

Evaluation of a new Bioceramic material & Mineral Trioxide Aggregate as Pulp-capping Agents in Permanent Human Teeth.

(In vivo study)

Thesis Submitted to the Department of Endodontics,

Faculty of Dentistry, Ain Shams University,

In partial fulfillment of the requirements of the Master's degree in
Endodontics

By

Maie Magdy Abdel Ghany Bassiouny

B.D.S, Faculty of Dentistry, Ain Shams University, 2011

Faculty of Dentistry

Ain Shams University

2019

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

فَلِلَّهِ الْحَمْدُ الْمُنِيبُ
إِنَّمَا تَقْوَىٰ الْقُلُوبُ لِلَّهِ

صَدَقَ اللَّهُ الْعَظِيمُ

Supervisors

Prof. Dr. Ahmed Abdel Rahman Hashem

Professor of Endodontics,
Faculty of Dentistry, Ain Shams University

Ass. Prof. Dr. Maram Farouk Obeid

Associate Professor of Endodontics,
Faculty of Dentistry, Ain Shams University

Dedication

To my Family, for their unconditional love & support.

My Father who had always been a role model of hard work & dedication.

My Mother whom I look up to whenever I want to remind myself that miracles do happen.

My Sisters, my backbone & support system.

My friends, my second family, who showered me with love & care throughout the years.

You give me all the reasons to be better.

Acknowledgement

The completion of this thesis would not have been possible without the support and encouragement of several special people. Therefore, I would like to take this opportunity to show my gratitude to those who have assisted me in this long journey.

First, I would like to express my heartfelt thanks and my deepest gratitude to my supervisors:

Prof. Dr. Ahmed Abdel Rahman Hashem not only is he my supervisor, but he is my mentor & the one whom I owe all what I know in my career. I would like to thank him for his continuous motivation & sincere support.

Ass. Prof. Dr. Maram Farouk Obeid, for her continuous support, valuable guidance, constant patience & understanding.

I would like as well to express my deepest appreciation to **Ass. Prof. Dr. Marwa Magdy**, Associate professor of Oral Biology, Faculty of Oral & Dental medicine, Cairo University & **Dr. Heba Saleh**, Assistant lecturer of Oral Pathology, Faculty of Oral & Dental Medicine, Cairo University, for their valuable help & support in the histological assessment.

Additionally, I would like to thank **Dr. Sarah Adel**, Lecturer of Operative Dentistry, Faculty of Dentistry, BUE, for her assistance in the

statistical analysis, as well as **Dr. Sherif Khadr**, Assistant Lecturer of Operative Dentistry, Faculty of Oral & Dental Medicine, FUE, for his help with the photography & other technical procedures.

Lastly my sincere gratitude goes to the departments of Orthodontics in both Ain Shams University & FUE, & in particular **Dr Lobna Adel**, lecturer of Orthodontics, Faculty of Dentistry, Ain shams University, for their assistance in the recruitment of the participants.

Contents

LIST OF TABLES	I
LIST OF FIGURES	II
LIST OF ABBREVIATIONS.....	VI
INTRODUCTION	1
REVIEW OF LITERATURE.....	3
I.Brief History of Direct Pulp Capping Materials:	3
II.The use of Bioactive materials in direct pulp capping:	5
III.Bio-active ceramic materials used for Direct pulp capping:	6
IV.The outcomes of direct pulp capping using bio-active ceramic materials:.....	10
V.Comparing the outcome of Direct pulp capping with Novel bio-ceramics to MTA:	19
AIM OF THE STUDY	22
PICOT FORMAT AND RESEARCH QUESTION	23
MATERIALS & METHODS.....	24
Materials:	24
Methods:	25
1.Study Design:	25
2.Ethics:	25
3.Participants:	25
4.Intervention:.....	28
5.Histological Analysis:	40
6.Statistical Analysis.....	43
RESULTS	

