بسم الله الرحمن الرحيم

(قالوا سبحانك لا علم لنا إلا ما علمتنا إنك أنت العليم الحكيم)

صدق الله العظيم

سورة البقرة، الأية ٣

Finite Element Analysis, Clinical and Radiographic Evaluation of Some Restorative Techniques for Badly Decayed Anterior Primary Teeth.

Thesis Submitted to the

Faculty of Oral and Dental Medicine, Cairo University

In partial fulfillment of requirements of Doctor's Degree in Pediatric Dentistry and Dental Public Health.

Submitted by

Nada Mohamed Mostafa Hassan Wassef

BDS (2002), MSc (2008)

Assistant lecturer in Pediatric Dentistry and Dental Public Health Departement

Faculty of Oral and Dental Medicine

Cairo University.

(2014)

Supervisors

Prof. Dr. Mahmoud Hamdy Eid

Professor of Pediatric Dentistry and Dental Public Health
Faculty of Oral and Dental Medicine
Cairo University.

Ass.Prof. Dr. Adel Abd El-Azim El-Bardissy

Associate Professor of Pediatric Dentistry and Dental Public Health

Faculty of Oral and Dental Medicine
Cairo University.

Ass.Prof. Dr. Sherif Bahgat El-Taweel

Associate Professor of Pediatric Dentistry and Dental Public Health

Faculty of Oral and Dental Medicine

Cairo University.

Dr. Ahmed Fouad El-Ragi

Faculty of Engineering

Al-Fayoum University.

Acknowledgement

First and most I thank **GOD** for all the mercies and blessings and for everything in our lives.

I would like to express my deepest thanks and gratitude to *Prof. Dr. Mahmoud Hamdy Eid*, Professor of Pediatric Dentistry and Dental Public Health, Faculty of Oral and Dental Medicine, Cairo University for his great effort, continuous advice and supervision and for teaching me a lot along the course of this thesis and for his valuable time and great effort and work that allowed completing this work.

My sincere gratitude and appreciation to **Ass.Prof. Dr. Adel Abd El-Azim El-Bardissy**, Associate Professor of Pediatric Dentistry and Dental Public Health, Faculty of Oral and Dental Medicine, Cairo University for his valuable scientific support, for his generous effort, and meticulous supervision and for his helpful guidance, encouragement and education and continuous outstanding advice that taught me a lot along the study.

I am greatly indebted to **Ass.Prof. Dr. Sherif Bahgat El-Taweel**, Associate Professor of Pediatric Dentistry and Dental Public Health, Faculty of Oral and Dental Medicine, Cairo University for his continuous motivation, enthusiasm and support, for his encouragement, outstanding tolerance and endurance and for his precious and valuable time, advice and guidance that helped greatly in finishing this work.

May **GOD** reward them generously and greatly for being there for me, for never will I be able to thank them enough.

I would like to thank *Dr. Ahmed Fouad El-Ragi*, Lecturer of Civil Engineering, Faculty of Engineering, Al-Fayoum University for his advice.

Words can never express how greatly I am indebted to **Dr. Amr Hosny El-Khadem**, Lecturer of Prosthodontics, Faculty of Oral and Dental Medicine, Cairo University for his great and valuable help in saving the work of this thesis and allowing the work to be completed through his generosity, genius work and valuable time.

I would like to express my thanks and gratitude to all staff members and workers in the Unit of Pediatric Dentistry and those with special needs, Faculty of Oral and Dental Medicine, Cairo University, for allowing the work to be done and for their help, support and encouragement.

Great appreciation and gratitude to all the children and their parents who allowed the work to be done and who were patient and kind enough to tolerate, for these children's contribution is the main cornerstone for our studies.

Never will I be able to thank all my friends and colleagues in the Pediatric Dentistry Department, Faculty of Oral and Dental Medicine, Cairo University for their continuous encouragement, help and support.

Dedication

To my MOTHER,

my FATHER,

my BROTHER,

my FAMILY and FRIENDS,

& my SUPERVISORS.

Contents

	Page
Introduction	1
Review of Literature	3
Aim of the Study	31
Sujects and Methods	32
Results	54
Discussion	71
Summary	82
Conclusions	85
Recommendations	86
References	87
Arabic Summary	

المشرفون أد. محمود حمدى عيد

أستاذ طب أسنان الأطفال و صحة الفم كلية طب الفم و الأسنان جامعة القاهرة

أدم عادل عبد العظيم البرديسي

أستاذ مساعد طب أسنان الأطفال و صحة الفم كلية طب الفم و الأسنان جامعة القاهرة

أدم شريف بهجت الطويل

أستاذ مساعد طب أسنان الأطفال و صحة الفم كلية طب الفم و الأسنان جامعة القاهرة

د. أحمد فؤاد الراجي

مدرس الهندسة المدنية كلية الهندسة جامعة الفيوم

تحليل العناصر المحدودة و تقييم إكلينيكى و إشعاعى لبعض تقنيات ترميم الأسنان الأمامية اللبنية شديدة التسوس.

