INTRODUCTION
Deep vein thrombosis is a commonly observed disorder and sometimes triggers serious complications, but no treatment has been established. Pulse infusion thrombolysis is an effective strategy for the treatment of huge thrombus in artery obstructions. We treated a 69-year-old man with massive deep vein thrombosis by pulse infusion thrombolysis.

CASE REPORT
A 69-year-old man underwent surgery for prostatic cancer in 1991, and since then he had been taking an artificial estrogen agent. He suffered from pain and swelling edema of the bilateral lower limbs for 2 years. He was hospitalized due to worsening leg pain and dyspnea even at rest in September 1999. Color photography of the swollen lower limbs is demonstrated in Fig. 1 - upper. Computed tomography with contrast medium showed occlusion of the lower inferior vena cava and thrombi extending into the bilateral femoral veins. Perfusion lung scanning scintigraphy detected some perfusion defects in the right and left lung fields. These findings indicated deep vein thrombosis and pulmonary thromboembolism. The artificial estrogen agent may have been involved in the etiology.

Based upon the size and duration of the thrombus, pulse infusion thrombolysis treatment was selected. The pulse infusion thrombolysis pump

Challenging Case of Pulse Infusion Thrombolysis Using a Unique Pump System for a Patient With Deep Vein Thrombosis: A Case Report

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Abstract
A 69-year-old man presented with chronic deep vein thrombosis due to massive thrombi extending from the inferior vena cava to both femoral veins. He had undergone surgery for prostatic cancer in 1991, and since then he had been taking an artificial estrogen agent. He was successfully treated by pulse infusion thrombolysis using a unique pump system, which we have developed, without complication.

Key Words
Thrombosis (deep vein)  Thrombolysis  Pulmonary embolism

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Nemoto Kyorindo allows constant forceful delivery of fibrinolytic agent in a spray-like fashion through multiple side holes of the pulse infusion thrombolysis catheter directly into the thrombus (Fig. 2). The pump system also has the advantage that extended times are possible. The detailed system was described before. The pulse infusion thrombolysis catheter was a Cragg-McNamara catheter (Micro Therapeutics, Inc.).

A temporary inferior vena cava filter (Neuhaus Laboratories, Inc.) was placed in the proximal inferior vena cava before pulse infusion thrombolysis to inhibit pulmonary thromboembolism. A bolus of heparin (5,000 U) was given through the venous line. The Cragg-McNamara infusion catheter was introduced via a sheath placed in the right jugular vein and passed downward through the filter. After the 0.035 inch radifocus guide wire crossed the thrombus lesion, the pulse infusion thrombolysis catheter was passed from the inferior vena cava to the femoral vein. Pulse infusion thrombolysis (96 – 10^4 U of urokinase/200 ml of saline) was performed step by step at each site for 10 min (Fig. 3). As reported in our previous study, the injection mode used the following conditions: three injections per min, 0.5 ml bolus at 2 ml/sec forced flow. The final venography demonstrated flow restora-
tion, but a significant amount of thrombus remained after use of the total amount of urokinase (96 x 10^4 U; Fig. 4). There was no symptom of dyspnea and no findings of hematoma, pulmonary infarction, or worsening of oxidization.

One week after the first procedure, repeat venography showed slow flow and persistent thrombus in the iliac to femoral veins. Second pulse infusion thrombolysis therapy using 48 x 10^4 U of urokinase was performed in a similar way. As shown in Fig. 5, final venography showed constant flow from the bilateral iliac to femoral veins. However, venography of the inferior vena cava showed thin flow (Fig. 5D), so flow recovery was possibly not sufficient. Physical examination showed dramatic improvement of symptoms and concordant normalized extremities (Fig. 1 lower). A few days later, a permanent venous filter was placed and anticoagulant therapy was started. There was no recurrence of deep vein thrombosis.

**DISCUSSION**

Pulse infusion thrombolysis lyses thrombi by the synergistic mechanisms of mechanical maceration of the thrombus by direct spray-like delivery of thrombolytic solution into the thrombus and the lytic mechanism of the agent. Fibrinolytic acceleration by pulse infusion thrombolysis was confirmed experimentally. We have used pulse infusion thrombolysis for acute myocardial infarction with huge intracoronary thrombus and early vein graft occlusion after coronary artery bypass surgery.

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**Fig. 3** Photographs of the temporary inferior vena cava filter and Cragg-McNamara infusion catheter used in the first pulse infusion thrombolysis procedure.

The Cragg-McNamara infusion catheter was inserted through the sheath into the right jugular vein, and the temporary inferior vena cava filter was delivered from another puncture site of the right jugular vein.

*Upper:* Level of inferior vena cava. *Lower:* Level of iliac veins.

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**Fig. 4** Venographs after the first pulse infusion thrombolysis therapy.

_A:_ Residual thrombus (arrows) is present in the right iliac to femoral veins, after administration of urokinase 48 x 10^4 U. _B:_ Flow recovery of the left iliac vein (arrow). _C:_ Final venograph of the right iliac to femoral veins after use of urokinase 96 x 10^4 U shows few residual thrombi.
Hemodialysis shunt obstruction can be successfully recanalized in more than 90% of cases by pulse infusion thrombolysis.

Deep vein thrombosis is an uncommon and elusive illness that can result in suffering and death if not recognized and treated effectively. The strategy for deep vein thrombosis is classified by its status, onset time, or clinical course. In this case, pulmonary embolism had occurred and the patient was suffering from dyspnea and needed analgesic agents to relieve leg pain and could not walk. Furthermore, the occluded section of the inferior vena cava was long and intravenous thrombus was considered to be partially organized. Based on our experience of vein graft thrombus occlusion, we thought that pulse infusion thrombolysis was the best treatment strategy for this particular case of deep vein thrombosis.

Experimental pulse spray thrombolysis with tissue plasminogen activator is effective for the treatment of rabbit inferior vena cava thrombosis, and pulse spray thrombolysis is superior to only intravenous injection of thrombolytic agent. Moreover, by changing the setting of pulse frequency, concentration and amount of thrombolytic agent, complications including hematoma and bleeding requiring blood transfusion can be reduced. Catheter-directed thrombolysis for deep vein thrombosis is safe and effective and the mean infusion time of urokinase through the catheter is 53 hr. This infusion time is too long. Thus, considering that complete flow restoration time in patients with peripheral ischemia was shorter in pulse spray thrombolysis than in conventional treatment, the pulse infusion thrombolysis technique may reduce the procedural time and total amount of thrombolytic agent. In the present case, urokinase of 96 $10^4$ U was used in the first and 48 $10^4$ U in the second procedure and the time was about 2 hr for each treatment. Therefore, the pulse infusion thrombolysis technique using a special pump system reduced the amount of thrombolytic agent and the procedure time.

We concluded that catheter-directed pulse infusion thrombolysis using a pump system for deep vein thrombosis is safe and effective.

Acknowledgments

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引用
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希少例

症例は60歳。男性。1991年に前立腺癌で摘出術が施行され、合併症ナロコラムを投与されて
いた。1999年9月に下肢の腫脹感と、高血圧で当科紹介となる。診療の結果、下大動脈下部から
大腿静脈まで血栓性に塞まった深部静脈血栓症で、大量の血栓であることが考えられ、通常の
血栓溶解薬投与では血流再開は困難と考え、我々は開発した特殊ポンプ装置を用いたパルススプ
レーによる血栓溶解療法を施行した。その後、プロトピセートを併用して、合併症なく安全に再通
が得られた。大量の血栓性閉塞を呈する血栓疾患に対しパルススプレーによる血栓溶解療法は有効と考えられた。

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References