

ACCURACY OF SCREENING COMPRESSION ULTRASONOGRAPHY AND CLINICAL EXAMINATION FOR THE DIAGNOSIS OF DEEP VEIN THROMBOSIS AFTER TOTAL HIP OR KNEE ARTHROPLASTY

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OBJECTIVE: To determine whether compression ultrasonography or clinical examination should be considered as screening tests for the diagnosis of deep vein thrombosis (DVT) after total hip or knee arthroplasty in patients receiving warfarin prophylaxis postoperatively.

DESIGN: A prospective cohort study.

SETTING: A single tertiary care orthopedic centre.

PATIENTS: One hundred and eleven patients who underwent elective total hip or knee arthroplasty were enrolled. Postoperatively the warfarin dose was adjusted daily to maintain the international normalized ratio between 1.8 and 2.5. Eighty-six patients successfully completed the study protocol.

INTERVENTION: Before they were discharged from hospital, patients were assessed for DVT by clinical examination, bilateral compression ultrasonography of the proximal venous system and bilateral contrast venography.

RESULTS: DVT was found in 29 patients (34%; 95% confidence interval [CI] 24% to 45%), and 6 patients (7%; 95% CI 3% to 15%) had proximal DVT. DVT developed in 18 (40%) of 45 patients who underwent total knee arthroplasty and in 11 (27%) of 41 patients who underwent total hip arthroplasty. The sensitivity of compression ultrasonography for the diagnosis of proximal DVT was 83% (95% CI 36% to 99%) and the specificity was 98% (95% CI 91% to 99%). The positive predictive value of compression ultrasonography was 71%. In contrast, clinical examination for DVT had a sensitivity of 11% (95% CI 2% to 28%) and a positive predictive value of 25%.

CONCLUSIONS: DVT is a common complication after total hip or knee arthroplasty. Compression ultrasonography appears to be a relatively accurate noninvasive test for diagnosing postoperative proximal DVT. In contrast, clinical examination is a very insensitive test. Whether routine use of screening compression ultrasonography will reduce the morbidity of venous thromboembolism after joint arthroplasty requires confirmation in a prospective trial involving long-term follow-up of patients.

OBJECTIF : Déterminer s'il faudrait envisager l'échographie par compression ou l'examen clinique comme test de dépistage pour diagnostiquer la présence d'une thrombose veineuse profonde (TVP) après une arthroplastie totale de la hanche ou du genou chez les patients qui reçoivent une prophylaxie à la warfarine après l'intervention.

CONCEPTION : Étude prospective des cohortes.

CONTEXTE : Un seul centre d'orthopédie de soins tertiaires.

PATIENTS : On a inscrit 111 patients qui ont subi une arthroplastie élective totale de la hanche ou du genou. Après l'intervention, on a rajusté la dose de warfarine tous les jours afin de maintenir entre 1,8 et 2,5 le rapport international normalisé. Quatre vingt-six patients ont terminé avec succès le protocole d'étude.

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INTERVENTION : Avant de leur donner congé de l'hôpital, on a évalué les patients pour dépister toute trace de TVP par examen clinique, échographie bilatérale par compression du système veineux proximal et phlébographie de contraste bilatérale.

RÉSULTATS : On a constaté la présence d'une TVP chez 29 patients (34 %; intervalle de confiance [IC] à 95 %, de 24 % à 45 %) et d'une TVP proximale chez six patients (7 %; IC à 95 %, de 3 % à 15 %). Une TVP a fait son apparition chez 18 (40 %) des 45 patients qui ont subi une arthroplastie totale du genou et chez 11 (27 %) des 41 patients qui ont subi une arthroplastie totale de la hanche. La sensibilité de l'échographie par compression pour diagnostiquer une TVP proximale s'est établie à 83 % (IC à 95 %, de 36 % à 99 %) et sa spécificité, à 98 % (IC à 95 %, de 91 % à 99 %). La valeur prédictive positive de l'échographie par compression s'est établie à 71 %. Par ailleurs, les examens cliniques de dépistage de la TVP avaient une sensibilité de 11 % (IC à 95 %, de 2 % à 28 %) et une valeur prédictive positive de 25 %.

