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SHORT REPORT

Underwater Sonography of Leg Veins

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Objectives: Hydrostatic compression (HC) occurring during body immersion is considered beneficial for venous return from the lower limbs. No study has evaluated the effects of HC on the veins of the lower limbs using duplex ultrasound (DU). The purpose of this study was to use DU to evaluate the morphology and flow of the leg veins during immersion.
Design: The femoral and great saphenous veins were evaluated before and during immersion in a specifically built pool, in normal and varicose limbs.
Results: HC reduces vein size in both normal and varicose limbs. During immersion spontaneous flow increases whereas when present, blood reflux decreases.
Discussion: This pilot, proof of concept study has demonstrated the feasibility of DU investigation of leg veins during immersion. Larger series of underwater DU evaluations of normal and varicose legs are necessary to quantify and better explain the effects of HC on the veins of the lower limb.

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INTRODUCTION

Hydrostatic compression (HC) that occurs during immersion in a pool of water has anecdotally been considered beneficial for venous return from the lower limbs.[1] No study has used duplex sonography (DU) to evaluate the effects of HC on the morphology and flow of the veins of the lower limbs.

The aim of this pilot, proof of concept study was to assess the technical feasibility of DU in evaluating vein morphology and flow in subjects standing in a water pool.

TECHNIQUE

Informed consent was obtained from all subjects. The calibres of the femoral (FV) and great saphenous (GSV) veins were evaluated at mid-thigh in 12 normal legs (6 subjects, mean age 54.1 years) while standing beside the pool. The calibre and reflux duration in seven varicose GSVs (6 patients, mean age 51.7 years) were also evaluated at mid-thigh. Reflux was elicited by standardised Valsalva or compression/release manoeuvres.[2] The same evaluations were repeated at the same sites immediately after immersion of both legs in a specifically built pool (water level 110 cm, water temperature 28°C) with one side consisting of tempered crystal glass.[3] This allowed investigators to see the screen of the echotomograph in operation when immersed.

Duplex findings

DU allowed excellent underwater evaluation of both superficial and deep vein morphology and flow. During immersion

- the calibre of the FV (Fig. 1A and B) reduced significantly (median 10.7mm (IQR 10.3–12.1) $>$ 9.8mm (IQR 8.8–11.4; $p = .004$) – the GSV (Fig. 1C and D) showed a significant decrease in calibre (median 5.6mm (IQR 4.7–6.2) $>$ 5mm (IQR 3.9–5.3; $p = .045$))
- spontaneous centripetal flow appeared in both the FV and the GSV (Fig. 1E and F)

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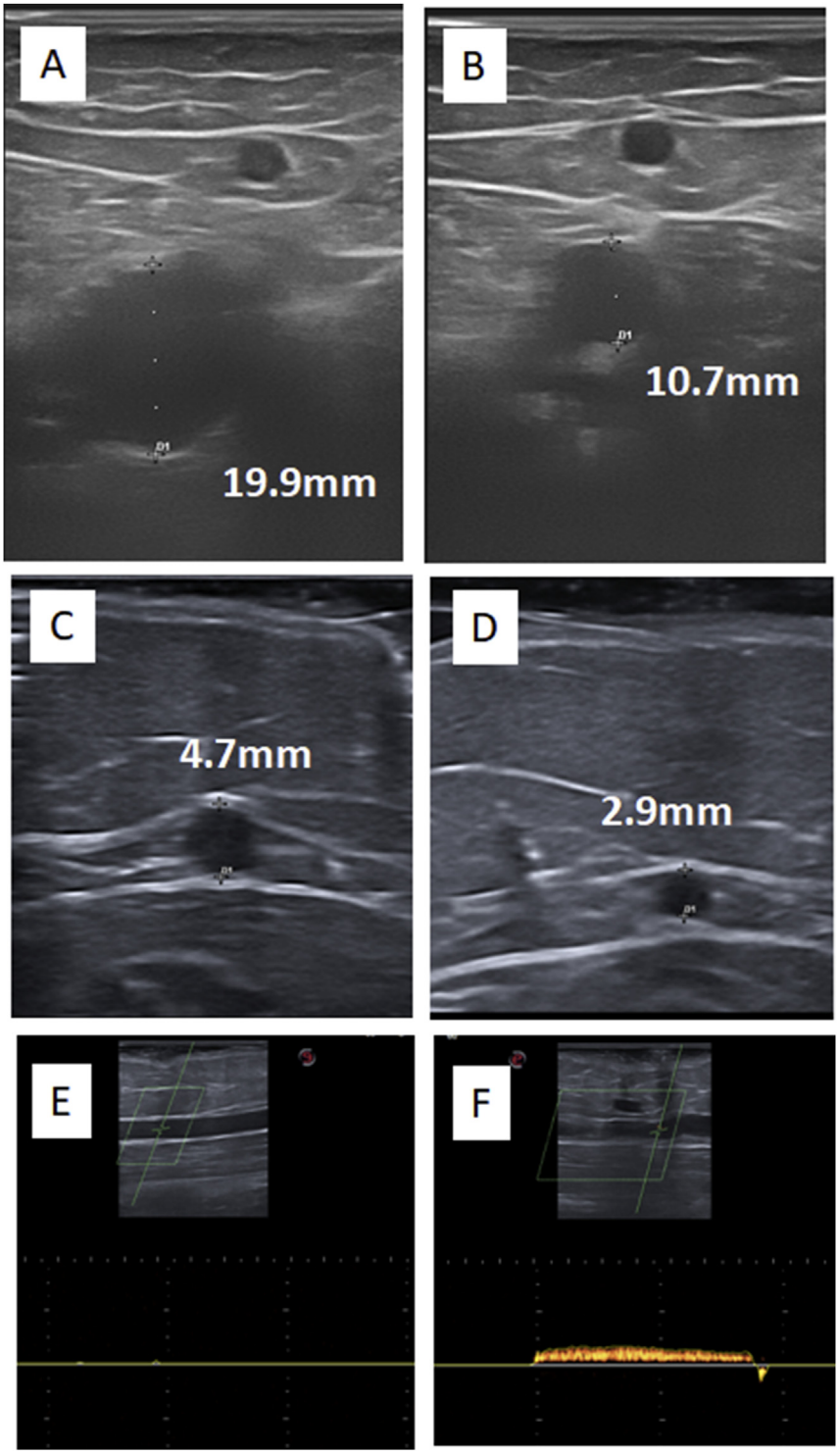

