

# *Utilizing Post-natal Stem Cells for Hard Tissue Formation in Pulp Capping*

Thesis submitted to the Faculty of Dentistry for Partial Fulfillment of Requirements for  
Doctor Degree in Endodontics

By:

*Maram Farouk Obeid*

(B.D.S., M.S.D., Ain Shams University.)

**Supervisors:**

*Prof. Dr. Ehab El-Sayed Hasanien*

Professor of Endodontics,

Faculty of Dentistry,

Ain Shams University

*Prof. Dr. Alaa El-Din Ismail*

Professor of General Surgery

Faculty of Medicine

Ain Shams University

*Dr. Shehab El-din Saber*

Lecturer of Endodontics

Faculty of Dentistry

Ain Shams University

Faculty of Dentistry

Ain Shams University

2011

# استخدام الخلايا الجذعية البالغة لتكوين مادة صلبة لغطاء اللب السني المكشوف

مشروع مقدم ضمن متطلبات الحصول على درجة الدكتوراه في تخصص علاج الجذور

من الطيبة :

مرام فاروق محمد أديب عبيد

مدرس مساعد قسم علاج جذور- كلية طب الأسنان- جامعة عين شمس

تحت إشراف

ا.د. إيهاب السيد حسنين

أستاذ علاج جذور- كلية طب الأسنان- جامعة عين شمس

ا.د. علاء الدين اسماعيل

استاذ الجراحة العامة - كلية الطب - جامعة عين شمس

د.شهاب الدين صابر

مدرس قسم علاج جذور- كلية طب الأسنان - جامعة عين شمس

كلية طب اسنان

جامعة عين شمس

٢٠١١



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



صدق الله العظيم

آية ١١٤ من سورة طه



## *Thanks GOD*

*I want to thank GOD for supporting and guiding me throughout my life asking for his mercy and forgiveness.*



# *Dedication*

*This work is dedicated to...*

*My father, to whom I owe everything I ever did & will  
achieve*

*My mother, for her love & care*

*My husband, for his encouragement & understanding*

*My lovely kids, for being the joy of my life.*



# *Acknowledgment*

*I would like to express my deep appreciation and gratitude to **Professor Doctor Ehab El-Sayed Hasanien**, Professor of Endodontics, Faculty of Dentistry, Ain Shams University, for his valuable advice which were essential for the completion of this study.*

*My sincere appreciation goes to **Professor Doctor Alaa El-Din Ismail**. Professor of general surgery, Faculty of Medicine, Ain Shams University, for his supervision, unlimited support & help.*

*I would like to thank **Dr. Shehab El-din Saber**, Lecturer of Endodontics, Faculty of Dentistry, Ain Shams University, for his encouragement & excellent advice.*

*Special thanks to all staff & members of the Endodontic Department, Faculty of Dentistry, Ain Shams University.*

*Finally I wish to thank my young sister **Dr. Raneem Obeid** for her continuous support & help all the time*



# List of Contents

Subject	Page
List of Figures.....	xi
List of Tables.....	xiii
Introduction.....	1
Review of literature.....	3
1- Stem cells:.....	3
- Classification of Stem Cells .....	3
- Sources of Stem Cells.....	5
- Types of Post Natal Stem cells.....	6
- Culturing.....	11
- Differentiation.....	13
2- Pulp Capping.....	15
- Calcium Hydroxide.....	15
- Mineral Trioxide Aggregate.....	17
- Bonding Agent.....	21
- Bioactive Material.....	23
*Enamel Matrix Protein.....	24
* Calcium Phosphate.....	27
*Growth Factor.....	29
*Dentine Derivatives.....	32
Aim of the study.....	35
Materials and Methods.....	37
Results.....	72
Discussion.....	101
Summary and Conclusion .....	113
References.....	117
Arabic Summary.	



