

POSSIBLE ERRORS IN ACRYLIC DENTURE FABRICATION LEADING TO TEETH-DENTURE BASE INTERFACE FAILURE

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ABSTRACT

The objective of this study was to evaluate the processing related errors accountable for teeth-denture base interface failure and to identify the popular materials and techniques used for denture fabrication. In six months this cross-sectional survey was accomplished to target population pool of fifty-eight prosthodontic technicians in twelve dental colleges, in five cities of Pakistan. Collection of the demographic data of the participants was followed by some technical questions to identify the possible errors accountable for teeth-denture base interface failure like the type of teeth and denture base materials used; chemical / mechanical modifications of ridge lap surface area (RLSA) of teeth; the presence of possible contaminants at the RLSA of acrylic teeth and their effective removal and some questions regarding acrylic denture packing and curing stages to assess technician's expertise. Live or telephonic interviews were conducted as per convenience by two dentists. Collected data was analyzed and interpreted using SPSS version 22. Majority of the dental technicians (91.4%) were qualified and preferred conventional acrylic teeth (91.4%) and heat cured acrylic resin (71.1%) for acrylic denture fabrication. To ensure effective bonding of teeth to the denture bases, wax elimination from teeth was ensured mostly via boiling water (98.3%) and the RLSA of teeth was modified with locking grooves (82.8%) and monomer wetting (79.3%). Boiling water (98.3%) was reported to ensure complete wax removal from acrylic teeth, most of the dental technicians used dental bench press (93.1%) for acrylic dough packing and long denture curing cycles with terminal boil.

Key Words: Acrylic Teeth, Acrylic Resin Denture Base, Teeth Debonding.

INTRODUCTION

Acrylic dentures due to their cost-effectiveness are quiet popular among elderly population seeking help for the replacement of missing teeth.¹ Despite chemical bonding between acrylic teeth and acrylic denture bases, teeth detachment particularly in the anterior segment of the dentures is a frequent occurrence and is quiet frustrating for both the dentists and the pa-

tients.²⁻⁴ To increase the life-span and strength of the acrylic dentures, an effective bond strength between the acrylic teeth and the denture base is mandatory.⁵ The studies indicating the frequency of denture repairs shows that about 22% to 30% of all the denture repairs carried out at commercial dental laboratories is due to the bond failure at the teeth-denture base interface.^{6,7}

Multiple variables such as occlusion, tooth/alveolar ridge position, ridge-lap surface area (RLSA) modification of acrylic teeth, types of denture base materials and processing methods may contribute to the bond failure at the acrylic teeth-denture base interface.⁵ Numerous laboratory processing related errors affect bonding between acrylic teeth and denture base including improper wax removal from the teeth RLSA, carelessness in the separating medium application, use of insufficient monomer and the polymerization method.^{6,8}

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Surface condition of the tooth plays a pivotal role in tooth-debonding in dentures.⁴ At the tooth-denture base interface, incompatible surface conditions lead to the failure of adequate chemical bonding.⁹ The modification of the RLSA of acrylic teeth can be carried out either mechanically or chemically. The chemical modification of the RLSA of teeth is not only less time consuming but also ensures satisfactory bonding.¹⁰

Contaminants at the tooth-denture base interface such as wax, cold-mold seal, tin-foil substitutes and petroleum jelly also affects the bond strength significantly.^{1,11} Different studies indicated, the residual wax to be the principal contaminant responsible for adhesive failure.^{6,11,12} The reasons of improper wax elimination during acrylic denture processing includes greater surface roughness of acrylic teeth at RLSA⁴, low dewaxing temperature⁴ and ignoring the need of using wax removing solvent following dewaxing.^{4,12}

The objective of this study was to find the research trend of acrylic dentures and to evaluate the prosthodontic technician's role in the processing related errors accountable for teeth-denture base interface failure in acrylic dentures and to identify the popular materials and techniques used for denture fabrication.

METHODOLOGY

The annual number of the publications on "Google Scholar" search engine was found from year 1990 to 2017 using the key words "acrylic teeth and acrylic resin denture bases and teeth debonding" and the research trend was calculated by plotting the number of publications against time using Microsoft Excel.

