

THE CAROTID ARTERY SURGERY FOR OBLITERATIVE ATHEROMATOUS LESIONS

THESIS

*submitted for the partial fulfillment of the
MD DEGREE IN SURGERY*

Presented by

Khaled Mahmoud A.ABDEL AAL
MBBCh

Under supervision of

Professor Nabil Amin EL-MEHAIRY
*Chief of the Department of Vascular Surgery,
Faculty of Medicine,
Ain Shams University, Egypt.*

Professor Yvon KERDILES
*Chief of the Department of Vascular Surgery,
Faculty of Medicine,
Rennes University, France.*

Dr. Ali Sadek SABBOUR
*Assistant Professor in Department of Vascular Surgery,
Faculty of Medicine
Ain Shams University, Egypt.*

**FACULTY OF MEDICINE
AIN SHAMS UNIVERSITY
1998**



ACKNOWLEDGMENT

PROFESSOR Y. KERDILES (*Chief of vascular surgery department - Rennes university hospital - France*) : You have been encouraging me all the time, allowed me to make my first steps in vascular surgery, taught me respect of patients and importance of the appropriate indications. You opened your department to me and offered me the chance to learn from your huge experience. You come to Egypt especially to support my work. Please accept my acknowledgment, sincere gratitude and my warm friendship.

PROFESSOR N. ELMEHEIRY (*Chief of vascular surgery department - Ein shams university*) : You accepted to supervise this work and advised me all the time. I am proud of being one of your students. Please accept all my gratitude.

PROFESSOR A. SABBOUR (*Assistant professor vascular surgery department - Ein shams university*) : Your valuable advise, precious instructions and warm support were of good help. Thank you for your friendship.

PROFESSOR ABOUBAKR EL SEDIK (*department of vascular surgery Ein Shams university*) **PROFESSOR Amir Imam NASSEF** (*Chief of department of vascular surgery - Cairo university*) : Thank you for your discussion of this thesis. I am very honored to have you as members of Jury. Please accept my gratitude.

To My Family for your support all these years. Without you this work would never come into existence. Please accept all my love.

To my wife Pascale and my daughter Ines. You are my reason to live. Thank you for your courage and patience as well as your continuous support.

All members of vascular surgery department. Thank you for your help in the realization of this thesis, your work and collaboration. Please accept all my gratitude.

Khaled ABDEL AAL

Digitized by Google

CONTENTS

<u>CONTENTS</u>	<u>PAGE</u>
1) INTRODUCTION	1
2) GENERALITIES	4
2.1 HISTORICAL	4
2.2 ANATOMY OF ARTERIAL CEREBRALCIRCULATION...	9
2.2.1 INNOMINATE ARTERY.....	10
2.2.2 COMMON CAROTID ARTERIES.....	10
2.2.3 INTERNAL CAROTID ARTERY.....	11
2.2.4 EXTERNAL CAROTID ARTERY.....	12
2.2.5 VERTEBRAL ARTERIES.....	13
2.2.6 BASILAR ARTERY.....	13
2.2.7 COLLATERAL CIRCULATION AND CIRCLEOF WILLIS.....	14
2.2.8 IMPORTANCE OF THECOLLATERAL...CIRCULATION.....	16
2.3 CEREBRO VASCULAR INSUFFICIENCY	18
2.3.1 MECANISMS OF CEREBRO VASCULAR ACCIDENTS.....	19
2.3.2 ETIOLOGY OF ISCHEMIC DISORDERS.....	20
2.4 CLINICAL PRESENTATIONS	21
2.4.1 TRANSIENT ISCHEMIC ATTACKS (TIA).....	21
2.4.2 STROKE.....	23
2.4.2.1 STROKE IN EVOLUTION.....	23
2.4.2.2 COMPLETED STROKE.....	23
2.4.3 VERTEBRO BASILAR INSUFFICIENCY (VBI).....	24
2.4.4 CLASSIFICATION OF CEREBRAL ISCHEMIA.....	24
2.4.5 PROGNOSIS OF CEREBRAL ISCHEMIA.....	27
2.5 EPIDEMIOLOGY AND NATURAL HISTORY	28
2.5.1 TRANSIENT ISCHEMIC ATTACKS (TIA).....	29
2.5.2 CEREBRAL INFARCTION.....	30
2.6 ASYMPTOMATIC LESION OF CAROTID ARTERY.....	32
2.7 OPERATIVE TECHNIQUE.....	33
2.7.1 OPERATIVE INDICATIONS.....	33
2.7.2 CONTRAINDICATIONS.....	34
2.7.3 PATIENT POSITION.....	35
2.7.4 INCISION.....	36

