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## Case Report

# Transcatheter arterial embolization using imipenem/cilastatin sodium and microspheres for traumatic pseudoaneurysm: A case report

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## ABSTRACT

For transcatheter arterial embolization (TAE) of pseudoaneurysms, when the culprit artery is too small or tortuous to be selected with a microcatheter, n-butyl-2-cyanoacrylate (NBCA) may be used as embolic material. Nevertheless, NBCA can cause inadvertent embolization and ischemic complications because liquid adhesives cannot be controlled precisely. In such cases, imipenem/cilastatin sodium (IPM/CS) could be used as an alternative to NBCA for TAE. However, TAE using IPM/CS for traumatic pseudoaneurysms has not been reported previously. Therefore, the possibility of using IPM/CS to embolize refractory traumatic pseudoaneurysms with small culprit arteries remains unknown.

A previously healthy 51-year-old man sustained multiple traumatic injuries, including an open pelvic fracture. An emergency TAE for the pelvic fracture, massive blood transfusion, and emergency colostomy and cystostomy were performed on admission day, following which the patient was hemodynamically stable. However, he had repeated episodes of hematochezia due to pelvic pseudoaneurysm on days 18, 53, 60, and 70 after admission despite several TAE attempts using gelatin sponge, coils, and NBCA. During recurrence on day 70, we performed TAE using IPM/CS and microspheres, following which the pseudoaneurysm resolved without rebleeding or obvious ischemic complications.

IPM/CS and microspheres could embolize, without rebleeding, the refractory pseudoaneurysm in small and tortuous culprit arteries that could not be embolized with NBCA. For embolization of traumatic pseudoaneurysms with severe tissue damage and small culprit arteries, NBCA might not be able to reach the bleeding point. In such cases, TAE using IPM/CS and microspheres could be a safe and effective procedure.

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## Introduction

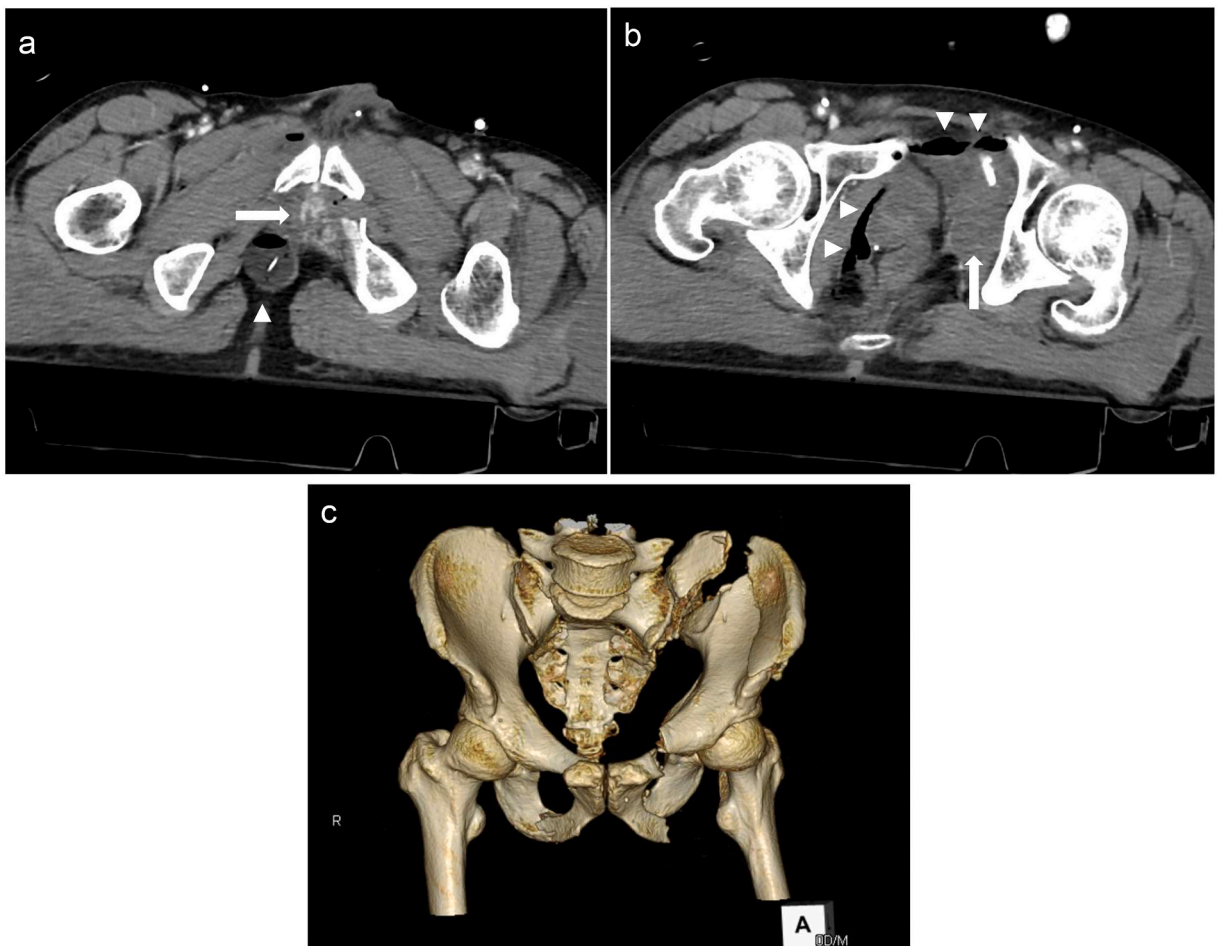
Transcatheter arterial embolization (TAE) is safe and effective for treating traumatic pseudoaneurysms. Although coils are commonly used for treating pseudoaneurysms, n-butyl-2-cyanoacrylate (NBCA) can be considered when the culprit artery is too small or tortuous for microcatheter use [1,2]. NBCA is a liquid embolic material that can be delivered distally through small arteries [3]. However, its use poses the risk of inadvertent embolization and ischemic complications because liquid adhesives cannot be controlled precisely. Imipenem/cilastatin sodium (IPM/CS) is also used for the embolization of small arteries [4]. Although IPM/CS is an antibiotic, it is reportedly a safe and effective transient embolic material for chronic musculoskeletal pain [5] and gastrointestinal bleeding from neoplasms [6].