DISCUSSION65

SUMMARY78

CONCLUSION79

REFERENCES80

APPENDIX99

الملخص العربي 1

List of Tables

Table No.	Description	Page No.
Table (1)	Formulation, Composition & setting time of the evaluated materials	24
Table (2)	Allocation of Samples to test groups	27
Table (3)	Criteria and Scores used during Histological Analysis of Dentinal Bridge & Dental pulp	42
Table (4)	Data collected from UPAT for groups BC1 & MTA1 after 1 week	46
Table (5)	Data collected from UPAT for groups BC2 & MTA2 after 1 week, 1 month, 3 months & 6 months	47
Table (6)	Frequencies (n), Percentages (%) and Mean \pm St. Deviation for grading scores of dentin bridge formation	51
Table (7)	Frequencies (n), Percentages (%) and Mean \pm St. Deviation for grading scores of pulp inflammation	56
Table (8)	Frequencies (n), Percentages (%) and Mean \pm St. Deviation for grading scores of odontoblastic cell layer	62

List of Figures

Figure No.	Description	Page No.
Figure (1)	AMTA	24
Figure (2)	TRRM	24
Figure (3)	(a) Operative field, after removal of the orthodontic wire to facilitate the placement of the clamp & ensure proper isolation, (b) Adminstration of Local anaesthesia.	33
Figure (4)	(a) ensuring proper rubber dam isolation by making sure the rubber dam sheet is below the contact area using a dental floss. (b) disinfection of the operative field using 2% chlorhexidine gluconate.	34
Figure (5)	(a) Class I cavitiy was done, followed by mechanical exposure at the center of the tooth using high speed contra-angle hand piece with a carbide round bur, under air-distelled water coolant. (b) The exposure site.	35
Figure (6)	(a) Hemostasis using paper point #80 wetted with 2.5% NaOCl. (b) Application of test material. (WAMTA in this clinical case)	36
Figure (7)	(a) Test material compaction using hand plugger. (b) Exposure site after Direct pulp capping with the test material.	37
Figure (8)	Placement & light-curing of Resin-reinforced glass ionomer cement, followed by finishing if needed.	38
Figure (9)	Universal Pain Assessment Tool(UPAT).	39

Figure (10)	Image Analyzer Computer System, Leica Qwin 500	41
Figure (11)	Copy of the display seen on the monitor of the image analyzer	41
Figure (12)	The CONSORT flow diagram of this study	45
Figure (13)	Intra-oral periapical radiograph from group MTA1 of a mandibular right first premolar, (a)pre-operative radiograph; (b)1-week post-operative follow up radiograph before extraction, showing no periapical or periodontal radiographic changes (Arrow: MTA)	48
Figure (14)	Intra-oral periapical radiograph from group BC2 of a mandibular right first premolar, (a) pre-operative radiograph; (b) 3-months post-operative follow up radiograph; (c) 6-months post-operative follow up radiograph. Both (b) & (c) showing no periapical or periodontal radiographic changes, & no hard tissue bridge formation is evident below the pulp capping material (BC).	49
Figure (15)	Mean histologic scores of Hard tissue bridge formation.	51
Figure (16)	A photomicrograph of BC2 group showing a completely formed hard tissue bridge (black arrow) beneath the pulp capping material (BC). (H & E, Orig. Mag.4X)	52
Figure (17)	A photomicrograph of BC2 group showing incompletely formed hard tissue bridge (black arrow) with the intrusion of the pulp capping material (BC) inside the pulp tissue.(blue arrow) (H & E, Orig. Mag.4X)	52

