



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم



MONA MAGHRABY



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم



شبكة المعلومات الجامعية التوثيق الإلكتروني والميكروفيلم



MONA MAGHRABY



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات



يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار



MONA MAGHRABY



Evaluation of the Accuracy of 3D Virtual Surgical Planning for Reconstruction of Mandibular Defects using Free Fibular Flap

Thesis

*Submitted to the Oral and Maxillofacial Surgery Department,
Faculty of Dentistry - Ain Shams University
in Partial Fulfillment of the Requirements for Doctoral Degree in
Oral and Maxillofacial Surgery*

By

Ibrahim Mohamed El Sharabasy

B.D.S. - Mansoura University (2008)

M.Sc. - Mansoura University (2016)

**Faculty of Dentistry
Ain Shams University
2020**

SUPERVISORS

Prof. Dr. Salah Abdel Fattah Ahmed Metwally

Professor of Oral and Maxillofacial Surgery,
Faculty of Dentistry
Ain Shams University

Prof. Dr. Wael Mohamed Ayad

Professor of Plastic and Reconstructive Surgery
Faculty of Medicine
Alazhar University

Ass. Prof. Heba Abd Elwahed Abd Elhafez

Assistant professor of Oral and Maxillofacial Surgery
Faculty of Dentistry
Ain Shams University

Acknowledgement

First and foremost, thanks and praise Allah, most gracious, most merciful.

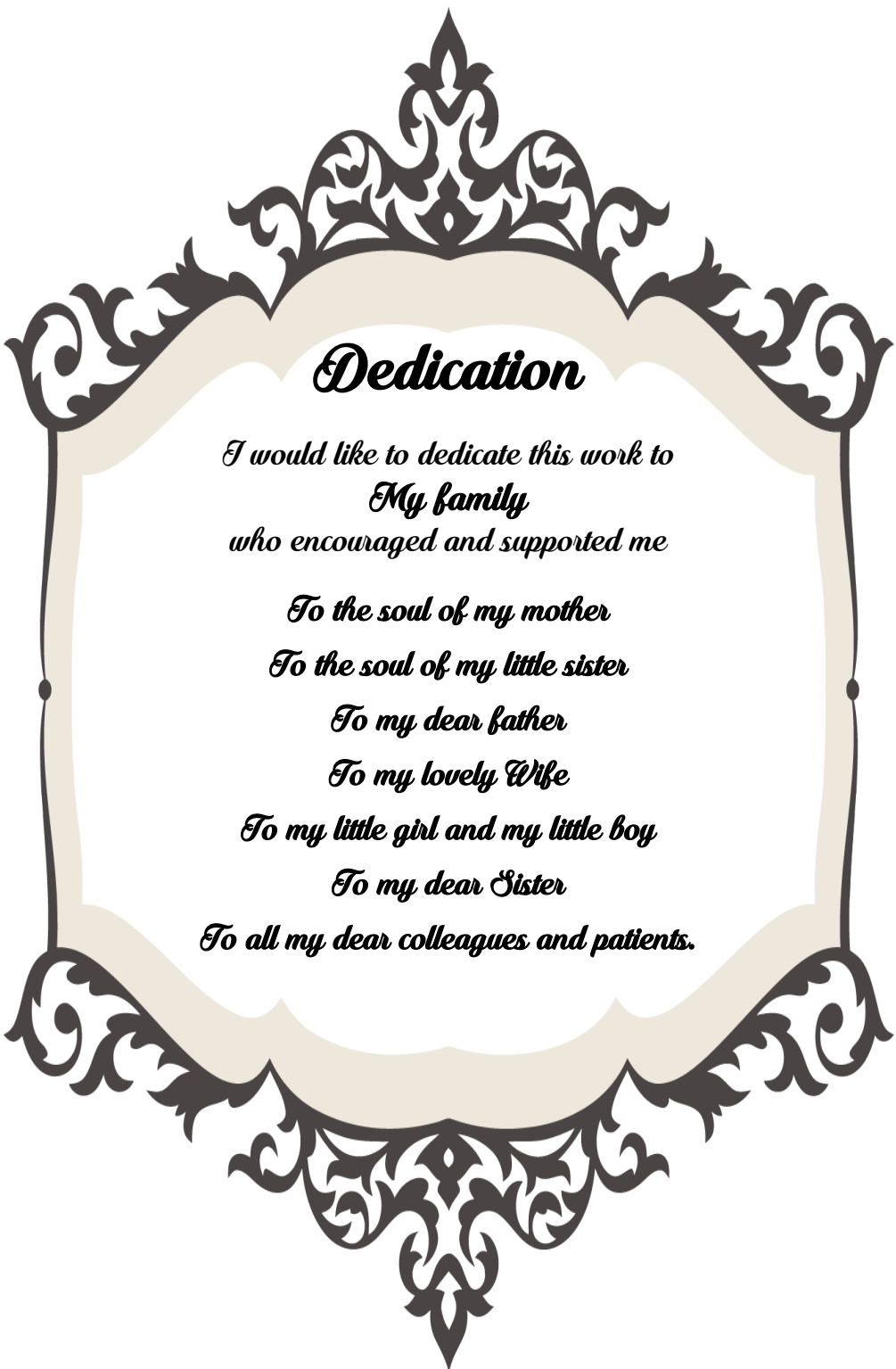
*Words stand short when coming to express my deepest gratitude and greatest thanks to **Prof. Dr/ Salah Abd Elfattah Ahmed**, Professor of Oral & Maxillofacial Surgery, Faculty of Dentistry, Ain Shams University, for his constant encouragement, constructive guidance and unlimited support all through my career. Working under his supervision is a real privilege. To him I fell indeed grateful.*

