Clinical Utility of the Modified Snare Technique for Percutaneous Antegrade Removal of Double J Ureteral Stents

Eung Tae Kim, MD, Woo Jin Yang, MD, Ji Hoon Shin, MD, PhD, Yan Hua Wang, MD, and Lemuel Narcise, MD

ABSTRACT

Although a snare is the commonly used device for antegrade double J (DJ) stent removal, there are some cases in which DJ stent removal using only a snare is particularly difficult. In the present study, an unfavorable positioning of the proximal DJ stent tip and tip embeddedness were significantly associated with a simple snare technique failure; thus, present the modified snare technique to overcome the simple snare technique failure. By applying these 2 techniques together, we can increase the overall technical success rate up to 97% (196/202). The modified snare technique is safe and effective in cases of simple snare technique failure.

ABBREVIATIONS

DJ stent = double J stent, PCN = percutaneous nephrostomy

INTRODUCTION

The classic method for removing indwelling double J (DJ) stents is by retrograde removal using retrieval forceps via cystoscopy (1–4); however, in situations of a proximally migrated DJ stent or abnormal anatomy of the ureter resulting from urinary diversion or surgery, stent removal in a retrograde manner is very difficult (5). Many reports have been published regarding antegrade removal of DJ stents under fluoroscopic and/or cystoscopic guidance to overcome these difficulties (2,6–9).

From the Department of Radiology (E.T.K.), Hanyang University Guri Hospital, Guri-si, Gyeonggi-do, Republic of Korea; Department of Medicine (W.J.Y.), Graduate School, Kyung Hee University, Seoul, Dongdaemun-gu, Republic of Korea; Department of Radiology (J.H.S.), Asan Medical Center, 88, Olympic-ro 43-gil, University of Ulsan College of Medicine, Seoul, Songpa-gu, Republic of Korea; Department of Radiology (J.H.S.), The Affiliated Cancer Hospital of Zhengzhou University, Zhengzhou, China; Department of Radiology (Y.H.W.), Qingdao University Affiliated Hospital, Qingdao, China; and Department of Radiology (L.N.), Saint Luke's Medical Center – Global City Metro Manila, Philippines. Received January 26, 2019; final revision received April 21, 2019; accepted April 22, 2019. **Address correspondence to** J.H.S.; E-mail: jhshin@amc.seoul.kr

E.T.K. and W.J.Y. contributed equally to this work and are co-first authors.

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Among the devices (including forceps, basket, or snare) used for antegrade DJ stent removal, the snare has been the most commonly used device (2,6–9). Although the overall technical success rate of antegrade DJ stent removal was high, ranging from 95% to 100% in previous studies on removal of 26–39 ureter stents (2,6–9), these success rates are based on the aggregated results for using various devices, including baskets or forceps. The technical success rate for using only snare, so called, simple snare technique, has not been documented in any of these studies and the failed cases with the simple snare technique still certainly exist (8,9). To overcome this simple snare technique failure, additional guidewire combined with snare, the so-called modified snare technique, can be used (10,11). Until now, large-scale patient studies on the antegrade removal technique of a DJ stent and analysis of factors for successful removal are limited. The purpose of this retrospective single-center study is to evaluate the safety and effectiveness of the modified snare technique for DJ stent removal and to determine the risk factors of DJ stent removal failure using the simple snare technique in a large patient cohort study.

MATERIALS AND METHODS

Patients

This retrospective cohort study was approved by our institutional review board (approval number 2018-1565). It

excluded the requirement for informed consent because only deidentified data routinely collected as part of patient care were accessed. Between January 2006 and March 2018, 235 cases of percutaneous antegrade DJ stent removal were performed in 168 patients. The most common indications for percutaneous antegrade DJ stent removal were preexisting nephrostomy route (82 cases in 58 patients) and physician request (ie, a surgical history resulting in an inaccessible retrograde route, cystoscopic failure, urethral stricture, upward stent migration, inability to obtain a lithotomy position, or patient refusal of cystoscopy). Cases were excluded when DJ stents were inserted in a transplanted kidney (17 cases in 12 patients), when only a forceps was used to remove a DJ stent (2 cases in 2 patients) or when no information regarding the removal technique was available (14 cases in 11 patients). The final numbers in this study were 202 cases in 144 patients (mean age 56.2 [range 14–87]; male:female = 74:70).

