Case Report

Treatment of Iatrogenic Pseudoaneurysm of Brachial Artery with Percutaneous Ultrasonographically Guided Thrombin Injection (PUGTI): A Case Report and a Literature Review

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Objective: Report the successful treatment of iatrogenic pseudoaneurysm of the brachial artery with the percutaneous ultrasonographically guided thrombin injection (PUGTI).

Material and Method: The pseudoaneurysm was caused by an accidental puncture into a native brachial artery instead of the venous side of an arteriovenous fistula during hemodialysis. The aneurysmal sac had a large size with a short neck, vulnerable to intra-arterial thrombosis and distal artery embolization during the thrombin glue injection.

Results: This procedure was secured by using color duplex ultrasonography (CDU) for the accurate positioning of the needle and the assessment of the optimal dosage of the injected bovine thrombin. After the procedure, an elastic compression was applied at the injection site to prevent the reentry of blood flow into the aneurysmal sac. The flow in the aneurysmal sac completely disappeared in seven days after the treatment. The 4-month follow-up demonstrated the complete resolution of the aneurysmal sac.

Conclusion: Percutaneous injection of bovine thrombin under ultrasound guidance is possible as one of the minimal invasive procedures to treat the pseudoaneurysm of the extremity artery.

Keywords: Pseudoaneurysm, Brachial artery, Iatrogenic pseudoaneurysm, Percutaneous thrombin injection, Ultrasonographically guided injection

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Pseudoaneurysm is one of the emergency vascular problems causing rupture, distal embolization, and compression of the adjacent organ. Open repair in an urgent situation is highly invasive, painful, and time-consuming with high morbidity. In the present paper, the authors report a case of brachial pseudoaneurysm treated by a simple procedure - percutaneous ultrasonographically guided thrombin injection (PUGTI).

A 58-year-old Thai male presented with a gradually enlarging and painful pulsatile mass at his right antecubital fossa (as shown in Fig. 1) after one month of accidentally puncturing his right brachial artery instead of a well-created arteriovenous fistula of his left arm during hemodialysis.

The co-morbidities of this patient - hypertension and diabetes mellitus - were well controlled. He also underwent a coronary artery bypass grafting 2 months earlier.

His physical examination revealed a large expansile pulsatile mass at the right antecubital fossa with systolic bruit. The patient was afebrile together with stable vital signs. The distal radial and ulnar pulses were palpable. The peripheral nerve function of the right arm was also normal.

Color duplex ultrasonography (CDU) and computerized tomographic angiography (CTA) demonstrated a large pseudoaneurysm of the right brachial
artery with 4.4 cm x 2.1 cm in size. The neck of the aneurysm was short and narrow (as shown in Fig. 2 and Fig. 3 respectively).

The procedure was performed in an operating theatre under sterile technique. The right arm lay perpendicular to the body in order to provide sufficient space for the surgeon and the ultrasonographer to work together. The strong right radial and ulnar pulses were confirmed prior to the procedure. Epinephrine (Adrenaline) with the concentration of 1:10,000 was prepared for an inadvertent anaphylactic reaction to the bovine thrombin.

After assessing the size of the pseudoaneurysm by CDU, its volume was calculated by a mathematic formula of ellipsoid volume as follows: The expected aneurysmal volume = \( \frac{A \times B \times C}{2} \)

A, B, and C are the approximated diameters of the three dimensions of an ellipsoid pseudoaneurysm.

Of utmost importance, the estimated bovine thrombin volume planned to inject into the aneurysmal sac was 3.6 cc (2.5 cm x 1.8 cm x 1.6 cm / 2), equal to the volume of active blood flow in the false aneurysm. However, this amount was not as large as the total pseudoaneurysm volume, 22.44 cc (6.0 cm x 3.4 cm x 2.2 cm / 2), since the majority of its internal space was occupied by thrombus.

During the procedure, 1% lignocaine solution was infiltrated into the subcutaneous layer over the aneurysm. A 25-gauge needle was inserted into the aneurysmal sac under ultrasonographic guiding (as shown in Fig. 4). When the needle was in the appropriate position, blood can be freely aspirated.

During the injection of bovine thrombin with low concentration (100 units/cc), the turbulent flow into the aneurysmal sac was continuously visualized. By CDU, the thrombin injection was stopped when the blood flow in the sac was absent. In order to prevent thrombosis or embolization of the distal artery, the tip of the needle was kept away from the aneurysmal neck. Eventually, the total volume of the bovine thrombin injected into the false aneurysm was only 3.0 cc, very close to the planned 3.6 cc, which was equal to the volume of active blood flow in the aneurysm as mentioned earlier. This was equivalent to 300 units of bovine thrombin.

