Accuracy of Duplex Scan in the Management of Chronic Leg Ischemia

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Abstract

Arteriography is considered to be the standard investigation for peripheral arterial diseases. It gives an accurate anatomical description of obstructive arterial lesions. However, it does not estimate the haemodynamic significance of such lesions. Recently, advances in duplex scan have raised the possibility that it could replace arteriography as the primary imaging modality for assessment of limb ischemia.

Aim: To look into the place of duplex scanning compared with arteriography in diagnosis of stenosis and occlusion in the peripheral arterial tree and to compare the management plan made on the basis of duplex scanning with that made on the basis of arteriography.

Patients and Methods: Fifty one legs of 44 patients were studied prospectively. They were presented to the Vascular division in KKUH between August 2001 to February 2003. Arteriography and duplex scanning was performed for each patient. Seven arterial segments were studied in each leg by measuring the peak systolic velocity at the arterial lesion. The data of duplex scanning were compared with arteriography performed which was used as the gold standard.

Results: In comparison with arteriography, sensitivity, specificity and accuracy of duplex scanning to assess obstructive arterial lesions was 93.5%, 97.6% and 94.9% respectively. Concerning the management plan, accuracy of decision making based on duplex scanning (94%) correlated wall with that based on arteriography (100%).

Conclusion: Duplex scanning, in comparison to arteriography is non-invasive investigation for rectifying obstructive arterial lesions, with high sensitivity and specificity. A sound decision could be made according to the results of duplex scanning.

INTRODUCTION

The development of duplex scanning has a significant impact on vascular surgical practice. It has become the first line of investigation for patient with symptomatic carotid artery disease[1] and clinically suspected acute deep vein thrombosis.[2,3]

However, duplex scanning has not found widespread acceptance in the diagnosis of lower limb arterial disease perhaps because most studies have focused on the capability of duplex to draw a precise arterial map, for this objectives cumbersome and time consuming.[4] Recent studies[5,6,7,8] have shown that duplex scan finding correlate well with the results of arteriography. Some reports,[9,10] have addressed the issue of patient management based primarily on duplex scanning. Our prospective study aimed to: 1) look into the accuracy of duplex scanning compared with arteriography in identifying and estimating the obstructive arterial lesions in lower limbs;[8] 2) compare the accuracy of duplex and arteriography for the planning of lower limb revascularization.

PATIENTS AND METHODS

Fifty one limbs of 44 patients (29 men and 15 women, mean age, 54.9 years) with chronic limb ischemia were studied between August 2001 and February 2003 at Vascular Laboratory of King Khalid University Hospital, Riyadh, Saudi Arabia. Duplex scanning were performed by one of

the three Vascular technologists using an ATL 5000 duplex scanner. Seven arterial segments were studied in every leg (iliac, common femoral, superficial femoral, popliteal above knee, popliteal below knee and anterior and posterior tibial arteries). Iliac segments were studied by 4 MHz probe while infrainguinal ones with 7 MHz probe.

Arterial lesions were located by changes in color flow patterns, changes in vessel diameter (on B-mode) and broadening of the doppler spectrum, whereas stenosis were quantified by measuring the peak systolic velocity (PSV) across a lesion. A PSV ratio greater than 2 was considered to define a significant stenosis. Vessels were considered to be occluded if no colour flow was detected. The vascular surgery team reviewed the duplex findings and a surgical plan was drawn.

All patients had arteriography within a week of duplex scanning by a radiologist who was unaware of the duplex findings, using the Seldinger technique. Digital subtraction (uniplanner in most and bi-planner when required) was used routinely. Significant stenosis on intraarterial digital subtraction angiography (IADSA) was defined 50-99% reduction of diameter of artery at the site of stenosis compared to the diameter of the nearest normal segment. All IADSA films were reviewed by a consultant radiologist who was unaware of the duplex findings. Both arteriogram findings and treatment plans were made on the basis of arteriogram, which were considered the gold standard ones. The sensitivity and specificity of duplex scanning compared with arteriography in detecting a non significant (less than 50 percent-true positive) and a significant lesion (greater than 50 percent stenosis or occlusion true negative) were calculated.

RESULTS

357 arterial segments in 51 legs were examined in 44 patients. Seven patients had bilateral limb scans. The clinical indications were claudication in 19 limbs, gangrene and ulcer in 21 limbs and rest pain in 11 limbs. Table I demonstrates the distribution of the arterial lesions in a two-way table of duplex and IADSA data. In the iliac region, 25 patent segments (less than 50% stenosis) 23 iliac lesions (more than 50% stenosis or occlusion) were diagnosed by both duplex and arteriography, while 3 lesions (false –ve) were identified only by duplex.

