



A Comparative Study Between Two Different Enamel Surface Etching Techniques

(An In-Vitro Study)

A

thesis

Submitted to the Faculty of Dentistry

Ain Shams University

In partial fulfillment of the Requirements for Master Degree in
Orthodontics

By

Bandar Fawaz Zakaria

B.D.S (2004)

October 6 University - (Egypt)

**Faculty of Dentistry
Ain Shams University
2013**

SUPERVISORS

Dr. Khaled Fawzy

Professor of Orthodontics

Faculty of Dentistry

Ain Shams University

Dr. Ibrahim Negm

Lecturer of Orthodontics

Faculty of Dentistry

Ain Shams University

DEDICATION

To my Family, I can never thank you enough for all that you have done for me. Your unconditional love and support throughout life has been of great value.

To my wife Sara, you are my best friend and biggest supporter. Without you, I would never have succeeded. Thank you for being a loving and understanding wife. Without your encouragement and assistance, it would not have happened. Thanks again and always know that I love you.

Bandar Zakaria

ACKNOWLEDGEMENT

I would like to express my most sincere gratitude and grateful appreciation to Professor. Dr. Khaled Fawzy Professor of Orthodontics, Orthodontic and pediatric Dentistry Department, Faculty of Dentistry, Ain Shams University, for his valuable guidance and support.

Words fail to express my deepest thanks to Dr. Ibrahim Negm, lecture of Orthodontics, Orthodontic and pediatric Dentistry Department, faculty of Dentistry, Ain Shams University for his guidance in designing and improving the in-vitro study.

Bandar Zakaria

TABLE OF CONTENTS

Title	Page
• TABLE OF CONTENTS	I
• LIST OF FIGURES	II
• LIST OF TABLES	IV
• LIST OF ABBREAVATIONS	V
I. INTRODUCTION	1
II. REVIEW OF LITERATURE	3
III. AIM OF THE STUDY	29
IV. MATERIAL AND METHODS	30
V. RESULTS	55
VI. DISCUSSION	71
VII. SUMMARY	82
VIII. CONCLUSIONS	84
IX. RECOMMENDATIONS	85
X. REFERENCES	86
XI. Appendix	97
XII. ARABIC SUMMARY	-

LIST OF FIGURES

Fig. No.	Title	Page
1.	Experimental design for the study.	32
2.	Experimental design for SBS test.	33
3.	Experimental design for enamel surface evaluation test.	34
4.	Integra™ standard edgewise bracket.	35
5.	Grēngloo™ composite bonding kit.	36
6.	Prep Start™ device.	38
7.	Aluminum oxide powder.	39
8.	Nozzle tip.	40
9.	Cross section view demonstration proper position of the tip.	41
10.	Instron® machine.	46
11.	a&b: Specimen attached to the machine with blunt stainless steel blade.	47
12.	Instron® 8874 series software program.	48
13.	Lecia EM SCD500.	52
14.	Scanning Electron Microscope.	53
15.	Stereomicroscope.	54
16.	A bar graph showing the mean SBS.	56
17.	A bar graph showing the upper and lower bound of SBS.	57

18.	A bar graph showing the coefficient of variation in percent for the three different etching surface treatments.	61
19.	A bar graph showing the percentage of the ARI for the three methods of etching surface treatment.	64
20.	Example of ARI scores.	65
21.	SEM of normal enamel surface at different magnifications. (a): SEM at 1500x.(b): SEM at 2000x.	67
22.	SEM of acid etched enamel at different magnifications. (a): SEM at 1500x.(b): SEM at 2000x.	68
23.	SEM of sandblasting enamel surface at different magnifications.(a): SEM at 1500x.(b): SEM at 2000x..	69
24.	SEM of sandblasting followed by acid etching enamel surface at different magnifications. (a): SEM at 1500x.(b): SEM at 2000x.	70

LIST OF TABLES

Fig. No.	Title	Page
1	Descriptive statistic of SBS measured in MegaPascal.	56
2	Analysis of variance for the three methods of surface treatment.	58
3	The mean difference, standard errors and significance results of comparison between shear bond strength of the studied subgroups.	59
4	Measurement of coefficient of variation between different etching surface treatments.	60
5	ARI Scores frequency distribution, percentages, means, standard deviation (SD), standard errors (SE), maximum, and minimum values for different subgroups.	63

LIST OF ABBREVIATIONS

ANOVA	Analysis of variance.
Al₅O₃	Alumina Oxide.
BIS-GMA	Bisphenol glycidyl methacrylate.
EF	Enamel Fracture.
J	Joule.
MPa	MegaPascal.
mA	milli Amperage.
mW/cm²	Milli-Watts per square centimeter.
lb	Pound mass.
SB	Sandblast.
SBS	Shear Bond Strength.
SD	Standard Deviation.
SE	Standard Error.
Sec	Second.
SEM	Scanning Electron Microscope.
TBS	Tensile Bond Strength.
W	Watt.