2.7.5	CEREBRAL TOLERANCE TO CLAMPING.....	39
2.7.5.1	LOCAL ANESTHESIA.....	39
2.7.5.2	GENERAL ANESTHESIA.....	40
2.7.6	REVASCULARIZATION TECHNIQUES.....	40
2.7.6.1	ENDARTERECTOMY.....	40
2.7.6.1.1	CLASSIC ENDARTERECTOMY.....	40
2.7.6.1.2	ENDARTERECTOMY BY EVERSION.....	41
2.7.6.1.3	ENDARTERECTOMY WITH PATCH.....	42
2.7.6.2	CAROTID BYPASS.....	43
2.7.6.3	ARTERIAL CLOSURE.....	44
2.7.6.4	SHUNT UTILIZATION.....	45
2.7.6.5	CAROTID ANGIOPLASTY.....	47
3)	PATIENTS AND METHOD	49
3.1	METHODOLOGY.....	49
3.1.1	PATIENT SELECTION.....	49
3.1.2	RETROSPECTIVE STUDY.....	50
3.1.3	COMPUTER CHART.....	50
3.2	OUR SERI.....	55
3.2.1	PATIENTS.....	55
3.2.2	AGE.....	56
3.2.3	SEX.....	56
3.2.4	ATHEROMATOUS RISK FACTORS.....	57
3.2.4.1	HYPERTENSION.....	57
3.2.4.2	SMOKING.....	57
3.2.4.3	DIABETES.....	57
3.2.4.4	DYSLIPEDYMIAS.....	57
3.2.4.5	OBESITY.....	58
3.2.4.6	CORONARY ARTERY INSUFFICIENCY.....	58
3.2.4.7	POLYVASCULAR PATIENTS.....	58
3.2.5	DESCRIPTION OF ARTERIAL LESION.....	58
3.2.5.1	CAROTID BRUIT.....	58
3.2.5.2	DUPLEX SCAN.....	59
3.2.5.3	ECHOGRAPHY.....	59
3.2.5.4	ARTERIOGRAPHY.....	60
3.2.5.5	CEREBRAL SCANNER.....	62
3.2.6	PERI OPERATIVE NEUROLOGICAL STATUS.....	62
3.2.6.1	SYMPTOMATIC LESIONS.....	62
3.2.6.2	ASYMPTOMATIC LESIONS.....	63
3.2.7	SURGICAL INTERVENTION.....	63
3.2.7.1	OPERATED SIDE.....	63
3.2.7.2	BILATERAL PROCEDURES.....	63
3.2.7.3	TYPE OF REVASCULARIZATION.....	64
3.2.7.4	ANESTHESIA.....	64
3.2.7.5	SHUNT.....	64
3.2.7.6	TIME OF CLAMPING.....	64
3.2.7.7	ASSOCIATED PROCEDURES.....	65
3.2.7.8	RESIDUAL PRESSURE AFTER CLAMPING.....	65
3.2.7.9	CAROTID REFLUX.....	65

4) RESULTS	67
4.1 PERI OPERATIVE RESULTS.....	67
4.1.1 TOTAL MORTALITY.....	67
4.1.2 CAUSE OF DEATH.....	67
4.1.3 CENTRAL NEUROLOGIC MORBIDITY.....	68
4.1.3.1 TRANSIENT ISCHEMIC ATTACKS.....	68
4.1.3.2 MINOR CEREBRO VASCULAR ACCIDENTS.....	68
4.1.3.3 MAJOR CEREBRO VASCULAR ACCIDENTS.....	69
4.1.3.4 ANALYSIS OF MORBIDITY.....	69
4.1.3.5 CUMMULATIVE MORTALITY MORBIDITY RATE.....	70
4.1.4 NON LETHAL COMPLICATIONS.....	70
4.1.4.1 CARDIOVASCULAR COMPLICATIONS.....	70
4.1.4.2 GENERAL COMPLICATIONS.....	71
4.1.4.3 LOCAL COMPLICATIONS.....	71
4.1.4.4 PERIPHERAL COMPLICATIONS.....	71
4.1.5 PREDICTIVE RISK FACTORS TO NEUROLOGIC COMPLICATIONS	72
4.1.5.1 HYPERTENSION.....	72
4.1.5.2 SEX.....	73
4.1.5.3 AGE.....	74
4.1.6 COMPLICATIONS OF ASYMPTOMATIC PATIENTS.....	74
4.1.7 COMPLICATIONS ACCORDING TO NEUROLOGIC STATUS.....	75
4.1.8 ACCORDING TO LESION IN OTHER SUPRA AORTICARCH ARTERIES.....	76
4.1.9 ACCORDING TO SURGICAL TECHNIQUE.....	78
4.1.9.1 SURGEON EXPERIENCE.....	78
4.1.9.2 OPERATIVE TECHNIQUE.....	79
4.1.9.3 HEMODYNAMICS AND CEREBRAL PROTECTION.....	80
4.1.9.4 UNILATERAL OR BILATERAL SURGERY.....	80
4.2 LONG TERM RESULTS	82
4.2.1 GLOBAL SURVIVAL RATE.....	82
4.2.2 CAUSE OF DEATH.....	83
4.2.3 SURVIVAL OF CORONARIAN PATIENTS.....	84
4.2.4 SURVIVAL OF ARTERITIC PATIENTS.....	85
4.2.5 SURVIVAL ACCORDING TO PREOPERATIVE NEUROLOGIC STATUS.....	86
4.2.6 SURVIVAL ACCORDING TO PREOPERATIVE CT SCAN.....	87
4.2.7 SURVIVAL ACCORDING TO CONTROLATERAL CAROTID THROMBOSIS.....	87
4.2.8 SURVIVAL ACCORDING TO HYPERTENSION	88
4.2.9 SURVIVAL ACCORDING TO OTHER FACTORS.....	89

