GRAFT FAILURE FOLLOWING CORONARY ARTERY BYPASS GRAFTING

Essay

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By

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Amr Mohammed Awad El-Shahawy

Dedication

This work is dedicated to . . .

My beloved father, to whom I owe everything I ever did in my life and will achieve and making me the man, I am now.

My mother for always being there for me

My sisters for their support

Finally my wife Dr. Marwa Erfan and my lovely sons (Adham & Marwan) for being the light of my life

List of Contents

List of Tables

Table No.	Title	Page No.

List of Figures

List of Figures (Cont...)

List of Abbreviations

Abb.	Full term
ACC/AHA	*America College of Cardiology/American Heart Association*
ACS	*Acute coronary syndrome*
BA	*Balloon angioplasty*
BFGF	*Basic fibroblast growth factor*
BMS	*Bare metal stent*
Ca++	*Calcium*
CABG	*Coronary artery bypass grafting*
CKMB	*Creatinine Kinase Myocardial Band*
DES	*Drug elutent stent*
DM	*Diabetes mellitus*
EF	*Ejection fraction*
EKG	*Electrocardiogram*
eSVS	*External saphenous vein graft support*
FFR	*Fractional flow reserve*
GEA	*Gastroepiploic artery*
GSV	*Greater saphenous vein*
HDL	*High density lipoprotein*
HDLC	*High density lipoprotein cholesterol*
ICA	*Intercostals artery*
IEA	*Inferior epigastric artery*
IMA	*Internal mammary artery*
LAD	*Left anterior descending*
LCOS	*Low cardiac output syndrome*
LCX	*Left Circumflex artery*
LDL	*Low density lipoprotein*
LITA	*Left internal thoracic artery*
LSV	*Lesser saphenous vein*

List of Abbreviations (Cont...)

Abb.	Full term
LV	*Left ventricle*
MI	*Myocardial infarction*
NO	*Nitric oxide*
OM	*Obtuse marginal*
PCI	*Percutaneous coronary intervention*
PDA	*Posterior descending artery*
PDGF	*Platelet derived growth factor*
PTFE	*Poly tetra fluoroethylene*
RA	*Radial artery*
RCA	*Right coronary artery*
RCT	*Randomised controlled trial*
RGEA	*Right gastroepiploic artery*
RIMA	*Right internal mammary artery*
SES	*Sirolimus eluting stent*
SMC	*Smooth muscle cells*
SOS	*Stenting of saphenous vein grafts*
SVG	*Saphenous vein graft*
TIMI	*Thrombolysis In myocardial infarction*
TPA	*Tissue plasminogen activator*
VCAM-l	*Vascular cell adhesion molecule-1*

INTRODUCTION

History of surgical revascularization

Alexis Carrel remarked in (1910), I attempted to perform an indirect anastomosis between descending aorta and the left coronary artery. It was for many reasons a difficult operation. On account of the continuous motion of the heart; it was not easy to dissect and to suture the artery; in one case; I implanted one end of a long carotid artery; preserved in a cold storage; on the descending aorta; the other end was passed through the pericardium and anastomosed to the pericardial end of the coronary near the pulmonary artery; unfortunately the operation was too slow. Three minutes after the interruption of the circulation fibrillary contractions appeared; but the anastomosis took five minutes by massage of heart; the dog was kept alive but he died less than two hours afterwards. It shows that the anastomosis must be done in less than three minutes ***(Carrel, 1910).***

In 1930; Claude Beck; a Cleveland Surgeon; developed methods to indirectly revascularize the hearts of animals by attaching adjacent tissues in hopes of forming collateral blood flow to ischemic myocardium ***(Beck, 1936).*** These tissues included pericardium; pericardial fat; pectoralis muscle and omentum.

Post-mortem examination showed that anastomotic vessels did develop between these tissues and the myocardium.

Arthur Vineberg; a Canadian Surgeon; in 1946 reported implanting the internal mammary artery (IMA) through a tunnel in the myocardium; but he did not actually anastomose the left internal mammary to coronary artery. He showed in animals that communications developed between the internal mammary and the coronary arteries ***(Mehta & Khan, 2002).*** Contemporary surgeons; however; remained skeptical; but Mason Sones validated Vineberg's concept by demonstrating communications between the graft in the myocardium and the coronary system by angiography in two patients operated on 5 and 6 years earlier. In the middle of 1960s; the Vineberg operation with many variations was performed in many institutions in the United States and Canada.

Selective coronary angiography was developed by Sones and Shirey at the Cleveland Clinic and reported in their 1962 classic paper entitled; "Cine coronary arteriography"; they used a catheter to inject contrast material directly into the coronary artery ostia; this technique gave a major impetus to direct revascularization of obstructed coronary arteries ***(Sones & Shirey, 1962).***

From 1960 to 1967; several sporadic instance of coronary grafting were reported; all were isolated cases and for uncertain reasons were not reproduced.

The major breakthrough in surgery, however, was the invention of the heart-lung machine in 1953, which allowed surgeons to perform open-heart procedures on a non-beating heart and controlled operating field while protecting other vital organs ***(Gibbon, 1978)***.