Figure (18)	A photomicrograph of MTA2 group showing completely formed dentin bridge (black arrow) beneath the exposure site. (black star) (H & E, Orig. Mag.4X)	53
Figure (19)	A photomicrograph of MTA2 group after four showing false pulp stone inside the pulp tissue(black arrow), with areas of granulation tissue in the pulp chamber. (black star) (H & E, Orig. Mag.4X)	53
Figure (20)	Mean histologic scores of Pulp inflammation.	57
Figure (21)	A photomicrograph from BC1 group showing shrinkage of the pulp tissue below the pulp capping material (TRRM), & Dilated blood vessels engorged with RBCs. (black arrows) (H & E, Orig. Mag.4X)	58
Figure (22)	Higher magnification of the previous figure showing dilated blood vessels engorged with RBCs with areas of hyalinization inside the blood vessels and extracellularly (black arrows), with Inflammatory cells infiltration and increase in the collagen fibers around the dilated blood vessels. (H & E, Orig. Mag.20X)	58
Figure (23)	A photomicrograph from MTA1 group showing severe angiogenesis in the pulp tissue with the presence of hyalinized granulation tissue bordering the site of the pulp capping material (WAMTA). (black arrow) (H & E, Orig. Mag.4X), (b) Higher magnification of the previous figure showing hyalinized granulation tissue beneath the site of the material (black arrow), the granulation tissue also involved the odontoblastic layer, in addition to areas of hyalinization in the pulp tissue. (black star) (H & E, Orig. Mag.20X)	59

Figure (24)	A photomicrograph from MTA1 group showing the involvement of the odontoblastic layer within the granulation tissue, with increase in the pulp cells, mainly UMCs. (black arrows) (H & E, Orig. Mag.40X)	59
Figure (25)	Higher magnification of figure(13) from BC2 group showing reduction in the number of dilated blood vessels as compared to that of group BC1, with the pre-dominance of Chronic inflammatory cells (fibroblasts in particular). (H & E, Orig. Mag.20X)	60
Figure (26)	Higher magnification of figure(16) from MTA2 group showing multiple areas of hyalinization in the pulp tissue (black stars), with relative decrease in the number of dilated blood vessels engorged with RBCs as compared to that of group MTA1. (H & E, Orig. Mag.40X)	60
Figure (27)	Mean Histologic scores of Odontoblastic cell layer.	62
Figure (28)	A photomicrograph from BC1 group showing partial loss of the odontoblastic layer (black arrows) with signs of inflammation in the pulp tissue. (H & E, Orig. Mag.20X)	63
Figure (29)	A photomicrograph from MTA1 group showing odontoblasts & odontoblast like cells (black arrows), with signs of mild inflammation in the pulp tissue. (H & E, Orig. Mag. 10X)	63
Figure (30)	A photomicrograph from MTA2 group showing continuous odontoblastic layer with areas of hyalinization (black arrow). The pulp tissue shows signs of mild chronic inflammation; granulation tissue with condensed extracellular matrix (black star) could be seen. (H & E, Orig. Mag.40X)	64

List of Abbreviations

AAPD	American Academy of Pediatric Dentistry
AEDB	Acid-etched, Dentin Bonded materials
ASU	Ain Shams University
BC RRM	Bioceramic Root Repair Material
CONSORT	Consolidated Standards of Reporting trials
CSM	Calcium Silicate-based Material
D	Dentin
DB	Dentin Bridge
DSP	Dentin Sialoprotein
E	Exposure Site
EDTA	Ethylene Di-amine Tetra-acetic acid
ERRM	Endosequence Bioceramic Root Repair Material
FUE	Future University in Egypt
GMTA	Gray Mineral Trioxide Aggregate
H & E	Haematoxylin & Eosin
HDPC	Human Dental Pulp stem cells
ISO	International Organization for Standardization
NaOCl	Sodium Hypochlorite
PBS	Phosphate Buffered Saline
PMNs	Polymorphonuclear cells
PT	Pulp Tissue
OL	Odontoblastic layer
RCT	Randomized Controlled trial
RP	Reparative Dentin

S.T.	Setting Time
TRRM	Total fill Bioceramic Root Repair Material
UMCs	Undifferentiated Mesenchymal cells
UPAT	Universal Pain Assessment Tool
WAMTA	White Angelus Mineral Trioxide Aggregate
WBCs	White Blood Cells