4.3	ACTUARIAL SURVIVAL CURVES FOR NEUROLOGIC STATUS.....	89
4.3.1	GLOBAL NEUROLOGIC EVENTS.....	89
4.3.2	INDEMNITY OF CONSTITUTED CVA.....	91
4.3.3	CURVES OF CMMR.....	93
4.3.4	FACTORS INFLUENCING LONG TERM NEUROLOGIC INDEMNITY.....	93
4.4	ACTUARIAL CURVES ACCORDING TO PERMEABILITY OF THE OPERATED CAROTID.....	94
5)	DISCUSSION.....	97
5.1	PATIENT SELECTION FOR SURGERY.....	99
5.2	PRE OPERATIVE ASSESSMENT.....	100
5.2.1	PHYSICAL EXAMINATION.....	100
5.2.2	DUPLEX SCAN.....	101
5.2.3	ANGIOGRAPHY.....	103
5.2.4	CT SCAN.....	113
5.2.5	THREE DIMENTIONAL IMAGERY.....	114
5.2.5.1	3D MORPHOMETRY.....	114
5.2.5.2	SPIRAL SCAN (HELICOIDAL).....	115
5.2.6	OCCULAR PNEUMOPLETYSMOGRAPHY.....	116
5.3	SPONTANEOUS EVOLUTION OF CAROTID STENOSIS.....	116
5.4	PROSPECTIVE STUDIES OF SYMPTOMATIC CAROTID LESIONS.....	119
5.4.1	RESULTS OF THE NASCET STUDY.....	119
5.4.2	RESULTS OF THE ECST STUDY.....	121
5.5	PROSPECTIVE STUDIES FOR ASYMPTOMATIC CAROTID LESIONS.....	123
5.5.1	RESULTS OF ACAS STUDY.....	123
5.5.2	RESULTS OF ECST STUDY.....	124
5.6	PERIOPERATIVE RISK IN CAROTID SURGERY.....	126
5.6.1	ETIOLOGY OF PERIOPERATIVE RISK.....	127
5.6.2	PREDICTING RISK FACTORS OF NEUROLOGIC COMPLICATIONS.....	129
5.6.2.1	CEREBRO VASCULAR RISK FACTORS.....	130
5.6.2.2	ANGIOGRAPHIC RISK FACTORS.....	132
5.6.2.3	INTRA OPERATIVE RISK FACTORS.....	133
5.6.2.4	LOCAL RISK FACTORS AND CONTROLATERAL CAROTID THROMBOSIS.....	134
5.7	DOES SHUNT PREVENT AGAINST CVA ?.....	136
5.7.1	INDICATIONS.....	136
5.7.2	LOCAL COMPLICATIONS.....	138
5.7.3	SELECTIVE SHUNT.....	139
5.7.4	TO SHUNT OR NOT TO SHUNT.....	140

5. 8 CEREBRAL PROTECTION DURING CAROTID SURGERY.....	141
5 . 8 . 1 MECANISM OF PERIOPERATIVE STROKE.....	141
5 . 8 . 2 TYPE OF ANESTHESIA.....	142
5. 9 LONG TERM RESULTS OF CAROTID SURGERY.....	145
5 . 9 . 1 CAUSE OF DEATH.....	146
5 . 9 . 2 ASYMPTOMATIC PATIENTS.....	147
6) CONCLUSION.....	149
<i>REFERENCES.....</i>	<i>151</i>
<i>ENGLISH SUMMARY.....</i>	<i>165</i>
<i>ARABIC SUMMARY</i>	

