Management of Failed Infrainguinal Arterial Bypass Surgery

Thesis submitted for the partial fulfillment of M.D. in Vascular surgery

By

Khaled Abdel Sattar El-Dieb
M.B., B. CH., M.Sc, General surgery
Under the supervision of

Prof. Dr. Wagih Fawzy Abd El-Malek
Professor of general and vascular surgery
Faculty of medicine
Ain Shams University

Prof. Dr. Atef Abd El-Hameed Desouki
Assistant Professor of general and vascular surgery
Faculty of medicine
Ain Shams University

Dr. Mohamed Abd El-Monaem Rizk
Lecturer of general and vascular surgery
Faculty of medicine
Ain Shams University

Dr. Mohamed Ismail Mohamed
Lecturer of general and vascular surgery
Faculty of medicine
Ain Shams University

Ain Shams University
2016

Acknowledgement

*First and foremost, thanks to **Allah** for giving me the will and patience to finish this work.*

*In a few grateful words, I would like to express my deepest gratitude and appreciation to **Prof. Dr. Wagih Fawzy** and **Prof. Dr. Atef Abd El-Hameed** for their concern and generous help. Without their help, this work would have not seen the light.*

*I am sincerely grateful to **Dr. Mohamed Rizk** and **Dr. Mohamed Ismail** for their help and constructive suggestions assistance and guidance to achieve this work.*

*Lastly, there are no words to express my gratefulness to my **family** who charges me with love and encouragement.*

Khaled Abd El Sattar El Dieb

Table of Contents

List of Abbreviations

ABI	: ankle-brachial index
ACAT	: acetyl-coenzyme A acetyltransferase
ACCP	: American College of Chest Physicians
ADP	: adenosine diphosphate
AHA	: American heart association
AI	: acute ischemia
AKA	: above knee amputation
AKFP	: above knee femoro-popliteal
AS	: athersclerosis
ASA	: acetyl-salicylic acid
ASA	: American society of anesthesiologists
ATA	: anterior tibial artery
BKFP	: below knee femoro-popliteal
B-mode	: brightness mode
CDT	: Catheter-Directed Thrombolysis
CFA	: common femoral artery
CFV	: common femoral vein
CLI	: critical lower limb ischemia
cm.	: centimeter
CTA	: computerized tomographic angiography
DA	: duplex angiography
DCB	: drug-coated balloon
DFA	: deep femoral artery
DUS	: duplex ultrasound
EC	: endothelial cells
ECM	: Extracellular matrix
EIA	: external iliac artery

ePTFE	: expanded polytetrafluoroethylene
FV	: superficial femoral vein
GSV	: great saphenous vein
HDL	: high density lipoproteins
HMG-CoA	: 3-hydroxy-3-methyl-glutaryl-coenzyme A
hr.	: hour
ICU	: intensive care unit
IEL	: internal elastic lamina
IH	: Intimal Hyperplasia
INR	: international normalized ratio
ITU	: intensive treatment unit
LDL	: low-density lipoproteins
MCP-1	: monocyte chemotactic protein-1
MI	: myocardial infarction
MIF	: migration inhibitor factor
ml.	: milliliter
mm.	: millimeter
MRA	: magnetic resonance angiography
MRI	: magnetic resonance imaging
NATALI	: United Kingdom National Audit for Thrombolysis in Acute Limb Ischemia
Ox-LDL	: oxidatively modified low-density lipoprotein
PA	: popliteal artery
PDGF	: platelet derived growth factor
PFA	: profunda femoris artery
PMNs	: polymorph nuclear monocytes
PSV	: peak systolic velocity
PT	: prothrombin time
PTA	: posterior tibial artery

PTT : partial thromboplastin time
PVR : peripheral vascular resistance
rt-PA : recombinant tissue plasminogen activator
SFA : superficial femoral artery
SFJ : saphenofemoral junction
SMC : smooth muscle cell
SMC-CF : smooth muscle cell colony stimulating factor
SRA : scavenger receptor type A
SREBP : sterol regulatory element binding pathway
TGF : tumor growth factor
TOF : time-of-flight
TPT : tibio-peroneal trunk
VKOR : Vitamin K epoxide reductase
VLDL : very low-density lipoprotein
Vr : velocity ratio
VSMCs : vascular smooth muscle cells
WHO : World Health Organization

List of tables

List of Figures

INTRODUCTION & AIM OF THE WORK

Introduction

Infrainguinal arterial bypass is defined as any major arterial reconstruction using a bypass conduit, either autogenous or prosthetic, that originates at or below the inguinal ligament. Inflow sites therefore include common femoral artery, superficial femoral artery, popliteal or tibial arteries and the outflow sites include superficial femoral artery, popliteal or tibial or pedal arteries **(*Nguyen et al., 2004)***.

