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TECHNICAL NOTE

Large-bore Chest Tube Insertion: Seldinger Technique over Two Guidewires

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Abstract:
Purpose: Large-bore chest tube insertion is commonly performed using the trocar technique and blunt dissection; however, large-bore chest tube can cause severe visceral injury due to penetration, which is a life-threatening complication. Conversely, small-bore chest tubes can be safely inserted using the Seldinger technique; however, small-bore chest tubes are prone to blockage, especially in empyema cases. Therefore, this study aimed to demonstrate large-bore chest tube insertion using the Seldinger technique over two guidewires following image-guided puncture.
Material and Methods: We started performing large-bore chest tube insertion using the Seldinger technique over two guidewires following image-guided puncture in February 2022. Demographic data and procedural details, such as chest tube size, dilator size, procedure time, and type of image-guided puncture, of patients who underwent this procedure between February 2022 and March 2023 were retrospectively reviewed. Technical success was defined as the successful drainage of the pleural cavity.
Results: This method was used for performing ten procedures in nine patients who presented with empyema, pneumothorax, and pulmonary fistula. The insertion of a large-bore chest tube with a size ranging from 18- to 24-French was successfully performed in all cases without any complications. The median procedure time was 17.5 (first quartile-third quartile, 13.5-28.0) min.
Conclusions: Large-bore chest tube insertion using the Seldinger technique over two guidewires may be used as an alternative to conventional methods.

Keywords:
large-bore chest tube insertion, Seldinger technique, two guidewires

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Introduction

Chest tubes are usually divided into size categories: large bore (≥20-French [Fr]) or small bore (≤16-Fr) [1]. Large-bore chest tubes (LBCTs) are inserted in two different ways: trocar technique and blunt dissection. Chest tube insertion using the surgical maneuver has potential risks. Harris et al. reported that overpenetration of the trocar and visceral injuries, such as the lung, liver, heart, and spleen, can cause deaths [2]. Moreover, Havelock et al. reported that the incidence of injuries (large bore, 1.4%, vs. small bore, 0.2%) and malposition (large bore, 6.5%, vs. small bore, 0.6%) was significantly higher in LBCTs than in SBCTs [1]. Due to this, small-bore chest tube (SBCT) insertion using the Seldinger technique gained popularity, and Diacon et al. reported that ultrasound (US)-guided chest tube insertion prevented possible accidental organ puncture [3]. However, SBCTs are prone to blockage [1, 4], especially in empyema and hemothorax cases, and LBCTs are still required. Although specific chest tube kit using Seldinger technique such as Thal-Quick Chest Tube Set (Cook Medical; Bloomington, IN) could be available in some institutions, LBCT insertion using the Seldinger technique is not commonly performed. To compensate the disadvantage of LBCT and obtain the advantage of SBCT, LBCT insertion was performed using the Seldinger technique over two guidewires following an image-guided puncture.

