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A phantom model study to identify the most effective manual aspiration thrombectomy for acute deep-vein thrombosis of the lower extremity

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AIM: To identify the most effective manual aspiration thrombectomy (MAT) method for the initial endovascular management of acute deep-vein thrombosis (DVT) in the lower extremity using a phantom model.

MATERIALS AND METHODS: An acute DVT phantom model was created by infusing a bovine acute thrombus in a 20-mm diameter, 120-cm long plastic tube with banding of the distal portion. A total of 32 types of aspiration methods using combinations of two aspiration catheters (8 and 10 Fr), four syringes (10, 20, 40, and 50 ml), and four different aspiration methods (I, II, III, and IV) were performed. Each method was performed 10 times. The total weight of the aspirated thrombus was measured and compared among the 32 aspiration methods. The aspiration methods were classified based on the length of the dynamic catheter withdrawal (0 cm [method I], 15 cm [II], 30 cm [III], or >45 cm [IV]) while maintaining continuous negative pressure using a syringe. Analysis of variance and Student's *t*-test were used for statistical analysis.

RESULTS: There were no statistically significant differences in the total amount of aspirated thrombus among the various types of aspiration catheters and syringes; however, different aspiration methods showed significantly different results. Acute thrombus was most effectively aspirated by method IV irrespective of the catheter and syringe used. The longer the length of dynamic catheter withdrawal, the greater the amount of total thrombi that could be aspirated, irrespective of the type of aspiration catheter and syringe used (IV > III > II > I; $p<0.05$).

CONCLUSION: MAT can be performed most effectively using method IV. Effective MAT relies on the length of the dynamic catheter withdrawal while maintaining continuous negative pressure using a syringe in the initial endovascular management of acute DVT in the lower extremity.

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Introduction

Traditionally, deep-vein thrombosis (DVT) therapy has consisted of systemic anticoagulation using intravenously administered and/or systemic infusion of thrombolytic agents, followed by warfarin sodium by mouth.[1–3] Because the results in some cases have been disappointing, additional, more aggressive therapy using various interventional radiology techniques, such as manual aspiration thrombectomy (MAT),[4–6] catheter-directed thrombolysis,[2,7] mechanical thrombectomy,[8,9] percutaneous transluminal angioplasty,[8,10] and self-expandable metallic stent placement[4,8] have been used recently and have been reported to be useful. Among these methods, MAT provides rapid and effective treatment without the risk of bleeding caused by thrombolytic administration. Based on its rapidity and effectiveness, MAT can clear the entire thrombus in the acute phase and single-session endovascular treatment is technically feasible.[4,5] A fresh thrombus and a relatively lower thrombus burden result in a good response to MAT alone. Another advantage of MAT is the excellent performance–price ratio. MAT is at present widely practised by many physicians as a first-line treatment method [4–6,11]; however, no phantom study concerning an effective aspiration thrombectomy method or standardisation of the technique has been reported. The purpose of the present study was to identify the most effective MAT method using a phantom model for the initial endovascular management of acute DVT in the lower extremity.

Materials and methods

An acute DVT phantom model was created by infusing a mixture of bovine acute thrombus and non-ionic contrast materials (iopamidol; Ilsung Pharmacy, Seoul, Korea) into a 20-mm diameter, 120-cm long plastic tube (Hoseworld, Seoul, Korea) with banding of the distal portion. The bovine acute thrombus was obtained from recently euthanised Korean cattle (Fig 1a). This study was approved by the institutional review board. The total weight of the mixture of bovine acute thrombus and non-ionic contrast materials infused was 180–200 g. The phantom model was placed on

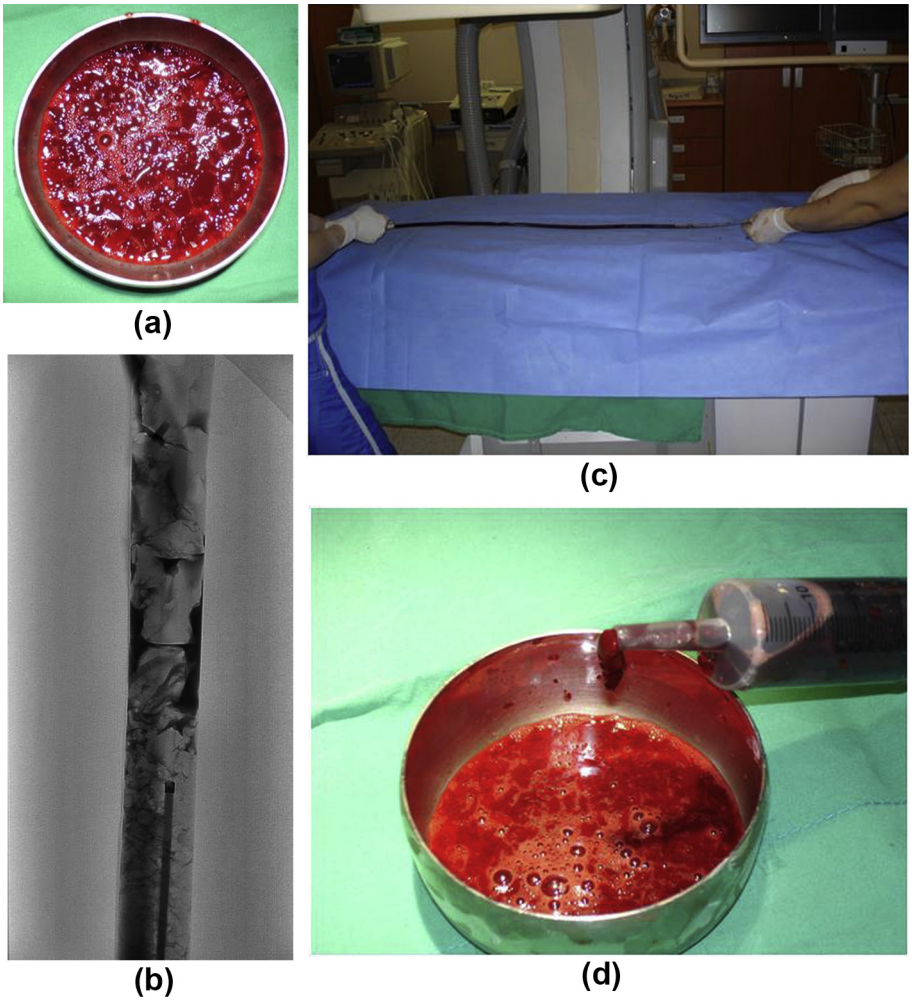

Figure 1 (a) Photograph of an acute bovine thrombus. The bovine acute thrombus was obtained from recently euthanised Korean cattle. (b) Fluoroscopic finding of the phantom model containing a mixture of acute bovine thrombus and contrast medium. (c) Photograph of the MAT procedure using a phantom model on an angiographic table. (d) Photograph of the acute bovine thrombus aspirated from the phantom model.