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EFFICIENCY OF WAX REMOVAL;

MECHANICALLY MODIFIED SURFACES OF DENTURE BASE RESIN (PMMA) USING HOT WATER AT DIFFERENT TEMPERATURES WITH ADDED DETERGENT

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ABSTRACT… Objectives: To Determine the efficiency of wax removal from denture base resin using hot water at a range of temperatures with added detergentand to Study the effects of mechanically modified surfaces of denture base resin on the efficiency of dewaxing using the above techniques. **Settings:** Eastman Dental Institute University Of London UK. **Period:** Jan 2007 to June 2007. **Material and Methods:** In this study cast acrylic rods 13 mm long and 6 mm in diameter were used. Three different surfaces were prepared for each rod, described as Polished, Abraded & Grooved. Nine experimental groups, each consisting of ten specimens were mechanically modified were contaminated with modeling wax, and then those in each group were subjected to agitation in hot water with detergent at different range of temperatures. The surfaces were then examined for traces of wax using Raman spectroscopy. **Results:** The spectrum for each specimen demonstrated peaks at different wavelengths and varying intensities, the spectra demonstrated traces of wax on abraded surfaces showed least wax when dewaxed at 100°C as compared abraded surfaces dewaxed at 65°C and 85° C temperatures respectively. **Conclusion:** The rough surfaces (abraded or grooved) showed more wax retention as compared to polished surfaces. These surfaces are usually prepared by the dental technician in a belief that modifying the ridge-lap area of the teeth will increase the bond strength between the teeth and the denture base. Residual wax can still remain on the tooth surface even after dewaxing it at 100˚C with detergent added to the water.

Key words: PMMA, Complete Denture, Acrylic Dentures, Denture Base Resin Dewaxing.

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INTRODUCTION

Acrylic resin was introduced in 1937 as a denture base material. After World War II due to the shortage of the raw material for vulcanite, acrylic resin became the material of choice for denture production.[1]

The reasons for acrylic resin's continued popularity in dentistry are the simple processing equipment required and the relatively low cost of the fabrication process. Comparison of the ratio of denture repairs to the number of dentures produced each year between 1977 and 1990 show that over 60% of the acrylic resin dentures produced by the National Health Services of Britain and Northern Ireland required repair within one or two years of being produced. Tooth de-bonding accounts for about one third of these repairs.[1] This was confirmed by another study whose survey showed that 33% of repairs were to replace debonded/detached teeth.[2] Unfortunately it appears that the bond between acrylic resin denture teeth and the denture base has remained unreliable, inconsistent and unpredictable.[3] The optimal combination of acrylic resin denture tooth, denture base material and processing method has not yet been achieved.[4] Many investigators have studied the causes of debonding of denture teeth and suggested denture processing methods in which a strong bond could be achieved between the denture teeth and the base.

It is reasonable to assume that if the union of the parts can resist separation until one of the materials fails, then the joint will have fulfilled its functional requirements.[3] The bond strengths between teeth and denture bases produced by different commercial and dental school laboratories were compared.[5] Variations in the tensile tooth de-bonding loads were found with all dentures; however they were unable to identify the causes.

Wax contamination of the bond surface of the tooth (ridge-lap area) has been consistently observed to be linked to a reduction in the tensile bond strength.[6] Another study investigated 11 different regimes for removing wax in a wax-eliminating machine. Acrylic and porcelain teeth were used and concluded that wax, and the temperature at which it was removed could be significant factors in reducing the bond strength.[7] A universal finding identified that wax

Contamination is the major cause of reduction in the strength of the bond between the tooth and denture base.[5,8,9]

Schoonoveretal[6] studied the effects of different wax removal techniques and application of tinfoil substitute on the bond strength between teeth and denture base. It was concluded that the conventional method (boiling water) cannot remove wax efficiently and that synthetic detergents should be used for effective wax removal.

Spratleyetal[7] studied 11 different regimes for removing wax in a wax-eliminating machine. Acrylic and porcelain teeth were used and concluded that wax, and the temperature at which it was removed could be significant factors in reducing the bond strength.

Cunningham[1] reviewed the literature relating to the determination of the tensile bond strength of acrylic resin denture teeth to the denture base material. Common findings were that highly cross-linked teeth had reduced tensile bond strength and that the use of high-impact resins enhanced bonding. Contamination with wax was considered a major cause of bonding failure.