To date, no studies have reported TAE using IPM/CS for traumatic pseudoaneurysms. Herein, we report the case of a refractory traumatic pseudoaneurysm that could not be embolized with NBCA but could be embolized with IPM/CS and microspheres without rebleeding.

This case report follows the CARE (Consensus-based Clinical Case Reporting) guidelines.

## Case report

A previously healthy 51-year-old man was injured in a traffic accident. On arrival at our hospital, his vital signs were as follows: blood pressure, 85/30 mm Hg; heart rate, 123 beats/min; respiratory rate, 24 breaths/min; Glasgow Coma Scale score, E3V4M6; and body temperature, 35.8 °C. Initial laboratory test results were as follows: serum hemoglobin, 5.4 g/dl; platelet count,  $124 \times 10^3/\mu\text{l}$ ; prothrombin time-international normalized ratio, 2.14; and fibrinogen, 85 mg/dl. The patient was diagnosed with hemorrhagic shock



**Fig. 1.** Contrast-enhanced computed tomography of the patient on arrival at our hospital. (a) Contrast-enhanced computed tomography (CECT) shows an open pelvic fracture with contrast medium extravasation (white arrow) and misplacement of the urinary catheter (white arrowhead). (b) Another CECT slice shows fluid collection, hematoma (white arrow), and free air (white arrowheads) in the retroperitoneal space. (c) A three-dimensional reconstructed bone image shows multiple pelvic fractures, including fractures of the left ilium, bilateral pubic bones, bilateral ischii, and right sacrum.

and traumatic coagulopathy.

Tracheal intubation and massive blood transfusions were performed. Contrast-enhanced computed tomography (CECT) revealed multiple injuries (injury severity score, 43) including an open pelvic fracture with bladder and rectal injuries (Fig. 1). After undergoing pelvic TAE using gelatin sponge particles (Serescue; Nippon Kayaku Co. Ltd., Tokyo, Japan), pelvic external fixation, colostomy, and cystostomy, the patient became hemodynamically stable.

Sudden hematochezia was observed on day 18 after admission. CECT identified a delayed pelvic pseudoaneurysm as the bleeding source (Fig. 2). An emergency TAE was performed using gelatin sponge particles and multiple coils (Hilal straight 1.0-mm coils, Cook Medical LLC, Bloomington, IN, USA) (Fig. 3a, b). Post-embolization angiography revealed pseudoaneurysm resolution (Fig. 3c, d).

