

Circle nephrostomy tube revisited

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Abstract

Introduction: There are few options for patients requiring chronic urinary drainage using nephrostomy tubes. Although circle nephrostomy tube (CNT) was invented in 1954, it is rarely used. Its advantages include longer indwelling time such that it is changed semi-annually when compared with the standard nephrostomy tube (SNT), which is changed monthly. However, there are no studies comparing indwelling times and costs with these two tubes. The aim of the present study was to compare CNT with SNT in terms of frequency of tube changes, reasons for earlier tube changes, and associated costs.

Methods: Patients who had CNT inserted between 2009 and 2015 were reviewed. The indications for chronic indwelling nephrostomy tubes were tabulated. The frequency of tube changes was compared between CNT and SNT in the same patients. Furthermore, costs associated with insertion and exchange of CNT and SNT were analyzed.

Results: Seven patients with mean age of 71.9 ± 7.6 years (range 43–96) had a total of 36 CNT changes. The mean number of CNT changes was four (range 2–5) at a mean interval of 168.3 ± 15.6 days (range 120–231). All patients had SNT prior to converting to CNT. When compared with the mean interval for SNT changes, the mean interval for CNT changes was significantly longer (44.8 ± 19.4 vs. 168.3 ± 41.3 days; $p=0.028$). Tube blockage and urinary leakage were the most common reasons for earlier than scheduled CNT changes. In our centre, CNT insertion and exchange cost \$1965.48 and \$923.96 compared with \$1450.43 and \$803.81 for SNT, respectively. There was an estimated cost savings of \$46 861.10 (range \$87 414.30 –\$40 553.20) for the whole cohort by switching from SNTs to CNTs.

Conclusions: Despite the small sample size as the main limitation, this study confirms that CNTs are associated with significantly fewer changes and lower cost when compared with SNTs for poor-surgical-risk patients requiring chronic NTs.

Introduction

The circle nephrostomy tube (CNT) was first described by Wenzel in 1954.¹ This pre-dated percutaneous renal access techniques; therefore, the method of insertion was open surgery.^{2–6} When compared with other nephrostomy tubes, the CNT enjoyed the following advantages: a) historically, it was associated with less mucosal irritation when compared with Foley catheters; b) it remained in the same position in the renal pelvis; c) it provided better drainage of the renal pelvis and calyces when compared with a Foley catheter, where the balloon may interfere with urinary drainage (especially in patients with small renal pelvises); d) it was useful to irrigate the renal pelvis; e) it was easier to change in the office without requiring fluoroscopic guidance; and f) it had the advantage that it would not slide out if adequately secured.^{2,4,5,7} Originally, the CNT was a useful renal drainage tool after open renal procedures, including pyeloplasties.^{2,8} In addition, its use was advocated for supra-vesical unilateral or bilateral urinary drainage of spinal cord injury patients.^{3,5} With the advent of percutaneous renal procedures, it became possible to convert a standard nephrostomy tube (SNT) to CNT using percutaneous techniques under local anesthesia for patients who were poor operative risk.⁹ In addition, its use was advocated in patients undergoing percutaneous ureterostomies, since CNTs offered less encrustation and occlusion when compared with Gibbons ureteral stents.¹⁰ In contemporary series, CNTs have been used post-percutaneous nephrolithotomy when multiple tracts were established.¹¹ Furthermore, CNTs have been described in palliative patients requiring chronic renal drainage.¹²

Although CNTs have been previously described, they are rarely used in contemporary urological practice. In addition, there are no studies comparing the effectiveness and cost of CNTs when compared with modern SNTs in patients requiring chronic NTs. Therefore, the aim of the present study was to: 1) examine the feasibility of converting SNTs to CNTs in poor-surgical-risk patients requiring long-term renal drainage; 2) analyze reasons for unscheduled tube changes; 3)

compare mean intervals for SNT and CNT changes; and 4) compare costs associated with insertion and exchange of both tubes. Since SNTs are usually changed on a monthly basis, whereas CNT are changed every three to six months,¹³ the hypothesis of this study was that the mean interval for CNT changes would be significantly longer than the mean interval for SNT changes, resulting in cost savings when CNTs are used.

Methods

Study design

Medical records and imaging studies of patients who had CNT inserted between 2009 and 2015 at a tertiary care centre were reviewed. All patients had SNT inserted prior to CNT insertion. Indications for SNT and CNT were reviewed. Emergency room and outpatient visits were noted. In addition, all of the interventional radiology suite visits were tabulated. The mean interval for SNT and CNT changes were calculated and compared for the same patients. Complications associated with CNT, in addition to reasons for earlier than scheduled CNT changes were documented. All patients had 14 F CNT from Cook Medical (Bloomington, IN, U.S.).

