THE ROLE OF COLOR DUPLEX SONOGRAPHY IN PRE-INTERVENTIONAL ASSESSMENT AND DUPLEX GUIDED PROCEDURES IN CASES OF DIABETIC FOOT WITH LOWER LIMB ARTERIAL DISEASES

Thesis

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PRESENTED BY
Rana Youssef Ibrahim
M.B.B.Ch, Cairo University

SUPERVISORS

Prof. Dr. Khaled Helmy El-Kaffas, MD
Assisstant Professor of Radiodiagnosis
Faculty of Medicine
Cairo University

Dr. Abo El Magd Mohamed El Bohy, MD
Lecturer of Radiodiagnosis
Faculty of Medicine
Cairo University

Prof. Dr. Ahmed Gamal El-Din Mahmoud, MD
Assisstant Professor of Vascular Surgery
Faculty of Medicine
Cairo University

Faculty of Medicine
Cairo University
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List of abbreviations :

ABPI	Ankle brachial pressure index
APSV	Ankle peak systolic velocity
ATA	Anterior tibial artery
CFA	Common femoral artery
CRI	Chronic renal impairment
CT	Computed tomography
CTA	Computed tomography angiography
DGBA	Duplex guided balloon angioplasty
DSA	Digital subtraction angiography
DUAM	Duplex ultrasound arterial mapping
Fr	French
GW	Guide wire
GE	General electric
MHz	Mega Hertz
MR	Magnetic resonance
MRA	Magnetic resonance angiography
PAD	Peripheral arterial disease
PAVF	Popliteal average volume flow
Pop	Popliteal
PRF	Pulse repetition frequency
PSV	Peak systolic velocity
PSVR	Peak systolic velocity ratio
PTA	Posterior tibial artery
PW	Pulsed wave
SFA	Superficial femoral artery
TASC	Trans-Atlantic Society Consensus
US	Ultrasound

ABSTRACT

Abstract

Color duplex ultrasonography has increasing role as pre-interventional imaging as well as a guiding modality to angioplasty procedures of lower limbs' arterial diseases in diabetic foot patients.

Objective :

The aim in this study is to assess the role of color duplex in diagnosis of lower limb arterial diseases and to compare color duplex with conventional fluoroscopy in guiding interventional procedures.

Methods :

This study included 30 patients (70% males and 30% females) aged 47 - 68 years (mean 57.13 +/- 5.48 SD). All are diabetic, 70% hypertensive, 46.7% cardiac, 30% with renal impairment, 46.7% smokers and 20% with contrast allergy. All patients were symptomatizing; 23 with claudication, 7 with rest pain, 4 with ischemic ulcers and 3 with gangrene. All of the 30 patients had preinterventional duplex; fifteen of them had fluoroscopic-guided angioplasty (group I) and the other fifteen patients had duplex-guided angioplasty (group II).

The 30 patients had femoropopliteal angioplasty, six of them proceeded to infrapopliteal angioplasty to improve the distal run-off; three of them were in group I and three in group II. Statistical analyses of the results using the statistical package SPSS version 21. Data was summarized using mean and standard deviation, in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Comparisons between quantitative variables were done using the unpaired t-test. For comparing categorical data, Chi square test was performed. Exact test was used instead when the expected frequency is less than 5. P-values less than 0.05 were considered as statistically significant.

Results :

The overall technical success was 93.3% (28/30 cases). Failure was found in one case for each group. Duplex guided angioplasty was the safest modality for patients with renal impairment and contrast allergy. The rate of complications was less in group II. These complications were more in fluoroscopy guided angioplasty group, such as thrombosis/embolism in one case, one case with gross hematoma and another with pseudoaneurysm. The data found at the preinterventional duplex was matching to the operative data found in the fluoroscopy guided angioplasty in 93% of cases.

Conclusion :

Color duplex ultrasonography is as effective as fluoroscopy in guiding the intervention procedures, with less rate of complications. Duplex guided angioplasty was the safest available modality for patients with renal impairment and contrast allergy. We recommend color duplex sonography as the preferable method for guiding intervention procedures.

Key words :

Pre-interventional color duplex, duplex guided angioplasty, diabetic foot.

Introduction

Diabetes mellitus is a metabolic disorder characterized by hyperglycemia and dyslipidemia. The abnormalities in nutrient metabolism and vascularity resulting from diabetes lead to infection, foot ulcers and impairment of wound healing. Diabetic lower limb ischemia often leads to limb necrosis. Lower extremity intervention is indicated to prevent limb loss in patients with critical leg ischemia ***(Tsai et al., 2009).***

Color duplex ultrasound is a widely available non-invasive, cheap and accurate diagnostic technique without the hazards of ionizing radiation and without the complications of contrast media. ***(Ekberg et al., 2008).***

