Ultrasound-guided compression repair of peripheral artery pseudoaneurysm: 8 years’ experience of a single institute

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Abstract

Background: Femoral artery pseudoaneurysm is a rare complication but with increasing frequency nowadays due to the advances of endovascular intervention. Rare cases of brachial or popliteal artery pseudoaneurysms had ever been reported and the predictive factors of failed ultrasound-guided compression repair (UGCR) are controversial.

Methods: During the past 8 years, 21 patients (12 males and nine females; median age, 64 years) with peripheral pseudoaneurysms (femoral artery, n = 17; brachial artery, n = 3; popliteal artery, n = 1) were enrolled. A high frequency of 10–12 MHz color ultrasound was used to evaluate the presence of a pseudoaneurysm. The area of the pseudoaneurysm sac and the width and length of the pseudoaneurysm neck were recorded. Under real-time ultrasound guiding, gradual pressure was applied with the probe to obliterate flow in the pseudoaneurysm neck while still allowing flow through the supplying artery for approximately 10–15 minutes with at most three times (45 minutes’ compression). Follow-up color sonography was obtained at 24 hours to detect any recurrence.

Results: The mean area and the largest dimension of the 21 pseudoaneurysms were 7.3 ± 6.5 cm² and 3.6 ± 1.8 cm, respectively. The mean width and the mean length of the pseudoaneurysm neck were 2.1 ± 0.9 and 3.3 ± 2.0 mm, respectively. Successful thrombosis of the pseudoaneurysm was achieved in 19(90.5%) patients. The mean compression time of the 19 successful UGCR was 21.2 ± 11.0 minutes. Two patients failed the UGCR procedure after a 45-minute compression. Both of the two pseudoaneurysms were located in the femoral artery with a large width of the pseudoaneurysm neck (4 and 5 mm, respectively).

Conclusion: UGCR is a safe and cost-effective therapy for treating peripheral pseudoaneurysms of not only femoral artery, but also brachial artery and popliteal artery. We considered the width of the pseudoaneurysm neck to be the predictive factor of technical success.

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Keywords: brachial artery; femoral artery; popliteal artery; pseudoaneurysm; ultrasound-guided compression repair

1. Introduction

Discovering a postangiographic femoral artery pseudoaneurysm is a rare complication, with a reported frequency of 0.05—0.55%.1,2 The rate of incidence of this complication has been increasing, however, with the growing use of large-diameter sheaths, and more potent anticoagulant regimens that may be as high as 6—8%.2,3 A pseudoaneurysm consists of a perfused sac (the false lumen) connected to the supplying artery by a “neck”, and it is contained only by hematoma and the pressure of surrounding tissues. Additionally, a pseudoaneurysm exists outside the arterial lumen due to disruption of the arterial wall as a result of puncture.4 Rupture leading to catastrophic bleeding is a potential complication, which may be occult if retroperitoneal.5 The other sequelae of...
pseudoaneurysms include pain, progressive enlargement, infection, skin necrosis, compression neuropathy, and distal limb ischemia.6–8

Ultrasound, especially adjunct to color Doppler imaging, is the method of choice for diagnosis of pseudoaneurysm. Typical findings of pseudoaneurysm include swirling color flow in a mass separating from the affected artery, color flow within a tract leading from the artery to the mass consistent with the pseudoaneurysm neck, and a typical to-and-fro Doppler waveform in the pseudoaneurysm neck.9 With the aid of color Doppler ultrasound, the presence of pseudoaneurysm, the relevant supplying artery, and the pseudoaneurysm sac and neck can be detected easily and accurately.6,8 The sensitivity of color Doppler ultrasound in diagnosing peripheral pseudoaneurysm was reported to be between 94% and 97%.9,10,11

Although the majority of small pseudoaneurysms (less than 2–3 cm in diameter) are prone to thrombose spontaneously within 4 weeks,12–14 this spontaneous resolution is unpredictable, and the watch-and-wait policy may reduce patients’ activity and delay discharge, prompting an early active management of most pseudoaneurysms. Since the first description by Fellmeth et al15 of ultrasound-guided compression repair (UGCR), it has been proved to be a safe and cost-effective method for achieving pseudoaneurysm thrombosis, with initial reports suggesting a failure rate of 10–35%.9,15–20

With the advances of endovascular intervention, vascular puncture from a different peripheral artery may be adopted as an entry site; thus, complications of postangiographic pseudoaneurysm may, in the future, occur in any other peripheral vessel. Meanwhile, the predictive factors for failed UGCR are controversial. In this article, we reported our 8 years’ experience of one institute in performing UGCR to treat peripheral pseudoaneurysms, including lesions in the femoral, brachial, popliteal arteries. Furthermore, the predictive factors of failed UGCR are discussed.

