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Bulkfill-Komposite: Effizienz und Evidenz

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Bulk-fill resin composites: current overview of efficiency and evidence

Bulk-fill resin composites offer an evidence-based material option for straightforward and safe clinical use. Even in terms of aesthetics, newer, optimized materials represent a significant enhancement to the portfolio previously available. The fact that low-viscosity bulk-fill composites no longer necessarily require a cover layer is now considered a welcome advancement. This paper aims to provide a review of the current literature on the bulk-fill approach and to illustrate the advantages of this efficient and aesthetic treatment option based on a wide range of clinical examples.

In 2003, Dentsply launched Quixfil – the first bulk-fill composite. It promised fast and easy handling, 4 mm curing depth in just 10 seconds, minimal volumetric shrinkage of 7%, and high abrasion resistance. In 2018, the University of Munich (LMU) published ten-year clinical data comparing Quixfil with Tetric Ceram [46]. After 10 years in service, no significant difference was found between Quixfil/Xeno III and Tetric Ceram/Syntac. Of the 46 Quixfil/Xeno III and 50 Tetric Ceram/Syntac restorations placed (14 Class I and 82 Class II cavities), 26 Quixfil and 30 Tetric Ceram restorations were available for follow-up investigation. Four Tetric Ceram and six Quixfil restorations failed during the observation period. The authors attested good clinical outcomes for both material combinations after ten years.

The next milestone in bulk-fill application followed in 2010: with the introduction of SDR – the first bulk-flow composite – raising the bar, also for applying in 4 mm layers, highly self-adapting and leveling, and with extremely low shrinkage stress. This marked a paradigm shift, as 4 mm of a flowable composite had previously never been polymerized in a single step [28]. As the worldwide scientific dental community quickly embraced this new restorative approach, SDR has since become the most extensively investigated bulk-flowable resin composite. More than 15 years of published studies attest to the material's very good results.

However, compared to sculptable materials, its inferior physical properties have made it necessary to cap it with a layer of a more stable, sculptable composite of at least 2 mm. This was widely accepted. However, this new approach to Class II cavities offered significant simplification, time savings, and enhanced safety by reducing the risk of errors during application. Bulk-fill resin composites have since become well established in widespread use in dental practices for over a decade.

There was plenty of skepticism– particularly regarding depth of cure and the shrinkage stress resulting from polymerization. Low shrinkage stress combined with high curing depth, as promoted, soon fueled suspicion that the material simply had a low conversion rate, which would naturally result in lower measurable shrinkage and shrinkage stress. One of the main sceptics included Professor Price from Dalhousie University, Nova Scotia. After all, over the past decades, Halifax has been the source of some of the most significant insights into light-polymerization of composites and having the most critical questi-

ons, along with pragmatic solutions for everyday clinical applications of visible light-curing (VLC). Especially the focus on clinical use and the development of practical recommendations made publications from and with Professor Price so important and valuable [29,33,92–95,105,106].

For this very reason, Price picked bulk-fill resin composites as the focus topic of the annual Northern Light Meeting, held on November 4–5, 2016, at Dalhousie University in Halifax, Nova Scotia, Canada. The attendees were 45 internationally renowned and respected scientists who were actively engaged in VLC research. However, the outcome of the very open conference turned out differently than Price had anticipated: the consensus statement paper on bulk-fill composites, published online in June 2017 [https://oasisdiscussions.ca/2017/06/07/csbf/], concluded that using bulk-fill resin composites resulted in noticeable time savings, along with a potential reduction in the risk of contamination and air bubbles. The participants agreed that the mechanical properties of bulk-fill composites are comparable to those of conventional hybrid resin composites. However, bulk-fill resin composites are not superior to traditional materials applied in a layering technique. It can therefore be expected that bulk-fill resin composites perform comparable to conventional resin composites placed in incremental technique of a maximum of 2 mm in areas subject to occlusal load. However, the participants also stressed that conventional resin composites applied in an incremental or layering technique can still be quoted as the gold standard. Hickel et al. published the findings in German in 2018 [50].

Before delving into individual studies on bulk-fill resin composites, it is useful to first have a look to meta-analyses, review articles, and overview papers on the topic of bulk-fill resin composites [27,78]. Since 2016, at least one meta-analysis and/or review paper on bulk-fill resin composites has been published each year [7,17,19,45,49,89,104,109,116,125,126,132]: hardly any other restorative concept has been the subject of so many review papers that scientifically examine and summarize the topic or question. Back in 2016, the year of the Northern Light Meeting on bulk-fill composites, Schwendicke et al. [104] published a general overview on resin composites in the Journal of Dental Research. However, bulk-fill resin composites were underrepresented in this meta-analysis. The authors described that in restorations subjected to occlusal load, conventional composites showed the highest probability of survival. When survival rate was the primary consideration, conventional or bulk-fill resin composites proved to be the most suitable for occlusally loaded restorations; bulk-fill composites were therefore placed on a par with conventional composites. The most comprehensive and valuable meta-analysis on bulk-fill composites was published in 2017 by the Loeven research group [125]. With regard to curing depth, it was found that low-viscosity bulk-fill materials generally exhibit better performance than sculptable bulk-fill materials [35,36,39,41,59,70,82,90,97,111,131].

