CT Fluoroscopy-Guided Percutaneous Drainage: Comparison of the One step and the Seldinger Techniques

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Keywords:	Nonvascular intervention, percutaneous drainage, computed tomography fluoroscopy, one step technique

Abstract

Objective: To evaluate the one step technique compared with the Seldinger technique in computed tomography (CT) fluoroscopy-guided percutaneous drainage of abdominal and pelvic abscess.

Material and methods: Seventy six consecutive patients (49 men, 27 women; mean age 63.5 years, range 19-87 years) with abdominal and pelvic abscess were included in this study. Drainages were performed with the one step (n=46) and with the Seldinger (n=48) technique between September 2012 and June 2014.

Results: The technical success and clinical success were 95.8% and 93.5%, respectively, for the one step group, and 97.8% and 95.7%, respectively, for the Seldinger group. The mean procedure time was significantly shorter with the one step than with the Seldinger method (15.0 ± 4.3 min, range 10 - 29 min vs 21.0 ± 9.5 min, range 13-54 min, $p < 0.01$). The mean abscess size and depth were 73.4 ± 44.0 mm and 42.5 ± 19.3mm, respectively, in the one step group, and 61.0 ± 22.8 mm and 35.0 ± 20.7 mm in the Seldinger group.

Conclusion: The one step technique was easier and faster than the Seldinger technique. The effectiveness of both techniques was similar for the CT fluoroscopy-guided percutaneous drainage of abdominal and pelvic abscess.

Keywords: Nonvascular intervention, percutaneous drainage, computed tomography fluoroscopy, one step technique

Introduction

Percutaneous drainage under imaging guidance is effective and, in combination with broad-spectrum intravenous antibiotics, it is the standard treatment for intra-abdominal and intrapelvic abscesses (1-3). Percutaneous catheter drainage under image guidance is now the primary treatment for such abscesses (4]; the reported abscess cure rates are 80%-91.0% (2, 5-8). Percutaneous drainage has been performed under ultrasonography and fluoroscopy, computed tomography (CT), and CT-fluoroscopy (9-11). Catheters can be inserted using either the one step technique or the Seldinger technique. As the difference between these techniques remains to be evaluated, we compared the ease and effectiveness of the one step and the Seldinger technique in the (CT) fluoroscopy-guided percutaneous drainage of abdominal and pelvic abscesses.

Material and methods

Approval for this research was obtained from the institutional ethics committee. Principles of the Declaration of Helsinki were followed. Informed consent for the procedure was obtained from all patients.

Patients

Between September 2012 and June 2014, CT fluoroscopy-guided percutaneous drainage was carried out on 76 patients (49 men, 27 women; mean age 63.5 years, range 19-87 years) with 94 procedures. Twenty-three abscesses were retroperitoneal, 48 abscesses were intraperitoneal, 21 abscesses were pelvic. In all cases, 7- to 8-Fr drainage catheters were used.

Between September 2012 and May 2013, all procedures were performed with the Seldinger technique. Between June 2013 and June 2014, almost all procedures were performed with the one step technique.

The suspicion of a fluid collection was based on clinical and laboratory findings and confirmed by CT. Patients had received empirical treatment with a broad-spectrum antibiotic before undergoing the procedure. Treatment was subsequently modified after CT guided percutaneous drainage on the basis of the antibiogram of the fluid aspirated during the drainage procedure.

Preliminary helical CT images were obtained with the skin marker in place on 3 mm-thick sections through the lesion. Based on these images we determined the appropriate patient position (supine, prone, or lateral), the level of the needle entry site, and the direction of the approach yielding the best direct route for drainage while avoiding the intestines, major blood vessels, and other important organs.