Figure 1. Changes of vein size and flow occurring in normal veins during immersion. Femoral vein out of the pool (A) and during immersion (B). Great saphenous vein out of the pool (C) and during immersion (D). Spontaneous flow in the great saphenous vein in standing position out of the pool (E) and during immersion (F).

- the size of the varicose GSV (Fig. 2A and B) reduced significantly (median 4.9mm (IQR 4.6—5.4) $>$ 4.1mm (IQR 3.7—5.2; $p = .031$))
- reflux in the GSV (Fig. 2C and D) decreased significantly (median 2.3s (IQR 0.85—3.79) $>$ 0.4s (IQR 0.28 $>$ 0.74; $p = .001$))

DISCUSSION

Until now, no study has evaluated the effects of HC on the morphology and haemodynamics of the leg veins. This preliminary proof of concept study is the first to have clearly demonstrated the feasibility of underwater DU and the influence of HC on vein size and flow.

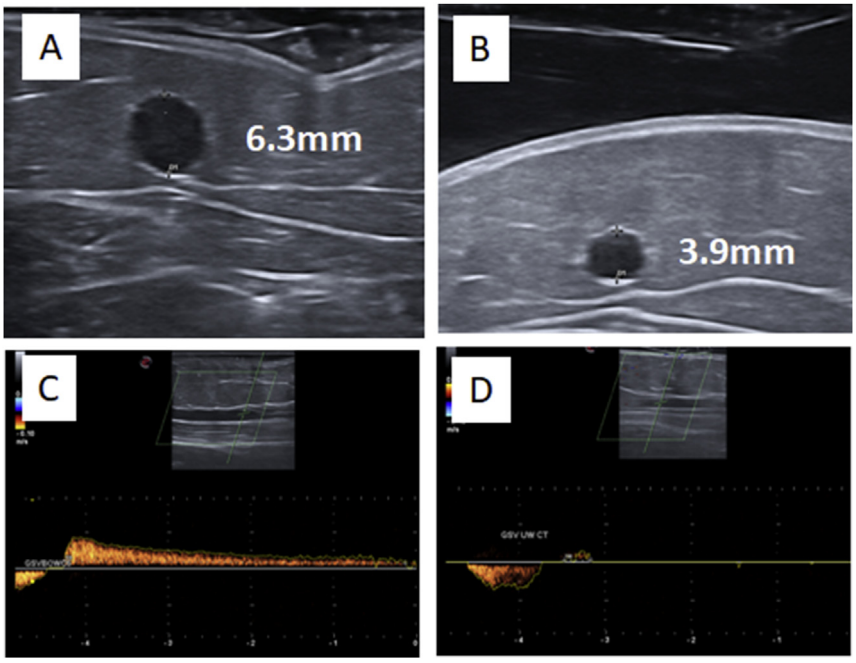

Figure 2. Changes of varicose vein size and flow during immersion. The calibre of a varicose great saphenous vein out of the pool (A) and during immersion (B). The reflux elicited by a Valsalva manoeuvre out of the pool (C) and during immersion (D).

These findings demonstrate that immersion reduces the diameter of normal and varicose veins, increases spontaneous flow, and decreases reflux when present. These morphological and haemodynamic changes are most likely due to the HC, which is proportional to the height of the water level. HC counteracts the hydrostatic pressure exercised by the column of blood between the right atrium and the point of duplex evaluation. Underwater DU evaluations of large series of normal and varicose legs are in progress to quantify the effects of HC exactly, to explain their mechanisms, and to evaluate possible implications in the field of prevention and rehabilitation of venous disease.

In conclusion, these findings support the current belief that immersion in water is an ideal model of compression for legs with venous insufficiency.[4] In fact, the pressure exerted by HC is well tolerated even if much higher than that obtained with stockings or bandages.

CONFLICTS OF INTEREST

None.

FUNDING

None.

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