Cunningham and Benington[8] studied different modifications of the ridge lap area of the teeth. Surfaces were contaminated with either cold mould seal or wax. It was concluded that contamination by wax had a major role in decreasing the bond strength between denture teeth and denture base. Mechanical modification and application of sodium alginate did not have a significant effect in this study, which was in agreement with the findings of Hugget et al[10] and Geertset al[11] but contrary to the findings of Fletcheretal[12] and Caswell and Norling.[13]

Cunningham and Benington[5] conducted a survey of the prebonding preparation of acrylic teeth and the efficiency of wax removal methods. It was concluded that the roughened surface increased the area thus increasing wax retention. Dewaxing at 90˚ also showed the presence of wax on the surface. The use of wax eliminator showed significant removal of wax and this was recommended for efficient wax removal.

Cunningham and Benington[9] carried out further studies to investigate the variables which might affect the bond between acrylic resin teeth and denture base acrylic resin. Again their results reconfirmed that wax contamination was a major cause of tooth bond failure.

Choudhryetal[14] investigated dewaxing of acrylic denture base resin with rough surface at three different temperature using hot water and found that The specimens dewaxed at 100ºC showed slight evidence of the presence of wax, with the abraded surfaces, as compared to dewaxing done at 65ºC and 85ºC. Dewaxing with hot water at 65ºC and 85ºC resulted in more wax contamination, with the rough surfaces (abraded) being widely contaminated.

MATERIAL& METHODS

In this study cast acrylic rods 13 mm long and 6 mm in diameter were used as tooth analogues. Three different surfaces were prepared for each rod, described as Polished, Abraded or Grooved. Nine experimental groups, each consisting of ten specimens were prepared. The surfaces of the specimens were contaminated with modeling wax, and then those in each group were subjected to agitation in hot water with a detergent at one of a range of temperatures. The surfaces were then examined for traces of wax using Raman spectroscopy.

PREPARATION OF THE TEST SURFACE OF THE RODS

A block of self-cured acrylic resin 8 cm long, 5 cm wide and 13 mm in depth was prepared and four holes (6 mm in diameter and 13 mm deep) were drilled through its largest surfaces using a drill stand. The rods were then divided into three groups of 30, each of which was prepared as to give a surface described as polished abraded and grooved.

Temperature (Water+Detergent)	65˚C	85˚C	100˚C
Surfaces			
Polished Colour Code (Red)	PD1/1-10	PD2/1-10	PD3/1-10
Abraded Colour Code (Green)	AD1/1-10	AD2/1-10	AD3/1-10
Grooved Colour Code (Black)	GD1/1-10	GD2/1-10	GD3/1-10

The modeling wax was melted with a hot plate which is normally used in the dental laboratory during waxing-up of the teeth. The molten wax was introduced to the surface of the acrylic rods in the silicone mould and allowed to cool at room temperature for 24 hours. For de-waxing, 30 specimens are inserted in the dental stone mould and held with a pair of tongs while de-waxing under a stream of hot water with detergent added at one of three different temperatures (65ºC, 85ºC, 100ºC) for 5 minutes. This process was repeated and 30 specimens with three different surfaces were dewaxed at these temperatures with hot water.

The surface analyses of the specimens were performed using Raman Spectroscopy to detect any traces of wax on the surfaces of the specimens. The area of the surface to be scanned was selected randomly for each specimen and was 20/20 µm. Nine different locations in this selected area were scanned, and spectra generated for subsequent comparison with the control spectra. These were generated for a clear acrylic rodand a waxed acrylic rod by scanning two acrylic rods, of which one had been contaminated with wax and other prepared. These were used as controls. The spectra of the experimental group were transferred to an Excel spread sheet for the preparation of graphs to facilitate a study of the intensity and wave length of the light rays passing through the specimens resulting in peaks of spectrum. The specimens which had peaks approximately identical to the clear acrylic spectra, showed that there was nowax present on that surface. Spectra similar to thatof the waxed acrylic rods indicating the presence of wax on that surface

RESULTS

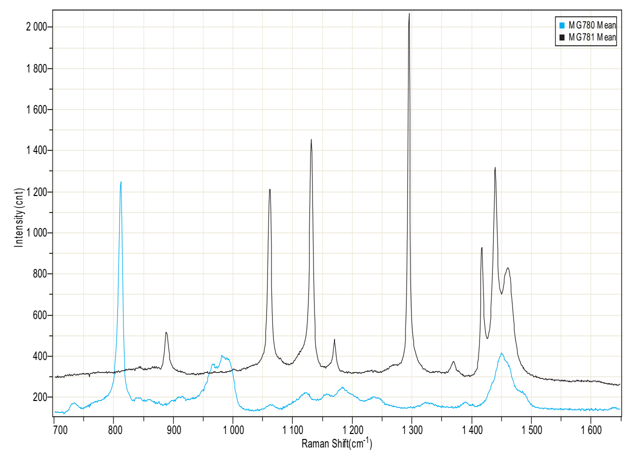

Figure-1. Control spectra for a clear acrylic rod (MG780) and an acrylic rod with wax contamination (MG781) showing peaks at 1400-1500cm^{-1} for the acrylic rod and at 1290-1300cm^{-1} for the contaminated specimen