In the one step technique, an 18- gauge needle was advanced under CT fluoroscopic guidance into the fluid collection. The inner stylet of the needle was removed and a fluid sample was aspirated to confirm satisfactory placement of the needle within the collection. Then a self-retaining locking 7 or 8 Fr pigtail catheter with a distal hydrophilic tip (Hydrophilic Drainage Catheter, Bioteque, Taipei, Taiwan) attached to a metal stiffener was advanced in parallel and approximately 5 mm adjacent to the 18- gauge needle to the appropriate depth. The catheter was then released from the metal stiffener and advanced into the fluid collection. Finally, CT imaging was obtained to confirm catheter position. With the catheter in place, the abscess cavity was aspirated with a syringe and the abscess was allowed to drain by gravity. In some cases, the position of the catheter tip was fine-tuned using a guidewire under fluoroscopy (Figure 2 a-d).

In the Seldinger technique, the fluid collection was punctured with an 18-gauge needle under CT fluoroscopic guidance. With the needle tip in the collection, the inner needle was withdrawn and a small quantity of fluid was aspirated. A 0.035 inch guide wire was inserted under guidance by CT fluoroscopy or fluoroscopy. A 7- or 8- Fr. pigtail catheter (Dawson-Mulleller Drainage Catheter, Cook, USA or CLINY, Create Medic, Yokohama, Japan) was advanced after track dilatation with gradual dilators.

After proper positioning of the catheter was confirmed by CT fluoroscopy, final CT images were obtained to confirm its position. A syringe was used to aspirate the abscess cavity and the abscess was then allowed to drain by gravity.

Parameters investigated

The following parameters were retrospectively investigated by three authors in consensus: technical success, clinical success, procedure time, additional treatment, and complication.

Technical success was defined as the catheter having been successfully inserted into the fluid collection. Clinical success was defined as a reduction in the abscess size on follow-up images with improvement in leukocytosis, fever, and the clinical condition. Procedure time was defined as the duration from initial localization of the abscess on the preliminary CT image to the final CT scan confirming the catheter location. Procedural complications were recorded according to the Society of Interventional Radiology clinical practice guideline.

The drainage interventions were performed using an interventional-CT system featuring a unified 16-row multidetector CT scanner and an angiography unit (Aquilion LB combined with Infinix Celeve-i INFX-8000V, Toshiba Medical Systems Tokyo, Japan). During the CT fluoroscopic drainage, the exposure parameters were 120 kV,

20-40 mA, a slice thickness of 4 mm, and scanning speed of 0.5 s per rotation. The operator in the CT room wore a protective lead apron and controlled CT fluoroscopic exposure via a foot pedal and assisted in gantry movement and directed the laser light beam via a control panel. Real-time imaging was limited to narrow range to visualize the position of the advancing needle tip.

Statistical analysis

The Mann–Whitney U test was performed to assess statistical differences in mean values, and the Fisher's exact test was performed to evaluate for significant differences in categorical date. A value of $p < 0.05$ was considered significant.

Results

Of the total of 94 percutaneous abscess drainage catheters placed in 76 patients, 39 patients with 48 procedures were performed with the one step technique, 37 patients with 46 procedures were performed with Seldinger technique. Between June 2013 and June 2014, we performed percutaneous drainage with the one step techniques for all patients with three exceptions. Two cases were performed by drainage via the transthoracic approach using the Seldinger technique to avoid iatrogenic lung puncture (Figure 3 a-c). In another patient with a small abscess close to the rectum we thought it

necessary to advance the catheter more accurately by using the Seldinger technique.