However, hematochezia and pelvic pseudoaneurysm occurred repeatedly at the same site on days 38, 53, and 60, and TAE was performed every time. We used NBCA (Histoacryl; B. Braun Surgical SA, Rubi, Spain) mixed with iodized oil (Lipiodol; Andre Guerbet, Aulnay-sous-Bois, France) in a 1:8 ratio in the fourth and fifth TAEs. Although we administered heparin for thrombosis prophylaxis from day 6 with short interruption due to first hematochezia, we completely discontinued it after day 38 when the second rebleeding was observed. Nevertheless, the pseudoaneurysm persisted, and recurrent bleeding occurred on day 70.

As an NBCA substitute, we selected IPM/CS and microspheres to embolize the culprit arteries (Fig. 4a, b). A suspension of 1 g IPM/CS in 20 ml contrast medium was prepared. First, this suspension was stirred and injected slowly through a microcatheter placed within the culprit arteries, as close to the pseudoaneurysm as possible, until the pseudoaneurysm disappeared. Thereafter, 100–300- $\mu$ m microspheres (Embosphere, Merit Medical Inc., South Jordan, UT, USA) were injected.

No rebleeding or obvious ischemic complications occurred after the last TAE. Follow-up CECT at 7 and 62 days after the last TAE showed disappearance of the pseudoaneurysm. For the pelvic fracture, internal fixation could not be performed throughout this case because of the multiple episodes of hematochezia and severe soft tissue injuries. Therefore, the patient was treated only with external fixation. Since bone consolidation was achieved over time, the external fixator was removed on day 163 after admission. Thereafter, partial weight bearing was allowed gradually. The patient was wheel-chair bound and transferred to another hospital for rehabilitation on day 196 after admission.

## Discussion

No studies have reported TAE using IPM/CS and microspheres for traumatic pseudoaneurysm, as presented herein. This report presents two important clinical issues.

First, IPM/CS could be delivered to a refractory pseudoaneurysm with small and tortuous culprit arteries otherwise not reachable by NBCA. Embolization might fail owing to proximal embolization when NBCA cannot reach the distal regions as intended [7]. IPM/CS can serve as small, transient, 10–130- $\mu$ m-sized embolic material [4,8]. Owing to its small size and peripheral accessibility, IPM/CS is able to effectively embolize small arteries in cases of gastrointestinal bleeding from neoplasms [6] and chronic musculoskeletal pain [5]. Although IPM/CS was injected from a relatively proximal point of the culprit arteries in our case, it successfully embolized the refractory pseudoaneurysm.

Second, injection of microspheres, in addition to IPM/CS, could prevent rebleeding. A previous study reported that rat renal arteries embolized by IPM/CS were recanalized within 48 h because of its temporary effect [4]. In a previous study on the use of IPM/CS for gastrointestinal bleeding, rebleeding was observed in 5 of 11 procedures [6]. Therefore, we utilized microspheres in addition to IPM/CS with the goal of lowering the chance of rebleeding via this combined methodology. The efficacy and safety of embolization with microspheres combined with other embolic materials were reported for uterine fibroid embolization [9]. In our case, the refractory pseudoaneurysm was successfully embolized without rebleeding.