After the thrombin was completely injected, the aneurysmal sac was mostly obliterated with clot

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**Fig. 1** A pulsatile mass of an iatrogenic pseudoaneurysm of right brachial artery

**Fig. 2** Pre-procedural colour duplex ultrasound of the pseudoaneurysm of the right brachial artery
except the area adjacent to the aneurysmal neck. The authors intended to leave this area intact to avoid the risk of distal brachial artery embolization and hand ischemia caused by repositioning the needle tip close to the persistent neck and additional thrombin given as noted in some other case reports\(^\text{1,2}\).

At the end of the procedure, an elastic compression was applied at the injection site in order to prevent arterial blood reflux into the aneurysmal sac. Blood flow in the aneurysmal sac was completely absent seven days after the injection. The 4-month follow-up demonstrated the reduced size and the complete resolution of the aneurysmal sac (as shown in Fig. 5 and Fig. 6 respectively).
Discussion

Pseudoaneurysm is a dilatation of an artery with actual disruption of one or more layers of its wall, rather than with expansion of wall layers. The significant increase in the incidence of iatrogenic pseudoaneurysm results from the higher popularity but less complexity of the percutaneous intervention. Pseudoaneurysm is one of the common complications of vascular intervention, apart from hematoma, thromboembolism, arteriovenous fistula, and arterial laceration. In addition, a false aneurysm could be found in more than 60% of vascular intervention related complications as stated in a previous study. The common causes of iatrogenic pseudoaneurysm are cardiac catheterization and peripheral angiography with/without angioplasty. Other intervention techniques, such as percutaneous hemodialysis access and percutaneous intra-aortic balloon pump placement, are less common causes of iatrogenic pseudoaneurysms.

Iatrogenic pseudoaneurysm can be treated by either non-invasive or invasive techniques. Non-invasive techniques comprise observation, blind compression and ultrasound-guided compression. Invasive techniques consist of open surgical repair and percutaneous techniques. In the past, the highly invasive procedure like an operation was the primary treatment for this complication, causing pain and high morbidity. Percutaneous techniques include ultrasound-guided thrombin injection, collagen plugs, implantable coils and thrombogenic wire mesh. Nowadays PUGTI, technically less invasive and time consuming, was introduced for treating pseudoaneurysm of the injured artery.

Thrombin, a serine protease, cleaves fibrinogen into fibrin monomers, enables the formation of cross-linked fibrin by activating Factor XIII, and stimulates platelet activation. When thrombin is exposed to a relatively static pool of blood in a pseudoaneurysm, it produces rapid thrombosis.

The brachial artery has been reported in many large case series as an unusual site of pseudoaneurysm following cardiac catheterization, whereas femoral artery is the most common site of iatrogenic false aneurysms.

For the historical background of minimal invasive techniques for pseudoaneurysm treatment, in 1986 Cope and Zeit reported their successful intraoperative direct injection of diluted thrombin to treat pseudoaneurysm of iliac, femoral and peroneal artery. In 1991, Fellmeth et al used ultrasound-guided compression to repair post-catheterization pseudoaneurysm. In 1997, Liau et al injected high-dose (1,000 U/cc) thrombin under ultrasonographic guiding. Four years later, Reeder et al employed low-dose (100 U/cc) thrombin injection to treat iatrogenic femoral artery pseudoaneurysm.

Since iatrogenic brachial artery pseudoaneurysms are rare, its literature review is compulsory for the selection of the most suitable method of treatment in order to prevent and correct any possible complications. Between 1998 and 2003, there are only 15 cases of the iatrogenic brachial artery pseudoaneurysm from seven publications (as shown in Table 1) reporting the results and complications of PUGTI as the primary treatment.

The special characteristic of iatrogenic brachial artery pseudoaneurysm is its relatively short aneurysmal neck that is prone to intra-arterial thrombosis or distal embolization of new thrombus during PUGTI. To prevent these dreadful complications, the volume of the injected thrombin into the aneurysmal sac must not be higher than that of active blood flow in the pseudoaneurysm. In addition, the needle tip must be guided by CDU to keep it away from the aneurysmal neck.

Of utmost importance, the estimated bovine thrombin volume planned for injecting into the aneurysmal sac was 3.6 cc (2.5 cm x 1.8 cm x 1.6 cm / 2) equal to the volume of active blood flow in the false aneurysm. The amount was not as large as the total volume of blood flow into the pseudoaneurysm at 22.44 cc (6.0 cm x 3.4 cm x 2.2 cm / 2) since the majority of the internal space of the aneurysm was occupied by thrombus.