Of the 39 patients undergoing the one step procedure, 25 (64.1%) had developed abscesses after surgery, 22 (56.4%) had a history of cancer, and 14 (35.9%) had an inflammatory disease (e.g. pancreatitis, inflammatory bowel disease, diverticulitis, iliopsoas muscle abscess). The mean abscess size and depth were 73.4 ± 44.0 mm and 42.5 ± 19.3mm, respectively. The technical and clinical success rates for the one step procedure were 95.8% (46/48) and 93.5% (43/46), respectively. There were two technical failure cases, the reasons were inability to deploy the catheter, and one abscess cavity was small and it was not possible to deploy the catheter. CT guided drainage was performed again with the Seldinger technique for this case. There were no procedure-related complications such as bowel perforation or bleeding, necessitating surgical intervention. The mean duration of catheter drainage was 12.0 ± 63.7 days. Additional treatment was required in 11 patients (29.7%); six patients needed additional drainage utilizing the same initial technique and five needed surgery. The mean procedure time was 21.0 ± 9.5 min (range 13 - 54 min).

Among the 37 patients in the Seldinger group, 26 (70.3%) developed abscesses after surgery; 18 (48.6%) had a history of cancer, and 12 (32.4%) had an inflammatory disease. The mean size and depth of the abscess were 61.0 ± 22.8 mm and 35.0 ± 20.7

technique.

Discussion

The development of image-guided percutaneous treatment in the early 1980s rendered percutaneous treatment and catheter drainage procedures possible and the management of abdominal and pelvic abscesses has moved strongly toward nonsurgical methods (12, 13). In the absence of immediate surgical indications, percutaneous catheter drainage and antibiotics are considered by many the treatment of choice for most abdominal and pelvic abscesses, primarily because this type of treatment is effective and avoids the risks of general anesthesia and surgery. The usefulness of percutaneous drainage for abdominal and pelvic abscesses is well known. Lambiase et al. (6) successfully performed drainage of abdominal and pelvic collections in 91% (305/335) of procedures, Akinci et al. (10) did so in 91.0% (273/300) of procedures, and Cinat al. (8) did so in 82.2% (79/96) of procedures.

Ultrasound guidance has been widely used to address intra-abdominal and intra-pelvic fluid collections. It is the easiest, fastest way to visualize such collections, allows real-time imaging, and is portable. On the other hand, CT studies can demonstrate the extent of the abscess and facilitate selection of a safe route to the

abscess to avoid injury to the bowel and large blood vessels. While CT-fluoroscopy overcomes the impossibility of real-time imaging by conventional CT methods (11,14-16) it can only scan a narrow area. The entirety of the guidewire used in the Seldinger technique cannot be imaged by CT-fluoroscopy due to its long length and sweeping form.

The one step technique is advantageous when CT fluoroscopy is employed. The stiffness of the catheter-cannula-stylet combination allows for more directional control of the catheter (9), it does not require serial dilation, and placement can be performed in a single step. Consequently, the one step technique is faster than the Seldinger technique (17). However, there are some disadvantages: Repositioning of the catheter in cases of malpositioning is difficult and the one step technique is not optimal in patients with small abscesses because the catheter tip may move upon withdrawal of the inner stylet of the needle. Although the Seldinger technique is safer than the one step technique because the external cylinder is smaller (12, 18), it is cumbersome and in institutions that do not have a unified CT/angiography system, the patient must be moved from the CT- to the fluoroscopy room. In our hands, the mean procedure time was significantly shorter with the one step technique than with the Seldinger technique (15.0 ± 4.3 min, range 10 - 29 min vs. 21.0 ± 9.5 min, range 13 - 54 min, $p < 0.01$).

mm, respectively. The technical and clinical success rates were 97.8% (46/47) and 95.7% (44/46), respectively. Technical failure in one patient was due to bending of the guidewire that disallowed introduction of the catheter. This patient was subsequently treated with the one step technique. There were no procedure-related complications. Mean catheter drainage duration was 25.0 ± 57.3 days. Additional treatment was required for 11 patients (29.7%); six patients needed additional drainage utilizing the same initial technique and five patients needed surgery. The mean procedure time was 21.0 ± 9.5 minute (range 13 - 54 minute).