CONCLUSIONS : La TVP est une complication fréquente après une arthroplastie totale de la hanche ou du genou. L'échographie par compression semble constituer une épreuve non effractive relativement précise qui permet de diagnostiquer une TVP proximale postopératoire. En revanche, l'examen clinique est très peu sensible. Il faut confirmer au moyen d'une étude prospective comportant un suivi de longue durée auprès des patients si l'échographie de compression utilisée de façon routinière à des fins de dépistage réduira la morbidité associée à la thromboembolie veineuse après une arthroplastie d'une articulation.

Deep vein thrombosis (DVT) and pulmonary embolism are common complications after total hip or knee arthroplasty.^{1,2} Although antithrombotic prophylaxis reduces the rates of postoperative thromboembolic complications and consensus guidelines strongly recommend its use,³ more than 15% of patients who undergo total hip arthroplasty and 30% of patients who have total knee arthroplasty will suffer DVT.^{2,3}

Concern about the risk of pulmonary embolism from postoperative DVT has led clinicians to consider performing routine screening tests to diagnose venous thrombosis before hospital discharge.^{3,4} The clinical examination of patients with suspected DVT is considered insensitive and nonspecific for the diagnosis of DVT especially in the postoperative period.^{5,6} Venography is the standard test for DVT. However, venography is an invasive, relatively expensive, technically difficult examination that is not readily available in all centres. These factors limit the utility of venography as a routine screening test.⁷ Compression ultrasonography is the most accurate noninvasive test for proximal DVT and may be the best available screening test for DVT after major operative procedures.^{8,9}

We undertook a prospective cohort study in patients who received warfarin prophylaxis after total hip or knee arthroplasty to evaluate the accuracy of screening compression ultrasonography and the clinical examination for the diagnosis of DVT. Based in part on this study, we wished to judge whether compression ultrasonography was sufficiently sensitive to be used as a screening test for DVT after lower limb joint arthroplasty.

METHODS

A prospective cohort study was conducted at a tertiary care centre between January and July 1993. The protocol was approved by the hospital research review committee. Informed consent was obtained from all patients.

Study population

Consecutive patients who underwent elective total hip or knee arthroplasty and received warfarin prophylaxis postoperatively were potentially eligible for the study. Exclusion criteria were: (1) previous venous thromboembolic disease, (2) indication for arthroplasty due to acute hip fracture, (3) a contraindication to anticoagulant prophylaxis, (4) hospitalization

for more than 21 days after arthroplasty and (5) a contraindication to contrast venography.

DVT prophylaxis and screening

Patients received 5 to 10 mg of sodium warfarin on the night before surgery. The dose was adjusted once daily to increase the international normalized ratio to more than 1.7 by postoperative day 4 and then maintain it between 1.8 and 2.5. Warfarin prophylaxis was continued until hospital discharge. Patients who were within 48 to 72 hours of hospital discharge were assessed for study eligibility, and consenting patients underwent clinical examination, bilateral screening compression ultrasonography and bilateral contrast venography. A single experienced clinician not involved in the daily care of the patients performed an examination and estimated, by clinical judgement alone, whether patients had findings strongly suggestive of DVT or not. The physician performing the clinical examination was unaware of the results of the compression ultrasonography or venography. Compression ultrasonography was performed with the use of a high-resolution colour duplex-Doppler scanner with an elec-

tronically focused linear array transducer (either 5 or 7.5 MHz probes). The entire proximal deep venous system between the proximal common femoral vein and the trifurcation of the popliteal vein in the calf was evaluated for compressibility at 1-cm intervals. Compression ultrasonography was considered positive if a vein or venous segment was not fully compressible.⁹