Technique of CNT insertion and exchange

Insertion of a CNT required two percutaneous access sites through upper and lower calyces. In the current case series, patients already had a SNT in place. Therefore, CNT placement only required one additional puncture. All procedures

were performed under both ultrasound and fluoroscopic guidance. After opacification of the pelvicalyceal system through contrast injection in the existing nephrostomy, a puncture of the opposite pole was performed and a guidewire was then advanced through the puncture needle, followed by the dilator/sheath complex. The indwelling nephrostomy tube was then cut and a guidewire was advanced via that tube, snared, and pulled out through the opposite access.

The tracts were dilated over the guidewire up to the desired size. The CNT was then advanced using the tip of the dilator, then cut and connected to the leading edge of the catheter to dilate the tract. The CNT was then advanced through the upper pole and out through the lower pole. Injection of contrast confirmed the appropriate tube positioning. Both ends of the catheter were secured to the unique drainage tube with a Y-connector that was connected to a bag for straight drainage⁹ (Figs. 1A, 1B).

Technique of CNT exchange

CNT changes were fairly simple. A shunt connector, provided with each new package of CNT, was used to connect the new silastic CNT to one of the two ends of the old CNT.⁶ Lubricant was added to minimize skin irritation as the new silastic CNT was pushed and the old CNT was gently pulled out. For security, a guidewire was passed through the new and old CNTs just in case the shunt connector came apart. The guidewire prevented loss of access to the kidney. Once the shunt connector was visible from the opposite end, the shunt connector was removed and the new CNT was pulled through the skin. The two ends of the new CNT were connected using the Y-connector to a drainage bag.^{6,10,13} If the

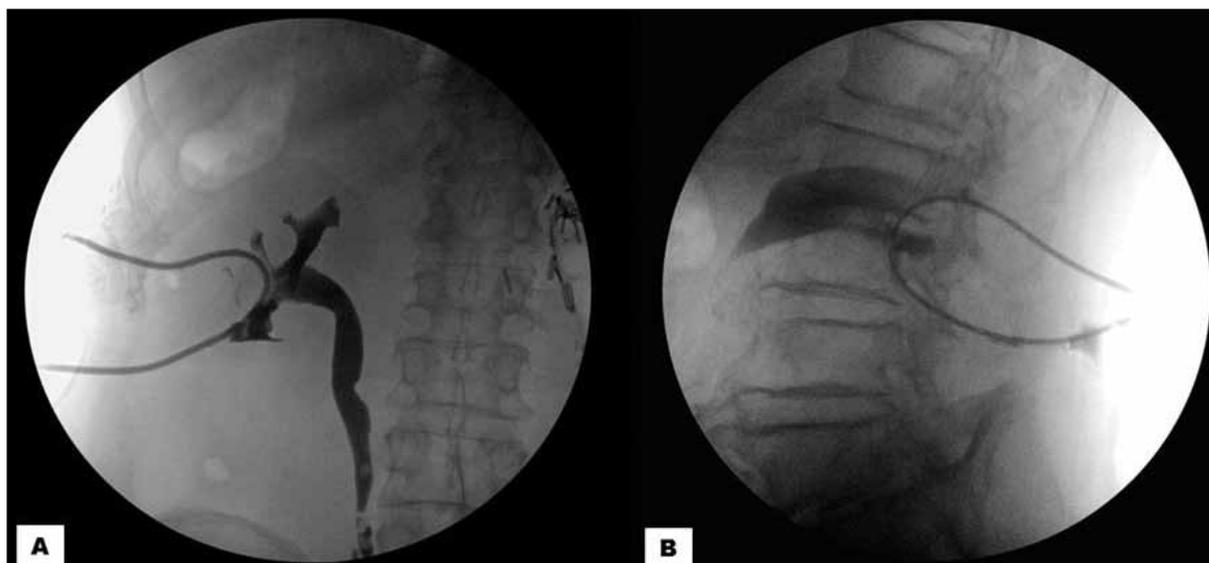


Fig. 1. (A) Antero-posterior view of inserted circle nephrostomy tube; (B) Lateral view of inserted circle nephrostomy tube.

patient had bilateral CNTs, both could be connected to a single drainage bag using a third Y-connector. A butterfly-winged securing device was used to secure the CNT ends at the skin to avoid the CNT from slipping and exposing the holes, thus causing urinary leakage.⁶

Cost analysis

All costs associated with insertion and exchange of CNT and SNT were collected. This included direct costs of the materials used and indirect procedural costs and professional fees. The mean intervals to CNT and SNT changes were calculated and costs were compared accordingly.

Statistical analysis

The Statistical Package of Social Sciences for Windows (SPSS, Chicago, IL, U.S.) version 21 was used for data analysis. Whenever appropriate, descriptive data were presented in terms of means and standard deviation or numbers and percentages. The mean interval to SNT and CNT changes were compared using the Wilcoxon Signed Rank test, with significance detected at two tailed *p* value of <0.05.