Among the 202 total stents, 53 DJ stents were placed with an antegrade route by urologists and other 149 DJ stents were placed in an antegrade route in the angiography unit by interventional radiologists. As for the DJ stent size, 8F stents were the most common (n = 77), followed by 6F (n = 47), 7F (n = 35), 5F (n = 2), and 4.7F (n = 1), whereas information regarding the DJ stent size was unavailable in 40 stents. Demographic features, including underlying diseases of the 144 patients, are shown in Table 1.

Table 1. Patient Factors of the Study Participants

Patient Factors	Participants (n = 144)
Age, mean, y (range)	56.2 (14–87)
Gender	
Male	74 (51.4%)
Female	70 (48.6%)
Causes of ureteral obstruction	
Bladder cancer	27
Cervical cancer	25
Advanced gastric cancer	25
Prostate cancer	14
Rectal cancer	12
Ovarian cancer	8
Colon cancer	4
Uterus cancer	3
Breast cancer	2
Cholangiocarcinoma	2
Gallbladder cancer	2
Ureter cancer	2
Other malignancies	3
Duodenal endocrine tumor, esophageal cancer, pancreatic cancer	
Benign causes	15
Appendicitis, pseudomyxoma peritonitis, retroperitoneal fibrosis, sacral schwannoma, small bowel desmoid tumor, necrotizing pancreatitis, ureter perforation, ureter stricture, ureterovaginal fistula, ureterovaginal prolapsed, pelvic fracture	

Removal Device and Technique

For DJ stent removal, the simple snare technique was initially attempted; if that technique failed, the modified snare technique was used in the same session. Neither prophylactic antibiotics nor general anesthesia was given to any of the patients. In this study, we defined "simple snare technique failure" as the patients in whom removal of a DJ stent failed using the simple snare technique; likewise, we defined "modified snare technique failure" as attempted DJ stent removal using the modified snare technique that failed. The decision of conversion to the modified snare technique was at the discretion of the individual operator.

Under local anesthesia using lidocaine (Daihan Pharmacy, Seoul, Korea) and fluoroscopic guidance, the 9F vascular sheath (Terumo, Tokyo, Japan) was exchanged for the previously inserted 8.5F percutaneous nephrostomy (PCN) tube. Using the simple snare technique, a snare (Amplatz Goose Neck Snare, Medtronic, Minneapolis, Minnesota) with a diameter of 10 or 15 mm and a 6F snare-guiding catheter, was used to grasp the proximal DJ stent tip.

When the modified snare technique was used, after the vascular sheath was introduced into the renal pelvis via the guidewire, both the additional 0.035-inch guidewire (Radifocus, Terumo, Leuven, Belgium) and the snare-guiding catheter were inserted through the vascular sheath. A combination of snare and guidewire was used to grasp the DJ stent. When the guidewire was caught with a snare, the snare-guiding catheter was withdrawn into the sheath. If the guidewire wound the DJ stent, the whole assemblies, including the DJ stent, guidewire, snare-guiding sheath as well as the vascular sheath, were removed to pull the DJ stent out of the skin. If the guidewire failed to wind the DJ stent, the guidewire was detached from the snare and catching the guidewire was repeated (Fig 1).

For the patients who required repeated DJ stent insertion, a DJ stent was inserted through the guidewire in an antegrade direction. If repeated DJ stent insertion was not necessary, the vascular sheath was removed or changed with an 8.5F PCN tube. In some patients whose proximal DJ stent tip was not able to be snared within the renal pelvocaliceal system, the simple or modified snare technique was used for snaring of distal DJ stent tip within the urinary bladder.