Contrast venography was done with the patient tilted in the semi-upright position and the examined leg was non-weight-bearing. Approximately 60 to 120 mL of nonionic contrast (iodine, 300 mg/mL) was injected into a dorsal foot vein. Spot films of the calf, knee, thigh and pelvis were obtained after maximal filling with contrast material as determined by fluoroscopy. DVT was diagnosed by the presence of a constant intraluminal filling defect present in at least 2 projections. DVT was excluded if the peroneal, posterior tibial, popliteal, superficial femoral, common femoral and iliac veins were adequately visualized and no filling defects were observed. Visualization of the anterior tibial veins was not required for a venogram to be considered adequate for interpretation. Venograms were considered inadequate for interpretation if opacification of the deep veins was insufficient. Proximal deep vein thrombi were defined as those involving the popliteal or more proximal leg veins.⁷

In this study, compression ultrasonography was always performed before venography. Venographers were made aware of the location of non-compressible venous segments so that careful attention was given to inject sufficient contrast to clearly outline these regions during the venography. The size and location of the DVT were documented for both compression ultrasonography and venography.

Outcome events

For the purposes of this study, the diagnosis of DVT by compression ultrasonography was made by the radiologist performing the original study. All venograms were reviewed by 2 experts unaware of the results of compression ultrasonography or the results of the original venography. In the event of disagreement between the experts, a third radiologist was consulted and final adjudication was made by consensus.

Statistical analysis

The sensitivity, specificity and positive predictive value of compression ultrasonography for the diagnosis of proximal DVT along with the associated 95% CI for these values were determined using venography as the standard. The sensitivity and positive predictive value of the clinical examination for DVT were also determined.

RESULTS

Study population

Over the 5-month recruitment period, 179 patients underwent total hip or knee arthroplasty at our institution. Twenty-four (13.4%) had one or more of the exclusion criteria and were ineligible for the study for the following reasons: 10 patients were hospitalized for more than 21 days; 8 patients had a history of documented venous thromboembolism; and 6 patients had an allergy to contrast media. None of the 179 screened patients was referred for investigations of suspected DVT or pulmonary embolism by their orthopedic surgeon before entry into the study. Thus, 155 patients met the eligibility criteria. Of these, 29 patients refused to give informed consent; 12 patients were dis-

charged unexpectedly before they could be screened for the study; and 3 patients were not approached at the request of their orthopedic surgeon. Thus, 111 (71.6%) of the 155 eligible patients consented to participate. Eleven patients did not undergo venography due to scheduling or technical difficulties. In addition, 14 patients were judged by the adjudication committee to have had inadequately performed venography. This left 86 patients for assessment, 41 of whom underwent total hip arthroplasty and 45 total knee arthroplasty. Patient demographics and indications for surgery are outlined in Table I.

Outcome events

Twenty-nine (34%) of the 86 patients (95% CI 24% to 45%) had venographic evidence of DVT. Six patients (7%, 95% CI 3% to 15%) had DVT in-

Table I

Demographic and Operative Characteristics of 86 Patients Available for Assessment After Total Hip or Knee Arthroplasty

Mean age, yr	69.4
Men, no. (%)	45 (52)
Total hip arthroplasty, no. of pts	41
Primary procedure	34
Revision	7
Total knee arthroplasty, no. of pts	45
Primary procedure	39
Revision	6
General anesthesia, no. of pts	62
Regional anesthesia, no. of pts	24
Preoperative diagnosis, no. of pts	
Osteoarthritis	65
Failed arthroplasty	7
Rheumatoid arthritis	5
Trauma	3
Other	6
Duration of hospitalization, d (and SD)	10.9 (3.1)

volving the proximal leg veins. DVT developed in 11 (27%) of 41 patients (95% CI 14% to 43%) who underwent total hip arthroplasty and in 18 (40%) of 45 patients (95% CI 26% to 56%) who underwent total knee arthroplasty. Similar rates of proximal DVT were observed in the 2 groups (Table II); 7.0% after total hip arthroplasty compared with 6.6% after total knee arthroplasty.

The sensitivity of compression ultrasonography for the diagnosis of proximal DVT was 83% (95% CI 36% to 99%) and the specificity was 98% (95% CI 91% to 99%). The positive predictive value of compression ultrasonography was 71% (5 of 7) (Table III). The only patient with a proximal DVT that was not detected by compression ultrasonography had a thrombus 1.5 cm in dimension seen on venography. Four of the five thrombi detected by compression ultrasonography were 4 cm or larger in size.