رسالة مقدمة إلى كلية طب الفم و الأسنان

جامعة القاهرة

للحصول على درجة الدكتوراة في طب أسنان الأطفال و صحة الفم

مقدمة من الطبيبة

ندى محمد مصطفى حسن واصف

مدرس مساعد بقسم طب أسنان الأطفال و صحة الفم

كلية طب الفم و الأسنان

جامعة القاهرة

كلية طب الفم و الأسنان جامعة القاهرة

Y . 1 £

List of Figures

Figure's	Title	Page
no.		
Figure (1)	Inverted cone bur marked at 3 and 4	34
	mms.	
Figure (2)	Diagram representing mushroom	35
	undercut.	
Figure (3)	Round bur marked at 3 and 4 mm.	36
Figure (4)	Application of the etchant.	36
Figure (5)	Bond material	37
Figure (6)	Flowable composite.	37
Figure (7)	Flowable composite applied in the canal.	38
Figure (8)	Composite material.	38
Figure (9)	Crown build-up using composite.	38
Figure (10)	Diagram representing undercuts created	39
	in the root canal.	
Figure (11)	Creation of undercuts in the root canal.	40
Figure (12)	Glass fiber post.	41
Figure (13)	Full length of the glass fiber post	41
Figure (14)	Cut part of the glass fiber post.	41
Figure (15)	Post placed in the canal and cemented	42
	using flowable composite.	
Figure (16)	Fiber reinforced composite material.	43
Figure (17)	Full length of the FRC.	43
Figure (18)	Cut part of the FRC.	43

Figure (19)	FRC placed in the canal and cemented	44
	using flowable composite.	
Figure (20)	Premaxillary segment.	48
Figure (21)	Periodontal ligament space.	48
Figure (22)	Root preparations and undercuts.	50
Figure (22a)	Root and 1mm of the crown.	50
Figure (22b)	Round undercut	50
Figure (22c)	Inverted cone undercut.	50
Figure (22d)	Cylindrical cut.	50
Figure (23)	Posts preparations.	51
Figure (23a)	Mushroom shaped post	51
Figure (23b)	Inverted cone projections	51
Figure (23c)	Cylindrical post.	51
Figure (24)	Model simulating the coronal restoration.	51
Figure (25)	Defining loads and restraints and	53
	meshing.	
Figure (26)	Comparison between mean age values in	55
	the four groups	
Figure (27)	Comparison between gender distributions	56
	in the four groups.	
Figure (28)	Comparison between success and failure	58
	in the four groups at first follow up period.	
Figure (29)	Comparison between success and failure	58
	in the four groups at second follow up	
	period.	

Figure (30)	Comparison between different types of	59
	failures in the four groups at the first	
	follow-up period.	
Figure (31)	Fracture in upper right primary lateral	60
	incisor in posts group at 6 months follow-	
	up (fracture of part of the restoration).	
Figure (32)	Comparison between different types of	61
	failures in the four groups at the second	
	follow-up.	
Figure (33)	Fracture in upper left primary central	62
	incisor in FRC group at 12 months follow-	
	up (fracture of part of the restoration).	
Figure (34)	Fracture in upper right primary lateral	63
	incisor in posts group, and in upper right	
	primary central incisor in FRC group at 12	
	months (fracture of part of the	
	restoration).	
Figure (35)	Fracture in upper left primary lateral	64
	incisor in four undercuts group at 12	
	months follow-up (fracture of the whole	
	crown).	
Figure (36)	Case representing success at 6 and 12	66
	months in undercuts groups.	
Figure (37)	Strain values in the different models on	68
	load application.	
Figure (38)	Comparison between the strain values in	68

	the different models (Strain values	
	expressed as microstrain x 10 ⁻⁶).	
Figure (39)	Stress values in the different models on	70
	load application.	
Figure (40)	Comparison between the stress values in	70
	the different models (Stress values	
	expressed in MPa).	

List of Tables

Table	Title	Page
no. Table (1)	Material properties used in the study.	52
Table (2)	Comparison between demographic data in the four groups	55
Table (3)	Comparison between success and failure percentages at follow up in the four groups.	57
Table (4)	Comparison between different types of failures in the four groups at the first follow-up period.	59
Table (5)	Comparison between different types of failures in the four groups at the second follow-up period.	61
Table (6)	Comparison between different types of radiographic failures in the four groups at the second follow-up period.	65
Table (7)	Comparison between the strain values in the different models.	67
Table (8)	Comparison between the stress values in the different models.	69

List of Abbreviations

AAPD	American Academy of Pediatric Dentistry.
CAS	Caries Analysis System.
ECC	Early childhood caries.
FEA	Finite element analysis.
FEM	Finite element method.
FRC	Fiber-reinforced composite.
MPa	Mega Pascal.
N	Newton.
PMIs	Primary maxillary incisors.
SD	Standard deviation.
SSCs	Stainless steel crowns.
S-ECC	Severe early childhood caries.