INTRODUCTION

In the early days of bracket adhesion research, the aim was to achieve a strong and reliable bond between the bracket base and the enamel surface. Now the focus is more on details such as faster bonding, harmless removal procedures, and antibacterial effects of the bonding materials to help oral hygiene.

The use of sandblasting technology for dental applications was initiated by Robert Black¹ in the 1951 and was successfully introduced in 1955 with the air-dent air abrasion unit. The air-abrasive technique such as sandblasting was used to improve the bond strength of amalgam, porcelain, and gold crowns.

Because this preparation procedure roughens the tooth surface, it was possible to direct bond of orthodontic brackets without acid etching. It has been suggested that the sandblasting technique could contribute to a better bond system with less enamel loss.

Existing research has been diverse with respect to controlling variables and set of parameters of sandblasting technique in relation to shear bond strength. Thus, it was found important to perform this research aiming to control the variables

of sandblasting technique to enhance the bond strength of orthodontic brackets to the enamel surface.

REVIEW OF LITERATURE

For the sake of clarity the review of literature would be presented under two main topics:

I. Orthodontic Bonding:

1. Shear bond strength.
2. Factor affecting bond strength tests and measurements.
3. The effect of storage media on bond strength of orthodontic brackets.
4. The effect of bracket base design on bond strength of orthodontic brackets.

II. Different approaches for enamel preparation prior to bonding of orthodontic bracket:

1. Acid etching.
2. Sandblasting.

I. Orthodontic Bonding

The bond strength of orthodontic attachment to enamel surface must be adequate to withstand orthodontic forces. The orthodontist is also concerned with the bond strength of the attachments because at the completion of treatment, the attachments will have to be intentionally removed.

Bishara et al.,² in 1993 found that a mean safe debonding strength should be less than 11.5 Kg/cm² (11.28 MPa). Mc Sherry³ in 1996 stated that higher bond strength were not always better and bond strengths that were too high may do nothing more than create iatrogenic damage during bracket debonding. Rossouw⁴ in 1999 found the optimum range was between 5.9 and 13.53 MPa.

Larmour et al.,⁵ in 2006 found excessive bond strength could cause unwanted damage to enamel surfaces. An acceptable range of bond strength is desirable during treatment to minimize bracket failure. The brackets should also be easy to remove at the end of treatment to avoid damage to the enamel surface.

1. Shear bond strength

In case of shear bond strength the debonding force applied to the junction between the bracket and adhesive interfaces; this method comes closest to applying a true shear force, which may never occur clinically. Furthermore, shear testing may not be

sensitive enough to detect variations at the enamel-resin interface that might be revealed by other modes of stress.

Eliades and Viazis⁶ in 2000 found the using of shear loading had been very popular, due to simplicity of the experiment and increased the reliability of simulating debonding that occurred during treatment. The tensile or torsion loading modes had been considered by many investigators as less relevant to clinical practice and had attracted less interest.

Ozutrck et al.,⁷ in 2003 applied shear stress using a variety of technique such as wire loops, steel blades or rods. The rates of loading included 0.5 mm/min, 1 mm/min, 2 mm/min and 5 mm/min. They concluded that the main disadvantage of shear bond testing might not represent the intraoral stresses and orthodontic appliance adjustments, which could result from short resin tags, inadequate etching, acid resistant enamel, or other factors.

Klocke and Nieke⁸ in 2006 determined the effect of debonding force direction on orthodontic shear bond strength. The debonding forces were directed either parallel to the bracket base, toward the enamel surface, or away from the enamel surface. Analysis of variance indicated that shear bond strength were significantly higher when a force direction toward the enamel

surface. Shear bond strength decreased significantly when a force direction away from the enamel surface was used.

Swartz⁹ in 2007 found main disadvantage of shear testing could not represent the intraoral stresses and orthodontic appliance adjustments.

Penido and Pinto¹⁰ in 2009 evaluated the shear bond strength in-vivo and in-vitro of metallic brackets bonded to human teeth with light curing bonding material. The test was performed one day after bonding. They found that test-performed in-vitro resulted in larger bond strength values than those performed in-vivo.

2. Factor affecting bond strength tests and measurements

Katona¹¹ in 1997 stated that bond strength could vary depending on the method of testing. Eliades and Viazis⁶ in 2000 mentioned some critical aspects of orthodontic bond strength protocols that affect the outcome of research trials, similar to:

- Bracket type.
- Design of debonding jig in universal testing machine.
- Pretreatment of enamel surface.
- Other factor that effect bond strength testing is fatigue of adhesive bracket system.