Over the last three decades, duplex ultrasonography has established itself as a fundamental component of diagnostic evaluation and management of arterial disease. The maturation of duplex technology now includes instrumentation which provides comprehensive anatomic and hemodynamic information capable of defining both normal and critical arterial conditions. By combining high-resolution grey-scale imaging with real-time pulsed Doppler spectral analysis, color Doppler, power Doppler or B-flow imaging. It can provide critical information relevant to blood flow characteristics, plaque morphology and vascular anatomy. The examination is adaptable for use in both, the outpatient and inpatient setting including use inside the operating and endovascular suites. Duplex technology is equally suitable for directing both endovascular interventions and open surgical revascularization, permitting not only the identification of disease but also its response to intervention ***(Armstrong et al., 2013).***

The conventional balloon angioplasty of infrainguinal arteries requires the use of fluoroscopy and injection of contrast material. Balloon angioplasty under duplex guidance makes it possible to avoid the nephrotoxic effect of contrast and eliminate or minimize radiation exposure. Duplex-guided balloon angioplasty and stent placement is a safe and effective technique for the treatment of femoral-popliteal and infrapopliteal arterial occlusive disease ***(Ascher et al., 2010).***

Anatomy

Arterial flow to the lower limbs comes from the abdominal aorta, which gives the iliac systems. The surface anatomy will be discussed due to its great importance in the examination of lower limb arterial system.

The abdominal aorta:

The abdominal aorta **(Fig. 1)** begins at the aortic hiatus of the diaphragm in front of the lower border of the body of the last thoracic vertebra, it descends in front of the vertebral column. It ends on the body of the fourth lumbar vertebra, commonly a little to the left of the midline by dividing into the two common iliac arteries. It diminishes rapidly in size, in consequence of the many branches which it gives of ***(Standring et al., 2005).***

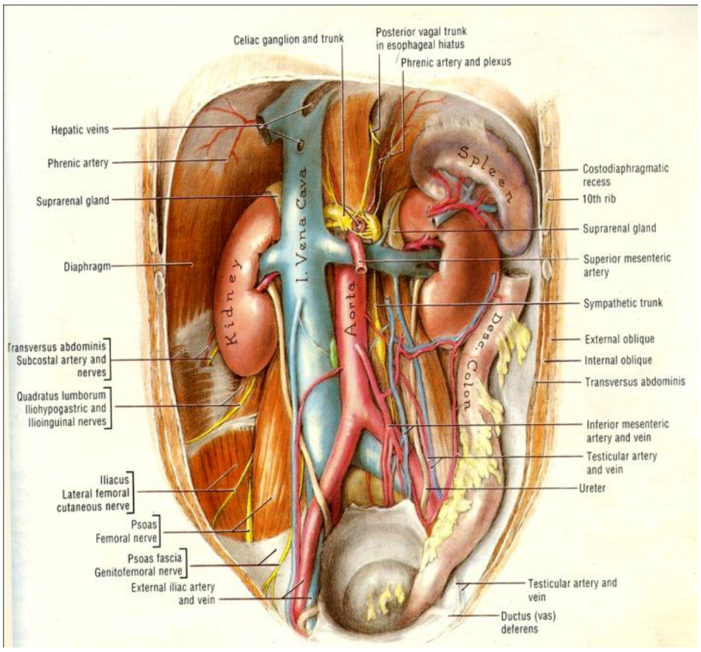

Fig. (1): Anatomy of abdominal aorta (Agur and Lee, 2005)

Branches:

The branches of the abdominal aorta may be divided in to three sets: visceral, parietal, and terminal **(Table 1)**

Visceral branches	Parietal branches
Celiac	Inferior phrenic
Superior Mesenteric	Lumbar
Inferior Mesenteric	Middle sacral
Middle Suprarenals	
Renals	
Internal Spermatics	**Terminal branches**
Ovarian (in the females)	Common iliacs

Standring et al., (2005)

Surface anatomy of the abdominal aorta:

It is represented by vertical band about 2 cm wide from a median plane, extending from 2.5 cm above the transpyloric plane, down to about 1 cm below and to the left of the umbilicus ***(Williams et al., 1992).***

The common, the external and the internal iliac arteries:

The common iliac arteries:

The abdominal aorta divides on the left side of the fourth lumbar vertebra into the two common iliac arteries, (**Fig. 2)** each is about 5 cm in length. They diverge from the termination of the aorta, passes downwards and lateralward and divide opposite the intervertebral fibrocartilages between the last lumbar vertebra and the sacrum into the two branches, the external iliac and the hypogastric arteries, the former supplies the lower extremity while the latter supplies the viscera and pelvis ***(Standring et al., 2005).***

External and internal iliac (the hypogastric) arteries:

The external iliac artery (fig. 2):

Is larger than the internal iliac and passes obliquely downward and lateralward along the medial border of the psoas major from the bifurcation of the common iliac to a point beneath the inguinal ligament midway between the anterior superior iliac spine and the pubic tubercle where it enters the thigh and becomes the femoral artery ***(Williams et al,. 1992).***

The internal iliac artery (hypogastric artery) (fig. 2):

Supplies the walls and viscera of the pelvis, the buttocks, the genital organs and the medial side of the thigh. It is shorter & smaller than the external iliac artery and it is about 4 cm long. It arises at the bifurcation of the common iliac opposite the lumbosacral articulation and passing downwards to the upper margin of the greater sciatic