Data Collection and Statistics

The level of the PCN route was classified depending on the calyx level. The favorability of the proximal DJ stent tip position was categorized as a favorable or unfavorable position. The favorable proximal DJ stent tip position was defined as the proximal tip of the DJ stent being located within the renal pelvis or proximal ureter. On the other hand, the unfavorable proximal DJ stent tip position was defined as when the proximal tip of the DJ stent was located in the

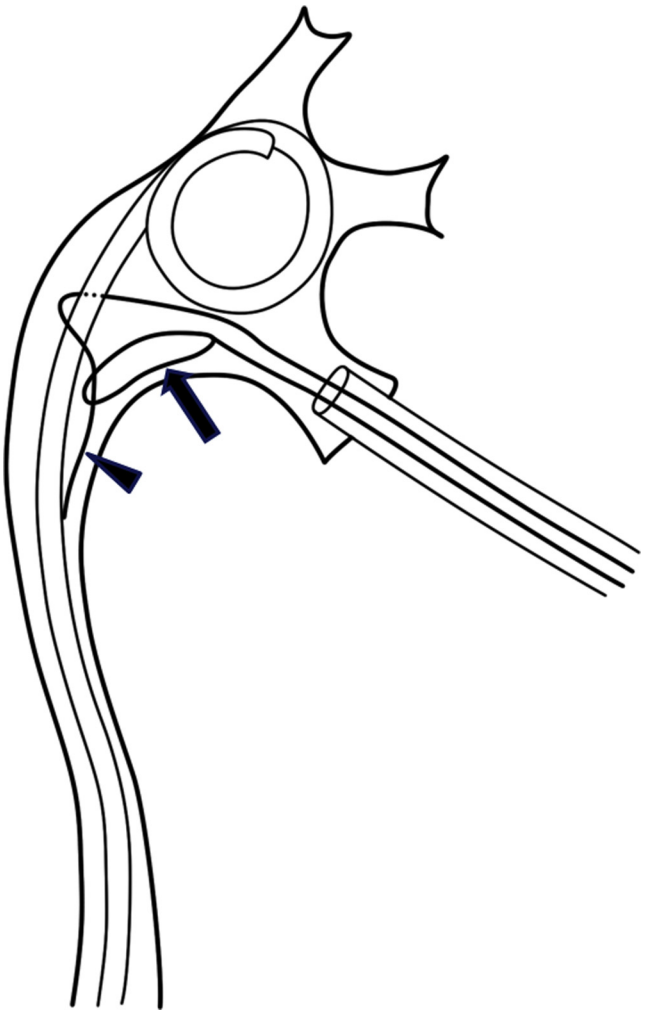

Figure 1. The modified snare technique for a DJ stent removal. The schematic illustration demonstrates the modified snare technique. Note the spatial relationship among the snare (arrow), guidewire (arrowhead), and DJ stent. After the guidewire winds the DJ stent, it is snared to create a loop around the DJ stent, after which the entire assemblies, including the DJ stent, guidewire, and snare-guiding sheath, are withdrawn through the sheath.

renal major calyces on fluoroscopy. The patient study population with an unfavorable position was further stratified into 1 of the following 2 subgroups: (*a*) Unfavorable position with the same PCN level or (*b*) unfavorable position with the different PCN level. Tip embeddedness was defined as proximal DJ stent tip was located in the minor calyx and abutting the calyx wall on fluoroscopy.

The simple snare technique failure rate and complications were analyzed. According to the quality improvement guidelines established by the Society of Interventional Radiology, major complications were defined as those necessitating further treatment or prolonged hospitalization; minor complications were defined as those that resolved spontaneously (12).

