Adhesive Biotechnology in Fixed Prosthodontics

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Adhesive biotechnology is a technique used to fix prostheses to the surface of a tooth structure or existing prosthesis using a dental bonding technique or resin luting cement. According to our PubMed search using MeSH keywords, the published research and reports on adhesive fixed prosthodontics encompass more than 20% of all the published papers on fixed prosthodontics in the last 10 years. Therefore, it is a very important technique in fixed prosthodontics.

Why is adhesive biotechnology important in dentistry? Many studies that meet the principles of evidence-based medicine show that it has significant advantages and can be used to resolve many clinical problems, which is difficult to do with conventional restorations. It can also improve the retention of a restoration and provide a better seal to a prepared wound, as well as increase the fracture-resistant strength of a restoration. It is biocompatible and less harmful for vital pulps. At the same time, it is minimally invasive to the tooth structure. Moreover, the resin luting cement comes in a variety of shades including a translucent material; its application can improve the esthetic effect. We are currently in an era of constant innovation; new materials and new technologies are coming out every day. More and more literature has shown the use of fiber-reinforced composites, all-porcelain, and computer-aided design/computer-assisted manufacture (CAD/CAM) reconstructions becoming more popular. Dental bonding is necessary for the application of these new materials and technologies. Therefore, adhesive biotechnology has a wide range of applications.

Adhesive biotechnology can be used anywhere from restorations of tooth defects to tooth replacements for partially edentulous cases.

- Inlay, onlay, and composite buildups are used for vital tooth restorations. All-ceramic inlays and onlays have been widely used clinically for more than 10 years and some research showed satisfactory outcomes. Recently, with the application of new hybrid composites, the direct composite layer-by-layer buildup is becoming available for some cases. Robinson[1] reported the techniques for restoring worn anterior teeth with direct composite resin.
- Posts and cores are used for nonvital tooth restorations. Post-and-core reconstructions tend to use fiber-reinforced posts and composite core materials. Many in vitro and in vivo studies show the effectiveness of fiber posts to be used in endodontically treated teeth. For posterior teeth, if the thickness of the dentin were more than 1 mm in three walls, the retentive form is suitable for using prefabricated metal posts and composite core material to build up the coronal form.
- Laminate veneers and all-ceramic crowns/fixed partial dentures (FPDs) are solutions used for esthetic problems. Laminate veneer crowns only need a layer of 0.5 to 0.8 mm of preparation in an abutment tooth that is minimally invasive to the tooth structure. The appropriate resin luting cements and adhesive technology are important to the success rate of it and the resin cement is also a basic requirement for silica-based all-ceramic prostheses.
- Resin-bonded FPDs are an alternative and minimally invasive way to replace a lost tooth with a long history. There has been no lack of in vitro and in vivo studies regarding this topic in past decades. The survival rate is a constant focus of attention, and it has increased with additional retentive preparations and the application of new materials, such as fiber-reinforced composites.
- A periodontal splint using a fiber-reinforced composite can help the fixation of teeth with mobility, as well as replace the lost teeth.
- Adhesive biotechnology is a useful way to repair the fractured metal-ceramic crowns. The techniques for repair of fractured porcelain restorations include: *(a)* rebonding the fractured chip to the fixed restoration, *(b)* fabricating a porcelain veneer to bond to the fractured porcelain, and *(c)* using a composite resin to restore the fractured porcelain.[2]

How long can adhesive-fixed prostheses last clinically and what are the main problems? The answer can be gained from a systematic review.

Systematic reviews on adhesive inlays and onlays showed that the failure rate was 8% after 10 years of application.[3] The main problems were fracture, marginal deficiencies, and color mismatch. With the application of a new generation of all-ceramic materials such as lithium disilicate, aluminum oxide, or zirconia, the fracture resistance of a restoration has been improved, but the clinical success is dependant upon cementation. CAD/CAM technology was reported for up to 18 years and it obtained a satisfactory clinical result.

A long-term survival rate of direct composite buildups has not yet been confirmed, but the microhybrid and nanohybrid composite resins offer improved strength, handling, and polishability of the restoration. The early risk of failure is attributed to bulk fracture and partial loss of the restorative material. Therefore, strict patient selection is needed.