*Also, I would like to direct my special thanks to **Prof.Dr/ Wael Mohamed Ayad**, Professor of Plastic and Reconstructive Surgery, Faculty of Medicine, Alazhar University, for his invaluable help, fruitful advice, continues support offered to me and guidance step by step till this work finished.*

*Gratefulness and appreciation are also directed to **Assoc. Prof. Dr./ Heba Abd Elwahed Abd Elhafez**, Assistant professor of Oral and Maxillofacial surgery, Faculty of Dentistry, Ain Shams University, for her close supervision, support and unlimited help.*

*Also, thanks to **Prof. Dr/ Marwa Elkassaby**, the head of the department, and to all the staff members of oral and maxillofacial surgery Department, Faculty of Dentistry, Ain Shams University.*

Ibrahim M. ElSharabasy



Dedication

*I would like to dedicate this work to
My family
who encouraged and supported me*

To the soul of my mother

To the soul of my little sister

To my dear father

To my lovely Wife

To my little girl and my little boy

To my dear Sister

To all my dear colleagues and patients.

LIST OF CONTENTS

	<i>Page</i>
LIST OF ABBREVIATIONS.....	III
LIST OF FIGURES	IV
LIST OF TABLES	X
INTRODUCTION.....	1
REVIEW OF LITERATURE	3
• <i>Mandibular reconstruction, overview</i>	3
• <i>Etiology of mandibular defects</i>	4
• <i>Classification of mandibular defects</i>	5
• <i>Timing of mandibular reconstruction</i>	8
• <i>Different mandibular reconstructive options</i>	10
• <i>Non-vascularized bone grafts</i>	12
• <i>Distraction osteogenesis</i>	14
• <i>Vascularized free flaps</i>	15
• <i>Free fibular flap</i>	19
■ <i>Fibula related anatomy</i>	19
■ <i>Fibula free flap advantages</i>	31
■ <i>Fibula free flap limitations and disadvantages</i>	34
■ <i>Free hand technique for fibula cutting and contouring</i>	34
■ <i>Virtual surgical planning</i>	38

	<i>Page</i>
AIM OF THE STUDY	41
PATIENTS AND METHODS.....	42
• <i>Study population.....</i>	42
• <i>Study procedure.....</i>	43
■ <i>Preoperative examination & preparation</i>	43
■ <i>Radiographic Records.....</i>	44
■ <i>Surgical technique</i>	53
■ <i>Postoperative records and data management</i>	64
■ <i>Statistical analysis.....</i>	65
RESULTS.....	70
DISCUSSION	92
SUMMARY	104
CONCLUSION.....	106
REFERENCES	107
ARABIC SUMMARY.....	-

LIST OF ABBREVIATIONS

Abbreviation	Meaning
CT	Computerized tomography
3D	Three dimensional
MRONJ	Medication-related osteonecrosis of the jaw
AO	Arbeitsgemeinschaft für Osteosynthesefragen (German for "Association for the Study of Internal Fixation")
THORP	Titanium hollow osseointegrated reconstruction plate
SCM	Sternocleidomastoid
TMJ	Temporo-mandibular joint
DO	Distraction osteogenesis
DCIA	Deep circumflex iliac artery
ALT	Anterolateral thigh
IMF	Intermaxillary fixation
Dicom	Digital Imaging and Communications in Medicine
CAD	Computer-aided design
CAM	Computer-aided manufacturing
VSP	Virtual surgical planning
STL	Stereolithography
ASA	American Society of Anesthesiologists
IU	International Unit
ICU	Intensive Care Unit
I.V	Intravenous
SC	Subcutaneous
CVP	Central Venous Pressure
ANS	Anterior Nasal Spine
PNS	Posterior Nasal Spine
ml	Milliliter
mm	Millimeter
Fig	Figure
SD	Standard Deviation
Sum	Summation
SPSS	Statistical Package for the Social Sciences
T	Test of significant
n	Number
P-value	Calculated Probability

