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Thoracic Duct Embolization for Treatment of Chyle Leakage After Thyroidectomy and Neck Dissection

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Objective: This study aimed to evaluate the safety and efficacy of intranodal lymphangiography and thoracic duct embolization (TDE) for chyle leakage (CL) after thyroid surgery.

Materials and Methods: Fourteen patients who underwent intranodal lymphangiography and TDE for CL after thyroid surgery were included in this retrospective study. Among the 14 patients, 13 underwent bilateral total thyroidectomy with neck dissection (central compartment neck dissection [CCND], n = 13; left modified radical neck dissection (MRND), n = 11; bilateral MRND, n = 2), and one patient underwent left hemithyroidectomy with CCND. Ten patients (76.9%) had high-output CL (> 500 mL/d). Before the procedure, surgical intervention was attempted in three patients (thoracic duct ligation, n = 1; lymphatic leakage site ligation, n = 2). Lymphangiographic findings, technical and clinical successes, and complications were analyzed. Technical success was defined as the successful embolization of the thoracic duct after access to the lymphatic duct via the transabdominal route. Clinical success was defined as the resolution of CL or surgical drain removal.

Results: On lymphangiography, ethiodized oil leakage near the surgical bed was identified in 12 of 14 patients (85.7%). The technical success rate of TDE was 78.6% (11/14). Transabdominal antegrade access was not feasible due to the inability to visualize the identifiable cisterna chyli or a prominent lumbar lymphatic duct. Among patients who underwent a technically successful TDE, the clinical success rate was 90.1% (10/11). The median time from the procedure to drain removal was 3 days (with a range of 1–13 days) for the 13 patients who underwent surgical drainage. No CL recurrence was observed during the follow-up period (ranging from 2–44 months; median, 8 months). There were no complications, except for one case of chylothorax that developed after TDE.

Conclusion: TDE appears to be a safe and effective minimally invasive treatment option for CL after thyroid surgery, with acceptable technical and clinical success rates.

Keywords: Intranodal lymphangiography; Thoracic duct embolization; Chyle leakage; Thyroid surgery; Neck dissection

INTRODUCTION

Chyle leakage (CL) is a rare complication of thyroid surgery that can result in clinical presentations such as postoperative neck swelling, chylous output in surgical drains, and chylothorax. The incidence of CL following thyroid surgery is reported to be 0.5%–2.0% [1-3]. However, some prospective studies have reported a much higher incidence, ranging from 4.7%–8.3%, depending on the extent of the surgery [4-6]. Due to the path of the major thoracic duct (TD), which enters the left venous angle, iatrogenic injury usually occurs after left lateral neck dissection during thyroid surgery. However, injury may also occur following right lateral or central neck dissection. Low-output CL (< 500 mL/day) can be effectively mitigated with conservative management, whereas high-output CL (> 500 mL/day) often requires surgical management [7].

Since the introduction of thoracic duct embolization (TDE) through transabdominal catheterization of the retroperitoneal lymphatic vessels after pedal

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lymphangiography, it has been used as an effective treatment for patients with traumatic and non-traumatic CL at various anatomical locations [8]. Additionally, only a few studies have described the effectiveness of TDE for postoperative CL after thyroid, head, and neck surgeries [9-13]. This study aimed to assess the safety and efficacy of TDE following intranodal lymphangiography for the treatment of postoperative CL after thyroidectomy and neck dissection in patients with thyroid cancer.

MATERIALS AND METHODS

Patients

This retrospective study was approved by the institutional review board of Severance Hospital (IRB No. 4-2023-0695), and the requirement for informed consent was waived. The electronic medical records of all consecutive patients who underwent intranodal lymphangiography for CL following thyroid surgery between January 2019 and March 2023 were reviewed. Demographic data, type of surgery, clinical presentation, CL output, technical details, complications, and clinical outcomes were also evaluated. Intranodal lymphangiography was performed in patients with refractory CL that persisted for > 1 week, despite conservative management, including diet modification, fasting with total parenteral nutrition, octreotide administration, and pressure dressing. A total of fourteen patients underwent the procedure.

Procedure

Intranodal lymphangiography was performed by three board-certified interventional radiologists with 2–13 years of experience. The right inguinal lymph node was first accessed using a 25-gauge needle under sonographic guidance. Ethiodized oil (Lipiodol; Guerbet LLC) was manually injected into the lymph node until opacification of the lymphatic system in the abdomen was observed. When sufficient opacification could not be achieved, bilateral inguinal lymph nodes were alternately accessed.

