

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

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

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 mathematical formula of ellipsoid volume as follows: The

expected aneurysmal volume = $(A \times B \times C) / 2$

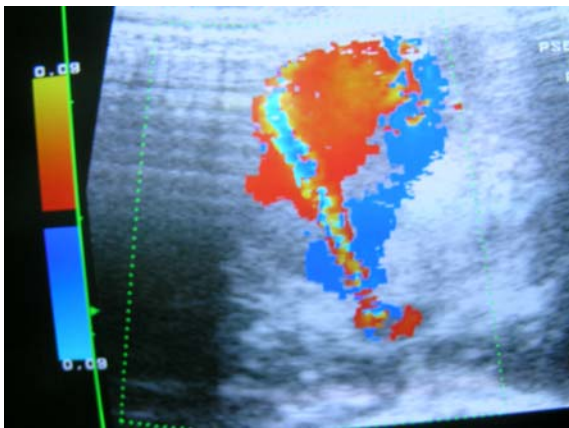
A, B, and C are the approximated diameters of the three dimensions of an ellipsoid pseudoaneurysm.

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.

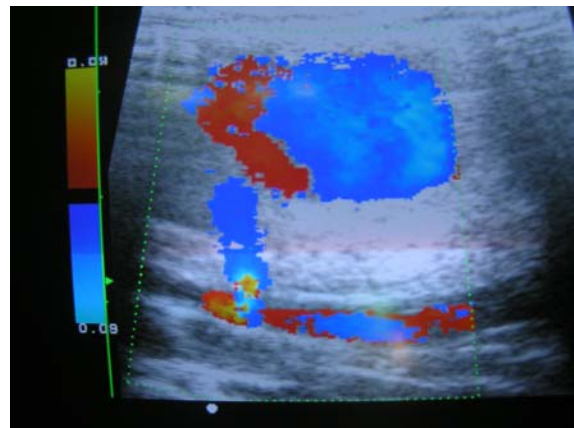
During the procedure, 1% lignocaine solution was infiltrated into the subcutaneous layer over the aneurysm. A 25-gauge needle was inserted into the aneurysmal sac under ultrasonographic guiding (as shown in Fig. 4). When the needle was in the appropriate position, blood can be freely aspirated.

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



A



B

Fig. 2 Pre-procedural colour duplex ultrasound of the pseudoaneurysm of the right brachial artery

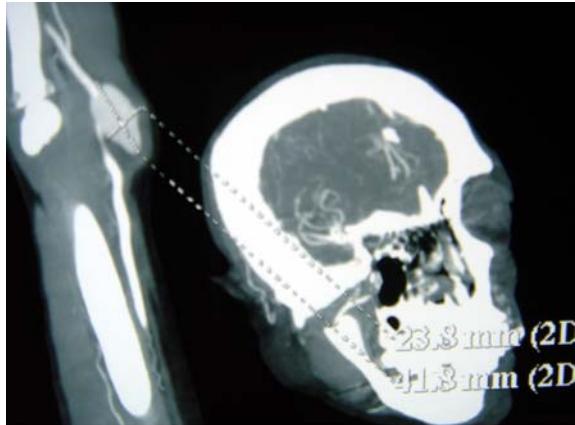


Fig. 3 Pre-procedural computerized tomographic angiography of the pseudoaneurysm of the right brachial artery



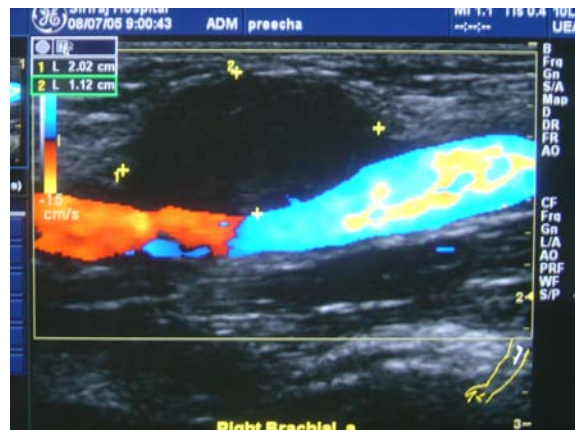
Fig. 5 The right brachial pseudoaneurysm with reduced size at 4 months following PUGTI



Fig. 4 The brachial pseudoaneurysm was punctured by a 25-gauge needle under ultrasound guiding during PUGTI



A



B

Fig. 6 The complete resolution of the brachial artery pseudoaneurysm 4 months post PUGTI (A, B)

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^(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⁽³⁾. 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^(4,5). In addition, a false aneurysm could be found in more than 60% of vascular intervention related complications as stated in a previous study⁽⁶⁾. 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⁽⁷⁾. 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⁽⁸⁻¹⁰⁾.