The best curing results were almost always achieved by the relatively translucent SDR [4,70]. This is particularly evident with SDR in measurements of the conversion rate [71]: it was the highest among the bulk-flow materials tested. The meta-analysis [125] of mechanical properties also showed that the higher the filler content, the greater are the elastic modulus [72], flexural strength [1,54], and surface hardness [6,26,35]. Consequently, most bulk-flow materials have inferior mechanical properties, which is why they should be capped with a sculptable resin composite. In line with their filler content, SonicFill and X-tra fil show the best mechanical properties, while Venus Bulk Fill and Filtek Bulk Fill Flowable exhibit the worst mechanical performance [1,11,21,23,40,44,54,72,102,115]. There are also exceptions, however: Tetric EvoCeram Bulk Fill often showed lower flexural strength (in some cases even lower than those of certain bulk-flow materials) [25,40,54,70,118], whereas X-tra base demonstrated above-average mechanical properties (with a filler content of 61 vol.% the highest among all bulk-flow materials matching that of Tetric EvoCeram Bulk Fill). The material showed significantly better abrasion resistance and greater hardness [26], which led Ilie et al. to consider using X-tra base without a cover layer of a sculptable material, contrary to the original manufacturer's recommendations [54,55].

A study published in 2017 is interesting in this regard [81]: In this study, SDR was used conventionally with a cover layer (G-aenial). Restorations layered with G-aenial served as the control group. This study was designed retrospectively, with all restorations placed in one dental practice by a single clinician. After two years, both groups showed a restoration survival rate of 93%. The failure rate increased in both groups with an increased number of surfaces and cuspal coverage, and consequently occurred more often in larger cavities. Tooth fractures mainly occurred in the SDR group, which the authors attributed to the slightly inferior physical properties of SDR. Also, a retrospective study assessing patterns of failure provides limited insight into whether the materials were processed correctly according to guidelines, such as VLC.

In terms of shrinkage stress, the meta-analysis summarized the following general observation: Polymerization stress is lower in bulk-fill materials than in conventional composites, and low-viscosity bulk-fill materials generate less shrinkage stress than their high-viscosity counterparts [25,36,59,65,102,112]. The lowest shrinkage stress was once again observed with SDR [53,66,80,99]. Cuspal flexure analysis can also be used to evaluate shrinkage stress: The less the cusps are "pulled together", the lower the shrinkage stress is likely to be, but only if the marginal sealing of the restorations is maintained: Detachment at the cavity margin would otherwise necessarily mean there would be no cuspal flexure at all. Moorthy et al. [83] already took just this into account back in 2012: the additional use of the bulk-flow materials SDR and/or X-tra base overlaid with GrandioSO (VOCO) significantly reduced cuspal flexure compared to restorations layered exclusively with GrandioSO – without any change in marginal sealing.

With regard to marginal sealing, the meta-analysis [125] found that most studies on the subject could not find any significant difference in marginal sealing with the use of bulk-fill composites [3,8,10,16,36,37,48,62,64,68,88,101,107,108]. Six studies showed improved results in terms of marginal integrity when a bulk-flow resin composite was used in addition of the first 4

mm layer [51,64,83–86]. Only one study reported poorer marginal quality with the use of a bulk-fill resin composite [91]. An interesting study in this context [61] found that some sculptable bulk-fill materials (Tetric N-Ceram Bulk Fill and SonicFill) exhibited better marginal quality than bulk-flow materials (SDR and Venus Bulk Fill).

The extremely low shrinkage stress of SDR [67,103] may contribute significantly to the very good marginal quality of this bulk-flow material. The most interesting finding from the meta-analysis [125] previously cited, however, was that the use of adhesives is more critical than the type of composite technique [56,60]. Also in 2017, Chestermann et al. [17] published another review on bulk-fill resin composites in the British Dental Journal. However, the review focused primarily on the material properties and handling advantages of the bulk-fill technique. The advantages of the application are stressed, which are certainly capable of contributing to better clinical outcomes. In their 2018 review article, Ilie and Manhart attested to the fact that bulk-fill composites appear to have performed well so far and thus make an important contribution to expanding the range of modern restorative materials [57]. (The same pair of authors from the University of Munich had already highlighted the growing popularity of bulk-fill resin composites back in 2015 [79].) Also in Germany, Tauböck et al. published another position paper on bulk-fill resin composites in 2019 [116]. They described that bulk-fill resin composites enable a simplified operative procedure and a faster workflow. In their estimation, bulk-fill resin composites are of significant clinical benefit, particularly in the minimally invasive treatment of hard-to-reach cavities, thanks to their easy application and reduced shrinkage stress. The authors also made particular reference here to the previously cited ten-year results of the clinical study on Quixfil conducted by University of Munich [46].