The study involved fifty-eight prosthodontic technicians at twelve dental schools in five cities of Pakistan i.e. Islamabad (Islamabad Medical & Dental College, Islamic International Dental College), Rawalpindi (Army Medical College, Margalla Institute of Health Sciences), Peshawar (Khyber College of Dentistry, Peshawar Medical College, Gandhara University), Abbottabad (Ayub Medical College, Abbottabad International Medical Institute, Women Medical College, Frontier Medical & Dental College) and Mardan (Bacha Khan Medical College). Interviews were carried out by two dentists with a sound knowledge of dental materials sciences and prosthodontics, to find out about the possible processing related aspects leading to teeth-denture base interface failure. For data collection live or telephonic interviews of the participant dental technicians were conducted and the prosthodontic laboratories at the targeted dental schools were carefully observed for required equipment. The identity of the study participants was kept confidential for ethical reasons.

A questionnaire was designed with a total of twenty-two questions. Four questions were asked to collect the demographic data. Two questions were about the type of acrylic teeth and denture base materials used, two questions were about the acrylic teeth RLSA modifications. Six questions were asked about the possible contaminants on the RLSA of acrylic teeth and its effective removal, one question was about acrylic dough packing technique and seven questions were about heat curing of acrylic denture. The collected data was analyzed and interpreted using SPSS version 22. Numerical variables were depicted as means and standard deviation while frequencies and percentages were calculated for categorical variables.

RESULTS

The research trend of the published literature from year 1990 to 2017 (Fig 1) on "Google Scholar" search engine for the key words "acrylic teeth and acrylic resin denture bases and teeth debonding" showed a surge in the number of publications from year 2007 and onwards. However, most of the studies published on this subject are in vitro studies. This cross-sectional survey targeted fifty-eight prosthodontic technicians (100% males) in twelve dental colleges. The mean experience of the participating technicians was 7.09 ± 6.41 years. Majority (91.4%) of the dental technicians had formal dental technician training (91.4%), either a diploma (31%) or a bachelor's degree (60.3%).

Response to the questions about the popularity of materials used for denture fabrication showed that majority of the technicians preferred conventional acrylic teeth (91.4%) over the cross-linked acrylic teeth (8.6%). Heat cure acrylic resin as a denture base material was most popular (74.1%) among dental technicians, followed by self-cure acrylic (24.1%) while only 1.7% reported using both heat/self-cure acrylic. For improved mechanical retention, majority of the technicians (82.8%) made locking grooves on the RLSA of the anterior acrylic teeth while only 3.4% reported

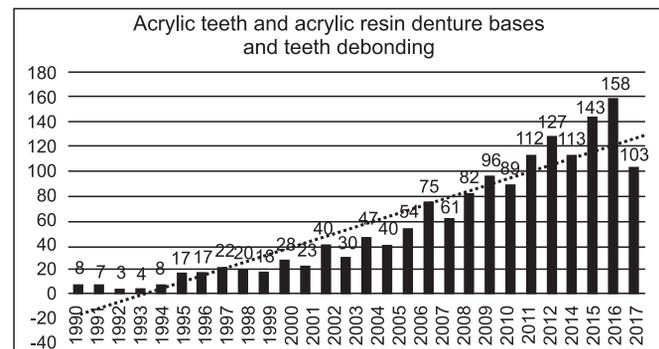


Fig 1: Articles published on debonding of teeth from acrylic dentures since 1990

TABLE 1: QUESTIONNAIRE REGARDING ACRYLIC DENTURE FABRICATION MATERIALS AND TECHNIQUES

Question	Options	Percentage
Type of denture base material preferred	Heat-cure acrylic	74.1%
	Self-cure acrylic	24.1%
	Both Heat/Self-cure acrylic	1.7%
Type of acrylic teeth preferred	Conventional	91.4%
	Cross-linked	8.6%
RLSA modification by locking grooves	Yes	82.8%
	No	13.8%
	Sometimes	3.4%
RLSA modification by monomer wetting	Yes	79.3%
	No	20.7%
Type of water used for wax wash out	Boiling	98.3%
	Simmering	1.7%
Using wax solvent	Yes	19%
	No	81%
Type of separating medium preferred	Cold mould seal	100%
Application of cold mould seal	On teeth	5.2%
	On investment mould surface	94.8%
Using dental bench press for packing acrylic into investment mould	Yes	98.3%
	No	1.7%
Using pressure flask for heat curing	Yes	94.8%
	No	5.2%
Type of curing cycle	Curing in a 74 °C water bath for 8 h and then boiling to 100 °C for 1h	60.3%
	Curing at 74 °C for 2 h then boiling to 100 °C and curing at 100C for 1 h	1.7%
	Putting flask assembly in water bath at room temperature & after water starts boiling, curing at 100oCfor 2h	37.9%
Adding another flask during curing	Yes	3.4%
	No	93.1%
	Sometimes	3.4%
Water bath level revival by the addition of	Tap Water	1.7%
	Warm Water	10.3%
	Simmering Water	10.3%
	Boiling Water	77.6%
Cooling flask	By allowing it to cool along with the water bath	74.1%
	By taking it out of water bath and allowing it to cool in air	24.1%
	By putting it directly under running tap-water	1.7%