To identify risk factors of simple snare technique failure, we conducted univariable and multivariable logistic regression analyses. Odds ratios (ORs) were calculated in the crude model and the adjusted model controlling for patient age, gender, the PCN-DJ stent removal interval, and the DJ stent insertion and removal interval. Complications were presented as frequencies and compared using the chi-square test. All reported *P* values were 2-sided, and the significance level was set at .05. All analyses were performed using STATA V.14 (StataCorp. LP, College Station, Texas) and SPSS software, version 21.0 (IBM Corporation, Armonk, New York).

RESULTS

Technical Factors

The level of PCN access, favorability of proximal DJ stent tip position, and tip embeddedness of 202 DJ stents are shown in **Table 2**. The favorability of the proximal DJ stent tip was unfavorable in 23.8% (48/202) of patients, with the same and different PCN levels in 14 (29.2%, 14/48) and 34 (70.8%, 34/48) patients, respectively. Tip embeddedness was observed in 44 (21.8%) patients.

Clinical Outcome and Complications

Technical results of the simple and modified snare techniques are shown in **Figure 2**. Overall, 97.0% (196/202) of the DJ stents were removed using the simple or modified snare technique (**Fig 3**). Antegrade DJ stent removal was performed in the urinary bladder in 4 patients (ie, 3 simple and 1 modified snare technique). In these patients, distal DJ stent tip was able to be snared within the urinary bladder, using an antegradely inserted snare.

The unfavorable position of the proximal DJ stent tip with the same PCN level (OR 10.78; 95% confidence interval [CI] 3.16–36.79, $P < .001$), unfavorable position of the proximal DJ stent tip with the different PCN level (OR 9.01; 95% CI 3.95–20.55, $P < .001$), and tip embeddedness (OR 8.44; 95% CI 4.01–17.75, $P < .001$) were associated with simple snare technique failure. This relationship was statistically significant when we adjusted patients' factors (**Table 3**).

There was no major complication during or after DJ stent removal. Minor complications were observed in 25 DJ stent removal procedures (12.4%, 25/202). All of the complications resolved spontaneously during the follow-up period and without further management. There was no significant difference in the complications risk between the simple (6.9%, 14/202) and modified (8.5%, 5/59) snare techniques ($P = .688$) (**Table 4**).

DISCUSSION

In our study, the success rate of the simple snare technique was 69.3%. Compared with previous studies reporting an overall success rate from 95% to 100% (2,6–9), our success rate may seem to be exceedingly low; however, in previous studies, many removal options, including baskets or forceps, were applied together (6–8,10–14). In addition, our result

Table 2. Technical Factors of the Study Participants

Technical Factors					
				No. (n = 202)	
Level of PCN					
Lower calyx				112	
Mid calyx				82	
Upper calyx				7	
Pelvis				1	
Location of the proximal end of the DJ stent					
Pelvis				141	
Proximal ureter				13	
Mid ureter				1	
Upper calyx				26	
Lower calyx				21	
Favorability of the proximal DJ stent tip					
Favorable	Proximal DJ stent tip location	Pelvis or ureter		154	
Unfavorable, with the same	Proximal DJ stent tip location PCN level	Upper calyx Upper calyx	2		14
PCN level	Proximal DJ stent tip location PCN level	Lower calyx Lower calyx	12		
Unfavorable, with the different	Proximal DJ stent tip location PCN level	Upper calyx Mid or lower calyx	25		34
PCN level	Proximal DJ stent tip location PCN level	Lower calyx Mid or upper calyx	9		
Tip embeddedness					
Embedded				44	
Not embedded				158	

DJ = double J; PCN = percutaneous nephrostomy.