2. Methods

From June 2003 to July 2011, 21 patients with peripheral pseudoaneurysms (femoral artery, n = 17; brachial artery, n = 3; popliteal artery, n = 1) referred to our department for UGCR were enrolled in this retrospective review. Exclusion criteria for compression repair included patients with pseudoaneurysms above the inguinal ligament, presence of a puncture site infection, or a limb threatened by vascular compromise. There were 12 males and nine females with the median age of 64 years (range, 1–87 years). Pseudoaneurysms were the complications of coronary intervention (n = 4, 7-Fr sheath), transcatheter arterial embolization (n = 2, 5-Fr sheath), hemodialysis (n = 3, 16-G needle), double lumen catheter insertion of the femoral vein (n = 3, 11-Fr catheter), percutaneous transluminal angioplasty (PTA) for peripheral arterial disease (n = 8, 6-Fr sheath), and renal artery stenosis (n = 1, 6-Fr sheath). The median time interval between the related procedure and UGCR was 3 days (range, 2–14 days).

In patients who used anticoagulants, heparin would be halted for at least 4 hours, or warfarin would be corrected. The international normalized ratio (INR) was then rechecked prior to the commencement of the procedure. Basic demographic data of the 21 patients were listed in Table 1.

A high frequency of 10–12 MHz color ultrasound (Acuson 128XP, Mountain View, CA, USA; or GE LOGIQ 9, Wauwatosa, WI, USA) was used to evaluate the presence of a pseudoaneurysm, the relevant supplying artery, and the size of the pseudoaneurysm sac and neck. The area (multiplied by the two dimensions) of the pseudoaneurysm sac and the width and length (from the pseudoaneurysm to the vessel of origin) of the pseudoaneurysm neck were recorded and listed in Table 1. UGCR was performed using the technique described by Fellmeth et al.15 Under real-time ultrasound guidance, gradual pressure was applied manually with the probe to interrupt flow in the pseudoaneurysm neck while still allowing flow through the supplying artery (Fig. 1). After approximately 10–15 minutes, both flow and peripheral pulses were reassessed, and the procedure may be repeated at most three times (45 minutes’ compression) if the false lumen and neck were still patent. The compression cycles would be ceased if patients could not tolerate further compression, and the compression time in each patient was recorded. A successful repair was defined as one that effected complete thrombosis of the pseudoaneurysm flow lumen. Intravenous analgesics (Fentanyl-Fresenius 100 μg) were given only if necessary; no other drugs were given during the procedure. Written informed consent was obtained from each patient or his/her family. The retrospective imaging and medical reviews were approved by the institutional review board of our hospital.

After successful thrombosis, the patient would be kept supine for 3–4 hours with the affected leg in a stretched position. Follow-up color sonography was obtained within 24 hours to detect any recurrence. Clinical follow-up (>30 days) was done by medical record review and/or telephone contact.

All statistical analyses were performed using SPSS 17 software. Continuous data were presented as mean, standard deviation, median, and range.

3. Results

The mean area and the largest dimension of the 21 pseudoaneurysms were 7.3 ± 6.5 cm² (median, 5.7 cm²; range, 0.5–31.5 cm²) and 3.6 ± 1.8 cm (median, 3.2 cm; range, 1.0–9.0 cm), respectively. The mean width and the mean length of the pseudoaneurysm neck were 2.1 ± 0.9 mm (median, 1.8 mm; range, 1.0–5.0 mm) and 3.3 ± 2.0 mm (median, 3.1 mm; range, 1.1–20.2 mm), respectively. None of the patients had significantly prolonged coagulation status with the INR, which ranged from 0.86 to 1.35. Successful thrombosis of the pseudoaneurysm sac and neck was achieved in 19(90.5%) of the 21 patients, including 15 femoral artery, three brachial artery, and one popliteal artery (Fig. 2). The mean compression time of the 19 successful UGCR was 21.2 ± 11.0 minutes (median, 20 minutes; range, 8–45 minutes). The results were summarized in Table 1.

Two
patients failed the compression repair after the 45-minute compression. Both of the two pseudoaneurysms were located in the femoral artery, with a large width of the pseudoaneurysm neck (4 and 5 mm, respectively). Of those two, one patient successfully underwent percutaneous transarterial embolization of the pseudoaneurysm track with coils (Fig. 3), and the other patient underwent surgical bypass procedure directly. All patients tolerated the UGCR procedure satisfactorily, with only one patient requiring intravenous analgesics. No other procedure-related complications were encountered.