In the past two decades, advance in endovascular equipment and techniques resulted in decline of surgical limb bypass. However, open surgical repair remains the gold standard for long or multilevel advanced atherosclerotic disease **(*Avino et al., 1999)***.

Graft failure is the most challenging complication of infrainguinal arterial bypass surgery that affects patient's morbidity and mortality, limb salvage, and tests the competence and experience of the surgeon **(*Landry et al., 2002)***.

There are three distinct temporal phases of failure: *Early graft occlusion* (less than 30 days postoperative), occurs in 5-20% of cases, generally ascribed to technical problems (e.g. small vein diameter, pre-existing vein pathology, retained valves). *Midterm failure* (from 1 to 24 months postoperative) and *long term failure* (more than 2 years postoperative) most commonly ascribed to development of intimal hyperplasia and progression of atherosclerotic disease (either proximally or distally) in native arterial tree **(*Nguyen et al., 2006)***.

Reporting standards have recommended defining bypass graft endpoints into three categories: primary patency, primary-assisted patency and secondary patency. *Primary patency* is defined as continued full conduit patency with no intervention directly performed on the conduit. *Primary assisted patency* is defined as failing of conduit (with no occlusion) that is maintained by any prophylactic intervention as balloon angioplasty. *Secondary patency* is defined as the time

interval between initial arterial reconstruction and conduit occlusion **(*Rutherford et al., 1997)***.

Causes of graft failure are multifactorial, and involve patient demographics, risk factors, co-morbidities, and technical factors. It was concluded from previous studies that in cases of infragenicular bypass graft failure occurring one year postoperatively; 50% of patients undergone major amputations, 25% develop ischemic rest pain and ulcerations and 15% eventually died **(*Singh et al., 2008)***.

However, graft patency and limb salvage have been improving over the past two decades, especially for patients with critical lower limb ischemia facing major amputation. Thanks to continued progress in surgical and endovascular approaches and equipment along with pharmacological advancements **(*Belkin et al., 2000)***.

Concomitant management of this specific outcome includes various surgical and endovascular options as thrombectomy of graft, patch angioplasty for stenotic areas, angioplasty with balloon dilatation and stenting (for inflow or outflow arterial tree or conduit), and recently using catheter directed thrombolytic therapy, or combinations of more than one procedure **(*Berceli, 2009)***.

Aim of the work

The aim of this study is to discuss the common risk factors for infrainguinal bypass occlusion and the management of graft failure by either operative or endovascular procedures or combined, determining which harbors the best outcome.

SURGICAL EXPOSURE OF LOWER LIMB VESSELS

Surgical anatomy of femoral region:

The common femoral artery is the principal channel supplying blood to the lower extremity ***(Beirne C et al., 2008)*.**

