Pre-bypass Quality Assessment of the Long Saphenous Vein Wall with Ultrasound and Histology

A. D. Giannoukas 1, N. Labropoulos 1, G. Stavridis 1, D. Bailey 1, B. Glenville 2 and A. N. Nicolaides 1

1 Academic Vascular Surgery Unit, 2 Department of Cardiothoracic Surgery and 3 Department of Histopathology, St. Mary’s Hospital Medical School, London, U.K.

Objectives: Pre-existing unsuspected wall changes in saphenous vein grafts have been implicated in the graft outcome. Pre-bypass assessment of the vein may identify grafts at high risk for failure. This study was conducted to evaluate preoperatively the quality of the long saphenous vein (LSV) wall with ultrasound and histology.

Design: Prospective clinical study.

Material and methods: Three particular LSV segments, ankle, knee and mid-thigh, were evaluated preoperatively by ultrasound in 40 limbs of 38 patients, candidates for coronary artery bypass grafting. The venous wall was characterised based on its thickness and echogenicity in three categories: normal, moderately and severely fibrotic. LSV specimens taken from the above sites were also grouped into the same three categories based on their fibrotic content found on histology.

Results: In total, 89 vein specimens were evaluated. On ultrasound, 81 specimens were detected as normal (91%), seven as moderately (8%) and one as severely fibrotic (1%). On histology, only eight specimens were found normal (9%), 75 with moderate (84%) and six with severe fibrosis (7%). Similar wall characterisation with both examinations was found in only 19% (17/89) of the specimens. Eighty-one specimens (91%) had some degree of fibrosis on histology. Different grades of fibrosis were found on histology in different sites of the same vein.

Conclusions: Pre-existing wall changes are very common in vein grafts used for bypass surgery. However, the ultrasonic characterisation of the venous wall preoperatively cannot reliably identify these changes.

Key Words: Vein wall; Vein graft; Ultrasound; Histology.

Introduction

The long saphenous vein (LSV) is the conduit of choice for arterial bypass reconstruction in the lower limb and the most commonly used conduit for coronary artery bypass grafting (CABG). Patency rate of 60-85% in 2-5 years have been reported for infragenicular bypass, 1-3 while in CABG the patency rate varies from 80-90% in 1 year and falls to 40-60% in 10-12 years. 4-7 Technical failures, poor distal runoff, myointimal hyperplasia, and progression of the disease have been considered as factors responsible for graft failure. 8-9 However, unsuspected changes of the venous wall prior to bypass have been found, 10-13 implicating their role in the graft patency rate, 14-16 although others have questioned this link. 17 Detection of pre-existing diseased vein conduits and selection of only those unimpaired vein segments for bypass surgery remains an important issue. New techniques such as duplex scanning, 12,17 angioscopy, 13,14 and intravascular ultrasound 18 are now available along these lines. This study was conducted to evaluate preoperatively the quality of the LSV wall with colour-flow duplex imaging (CFDI), in patients who were candidates for CABG, and to correlate the findings with the histology.

Patients and Methods

The LSV in 40 legs of 38 consecutive patients, candidates for CABG, was examined preoperatively by CFDI (ATL, Ultramark 9, Bothel, U.S.A.) using a 5 MHz scanhead. Thirty-three patients were male and five female, with mean age of 63 years (47-73 years). None of the patients had previously documented deep vein thrombosis or superficial thrombophlebitis. The patients were examined in a standing position. This
position causes distention of the LSV, allowing ultrasonic evaluation of the vein wall thickness under physiological conditions (effect of gravity). Three particular segments of the LSV were evaluated specifically: ankle, knee and mid-thigh. These were the expected sites of LSV division in order to prepare the grafts for CABG, and thus available for histology. The venous wall at the above mentioned sites was classified into three categories—normal, moderately and severely fibrotic—based on the ultrasonic wall thickness and appearance. A thickness up to 0.4 mm was considered normal, 0.41–0.8 mm as moderate and more than 0.8 mm as severe fibrosis. Three measurements were taken at each site and the mean was considered as the wall thickness. Based on the ultrasonic appearance of the venous wall, a normal vein was characterised by a clearly defined intima as a sharp white line with an echolucent area underneath it. Skin marking over the course of the LSV was undertaken preoperatively with a permanent ink marker, matching the sites examined specifically with CFDI (ankle, knee, mid-thigh), in order to aid the harvesting of the appropriate vein segments for histology.

Each specimen was fixed in formalin for at least 24 h before being embedded in paraffin. Elastic van Gieson and haematoxylin/eosin stains were performed on four micron sections cut from each block. The specimens were examined for the presence of any lesion and according to the amount of smooth muscle cell hyperplasia and extracellular matrix found in the vein wall (intima, media), and were subjectively classified into three categories: normal (0), moderate (+) and severe (++) . Both examiners, the ultrasonographer and the histopathologist were blinded. Informed consent was obtained from the patients and approval for this study was obtained by the local ethics committee.

