Utility of Portable Continuous-Wave Doppler Examination in Screening for Postoperative Deep Vein Thrombosis

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BACKGROUND: Early and accurate diagnosis of post-surgical deep vein thrombosis (DVT) can be difficult and time-consuming, even with duplex ultrasonography. Portable continuous-wave Doppler ultrasonography may be useful in screening patients for postoperative DVT. Further confirmation of Doppler-positive cases by duplex ultrasonography might then be more cost-effective.

METHODS: All major post-surgical patients from the departments of general surgery, orthopaedic surgery and colorectal surgery were screened on the third postoperative day for DVT by assessing the quality of the flow signal (“whoosh”) obtained by placing the probe over the femoral vein and subsequently over the popliteal vein, both with a distal squeeze, as well as assessment of phasic flow with respiration. An absent or attenuated “whoosh” was judged to be suspicious for DVT and required formal duplex ultrasonography. The first 800 consecutive patients were studied to determine the sensitivity, specificity and accuracy of portable Doppler ultrasonography for DVT screening.

RESULTS: Twenty-four cases of DVT were diagnosed, comprising seven cases in the proximal veins and 17 cases in the calf veins. The sensitivity of Doppler ultrasonography was 12.5% and the specificity was 96.8%. The positive and negative predictive values were 10.7% and 97.3%, respectively.

CONCLUSIONS: Portable Doppler ultrasonography does not have adequate accuracy to be used as a quick screening tool for DVT. [Asian J Surg 2003;26(3):159–62]
patients for DVT. Those patients that show abnormalities would then be examined using formal duplex ultrasonography in the vascular laboratory. However, the utility of portable Doppler ultrasonography has yet to be proven conclusively in the literature. The results quoted for portable Doppler ultrasonography range up to a sensitivity of 89%, specificity of 100% and accuracy of 94%. Therefore, as part of a large ongoing prevalence study of post-surgical DVT, screening with portable Doppler ultrasonography was introduced to assess its efficacy in detecting DVT. Screening results were then compared with those from concomitant duplex ultrasonography.

**Patients and Methods**

A total of 1,278 patients who had undergone elective or semi-elective major general surgical, colorectal or orthopaedic procedures were recruited into a large DVT prevalence study and investigated by daily clinical examination, portable Doppler ultrasonography on the third postoperative day or whenever indicated, as well as duplex ultrasonography on the fifth postoperative day. Examples of the type of surgical procedure performed included hemi-arthroplasty, total joint arthroplasty, major abdominal and pelvic surgery for malignant as well as benign conditions and other oncological resections that involved a significant postoperative stay. These procedures are known from the Western literature to carry a significant risk of peri-operative DVT. All patients who received pharmacological or mechanical DVT prophylaxis were excluded. Other exclusion criteria were less than 5 days postoperative hospital stay, emergency surgery, trauma and administration of intra- or peri-operative heparin, such as in vascular surgical procedures.

The initial schema for Doppler examination is shown in the Figure. The usefulness of portable Doppler ultrasonography as a screening tool was assessed in the first 800 patients who were recruited into the peri-operative DVT study. Of these, the first 100 patients were also subjected to preoperative duplex ultrasonography to exclude pre-existing or resolving DVT. The rest of the cohort had duplex ultrasonography on the fifth postoperative day or anytime earlier if indicated by a suspicious or equivocal clinical or Doppler ultrasonography result. In view of the significant proportion of patients in this institution with diabetes mellitus,
some degree of renal impairment (being the largest nephrology centre in the country), or both, confirmation of Doppler or duplex findings by ascending venography was not done in the majority of patients, and indeed, was thought to be hazardous.

Each examiner had to perform at least 20 validated Doppler examinations of the lower limb venous system before he was judged to be capable of performing the examination on his own. Normal Doppler examination was defined as when the venous “whoosh” was demonstrated on calf compression with the Doppler probe over the popliteal vein, and with thigh compression with the probe over the femoral vein at the groin. Phasic flow with respiration was also sought during sonography of the femoral, popliteal and posterior tibial veins. A negative or attenuated “whoosh” or a loss of phasic flow with respiration was deemed suspicious for DVT, and the patient was then subjected to duplex ultrasonography.