An international review on bulk-fill resin composites was published in 2019 in Dental Materials [19]: this meta-analysis mainly focused on in-vitro studies (n = 103) on bulk-fill materials, although some clinical studies were also included. The bulk-fill materials described showed reduced polymerization shrinkage, less cuspal flexure, and microhardness comparable to conventional resin composites, along with comparable marginal quality and fracture strength. The results for conversion rate were also similar to those of conventionally layered composites. The authors concluded that bulk-fill materials delivered results comparable to, if not better than conventionally layered materials.

In the same year, a meta-analysis was also published in Clinical Oral Investigations [126], which (from an initial pool of 941 publications considered) included ten clinical studies with observation periods ranging from 12 to 72 months. However, the mean observation period here was just under three years. Here too, no significant differences in failure rates were observed between bulk-fill resin composites (bulk-flow and sculptable) and conventional resin composites placed using the layering technique. However, the authors stressed the need for longer-term clinical studies.

The next meta-analysis was published just one year later [7]: the analysis of 16 clinical studies with follow-up periods ranging from six months to ten years – published between 2010 and 2020 – also found no differences between bulk-fill and conventional resin composites, regardless of the cavity class (I or II), dentition type (deciduous or permanent tooth), or restoration technique (incremental, complete bulk-fill, or bulk-fill with a conventional cover layer). Another year later (2021), an analysis was published reviewing eight clinical studies that had been published since 2006 [132]. Here too, the authors stressed the simplification of composite application by reducing the number of working steps, which in turn led to a decrease in treatment time. However, they stress the lack of evidence for a correlation between the bulk-fill approach and marginal quality. The 2022 review [12], which generally describes all available restorative materials, both direct and indirect, also emphasizes this in a similar way. Particular attention is also given here to bulk-fill composites. The systematic review by Tirapelli [117] reaches the same positive conclusions: for the parameters retention rate, fractures, anatomical form, surface texture, shade matching, marginal seal, marginal discoloration, secondary caries, and postoperative sensitivity, no differences were found between incremental and bulk-fill application of resin composites in Class I and II restorations.

In 2022, Heintze et al. updated their meta-analysis on posterior composites, originally published ten years earlier [49,47]. The background for the authors was the availability of numerous new clinical studies on posterior composite restorations, as well as the successful market launch of bulk-fill resin composites. Studies with a minimum duration of two years, published between 2000 and 2019, were considered. Of the 423 studies considered here, 62 were included in the meta-analysis, nine of them were on bulk-fill resin composites. The analysis documented a ten-year survival rate of 85–90%. The main reasons for failure were bulk fractures and abrasion (70% of reasons for re-intervention). Caries accounted for 20% of the failures, while loss of retention, no longer acceptable marginal defects, endodontic interventions, and cuspal fractures, together made up the remaining 10% of failures. No significant differences were found between hybrid, micro-hybrid, nano-hybrid, and bulk-fill composites with regard to material fractures, shade, changes in surface morphology, and anatomical shape. Interestingly, the analysis confirmed that the enamel etching technique generally produced the best clinical outcomes.

The year 2023 also saw the publication of three reviews and meta-analyses on the topic of bulk-fill resin composites. The meta-analysis by Sengupta et al. [109] investigated publications of clinical studies up to April 2023: 18 studies were filtered out from an initial pool of 1,445 publications and considered in closer detail. Here too, the bulk-fill approach was found to yield results comparable to those of the conventional layering technique. Silva et al. [110] considered eight studies published between 2018 and 2021. Here too, the performance of bulk-fill approaches was found to be comparable to that of conventional resin composites. In the review published in Biomaterial Investigations in Dentistry [89], out of 684 studies initially selected, 53 were selected for closer consideration. The results proved to be very heterogeneous. The degree of conversion

ranged from 19% to 94%, and shrinkage varied between 1.2% and 10.5%. Shrinkage stress ranged between 2 and 3 MPa, falling within a significantly narrower window. The measured flexural strength for most materials were above 80 MPa. Here too, the authors concluded that bulk-flow materials meet the requirements for final restorative materials.

Meta-analyses and guidelines represent the highest level of evidence in the literature. In addition to considering published meta-analyses, reviewing guidelines is therefore of particular importance. A new S3 guideline on direct resin composite restorations in permanent anterior and posterior teeth was recently published in Germany [133]. It superseded a former S1 recommendation on composite restorations in posterior teeth from the year 2016. The evaluation of bulk-fill resin composites was added now. There was strong consensus on the statement that bulk-fill resin composites can be safely polymerized to a depth of up to 4 mm using polymerization devices with the appropriate power output.