When the cisterna chyli or a prominent lumbar lymphatic duct was identified, fluoroscopic transabdominal antegrade access was attempted using a 21-gauge Chiba needle (Cook Medical Co.). Once access was established, a 105 cm 1.9-F microcatheter (Masters Parkway Soft; Asahi Intecc) was advanced into the TD over a 165 cm 0.016-inch guidewire (Meister 16; Asahi Intecc). An iodinated contrast agent was injected to locate the CL site. After identifying the leakage site, we embolized the TD proximal to it using diluted n-butyl cyanoacrylate (n-BCA) in ethiodized oil at a 1:1 to 1:5 ratio (n-BCA:ethiodized oil), either alone or with the assistance of microcoils.

Technical success of TDE was defined as successful access to the TD followed by embolization of either the leakage site or the TD. Clinical success was determined by the resolution of chylous drainage output sufficient for surgical drainage or chest tube removal (< 25 mL/day) within 1 week after the procedure.

RESULTS

Patients' baseline characteristics are summarized in Table 1. Bilateral thyroidectomy was performed in most patients (92.9%) with papillary carcinoma of the thyroid, while left thyroidectomy was performed in only one patient. Left modified radical neck dissection (MRND) was performed in 13 patients, including two with bilateral MRND. CL was confirmed by surgical drain output or aspiration, except in one case of chylothorax. The study population included 10 patients with high-output CL and three patients with low-output CL.

Intranodal lymphangiography and TDE were performed on all 14 patients. The technical success rate was 78.6%. The CL sites were identified by the presence of ethiodized oil leakage on the surgical bed by the left side of the neck in 12 patients (85.7%). Among the study population, TD ligation was attempted in three patients prior to intranodal lymphangiography, and the CL sites were identified in two patients. In one patient, the CL was not detected, and the major TD was completely ligated. TDE was successfully performed in 11 patients, but transabdominal antegrade access to the TD was unsuccessful in three patients due to the absence of identifiable cisterna chyli on intranodal lymphangiography. Among these three patients, two had a low-output CL and the other had a high-output CL (approximately 600 mL/day). Following lymphangiography, conservative management (compression dressing and low-fat diet) was continued. The drainage output decreased sufficiently to remove the surgical drain within one week in all three patients (Fig. 1).

The clinical success rate stood at 90.1% for patients who underwent a technically successful TDE. The median time from the procedure to drain removal was 3 days (range 1–13 days) for the 13 patients who underwent surgery. No CL recurrence was observed during the follow-up period, which

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Table 1. Baseline characteristics of patients and clinical outcomes

Characteristics	Values
Age, yr*	35 (26–66)
Sex	
Male	4/14 (28.5)
Female	10/14 (71.5)
Surgery	
Left thyroidectomy	1/14 (7.1)
Bilateral thyroidectomy	13/14 (92.9)
Neck node dissection	
Left MRND	11/14 (78.6)
Bilateral MRND	2/14 (14.2)
CCND	13/14 (92.9)
Chyle leak	
Surgical drain	12/14 (85.8)
Aspiration	1/14 (7.1)
Chylothorax	1/14 (7.1)
Drain output	
High-output CL (> 500 mL/day)	10/13 (76.9)
Low-output CL (< 500 mL/day)	3/13 (23.1)
Technical success	11/14 (78.6)
Clinical success	10/11 (90.1)
Recurrence during the follow-up period	0/11 (0)
Time to drain removal after the procedure, day*	3 (1–13)
Complications	
Chylothorax	1/11 (7.1)
Inguinal LN access	
Right	9/14 (64.3)
Bilateral	5/14 (35.7)
Ethiodized oil leakage	12/14 (85.7)
Embolic material	
n-BCA (1:1)	2/11 (18.2)
n-BCA (1:2)	5/11 (45.6)
n-BCA (1:3)	2/11 (18.2)
n-BCA (1:5)	1/11 (9.0)
n-BCA (1:3) + microcoil (3–4 mm)	1/11 (9.0)

Data are number of patients with % in parentheses, unless specified otherwise.
*Data are presented as median (range).
MRND = modified radical neck dissection, CCND = central compartment neck dissection, CL = chyle leakage, LN = lymph node, n-BCA = n-butyl cyanoacrylate

ranged from 2 to 44 months (median, 8 months).