All 19 patients who had successful UGCR further had 24-hour color ultrasound and clinical follow-up after 30 days. After the follow-up medical examination, all patients were found to be asymptomatic with no evidence of recurrence.

4. Discussion

Surgery had been the traditional approach for repair of the peripheral pseudoaneurysm. Although surgery is effective, it is also relatively expensive and carries particular risks for patients with coronary artery disease. A complication rate of approximately 20% had been reported, with risks including bleeding (7.4%), neuralgia (5.2%), and death (2.1%). Moreover, patients with groin hematomas may have poor healing of the surgical site, leading to prolonged hospitalization and delayed ambulation. Percutaneous endovascular management approaches of the peripheral pseudoaneurysm include the following: (1) transcatheter coil embolization of the aneurysm sac, whose potential limitations include increasing pressure in a cavity that does not have a true wall.

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**Table 1**

Demographic data of 21 patients.

<table>
<thead>
<tr>
<th>No.</th>
<th>Sex/age</th>
<th>Related procedure</th>
<th>Side</th>
<th>Location</th>
<th>Interval(d)</th>
<th>Aneurysm area (cm²)/LD (cm)</th>
<th>Tract (mm) Width × length</th>
<th>S/F</th>
<th>Comp. (min)</th>
</tr>
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<td>1</td>
<td>M/87</td>
<td>TAE</td>
<td>R</td>
<td>CFA</td>
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<td>7.1/4.4</td>
<td>2.0 × 5.6</td>
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<td>15</td>
</tr>
<tr>
<td>2</td>
<td>M/58</td>
<td>Coronary stenting</td>
<td>R</td>
<td>CFA</td>
<td>14</td>
<td>10.8/3.6</td>
<td>2.0 × 6.2</td>
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<td>40</td>
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<td>F/59</td>
<td>Hemodialysis</td>
<td>R</td>
<td>BA</td>
<td>3</td>
<td>7.5/4.7</td>
<td>1.8 × 3.2</td>
<td>S</td>
<td>10</td>
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<tr>
<td>4</td>
<td>M/78</td>
<td>FVC</td>
<td>R</td>
<td>CFA</td>
<td>5</td>
<td>8.5/1.0</td>
<td>5.0 × 3.5</td>
<td>F</td>
<td>45</td>
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<tr>
<td>5</td>
<td>M/36</td>
<td>PTA for renal artery</td>
<td>L</td>
<td>CFA</td>
<td>7</td>
<td>5.7/2.7</td>
<td>4.0 × 20.2</td>
<td>F</td>
<td>45</td>
</tr>
<tr>
<td>6</td>
<td>F/61</td>
<td>Hemodialysis</td>
<td>L</td>
<td>BA</td>
<td>6</td>
<td>1.5/1.5</td>
<td>1.8 × 2.5</td>
<td>S</td>
<td>12</td>
</tr>
<tr>
<td>7</td>
<td>M/63</td>
<td>FVC</td>
<td>L</td>
<td>CFA</td>
<td>5</td>
<td>2.8/2.5</td>
<td>1.9 × 19.2</td>
<td>S</td>
<td>35</td>
</tr>
<tr>
<td>8</td>
<td>F/70</td>
<td>Coronary stenting</td>
<td>R</td>
<td>CFA</td>
<td>6</td>
<td>31.5/9.0</td>
<td>2.2 × 3.2</td>
<td>S</td>
<td>35</td>
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<td>M/80</td>
<td>PTA for PAD</td>
<td>L</td>
<td>CFA</td>
<td>2</td>
<td>2.4/1.7</td>
<td>1.7 × 3.5</td>
<td>S</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
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<td>L</td>
<td>BA</td>
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<td>2.5 × 1.5</td>
<td>S</td>
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<td>11</td>
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<td>L</td>
<td>CFA</td>
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<td>10.5/6.2</td>
<td>2.2 × 20.1</td>
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<tr>
<td>12</td>
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<td>R</td>
<td>CFA</td>
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<td>5.0/2.4</td>
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<td>20</td>
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<td>R</td>
<td>CFA</td>
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<td>5.3/3.1</td>
<td>2.0 × 3.5</td>
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<tr>
<td>14</td>
<td>F/85</td>
<td>PTA for PAD</td>
<td>R</td>
<td>CFA</td>
<td>2</td>
<td>4.1/2.9</td>
<td>2.3 × 14.1</td>
<td>S</td>
<td>17</td>
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<tr>
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<td>M/64</td>
<td>Coronary stenting</td>
<td>R</td>
<td>CFA</td>
<td>11</td>
<td>7.6/3.8</td>
<td>2.0 × 4.0</td>
<td>S</td>
<td>45</td>
</tr>
<tr>
<td>16</td>
<td>F/64</td>
<td>PTA for PAD</td>
<td>R</td>
<td>CFA</td>
<td>7</td>
<td>4.0/3.6</td>
<td>1.6 × 1.6</td>
<td>S</td>
<td>8</td>
</tr>
<tr>
<td>17</td>
<td>M/85</td>
<td>PTA for PAD</td>
<td>L</td>
<td>Pop-A</td>
<td>2</td>
<td>11.5/5.0</td>
<td>1.6 × 4.5</td>
<td>S</td>
<td>10</td>
</tr>
<tr>
<td>18</td>
<td>F/70</td>
<td>FVC</td>
<td>R</td>
<td>CFA</td>
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<td>5.8/3.2</td>
<td>2.3 × 14.9</td>
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<td>15</td>
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<td>19</td>
<td>F/71</td>
<td>TAE</td>
<td>R</td>
<td>CFA</td>
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<td>4.1/2.3</td>
<td>2.7 × 8.3</td>
<td>S</td>
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<tr>
<td>20</td>
<td>M/1</td>
<td>Coronary stenting</td>
<td>R</td>
<td>CFA</td>
<td>9</td>
<td>4.8/2.5</td>
<td>1.0 × 1.1</td>
<td>S</td>
<td>10</td>
</tr>
<tr>
<td>21</td>
<td>M/85</td>
<td>PTA for PAD</td>
<td>R</td>
<td>CFA</td>
<td>2</td>
<td>13.9/5.7</td>
<td>3.9 × 29</td>
<td>S</td>
<td>20</td>
</tr>
</tbody>
</table>