LIST OF FIGURES

Figure no.	Title	Page
1	Demonstrating classification of mandibular defects	6
2	Demonstrating new classification of mandibular defects.....	7
3	Demonstrating classification of fibular flap osteotomies according to different anatomical locations of the mandibular defects and its extensions	8
4	Demonstrating Fascial layers, compartments and cross-sectional anatomy of left leg.....	21
5	Demonstrating the muscular contents of each compartment of the lower leg.....	21
6	Demonstrating vascular anatomy of the lower limb, the popliteal artery which is the continuity of the femoral artery which further divides into anterior tibial artery and tibioperoneal trunk, the tibioperoneal trunk further divided into posterior tibial and peroneal vessels.....	24
7	Demonstrating the anatomical variations of the peroneal artery a. (Type I) The Popliteal A divides into the Anterior Tibial A and the common junction of the posterior tibial and fibular arteries; b. (Type II) The Popliteal A divides into the Anterior Tibial A and Posterior Tibial A; c. (Type III) The Popliteal A trifurcates into the Anterior Tibial A, Post Tibial A, and Fibular A; d. (Type IV) The Popliteal A divides into the Anterior Tibial A and Fibular A	25
8	Demonstrating the different patterns of the perforators supplying the flap skin paddle a. (Type A) Peroneal septocutaneous perforator supplying the skin paddle; b. (Type B) Skin paddle receiving dominant contributions from soleus musculocutaneous perforator; c. (Type C) Skin paddle receives its sole source of blood supply from the soleus musculocutaneous perforator	27
9	Demonstrating neural anatomy of the lower limb from anterior and posterior views	29
10	Demonstrating neural anatomy of the lower limb at the popliteal region and the furcating sciatic nerve to common peroneal and tibial nerves	29

Figure no.	Title	Page
11	Demonstrating the lateral Sural cutaneous nerve which could be included in flap to have sensate skin paddle	29
12	Demonstrating the cutaneous nerve supply distribution all over lower leg	30
13	Demonstrating the free fibular flap components at the end of harvesting	31
14	Demonstrating intraoperative planning of the paper templates based on the contour of the reconstruction plate and osteotomization of the fibula on the back table guided by the paper templates after division of the peroneal pedicle.	35
15	Panoramic x-ray view demonstrating (A) inferiorly positioned fibular bone with increased interarch space not ideal for dental implant insertion (B) decreased inter arch space posteriorly not enough for implant insertion and dental rehabilitation	36
16	Demonstrating extraoral reconstruction plate exposure with oro-cutaneous fistula due to improper contouring of the fibular bone which is not matching the mandibular contour and the plate as demonstrated in the axial CT view and the panoramic x-ray view	37
17	A) Demonstrating virtual planning of mandibular reconstruction by fibular free flap which osteotomized in multiple segments to match natural mandibular contour; B) Intraoperative photograph demonstrating 3D printed fibular cutting guide in place and osteotomization according to its planes of cut	39
18	(A, B, C and D): Preoperative extraoral photographs in frontal view, worm`s view, oblique lateral view and profile view respectively; (E,F): Showing intraoral photographs demonstrating mandibular teeth malocclusion regarding dental midline shift and contralateral openbite	45
19	Showing CT Angiography demonstrating the normal vascular system of lower limb	46
20	Showing CT Angiography demonstrating the vascular system of previously operated patient	46
21	(A,B): Showing CT of the patient`s skull after rendering its DICOM data into a 3D reconstructed model ready for virtual planning.....	47