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⁽¹¹⁾. In 1991, Fellmeth et al used ultrasound-guided compression to repair post-catheterization pseudoaneu-

rysm⁽¹²⁾. In 1997, Liao et al injected high-dose (1,000 U/cc) thrombin under ultrasonographic guiding⁽¹³⁾. Four years later, Reeder et al employed low-dose (100 U/cc) thrombin injection to treat iatrogenic femoral artery pseudoaneurysm⁽¹⁴⁾.

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⁽²⁰⁾. 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⁽²¹⁾. Abnormal hemostasis is

Table 1. Published reports of the treatment of iatrogenic brachial artery pseudoaneurysm with PUGTI

Year	First author	No. of case(s)	Pathology	Cause(s)	Method of treatment	Complication(s)
1998	Lennox ⁽¹⁾	1	Brachial artery pseudoaneurysm in an infant	Cardiac catheterization	PUGTI (1,000U/cc)	Intra-arterial thrombosis
1999	Sheiman ⁽¹⁵⁾	2	Brachial artery pseudoaneurysm	Cardiac catheterization	PUGTI (1,000U/cc)	None
2000	Kang ⁽²⁾	5	Brachial artery pseudoaneurysm	(2)-Cardiac catheterization (2)-GSW (1)-Removal of infected A-V graft	PUGTI (1,000U/cc)	Intra-arterial thrombosis (1)
2000	Clark ⁽¹⁶⁾	2	Brachial artery pseudoaneurysm of hemodialysis fistula	Hemodialysis access	PUGTI (1,000U/cc) with balloon angioplasty (1)	None
2000	Perna ⁽¹⁷⁾	2	Brachial artery pseudoaneurysm	Cardiac catheterization	PUGTI (1,000U/cc)	None
2002	Pezzullo ⁽¹⁸⁾	1	Brachial artery pseudoaneurysm in a neonate	Cardiac catheterization	PUGTI (1,000U/cc)	None
2003	Ghersin ⁽¹⁹⁾	2	Brachial artery pseudoaneurysm of hemodialysis fistula	Hemodialysis access	PUGTI (1,000U/cc)	None

PUGTI, Percutaneous ultrasound-guided thrombin injection; GSW, Gun shot wound; A-V graft, Arterio-venous graft

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

1. Lennox A, Griffin M, Nicolaidis A, Mansfield A. Regarding "Percutaneous ultrasound guided thrombin injection: a new method for treating postcatheterization femoral pseudoaneurysms". *J Vasc Surg* 1998; 28: 1120-1.
2. Kang SS, Labropoulos N, Mansour MA, Michelini M, Filliung D, Baubly MP, et al. Expanded indications for ultrasound-guided thrombin injection of pseudoaneurysms. *J Vasc Surg* 2000; 31: 289-98.
3. The American Heritage[□] Steadman's Medical Dictionary. New York: Houghton Mifflin; 2007. Pseudoaneurysm. Available from: <http://www.houghton-mifflinbooks.com/epub/medical.shtml>
4. Kent KC, McArdle CR, Kennedy B, Baim DS, Anninos E, Skillman JJ. A prospective study of