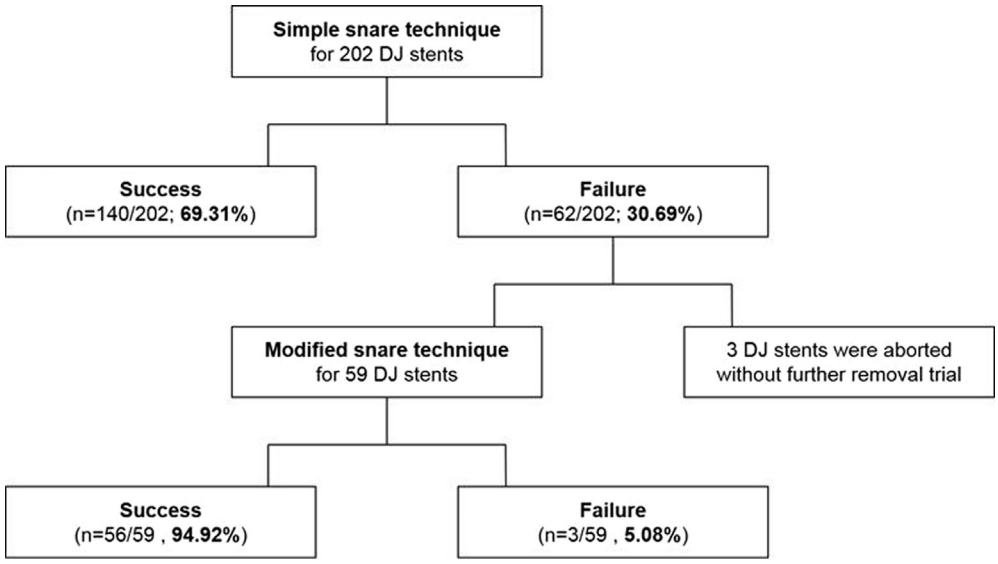

Figure 2. Schema of the technical results of the simple and modified snare techniques.

might be due to the early conversion from the simple snare technique to the modified snare technique when there was initial failure of the simple snare technique. To our knowledge, there has been no study about percutaneous DJ stent removal by only using snare. Although success rate was low using the simple snare technique only, with application of the modified snare technique, 97.0% of the DJ stents were successfully removed in an antegrade direction and without major complications.

According to previous reports, retrograde DJ stent removal with flexible cystoscopy could be more preferred method for difficult DJ stent removal (13,14). In many situations, however, such as previous radical cystectomy with neobladder reconstruction, stent migration, stent fracture, or