Major complications of PUGTI are anaphylaxis, abnormal hemostasis, intra-arterial thrombosis, and distal embolization. Anaphylaxis results from allergic reaction to bovine thrombin or antithrombin IgE titre elevation after repeated topical applications of thrombin. Anaphylaxis reactions are classified as type I hypersensitivity reactions. The patient with anaphylactic reaction to injected thrombin may present with diffuse itching, severe shortness of breath, generalized edema, and hypotension. This condition can be managed by endotracheal intubation and ventilation, Epinephrine, an intravenous fluid and corticosteroids administration, and hospitalization until the symptoms resolve. Anaphylaxis prevention should be focused on patients with the history of repeated bovine thrombin exposure. Skin prick test with 1,000U/cc. bovine thrombin is performed in these patients followed by observation of wheal and flare for 15 minutes as suggested by Tadokoro et al. Abnormal hemostasis is
caused by repeated bovine thrombin exposure and antibodies cross-reaction with human coagulation factor V(22-28). Therefore, this coagulopathy should be of concern when the pseudoaneurysm is remedied by thrombin injection. Intra-arterial thrombosis and distal embolization were treated by 5,000 unit heparin infusion, thrombectomy and intra-arterial thrombolysis (rt-PA 1-2 mg/h)(1,2,29).

**Conclusion**

A case of the successful treatment of an iatrogenic brachial artery pseudoaneurysm by PUGTI was reported. The report illustrates that the procedure is possible to be one of the minimal invasive procedures to treat a pseudoaneurysm of the extremity artery.

**References**

4. Kent KC, McArdle CR, Kennedy B, Baim DS, Anninos E, Skillman JJ. A prospective study of

<table>
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<tr>
<th>Year</th>
<th>First author</th>
<th>No. of case(s)</th>
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<td>Intra-arterial thrombosis</td>
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<td>(2)-Cardiac catheterization (2)-GSW (1)-Removal of infected A-V graft</td>
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<td>2000</td>
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<td>2003</td>
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PUGTI, Percutaneous ultrasound-guided thrombin injection; GSW, Gun shot wound; A-V graft, Arterio-venous graft
การรักษาหลอดเลือดแดงที่ต้นแขนโป่งพองที่เกิดขึ้นหลังการบาดเจ็บ ด้วยวิธีการฉีดสารธรอมบิน
ร่วมกับการใช้เครื่องอัลตราซาวด์นำทาง: รายงานผู้ป่วยและการทบทวนวรรณกรรมที่เกี่ยวข้อง

ชุมพล ว่องวานิช, เจริญ เจริงเศรษฐกิจ, นนทปฏิ เสริม vara สวัสดิ, คำสนิท คามิน, หินตระกูล, มุทิระวุฒิ

วัตถุประสงค์: รายงานผลสำเร็จของการรักษาโรคก้อนหลอดเลือดแดงที่ต้นแขนโป่งพองที่เกิดขึ้นหลังได้รับบาดเจ็บจากเข็มที่ใช้ฟอกเลือดแทงโดยการฉีดสารธรอมบินร่วมกับการใช้เครื่องอัลตราซาวด์นำทางในผู้ป่วยชายไทยอายุ 58 ปีที่เป็นโรคไตวายเรื้อรัง และพบสมบัติที่เกี่ยวข้อง

วัสดุและวิธีการ: การฉีดสารธรอมบินที่มีความเข้มข้นต่ำ (100 หน่วยต่อ ลบ.ซม.) เข้าไปในโพรงหลอดเลือดแดงโป่งพองที่ต้นแขนขวา เพื่อทำให้เกิดลิมเลือดภายในโพรงหลอดเลือดแดงที่โป่งพอง และทำให้เห็นโครงการเพื่อป้องกันโรคที่เกิดขึ้นตามเวลานั้น เข้าไปในโพรงหลอดเลือดแดงโป่งพอง เพื่อป้องกันการแพร่กระจายของหลอดเลือดแดงโป่งพองอันนำไปสู่การขยายขนาด, การขยาย หรือ การขาดเลือดของแขนขวาบน

ผลการศึกษา: ผู้ป่วย 1 ราย ได้รับการฉีดสารธรอมบินที่มีความเข้มข้นต่ำ เข้าไปในโพรงหลอดเลือดแดงต้นแขนขวาโป่งพอง ที่มีการเกิดลิมเลือดภายในโพรงหลอดเลือดแดงที่โป่งพองได้สำเร็จ ประกอบไปด้วยการฉีดสารธรอมบินร่วมกับการใช้เครื่องอัลตราซาวด์นำทางในการรักษาด้วยวิธีการต่าง ๆ และพบสมบัติที่เกี่ยวข้อง หลังการรักษา 4 เดือน

สรุป: วิธีการรักษาโรคก้อนหลอดเลือดแดงโป่งพองที่ต้นแขนซื้อเกิดขึ้นหลังได้รับบาดเจ็บด้วยการฉีดสารธรอมบินที่มีความเข้มข้นต่ำ ร่วมกับการใช้เครื่องอัลตราซาวด์นำทางเป็นวิธีการรักษาทางเลือกใหม่ นอกเหนือจากการรักษา วิธีดังกล่าวเพิ่มความสะดวก ซึ่งวิธีการใหม่นี้เป็นวิธีการที่สะดวกรวดเร็วและไม่ทำให้ผู้ป่วยได้รับความเจ็บปวดในการรักษาด้วยการฉีดแบบตังค์