of making locking grooves only when required, while (13.8%) did not feel the need of grooving the RLSA of acrylic teeth. To ensure effective chemical bonding at teeth-denture base interface, majority of the prostho-

dontic technicians preferred chemical modification of the RLSA of acrylic teeth by wetting with monomer (79.3%) at the dough packing stage of acrylic denture fabrication.

When inquired about the use of thermometer to gauge the temperature of water during de-waxing and curing procedures, majority of the technicians (89.7%) negated the need of using water-bath thermometer. The questions pertaining to the possible contaminants on the RLSA of teeth and its effective removal showed that majority (98.3%) used boiling water while only 1.7% reported using simmering water for de-waxing. However, only 19% affirmed the use of wax solvent, rest (81%) didn't use it at all. Cold mould seal as a separating medium was equally popular among all (100%). Majority (94.8%) applied the cold mould seal only on investment mold area while only a few (5.2%) applied it on teeth as well.

Majority of the dental technicians reported using dental bench-press (Handler or Gibling Bros) (98.3%) for packing acrylic dough in the investment mold and using students dental flask set with press (94.2%) during acrylic denture curing. All the prosthodontic technicians preferred curing cycles that involved gradually increasing the water bath temperature with a terminal boil. Majority (93.1%) negated adding another flask to the water bath during acrylic denture curing and reported water bath level revival by the addition of boiling water if needed (77.6%). Following curing majority (96.6%) allowed the flask to cool down slowly in the water bath to room temperature while only small number of technicians reported cooling the flask either in air (1.7%) or under tap water (1.7%).

DISCUSSION

Several advancements are made in prosthodontics to restore the edentulous dental arches. Still a surge in the research trend on "Google Scholar" search engine (Fig 1.) was detected when using the key words "Acrylic teeth and acrylic resin denture bases and teeth debonding". This illustrates the popularity and unshaken interest of dentists and patients regarding removable dental prosthesis. Debonding of denture teeth from denture base is a common finding and the prosthodontic technician is usually the one held responsible for this misfortune. The present survey was aimed at interviewing the prosthodontic technicians to evaluate the possible processing mistakes that may lead to teeth-denture base interface failure.

All the participants of this study were male showing male dominance in the field of prosthodontics at technical level. The small sample size of this study is due to the fact that only two to five technicians are present in the prosthodontic departments of most of the targeted dental colleges except Army Medical College in which there were thirty prosthodontic technicians. Majority (91.4%) of the dental technicians in this study

preferred to use conventional acrylic teeth for acrylic denture fabrication. Artificial teeth of the brand Wel-bite (Technodent Industries, Lahore, Pakistan) were preferred over other brands. Mechanical modifications of denture teeth involve surface roughening by grinding and grooving. In-vitro study by Akin et al showed that Er: YAG laser-irradiation and air abrasion can also be employed to increase ridge lap surface roughening to ensure effective bonding to denture base.¹³ Another in-vitro study by V Mahadeven et al showed that surface roughening by sand blasting and forming retentive grooves at the RLSA highly amended the shear bond strength at teeth-denture base interface when compared to the unmodified and chemically modified teeth which supports our study as most (82.8%) of the technicians in the present study made grooves in the RLSA of the acrylic teeth to supplement retention to the denture base.¹⁴