Material and Methods

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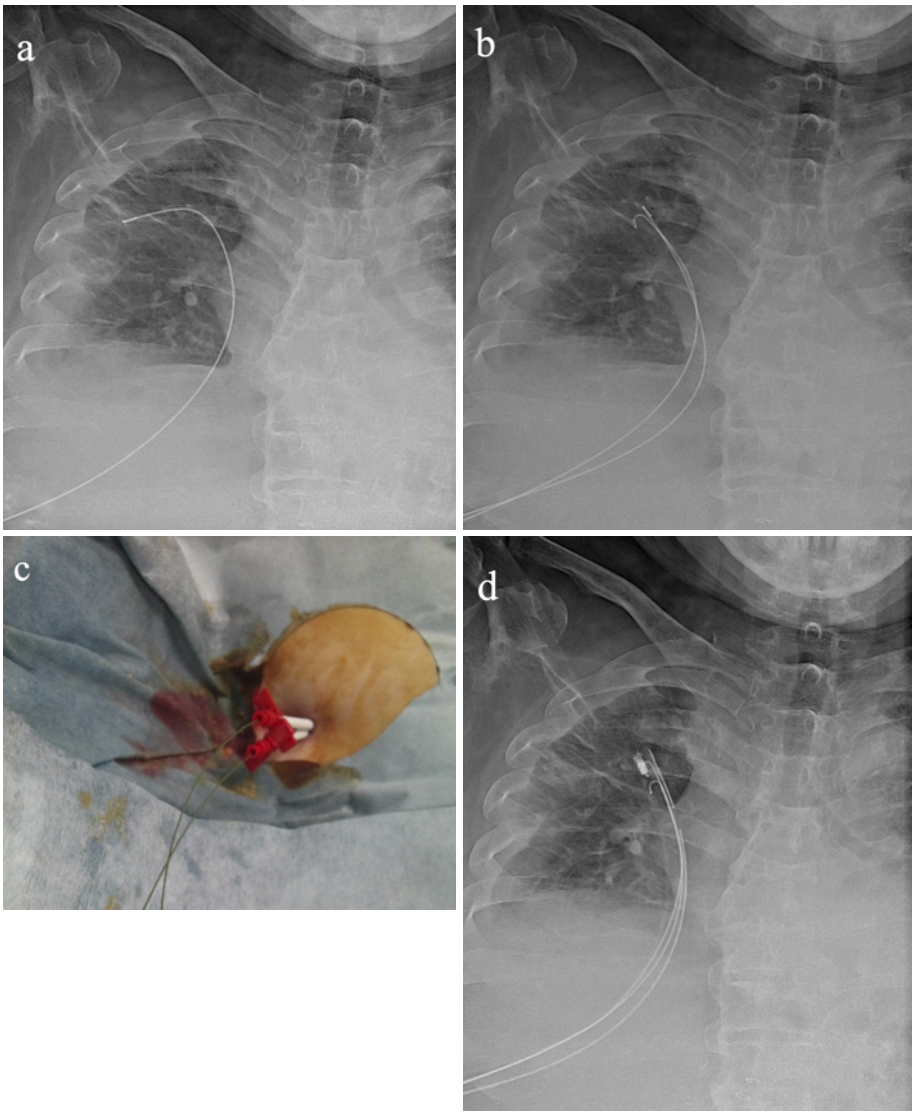

Figure 1. a. A 0.035-in. J-shape spring guidewire was introduced through the needle in the right pleural space under fluoroscopy. b. Through a peel-away sheath introducer, additional 0.035-in. J-shape spring guidewire was inserted. c. Two 16-Fr peel-away sheath introducers are applied over each guidewire. d. A 24-Fr large-bore chest tube was placed in the right pleural cavity over the two guidewires.

patients signed written informed consent for chest tube insertion procedure. Study participants also provided opt-out informed consent.

Patients

This study retrospectively reviewed all cases that underwent LBCT insertion between February 2022 and March 2023. LBCT insertion with the trocar technique was excluded from this study. Patient (age, sex, and etiology) and procedural data (tube size, dilator size, procedure time, image-guided methods, and technical success) were retrospectively obtained. The procedure time was defined as the duration from administration of local anesthesia to securing of the tube to the skin via suturing. Furthermore, technical success was defined as the introduction of the chest tube into the pleural cavity at the preferred location and with adequate drainage.

LBCT insertion using the Seldinger technique over two guidewires following image-guided puncture

US- or computed tomography (CT)-guided thoracic puncture was performed under local anesthesia using an 18-gauge needle (Hakko, Tokyo, Japan; length, 180 mm). A 0.035-in. J-shape spring guidewire (fixed core wire guide safe-T-J curved; Cook Medical, IN, USA; length, 145 cm) was introduced through the needle in the pleural space under fluoroscopy (**Fig. 1a**); gradual dilation was then performed with sequentially larger dilators (8- to 16-Fr peel-away sheath introducer [T-handle; Create Medic Co., Ltd., Kanagawa, Japan; length, 140 mm]) with an inner dilator over the guidewire. After the dilation, the inner dilator of the 16-Fr peel-away sheath was removed. Through the 16-Fr peel-away sheath introducer, additional 0.035-in. J-shape spring guidewire was inserted (**Fig. 1b**). The 16-Fr peel-away sheath was once removed. Next, the peel-away sheath

Table 1. Patient and Procedural Characteristics.