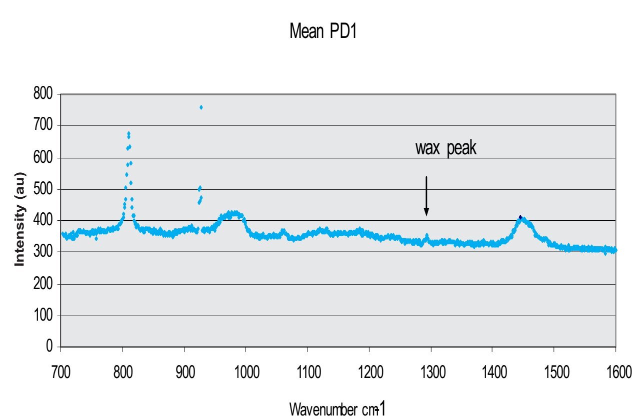

Figure-2. Mean spectra of experimental groups dewaxed with hot water+detergent.

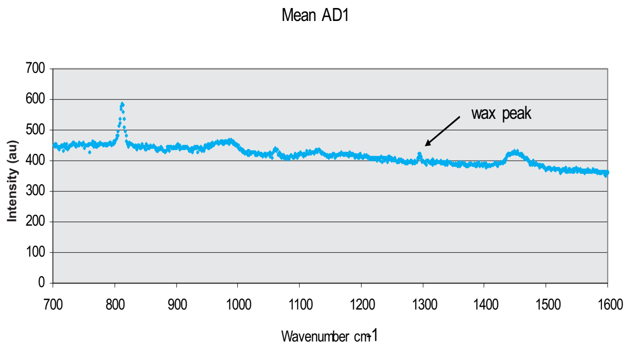

Figure-3. Mean spectra of ten acrylic rods with an abraded surface showing a peak at 1294.22cm^{-1} with an intensity of 421.6 a.u

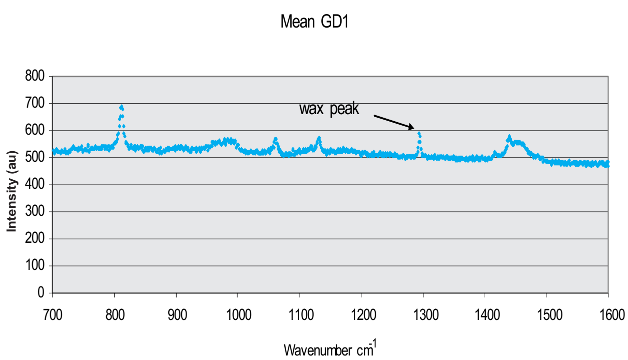

Figure-4. Mean spectra of ten acrylic rods with a grooved surface showing a peak at 1294.22cm^{-1} with an intensity of 590.4a.u.

DISCUSSION

The present study investigates the efficiency of wax removal from the rough acrylic surfaces using hot water with detergent at three different temperatures, 65ºC, 85ºC and 100ºC. The specimens dewaxed at 100ºC showed slight evidence of the presence of wax, with the abraded surfaces, as compared to dewaxing done at 65ºC and 85ºC. Dewaxing with hot water with detergent at65ºC and 85ºC resulted in more wax contaminated with the rough surfaces (abraded& grooved) being widely contaminated. These findings are in agreement witha previous study Cunningham et al. which showed that dewaxing with hot water at lower temperature showed morewax retention and as the dewaxing temperature was increased, the efficiency ofwax removal was increased, although it was not completely removed[5] Another study by the same worker showed that dewaxing with hot water at 70ºC did not result in efficient wax removal and decreased the bond strength between the tooth and the denturebase.[9] Sprately[7] suggested that teeth showed adhesive failures in which dewaxing was performed with hot water at 70ºC resulting in difficulty in efficient wax removal from the rough surfaces.