Based on the consistent findings from the numerous meta-analyses and reviews available over the past ten years, as well as the guideline, the use of bulk-fill resin composites at this high level, if properly applied, can be considered safe and stable in long-term. For this reason, in recent years the focus has been on further optimizing the clinically effective and proven bulk-fill approach. As physical properties such as stability, shrinkage stress, and curing depth had already been thoroughly investigated, the focus shifted to handling and aesthetics. Among the bulk-flow materials, Venus Bulk Flow ONE [32] and Omnichroma Flow Bulk were the pioneers. The latter is a bulk-fill variant of the already successfully introduced Omnichroma Flow [30], which has since been attested to deliver good two-year results in a clinical study [20]. A plus point here remains its excellent shade adaptation to the underlying tooth structure [38,128]. Polishability is also part of aesthetics: both Venus Bulk Fill ONE and Omnichroma Flow Bulk achieved smoother surfaces when polished with the three-stage Super-Snap Rainbow Kit (Shofu, Kyoto, Japan) than with Diacomp Plus Twist polishers (EVE Technik, Pforzheim, Germany) [5]. Interestingly, however, the most recent study on Omnichroma Flow Bulk reported a curing depth of 3.3 mm [77]. However, in the study, SDR flow+ also achieved a curing depth of only 3.9 ± 0.2 mm, which, in view of the previously published data on SDR [52,69,100], may raise some doubt about the study's methodology.

On the other hand, a 2023 study [113] considering the correlation between bottom and top surface hardness found that none of the bulk-fill materials investigated were able to sufficiently cure to a depth of 4 mm. As always, it ultimately depends on the measurement method used. Beyond the cited meta-analyses, interesting individual clinical studies on bulk-fill composites continue to be published, e.g., on the mean annual failure rate of posterior restorations with and without SDR [122] after three years in Class II cavities. The bulk-flow material SDR was used exactly according to the instructions for use – with a cover layer of CeramX. In the split-mouth approach, the control group consisted of layered CeramX fillings. During the observation period, four out of 80 fillings failed (5%): one in the SDR group and three in the CeramX layering group. The mean annual failure rate was therefore 0.8% in the SDR/CeramX group and 2.5% in the CeramX group. However, the difference was not statistically significant. Here too, SDR was attested to have good clinical suitability. The study is similar in its experimental design and results to the earlier studies by van Dijken and Pallesen from 2016 and 2017 [123,124].

In 2022, a clinical study comparing Tetric EvoCeram Bulk Fill and Filtek Ultimate with six-year results was published [129], which showed fewer marginal discolorations with the bulk-fill approach. No significant differences were found in the other parameters investigated. The authors even went so far as to conclude that a bulk-fill composite could work better than an incrementally applied material from a clinical perspective, particularly with regard to marginal discoloration. Five-year data for another bulk-fill material (Tetric N-Ceram Bulk Fill, equivalent to Tetric EvoCeram Bulk Fill) was published in 2023 [73]. The mean annual failure rate was 1.0% for the incremental technique and 1.2% for the bulk-fill group. The difference was also not statistically significant here ($p = 0.35$). Thus, good clinical outcomes were documented after a five-year observation period even for high-viscosity bulk-fill materials.

A more recent study from 2024 on Filtek Bulk Fill, heated Filtek Bulk Fill, G-ænial BULK Injectable, and SonicFill3, published in the Journal of Esthetic and Restorative Dentistry, attested "promising" clinical results for all the bulk-fill materials studied after a two-year observation period for Class II restorations [42]. No significant aesthetic, functional, or biological differences were found between the materials, despite their significant differences in viscosity. A study published in the same journal in 2024 [2] not only looked at Tetric Powerfill but also on Cention N and Surefil One. After a two-year observation period, Tetric Powerfill and Surefil One showed a clinical success rate of 100%, while for Cention N this was only 96%, which was still considered clinically acceptable. Only the marginal quality of Cention N changed significantly compared to baseline.

The three-year study by González et al. [43] primarily focused on the application of the adhesive Adper Single Bond 2 on moist or dry dentin. All cavities, however, were restored with Filtek Bulk Fill. The differences in dentin moisture showed no significant impact on clinical performance after three years. In each group, 22% of the restorations showed slight marginal discoloration, and 24% minor marginal defects. Two fillings per group (4%) were lost. Another two-year study in a split-mouth design with 30 restorations in each group investigated a bulk-flow ormocer (organic ceramic) with the layering technique using a conventional 2-mm layering resin composite. Again, no significant differences were found between the two restoration concepts after the two-year follow-up period. The clinical success rate was 93% in both groups [120].

The study by Twigg et al. [121] presents rare two-year data on a true bulk-fill material – the self-curing Fill-Up (compared to the layered Brilliant Everglow). The focus of this study was primarily on the occurrence of postoperative sensitivities. These were not significantly different between the two groups. Interestingly, a Fill-Up restoration was lost after ten days due to debonding.