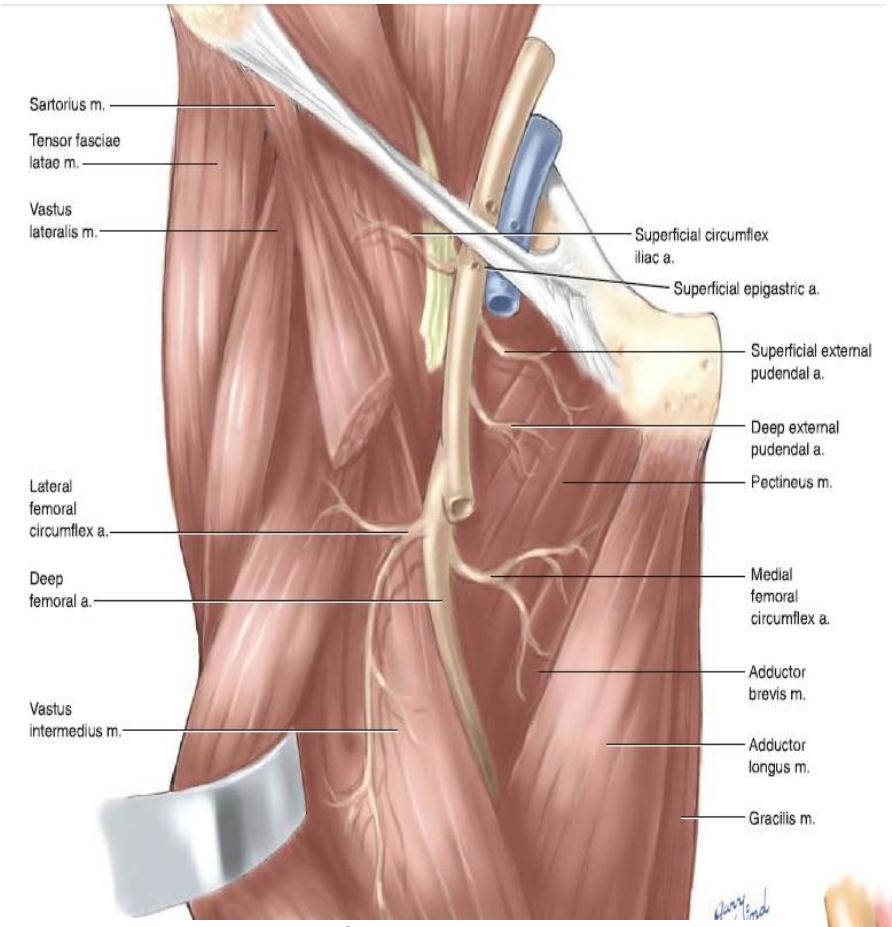

Figure (1): Boundaries of the femoral triangle *(source: Anatomic exposure in vascular surgery, p.390)*

Inside the abdominal wall, the external iliac artery gives two small branches that run in a plane between the transversalis fascia and peritoneum; the inferior epigastric artery and deep circumflex iliac artery ***(Beirne C et***

In approximately 30% of the population have an obturator artery that arises from inferior epigastric artery rather than internal iliac artery. This aberrant vessel descends across the pectinate line adjacent to lacunar

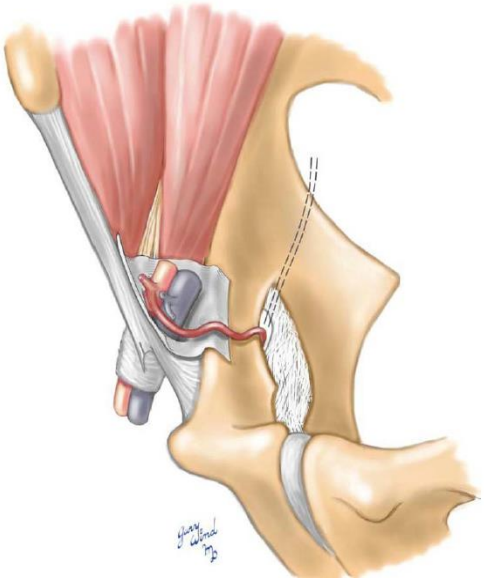

Figure (2): Anatomy of the CFA, CFV and obturator artery *(source: Anatomic exposure in vascular surgery, p.399)*

ligament (in only 3% of patients) that can be injured during graft tunneling at this position ***(Baril DT et al., 2010)***.

The boundary mark between the external iliac artery and common femoral artery is the inguinal ligament. The artery lies just medial to midpoint of inguinal ligament (between the anterior superior iliac spine and pubic tubercle). The femoral vasculature is bounded laterally by iliopsoas muscles, medially by reflected fibers of inguinal ligament (forming the lacunar ligament) and posteriorly by superior pubic ramus ***(Beirne C et al., 2008)*.**

The proximal femoral artery and vein are wrapped by a fibrous covering called the femoral sheath ***(Beirne C et al., 2008)***.

The course of the vessels in the proximal third of the thigh lies within another triangular space defined by muscular boundaries (Scarpa's triangle). The lateral margin of the triangle is formed by the Sartorius muscle, the medial margin by adductor longus, and the cephalad base of triangle by the inguinal ligament **(*Beirne C et al., 2008)***.

The fascia lata forms the anterior roof over the femoral triangle and attaches to the inguinal ligament. It is breached by an oval opening (fossa ovalis) through which lymphatics and great saphenous vein pass. The fossa ovalis is covered by the cribriform fascia, which supports one of the two groups of superficial subinguinal lymph nodes. The more cephalad group of nodes lies parallel to inguinal ligament. These nodes are in the path of the anterior exposure procedure of femoral vessels, and the rich plexus of lymphatics surrounding the nodes increases the risk of postoperative lymphocele in that area. The latter can be overcome by making the longitudinal incision over CFA just lateral to the pulse or by making a C-shaped incision lateral to the pulse, raising a flap of skin and subcutaneous fat and lymphatics over the vessel **(*Beirne C et al., 2008)***.

The superficial branches of the CFA arise just distal to the inguinal ligament and penetrate both the femoral sheath and fascia lata to reach the subcutaneous tissue of the lower abdomen and upper thigh. These branches are superficial