The dewaxing of the specimens with hot water with detergent did not result in complete removal of the wax, for any of the three different surfaces; however it slightly decreased the number of specimens contaminated with wax as compared to those specimens dewaxed with hot water only. The same sequence was observed in relation to the surface most affected. The polished surface showed least wax contamination as compared to the abraded and grooved surfaces, and dewaxing at 100˚C showed improvement in the efficiency of wax removal in comparison with dewaxing at 65˚C and 85˚C. These findings are in agreement with the findings of Schoonover et al[6] in which it was concluded that the bond strength between the teeth and denture base was reduced in the experimental group in which dewaxing of the specimens was done by boiling water only as compared to the other group in which a wax eliminator solution was used, showing that wax contamination resulted in decreased bond strength. Another study by Cunningham et al[5] showed that dewaxing with a wax eliminating agent improved efficiency of wax removal even at 60˚ C as compared to the specimens dewaxed with boiling water only.

CONCLUSION

- There is no efficient method of dewaxing for complete removal of wax residues during denture construction.
- The rough surfaces (abraded or grooved) showed more wax retention. These surfaces are usually prepared by the dental technician in a belief that modifying the ridge-lap area of the teeth will increase the bond strength between the teeth and the denture base.
- Residual wax can still remain on the tooth surface even after dewaxing it at 100˚C with detergent added to the water.
- Wax elimination machines used in many dental

laboratories have a recirculation mechanism resulting in wax in the circulating water which can itself cause wax contamination during dewaxing.

- The temperature used for dewaxing is also an important factor as it can affect the efficiency of wax removal. Boiling water units do not always dispense water at 100˚Cand it has been suggested that for efficient dewaxing the boiling out units should be checked on a regular basis.[5]

SUGGESTIONS

In this study wax contamination of the acrylic rods was investigated, in a future study the amount of wax present on the three different surfaces could be investigated using the same system to quantify the amount of wax.The dewaxing of the specimens could be done with a boiling unit to simulate laboratory conditions as this would be more consistent in dispensing water, provided that care was taken to ensure that it dispensed water at required temperature and was not pre-contaminated with wax.

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REFERENCES

1. Cunningham J. **Bond strength of denture teeth to acrylic bases.** Journal of dentistry. 1993;21(5):274-80.

2. Darbar U, Huggett R, Harrison A. **Denture fracture--a survey.** British dental journal. 1994;176(9):342-5.

3. Zuckerman GR. **A reliable method for securing anterior denture teeth in denture bases.** The Journal of prosthetic dentistry. 2003;89(6):603-7.

4. Schneider RL, Curtis ER, Clancy JM. **Tensile bond strength of acrylic resin denture teeth to a microwave-or heat-processed denture base.** The Journal of prosthetic dentistry. 2002;88(2):145-50.

5. Cunningham J, Benington I. **A survey of the pre-bonding preparation of denture teeth and the efficiency of dewaxing methods.** Journal of dentistry. 1997;25(2):125-8.

6. Schoonover I, Fischer T, Serio A, Sweeney W. **Bonding of plastic teeth to heat-cured denture base resins.** The Journal of the American Dental Association. 1952;44(3):285-7.

7. Spratley M. **An investigation of the adhesion of acrylic resin teeth to dentures.** The Journal of prosthetic dentistry. 1987;58(3):389-92.

8. Cunningham J, Benington I. **A new technique for determining the denture tooth bond.** Journal of oral rehabilitation. 1996;23(3):202-9.

9. Cunningham J, Benington I. **An investigation of the variables which may affect the bond between plastic teeth and denture base resin.** Journal of dentistry. 1999;27(2):129-35.

10. Huggett R, John G, Jagger R, Bates J. **Strength of the acrylic denture base tooth bond.** British dental journal. 1982;153(5):187.

11. Geerts GA, Jooste CH. **A comparison of the bond strengths of microwave-and water bath-cured denture material.** The Journal of prosthetic dentistry. 1993;70(5):406-9.

12. Fletcher A, Ai-Mulls M, Amin W, Dodd A, Ritchie G. **A method of improving the bonding between artificial teeth and PMMA.** Journal of dentistry. 1985;13(2):102-8.

13. Caswell CW, Norling BK. **Comparative study of the bond strengths of three abrasion-resistant plastic denture teeth bonded to a cross-linked and a grafted, cross-linked denture base material.** The Journal of prosthetic dentistry. 1986;55(6):701-8.

14. Choudhry Z, Malik S, Khan S, Ahmed MA. **Bonding of acrylic resin teeth with denture base resin.** Pakistan Oral & Dental Journal. 2015;35(4).

Noble deeds that are concealed are most esteemed.

– Blaise Pascal –

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