The characteristics of the 76 patients who underwent 94 procedures are summarized in Table 1. The two patients groups had similar demographic and baseline clinical characteristics. The demographics and baseline clinical characteristics of the patients treated with the Seldinger or the one step procedure were similar, as were the prognostic procedure-related variables including the size, depth and location of the lesions ($p > 0.05$) and the overall technical success rate, the clinical success rate, the rate of complications, and the need for additional treatment. On the other hand, the mean procedure time was significantly shorter ($p < 0.01$) in the one step group than in the Seldinger group (15.0 ± 4.3 min, range 10 - 29 min vs. 21.0 ± 9.5 min, range 13 - 54 min). The one step technique required 28.6% less time per drainage than the Seldinger

Overall, the one step technique required 28.6% less time per drainage than the more complex Seldinger technique which, unlike the one step method, may require moving the patient for CT and fluoroscopy studies. Our overall technical and clinical success rates were 95.8% (46/48) and 93.5% (43/46), respectively, in patients treated with the one step procedure. These rates were 97.8% (45/46) and 95.6% (43/45) when we used the Seldinger method. As these rates were not significantly different between the two procedures, we suggest that the one step technique is appropriate in most instances. In fact, in 49 cases for which drainage procedure was performed during the period when the one step technique was used as the first choice (i.e., from June 2013 to June 2014), there are only three cases for which we chose the Seldinger technique; this shows that one step technique was possible in most cases. Hence, we should choose the Seldinger technique if necessary for cases in which procedures using the one step technique is considered undoubtedly difficult.

Our study has some limitations. Its design was retrospective and observational. The two groups were not strictly randomized using a computerized randomization program.

In conclusion, we suggest that the one step technique is easier and faster than the Seldinger technique for the percutaneous CT fluoroscopy-guided drainage of

abdominal and pelvic abscesses. Our findings indicate that the effectiveness of the one step procedure equals that of the the Seldinger technique.

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Figure legends

Figure 1

(a) Devices included in the drainage set: trocar needle with sharp tip (top), trocar stylet with coring top (mid), and the pigtail catheter (bottom). (b) An assembled drainage catheter at the time of placement.

Figure 2

A 63-year-old man two weeks after surgery for rectal cancer: (a) Enhanced CT showed a presacral abscess that originated from a postsurgical fluid collection (arrow). (b,c) The drainage tube was inserted with the one step technique. The patient was in the prone position. (d) The drainage tube was removed eight days after the one step procedure. The enhanced CT image acquired three months later shows complete resolution of the fluid collection (arrow).

Figure 3

A 34-year-old man with an immunosuppressive disease: Enhanced CT image showing a subphrenic abscess without a fistula (arrow). (b) The abscess was punctured with an 18-gauge needle and a 0.035 inch guide wire was inserted under guidance by CT fluoroscopy. (c) The drainage tube was inserted via the transthoracic approach using the Seldinger technique.

Table 1 Demographic and baseline comparison between the one step and the seldinger group with 76 patients

Characteristics	One step *N*=39	Seldinger *N*=37	*P* values
Sex			
Male	25	24	0.944
Female	14	13	
AGE (years)	66±19.5	61±16.6	0.1878
Lesion size (mm)	73.4±44.0	61.0±22.8	0.38 25
Lesion depth (mm)	42.5±19.3	35.0±20.7	0.0849
Location			
intraperitoneal	22	28	0.1012
retroperitoneal	11	12	
pelvic	15	6	
Postsurgical abscess	25	26	0.5673
Underlying disease			
Cancer	22	18	0.4982
Inflammatory disease	14	12	0.7503

Table 2 Procedure and outcome variable comparisons between the one step and the Seldinger group of 94 procedures

Characteristics	One step	Seldinger	*P* values
Technical success rate	95.8% (46/48)	97.8% (45/46)	0.5826
Clinical success rate	93.5% (43/46)	95.6% (43/45)	0.6812
Procedure-related complications	0	0	1
Additional treatment	12/39	11/37	0.90247
duration of catheterization (days)	12.0±63.7	25.0±57.3	0.1934
Procedure time (min)	15.0±4.3	21.0±9.5	<0.01