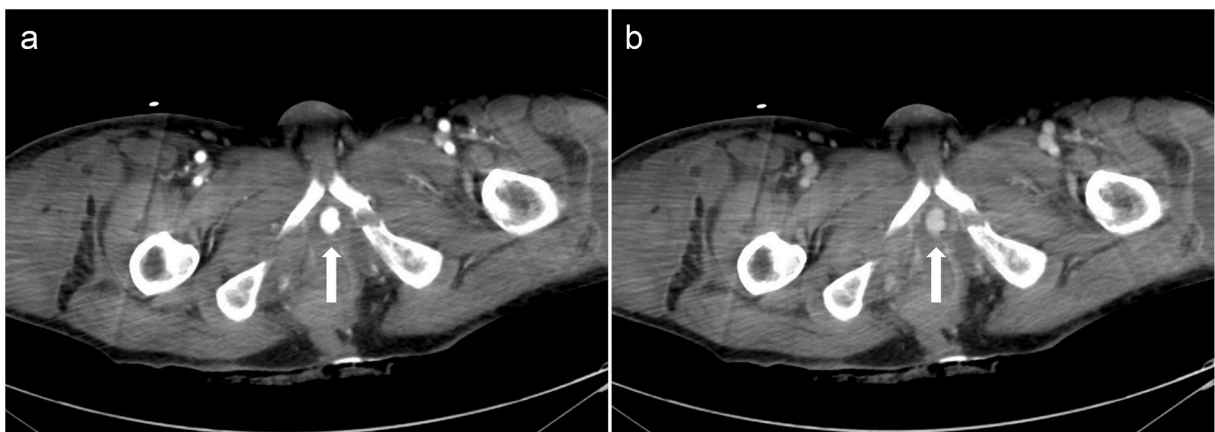
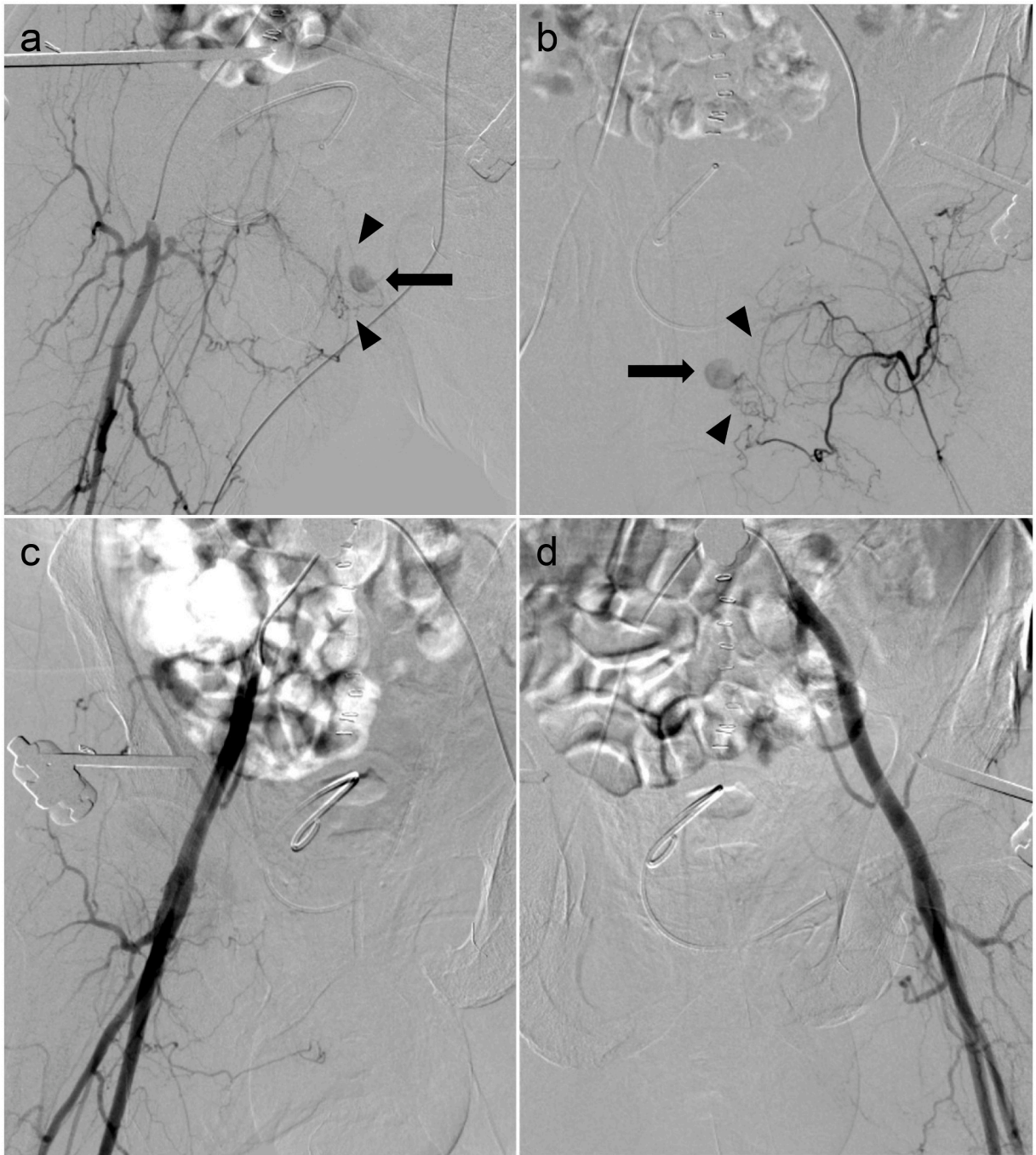


Fig. 2. Contrast-enhanced computed tomography (CECT) on day 18 after admission.

(a) CECT performed on post-admission day 18 shows a pelvic pseudoaneurysm (white arrow) in the arterial phase. (b) The same pseudoaneurysm (white arrow) is also noted on the delayed phase of CECT.

