Transcatheter Arterial Embolization of Traumatic Lumbar Artery Injury: Experience in One Institution

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ABSTRACT

Transcatheter arterial embolization has been well recognized and popular for the management of traumatic lumbar artery injury (TLAI). Current evidence regarding the management of TLAI is still based on case reports and a few small series of studies. The purpose of the study is to evaluate the efficacy and results of embolotherapy in the management of lumbar artery trauma in our hospital, a 3000-bed tertiary hospital in the Northern Taiwan.

We retrospectively recruited all patients who underwent angiography and transcatheter arterial embolization (TAE) for lumbar artery injury from April 2004 to December 2008. Angiographic images and procedural reports were reviewed to assess immediate results. Trauma mechanism, associated trauma, injury severity score, clinical outcomes and post-embolization complications were obtained by chart review.

Of seventeen patients with lumbar artery injury who underwent angiography, selective embolization was performed in fourteen patients. All fourteen patients exhibited immediate angiographic success. The overall mortality was 36% (5/14). However, there was only one suspected TLAI-related death. Two patients had minor neurological complaints in the follow-up period. No patient exhibited major neurological deficits or soft tissue complications.

Traumatic lumbar arterial injury is an uncommon condition that requires a high index of clinical suspicion in the patients of retroperitoneal hemorrhage. According to the literature and our experience, TAE is a safe and effective method to achieve hemostasis.

Retroperitoneal vascular injury from blunt and penetrating trauma is life threatening, and requires accurate diagnosis and prompt treatment. Traumatic lumbar artery injury (TLAI) is rare, accounting for only 4.3% of retroperitoneal hemorrhage cases that requires angiographic evaluation [1]. Operative access to lumbar artery is difficult because surgical exploration and control of bleeding vessels are technically challenging. Sclafani and his colleagues were the first to successfully demonstrate the safety and efficacy of endovascular management for traumatic lumbar arterial injury [2]. Thereafter, the success of transcatheter arterial embolization (TAE) has been demonstrated in several small series[1] and case reports [3, 4]. In this retrospective study, we report our experience of TAE and review the outcome in patients with TLAI in our institution, a 3,000-bed tertiary hospital in Taiwan. To our knowledge, this is the largest series in the English literature.

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MATERIALS AND METHODS

Patients

The institutional review board at our hospital reviewed and approved the study. This study enrolled all patients of angiography-proved TLAIs from April 2004 to December 2008. Patients with retroperitoneal neoplasm, underlying bleeding disorder, and iatrogenic injuries related to percutaneous procedures or cardiac catheterization were excluded. The initial population consisted of 17 patients (16 males, age range: 13-62 years; and one female, age: 62 years). The trauma mechanism, injury severity score (ISS), associated injury, angiographic images, procedural reports, and clinical outcome were reviewed.

All patients underwent abdominal computed tomography (CT) for the initial evaluation. The indications
for emergency angiography included: (1) persistent hemodynamic instability after resuscitation accompanied by retroperitoneal hematoma; or (2) CT-depicted contrast medium extravasations or pseudoaneurysm.

Angiographic Techniques

All patients received emergency angiography immediately. Abdominal aortography and arteriography procedures were performed on suspect injured vessels. A coaxial microcatheter was introduced through a four-French catheter. At first, the artery of Adamkiewicz must be identified if it arose from the injured vessel. If the artery of Adamkiewicz cannot be bypassed, no further embolization was attempted. The microcatheter was advanced as close as possible to the bleeder. Superselective embolization was then performed using microcoils (Boston Scientific, Cork, Ireland) (Fig. 1). If the patient was unstable or superselective catheterization was difficult, Gelfoam pledges or liquid embolizer were slowly injected using flow-directed techniques or microcoils were deployed in the proximal vessel for hemostasis depending on the radiologist’s preference. Before completion of the procedure, arteriograms of the injured vessel and adjacent caudal and cranial lumbar arteries were checked to exclude the presence of collateral vessels.

