Flow-Augmentation Device for Peripheral Vascular Doppler US[1]

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To augment venous blood flow at Doppler ultrasonography (US) of the extremities, a device comprising a blood pressure cuff connected to an external reservoir was tested. Constant and easily controlled pressure was delivered with each compression by the same operator performing US. In 10 patients (four men and six women, aged 54–86 years), discomfort was reduced compared with discomfort during manual compression, which requires two operators.

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At Doppler ultrasonography (US) of the peripheral circulation, slow flow is often undetectable and is indistinguishable from absence of flow. To differentiate between slow flow and echo-poor thrombus, compression or flow augmentation maneuvers are usually performed (1,2).

The compression maneuver, which is performed to demonstrate the compliance of patent vessels, is not entirely without complications. Focal pressure applied to a thrombosed vessel may dislodge thrombus (3).

The augmentation maneuver consists of gently squeezing the limb distal to the level of the Doppler examination so blood is forced through the venous system and patency can be demonstrated. The augmentation maneuver is effective but cumbersome: It requires the presence of a second operator, the degree of compression is not well controlled, and focal pressure applied by hand to a limb that is tender causes considerable discomfort.

The device described herein helps reduce or eliminate these problems since it allows the augmentation maneuver to be performed by a single operator, delivers more constant and better-controlled pressure, is intrinsically safer than manual compression because it distributes the pressure over a wider area, and helps reduce patient discomfort.

The augmentation device comprises a blood pressure cuff connected to an external reservoir with a flexible tube (Fig 1). The cuff is applied loosely to the limb in the usual fashion at a level distal to that of the Doppler examination (Fig 2). When the cuff is deflated, only a negligible pressure is applied to the limb. When air is pumped into the cuff-bag system, the pressure to the limb is still negligible because most of the air accumulates in the very compliant external bag. When the bag is squeezed, the air quickly transfers into the blood pressure cuff. When the bag is released, the air rapidly leaves the blood pressure cuff and reaccumulates in the bag. Flow augmentation is produced by squeezing the bag with a brisk and gentle compression.

The bag can be squeezed by hand or can be placed on the floor and squeezed with a foot. In this case the operator has both hands free to perform US scanning. The pressure is evenly distributed over a large surface so the focal pressure is reduced.

The device was tested in the US examination of 10 patients (four men and six women, aged 54–86 years) seen from March through June 1991 to rule out deep venous thrombosis in the lower extremities. Verbal consent was obtained from each patient. The compression maneuver was performed by hand and with the device. The patients were asked which procedure caused less discomfort. No attempt was made to quantify the degree of discomfort. In all cases augmentation with the blood pressure cuff caused less discomfort than did

Figure 1. Example of an augmentation device made of standard parts of a blood pressure cuff.

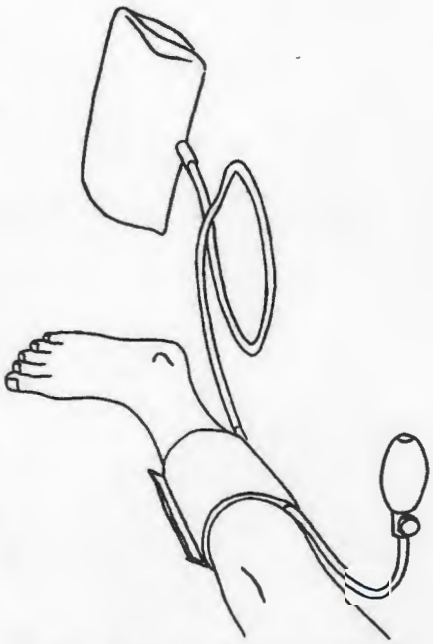

Figure 2. Illustration of flow augmentation device in use. The cuff is applied distal to the level of the site of the Doppler US examination.

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[2] 9* indicates generalized vein and artery involvement.

manual compression. I performed approximately two-thirds of the procedures, and the remainder were performed by the US technologists under my supervision.

Good flow augmentation was observed under a wide range of compression pressures; however, use of a fixed amount of air gives more consistent results. Use of a foot pump was not tested, but it is expected to produce a more controlled compression. Most studies were performed with a second operator manually squeezing the bag. Even when a single operator performed the maneuver, assistants were in the room to observe.

The device does not require the use of specialized parts and can be easily assembled with components readily available in any radiology department. The external reservoir is the same size as the bag of the blood pressure cuff and contains approximately the same amount of air. The bag should be squeezed completely during the augmentation maneuver so that approximately the same amount of air is displaced each time. Operation of the device can be improved by using custom-made parts, such as a foot pump for accurate control of the degree of compression and of a wider cuff than is used with manual compression to reduce the pressure to the limb while efficient flow augmentation is maintained. ■

References

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