- the clinical outcome of femoral pseudoaneurysms and arteriovenous fistulas induced by arterial puncture. *J Vasc Surg* 1993; 17: 125-31.
5. Ricci MA, Trevisani GT, Pitcher DB. Vascular complications of cardiac catheterization. *Am J Surg* 1994; 167: 375-8.
 6. Hallett JW Jr, Wolk SW, Cherry KJ Jr, Gloviczki P, Pairolero PC. The femoral neuralgia syndrome after arterial catheter trauma. *J Vasc Surg* 1990; 11: 702-6.
 7. Vaughan DE, Schafer AI, Loscalzo J. Normal mechanisms of 33 hemostasis and fibrinolysis. In: Loscalzo J, Creager MA, Dzau VJ, editors. *Vascular medicine*. 2nd ed. Boston: Little Brown; 1996: 207-16.
 8. Khoury M, Batra S, Berg R, Rama K, Kozul V. Influence of arterial access sites and interventional procedures on vascular complications after cardiac catheterizations. *Am J Surg* 1992; 164: 205-9.
 9. McCollum CH, Mavor E. Brachial artery injury after cardiac catheterization. *J Vasc Surg* 1986; 4: 355-9.
 10. Babu SC, Piccorelli GO, Shah PM, Stein JH, Clauss RH. Incidence and results of arterial complications among 16,350 patients undergoing cardiac catheterization. *J Vasc Surg* 1989; 10: 113-6.
 11. Cope C, Zeit R. Coagulation of aneurysms by direct percutaneous thrombin injection. *AJR Am J Roentgenol* 1986; 147: 383-7.
 12. Fellmeth BD, Roberts AC, Bookstein JJ, Freischlag JA, Forsythe JR, Buckner NK, et al. Postangiographic femoral artery injuries: nonsurgical repair with US-guided compression. *Radiology* 1991; 178: 671-5.
 13. Liao CS, Ho FM, Chen MF, Lee YT. Treatment of iatrogenic femoral artery pseudoaneurysm with percutaneous thrombin injection. *J Vasc Surg* 1997; 26: 18-23.
 14. Reeder SB, Widlus DM, Lazinger M. Low-dose thrombin injection to treat iatrogenic femoral artery pseudoaneurysms. *AJR Am J Roentgenol* 2001; 177: 595-8.
 15. Sheiman RG, Brophy DP, Perry LJ, Akbari C. Thrombin injection for the repair of brachial artery pseudoaneurysms. *AJR Am J Roentgenol* 1999; 173: 1029-30.
 16. Clark TW, Abraham RJ. Thrombin injection for treatment of brachial artery pseudoaneurysm at the site of a hemodialysis fistula: report of two patients. *Cardiovasc Intervent Radiol* 2000; 23: 396-400.
 17. La Perna L, Olin JW, Goines D, Childs MB, Ouriel K. Ultrasound-guided thrombin injection for the treatment of postcatheterization pseudoaneurysms. *Circulation* 2000; 102: 2391-5.
 18. Pezzullo JA, Wallach MT. Successful percutaneous thrombin injection of a brachial artery pseudoaneurysm in a neonate. *AJR Am J Roentgenol* 2002; 178: 244-5.
 19. Ghersin E, Karram T, Gaitini D, Ofer A, Nitecki S, Schwarz H, et al. Percutaneous ultrasonographically guided thrombin injection of iatrogenic pseudoaneurysms in unusual sites. *J Ultrasound Med* 2003; 22: 809-16.
 20. Pope M, Johnston KW. Anaphylaxis after thrombin injection of a femoral pseudoaneurysm: recommendations for prevention. *J Vasc Surg* 2000; 32: 190-1.
 21. Tadokoro K, Ohtoshi T, Takafuji S, Nakajima K, Suzuki S, Yamamoto K, et al. Topical thrombin-induced IgE-mediated anaphylaxis: RAST analysis and skin test studies. *J Allergy Clin Immunol* 1991; 88: 620-9.
 22. Ortel TL, Moore KD, Quinn-Allen MA, Okamura T, Sinclair AJ, Lazarchick J, et al. Inhibitory anti-factor V antibodies bind to the factor V C2 domain and are associated with hemorrhagic manifestations. *Blood* 1998; 91: 4188-96.
 23. Ortel TL, Charles LA, Keller FG, Marcom PK, Oldham HN Jr, Kane WH, et al. Topical thrombin and acquired coagulation factor inhibitors: clinical spectrum and laboratory diagnosis. *Am J Hematol* 1994; 45: 128-35.
 24. Dorion RP, Hamati HF, Landis B, Frey C, Heydt D, Carey D. Risk and clinical significance of developing antibodies induced by topical thrombin preparations. *Arch Pathol Lab Med* 1998; 122: 887-94.
 25. Spotnitz WD. Fibrin sealant in the United States: clinical use at the University of Virginia. *Thromb Haemost* 1995; 74: 482-5.
 26. Jackson MR, MacPhee MJ, Drohan WN, Alving BM. Fibrin sealant: current and potential clinical applications. *Blood Coagul Fibrinolysis* 1996; 7: 737-46.
 27. Gardner EC Jr, Brooks WS Jr. Absence of disseminated intravascular coagulation with endoscopic sclerosis of esophageal varices. *Gastrointest Endosc* 1982; 28: 67-9.
 28. Muntean W, Zenz W, Finding K, Zobel G, Beitzke A. Inhibitor to factor V after exposure to fibrin sealant during cardiac surgery in a two-year-old child. *Acta Paediatr* 1994; 83: 84-7.
 29. Sadiq S, Ibrahim W. Thromboembolism complicating thrombin injection of femoral artery pseudoaneurysm: management with intraarterial thrombolysis. *J Vasc Interv Radiol* 2001; 12: 633-6.

