however, had a "Delta" rating. All the teeth were vital and not a single tooth showed any signs of hypersensitivity during probe evaluation procedures or air. The periodontal tissues showed no signs of inflammation or suppuration. Only two patients had "Bravo" (gingivi-

Table 2: *Modified USPHS Criteria Applied for the Clinical Evaluation of Restorations*

	Alpha	**Bravo**	**Charlie***	**Delta****
Surface texture	Sound	Rough	-	-
Anatomical form	Sound	Loss of material within the composite	Loss of material extending to the tooth surface	Complete or partial (>50%) loss of the bulk
Marginal integrity	Sound	Positive/negative step, removable by finishing	Negative step, not removable by finishing	Strong negative step, not removable in major parts
Marginal discoloration	None	Slight discoloration, removable by finishing	Discoloration, localized not removable	Strong discoloration in many parts, not removable
Secondary caries	None	Caries present	-	-
Marginal inflammation	None No pockets >3 mm; no bleeding	Slight No pockets >3 mm; bleeding	Moderate pockets 4-5 mm; bleeding	Severe pockets ≥6 mm; bleeding
Restoration color stability	No change	Change of color in comparison to baseline	-	-
Color match	Sound	Non-perceptible at talking distance	Perceptable at talking distance	Total mismatch
Postoperative sensitivity (air)	None	Moderate	Severe	-

**Treatment: repairable; **needs complete re-restoration*

Table 3: *Results of the USPHS evaluation of the individual patients (cases, # of restorations in brackets). The total number of teeth with respective scorings and the percentages were calculated.*

	Rating	Case								
	1	**2** (14)	**3** (8)	**4** (8)	**5** (14)	**6** (15)	**7** (13)	(13)	**Total** N	%
Surface texture	Alpha	14	8	8	14	15	13	13	**85**	**100**
	Bravo								**0**	
	Charlie								-	
	Delta								-	
Anatomical form	Alpha	6	1	8	12	3	7	6	**43**	**51**
	Bravo	7	7		2	11	6	6	**39**	**46**
	Charlie	1				1			**2**	**2**
	Delta							1	**1**	**1**
Marginal integrity	Alpha	10	7	2	5	7	8	3	**42**	**49**
	Bravo	4	1	6	8	8	5	9	**41**	**49**
	Charlie				1			1	**2**	**2**
	Delta								**0**	
Marginal discoloration	Alpha	8	7	4	10	9	4	8	**50**	**59**
	Bravo	6	1	4	3	6	7	5	**32**	**38**
	Charlie				1		1		**2**	**2**
	Delta						1		**1**	**1**
Secondary caries	Alpha	14	8	8	13	15	13	13	**84**	**99**
	Bravo				1				**1**	**1**
	Charlie								-	
	Delta								-	
Restoration color stability	Alpha	14	8	8	14	15	13	13	**85**	**100**
	Bravo								**0**	
	Charlie								-	
	Delta								-	
Color match	Alpha	14	8		14	15	13	13	**77**	**91**
	Bravo			8					**8**	**9**
	Charlie								**0**	
	Delta								**0**	
Postoperative sensitivity (air)	Alpha	14	8	8	14	15	13	13	**85**	**100**
	Bravo								**0**	
	Charlie								**0**	
	Delta								-	
Marginal inflammation	Alpha	14	8	8	14	11	11	11	**77**	**91**
	Bravo					4	1	2	**7**	**8**
	Charlie						1		**1**	**1**
	Delta								**0**	

tis) scorings, and only one site had a periodontal lesion with loss of attachment adjacent to a non-erupted wisdom tooth.

During the observation period, only two restorations from one patient (case 4) had to be repaired after 24 months due to a small cusp fracture limited to that one cusp (biting on a nut). These restorations were excluded from the evaluation.

The subjective analysis of patient-related criteria using the visual-analogue scale (VAS) is given in Table 4. In general, all patients demonstrated good to excellent acceptance of the treatment. They did not perceive any discomfort during or after treatment. Function and aesthetics of the restorative treatment were judged to be good. Muscle or joint problems were very rare. Only one patient had higher scores. This particular patient, however, already had problems prior to treatment, which neither got worse nor disappeared. The subjective acceptance of the overall treatment was obviously very high in a way that all patients would recommend their treatment to other patients without hesitation.

DISCUSSION

This case-series evaluated the quality of direct composite build-ups restoring posterior teeth with excessive occlusal wear using USPHS criteria. In addition, criteria relating to patient satisfaction were assessed using VAS. In general, the authors of the current study found excellent clinical performance and patient acceptance after a mean service time of three years.