We used n-BCA diluted in ethiodized oil at ratios ranging from 1:1 to 1:5, respectively, for TDE, both with and without the combined use of microcoils (Fig. 2). A 1:5 ratio of n-BCA to ethiodized oil was used for one patient whose leakage site was far from the TD.

One patient developed chylothorax as a complication after the initial TDE and subsequently required a repeat intranodal lymphangiography and TDE. During the second lymphangiography, contrast leakage into the right pleural space was observed around the previous access site in the lower TD segment. The lower TD segment was embolized using a microcoil and n-BCA mixed with ethiodized oil at a 1:3 ratio. Following a successful second TDE, the chylothorax resolved without surgical intervention. No other complications were observed during the follow-up.

DISCUSSION

TDE has been used to effectively treat CL after thyroidectomy and neck dissection in patients with thyroid cancer. In this retrospective study, both the technical and clinical success rates were high, standing at 78.6% and 90.1%, respectively, demonstrating acceptable outcomes. These results are consistent with previously reported success rates. Itkin et al. [9] achieved an overall success rate of 71% and a clinical success rate of 90% in the treatment of iatrogenic CL, while Pamarthi et al. [10] reported a technical success rate of 79% and a clinical success rate of 72% in the treatment of traumatic TD injuries. The surgical drain could be removed within 1 week in most patients who underwent successful TDE; removal occurred within 3 days in 54.5% (6/11) of the patients and within 7 days in 90.9% (10/11) of the patients.

Post-operative CL was more commonly observed after left radical neck node dissection, which was performed in 13 patients (92.9%), including two patients with bilateral neck node dissection. The lymphovenous junction of the major TD is located within 2 cm of the left jugular vein [14]. Due to the proximity of the major TD to the left internal jugular vein, unintended iatrogenic injury can occur, particularly during lower jugular lymph node dissection, resulting in a large CL volume [1]. However, CL after right lateral neck node dissection or central neck node dissection is usually due to injury to a small lymphatic vessel, such as a minor TD or its tributaries, and its incidence is relatively low. Such cases can be effectively managed using conservative management [6,15]. Anatomical variations in the terminal portion of the TD, such as its course, the number of ducts, and the location of its tributaries, can also contribute to the risk of major TD injury [14].

Ethiodized oil leakage was observed in 85.7% of patients (12/14) during intranodal lymphangiography. In cases of traumatic chylothorax or chylous ascites, the leakage site may not be clearly visible on lymphangiography. However,

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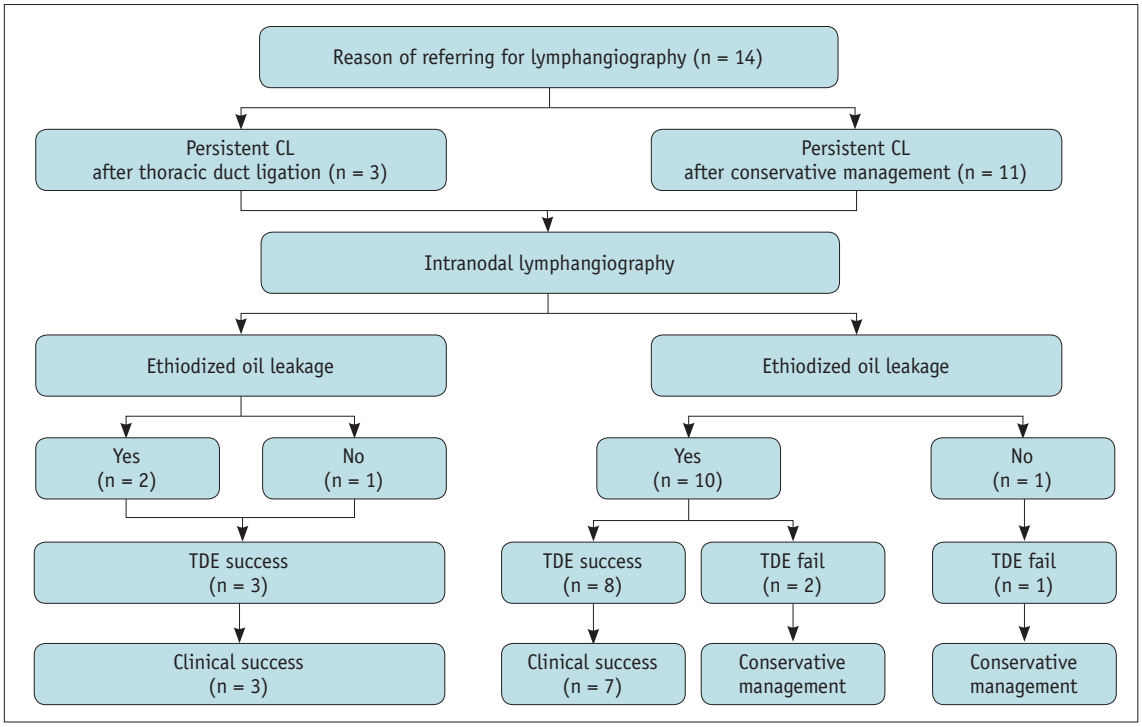

