

**UNIVERSITI TEKNOLOGI MARA**

**EFFECTS OF  
ADHESIVE MATERIALS  
AND  
REMNANT REMOVAL  
TECHNIQUES  
ON  
DENTAL TRAUMA SPLINT  
WORKING TIME, ENAMEL LOSS,  
AND ADHESIVE REMNANT INDEX  
(ARI)**

**ZALIKHA ADILA BINTI ZAINUREN**

Dissertation submitted in fulfillment  
of the requirements for the degree of  
**Doctor in Paediatric Dentistry**

**Faculty of Dentistry**

**July 2023**

## ABSTRACT

The placement and removal of dental trauma splints have become a great challenge, especially in paediatric patients. Therefore, there is a need for a fast splinting procedure that allows the splint to last long for the entire splinting duration and results in less damage and less remnant left on the enamel after the removal. The purpose of this study was to evaluate the effects of different adhesive materials and remnant removal techniques on dental trauma splint working time, enamel loss, and adhesive remnant index (ARI). Eight types of adhesive materials (packable composite resin with self-etch and etch-and-rinse, flowable composite resin with self-etch and etch-and-rinse, self-cure and light-cure RMGIC, and temporary and semi-permanent GIC) and six types of remnant removal techniques (white stone bur (high speed and slow speed), high-speed pointed diamond bur, high-speed tungsten carbide bur, and two types of polishing discs) were investigated. The working time during placement and removal of the splint was recorded. The ARI was determined by using the SEM microphotograph and enamel loss was measured using a contact stylus profiler. Data for the working time were analyzed with one-way ANOVA and revealed a significant difference in different groups of adhesive materials for both splint placement ( $p < 0.001$ ) and removal ( $p = 0.007$ ). The fastest working time for placement was recorded with flowable composite resin self-etch and for removal was recorded with light-cure RMGIC. A Kruskal Wallis H test was performed for data on ARI and revealed a significant difference between different types of adhesive materials ( $p < 0.001$ ); the packable composite resin etch-and-rinse had the most adhesive remnants retained on the enamel surface after splint removal. No significant difference was noted in the ARI between different types of remnant removal techniques for individual adhesive materials. Data for enamel loss were analyzed with a 2-way ANOVA and showed a significant difference ( $p < 0.001$ ) between different groups of adhesive materials, while no significant difference ( $p = 0.098$ ) was noted between different remnant removal techniques. The flowable composite resin etch-and-rinse with high-speed pointed diamond bur showed the greatest enamel loss. Meanwhile, the light-cure RMGIC group with slow-speed white stone bur resulted in the least enamel loss. Light-cure RMGIC is very favourable in terms of working time and enamel loss regardless of the remnant removal techniques. It is recommended as the material of choice for dental trauma splints in the emergency setting. Meanwhile, in a good clinical setting, the flowable composite resin self-etch can be recommended.

## ACKNOWLEDGEMENT

Firstly, I wish to thank God for allowing me to embark on my program, Doctor in Paediatric Dentistry, and for completing this long and challenging journey successfully. My gratitude and thanks go to my supervisors whom I have worked with for the past four years, Dr. Norashikin Abu Bakar and Associate Professor Dr. Annapurny Venkiteswaran. Both of you have given your time, energy, and expertise, and I am richer for it.

I also appreciate Mr. Mazli Bonit, Mrs. Asdaarnida Haron, and all the research, clinical, and pre-clinical laboratory staff who provided the facilities and assistance during this research journey. My deepest gratitude also goes to Madam Izyan and Madam Najibah for all the statistical knowledge and guidance.

To my friends and colleagues, thank you for listening, offering advice, and supporting me through this process. Special thanks to my batchmates: Zulfadli, Zaridah, Saima, and Dayang. The sharing discussions, as well as editing advice, were all greatly appreciated. To my best friends, thank you for your thoughts, encouraging words and prayers, and for being there whenever I needed a friend.

Finally, this journey would not have been possible without the support of my family. This dissertation is dedicated to my lovely parents for their vision and determination to educate me. Thank you for encouraging me in my pursuits and inspiring me to follow my dreams. I am incredibly grateful to them, who supported me emotionally and financially. This piece of victory is dedicated to both of you. Alhamdulillah.

# TABLE OF CONTENTS

	<b>Page</b>
<b>CONFIRMATION BY PANEL OF EXAMINERS</b>	<b>i</b>
<b>AUTHOR'S DECLARATION</b>	<b>ii</b>
<b>ABSTRACT</b>	<b>iii</b>
<b>ACKNOWLEDGEMENT</b>	<b>iv</b>
<b>TABLE OF CONTENTS</b>	<b>v</b>
<b>LIST OF TABLES</b>	<b>ix</b>
<b>LIST OF FIGURES</b>	<b>xi</b>
<b>LIST OF PLATES</b>	<b>xii</b>
<b>LIST OF SYMBOLS</b>	<b>xiii</b>
<b>LIST OF ABBREVIATIONS</b>	<b>xiv</b>
<b>LIST OF NOMENCLATURE</b>	<b>xvi</b>
<b>CHAPTER 1 INTRODUCTION</b>	<b>1</b>
1.1 Research Background	1
1.1.1 The Adhesive Materials	3
1.1.2 The Adhesive Remnant Removal Techniques	4
1.2 Problem Statement	5
1.3 Research Question	7
1.4 Objectives	7
1.4.1 Main Objective	7
1.4.2 Specific Objectives	7
1.5 Justification to Conduct The Study	8
1.6 Significance of Study	8
1.7 Scope and Limitation of Study	8
1.8 Hypothesis	9
1.8.1 Null hypothesis	9
1.8.2 Alternative hypothesis	9

# CHAPTER 1

## INTRODUCTION

### 1.1 Research Background

Splinting of traumatized teeth before the 1970s was primarily accomplished via methods employed in treating jaw fractures such as using cap splints, arch bars, and wires (J. O. Andreasen, 1981; Oikarinen, 1987). Due to a lack of understanding of the healing mechanism of traumatized teeth and the limited splinting techniques available during that era, these types of splints were used in the management of traumatic dental injuries (Andreasen, J. O. & Oikarinen, 2019).

The current practice of dental trauma splints has become well-defined in the guidelines for trauma management published by the International Association of Dental Traumatology (IADT) in 2020 (Fouad et al., 2020). Based on the current evidence, a short-term, passive, and flexible splint is recommended for the stabilization of the traumatized teeth (Bourguignon et al., 2020; Fouad et al., 2020). It is attributed by better understanding and advanced knowledge of the pulpal and periodontal healing process (Kahler, Hu, Marriot-Smith, & Heithersay, 2016). This type of splint is subjected to slight mobility and function thus promoting the periodontal and pulp healing of the injured teeth (J. O. Andreasen, Andreasen, F. M., & Andersson, 2019).

An ideal dental trauma splint should combine features of stability with slight flexibility, be atraumatic to periodontal tissues, and allows good maintenance of oral hygiene care (Dettwiler et al., 2018). In addition, the splint must be easy to handle, affordable to the patient, and aesthetically acceptable. Dental trauma splints should also provide comfort, especially for younger children to prevent them from removing the splint by themselves. In addition, the splint should be stable and remain in the oral cavity for the entire splinting duration (Ben Hassan, Andersson, & Lucas, 2016).