# *List of Figures:*

FIGURE 1: THE ANESTHETIC SYRINGE CONNECTED TO FEMORAL VEIN.....	40
FIGURE 2: ROSENTHAL NEEDLE.....	40
FIGURE 3: ASPIRATION OF BONE MARROW .....	40
FIGURE 4: VERTICAL LAMINAR FLOW FIGURE HOOD .....	45
FIGURE 5: BONE MARROW ADDED OVER THE HISTOPAQUE .....	46
FIGURE 6: DILUTED MARROW PHASE ON THE TOP OF HISTOPAQUE.....	46
FIGURE 7: THE MIDDLE PHASE .....	47
FIGURE 8: ASPIRATION OF THE MONONUCLEAR LAYER.....	47
FIGURE 9: CELL PELLET.....	47
FIGURE 10: HYMOCYTOMETER & TRYPAN BLUE STAIN .....	48
FIGURE 11: DYE EXCLUSION .....	48
FIGURE 12: BMSCs NEARLY CONFLUENT CELLS & CONFLUENT CELLS.....	49
FIGURE 13: SPINDLE MORPHOLOGY OF BMSC.....	50
FIGURE 14: 6 WELL PLATES.....	52
FIGURE 15: JAW SEPARATION .....	60
FIGURE 16::(A,B) CLASS V CAVITIES.....	60
FIGURE 17: (A,B) GROUP A: MTA APPLICATION & CONDENSATION.....	61
FIGURE 18: BMSCS TRYPSINIZATION .....	62
FIGURE 19:MICROPIPETTE .....	62
FIGURE 20: APPLICATION OF HA/TCP POWDER OVER BMSCS.....	63
FIGURE 21: (A,B) THE STEM CELLS COVERED BY GOLD FOIL.....	63
FIGURE 22: GROUP C: HA/TCP APPLICATION.....	64
FIGURE 23: CORONAL RESTORATION WITH GLASS IONOMER .....	64
FIGURE 25: IMAGE ANALYSIS FOR COUNTING INFLAMMATORY CELLS.....	71
FIGURE 26: BMSCS.....	72
FIGURE 27: BMSCS (H&E X100)FIBROBLASTS LIKE .....	73
FIGURE 28:BMSCS AT 5 DAYS IN ODONTOGENIC MEDIUM.....	75
FIGURE 29 : MICROPHOTOGRAPH OF BMSC AT 7 DAYS IN ODON. MEDIUM.....	75
FIGURE 30: MICROPHOTOGRAPH OF BMSC BY 14 DAYS IN ODON. MEDIUM.....	76
FIGURE 31: MICROPHOTOGRAOF BMSC PH AT DAY 21 IN ODON. MEDIUM.....	76
FIGURE 32: A PHOTOMICROGRAPH OF NORMAL PULP(H&E X 100).....	82
FIGURE 33: MTA GROUP SHOWING DIFFUSE INFLAMMATORY CELLS.....	82
FIGURE 34: MTA GROUP SHOWING MIDDLE PART OF THE PULP.....	83
FIGURE 37: HA/TCP GROUP : TISSUE DESTRUCTION.....	83
FIGURE 38: HA/TCP GROUP : CONGESTED BLOOD VESSELS.....	84
FIGURE 39: HA/TCP GROUP SUPERFICIAL NECROCIS & INFLAMMATORY CELLS.....	84
FIGURE 40: MTA GROUP NEW INFLAMMATORY CELLS AFTER 12 WEEKS.....	84
FIGURE 41: MTA GROUP SHOWING FIBROUS DENTIN BRIGE AFTER 12 WEEK.....	84

FIGURE 42: (A,B) BMSCS FORMED OSTEODENTINE TISSUE AFTER 12 WEEKS.....85

FIGURE 43: CONGESTED BLOOD VESSELS WITH BMSCS AFTER 12 WEEKS.....86

FIGURE 44: (A,B) HA/TCP GROUP CALCIFIC NODULES AFTERE 12 WEEKS.....86

FIGURE 45: RADIOGRAPH OF MTA GROUP SHOWED NORMAL PERIAPICAL AREA.....88

FIGURE 46: RADIOGRAPH OF BMSCS SHOWED NORMAL PERIAPICAL AREA.....88

FIGURE 47: RADIOGRAPH OF HA/TCP SHOWED PERIAPICAL RADULUCENCIES.....88

FIGURE 48: CEPHALIC CBCT OF MTA SHOW NORMAL PERIAPICAL AREAS.....90

FIGURE 49: LS OF CBCT :CONTINUOUS RADIOPAQUE BAND UNDER MTA.....91

FIGURE 50: CS OF CBCT :CONTINUOUS RADIOPAQUE BAND BENEATH MTA.....91

FIGURE 51: PANORAMIC CBCT OF BMSCS CAPPED TEETH APICAL AREA .....92

FIGURE 52: LS IN CBCT OF BMSC: CONTINUOUS RADIOPAQUE LINE .....93

FIGURE 53: CS CBCT OF BMSC: CONTINUOUS & DISCONTINUOUS RADIOPAQUE LINE.93

FIGURE 54: CS CBST OF BMSCS: CONTINUOUS FAINT RADIOPAQUE BAND.....93

FIGURE 55: RADIOGRAPH OF HA/TCP> APICAL RADULUCENCIES OF VARIABLE SIZES ..94

FIGURE 56: LS OF CBCT IN HA/TCP: INTRAPULPAL CALCIFICATION .....95

FIGURE 57: CS OF CBCT: INTRAPULPAL CALCIFICATION WITH HA/TCP.....95

FIGURE 58: BAR CHART REPRESENTING MEAN INFLAMMATORY CELL COUNTS.....97

FIGURE 59: LINE CHART REPRESENTING CHANGES IN MEAN INFLAMMATORY CELL COUNTS.....98