The sensitivity of the clinical examination for all DVT was 11% (95% CI 2% to 28%) and the positive predictive value was 25% (95% CI 5% to 57%) (Table

IV). None of the 5 patients with proximal DVT examined by the physician was suspected clinically of having DVT.

DISCUSSION

DVT is a common complication of total hip or knee arthroplasty despite the use of effective prophylaxis.¹⁻³ In our study, in which all patients received warfarin prophylaxis postoperatively, 27% of patients who underwent total hip arthroplasty and 40% of patients who underwent total knee arthroplasty had venographically confirmed DVT; about 7% of the thrombi involved the proximal venous system.

The reported sensitivity of compression ultrasonography for the diagnosis of proximal DVT after joint arthroplasty varies. In a meta-analysis of 11 clinical trials of high methodologic quality, involving 1616 patients, the overall sensitivity of compression ultrasonography was 62%;¹⁰ in contrast, the sensitivity of compression ultrasonography in our study was 83%. However, the number of patients in our trial was small and the

95% CI of our estimated sensitivity overlaps that reported in the literature. One potential explanation for the high sensitivity and positive predictive value of compression ultrasonography in our study was that the venographers were explicitly notified of the location where thrombosis was suspected on compression ultrasonography. This process was meant to ensure that sufficient contrast material was injected to outline clearly the venous segment of interest and to minimize the risk of misclassifying a true-positive study. This process did not create a bias since the final interpretation of venography was done by experts who were blinded to the compression ultrasonography findings and to the original interpretation of the venogram.

Our study is consistent with previous reports that the sensitivity of compression ultrasonography depends on the size of the proximal DVT.^{11,12} In our study, each of the 4 thrombi that were 4 cm or longer were detected by compression ultrasonography whereas 1 thrombus which was only 1.5 cm long was not.

Our study confirmed that clinical examination by itself is not helpful in assessing patients after joint arthroplasty for DVT, presumably because postoperative thrombi are usually asymptomatic.^{3,4} The sensitivity of the clinical examination by an independent experienced clinician was only 11%, which is less than would be expected

Table II

Incidence and Location of Venographically Confirmed Postoperative Deep Vein Thrombosis (DVT)

Type of arthroplasty	No. of patients	DVT, no. (%)		
		Calf	Proximal	Total
Hip	41	8 (20)	3 (7)	11 (27)
Knee	45	15 (33)	3 (7)	18 (40)
Total	86	23 (27)	6 (7)	29 (34)

Table III

Accuracy of Compression Ultrasonography (CUS) for the Diagnosis of Proximal Deep Vein Thrombosis (DVT)

CUS finding	DVT finding, no.		Total no. of patients
	DVT	No DVT	
Positive for DVT	5	2	7
Normal	1	78	79
Total	6	80	86

Table IV

Accuracy of the Clinical Examination for the Diagnosis of Deep Vein Thrombosis (DVT)

Clinical findings	DVT finding, no.		Total no. of patients*
	DVT	No DVT	
DVT suspected	3	9	12
DVT not suspected	25	46	71
Total	28	55	83

*3 patients did not have a clinical examination.

by chance. The positive predictive value of an abnormal examination was only 25%. The low sensitivity of the clinical examination in this setting is likely due to the small size and lack of vein occlusiveness of postoperative DVT. The poor positive predictive value of the clinical examination is probably a result of the difficulty in distinguishing symptoms of thrombosis from usual postoperative symptoms.

Although compression ultrasonography lacks the sensitivity of venography for the diagnosis of postoperative DVT it may be an adequate screening test if the thrombi not detected by ultrasonography do not cause subsequent symptomatic venous thromboembolic complications. One study suggests this may be the case. Grady-Benson and colleagues⁴ have reported that none of 71 patients who underwent joint arthroplasty and had normal compression ultrasonography results at hospital discharge had symptomatic DVT or pulmonary embolism over a 3-month period. Although the results of that study were encouraging, a randomized trial involving long-term follow-up, comparing postoperative screening compression ultrasonography to a control group is required to establish whether the routine performance of ultrasonography is of benefit after joint arthroplasty.

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