Another study on the same self-curing bulk-fill material with a light-curing option was published in Clinical Oral Investigations [24]: in addition to Fill-Up, the clinical study investigated QuiXfil and Tetric N-Ceram Bulk Fill in 40 patients. One Coat 7 Universal adhesive was used in all cavities in the selective enamel etching technique. Three restorations were placed for each patient. The study was described as a double-blind study, but the question arises how this could work in the case of Fill-Up. In the end, no significant differences were found between the three study groups in all the parameters investigated. Right after 18 months, the sonic-activated bulk-fill composite Sonicfill 2 proved to be superior to the glass hybrid Equia Forte HT in terms of retention loss and shade matching [9], and was generally convincing with good clinical outcomes. The bulk-fill ormocer Admira Fusion x-tra showed significantly better clinical results after two years of observation for the parameters of surface gloss and surface changes compared to the conventional layered composite Grandio used in the same study. However, Admira Fusion x-tra showed poorer results in terms of surface discoloration and shade matching. Both materials were applied in a split-mouth design to the first molars of six- to twelve-year-old children. Both filling materials were classified as clinically acceptable [14].

A four-year study on a bulk-fill composite was also published in Dental Materials in 2024 [15]. The focus here was on the additional use of a sealing varnish (Biscover or Permaseal). Only one restoration (without sealing) was lost during the observation period, which reduced the four-year success rate in this group to 98%; with the sealants applied, the success rate was 100% in both cases. The authors reported excellent results for the bulk-fill composite after four years – regardless of whether an additional sealing varnish was applied – which implies that this extra step may be unnecessary.

As the evidence in the literature is clear and describes the use of bulk-fill techniques (whether bulk-flow or sculptable bulk-fill materials) as safe and efficient, there is nothing preventing their broad clinical use if the user is looking for a simplified version of the proven layering technique in 2-mm increments. The somewhat hesitant acceptance of bulk-fill materials was probably due to their previously limited aesthetic potential. A lot has changed in recent years, however: in addition to the highly aesthetic bulk-flow materials, Venus Bulk Flow ONE [31,32] and Omnichroma Flow Bulk, as described above, there are also sculptable bulk-fill composites, such as Filtek ONE (Solventum, formerly 3M Oral Care) and Ecosite Bulk Fill, which allow for very good aesthetic results. While Filtek ONE follows the classic Vita shade guide, Ecosite Bulk Fill is offered in a universal shade that covers nearly all applications – and that with a 5 mm layer thickness (20 sec. curing time) as claimed. The "universal shade approach" is followed by the sculptable material Ecosite Bulk Fill, and the Flowable bulk fill resin composites Venus Bulk Flow ONE, Omnichroma Flow Bulk, as well as Brillant Bulkflow, which is offered in a version called "multishade".

Kettenbach has now brought out a bulk-flow material (Visalys Bulk Flow), which, however, differs slightly in its consistency from traditional bulk-flow materials: it is significantly more stable, tending toward an "injectable composite" and thus offers much more flexibility in shaping the occlusal surface and marginal ridge on account of its very good handling properties. Additionally, it does not require a cover layer of a sculptable material. This stability, combined with flowability, is a major advantage, especially for restoring approximal slot cavities.

Just like Venus Bulk Flow ONE and Omnichroma Flow, Visalys Bulk Flow is offered exclusively in a single aesthetic universal shade, delivering equally beautiful treatment results as the afore mentioned materials. The following treatment examples illustrate the application of this material.

Case studies

Case 1: Initial caries on lower right 2nd premolar

The 54-year-old patient had a concealed proximal caries detected distal on her 2nd right lower premolar **(Fig. 1)**. After opening the defect **(Fig. 2)**, the extent of the severely undermining caries became apparent. After complete caries excavation, preparation of the cavity and shaping of the cavity with the use of a sectional matrix (Danville ultra thin flex, Zest Dental Solutions, CA, USA), a flexible resin wedge (G-Wedge, Garrison, MN, USA), and a NiTin premolar separation ring (re-invent Dental Products GmbH, **Fig. 3**), restoration was carried out after adhesive pre-treatment (G2 Universal, GC, total etch) using the low-viscosity Visalys Bulk Flow – in a single increment **(Fig. 4)**. After application, the material could be shaped with a probe, and the marginal ridge was so well formed by spreading along the inside of the matrix foil that there was hardly any need for further finishing once the matrix was removed. VLC was first carried out for 20 seconds from the occlusal direction (Elipar Deep Cure, 3M). After removing the matrix, two additional curing cycles were carried out, each for 20 seconds: one from the buccal direction, and another one of the restoration with the light emission

Fig. 1: Concealed proximal caries distal in a lower right 2nd premolar.

Fig. 2: Clinical situation after opening the defect.

Fig. 3: Prepared Class II cavity with shaping using a sectional matrix.

Fig. 4: Application of the bulk-flow material in a single increment.

Fig. 5: Restoration immediately after finishing and polishing.

Fig. 6: Examination after six months: the marginal integrity and aesthetics are unchanged.

window centrally on the marginal ridge of the resin composite restoration.

Figure 5 shows the restoration immediately after finishing and polishing (Diacomp Plus Twist, EVE). The very good shade matching is impressive: the material does not appear too translucent, even though it was used in a 4-mm bulk application. By restoring the small defect in a single increment, both the working time and the risk of a defect going unnoticed between individual increments is reduced, especially in such cavities that are hard to see and control. The result speaks for itself in terms of both aesthetic and functional aspects. **Figure 6** shows the clinical situation on follow-up examination after six months: no marginal discoloration or disintegration is visible, and the aesthetics remain unchanged.