BA = brachial artery; CFA = common femoral artery; comp. (min) = time of compression; FVC = femoral venous double lumen catheter; interval (d) = time after catheter or sheath removal; PAD = peripheral arterial disease; PopA = popliteal artery; PTA = percutaneous transluminal angioplasty; R/L = right/left; S/A = sex/age; S/F = success/failure; TAE = transcatheter arterial embolization.

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Fig. 1. It is a case of a 70-year-old woman after femoral venous catheterization for hemodialysis complicated with femoral artery pseudoaneurysm. (A) Color Doppler ultrasound showed a pseudoaneurysm (ps) connecting with the superficial femoral artery (SFA). Curved arrow shows pseudoaneurysm neck. (B) The pseudoaneurysm neck was compressed to obliterate the flow in both the pseudoaneurysm neck and the pseudoaneurysm sac, while maintaining the patency of the underlying SFA. (C) Follow-up color Doppler ultrasound showed complete thrombosis of the ps.
as well as the formation of a potential focus of infection\textsuperscript{19}; and 
(2) stent-graft placement across the pseudoaneurysm neck, 
thus excluding it from arterial circulation.\textsuperscript{4} Additional limi-
tations of the procedure include its high cost, unfavorable 
vessel anatomy, potential fracture of the stent at a site of 
mobility near the hip, and inability to reuse the groin for future 
access.\textsuperscript{5}

Sonographically guided probe compression of the pseu-
doaneurysm neck with simultaneously injected thrombin is 
currently the method of choice in many centers because of its 
ease, rapidity, and minimal discomfort, with successful 
thrombosis of the femoral artery pseudoaneurysm occurring at 
a rate between 86\% and 100\%.\textsuperscript{25,27} But the use of thrombin, 
a bovine or human serum preparation, is not without potential 
risks of allergic sensitization and development of antibodies to 

thrombin with the resultant potential of bleeding complica-
tions and possible infectious transmission.\textsuperscript{28} Besides, human 
or newer recombinant thrombin is expensive and/or an off-
label use for this purpose.\textsuperscript{12} On the contrary, simple UGCR 
is less expensive, although time consuming, with an accept-
able thrombosis rate.