Still it was not until 1960 when the first successful human coronary artery bypass surgery was performed by Goetz and Rohman, who used the IMA as the donor vessel for anastomosis to the right coronary artery ***(Haller & Olearchyk, 2002).*** The bypass graft technique as we know today was developed by ***Favaloro et al. (1971).*** In his physiologic approach in the surgical management of coronary artery disease, Favaloro and his team initially used a saphenous vein autograft to bypass a stenosis of the right coronary artery. Shortly hereafter, Favaloro began to use the saphenous vein as a bypassing conduit. After the saphenous vein bypass procedure was extended to include the left arterial system by Johnson ***(Johnson et al., 1969),*** the use of the IMA for bypass grafting was performed by Bailey and Hirose in 1968 ***(Bailey & Hirose, 1968).*** Arguably, the first successful IMA– coronary artery anastomosis was already performed 4 years earlier by the Russian surgeon Vasilii Kolessov (Figure 1) ***(Kolessov, 1967).***

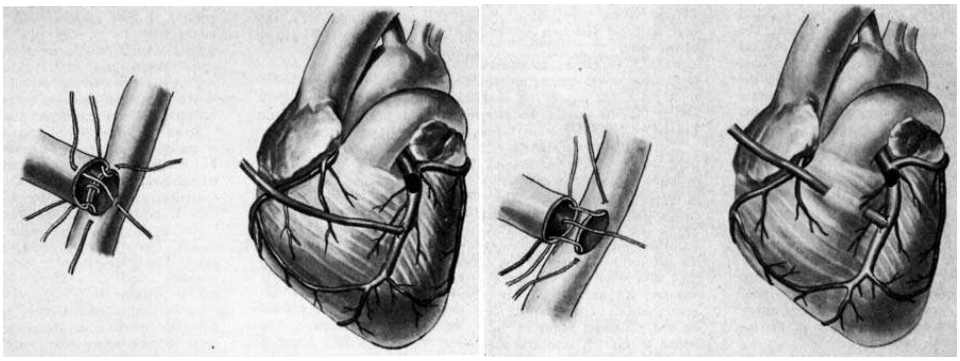

Figure (1): Kolessov's anastomotic technique ***(Kolessov, 1967).***

Use of the radial artery (RA) as a bypass conduit was introduced by Carpentier in 1971 and fell into disrepute shortly after its introduction because of high failure rates but was revisited as many of these original grafts appeared widely patent at 6 years ***(Acar et al., 1992).*** Initially used as a free graft in a fashion similar to that of the saphenous vein graft, more recently the RA has been used as a T or Y graft from the left IMA (LIMA) or an extension graft from the distal right IMA (RIMA).

On the basis of superior long-term outcomes of arterial conduits compared with vein grafts, other arteries have been used in CABG such as the gastroepiploic artery (GEA), the inferior epigastric artery (IEA), the splenic artery, the subscapular artery, the inferior mesenteric artery, the descending branch of the lateral femoral circumflex artery, and the ulnar artery (Table 1)(Figure 2). However none of these arteries have shown similar patency rates as the internal mammary artery ***(Boehm et al., 1999).***

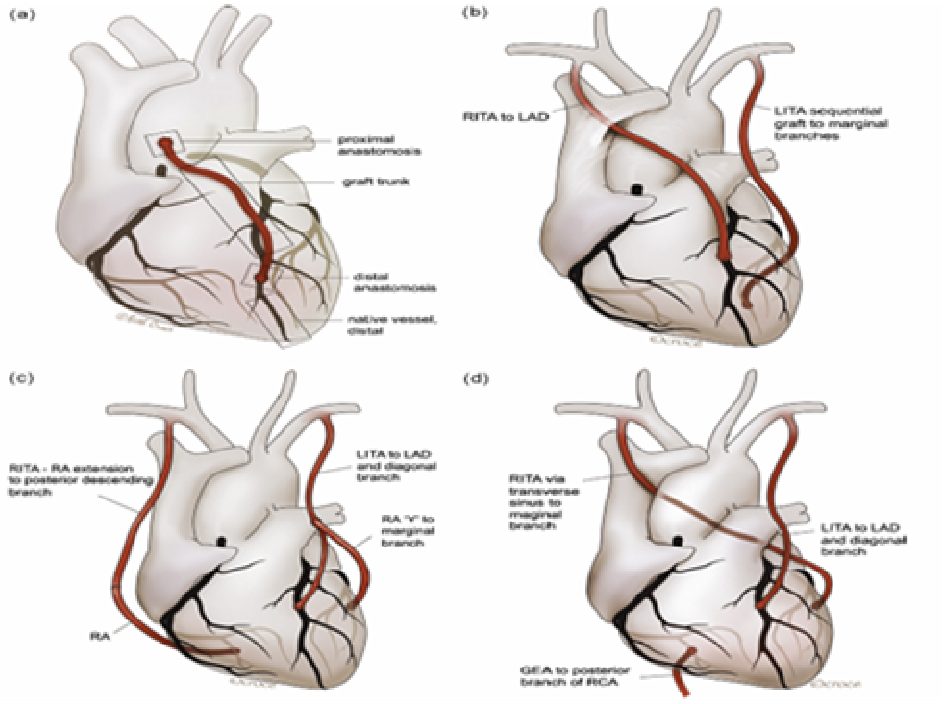

Figure (2): Different Conduits used in CABG ***(Boehm et al., 1999).***