LIST OF TABLES

N ^o	Designation	Page
1	<i>Classification of Marseille for cerebro-vascular accidents.....</i>	25
2	<i>Degree of stenosis measured by duplex scan.....</i>	59
3	<i>Echographic aspect of the carotid plaque.....</i>	59
4	<i>Degree of stenosis by arteriography.....</i>	60
5	<i>Arteriographic lesions of other arteries.....</i>	61
6	<i>Peri operative symptomatic neurologic status.....</i>	62
7	<i>Peri operative asymptomatic neurologic status.....</i>	63
8	<i>Techniques of revascularization.....</i>	64
9	<i>Non lethal cardio vascular complications.....</i>	70
10	<i>Other general complications.....</i>	71
11	<i>Neurologic accidents according to hypertension.....</i>	72
12	<i>Neurologic complications and hypertension.....</i>	73
13	<i>Mortality and morbidity according to sex</i>	73
14	<i>Neurologic complications according to age.....</i>	74
15	<i>Neurologic complications according to clinical staging.....</i>	75
16	<i>Neurologic complications according to associated lesions.....</i>	76
17	<i>Mortality and morbidity according to surgeon's experience.....</i>	78
18	<i>CMMR according to operative technique.....</i>	79
19	<i>CMMR according to hemodynamics and cerebral protection.....</i>	80
20	<i>CMMR according to unilateral or bilateral operation.....</i>	80
21	<i>Global survival rate.....</i>	83
23	<i>Reaction to intra venous injection of arteriographic contrast media.....</i>	107
24	<i>Complications and treatment of contrast media.....</i>	112
25	<i>CMMR in literature.....</i>	132
26	<i>Results of systematic use of shunt.....</i>	137
27	<i>Results without use of shunt.....</i>	138
28	<i>Residual pressure measurement with and without shunt.....</i>	140
29	<i>Results according type of anesthesia.....</i>	143
30	<i>Comparative tables of neurologic complications in literature.....</i>	147

LIST OF FIGURES

No	Designation	Page
1	<i>Intervention of DE CARREA</i>	6
2	<i>Intervention of DEBAKEY</i>	7
3	<i>Intervention of EASTCOTT</i>	8
4	<i>Arteries of cerebral destination</i>	10
5	<i>Different level of carotid bifurcation</i>	11
6	<i>Internal and external carotid arteries</i>	12
7	<i>Circle of WILLIS and branches</i>	14
8	<i>Circle of WILLIS at the esthmoidal level</i>	15
9	<i>Different forms of the circle of WILLIS</i>	16
10	<i>Patient position in carotid operation</i>	35
11	<i>Lines of incision a) and b)</i>	36
12	<i>Exposure before ligation of the common facial vein</i>	37
13	<i>Exposure of the carotid arteries</i>	38
14	<i>Residual pressure measurement</i>	40
15	<i>Fixation of the distal end of carotid plaque</i>	41
16	<i>Endarterectomy by eversion</i>	42
17	<i>Endarterectomy with patch</i>	43
18	<i>Carotid bypass</i>	44
19	<i>Arterial closure</i>	45
20	<i>Steps of shunt placement</i>	46
21	<i>Carotid angioplasty (rteriography)</i>	48
22	<i>Stenosis of left internal carotid artery (Arteriography)</i>	105
23	<i>Ischemic lesion on CT scan secondary to internal carotid artery stenosis</i>	114
24	<i>Three dimensional morphometry</i>	115
25	<i>Helicoidal scan (Spiral scan)</i>	115
26	<i>Different methods of measurements of carotid stenosis</i>	122

LIST OF CURVES

AND GRAPHICS

Nº	Designation	Page
1	<i>Survival free from stroke.....</i>	30
2	<i>Age histogram.....</i>	56
3	<i>Global survival rate.....</i>	82
4	<i>Causes of mortality.....</i>	84
5	<i>Survival of coronary patients.....</i>	85
6	<i>Survival of arteritic patients.....</i>	85
7	<i>Survival according to neurologic staging.....</i>	86
8	<i>Survival according to CT scan results.....</i>	87
9	<i>Survival of patients with controlateral carotid thrombosis.....</i>	88
10	<i>Survival of hypertensive patients.....</i>	88
11	<i>Global neurologic events.....</i>	90
12	<i>Indemnity from constituted CVA.....</i>	92
13	<i>Indemnity from neurologic complications of the operated side...</i>	91
14	<i>CMMR for homolateral and controlateral neurologic event.....</i>	93
15	<i>Long term permeability of the operated carotid by duplex.....</i>	95