Fig. 1. Technical and clinical outcomes in 14 patients who underwent intranodal lymphangiography for postoperative chyle leakage after thyroid surgery. Technical and clinical success was achieved in all three patients with persistent CL after thoracic duct ligation. TDE was unsuccessful in three patients with persistent CL after conservative management. However, clinical success was eventually achieved in these patients through conservative management after intranodal lymphangiography. CL = chyle leakage, TDE = thoracic duct embolization

in patients with CL after thyroid surgery, the site of leakage is easily visible in most cases. Moussa et al. [11] also confirmed ethiodized oil leakage related to CL in all patients from their case series who underwent thyroidectomy and neck dissection. The leakage site typically presents as a simple pseudoaneurysm or spread through single or multiple channels (Fig. 3). Kim et al. [13] categorized CL after neck surgery according to the anatomical location. According to this categorization, CL after thyroidectomy and neck dissection primarily originates from the terminal TD, with or without concurrent leakage from the jugular trunk. Leakage from the bronchomediastinal trunk was confirmed (Fig. 3). Notably, normal contrast flow to the systemic vein was not observed during intranodal lymphangiography in almost all patients. This is because CL after thyroid surgery is predominantly caused by an iatrogenic injury to the terminal portion of the TD, which transitions to the lymphovenous junction. Compared to blood, n-BCA polymerization in the lymph occurs more slowly due to its physiological properties [9,16]. Thus, when performing conventional TDE, a high n-BCA ratio (1:1 or 1:2, n-BCA: ethiodized oil) is preferred to prevent unintended glue migration to the systemic vein. Microcoils are also used adjunctively to provide a matrix for glue polymerization in conventional TDE. However, in cases of CL after thyroid surgery, the lymphatic channel connected to the systemic vein is lost, alleviating concerns regarding glue migration to the systemic vein. In the early stages of the operator's experience, some patients used a 1:3 ratio of n-BCA to ethiodized oil along with microcoils. For the reasons mentioned earlier, if the microcatheter accessed the area immediately proximal to the leakage site, embolization could be safely performed using only high-concentration glue without the adjunctive use of microcoils.

Transabdominal antegrade access to the TD was unsuccessful in three patients because of the lack of visualization of the identifiable cisterna chyli or a prominent lumbar lymphatic duct on intranodal lymphangiography. When transabdominal antegrade access fails, ultrasound (US)- or fluoroscopy-guided retrograde TD access in the left neck area may be an alternative option to improve technical success rates. Ushinsky et al. [12] achieved a high technical success rate (86%, 12/14) for TDE in cases of postoperative CL after head and neck surgery, using backup US-guided retrograde TD access in the left neck. Kim et al.

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[13] achieved 100% technical success (8/8) using lymphatic embolization for CL treatment after neck surgery. Various retrograde access techniques have been employed, including direct transcervical access under US or fluoroscopic guidance, transvenous TD catheterization, and the utilization of a Jackson-Pratt (JP) drain tract [13]. Even though our results