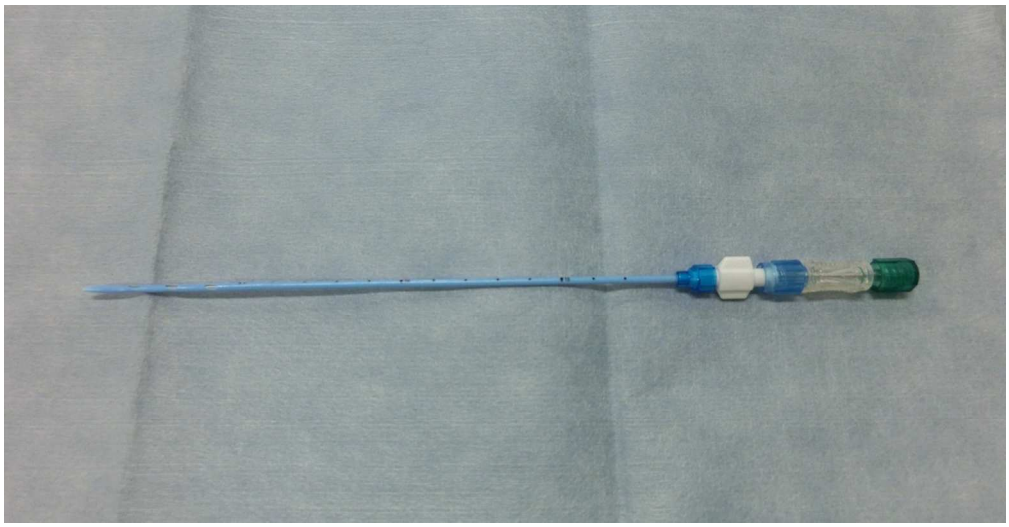

Fig1-a

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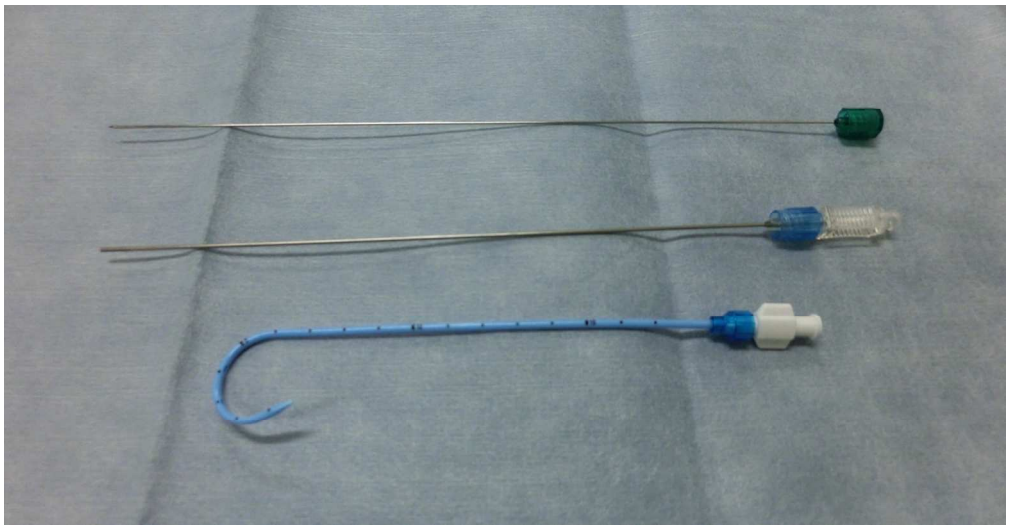

Fig1-b

127x65mm (300 x 300 DPI)

Fig 2-a

68x61mm (300 x 300 DPI)

Fig 2-b

49x51mm (300 x 300 DPI)