Results

A total of 36 CNTs were inserted and changed for seven patients with a mean age of 71.9 ± 7.6 years (range 42–96) (Table 1). All patients were over the age of 50 except for one patient, who was 42 years old with paraplegia, neurogenic bladder, and proximal ureteral stones and strictures (Patient 6) (Table 1). Females represented 57.1%. All patients had indwelling SNTs prior to insertion of CNTs. Indications for chronic NT insertions are described in Table 1. Over an average period of 934.7 ± 169.2 days (range 603–1610), each patient had on average of four CNT changes (range 2–5). When compared with the mean interval for SNT changes, the mean interval for CNT changes was 3.75 times longer in the same patients (44.8 ± 19.4 vs. 168.3 ± 41.3 days; *p*=0.028). Post-CNT insertion complications were reported with nine CNTs (25%). Complications were broken down into four categories: blockage due to chronic urinary tract infections (UTI) in four CNTs (11.1%), leakage due to displacement in three CNTs (8.3%), leakage due to an incompatible adapter in one CNT (2.7%), and one CNT was intentionally cut by the patient (2.7%) (Patient 3). The remaining 27 CNT changes (75%) were done routinely without any complications. Finally, one patient (Patient 2) had her CNT switched back to SNT due to urinary leakage secondary to her Pott's disease and severe scoliosis, leading to persistent exposure of one of the CNT holes.

In our centre, CNT insertion and exchange cost \$1965.48 and \$923.96\$ compared with \$1450.43 and \$803.81

for SNT insertion and exchange, respectively (Table 2). Assuming that patients would continue the same interval of tube changes during the followup period of 934.7 days, there was an estimated cost savings of \$46 861.10 (range \$87 414.30– \$40 553.20) for the whole cohort by switching from SNTs to CNTs (Table 2).

Discussion

Although CNT was invented in 1954 as a renal drainage tube after open surgery, it is still a useful renal drainage tube using modern percutaneous renal procedures.¹¹ However, it is rarely used in contemporary urological practice. In the present study, the feasibility of converting SNTs to CNTs was examined. The indications for CNT were as follows: 1) patients who required chronic renal drainage and were poor surgical candidates for major reconstructive surgeries (all patients); 2) patients who lived in remote areas and required chronic NT changes (Patient 2); 3) palliative patients with advanced pelvic cancers causing ureteral obstruction (Patients 5 and 7); and 4) patients with dementia who kept pulling out SNTs (Patient 3). Although all patients successfully had CNTs inserted, in one patient (Patient 2), the CNT had to be switched back to SNT due to urinary leakage. This was due to the relatively short distance between the upper and lower calyces resulting from her short stature, Pott's disease, and severe scoliosis, leading to one of the CNT holes being outside of the kidney and resulting in urinary leakage. Therefore, CNTs may not be appropriate for patients with severe scoliosis or relatively short cranio-caudal renal dimension.

Urinary leakage associated with CNTs has been previously reported to result from either one of the holes being exposed or due to significant resistance in the drainage tube preventing free flow of urine to the drainage bag.¹³ In the present study, urinary leakage due to CNT displacement or incompatible adapter was found in 4/36 (11.1%) of CNTs. This is lower than previously reported urinary leakage rate of 29%.¹⁴ In addition, 11.1% of CNTs were associated with blockage secondary to UTIs, requiring earlier than scheduled changes. Previous retrospective series did not report UTIs and encrustations associated with CNTs.¹³ Perhaps this is due to larger sizes of CNTs (16 F or larger) being used in previous studies, whereas all patients had 14 F CNTs in the present study.

Finally, Patient 3 was a 96-year-old demented patient who had cut one end of the CNT, necessitating earlier than scheduled CNT change.

Two other factors may limit the widespread use of CNTs in contemporary urological practice. Some interventional radiologists are reluctant to dilate the tract to ≥ 14 F for the initial insertion of CNT. Another factor is that some patients may not like to have two tubes coming out of their flanks.