Figure 1

Table 1: Distribution of the arterial lesions diagnosed by Duplex scan and angiography

Duplex Findings	Arteriography		TOTAL
	<50%	50-100%	
Non significant stenosis PSV < 2	216	3	219
Significant stenosis or occlusion PSV > 2.0	15	123	138
TOTAL	331	126	357

PSV : Peak systolic velocity

In femoro-popliteal region, 146 and 51 segments were diagnosed on both modalities as patent segments and arterial lesions respectively. However, one patent segment and 6 arterial lesions were diagnosed only by duplex scan.

At the level of the run-off vessels (tibial arteries) 49 lesions and 45 patent segments were recognized by both IADSA and duplex scanning. On the other hand, 6 lesions and 2 patent segments were identified only by duplex scan. A summary of the overall accuracy of duplex scanning in all segments is shown in table 2.

Figure 2

Table 2: Sensitivity and Specificity of All Arterial Segments

Items	Sensitivity	Specificity
Overall segments	93.5%	97.6%
Iliac region	89.2%	100%
Femoro-popliteal region	95.4%	97.6%
Tibial arteries	88.2%	96%

CLINICAL OUTCOME

15 were managed conservatively (30%), 13 (25%) were referred for PTA and 23 (45%) for surgery (table 3).

Figure 3

Table 3: Type of Surgery in 23 Patients

Femoro-pop A-K bypass	9
Femoro-tibio peroneal bypass	1
Ilio-femoral bypass	1
Ext. ileo-pop	1
Femoro-femoro crossover bypass	1
Aorto-bifemoral bypass	2
A-K amputation	2
B-K amputation	2
Pop-post tibial bypass	1
SFA patch angioplasty	1

A-K : Above knee
B-K : Below knee
SFA : Superficial femoral artery

When surgeon's decision based on IADSA was used as the reference standard, the mean accuracy of duplex scanning for plan management was 94%. Of the management plans made by duplex, 48 decisions were not changed by arteriography. Incorrect surgical plans were in three patients. (Table 4).

Figure 4

Table 4: Management Plan Discrepancy

Items	Duplex	Arteriogram
1	Fem-post tibial bypass	Femoro-tibio peroneal bypass
2	Femoro-popliteal (B-K) bypass	Femoro-popliteal (A-K) bypass
3	SFA-angioplasty	No significant stenosis

B-K Below knee
A-K Above knee
SFA Superficial femoral artery

DISCUSSION

Recently, duplex scanning has reduced the indications for arteriography in the routine assessment of carotid artery disease and bypass graft patency.[1] Some studies[11,12,13] have compared duplex assessment of the lower limb with conventional arteriography, accepting arteriography as the gold standard, and have used PSV ratio to characterize stenosis. A PSV ratio of 2:0 was used in many reports,[6,7,14,15] to discriminate between a lesion with more than 50% and that with less than 50 percent reduction in diameter.

Previously, Kohler et al,[7] reported that duplex scanning had a sensitivity of 82 percent and a specificity of 92 percent, in detailing significant disease but admitted difficulty in detecting lesions distal to critical stenosis or occluded segment. Cossman and Ellison,[6] reported that duplex scanning had sensitivity and specificity of 87% and 99% respectively. Our study showed that duplex scan was able to determine significant disease with an overall sensitivity of 93.5%, specificity of 97.6% positive predictive value of 98.6% and negative predictive value of 89.1%. In iliac region, it was found that only 3 segments were incorrectly diagnosed (as the presence of overlying bowel gas can make identification of iliac pathology difficult). However, this problem can be overcomed by the use of bowel preparation prior to examination.[9] Many studies,[12,11,14] have found that there is good correlation between duplex scan findings and arteriography in iliac segments.

The accuracy for the diagnosis of haemodynamic stenosis and occlusions at femoro-popliteal region in our study was 96.5%. In one segment, duplex scan under estimated and in 6 segments over estimated the severity of disease. Again, good correlation has been reported between duplex scanning and arteriography at femoro-popliteal region.[11]

Few studies[8,16,17] have studied the accuracy of duplex scanning for below knew arterial lesions (an overall sensitivity of 75% and specificity of 95%). In our study, the sentisitivity and specificity of duplex scanning in assessing the infrageniculate arterial lesions was 88.2% and 96% respectively. Sometimes, it is not easy to identify the tibial vessels because of their small caliber and wall calcification.

Management plan can be made depending on duplex scanning alone.[5] Elsman et. al[10] reported in their series of 100 patients that 36 lesions had successful angioplasty and in 62 patients, the management decision could be achieved according to the informations of duplex scanning alone. Our results of management decision support these data with accuracy of 94% when each vascular lesion was used as the reference plan. Some authors have emphasized the need for preoperative angiography in cases of infrapopliteal revascularization.[12,18,19] others have reported good results after aorto iliac[20] and infragenicular[21,22,23] revascularization based solely on duplex scan.

In qualified vascular laboratory, duplex scanning is an accurate procedure for assessing the lower limb arterial obstructive disease. Safe management plan can be made depending on results of duplex scanning without diagnostic arteriography.

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