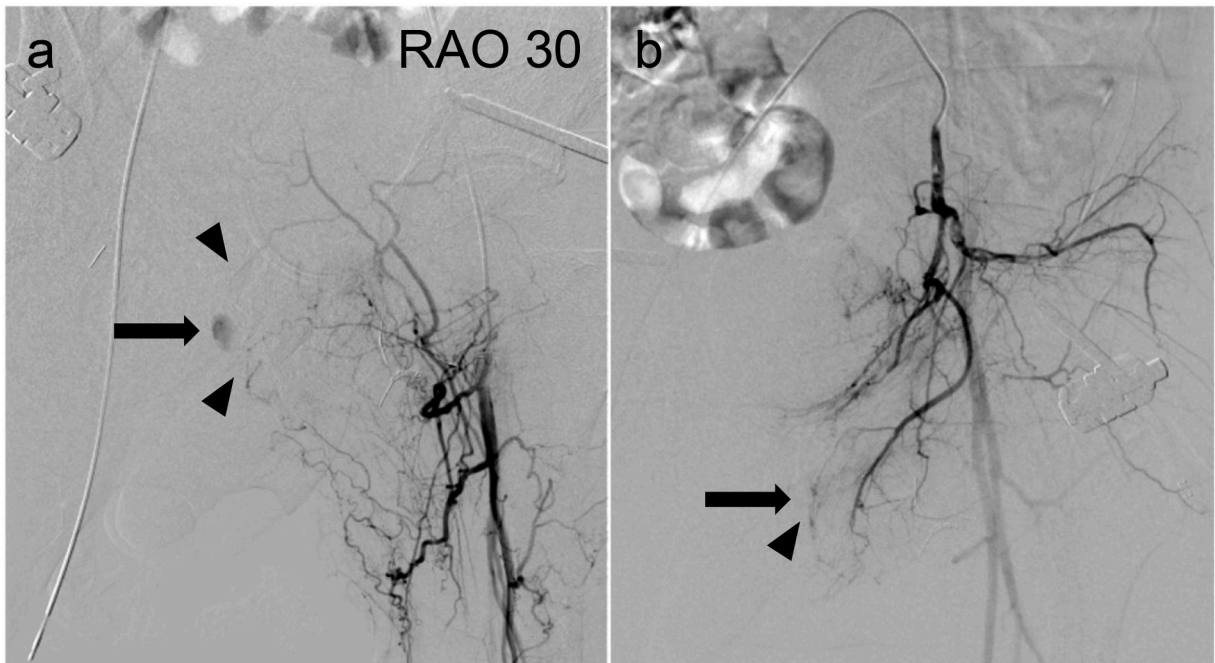


**Fig. 3.** Pseudoaneurysms shown by angiography.

(a) Right deep femoral artery angiography shows a pseudoaneurysm (black arrow). The culprit arteries of this pseudoaneurysm are multiple small branches of the right medial circumflex femoral artery (black arrowheads). (b) Left medial circumflex femoral artery angiography shows a pseudoaneurysm (black arrow). The multiple small branches of this artery (black arrowheads) are also culprit arteries. (c) Post-embolization angiography of the right external iliac artery reveals disappearance of the pseudoaneurysm. (d) Post-embolization angiography of the left external iliac artery also shows disappearance of the pseudoaneurysm.

TAE with IPM/CS may be useful in trauma patients with severe tissue injuries wherein small arteries are involved. Tissue damage induces angiogenesis with rapid capillary growth to supply oxygen and nutrients to the damaged tissue, resulting in increased capillary density [10]. In such cases, small capillaries can form traumatic pseudoaneurysms.

In conclusion, IPM/CS can be delivered to refractory pseudoaneurysms with small and tortuous culprit arteries otherwise



**Fig. 4.** Small arteries feeding the pseudoaneurysms.

(a) Left medial circumflex artery angiography in the right anterior oblique (RAO) position shows the pseudoaneurysm (black arrow). The multiple small branches of this artery feed the pseudoaneurysm (black arrowheads). (b) Left inferior gluteal artery angiography also shows the pseudoaneurysm (black arrow). The multiple small branches of this artery are the feeding arteries (black arrowhead).

unreachable by NBCA. Microsphere injection, further to IPM/CS use, could successfully embolize such pseudoaneurysms without rebleeding. More cases should be accumulated in which IPM/CS and microspheres are shown to be effective and safe for embolization.

#### Informed consent

Informed consent was obtained from the patient described in this case report.

#### Ethical statement

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

#### Conflict of interest

None.

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