Fig 2-c

49x48mm (300 x 300 DPI)

Fig 2-d

49x51mm (300 x 300 DPI)

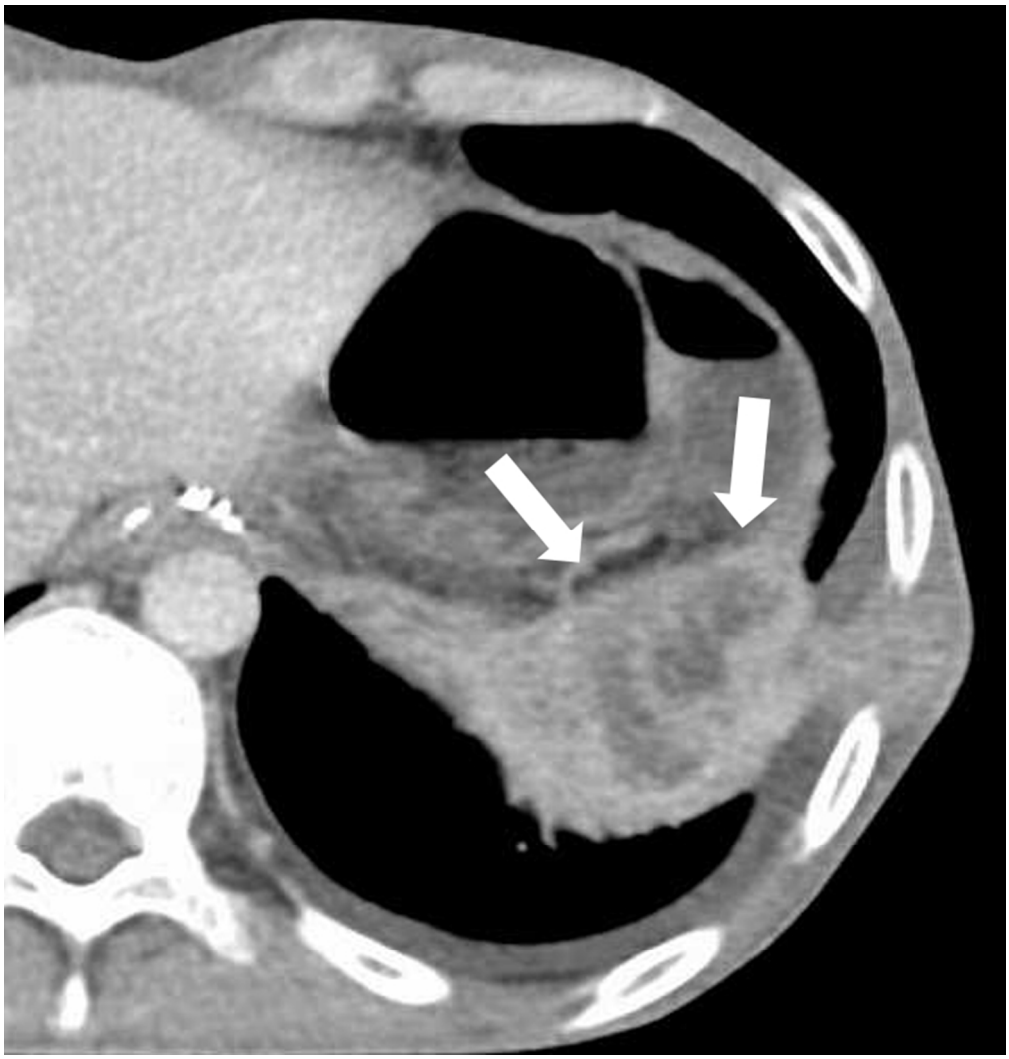

Fig 3-a

67x70mm (300 x 300 DPI)

Fig 3-b

49x49mm (300 x 300 DPI)

Fig 3-c

49x51mm (300 x 300 DPI)