Only a few randomized clinical trials on fiber posts have been published. Fiber-reinforced composite posts outperform metal posts. The placement of a fiber-reinforced composite post protects against failure, especially under conditions of extensive coronal destruction.[4]

There are a large number of in vitro studies on fiber posts regarding the evaluation of fatigue behavior, bond strength, and the interface between the post and dentin, as well as post and core materials. The results showed that nonvital teeth restored with composite resin or composite resin combined with fiber posts resisted fatigue tests and currently represent the best treatment option. The elastic modulus of a fiber post is desirable to save the root from fracture under fatigue and overloading. The sufficient tooth-structure support and dentin ferrule effect is important to the fatigue behavior of the root and post.

The most common type of failure with fiber-reinforced composite posts is debonding. Debonding of posts is related to the form, material, and surface pretreatment of the post. The bond strength is also affected by the bonding system and the handling of the bonding material.

A systematic review on laminate veneer crowns could not be found, but a 10-year investigation on the outcome of porcelain laminate veneers showed that 53% of 2,562 porcelain veneers survived without reintervention at 10 years.[5] More clinical research is desirable.

There are many studies on all-porcelain crowns, such as the VITA In-Ceram system (Vita Zahnfabrik). A review of 299 publications showed that only 21 publications met the criteria. Survival rates were more than 95% at 36 months, but decreased to 88.5% for FPDs.[6] The prostheses made using the CAD/CAM technique had quite a high success rate of 94.5% to 100%.

The overall estimated survival of resin-bonded FPDs after 4 years was 74% ± 2% in 1991, and it increased to 88% in 2008 after 10 years' application with additional retentive preparation.[7] But if we compare it with that of other fixed prostheses, for example the survival rate of conventional FPDs (90% at 10 years) and implant-supported FPDs (95% at 5 years), we found that it did not match the survival rate of a conventional restoration. In order to increase the survival rate of resin-bonded FPDs, the following improvements were contrived, in addition to improved resin luting cements.

- Increased mechanical retention– proximal or occlusal grooves, needle way, inlay type retainers, Crownless Bridge Work (CBW) attachments, etc.
- Cantilevered pontics to eliminate the influence from the different mobilities of two-end abutment teeth. The two-unit cantilevered FPDs show better longevity than resin-bonded FPDs in similar situations.[8]
- Connector with mobility.
- Application of new materials– fiber-reinforced resin, all-ceramic, and ceramic-like composites. The overall survival rate of fiber-reinforced resin-bonded FPDs was 73.4% (69.4% to 77.4%) at 4.5 years (n = 339).[9] The most common technical problems were fracture of the FPD and debonding of the veneering composite.

For the reason that the survival rate of resin-bonded FPDs is still lower than that of conventional FPDs, careful abutment selection, tooth preparation, alloy selection, and bonding techniques are critical for clinical success.

Conclusion

Adhesive techniques can improve the retention and seal of prosthodontic restorations, but in terms of longevity, adhesive restorations do not match conventional restorations. The survival of teeth with adhesive restorations can match the survival of teeth with conventional restorations. Adhesive restorations offer a minimally invasive treatment approach that may be beneficial to the teeth, the dentition, or the patient.

References

1. Robinson S, Nixon PJ, Gahan MJ, Chan MF. Techniques for restoring worn anterior teeth with direct composite resin. Dent Update 2008;35:551–552,555–558.
2. Rosen H. Chairside repair of ceramo-metallic restorations. J Can Dent Assoc 1990;56:1029–1033.
3. Sadowsky SJ. An overview of treatment considerations for esthetic restorations: A review of the literature. J Prosthet Dent 2006;96: 433–442.
4. Cagidiaco MC, Goracci C, Garcia-Godoy F, Ferrari M. Clinical studies of fiber posts: A literature review. Int J Prosthodont 2008;21: 328–336.
5. Burke FJ, Lucarotti PS. Ten-year outcome of porcelain laminate veneers placed within the general dental services in England and Wales. J Dent 2009;37;31–38.
6. Wassermann A, Kalser M, Strub JR. Clinical long-term results of VITA In-Ceram Classic crowns and fixed partial dentures: A systematic literature review. Int J Prosthodont 2006;19:355–363.
7. Aggstaller H, Beuer F, Edelhoff D, Rammelsberg P, Gernet W. Long-term clinical performance of resin-bonded fixed partial dentures with retentive preparation geometry in anterior and posterior areas. J Adhes Dent 2008;10:301–306.
8. van Dalen A, Feilzer AJ, Kleverlaan CJ. A literature review of two-unit cantilevered FPDs. Int J Prosthodont 2004;17:281–284.
9. van Heumen CC, Kreulen CM, Creugers NH. Clinical studies of fiber-reinforced resin-bonded fixed partial dentures: A systematic review. Eur J Oral Sci 2009;117:1–6.