Case number	Age (years)	Etiology	Tube size (Fr)	Size of peel-away sheath 1 (Fr)	Size of peel-away sheath 2 (Fr)	Procedure time (min)	Guiding image for puncture
1	61	Empyema	18	16	16	13	CT
2	75	Pneumothorax with empyema	20	12	16	10	CT
3			20	12	16	10	CT
4	78	Empyema	20	16	16	22	CT
5	65	Empyema	20	16	16	30	US
6	64	Empyema	24	16	16	32	US
7	38	Pulmonary fistula	24	16	16	33	CT
8	76	Empyema	18	12	16	15	US
9	77	Pneumothorax	20	16	16	18	CT
10	65	Empyema	20	16	16	17	US

Fr, French; min, minutes; US, ultrasound; CT, computed tomography

introducers were applied over each guidewire (**Fig. 1c**); subsequently, they were removed. Finally, an 18- to 24-Fr LBCT (Argyle Fukuroi; Cardinal Health K.K., Shizuoka, Japan; length, 30-40 cm; lumen, single or double) was placed over the two guidewires (**Fig. 1d**).

Results

Ten LBCT insertions were performed in nine patients (seven males and two females; median age, 65 years; first quartile-third quartile, 64-76 years) during the study period. Technical success was achieved in all cases. All procedures used the Seldinger technique with two guidewires following an image-guided puncture. No LBCT insertion was performed using the trocar technique. **Table 1** shows the patient and procedure characteristics. Seven out of nine patients presented with empyema. The size of the LBCT ranged from 18- to 24-Fr. The size of the most common peel-away sheaths as a dilator was 16-Fr. The median procedure time was 17.5 (first quartile-third quartile, 13.5-28.0) min. There were no technical-related complications.

Discussion

Our findings showed that LBCT insertion using the Seldinger technique over two guidewires could be an alternative to conventional methods. All technical procedures were successfully completed without any complications. There were no reports regarding this technique. Furthermore, this technique can be applied to other areas, such as the abdominal and pelvic cavities, when large drainage tubes are required.

Although LBCT insertion is required in case of empyema and active bleeding [5], complications after LBCT insertion using the trocar technique and blunt dissection could be severe owing to some organ injuries [2]. Conversely, SBCT insertion using the Seldinger technique has already been accepted as a safe method [6, 7]. However, some studies, such as those by Havelock et al. (8.1%) [1] and Krishnakumar et al. (15%) [4], have reported that drain blockage is the most common SBCT complication, which has led them to recommend LBCT insertion. Therefore, LBCT insertion was developed using the Seldinger technique with two guidewires following image-guided puncture.

When LBCT is inserted using the Seldinger technique, there are some points for improvement. A suitable large-bore sheath introducer and a designated guidewire are not available. LBCT pushability was satisfactory because the chest tube was made of polyvinyl chloride having mechanical strength. Therefore, LBCT could be delivered into the pleural cavity without a sheath introducer, if the tract dilation was enough, and trackability of LBCT was improved using a stiff supporting guidewire. In terms of these points, two peel-away sheaths were used as dilators for sufficient track creation and two guidewires for greater rail support. The outer diameters of 12- and 16-Fr peel-away sheath introducers in the study were 4.9 and 6.2 mm, respectively. Conversely, the outer diameters of 18- and 24-Fr LBCT in this study were 6.4 and 8.5 mm, respectively. Although the tract tends to be wider than ideal, this method is less invasive than a 2-cm skin incision in the trocar technique [8].

This method has some advantages: First, interventional radiologists are extremely familiar with US- or CT-guided puncture and over-the-guidewire procedures. No new technique and practice are required. Image-guided puncture can reduce postprocedural complications even in trainees [1]. Second, the dissection of the intercostal tissues, which is considerably strenuous for nonsurgical physicians, can be skipped, and the trocar can be navigated into the suitable position using a seeking catheter plus guidewire. Third, if the LBCT trackability through the two guidewires is inadequate, another guidewire can be added with the same procedure.

The limitation of this study is its retrospective single-center design and small sample size in analysis. Moreover, no comparison was performed with the conventional method in LBCT insertion.

In conclusion, Seldinger LBCT insertion over two guidewires may be used as an alternative to conventional methods.

Conflict of Interest: None

Author Contribution: AS, TA, and RS contributed to the

design and implementation of the research and to the analysis of the results. AS wrote the manuscript. All authors read and approved the final manuscript.

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