Case 2: Initial caries in a 1st and 2nd upper right premolar

The 26-year-old patient was unhappy with the proximal gap between her upper right premolars, as food debris would often be trapped there. During clinical inspection, initial caries was observed distal on the 1st upper right premolar **(Fig. 7)**. The patient was advised to have this gap filled with a minimally invasive resin composite restoration – while excavating the caries on the tooth. After excavating and preparing the defect, the cavity was formed in the same way as in Case 2, using a sectional matrix (Danville ultra thin flex), a flexible resin wedge (G-Wedge), and separated with a NiTin premolar separator ring (re-invent, **Fig. 8**). Sectional matrix systems are currently the first choice for forming anatomical contact surfaces [22]: they guarantee correct anatomical shapes, tight proximal contacts, and load-optimized marginal ridges [74–76]. Following adhesive pre-treatment (G2 Universal, GC, total etch), the defect was filled in a single increment with the low-viscosity Visalys Bulk Flow, just as in the previous case, and shaped using the probe tip **(Fig. 9)**. The curing (Elipar Deep Cure) was again standardized for 20 seconds each time: once centrally from the occlusal direction after placing the bulk-fill material, and once each for post-curing after removing the matrix, from the buccal and once again from the occlusal direction, with the light guide tip positioned precisely on the center of the marginal ridge. This ensures sufficient curing of the 4 mm deep defect. **Figure 10** shows the treatment result immediately after finishing and polishing (Diacomp Plus Twist, EVE), while **Figure 11** is from a further follow-up at six months. At this follow-up, bitewing x-rays were taken as part of the routine two- to three-year interval for caries diagnosis. The x-ray shows the new Visalys Bulk Flow restoration to be marginally sealed, anatomically shaped, and with sufficient radiopacity **(Fig. 12)**. The enamel lesion mesial on teeth 15 and 16 did not require treatment, as the surface was intact, whereas the hidden dentin lesion distal on tooth 15 did require treatment. The defect was restored in a subsequent session using the same material combinations and identical polymerization protocol **(Fig. 13 to 15)**.

Fig. 7: Proximal gap between the upper right premolars, in which food debris would often be trapped, with a wish for a restorative solution.

Fig. 8: After removing the caries beneath the marginal ridge distal on the 1st upper right premolar: Matrix placement using a sectional matrix system.

Fig. 9: Filling the defect with a low-viscosity bulk-flow material.

Fig. 10: The treatment result immediately after finishing and polishing.

Fig. 11: Clinical examination after six months.

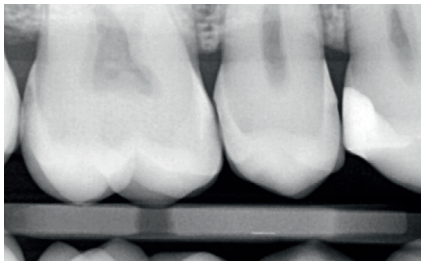

Fig. 12: Bitewing x-rays: The bulk-fill restoration is marginally sealed, anatomically correct shape, and sufficient radiopacity.

Fig. 13: Restoration of the defect in the upper right 2nd premolar. The dentin caries was visible in the bitewing x-ray (Fig. 12).

Fig. 14: Filling the defect with the stable bulk-flow material.

Fig. 15: Completed restoration in the upper right 2nd premolar.

Case 3: Initial caries in an upper left 2nd premolar next to a gold crown

The restoration of approximal lesions next to metal fillings (amalgam or gold) is usually challenging with common bulk-fill materials, as the high translucency of the restoration materials often causes the filling to appear grayish. The gray shade is often difficult to interpret during clinical examinations. The spread of caries beneath the filling must be clearly differentiated from the material's intrinsic translucency. For this reason, it is extremely desirable for bulk-fill materials to achieve shade matching that ensures they do not appear too translucent. This is the case with the bulk-flow materials Venus Bulk Flow ONE, Omnichroma Flow Bulk, and Visalys Bulk Flow. Thus, the application of Visalys Bulk Flow in the cavity next to the gold partial crown in this 57-year-old patient resulted in a clinical appearance that corresponds 1:1 to the natural tooth **(Figs. 16 to 19)**. The treatment procedure corresponds to the previous approximal cases. Only instead of the G-Wedge, a Fusion Wedge (also from Garrison) was used, as it ensured even better cervical sealing of the matrix.

Fig. 16: Cavity after excavation, preparation, and matrix placement on an upper left 2nd premolar.

Fig. 17: Filled defect (bulk flow material without cover filling).

Fig. 18: The clinical result after finishing and polishing.

Fig. 19: Six months later: aesthetics is unchanged.