This study defined immediate angiographic success of embolization as disappearance of contrast medium extravasation and/or pseudoaneurysm. Clinical success refers to the stabilization of hemodynamic status without further surgical intervention or repeat embolization. In addition to angiographic and clinical success, we also reviewed post-embolization complications, such as neurological deficits, including spinal cord infarction and paralysis, and soft tissue complications, including soft tissue necrosis and abscess formation.

RESULTS

Population, injury characteristics, and Injury Severity Score (ISS)

Fourteen of the 17 patients in the study sample (13 male, one female) received embolization of the lumbar arteries (Table 1). The median age was 27 (range, 16-62) years.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age/ Sex</th>
<th>Mechanism</th>
<th>ISS</th>
<th>Injured vessel</th>
<th>Injured branch</th>
<th>Embolic agents</th>
<th>Embolization location</th>
<th>Outcome</th>
<th>Sequelae or Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>27/M</td>
<td>Blunt</td>
<td>57</td>
<td>Right 5th</td>
<td>Ventral + Dorsal</td>
<td>Gelfoam</td>
<td>Main trunk</td>
<td>Expired due to intracranial hemorrhage</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>24/M</td>
<td>MVA</td>
<td>50</td>
<td>Left 4th</td>
<td>Dorsal</td>
<td>Gelfoam</td>
<td>Main trunk</td>
<td>Expired on the same day</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>30/M</td>
<td>MVA</td>
<td>26</td>
<td>Left 3rd, 4th</td>
<td>Ventral</td>
<td>Microcoils</td>
<td>Ventral</td>
<td>Survive</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>27/M</td>
<td>Blunt</td>
<td>54</td>
<td>Right 4th</td>
<td>Ventral</td>
<td>Microcoils</td>
<td>Main trunk + ventral</td>
<td>Expired due to IICP</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>19/M</td>
<td>Blunt</td>
<td>41</td>
<td>Left 4th</td>
<td>Ventral</td>
<td>Gelfoam</td>
<td>Main trunk</td>
<td>Survive</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>62/F</td>
<td>Fall</td>
<td>32</td>
<td>Right 3rd</td>
<td>Ventral</td>
<td>Gelfoam</td>
<td>Main trunk</td>
<td>Expired due to sepsis</td>
<td>Paraplegia</td>
</tr>
<tr>
<td>7</td>
<td>62/M</td>
<td>Penetrating</td>
<td>16</td>
<td>Left 3rd, 5th</td>
<td>Ventral + Dorsal</td>
<td>Gelfoam + microcoils</td>
<td>Main trunk</td>
<td>Survive</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>16/M</td>
<td>Fall</td>
<td>45</td>
<td>Right 2nd</td>
<td>Dorsal</td>
<td>Gelfoam</td>
<td>Main trunk</td>
<td>Survive</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>29/M</td>
<td>Fall</td>
<td>57</td>
<td>Right 4th</td>
<td>Ventral</td>
<td>NBCA</td>
<td>Main trunk</td>
<td>Expired due to liver injury</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>21/M</td>
<td>MVA</td>
<td>57</td>
<td>Left 2nd</td>
<td>Ventral + Dorsal</td>
<td>Gelfoam + microcoils</td>
<td>Main trunk</td>
<td>Survive</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>24/M</td>
<td>Penetrating</td>
<td>16</td>
<td>Left 3rd</td>
<td>Ventral</td>
<td>Microcoils</td>
<td>Main trunk + Dorsal</td>
<td>Survive</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>24/M</td>
<td>Penetrating</td>
<td>16</td>
<td>Right 1st, 2nd</td>
<td>Main trunk</td>
<td>Microcoils</td>
<td>Main trunk</td>
<td>Survive</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>36/M</td>
<td>Blunt</td>
<td>48</td>
<td>Right 4th</td>
<td>Ventral</td>
<td>Microcoils</td>
<td>Main trunk + Ventral</td>
<td>Survive</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>27/M</td>
<td>MVA</td>
<td>34</td>
<td>Left 4th</td>
<td>Dorsal</td>
<td>Gelfoam</td>
<td>Main trunk</td>
<td>Survive</td>
<td></td>
</tr>
</tbody>
</table>