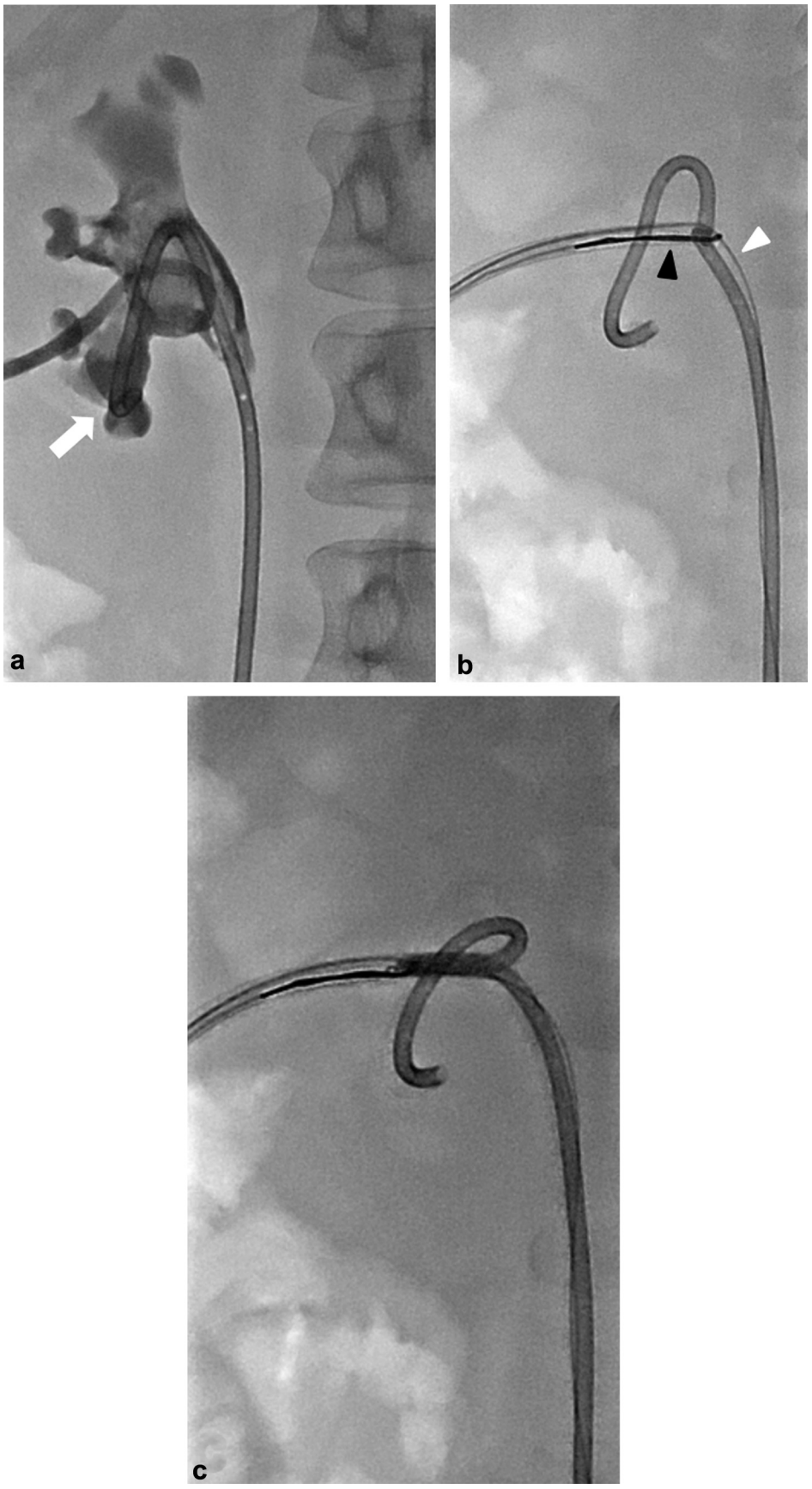

Figure 3. The modified snare technique in a 34-year-old woman. **(a)** Scout radiograph obtained after a contrast medium injection shows the embedded proximal DJ stent tip (arrow) in the lower renal calyx. The stent could not be removed using the simple snare technique. **(b)** After an additional guidewire (white arrowhead) was inserted through the vascular sheath, the combination of the snare (black arrowhead) and guidewire was able to capture the DJ stent. **(c)** The entire assemblies, including the DJ stent, guidewire, and snare, were pulled to remove the DJ stent.

Table 3. ORs (95% CIs) for Failed Simple Techniques According to the Patients and Techniques Factors

Variable	Crude Model		Adjusted Model*	
	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
Patient factors				
Age, y	0.99 (0.97–1.01)	.17	0.99 (0.97–1.01)	.15
Gender				
Male	Referent		Referent	
Female	0.99 (0.55–1.81)	.98	0.87 (0.46–1.63)	.66
Technical factors				
Proximal DJ stent tip location				
Lower calyx	21.12 (2.30–193.81)	.007	18.98 (2.05–175.69)	.01
Upper calyx	35.29 (3.87–321.93)	.002	33.18 (3.62–303.96)	.002
Pelvis	3.37 (0.42–26.80)	.25	3.10 (0.39–24.91)	.29
Mid or proximal ureter	Referent		Referent	
Favorability of the proximal DJ stent tip location				
Favorable	Referent		Referent	
Unfavorable, with the same PCN	10.78 (3.16–36.79)	<.001	10.76 (3.13–36.94)	<.001
Unfavorable, with the different PCN	9.01 (3.95–20.55)	<.001	8.86 (3.87–20.28)	<.001
Embedded				
Not embedded	Referent		Referent	
Embedded	8.44 (4.01–17.75)	<.001	8.42 (3.98–17.81)	<.001

Note–Adjusted for patients' factors including age and gender.
DJ = double J; PCN = percutaneous nephrostomy.