The vascular technologists performing duplex ultrasonography were not blinded to the results of portable Doppler ultrasonography; suspected DVT from the portable Doppler examination was listed as the reason for duplex scan if done before the fifth postoperative day. All results were entered into a database and analysed using SPSS 9.05 (SPSS Inc., Chicago, IL, USA). Analyses of sensitivity, specificity, and positive and negative predictive values were by cross-tabulation of portable Doppler-positive cases against the number of cases of DVT actually encountered.

### Results

The DVT prevalence data from the completed study are not the subject of this communication and will be reported separately. For the purposes of assessing the utility of portable Doppler ultrasonography, the first 800 patients recruited into the study were selected for analysis of sensitivity and specificity. These yielded a total of 24 cases positive for postoperative DVT. Seven cases involved the femoral or popliteal vein (“proximal DVT”) and the other 17 involved the calf veins only.

Cross-tabulation of Doppler-positive cases against actual cases of DVT is shown in the Table. In our study, portable Doppler ultrasonography had a sensitivity of only 12.5% and a specificity of 96.8%. The positive predictive value was 10.7% whereas the negative predictive value was 97.3%.

On examination of subsequent case records of these 24 patients with confirmed DVT, none of them suffered a clinically apparent pulmonary embolism and all of them were well on follow-up.

### Discussion

This study set out to screen patients who had undergone surgical procedures that are reported to yield a significant (12%–53%) rate of peri-operative DVT. Portable Doppler ultrasonography was thought to be a useful screening tool to select suspected cases of DVT that would need more detailed evaluation by duplex ultrasonography. This would translate into significant time and cost savings as large numbers of patients could be screened rapidly by persons who had a minimum of training. This would liberate the vascular laboratory to deal with patients needing more elaborate examinations. However, our results showed that portable Doppler ultrasonography for DVT screening was not sensitive or accurate. There are a few possible explanations for this.

Firstly, 17 of the initial 24 cases of DVT involved calf veins. About half the cases involving the femoral or popliteal vein (“proximal DVT”) and the other 17 involved the calf veins only.

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### Table. Analysis of sensitivity and specificity of portable Doppler ultrasonography

<table>
<thead>
<tr>
<th></th>
<th>DVT present</th>
<th>DVT absent</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>Doppler-positive</td>
<td>3 (12.5)</td>
<td>25 (3.2)</td>
<td>28</td>
</tr>
<tr>
<td>Doppler-negative</td>
<td>21 (87.5)</td>
<td>751 (96.8)</td>
<td>772</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>776</td>
<td>800</td>
</tr>
</tbody>
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tion of the vein walls – this increases its sensitivity and accuracy compared to flow studies alone. This evaluation of compressibility is obviously not possible with portable Doppler.

Finally, in those patients who had undergone total knee replacements (in whom the literature shows significant DVT rates), evaluation with the calf squeeze was difficult because it tended to cause a great deal of pain, and ideal probe placement was almost always hindered by bulky dressings. This, too, could have contributed to the significantly lowered sensitivity.

In retrospect, it is clear from some of the literature on this subject that the relatively good results obtained with portable Doppler ultrasound in a community hospital setting or in the emergency department were from examinations done on non-operated, frequently symptomatic limbs or on patients with clinical suspicion of DVT or pulmonary embolism who were being rapidly screened for a source. It seems logical that the yield from these patient groups would be higher than in our study. Notwithstanding the results obtained by other investigators, it would appear that portable Doppler ultrasonography is not an adequate screening tool for post-surgical DVT. The sensitivity and positive predictive values are much too low to be of use in the early diagnosis of DVT. On the basis of this study, portable Doppler ultrasonography has no role in the diagnosis of DVT in the early postoperative period. Duplex ultrasonography remains the non-invasive method of choice for that purpose.

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References