

The bond between acrylic resin denture teeth and the denture base: recommendations for best practice

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In brief

- Detachment of denture teeth from acrylic resin dentures has been a problem ever since the introduction of acrylic resin in 1937.
- Research has shown the causes to be multifactorial consisting of factors which aid a good bond being ignored and practices which result in a weaker bond being adopted.
- To achieve a good bond the dental technician's attention to detail is critical.

Abstract

Failure of the bond between denture teeth and base acrylic resin has been shown to be a cause of denture failure leading to inconvenience and costly repair. The optimal combination of acrylic resin denture tooth, denture base material, laboratory protocol and processing method has not yet been established. Extensive research enables the following recommendations for best practice to be made. Adopt practices that maximize the strength of the bond: select appropriate denture teeth; select base acrylic resin from the same manufacturer as the denture teeth; remove the glaze from ridgelaps of the denture teeth; apply monomer to the ridgelaps of the denture teeth prior to packing the base acrylic resin dough; use the manufacturers' recommended liquid/powder ratio; follow the manufacturers' recommended curing cycle; allow the flask to cool slowly and rest before deflasking. Adopt practices that avoid factors detrimental to bond strength: remove all traces of wax from the ridge laps of the denture teeth; remove all traces of mould seal from the ridgelaps of the denture teeth. It is evident that a number of factors are involved which may assist or prevent formation of an adequate bond, suggesting that attention to detail by the dental technician may be the most critical factor.

INTRODUCTION

Failure of the bond between denture teeth and base acrylic resin has been shown to be a problem in reviews of dentures made in the National Health Services of Britain and Northern Ireland.^{1,2} The bond between acrylic resin denture teeth and the denture base has been described as unreliable, inconsistent and unpredictable³ and there is no reason to suppose that this problem is limited to the British National Health Service.

The optimal combination of acrylic resin denture tooth, denture base material, laboratory protocol and processing method has not yet been achieved.⁴ The presence of strong or weak bonds within the same denture⁵ and the number of aspects of this failure, which appear in the literature, suggests that this is a multi-factorial problem related to a process, which is technique sensitive.

The bond between polymerised Polymethylmethacrylate (PMMA) and additional PMMA is thought to be formed by penetration of monomer,^{6,7} which then polymerises. The resulting polymer chains either intertwine with existing polymer chains forming an essentially physical bond, or in favourable circumstances may form contiguous chains with the previously polymerised PMMA of the denture teeth.

In practical terms all factors involved need to be understood and a protocol needs to be developed and employed in dental laboratories, which maximises factors that are likely to facilitate a stronger bond whilst minimising those factors, which may lead to a weaker bond.

FACTORS MAXIMISING BOND STRENGTH

Tooth selection

There are three types of acrylic resin denture teeth in common use: homogenous, layered and polycarbonate coated. The type of denture teeth used has been shown to affect the bond strength.⁸⁻¹¹ Homogenous acrylic resin teeth had higher bond strength than cross-linked teeth.¹² A significant difference in bond strength between base acrylic resin and the inner and outer layer of multilayered teeth¹² suggested that in cases where significant reduction of the ridgelap may be required, such as for example in implant supported overdentures, homogenous teeth should be selected.

Recommendation: Select teeth to ensure sufficient bonding region even after some or significant tooth removal in the ridgelap region.

Selection of base acrylic resin

Of the different forms of PMMA denture base materials heat cured resin has been shown to give the highest bond strength followed by microwave-cured and the weakest bond was found in pour-type self cured resin.^{9,12-15}

Recommendation: Use heat cured acrylic resin denture base material.

Compatibility of teeth and base acrylic

A study on the effect of different curing cycles suggested that a stronger bond might be achieved between acrylic resin denture base material and acrylic denture teeth when both are made by the same manufacturer.¹⁶ A subsequent study¹⁸ investigated the bond strength when three denture base acrylic resin denture base materials and acrylic denture teeth when both are made by the same manufacturer. There was a trend that the bond strength achieved between the teeth and base material from the same manufacturer was higher than the unmatched pairs but statistical significance was not achieved.

Recommendation: select denture teeth and acrylic resin base material from the same manufacturer.

Physical preparation of the ridgelap of the denture teeth

Removing the glaze from the ridgelap has been shown to improve the bond strength.^{11,18} However, more elaborate modification of the ridgelap has shown little extra improvement probably because base acrylic in the grooves was too thin to provide added strength.¹⁹⁻²¹ However, a recent study²² has shown some improvement in strength using substantial grooves. The probability is that the improvement is in physical retention rather than strength of the chemical bond.

