Going universal – adhesives in the dental clinic

Laura Ceballos García[1], Roland Frankenberger[2], Ivo Krejci[3] and Marleen Peumans[4]

What are the main criteria for you to choose your adhesive? Do you use different types of adhesives for different indications?

Laura Ceballos: I consider that we should select our adhesive according to the best scientific evidence available. It would be advisable to use an adhesive that has been tested in randomized clinical trials and obtained adequate and consistent results. Therefore, the clinical performance would be independent of the operator skills, as much as possible. And, of course, we should be confident with its application mode and not detect premature clinical problems such as post-operative sensitivity. I try to use the same adhesive for all clinical procedures.

Roland Frankenberger: As I have been testing every adhesive on the market since 1994, the question is easy. When an adhesive "survives" our array of in vitro investigations such as chewing simulation, deep-cavity-microtensile testing, and some handling tests, then I'm free to use it. Normally, I tend to use the same adhesive in every indication, I do not differentiate.

Ivo Krejci: Efficiency, ease of use and low handling sensitivity are most important. I also prefer using just one universal one-component adhesive that suits all indications.

Marleen Peumans: To me, the most important criterium is the bonding efficiency of the adhesive system in vitro and in vivo. I still tend to rely on a three-step etch-and-rinse adhesive, especially in case it is difficult to see if dentine has been exposed on the prepared tooth surface, like for instance with a veneer preparation. When I see clearly where dentine and enamel are located, I use a 2-step self-etch adhesive system with prior selective enamel etching. Either way, I always etch the enamel with phosphoric acid at 35% for increased micro-retention. Nowadays, universal adhesives containing the 10-MDP functional monomer, used in a two-step self-etch mode - applying the adhesive, air-thin, polymerize, application of a hydrophobic resin or flowable - also work very well in vitro (G2-BOND Universal is such an adhesive, ed.). But, at this moment, long-term clinical trials are not yet available.

Prof. Peumans, GC launched its first one bottle self-etch system, G-BOND in 2004. Your research group was one of the first to evaluate it in a clinical trial1. For how long do you now have clinical feedback on this product?

Marleen Peumans: Two years ago, we finished a 14-year clinical trial where we evaluated the bonding efficiency of G-BOND from GC and Optibond FL from Kerr in non-carious cervical lesions.

[1] Prof. Laura Ceballos García
Professor, Rey Juan Carlos University, Madrid, Spain

[2] Prof. Roland Frankenberger
Dean, Marburg Dental School, Germany
Chairman, Dept of Operative Dentistry, Endodontics, and Paediatric Dentistry, Philips University Marburg, Germany.

[3] Prof. Ivo Krejci
Professor emeritus at the University of Geneva, Switzerland.

[4] Prof. Marleen Peumans
Professor, KUL, University of Leuven, Belgium

According to the research you conducted, what is the clinical performance?

Marleen Peumans: After 14 years, restorations bonded with the HEMA-free one-step self-etch adhesive – which was G-BOND - performed as well as those bonded with the three-step etch-and-rinse "golden standard" - Optibond FL. Unacceptable marginal deterioration or severe marginal discoloration were the main reason for failures, followed by loss of retention. The overall clinical success rate was 58.9% and 57.9% for G-BOND and Optibond FL, respectively. The overall clinical performance was not significantly different for the two adhesives. Changes in medical health of some patients and recurrence of abrasion, erosion or abfraction decreased the success rate and retention rate.

How important is the thickness of the bonding layer and why? And in relation to that, how important is the radiopacity of a bonding system?

Roland Frankanberger: Unfilled adhesives may cause issues when the layer is too thick because it will look like a gap in the X-ray. Therefore, I prefer adhesives with low film thicknesses. When this is given, radiopacity does not play a major role. It may only be of some interest when we bond to caries-affected dentin where hybrid layers are quite thick.

Marleen Peumans: If the adhesive has a film thickness below 10 µm, what is often the situation for universal adhesives, there is an increased risk of suboptimal stabilization of the adhesive interface and reduction of the adhesive layer's ability to absorb stress imposed by the overlaid shrinking restorative composite. In addition, polymerisation of a very thin adhesive layer is suboptimal due to oxygen inhibition. The radiopacity is then important in order to avoid misinterpretation of the presence of caries recurrence underneath the restoration, and even more so when the restoration is evaluated by another dentist.

Ivo Krejci: I believe that the optimal situation lies somewhere in the middle. The physical properties of an adhesive system are inferior to a highly filled restorative composite, so thick adhesive layers may compromise the biomechanical properties of the restorative system. Hence, the adhesive layer should be as thin as possible, but thick enough to allow for complete coupling to the restorative composite. Radiopacity is advantageous in case that an adhesive system was placed in a thicker layer for whatever reason or in case of pooling, for example in the cavity angles.

Currently, there is an increased trend towards universal single bottle bonding agents. What is the evidence to their success rate? What is your personal understanding of a "universal" approach?

Marleen Peumans: A universal adhesive is an improved one-step self-etch adhesive that can be applied in several application modes: etch-and-rinse mode, self-etch mode or selective etching of the enamel alone.