**Results**

All LSVs were clinically evaluated as suitable for grafting. On ultrasonic examination, none were found to be varicose, occluded, or recanalised.

In total, 89 vein specimens were evaluated by both CFDI and histology. These particular vein segments on preoperative ultrasonic examination were classified as: 81 normal (91%), seven moderately (8%) and one severely fibrotic (1%). On histology only eight specimens (9%) were found normal, 75 (84%) were moderately and six (7%) severely fibrotic. Agreement with both examinations as far as the vein wall characterisation is concerned was found in 19% (17/89) of the specimens.

**Discussion**

Numerous studies have shown that changes occur in the saphenous vein grafts after implantation and these have been regarded as acquired, representing their adjustment to the arterial circulation. However, evidence of unsuspected pre-existing venous wall changes in otherwise macroscopically normal saphenous veins prior to bypass has been presented and the morphological similarity of these changes with the intimal hyperplasia seen in vein grafts has led to the hypothesis that they may be related. The presence of these changes may have significance for the outcome.
of the grafts in regard to the development of stenosis or occlusion, and their identification prior to bypass operation would be extremely useful in the selection of the appropriate vein conduits.

Duplex scanning is a useful technique to investigate non-invasively the LSV prior to its use for bypass arterial surgery. Panetta et al. examined with ultrasound and histology the long saphenous vein in 21 patients. It was shown that ultrasound correctly identified unsuspected pre-existing disease (varicose veins, thickened-wall veins, decreased luminal diameter, brightly echogenic walls and partial compressibility) in 62% of the patients. However, it is not clear from their study whether the sites examined by ultrasound were accurately marked in order to match the specimens taken for histology. Our series also revealed a high incidence of histological changes suggesting that it is rather uncommon to find LSV conduits without changes. This might reflect the aged population undergoing coronary and peripheral artery bypass surgery. It has been shown that age-linked changes in the venous wall appear between 50 and 60 years. Furthermore, in contrast to a recent study, in our series specimens from the mid-thigh portion of the LSV were taken, and it was again confirmed that these changes are present throughout the vein as was found in previous studies.

The inevitable limitation in our study, as is usual in similar studies, was that the whole length of the LSV was not available for histological examination, as it had to be used for grafting. Duplex scanning is undoubtedly a useful tool in preoperative evaluation of the LSV. In two recent studies, it has been postulated that the use of duplex scanning in the preoperative identification of pre-existing changes in the LSV prior to its use in bypass surgery is warranted. Although this may be true in order to identify anatomical variations of the LSV to depict an occluded or severely post-thrombotic vein, and to exclude a varicose vein with an unacceptable luminal diameter or a normal vein with very small calibre, our findings showed that duplex scanning failed to identify veins with pre-existing wall changes (moderate or severe fibrosis). This was also found to some extent in Panetta et al.’s study where they failed to identify recanalised veins after thromboembolic disease by duplex ultrasonography prior to bypass surgery. We failed to demonstrate any correlation of the ultrasonic findings with the histological examination as far as the fibrosis of the venous wall is concerned. The resolution of the utilised ultrasonic transducer (5 MHz linear array) and the nature of the investigated wall changes confined to the intima and media might explain some of the reasons for this failure. Higher resolution transducers might possibly give better results. Furthermore, the limits of the venous wall thickness used to characterise the vein wall on ultrasonic examination were arbitrarily selected based on a previous study. Van der Lugt et al., using intravascular ultrasound, found that the thickness of the normal LSV wall was 0.25 mm (range 0.17–0.40). However, there are no other studies in which adequate number of specimens have been taken from different parts of the LSV to define the normal wall thickness at different levels. Thus, it should be acknowledged that the ultrasonic evaluation of the venous wall is a difficult issue based on the criteria currently used. In order to make more accurate ultrasonic definitions more work is needed, i.e. in vitro experiments comparing ultrasound with histology.

Angioscopy may be an alternative in the evaluation of the venous wall. However, in a recent study angioscopy failed to identify thick-walled and varicose vein segments as abnormal because of their normal intimal surface, showing that even this technique, which allows direct visualisation of the venous wall, has considerable drawbacks. Intravascular ultrasound is another modality with potential in identification of pre-existing vein wall changes, but further experience and histological validation of the findings are required.

In conclusion, although duplex scanning is a useful tool in mapping and determining the calibre of the venous conduits prior to bypass surgery, it cannot reliably identify pre-existing fibrotic changes in the vein wall.

Acknowledgments

The authors should like to thank the Cardiovascular Disease Educational and Research Trust for financial support to Dr Athanasios Giannoukas.

References


Eur J Vasc Endovasc Surg Vol 14, July 1997
and late closure of aortocoronary saphenous vein grafts: Sequential angiographic studies at 2 weeks, 1 year, 5 to 7 years and 10 to 12 years after surgery. Circulation 1983; 68 (Suppl. II): 1.


Accepted 23 December 1996