Figure no.	Title	Page
22	(A,B): Showing CT of the patient`s lower limb after rendering its DICOM data to a 3D reconstructed model ready for virtual planning	47
23	(A, B) Showing virtual osteotomy guide for resection edge preparation. (C) Showing the 3D printed osteotomy guide	50
24	(A, B) Showing virtual adjustment and contouring of the fibula based on mirror image from the unresected side after correcting the disturbed occlusion and positioning the mandible in the normal relation with the maxilla.....	50
25	(A,B) Showing virtual restoring and reconstruction of anterior mandiblar defect based on a superimposed mandibular model of a patient of the same gender, age and skeletal size	50
26	(A, B and C) Showing virtual planning and reconstruction of fibula cutting guide with its positioning arm from the lateral epicondyle (malleolus) as a reference point (D) Showing the 3D printed fibula cutting guide system.....	51
27	(A) Showing virtual mandibular model after reconstruction by fibular parts, note the position of the fibular graft to the upper border of the remaining mandible; (B) Showing the 3D printed mandibular model after reconstruction plate preadaptation and adjustment	52
28	(A) Showing virtual fabrication of the fibula parts contouring/positioning guide which fits on the mandible and screwed in the pre-drilled holes in the fibular segments by the osteotomy guide; (B,C) Showing the 3D printed contouring/positioning guide in place on the mandible model with the adapted plate in the exact planned position below the positioning guide.....	52
29	Intraoperative clinical photograph showing preparation of the donor site with marking of the incision, surface landmark of the fibular bone, skin paddle with its perforators using hand held Doppler ultrasound	57
30	(A) Intraoperative clinical photograph showing cervical incision and dissection in subplatysmal plane until full exposure of the mandibular defect and reconstruction plate; (B) Intraoperative clinical photograph showing the removed reconstruction plate, condylar prosthesis and screws.....	57

Figure no.	Title	Page
31	(A,B): Intraoperative clinical photograph showing application of the resection edge osteotomy guide for resection edge decortication and preparation	58
32	Intraoperative clinical photograph showing the mandibular edge after marginal osteotomy and decortication.....	58
33	(A): Intraoperative clinical photograph showing application of the fibula cutting guide guided in position; (B) Intraoperative clinical photograph showing the fibula cutting guide fixed in place; (C) Intraoperative clinical photograph showing the guide after removal of the connecting prisms	59
34	Intraoperative clinical photograph showing full dissection of the fibular bone, related muscle cuff and the peroneal pedicle in view.....	60
35	Intraoperative clinical photograph showing fibular segments after bony wedges excision utilizing sagittal saw guided by the planes of the cutting guide	60
36	Intraoperative clinical photograph showing fibular bony segments after osteotomies just pedicled and connected to each other by the muscle and the periosteum and supplied by the peroneal pedicle	60
37	(A,B) Intraoperative clinical photographs showing application of the contouring/positioning guide which gather the fibular segments within it and then fixing them to the guide with 2.0mm miniscrews; (C) Intraoperative clinical photograph showing the fibular graft-reconstruction plate- positioning guide complex ready to be divided and transferred to the recipient site for fixation and anastomosis.....	61
38	Intraoperative clinical photograph showing the fibular graft-reconstruction plate-positioning guide complex after pedicle division to be transferred to the recipient site	62
39	(A,B) Intraoperative clinical photographs showing fibular graft-reconstruction plate-positioning guide complex after fixation of the complex to the mandible by 2.7mm reconstruction screws system in the exact planned position guide	62
40	Intraoperative clinical photograph showing the final fixation of the free fibular flap in the planned position and after removal of the positioning guide.....	63

Figure no.	Title	Page
41	(A) Intraoperative clinical photograph showing the cervical wound closure with drains in position; (B) Intraoperative clinical intraoral photograph showing immediate intraoperative improvement and correction of the malocclusion demonstrated by mandibular midline shift	63
42	(A, B): Showing postoperative CT of the patient's skull and mandible after rendering its DICOM data to a 3D reconstructed model ready for evaluation	66
43	(A,B): Showing superimposition of the actual postoperative 3D reconstructed model of the mandible over the preoperative virtual reconstructed mandible	66
44	(A,B): Showing the reconstructed 3 planes of space, the Sagittal, the Frankfort horizontal plane and the Coronal plane	67
45	(A, B): Showing the positions of the fixed landmark points on the ends of fibula parts in both virtual and postoperative 3D reconstructed mandibular model	67
46	(A, B): Showing linear measurements between the fibula landmark points and the sagittal plane	68
47	(A, B): Showing linear measurements between the fibula landmark points and the Frankfort horizontal plane.....	68
48	(A, B): Showing linear measurements between the fibula landmark points and the coronal plane	69
49	(A, B): Showing angular measurements between lines formed by interconnecting the fibula landmark points.....	69
50	Bar chart representing measurements in different planes for all patients	80
51	Bar chart representing angles between lines connecting points over osteotomy sites	82
52	(A) Showing preoperative extraoral frontal view; (B) Showing postoperative extraoral frontal view	83
53	(A) Showing preoperative extraoral right profile view; (B) Showing postoperative extraoral right profile view, note lower lip support by the flap.....	84