การรักษาหลอดเลือดแดงที่ต้นแขนโป่งพองที่เกิดขึ้นหลังการบาดเจ็บ ด้วยวิธีการฉีดสารทอมบิน ร่วมกับการใช้เครื่องอัลตราซาวด์นำทาง: รายงานผู้ป่วยและการทบทวนวารสารที่เกี่ยวข้อง

ชุมพล ว่องวานิช, เจริญน เรืองเศรษฐิกิจ, ณัฐวุฒิ เสริมสาธณสวัสดิ์, คามิน ชินศักดิ์ชัย, ประมุข มุทิตรางกูร

วัตถุประสงค์: รายงานผลสำเร็จของการรักษาโรคก้อนหลอดเลือดแดงที่ต้นแขนโป่งพองที่เกิดขึ้นหลังได้รับบาดเจ็บจาก เข็มที่ใส่พอกเลือดแดง โดยการฉีดสารทอมบินร่วมกับการใช้เครื่องอัลตราซาวด์นำทางในผู้ป่วยชายไทยอายุ 58 ปี ที่เป็นโรคไตวายเรื้อรัง และทบทวนบทความที่เกี่ยวข้อง

วัสดุและวิธีการ: การฉีดสารทอมบินที่มีความเข้มข้นต่ำ (100 หน่วยต่อ ลบ.ซม.) เข้าไปในโพรงหลอดเลือดแดงโป่งพอง ที่ต้นแขนขวา เพื่อทำให้ลิ้มเลือดก่อดำขึ้นภายในโพรงหลอดเลือดแดงที่โป่งพองนั้น และทำให้เลือดหยุดไหลเวียน เข้าไปในโพรงหลอดเลือดแดงที่โป่งพอง เพื่อป้องกันภาวะแทรกซ้อนของหลอดเลือดแดงโป่งพองอันได้แก่ การขยาย ขนาด การแตก หรือ การขาดเลือดของแขนข้างนั้น

ผลการศึกษา: ผู้ป่วย 1 ราย ได้รับการฉีดสารทอมบินที่มีความเข้มข้นต่ำเข้าไปในโพรงหลอดเลือดแดงต้นแขนขวา โป่งพอง ก่อให้เกิดลิ้มเลือดภายในโพรงหลอดเลือดแดงที่โป่งพองได้สำเร็จ ร่วมกับการใช้ผ้ายืดพันรอบก่อนร่วมด้วย เป็นระยะเวลาสั้น ๆ เพื่อหยุดการไหลเวียนของเลือดนั้นอย่างสมบูรณ์ โดยปราศจากภาวะแทรกซ้อนจากการรักษา ด้วยวิธีการดังกล่าว และพบว่าก่อนดังกล่าวมีขนาดเล็กลง หลังการรักษา 4 เดือน

สรุป: วิธีการรักษาโรคก้อนหลอดเลือดแดงโป่งพองที่ต้นแขนซึ่งเกิดขึ้นหลังได้รับบาดเจ็บด้วยการฉีดสารทอมบิน ที่มีความเข้มข้นต่ำ ร่วมกับการใช้เครื่องอัลตราซาวด์นำทางเป็นวิธีการรักษาทางเลือกใหม่ นอกเหนือจากการรักษา วิธีดั้งเดิมด้วยการผ่าตัด ซึ่งวิธีการใหม่นี้เป็นวิธีการที่สะดวกรวดเร็วกว่า และทำให้ผู้ป่วยได้รับความเจ็บปวดน้อยกว่า การรักษาด้วยการผ่าตัดแบบดั้งเดิม