Table 1. Baseline characteristics of patients

Patient #	Age (yr)	Gender	Past medical history	Indications for CNT	Mean interval for SNT changes (days)	Mean interval for CNT changes (days)	# of CNT changes	Indwelling times of CNT's (months)	F/U time	Complications	Cost of CNT insertion and exchanges over the F/U period (\$)	Estimated cost of maintaining SNT over the F/U period (\$)
1	88	M	CRF, CHF, DLPD, urolithiasis	Right obstructive mid-ureteral stone (1.4 cm) and stricture, failed SWL X 3	N/A	140.7	3	6 m; 2 m; 6 m	610	Incompatible adapter; Blockage	4737.36	9042.86
2	64	F	COPD, HTN, TB, Pott's, scoliosis, glucose intolerance, cerebral TB + seizures, laser endoureterotomy	Left ureteral stricture with failed endoureterotomy; Nunavut resident	48.4	120	5	1 m; 4 m; 3 m; 3 m; 6 m	1610	Leaking; Blockage	6585.28	15 071.44
3	96	F	Dementia	Recurrent urosepsis with obstructive proximal ureteral stones and strictures; patient pulled out several SNTs	42	209	4	1 m; 8 m; 6 m; 3 m	628	Patient cut the tubes	5661.32	12 057.15
4	92	M	BPH; CRF; HTN; CABGx3; CHF; uric acid urolithiasis	Left ureteral stones and stricture	82	149.6	10	2 m; 2 m; 3 m; 5 m; 4 m; 6 m; 6 m; 5 m; 1 m; 6 m	1555	Blockage; Leaking	11 205.08	30 142.88
5	63	F	Ovarian cancer; asthma	Right ureteral obstruction; SNT fell out frequently	32.2	231	4	3 m; 2 m; 1 m; 2 m	603	Leaking	5661.32	12 057.15
6	42	M	Paraplegic; depression; GERD; neurogenic bladder; DVT on anticoagulation	Right ureteral stones and stricture; baclofen pump on the course of ureter; Recurrent UTI and urosepsis	34.1	139.7	2	5 m; 1 m	753	Incompatible adapter	3813.40	6028.57
7	57	F	Cervical cancer; solitary kidney	Left ureteral obstruction	30.2	188	1	6 m	784	None	2889.44	3014.28
Mean for the cohort					44.8	168.3	4	NA	934.7	Total cost	40 553.20	87 414.30

BPH: benign prostatic hyperplasia; CABG: coronary artery bypass graft; CHF: congestive heart failure; CNT: circle nephrostomy tube; COPD: chronic obstructive pulmonary disease; CRF: chronic renal failure; DLPD: diffuse parenchymal lung disease; DVT: deep vein thrombosis; HTN: hypertension; F: female; F/U: followup; GERD: gastro-esophageal reflux disease; M: male; NT: nephrostomy tube; SNT: standard nephrostomy tube; SWL: shockwave lithotripsy; TB: tuberculosis; UTI: urinary tract infection.

Table 2: Cost of CNT and SNT insertion and exchange

Variable	Insertion costs (\$)		Exchange costs (\$)	
	SNT	CNT	SNT	CNT
Angio tray	50.00	50.00	50.00	50.00
Angio kit	21.80	21.80	21.80	21.80
Scalpel	0.55	0.55	—	—
Saline bag (500 mL)	1.31	1.31	1.31	1.31
Drapes	16.00	16.00	16.00	16.00
US probe cover	11.37	11.37	—	—
Neff. set	113.00	113.00	—	—
Rosen wire	26.50	26.50	—	—
Newton C wire	—	—	23.10	—
Amplatz stiff guidewire	—	—	—	59.00
Standard nephrostomy tube (Cook)	116.00	—	116.00	—
Circle nephrostomy tube (Cook)	—	200.25	—	200.25
Leg bag	18.00	18.00	18.00	18.00
Large bore stopcock	3.80	3.80	3.80	3.80
Angiography suite costs	861.60	1292.40	448.80	448.80
Professional fees	210.00	210.00	105.00	105.00
Total cost	1450.43	1965.48	803.81	923.96

CNT: circle nephrostomy tube; SNT: standard nephrostomy tube.

Other alternatives to CNT include maintaining the SNT or increasing the size of the SNT to 12 F or 14 F so that they can be left in situ for longer periods than usual. However, there are no studies examining the optimal duration of SNT in patients requiring chronic renal drainage.

Despite these disadvantages associated with CNTs, the mean interval for CNT changes was significantly longer than the mean interval for SNT changes (168.3 ± 41.3 vs. 44.8 ± 19.4 days; $p=0.028$). When comparing the mean interval for CNT change, it was equivalent to 3.75 SNT changes ($168.3/44.8=3.75$). Therefore, the interval between tube changes almost quadrupled (3.75X) after switching to CNT, resulting in significant cost savings of \$46 861.10 during the study period (Table 2).

The main limitations of this study include its retrospective nature and its small sample size. In addition, this is a single-centre study. Nonetheless, this is the first case series assessing the feasibility of converting SNTs to CNTs in contemporary urological practice in poor-surgical-risk patients requiring chronic renal drainage. Prospective studies with larger sample size are needed to confirm the benefits of CNTs when compared with SNTs.

Conclusion

Although the SNT is the most commonly used NT for renal drainage, the CNT is an alternative option for poor-surgical-risk patients requiring chronic NTs and it is associated with significantly fewer changes and lower cost of disposable NTs.

Competing interests: The authors declare no competing personal or financial interests.

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