Case 4: Two adjacent interproximal lesions

The case of the 19-year-old patient whose both upper left premolars show that two adjacent cavities can be restored simultaneously using very thin matrix bands. Simulation restoration is economical and reduces the risk of contaminating the second cavity with adhesive during its dispersion with air: because changing the matrix almost always leads to bleeding or other contamination, the second cavity must be cleaned or prepared

again. Only rinsing the cavity before adhesive sealing is likely to be ineffective, as phosphoric acid conditioning of the enamel margins can hardly be carried out sufficiently, as the surface is coated with adhesive blown over from the cavity first restored. The adhesive surfaces would therefore need to be refreshed again, which, owing to the narrowness of the minimally invasive cavity area, represents an additional and not entirely straightforward step. For this reason, simultaneous restoration of such approximal lesions is easier to manage in terms of contamination and is therefore preferable – provided the approximal contact is sufficiently strong. This was ensured in this case by the use of two very thin (0.03 mm) sectional matrix bands (QuickmatFLEX Titan, Polydentia, Switzerland, **Figs. 20 and 21**). The excellent separation force of the NiTin separator ring used guarantees sufficient contact strength **(Fig. 22)**. The restoration procedure followed the same protocol as in the previous cases. However, the polymerization of the adhesive (G2 Universal) and the bulk-fill composite (Visalys Bulk Flow) was performed separately, rather than covering both cavities simultaneously with the 10 mm light guide of the Elipar Deep Cure, in order to minimize shadowing from the two sectional matrices. Post-polymerization after removing both matrices was performed just once for both cavities: once from occlusal centrally directed at the newly built-up marginal ridges, and once from interproximal/buccal. The final clinical result was once again convincing: Functionally and aesthetically. **Figure 23** shows the clinical follow-up after six months: no marginal discoloration or disintegration is visible, and the aesthetics remain unchanged.

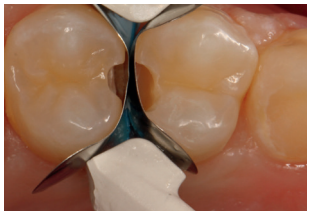

Fig. 20: Simultaneous restoration of two approximal lesions.

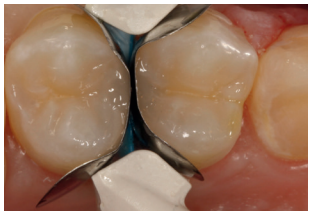

Fig. 21: Filling of both defects.

Fig. 22: Completed restoration of the adjacent approximal cavities with approximal contact fully re-established.

Fig. 23: Follow-up image after 6 months: no marginal discoloration or disintegration is visible, and the aesthetics remain unchanged.

Case 5: Occlusal cavity on a lower molar

Bulk-flow materials can also be used effectively and economically in the molar region without compromising aesthetics, as shown by the restoration of lower right 1st molar in this 22-year-old patient. **Figure 24** shows the cavity already prepared, isolated with a single-tooth rubber dam, and the phosphoric acid conditioning of the enamel margins (Gel Etchant, Kerr). The decision to maintain absolute dry isolation was taken due to the difficulty in controlling the tongue and frequent swallowing reflexes, which significantly increased the risk of unwanted salivary contamination of the bonding surface.

The use of a rubber dam is generally recommended, but not an absolute requirement for establishing sufficient contamination control [47,96]. The two-step universal adhesive G2 Universal, as used previously, was applied here using the selective enamel etching technique, that means that the material self-conditions on the dentin **(Fig. 25)**. The data published to date on this multi-bottle universal adhesive show impressive performance that stands up well to comparison with the "gold standards" [98] such as Optibond FL [13,18,34,58,63,114,119,127,130]. In the next step, the individual cusps were built up using the pleasantly stable flowable material **(Fig. 26)**. **Figure 27** shows the fully restored occlusal cavity, while **Figure 28** shows the situation immediately after finishing and polishing. The excellent shade adaptation is impressive once again.

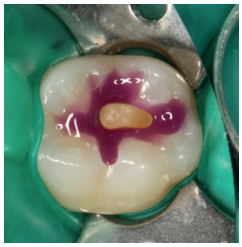

Fig. 24: Prepared, isolated cavity with phosphoric acid conditioning of the enamel margins.

Fig. 25: Adhesive sealing of the cavity.

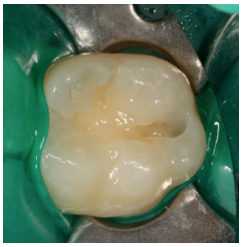

Fig. 26: Build-up of a cusp using the stable bulk-fill material.

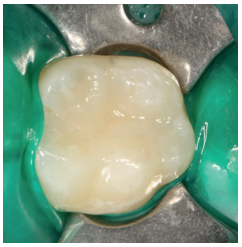

Fig. 27: Restoration of the entire cavity with the same bulk-fill material.

Fig. 28: Finished and polished restoration.

