Transarterial Infusion Chemotherapy/Embolization in the Pelvic Cavity Using a Steerable Microcatheter Alone Through the Outer Cannula of an 18G Needle (SMOC)

Yuya Koike¹, Borbala Kiss², Hiromitsu Tannai², Seishi Matsui¹

Abstract
Purpose: To report our initial experience with transarterial infusion chemotherapy/embolization (TAI/TAE) in the pelvic cavity using a steerable microcatheter alone through the outer cannula of an 18-gauge needle used as a sheath (SMOC) without a conventional diagnostic catheter and introducer sheath.

Materials and Methods: From January to September 2017, the SMOC method was attempted in six consecutive patients (4 male, 2 female; median age, 79.5 years; range, 21-88 years) undergoing elective TAI/TAE in the pelvic cavity. TAI was performed with cisplatin and methotrexate for bladder cancer in four patients, while TAE was performed with gelatin sponge particles for chronic urethral bleeding after total cystectomy in one patient and for a retained placenta in one patient. The items evaluated were the performance of TAI/TAE procedure with the SMOC method, fluoroscopic time, manual compression time, post-procedural bed rest time, and complications.

Results: Five of six patients (83%) successfully underwent the procedure with the SMOC method; in one patient with a severely tortuous iliac artery, we abandoned the SMOC method. The median fluoroscopic time in the five successful cases was 16 min (range, 7-33 min). The manual compression time was approximately 5 min in each case. The postoperative bed rest time was 5 h in the first three cases and 2 h in the subsequent two cases. No procedure-related complications, including arterial injury and hematoma formation, occurred in any patients.

Conclusions: The SMOC method can be an alternative to the conventional method for TAI/TAE in the pelvic cavity.

Key words: steerable microcatheter, intraarterial chemotherapy, transarterial embolization

Introduction
Pelvic transarterial therapy is generally performed with a 4-French (4-F) or 5-F conventional diagnostic catheter and a microcatheter via a 4-F or 5-F introducer sheath [1]. The duration of bed rest after vascular intervention varies from 4 to 6 h, based on the clinical experience of each institution or operator. Even in patients undergoing angiography using 3-F sheaths, at least 3 h of postoperative bed rest is recommended to prevent bleeding [2]. Puncture-site hematoma is the most commonly reported complication of angiography, with an incidence of approximately 3% [2]. Downsizing the pelvic transarterial infusion chemotherapy/embolization (TAI/TAE) system can reduce postoperative bed rest, patient discomfort, and complications [2, 3]; however, the smaller gauge of the catheter, the more difficult it is to guide the catheter to its destination [3].

Received: December 8, 2018. Accepted: June 28, 2018.
doi: 10.22575/interventionalradiology.2017-0022
Correspondence Author: Yuya Koike. E-mail: r06118@hotmail.co.jp
The recently developed 2.4-F steerable microcatheter (SwiftNINJA®; Sumitomo Bakelite, Tokyo, Japan) has unique characteristics in selective catheterization [4]. This microcatheter has a lumen diameter of 0.021 inches and a length of 125 cm. The tip of the steerable microcatheter can be angulated by a hand-controlled dial. This device enables the user to change the angle of the tip manually, which might make selective catheterization easier. Therefore, even without the use of a conventional diagnostic catheter and introducer sheath, the outstanding utility of the steerable microcatheter might make it possible to advance the catheter tip into the target vessel to perform drug injection or embolization. This method holds the potential to achieve considerable downsizing of the angiographic system.

We retrospectively evaluated our experience with transarterial therapy in the pelvic cavity using a steerable microcatheter alone through the outer cannula of an 18-gauge (18G) needle (hereafter called “SMOC”).

Materials and Methods

We obtained Institutional Review Board approval for this retrospective study. From January to September 2017, we attempted the SMOC method in six consecutive patients (4 male, 2 female; median age, 79.5 years; range, 21-88 years) undergoing elective TAI/TAE in the pelvic cavity. No patients were excluded during this period. Four patients underwent TAI with cisplatin and methotrexate for bladder cancer, one patient underwent TAE for chronic urethral bleeding after total cystectomy, and one patient underwent TAE for a retained placenta.

We began the procedure with right femoral artery puncture using an 18G 64-mm entry needle (TIF Needle™; Terumo, Tokyo, Japan) under local anesthesia. The outer cannula of the needle was inserted using a 0.035-inch guidewire (Radifocus Guidewire M; Terumo). After connecting a hemostasis valve (Radifocus Hemostasis Valve II; Terumo), we advanced the steerable microcatheter with a 0.014-inch micro-guidewire (Meister S14®; Asahi Intecc, Nagoya, Japan) (Fig. 1). The outer diameter/inner diameter of the 18G outer cannula and steerable microcatheter were 1.3/0.95 and 0.80/0.54 mm, respectively. Therefore, the steerable microcatheter could pass through the 18G outer cannula.