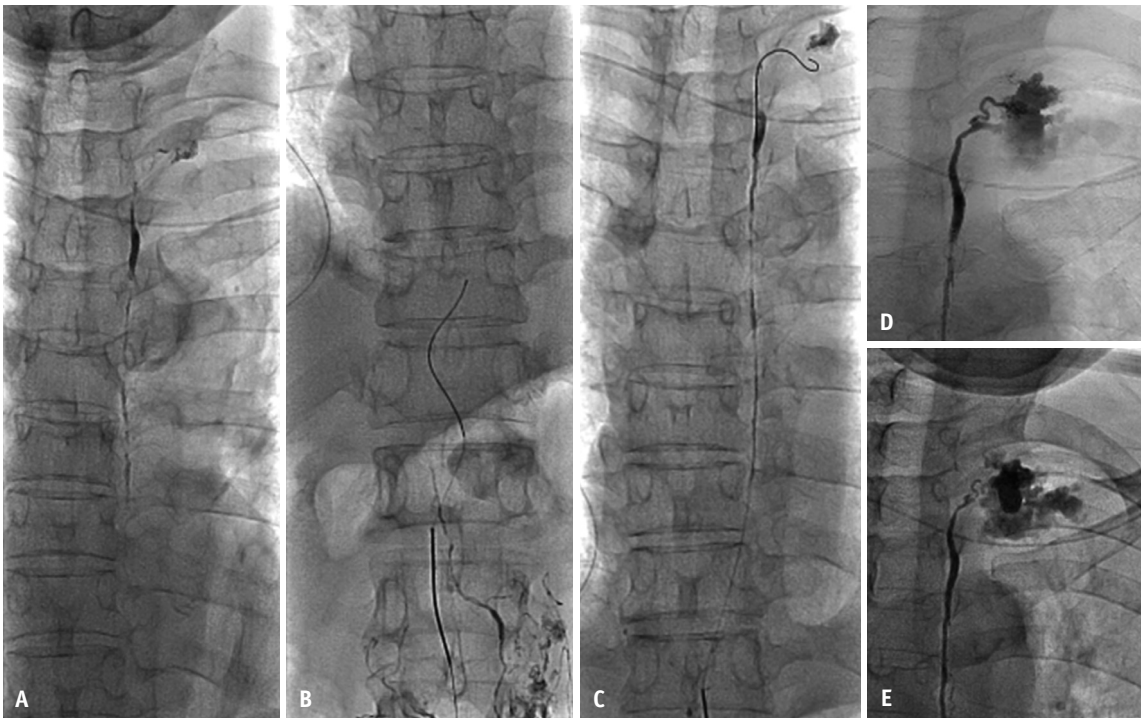

Fig. 2. A 66-year-old female patient underwent bilateral thyroidectomy with left modified radical neck node dissection and central compartment neck dissection for thyroid cancer. Despite thoracic duct ligation being performed prior to thoracic duct embolization, the amount of drainage output via the Jackson-Pratt (JP) drain was 1015 mL/day. **A:** Ethiodized oil leakage was identified around the surgical site on the left side of the neck on intranodal lymphangiography. **B:** The thoracic duct was successfully accessed through a transabdominal antegrade approach. **C:** A microcatheter was advanced immediately proximal to the leakage site. **D:** Ethiodized oil was observed dispersing through multiple channels. **E:** The leakage site was embolized using n-butyl cyanoacrylate mixed with ethiodized oil in a 1:2 ratio. The chylous output rapidly decreased to 17 mL/day following the procedure, and the JP drain was removed 3 days after thoracic duct embolization.

