Association of Deep Venous Thrombosis with Calf Vein Diameter in Acute Hemorrhagic Stroke

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We investigated the association between the development of deep venous thrombosis (DVT) and calf vein diameter in patients with acute hemorrhagic stroke. We measured the maximum diameter of paralytic side posttibial veins (PTVs) and peroneal veins (PVs) in 49 patients with intracerebral hemorrhage on admission and at 2 weeks after stroke onset by ultrasonography. We also examined for the presence or absence of DVT, and then analyzed the association of DVT with the maximum vein diameter. At 2 weeks after stroke, DVTs were detected in PTVs in 7 patients and in PVs in 6 patients. The maximum calf vein diameters at 2 weeks were significantly greater in patients with DVT compared with those without DVT (PTV, $P = .033$; PV, $P = .015$). Although calf vein diameter at admission did not influence the future incidence of DVT in patients with intracerebral hemorrhage, the presence of DVT was associated with calf vein dilatation. **Key Words:** Calf vein—deep venous thrombosis—diameter—intracerebral hemorrhage—ultrasonography.

Venous thromboembolism is a common complication of acute stroke, associated with increased mortality and long-term morbidity.[1] The estimated rate of deep venous thrombosis (DVT) in hospitalized patients who sustained stroke is 20%-50%,[2] and two-thirds of these are below-knee DVTs.[3] Although venous thromboembolism is one of the main causes of death in patients with hemorrhagic stroke, prevention and treatment of venous thromboembolism remain difficult. A small randomized trial suggested that low-dose heparin has possible efficacy as prophylaxis for DVT,[4] but may increase the risk of rebleeding. Lacut et al[5] reported the efficacy of intermittent pneumatic compression for the prevention of DVT. However, the health care costs for its management remain substantial.[2]

Although a diagnosis of venous thromboembolism is often based on the Wells score,[6] it might not be applicable in patients with acute intracerebral hemorrhage (ICH) who have lower extremity paralysis/paresis and are bedridden. Thus, a more effective technique for diagnosing DVT is crucial for the management of ICH. Ultrasound is recommended for diagnosing DVT in patients considered at high risk for DVT[7]; however, the prediction and prevention of DVT is a more beneficial strategy.

When a DVT occurs, the veins distal to the site may become dilated because of blood congestion. Thrombi may form in these dilated veins. Therefore, measuring calf vein diameter to diagnose or predict DVT might be beneficial for the management of patients with ICH. To the best of our knowledge, however, there has been no previous report on the association between below-knee DVT and calf vein diameter.

The purpose of the present study was to test the hypothesis that calf vein diameter could be predictive of future below-knee DVT and aid diagnosis of existing below-knee DVT. We also hypothesized that the degree

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of lower extremity paralysis would affect DVT. To test these hypotheses, we analyzed data from patients with acute ICH.[8]

Materials and Methods

Patient Care

We analyzed data from a previously published prospective study.[8] In brief, we prospectively registered 67 patients who had been admitted within 72 hours of acute spontaneous ICH between June 2005 and September 2006. Of these 67 patients, 53 underwent ultrasonography of the lower extremities within the first 72 hours and again at 2 weeks after onset of ICH. Informed consent was obtained from all patients. Two patients with DVT of the posterior tibial veins (PTVs) or peroneal veins (PVs) on the paralytic side at admission and 2 patients with bilateral ICH (eg, pontine hemorrhage) were excluded from our analysis. After exclusions, 49 patients were included in the study. The degree of lower extremity paralysis contralateral to the ICH was assessed by manual muscle testing. Real-time B-mode and color-mode ultrasonography was performed by an experienced sonographer (T.O.) using a Philips iU22 ultrasound system (Philips Medical Systems, Tokyo, Japan) equipped with a 4- to 8-MHz linear array transducer. DVT was diagnosed based on the detection of a noncompressible segment or inadequately compressible lesion. A vein was also classified as abnormal if a lesion or defect was identified on color Doppler ultrasound. In addition, PTVs and PVs on the paralyzed side were visualized by ultrasound, and maximum diameters were measured both at admission and 2 weeks later.

Statistics

The associations between maximum PTV and PV diameters at admission and the incidence of DVT at 2 weeks were analyzed separately. Then PTV and PV maximum diameters were compared in patients with DVT and those without DVT using univariate analysis, followed by multiple logistic regression analysis. The maximum diameters were compared using the unpaired *t*-test once they were identified as normally distributed by the Shapiro-Wilk test. In the multiple logistic regression analyses, adjustments were made for age, sex, baseline National Institutes of Health Stroke Scale (NIHSS) score, and D-dimer value at admission, all of which are reportedly significantly associated with DVT formation.[8,9] Once the differences between the venous diameters between the DVT and non-DVT groups were determined, the diameter cutoff values for predicting DVT were calculated using receiver operating characteristic (ROC) curve analysis. Finally, the correlations between the maximum PTV and PV diameters at admission and the degree of lower extremity paralysis were examined using Spearman's rank correlation test. A P value $\leq .05$ was considered to indicate statistical significance. Data were analyzed using SPSS version 16.0 (IBM, Somers, NY).

Results

We evaluated PTVs and PVs in 49 patients by ultrasonography. These patients' baseline characteristics are summarized in Table 1. Within 2 weeks of admission for ICH, 7 patients (14.3%) developed DVT in a PTV and 6 (12.2%) developed DVT in a PV.

No significant differences in PTV diameter (3.8 ± 1.0 mm vs 3.9 ± 1.1 mm; $P = .77$) or PV diameter (5.1 ± 1.3 mm vs 4.7 ± 0.9 mm; $P = .37$) at admission were found between the patients who developed DVT and controls. At 2 weeks after admission, patients with DVT had significantly larger PTV and PV diameters than controls (PTV: 5.4 ± 0.9 mm vs 3.6 ± 0.9 mm, $P < .001$; PV: 6.5 ± 1.0 mm

Table 1. *Baseline characteristics of the patients with DVT and without DVT*

	DVT (n = 19)	No DVT (n = 30)
Age, years, mean ± SD	73.2 ± 8.7	68.6 ± 10.9
Male sex, n (%)	7 (36.8)	15 (50.0)
Site of ICH, n (%)		
Putamen	5 (26.3)	8 (26.7)
Thalamus	9 (47.4)	11 (36.7)
Subcortex	3 (15.8)	7 (23.3)
Cerebellum	1 (5.3)	3 (10.0)
Other	1 (5.3)	1 (3.3)
Right-sided ICH, n (%)	8 (42.1)	10 (33.3)
Size of ICH, mL, median (IQR)	11.8 (7.8-24.8)	6.7 (2.6-15.9)
NIHSS score, median (IQR)	16 (14-20)	5 (2-15)
Manual muscle testing score, median (IQR)	2 (1-3)	4 (2-5)
D-dimer, μg/mL, median (IQR)	1.0 (0.6-1.5)	0.6 (0.5-0.9)
Elastic stockings, n (%)	8 (42.1)	10 (33.3)

Abbreviation: IQR, interquartile range.