Note: MVA = Motor Vehicle Accident; TAE = Transcatheter Arterial Embolization; TLAIs = Traumatic Lumbar Arterial Injuries;
Of the three patients who did not receive embolization, one patient had severe right iliac venous laceration and relatively faint blushes at the left second lumbar artery. The surgeon performed surgical repair to the right iliac vein and kept observation on injured lumbar artery. The patient was discharged uneventfully later. The other two patients sustained comminuted pelvic fractures. They were severely hypotensive and received embolization of bilateral internal iliac arteries only. These patients died from profound shock on the first day.

Of the 14 patients, who received lumbar artery embolization, eleven patients (79%) sustained blunt trauma, and 3 patients flank penetrating injuries. Mechanisms of blunt trauma included fall from height (n = 1), motor vehicle accidents (n = 4), and heavy object crushing injuries (n = 6). All patients had multiple organ injuries (ISS: 25 – 57, mean: 46). The most common associated injury was pelvic fracture (n = 7), followed by pulmonary contusion (n = 6), fractures of vertebral columns, and craniofacial injuries (n = 5). Of all the patients suffering from penetrating injuries, one patient had associated left iliac vein injury, and two had isolated TLAI without other visceral injury.

**Embolization Techniques and Clinical outcome**

Of the 14 patients who received TAE, five received superselective embolization and nine received proximal or main trunk occlusion. All patients exhibited immediate angiographic success. No patients received non-target embolization.

As Table 1 shows, three patients died within 2 days after the procedure. One of them was persistent hypotension after embolization and died on the same day (patient 2). The second patient received simultaneous embolization of liver laceration, pelvic fractures, and lumbar artery injury. He was still persistent hypotensive after receiving the embolization procedure. Emergency laparotomy found active liver exsanguinations, and the patient died the next day (patient 9). The third death was related to severe head injury and increased intracranial hypertension (Patient 4).

Two patients died 10 days after admission. One died of severe sepsis (patient 6) and the other patient died of brainstem failure due to intracranial hemorrhage and dural venous sinus injury (patient 1).

**Complications**

Two of the 14 patients had paraplegia when admitted to the emergency department due to vertebral burst fractures (patients 6 & 9), but none had worsening of neurological symptoms after embolization. In the subsequent follow-up period, another two patients presented with mild neurological complaints. One had difficulty bending his left knee after successful embolization of the left third and fifth lumbar arteries caused by a penetrating injury (patient 7). The other, who received left second lumbar artery embolization, complained of numbness in the left lower back (patient 10). No soft tissue complications, such as retroperitoneal abscess or infarction, developed in all of our patients.

**DISCUSSION**

The management of retroperitoneal hemorrhage remains controversial. Although there are no specific guidelines to suggest when and how to intervene to stop the bleeding [5], the endovascular approach is an established treatment option. There is a growing trend for the early use of endovascular techniques as an alternative to open surgery. The retroperitoneum is a highly vascular region. Even when a bleeding lumbar artery is controlled, abundant collateral vessels can supply the same region, which could result in rebleeding. The difficulty of a surgical approach...

<table>
<thead>
<tr>
<th>Table 2. Summary of previous studies on TAE in patients with TLAI</th>
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<tbody>
<tr>
<td><strong>Author (year)</strong></td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Sclafani (1987)</td>
</tr>
<tr>
<td>Sofocleous (2005)</td>
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<tr>
<td>Present study</td>
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</table>

Note: TAE = transcatheter arterial embolization; NBCA = n-Butyl Cyanoacrylate
and the multiplicity of injuries in blunt trauma have contributed to the growing popularity of TAE [1, 2, 5]. In addition, endovascular treatment allows the evaluation of nearby vessels, such as above and below the embolized vessel, while the procedure is in progress.