Recommendation: Remove the glaze from the ridgelap [Fig.1].



Fig.1 The ridgelap glaze being removed from a tooth prior to setting up.

Chemical preparation of the ridgelap of the denture teeth

Self-cure monomer^{6,7} has been shown to penetrate the ridgelap surface of the denture teeth and contribute to an improvement in bonding.²³⁻²⁵ The balance of probabilities suggests that heat-cured monomer does the same.

Recommendation: Drip monomer on the ridgelap prior to packing [Fig.2].



Fig.2 Monomer being dripped on to the ridgelaps of the teeth.

Monomer/polymer ratio

There have been very few investigations into the effect different monomer/polymer ratios have on the strength of the bond between denture teeth and the base acrylic resin. However, following the manufacturers' instructions regarding the monomer/polymer ratio and packing early rather than late seemed to have a slight advantage.²⁶

Recommendation: Follow the manufacturers' instructions.

Processing cycle

Differences in bond strength between denture teeth and acrylic resin denture base material result from different curing cycles. Short cycles resulted in the lowest bond strength whereas the manufacturers' recommended cycles produced the highest bond strength.^{16,17}

Recommendation: Follow the manufacturers' recommended curing cycle.

Cooling regime

A long cooling cycle has been shown to minimise distortion in heat cured acrylic resin denture bases and a further 24 hour rest before deflasking has been shown to further reduce stress in the denture.^{27,28} So far attempts to demonstrate an effect of cooling regime on the strength of the denture tooth denture base bond have been inconclusive.²⁹ However, given that the overall dimensional accuracy of the processed denture is affected by the cooling cycle and it is possible that slow cooling would be expected to set up fewer stresses, not only in the denture, but across the bond between the teeth and the base, it would seem to be sensible to use a slow cooling regime.

Recommendation: Cool slowly and allow to rest at room temperature before deflasking.

FACTORS MINIMISING BOND STRENGTH

Wax contamination from the ridgelaps of the denture teeth

Most studies agree that any contamination of the ridge lap surface will decrease the bond strength.³⁰⁻³⁵ Wax elimination and ensuring that teeth are uncontaminated and free of any debris has been found to be more likely to achieve adequate bonding strength than any mechanical preparation, which could be, applied to the ridge lap surfaces of the teeth. Wax contamination of the tooth ridge lap surface has been found to be a cause of significantly reduced bond strength.³⁵ To obtain optimal wax elimination a minimum of 90°C water temperature should be used at the 'boiling out stage'. At a lower temperature an eliminating agent should be used.^{36,37}

Recommendation: Remove all traces of wax.

Sodium Alginate Mould seal elimination from the ridgelaps of the teeth

No consensus appears to have been reached regarding contamination with sodium alginate mould seal.³³ Some studies^{33,35} have concluded that contamination by sodium alginate mould seal had no significant effect on the bond strength. However, others have concluded that sodium alginate mould seal did reduce the bond strength. Common sense would perhaps suggest that anything other than an organic solvent might form a barrier.

Recommendation: Avoid sodium alginate mould seal contact with the ridgelaps and remove all traces of mould seal from the ridgelaps [Fig 3].



Fig.3 Removing all traces of mould seal from the ridgelaps of the denture teeth.

DISCUSSION

Importance has been attributed to many factors involved in forming a bond between denture teeth and base acrylic resin and in each case there is evidence that each factor plays a part but in some cases the evidence may not seem to be strong. However, there is general consensus that failure of the bond between the denture teeth and the base acrylic resin may have many causes, which may act separately or together to cause failure. It would seem sensible therefore to adopt a technique, which eliminates as many possible causes of failure as possible. It follows that the dental technician's attention to detail is fundamental to achieving a good bond. With the increasing use of implant supported overdentures, the higher forces both in an occlusal and lateral directions that patients apply to prostheses, and often the reduced intermaxillary space, this issue which has been identified and researched over a period of 60 years is still relevant in the clinic-laboratory interface.

CONCLUSION

The following suggestions for best practice are recommended

1. Select appropriate denture teeth.
2. Select base acrylic from same manufacturer as the denture teeth.
3. Remove the glaze from ridgelaps of the denture teeth.
4. Remove all traces of wax from the ridge laps of the denture teeth.
5. Remove all traces of mould seal from the ridgelaps of the denture teeth.
6. Apply monomer to the ridgelaps of the denture teeth prior to packing the base acrylic dough.
7. Use the manufacturers' recommended liquid/powder ratio.
8. Follow the manufacturers' recommended curing cycle.
9. Allow the flask to cool slowly before deflasking.

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