The predictive factors for successful UGCR are contro-
versial. Coley et al\textsuperscript{2} reported that technical success for pseudo-
aneurysms with a largest dimension of 4 cm or less was 
87\%, while only 62\% for lesions more than 4 cm. Eisenberg 
et al\textsuperscript{9} reached the same conclusion, with the mean dimension 
of the pseudoaneurysm in the failure group being 3.3 cm, 
while that in the success-group being 2.8 cm. It is assumed 
that blood flow through a large pseudoaneurysm tends to be 
greater than flow through a small pseudoaneurysm and

Fig. 2. It is a case of an 85-year-old man after subintimal angioplasty of occluded left superficial femoral artery. (A) Angiogram showed occlusion of the left 
superficial femoral artery. The arrow indicates the catheter via popliteal approach. (B) Image showed successful restoration of the left superficial femoral artery 
(arrow) on immediate follow-up angiogram. (C) A pseudoaneurysm (ps) was complicated at the popliteal fossa after removal of vascular sheath. (D) Complete 
thrombosis of the ps with patency of the popliteal artery (curved arrow) was demonstrated on the follow-up color Doppler ultrasound.

Fig. 3. This is a case of a 36-year-old man after transluminal angioplasty of a stenotic transplant renal artery complicated with femoral artery pseudoaneurysm. 
(A) A left common femoral artery (arrowhead) pseudoaneurysm with a wide neck (curved arrow) was demonstrated on the color Doppler ultrasound, which failed 
compression repair. (B) Angiography showed the pseudoaneurysm neck (curved arrow) and the pseudoaneurysm sac (ps). (C) Image showed successful super-
selective embolization of the pseudoaneurysm neck with metallic coils (curved arrow). (D) Follow-up color Doppler ultrasound showed complete thrombosis of the 
pseudoaneurysm (ps).
the shape of the humerus and the mobility of the brachial artery pseudoaneurysm. It is thought that combinations of multiple comparisons. Eisenberg et al. showed a strong negative correlation between anticoagulation status and the likelihood of success, with a 70% failure rate in patients using anticoagulants versus 26% in patients not using anticoagulants. The latter corroborated most of those prior studies in which the success rate of patients with anticoagulation is less than that of patients without anticoagulation. We considered that, minimally, a longer compression time should be required for anticoagulated blood to be thrombosed in a pseudoaneurysm sac. As pseudoaneurysm age was considered not to be a predictive factor of technical success, it is reasonable to withhold anticoagulants prior to attempting compression, if feasible, as in our series.

With the increasing use of percutaneous access to the brachial artery or popliteal artery, it is possible that pseudoaneurysms in these vessels will become more common. In patients with hemodialysis shunt, pseudoaneurysm of the native artery can occur following mal positioning of the dialysis cannula, making further attempts at cannulation difficult or even impossible. It is thought that combinations of the shape of the humerus and the mobility of the brachial artery make compression repair difficult. So far in the literature, there are limited case reports involving the use of simple UGCR or combined thrombin injection to manage brachial artery pseudoaneurysm. Our series exhibited successful complete thrombosis of the brachial pseudoaneurysm with simple UGCR in all three patients. Also, to the best of our knowledge, we reported the first case of a popliteal artery pseudoaneurysm treated successfully by UGCR.

Although the overall safety of the UGCR procedure is widely accepted, Eisenberg et al. had reported a 3.6% complication rate, including acute enlargement of the pseudoaneurysm, frank rupture, vasovagal response, deep vein thrombosis, acute hypertension, and angina. Additionally, femoral artery thrombosis after simultaneous temporary occlusion of the underlying artery had been reported previously. Schaub et al. stated that no vascular complications involving interruption of the underlying artery occurred in 45 of their 53 patients. This result might have transpired because most of their patients were in an anticoagulated status. During compression repair, if the neck could not be localized, some investigators proposed to compress the pseudoaneurysm itself directly. However, as this will increase extraluminal pressure of the pseudoaneurysm sac, acute enlargement or rupture may occur.

Our study had several limitations. First, this was a retrospective review with a small patient number. Second, the actual prevalence of postangiographic pseudoaneurysm formation in our hospital could not be calculated from the database of the sonographic unit. Third, because patients’ coagulation status had been corrected in this study, we could not evaluate the influence of anticoagulant use on the success rate of UGCR.

In conclusion, UGCR is a safe and cost-effective therapy for treating peripheral pseudoaneurysms of not only the femoral artery, but the brachial artery and popliteal artery as well. We considered the width of the pseudoaneurysm neck to be the most reliable predictive factor for technical success. As age of the pseudoaneurysm was not considered to be correlated with the success rate of the procedure, we suggest that medical practitioners first correct patients’ anticoagulated status, if possible, prior to attempting UGCR.

References