Traumatic lumbar artery injury is rare but is often associated with severe trauma and multiple injuries. In our study, TAE can successfully stop the hemorrhage of traumatic lumbar arterial injuries but the overall mortality rate was still high (36%, 5/14). Most of the deaths were non-hemorrhage-related but related to concomitant brain injury or sepsis (Table 1). The reported mortality rate of retroperitoneal hemorrhage in the literature ranges from 20% [6] to 55% [7]. However, the "true" mortality rate of traumatic lumbar arterial injuries (TLAIs) is often overestimated because they are usually associated with multiple trauma [2]. The mortality rate in our review was higher than that of isolated lumbar artery injury in the work of Sofocleous et al (Table 2), but our results were similar to those of other series of traumatic retroperitoneal hemorrhage [2].

Most of the deaths were attributable to other injuries, including traumatic brain injury (n = 2), sepsis (n = 1), and liver laceration (n = 1). Only one death was considered possibly related to persistent retroperitoneal bleeding (patient 2).

The most dangerous complication of lumbar artery embolization is spinal cord infarction due to occlusion of the artery of Adamkiewicz. This vessel may originate from the dorsal trunk of the lumbar artery and provides the main arterial supply of the dorsolumbar spinal cord. In 19% of patients, the artery of Adamkiewicz is supplied from the first or second lumbar artery [8] but it may rarely arise from a lumbar artery below the second lumbar artery [8, 9]. Embolization of the artery of Adamkiewicz can cause spinal cord infarction and paraplegia. Therefore, it is important to identify and avoid the artery of Adamkiewicz before embolization. Placing the tip of the catheter distal to the spinal branches of the target lumbar artery can lower the risk of spinal cord infarction [2]. Fortunately, the artery of Adamkiewicz did not originate from any of the target vessels in our patients. No patient developed paralysis or worsening pre-existing symptoms after the procedure.

In addition to the spinal cord, ischemic changes of the nerve roots and lumbosacral plexus have also been reported after surgery or endovascular procedures [10]. The incidence of this complication is rare [11]. The blood supply to the distal spinal cord, nerve roots, and lumbosacral plexus has a rich collateral network, including the artery of Adamkiewicz and the lumbar, iliolumbar, and sacral arteries. This study described two (14%) patients who suffered minor neurological impairment. Both patients were embolized with a combination of Gelfoam and microcoils. A possible explanation for this is that synergistic cessation of proximal (microcoils) and distal collaterals (Gelfoam) to the nerve roots increased the risk for tissue infarction. However, as most trauma patients did not receive detailed neurological evaluation before the procedure, it was difficult to determine whether the neurological complications were caused by the initial injury or the embolization procedure.

Complications of retroperitoneal ischemia and abscess formation after lumbar artery embolization have been reported [12]. The smaller the embolic agents, the farther they flow down the distal branches, theoretically increasing the risk of tissue infarction [12, 13]. Since the goal of TAE in trauma patients is to achieve rapid hemostasis and correct hypotension [14], Gelfoam pledgets are the preferred embolic material to the particles or liquid agents in our institution.

The limitations of our study include its retrospective nature and the relatively small number of patients. The question of when embolotherapy, surgery alone or conservative management should be used cannot be definitely addressed by any retrospective study. This preliminary study and previous similar reports [1, 2] can, however, be the basis of a future prospective evaluation in the management of retroperitoneal trauma.

CONCLUSION

Traumatic lumbar arterial injury is an uncommon condition that requires a high index of clinical suspicion in the patients of retroperitoneal hemorrhage. TAE is an established and well-accepted treatment of choice. It should be kept in mind that even in institutions with appropriately trained interventional radiologists, endovascular management in trauma still requires a multimodality approach with close coordination between the trauma surgeon and the radiologist.

REFERENCES