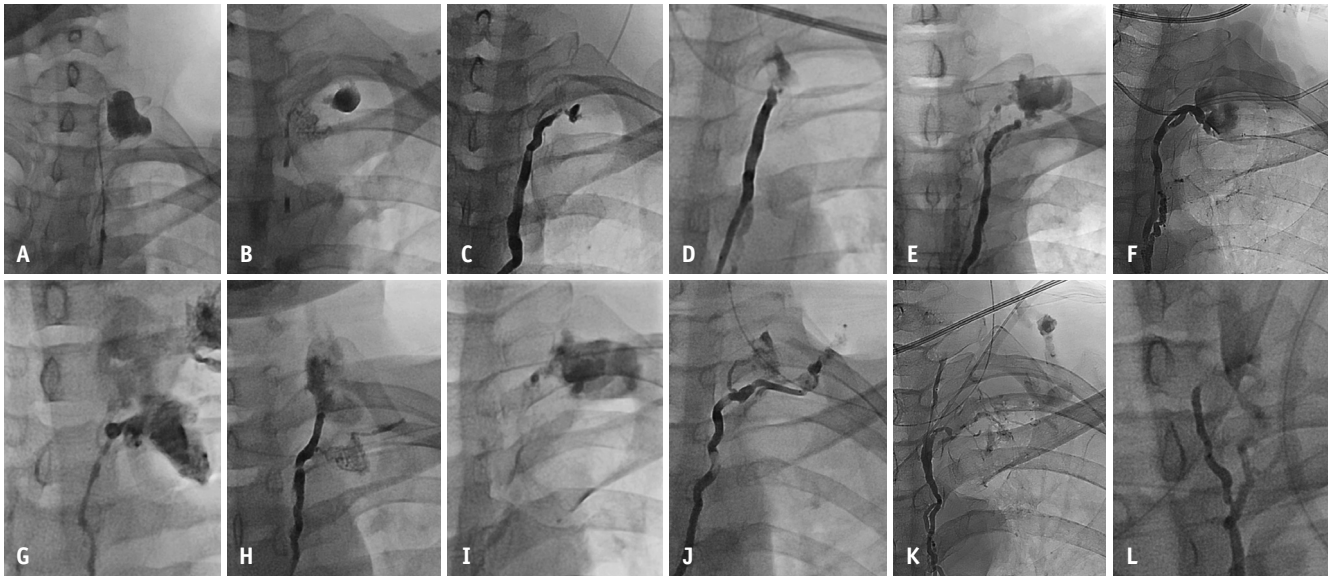

Fig. 3. Lymphangiographic patterns of ethiodized oil leakage at the surgical bed in 12 patients. **A-C:** Ethiodized oil leakage manifested as a simple pseudoaneurysm. **D-L:** Ethiodized oil was found to disperse through either single or multiple channels.

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are consistent with previously reported technical success rates, an improved technical success rate was expected when using the alternative retrograde access technique.

Postoperative CL resolved following intranodal lymphangiography, even in patients with unsuccessful TDE. This could be attributed to the therapeutic effects of intranodal lymphangiography or the unintended disruption of the TD due to repeated needle punctures on the visualized, but non-prominent lumbar lymphatic duct during the transabdominal antegrade access process, which is similar to the "TD disruption" technique. Matsumoto et al. [17] reported the therapeutic effect of lymphangiography with a high clinical success rate of 89% (7/9) for various types of CL. Retention of ethiodized oil at the leakage site, secondary embolic effects, and inflammatory reactions caused by the stagnated ethiodized oil may have therapeutic effects. Matsumoto et al. [17] reported a mean period of 17 days from the procedure to CL resolution. Although the patient group in their study was heterogeneous and different from ours, the time to CL resolution was relatively longer than ours, especially considering that the surgical drain was removed within a week in most of the patients in our study. Evaluating additional therapeutic effects of embolization might be possible by comparing patients who underwent only intranodal lymphangiography with those who also underwent TDE. However, the limited sample size of our study makes this analysis difficult. Nevertheless, this topic warrants further investigation.

The cisterna chyli is found behind the right diaphragmatic crus, ranging from the T12-L2 levels and occasionally extending to the T11 level [18,19]. Therefore, if there is leakage from the access point, chylothorax can occur through the retrocrural space. Some authors have suggested puncturing the prominent lumbar trunk below the cisterna chyli [9]. Furthermore, injecting glue into the access point helps prevent leakage from the access point.

This study has several limitations. First, because of the relatively rare incidence of refractory postoperative CL after thyroid surgery and neck node dissection, few patients were included and retrospectively reviewed. Second, although there is the potential for improving the technical success rate of the procedure through US-guided or fluoroscopy-guided retrospective TD access, only transabdominal antegrade access attempts were performed in this study. In conclusion, TDE appears to be a safe, effective and minimally invasive treatment option for postoperative CL following thyroid surgery, with acceptable technical and clinical success rates.

Availability of Data and Material

The datasets generated or analyzed during the study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

Author Contributions

Conceptualization: Gyoung Min Kim. Data curation: all authors. Formal analysis: Sungmo Moon, Gyoung Min Kim. Investigation: Sungmo Moon. Methodology: Sungmo Moon, Gyoung Min Kim. Project administration: Gyoung Min Kim. Resources: Juil Park, Kichang Han, Joon Ho Kwon, Hyung Cheol Kim, Man-Deuk Kim, Jong Yun Won. Software: Sungmo Moon. Supervision: Gyoung Min Kim. Visualization: Sungmo Moon. Writing—original draft: Sungmo Moon. Writing—review & editing: Gyoung Min Kim.

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