Clinical data regarding rehabilitation of the occlusion with direct resin composite restorations is scarce. There

is still a debate concerning the general applicability of resin composite materials for restoring teeth in load-bearing areas. Bartlett and Sundaram[12] investigated direct and indirect posterior resin composites used to restore worn posterior teeth over a comparable observation period of three years. In their analysis, they included 32 paired teeth in 16 patients. Seven restorations (22%; four indirect, three direct) fractured and nine were completely lost (28%; five indirect and four direct). This high failure rate led to the authors' conclusions that, using both direct and indirect resin composite materials is contraindicated for restoring worn posterior teeth. This observation could not be confirmed in the current investigation, where all restorations were retained and showed almost complete "Alpha" and "Bravo" scores (>90%) within all the criteria assessed. The relatively high rate of restoration fracture or loss of retention as reported by Bartlett and Sundaram may be partially explained by bruxism and the use of microfilled resin composite material. In the current study, a hybrid resin composite material was used; both studies, however, applied the same adhesive material, which cannot explain the differences in adhesive failures. Five patients in the current study received a Michigan or full-coverage heat-cured acrylic resin splints, whereas, patients in the latter evaluation did not. It is not clear whether this supportive therapy has contributed to this difference in outcomes. It must be noted in this context that four patients did not wear the splint on a regular basis, which was evident when assessing the anatomical form and wear due to attrition (cases 1, 2, 5 and 6). The fact that these patients did not show any fractures despite this mechanical load does not support this assumption.

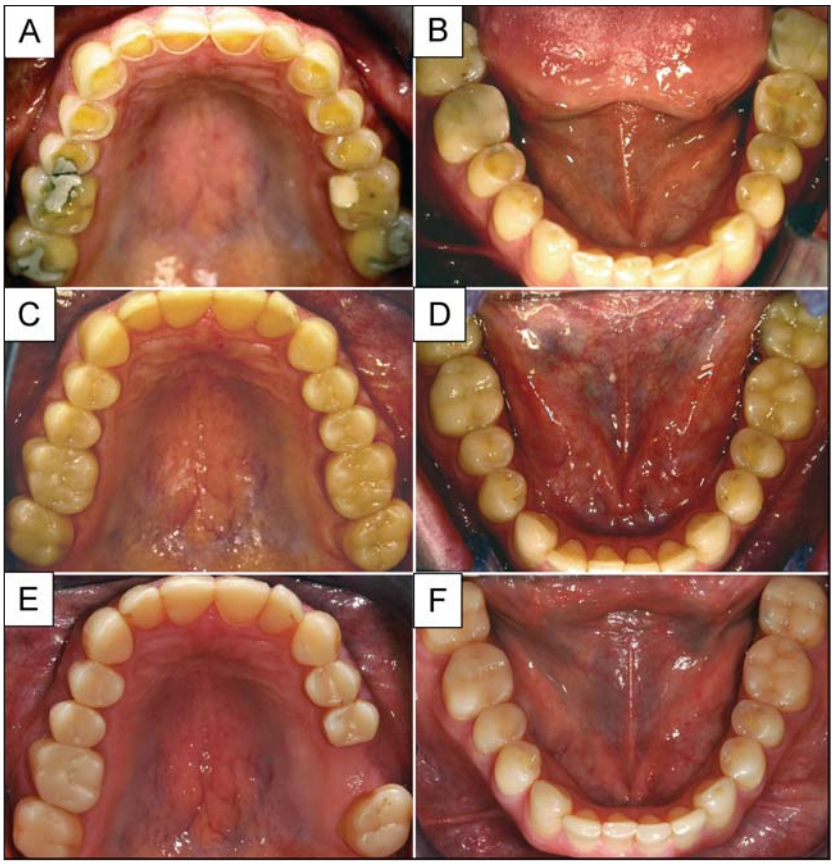

Figure 2. *Example of a case (occlusal view): Clinical situation before treatment (A and B) and one week after the template-based vertical bite reconstruction (C and D). Panels E and F show the situation 39 months after treatment. Tooth 26 was extracted alio loco due to a history of neuralgic pain. The tooth was vital, no fracture or caries was evident.*

Supplementary clinical data on large but not full-coverage restorations using direct resin composite materials to replace missing cusps are also limited, especially when a minimal evaluation period of more than two years is stipulated. In a 30-month clinical study, direct microhybrid resin composite restorations with one or two missing cusps were assessed.[15] All the restorations were retained and showed high "Alpha" scores and corroborate the findings of the current study. Additional reports and reviews support this good clinical performance of larger composite restorations, and they showed no significant difference between direct and indirect resin composite restorations.[16-17]

Surface texture of the restorations investigated was inconspicuous overall. However, micro-defects caused by physico-mechanical wear may affect the resin composite material surface. Especially in patients with an erosive background, the clinical long-term success can be hampered due to a combination of abrasion, attrition, chemical degradation and material fatigue even in stress-free areas.[18-19] The matrix can be softened and filler components can be lost.[20-23] Alcohol-containing solutions, which are frequently used during supportive maintenance care, can also negatively influence the mechanical and physical properties of the resin composite materials.[24]

Another important issue is the problem of postoperative sensitivity, which has always been a major point of concern when using direct composite restorations under clinical situations.[16] No postoperative sensitivity, however, has been observed in the current study. This is in accordance with findings of previous studies.[15] Tooth sensitivity can often be found after marginal gap formation, which may lead to microleakage and caries formation. One explanation is the good C-factor in the restorations. Caries was found in only one restoration. This also corroborates other studies that also recorded no caries despite some observed discolorations.[12,15]

CONCLUSIONS

Within the limitations of the current study, the authors conclude that direct resin composite materials represent a viable economic method to restore severely worn teeth at least for the medium-term. Additional studies, however, with more patients and longer evaluation periods, are needed to help confirm the positive clinical performance reported in the current study in the long-term.

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