Table 4. Complications

	Total (n = 202)	Complications Unrelated to Removal Methods* (n = 202)	Complications during Removal Methods		
			Simple (n = 202)	Modified (n = 59)	*P* Value
Complication					.688
No	177 (87.6%)	196 (97.0%)	188 (93.1%)	54 (91.5%)	
Yes	25 (12.4%)	6 (3.0%)	14 (6.9%)	5 (8.5%)	
Type of complication (n = 25)					
Minor	25	6	14	5	
Hematoma	17	3	10	4	
Pelvis injury	5	1	3	1	
Ureter injury	1	1	0	0	
Hematoma + pelvis injury	1	0	1	0	
Fistula, ureteroileal	1	1	0	0	
Major complication	0	0	0	0	

*For example, complications during PCN, balloon dilatation of the ureter stricture, etc.

failed retrograde removal, percutaneous antegrade DJ stent removal could be used (5,13,14). Moreover, considering different clinical practices of each hospital and various criteria of treatment indications, clinical studies on antegrade DJ removal may also render meaningful. In our study, the most common indications for percutaneous antegrade DJ stent removal were preexisting nephrostomy route. In these cases, antegrade approach can be comfortable to the patients.

In the current study, an unfavorable position of the proximal DJ stent tip, regardless of the PCN level, and embeddedness of the DJ stent tip were risk factors for simple snare technique failure. In other words, favorability (ie, a proximal DJ stent tip within the renal pelvis or proximal ureter) offers easiness of manipulation of the snare to capture the DJ stent tip. It is predictable that a proximal DJ stent tip within a small space, such as the calyces, would be unlikely to be captured using the simple snare technique. For the relationship as to whether the DJ stent tip is at the same or a different PCN level, there was no statistically significant difference in the successful removal using the simple snare technique between the same and different PCN levels. It could be explained that unfavorability caused by a small space for snare manipulation cannot be overcome by

selecting the PCN level for DJ stent removal. That is, even at the same PCN level, it was difficult to snare the DJ stent tip because of the small space of renal calyces. Tip embeddedness as a risk factor for stent removal failure using the simple snare technique seems intuitive, as has been previously reported (8).

The modified snare technique using additional wire with the snare has been widely used for foreign body removal in such difficult cases in other organs (10,11). Both the snare and an additional guidewire were introduced into the 9F vascular sheath in our study. Manipulation of the guidewire by grasping it with the snare was able to make the large loop to capture the DJ stent. The technical success rate in our study was 94.9% with the modified snare technique after removal failure using the simple snare technique. We therefore recommend that the modified snare technique could be an excellent alternative in patients with high-risk factors for DJ stent removal using the simple snare technique.

In this study, there was no major complications in either the simple or modified snare technique, and the complication rate of the 2 techniques was similar. We surmise that using a snare may be at a greater risk of tissue damage than a guidewire; therefore, manipulation with an additional guidewire combined with a snare might not increase the chance of developing complications such as pelvicalyceal injury.

There are several limitations to this study. First, it was designed as a retrospective study, which has inherent problems. For example, in the current study, operation time and radiation dose were not available when comparing the 2 techniques. Second, many operators have participated in removing DJ stent during the past decade, resulting in heterogeneity in the removal technique. Third, embeddedness of the proximal DJ tip should be evaluated within a cross-sectional image, such as the pelvicalyceal system, which is a 3-dimensional structure. In daily clinical practice, this latter option is not available in most patients and further study might be necessary to determine the accuracy of fluoroscopic evaluation of tip embeddedness.

In conclusion, the modified snare technique is safe and effective in cases of failed DJ stent removal using simple snare technique. An unfavorable position of the proximal DJ stent tip and tip embeddedness were significantly associated with simple snare technique failure.

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