During selection of large vessels such as the contralateral common iliac artery, contralateral internal iliac artery, and ipsilateral internal iliac artery, we bent the catheter tip to face the orifice of the vessel using the steering function and advanced the micro-guidewire into the vessel. We then navigated the microcatheter over the wire while gradually restraightening the bent catheter tip. For the selection of the branch artery, we advanced the micro-guidewire without using the steering function. We obtained arteriograms by administering 6 to 8 ml of contrast media (iopromide, 300 mg I/ml) at a flow rate of 1.5 to 2.0 ml/s with power injection into each internal iliac artery, and 1 to 2 ml with manual injection into each target branch.

In cases where the vesical arteries were selected, we also performed cone-beam computed tomography (CT) angiography to monitor the drug distribution. If the contralateral internal iliac artery could not be reached within 5 min of fluoroscopic time, we abandoned the SMOC method and used the conventional technique with a 5-F introducer sheath and 5-F catheter.

Pre-procedural imaging included non-enhanced CT in two patients, contrast-enhanced CT in three, and CT angiography in one. The target vessels initially planned before the procedure were the bilateral vesical arteries in the four patients with bladder tumors (Patients 1-4), distal to the origin of the superior gluteal arteries in the bilateral internal iliac arteries in one patient with chronic urethral bleeding (Patient 5), and the left uterine artery in one patient with a retained placenta (Patient 6). However, because the angiograms showed that the vesical arteries were occluded on both sides in Patient 1 and on the right side in Patients 2 and 3, we changed the target vessels to distal to the origin of the superior gluteal arteries [5]. In Patient 3 (Fig. 2), we added the right vaginal artery as a target vessel because cone-beam CT angiography revealed that the artery had replaced the inferior vesical artery. In Patient 6 (Fig. 3), because pre-procedural CT angiography confirmed a pathologic lesion located on the left side of the uterus, we set the left uterine artery as the target vessel. Table 1 summarizes the target vessels after angiography.

The evaluation items were performance of the TAI/TAE procedure with the SMOC method, fluoroscopic time, manual compression time, post-procedural bed rest time, and procedure-related complications. A procedure with the SMOC method was defined as successful when the steerable microcatheter could be advanced to the target vessels based on angiography and a subsequent TIA/TAE procedure could be achieved without displacement of the catheter tip.
Figure 2. (a) Angiography of the left internal iliac artery of Patient 3. The arrow indicates the left vesical artery. (b) Angiography of the left vesical artery. The vascular supply has spread to the right side (arrow). (c) Angiography of the right internal iliac artery. The arrow indicates the right vaginal artery. (d) Angiography of the right vaginal artery. The artery replaced the inferior vesical artery.

manual compression time was defined as the time between outer cannula removal and completion of hemostasis by manual compression. During post-procedural bed rest, we placed the patients in the supine position and continued compression of the puncture site with a gauze roll and elastic dressing. After the bed rest and on the next morning, we assessed for the presence of hematoma formation at the puncture site by visual inspection. We graded procedure-related complications according to the JCOG Japanese version of CTCAE version 4.0.

Results

Five of six patients (83%) successfully underwent the procedure with SMOC. In one patient (Patient 4), the right external iliac artery was so highly tortuous that the steerable microcatheter was difficult to advance even into the contralateral internal iliac artery; for this reason, we abandoned SMOC and used the conventional technique with a 5-F introducer sheath and 5-F catheter (Fig. 4).

In Patients 1 to 3, we implemented TAI with cisplatin and methotrexate, and in Patients 5 and 6, we performed TAE using gelatin sponge particles (Spongell®; Astellas Pharma, Tokyo, Japan) via a pumping method. We did not encounter displacement of the microcatheter tip during the TAI/TAE procedure. The median fluoroscopic time for the five patients was 16 min (range, 7-33 min). The duration of time from manual compression to hemostasis was approximately 5 min in each case. In the first three cases, the patients underwent 5 h of postoperative bed rest in accordance with the clinical pathway. In the subsequent two cases, the postoperative bed rest was set at 2 h. No procedure-related complica-
Figure 3. (a) Maximum-intensity projection image of the CT angiography of Patient 6. The arrow indicates retained placental tissue with a suspected pseudo-aneurysm arising from the left uterine artery. (b) Angiography of the left uterine artery. The arrow indicates the outer cannula of an 18G entry needle.