Chemical modifications of the denture teeth are usually carried out by the application of methyl methacrylate monomer, dissolved polymethyl methacrylate, non-polymerizable solvents, tribochemical silica coating with salinization or combinations of above 7. In the present survey, 79.3% of the prosthodontic technicians preferred wetting the ridge lap surface area of the acrylic teeth with methyl methacrylate monomer at acrylic dough packing stage of denture fabrication to ensure effective bonding to the acrylic denture base. Studies showed that wetting the RLSA of teeth with monomer resulted in higher shear bond strengths at teeth-denture base interface as compared to acid etching.^{9,15} Some new studies showed that Er:YAG laser-irradiation of the RLSA of teeth resulted in equally effective shear bond strength as methyl methacrylate monomer application. However, other studies indicated that salinization of RLSA of teeth resulted in higher shear bond strength as compared to methyl methacrylate monomer application.^{13,15}

To eliminate wax from the surface of the teeth, majority (98.3%) of the study participants used boiling water alone while only 19% of the prosthodontic technicians used a wax solvent such as benzene, chloroform or alcohol in addition to boiling water. Technicians stated that if properly used, boiling water alone serves as an effective wax remover. These findings are endorsed by those of Mosharraf and Abed-Haghighi who reported that use of a wax solvent, despite its effectiveness, is less common⁴. Cunningham and Benington also reported that using a wax solvent was an effective wax elimination method but seldom used.¹²

Research has suggested tin foil as the best separating medium resulting in acrylic dentures with less

porosity and higher strength¹⁶, but cold mould seal is still popular and a widely used as a tin-foil substitute in denture fabrication¹⁷ which supports our study as all the dental technicians preferred using cold mold seal as a separating medium during denture processing. Technicians reported of applying the cold mould seal to the investment mold surface only and not to the teeth to avoid contamination of the RLSA of the denture teeth during denture fabrication.

The composition of the denture base resins and the denture teeth affect the bonding effectiveness of the plastic teeth to the denture base. In the present study, heat cured acrylic resins turned out to be the most commonly used denture base material, with about 74.1% technicians stating that heat-cured acrylic yielded stronger and durable bond at teeth-denture base interface. This is in accordance with the results of T Korkmaz et al who observed higher bond strengths with heat-cure resin as compared to self-cure acrylic resin, microwave polymerized denture base resin and injection-molded, polyurethane-based microwave-polymerizable resin.¹⁸

All the technicians in this survey preferred curing cycles that involved the water bath with gradual temperature rise to a terminal boil. This has been shown to decrease the residual monomer content in the cured dentures and a consequent decrease in the porosity in the denture base¹⁹ thus, decreasing the occurrence of breaches at teeth-denture base interface.

Results of this survey showed that most of the technicians have a sound knowledge of acrylic denture fabrication resulting in an over-all satisfactory practice. Prevalence of malpractice, such as adding another flask to an on-going curing cycle or revival of water bath with cold water or cooling of a flask under tap water was negligible and was probably due to a lack of experience or training in the concerned field. While technicians are held responsible for processing errors, surveys targeting dental technicians are rather scarce. This study, therefore, attempted to address this lack of data concerning the technician's perspective and practice. The technicians were requested for live or telephonic interviews in which the questions were asked systematically according to the designed questionnaire. The dental laboratories were also visited as per convenience to countercheck the availability of the equipment needed for acrylic denture processing. This was done to decrease the risk of bias inherent in questionnaire – based surveys.

Despite the advancements in dental materials and technology, acrylic resin has served as a reliable den-

ture base and synthetic teeth material over the years. It is still the material of choice for conventional partial and complete dentures. Research, therefore, needs to be aimed at minimizing the processing mistakes in denture fabrication. This will lead to less frequent post-insertion complications such as debonding of teeth, and consequently, improved quality of prosthodontic care in addition to directing the research towards genuine factors responsible for teeth detachment in acrylic dentures.

CONCLUSIONS

Within the limitations of this cross-sectional study, the following inferences can be made:

- i Majority of the dental technicians (91.4%) in this study are qualified and have a sound knowledge and experience in acrylic denture fabrication.
- ii For denture base fabrication heat-cure acrylic resin is widely used by the dental technicians (74.1%) along with conventional acrylic teeth (91.4%) to ensure quality control.
- iii Majority of the technicians reported of modifying the RLSA of teeth by making locking grooves (82.8%) or methyl methacrylate monomer wetting (79.3%) for effective bonding with denture base.
- iv The contaminants at RLSA of acrylic teeth which are held responsible for teeth-denture base interface failure i.e. like residual wax and cold mould seal, are well taken care of during acrylic denture fabrication by most prosthodontic technicians in the twelve major dental institutes of Pakistan.

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