In addition, they have the possibility to bond chemically to various restorative substrates. There is an increase in the use of these universal adhesives, because of their ease of use, and the fact that different application methods can be used. Regarding bonding efficiency, these perform quite well in in vitro bond strength tests. Moreover, they show a good bonding efficiency when tested in clinical studies of non-carious cervical lesions, especially when at least the enamel is etched with phosphoric acid.

Laura Ceballos García: Unfortunately, in general, the number of clinical reports available regarding adhesives´ performance is still not as high as we would like, as they are very difficult to conduct. Universal adhesives have been available in the market for more than 10 years, although there are only few clinical studies that evaluate their long-term performance, mainly after 5 years of clinical service. According to these, the retention of restorations in non-carious cervical lesions is over 80% for the adhesives tested and even higher when enamel margins are previously etched with phosphoric acid.

Roland Frankenberger: After several years of clinical use, I believe that universal adhesives have reached a very high clinical standard today. I use them all the time.

Marleen Peumans: However, the bonding efficiency is material-dependent and subject to hydrolytic degradation. The long-term clinical performance of the universal adhesives still needs to be proven.

Ivo Krejci: To me, a universal approach means that the adhesive system performs well on enamel, dentine, composite and ceramic surfaces as well in a single application without any additional treatment steps. The evidence is growing that contemporary universal, one-component adhesive systems perform as well as traditional multistep adhesives.

Laura Ceballos García: There is a recent clinical report in which G-Premio BOND was evaluated and the survival rate of the cervical restorations performed with this adhesive was 96.5%.[2]

What does the evidence show about HEMA-free bonding agents (such as G-BOND and G-Premio BOND)?

Ivo Krejci: HEMA is a small molecule which may cause allergic reactions, which is why HEMA-Free adhesives are gaining ground. Even though it's incorporated in most adhesives, there is no evidence that HEMA is indispensable for a good adhesion.

Laura Ceballos García: HEMA-free adhesives are less hydrophilic and consequently lower water sorption and hydrolytic degradation of the adhesive layers would be expected.

Marleen Peumans: A systematic review of clinical trials showed that HEMA-free and HEMA-containing adhesive systems showed a similar clinical performance in these restorations. This was also confirmed in the in-house long-term 14-year clinical trial that I mentioned before.

Roland Frankenberger: The secret of their clinical success is definitely not the fact that they are HEMA-free; however, it is nice to have anyway.

What is your opinion about the use of bonding agents as restoration primer for indirect restorations?

Roland Frankenberger: For this case, I still tend to use separate silanes or metal primers.

Marleen Peumans: I agree. It is clearly proven in vitro that separate application of silane onto the indirect restoration, followed by application of the adhesive, results in a higher and more durable bond strength to the indirect restoration in comparison to the application of an adhesive system where silane is incorporated. Therefore, we still advise to apply silane and the adhesive in two different steps.

What do you think is the next step in the field of bondings? Where is the science heading?

Ivo Krejci: Self-adhesive restorative composite materials.

Marleen Peumans: Indeed, there is a lot of research going on in this regard. But at this moment, the bonding efficiency of these self-adhesive materials still underscores the bonding efficiency of the golden standard adhesive systems in combination with a composite material. Adhesive bio-active materials are another topic that science is heading to.

Roland Frankenberger: To be honest, I am so glad that we finally have reached a good standard with rather quick universal adhesives. For me, the most important aspect besides pure bonding performance is low technique-sensitivity. And this aspect has improved a lot since the first one-bottle systems. Let me say so: we started with former gold standard adhesives 30 years ago, but afterwards the whole evolution went in the wrong direction: speed was prioritised over performance, leading to unacceptably high technique-sensitivity such as wet bonding approaches. This is long gone. Today, universal adhesives offer good performance ánd low technique-sensitivity, which is great. Of course, much is written about things like bioactive adhesives, however, this is only an option and no fundamental prerequisite for future bondings.

Laura Ceballos García: Yes, nowadays we have adhesive systems good enough for direct and adhesive indirect bonding with ease and predictably. Clinical failures are mainly consequence of secondary caries or fracture of the restoration or the tooth. Therefore, we should seek for adhesives able to modify the biofilm, reducing its cariogenicity, preventing secondary caries or with remineralizing properties. Self-adhesive resin composites are indeed another possibility. Either way, there is still a long way to go.

Roland Frankenberger: Unfortunately, the EU medical device regulation holds several stumbling blocks for further developments, and clinical trials are so much more complicated and expensive compared to the 2000's that I'm not convinced that the development of new adhesives will continue in the same speed as it has been up to now.

References

1. Peumans M, Van de Maele E, De Munck J, Van Meerbeek B, Van Landuyt K. Fourteen-year clinical performance of a HEMA-free one-step self-etch adhesive in non-carious cervical lesions. J Adhes Dent, 2023 (Accepted)

2. Oz FD, Ozturk C, Soleimani R, Gurgan S. Sixty-month follow up of three different universal adhesives used with a highly-filled flowable resin composite in the restoration of non-carious cervical lesion. Clin Oral Investig. 2022 Aug;26(8):5377-5387.