Table 1. Patient characteristics and outcomes

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Age</th>
<th>Sex</th>
<th>Disease</th>
<th>Procedure</th>
<th>Target Vessels</th>
<th>SMOC</th>
<th>Fluoroscopic time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>74</td>
<td>M</td>
<td>bladder cancer</td>
<td>TAI</td>
<td>contralateral IIA distal to the origin of the SGA</td>
<td>successful</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ipsilateral IIA distal to the origin of the SGA</td>
<td>successful</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>88</td>
<td>M</td>
<td>bladder cancer</td>
<td>TAI</td>
<td>contralateral vesical artery</td>
<td>successful</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ipsilateral IIA distal to the origin of the SGA</td>
<td>successful</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>55</td>
<td>F</td>
<td>bladder cancer</td>
<td>TAI</td>
<td>contralateral vesical artery</td>
<td>successful</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ipsilateral vaginal artery</td>
<td>successful</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ipsilateral IIA distal to the origin of the SGA</td>
<td>successful</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>86</td>
<td>M</td>
<td>bladder cancer</td>
<td>TAI</td>
<td>contralateral vesical artery</td>
<td>failure</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>85</td>
<td>M</td>
<td>chronic urethral bleeding</td>
<td>TAE</td>
<td>contralateral IIA distal to the origin of the SGA</td>
<td>successful</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ipsilateral IIA distal to the origin of the SGA</td>
<td>successful</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>21</td>
<td>F</td>
<td>retained placenta</td>
<td>TAE</td>
<td>contralateral uterine artery</td>
<td>successful</td>
<td>16</td>
</tr>
</tbody>
</table>

SMOC, Steerable Microcatheter alone through the Outer Cannula of an 18G needle used as a sheath; TAI, transarterial infusion chemotherapy; TAE, transarterial embolization; IIA, internal iliac artery; SGA, superior gluteal artery; N/A, not applicable

Discussion

Because the stability and operability of the catheter is markedly decreased when using a microcatheter alone without a conventional angiographic catheter, the clinician may encounter difficulty in selective catheterization to the target vessels [3]. A steerable microcatheter could overcome such decreased operability by means of the steerable tip [4]. The use of a preshaped microcatheter [6] may be a viable alternative when performing TAI/TAE in the pelvic cavity without a conventional angiographic catheter and sheath. However, a steerable microcatheter has two advantages: first, the tip can hold its shape well even in large vessels and is useful for crossing the aortic bifurcation and selecting each internal iliac artery; second, the tip angle can be altered in response to the subsequent target vessel without reshaping the catheter tip.

We successfully navigated the steerable microcatheter into the target vessels in five patients without tortuous iliac arteries. The fluoroscopic time was favorable, and we encountered no difficulty in selective catheterization into target vessels in the pelvic cavity using the SMOC method. In the remaining patient, however, we could not advance the steerable microcatheter into the target vessel because of the highly tortuous iliac artery. When using only a microcatheter...
Figure 4. Angiography of the left vesical artery of Patient 4 (the failure case). Note the severe tortuosity of the right external iliac artery (arrow).

without a conventional angiographic catheter, the pushability is markedly decreased. This limits its application in patients with high vessel tortuosity.

With regard to embolic materials, we used no microspheres, coils, or n-butyl-2-cyanoacrylate in this limited series. In particular, stability during coil embolization needs further evaluation. Applicability of the SMOC method in areas outside of the pelvis, and moreover in endovascular therapy in infants and children, can be expected.

The outer cannula of an 18G entry needle is used in the SMOC method. Because the outer circumference of the steerable microcatheter is tapered (it gradually thickens toward the operator’s hand), the risk of bleeding around the microcatheter increases if it is inserted directly into the blood vessel. Therefore, we introduced the smallest outer cannula that fit the steerable microcatheter to prevent puncture-site bleeding during the procedure. The advantage of the SMOC method is that downsizing the TAI/TAE system can result in reduction of bed-rest time and fewer complications [2, 3]. The outer diameter of an 18G outer cannula is 1.3 mm, and that of a 3-F introducer is 1.6 mm. Therefore, the cross-sectional area in the SMOC method amounts to approximately 66% of that in a 3-F system. Previous authors have recommended a 3-h period of bed rest after a procedure using 3-F system [2]. In addition, the current invasive arterial pressure monitoring technique using a 20G needle commonly includes 1 to 2 h of bed rest in clinical practice. Therefore, we used a 2-h period of post-procedural bed rest. Although this series is evidently limited, we observed no puncture-site hematomas. We did not include patients taking anti-platelet drugs or anticoagulants, or patients with a bleeding tendency or coagulation disorders.

As the use of the SMOC method becomes more widely adopted, we anticipate that the most appropriate bed-rest time and most accurate incidence of complications will be determined by clinical experience and research.

In conclusion, the SMOC method can be an alternative to the conventional method for TAI/TAE in the pelvic cavity.

**IRB statement:** Institutional review board approval was obtained.

**Conflict of interest:** The authors have no conflict of interest to disclose.

**Acknowledgement:** We thank Angela Morben, DVM, ELS, from Edanz Group (www.edanzediting.com/ac), for editing a draft of this manuscript.

**References**