Case 6: Mini-slot cavity in an upper molar
The small mesial approximal caries on the upper left 1st molar of the 34-year-old patient was shown to be in need of treatment from the clinical cavitation recognizable from the palatal view. Following cavity preparation with the Sonicsys Quick Micro-Prep sonic tip SFQ 30 M (Komet, Lemgo), which allowed maximum protection of the adjacent tooth [87], the cavity was sealed again using a QuickmatFLEX Titan sectional matrix band (Polydentia), a Fusion Wedge (Garrison), and a NiTin separator ring **(Fig. 29)**. G2 Universal adhesive was applied again – this time using the "total-etch" technique. Differentiated etching of enamel and dentin is not possible with such small cavities. As dentin etching with phosphoric acid is optional with universal adhesives and does not cause negative effects, the use of a universal adhesive is an ideal material option. The slot defect was again filled in a single step using the single-shade bulk-fill Visalys Bulk Flow **(Fig. 30)**.
Following polymerization for 20 seconds from the occlusal (Elipar Deep Cure), post-polymerization is carried out over the marginal ridge and from the buccal for an additional 20 seconds each, followed by finishing and polishing, the result was once again functionally stable and aesthetically attractive **(Fig. 31)**. A routine bitewing x-ray taken during the session shows the marginally sealed mini-restoration and very good radiopacity **(Fig. 32)**.

Fig. 29: Mesial interproximal defect in an upper left 1st molar with matrix placement already completed.

Fig. 30: Filling the slot defect in a single step with the single-shade bulk-fill material.

Fig. 31: Functionally stable and aesthetically attractive result.

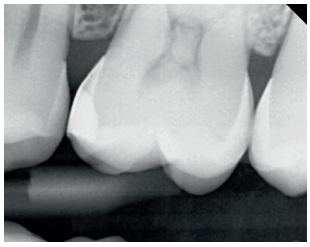

Fig. 32: The bitewing x-ray shows the marginally sealed mini-filling and good radiopacity.

Case 7: Class II restoration in another upper left 1st molar
The interproximal lesion of the 57-year-old patient mesial on his upper left 1st molar **(Figs. 33 and 34)** is similar to the previous case on the same tooth, but was only undermined slightly further in the orovestibular direction. The Sonicsys Quick Micro-Prep sonic tip SFQ 30 M (Komet, Lemgo) was also used here. The matrix placement of the cavity was optimal using a Danville ultra thin flex sectional matrix, a Fusion Wedge (Garrison), and a NiTin premolar separator ring (re-invent) **(Fig. 35)**. Under isolation with cotton roll and suction, after adhesive conditioning (G2 Universal, GC, total etch), the restoration with the low-viscosity Visalys Bulk Flow was easily placed in a single increment and shaped with the tip of the probe along the inside of the matrix foil adjacent to the marginal ridge **(Fig. 36)**. Once again, the result after VLC, finishing, and polishing is convincing both aesthetically and functionally **(Fig. 37)**.

Fig. 33: Interproximal lesion mesial in an upper left 1st molar.

Fig. 34: Opening and visualization of the defect.

Fig. 35: Placement of the matrix around the excavated and prepared approximal defect.

Fig. 36: Filling of the defect with the single-shade bulk-fill material.

Fig. 37: Completed bulk-fill restoration in single-shade technique without a cover layer.

Case 8: Replacing filling in an upper left 1st molar
This time, it was a defective interproximal restoration in an upper left 1st molar **(Fig. 38)**. The patient presented as an emergency patient for the first time. After excavation and matrix placement of the defect, analogous to the previous cases **(Fig. 39)**, adhesive sealing and restorative treatment of the tooth were carried out with the same material combination (G2 Universal, Visalys Bulk Flow). **Figure 40** shows the finished and polished adhesive restoration, while **Figure 41** shows a bitewing x-ray taken during a subsequent follow-up examination. The x-ray highlights the deeply undermined defect, which was filled completely and bubble-free with the bulk-fill material.

Fig. 38: Defective interproximal filling in an upper left 1st molar with secondary caries.

Fig. 39: The excavation and matrix placement of the defect were carried out in the same way as in the previous cases.

Fig. 40: Restoration of the tooth using only a bulk-fill material.

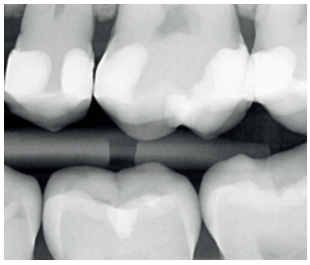

Fig. 41: Bitewing x-ray. The bubble-free complete sealing of the deeply undermined cavity in the upper left 1st molar.

Conclusion

High-quality light-curing bulk-fill restorative materials now represent a valuable addition to the restorative product portfolio. They have been extensively investigated for decades, scientifically evaluated in detail, proven to be effective, and are therefore definitely suitable for widespread use. From the initial concept of purely "functional" indication, this material group has now developed into reliable all-rounders whose aesthetic qualities can certainly stand comparison with those of their "layered counterparts". As recent product developments show, there are always opportunities for optimization in terms of handling, aesthetics, etc. These have been successively addressed and consistently implemented by various manufacturers in recent years. What has emerged are universal materials that can hold their own even in a single standard shade, and challenge materials that are offered in different shades. It remains to be seen what new products will be offered in the future. After the IDS is before the IDS. ■

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