

# Evaluation of a nitinol stone retrieval basket as an alternative to biopsy forceps for biopsy of suspected upper tract genitourinary malignancies

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## Abstract

**Background:** The anatomical nature of the ureteroscopic approach for biopsy of upper urothelial tract tumors requires the utilization of small instruments, often limiting biopsy specimen quality. This leads to lower-than-desired tumor grading accuracy and malignancy detection capabilities on the initial evaluation of upper tract tumor specimens. This is problematic because optimal treatment of upper tract urothelial carcinoma (UTUC) depends on early disease detection and subsequent accurate diagnosis.

**Objective:** The objective of our study was to compare the biopsy capabilities of two ureteroscopic biopsy instruments – biopsy forceps and the nitinol stone retrieval basket.

**Methods:** We performed a retrospective analysis of ten patients who underwent biopsy of an upper tract mass with either instrument. Average specimen size, muscularis propria presence, and malignancy detection sensitivity were the variables of interest.

**Results:** The nitinol stone retrieval basket obtained larger biopsy samples than the biopsy forceps, with average biopsy volumes being 0.0674 cm<sup>3</sup> and 0.0075 cm<sup>3</sup>, respectively ( $P = 0.00017$ ); this was the only statistically significant result of our study. Muscularis propria was present in 31% (4/13) of the biopsies with the nitinol stone retrieval basket, whereas 0% (0/5) of the biopsy forceps biopsies contained muscularis propria ( $P = 0.2778$ ). Regarding malignancy detection sensitivity, the nitinol stone retrieval basket biopsies identified malignancy in 100% of the specimens that had confirmed malignancy; the biopsy forceps only detected malignancy 40% of the time ( $P = 0.4134$ ).

**Conclusion:** These findings suggest that the nitinol stone retrieval basket is a useful diagnostic tool for UTUC, although further investigation is warranted to determine its superiority compared to biopsy forceps.

**Keywords:** Neoadjuvant chemotherapy, nephroureterectomy, nitinol stone retrieval basket, Piranha biopsy forceps, transitional cell carcinoma, upper tract urothelial carcinoma, upper urinary tract biopsy, ureteroscopy with biopsy, urinary tract cancer

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## INTRODUCTION

Upper tract urothelial carcinoma (UTUC) accounts for roughly 5% of all urothelial cancer cases in the United States, and the frequency of UTUC is increasing.<sup>[1,2]</sup> The diagnosis and treatment of these carcinomas often depend on the pathology results associated with respective biopsies; ureteroscopy with biopsy remains the current standard for obtaining tissue biopsies for UTUC diagnosis. The anatomical nature of this approach requires the utilization of small instruments which limits biopsy specimen size – the most important factor with regards to overall biopsy quality.<sup>[3]</sup> In addition to specimen size, another important biopsy quality consideration is muscularis propria presence within the specimen, which is also limited by instrument size.<sup>[4]</sup> Since the determination of tumor grade and stage greatly depends on these two biopsy characteristics, UTUC diagnosis is difficult and often inaccurate.<sup>[5]</sup>

UTUC has a high mortality risk if not managed effectively early in the disease course.<sup>[6]</sup> Therefore, obtaining an adequate initial biopsy is critical for early disease detection, accurate pathologic diagnosis, and subsequent determination of optimal treatment. Patients with high-grade disease and/or parenchymal invasion are eligible for neoadjuvant chemotherapy in addition to nephroureterectomy.<sup>[7,8]</sup> However, patients with low-grade tumors and/or many comorbidities are managed less aggressively with nephron-sparing treatments, such as endoscopic resection or segmental ureterectomy.<sup>[7]</sup> This further emphasizes the importance of accurate initial UTUC diagnosis with correct tumor grading and staging, since under-staging tumors may result in patient ineligibility for adjuvant chemotherapy after nephroureterectomy due to kidney loss and decreased glomerular filtration rate.<sup>[9]</sup>

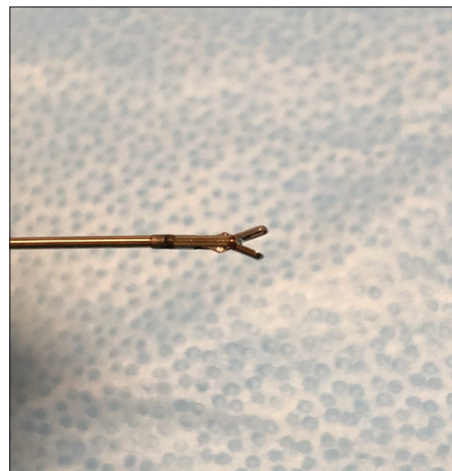
Numerous biopsy instruments exist, including but not limited to: Graspers, snares, brushes, aspiration catheters, biopsy forceps, and nitinol stone retrieval baskets.<sup>[10,11]</sup> For all the reasons mentioned previously, determining the most reliable instrument (s) and technique (s) for consistently procuring high-quality upper tract biopsies would be beneficial for the accurate diagnosis and management of UTUC in the future practice. The purpose of this study was to compare biopsy adequacy of two commonly used instruments – biopsy forceps and nitinol stone retrieval basket – when obtaining upper tract biopsies in patients with UTUC.

## MATERIALS AND METHODS

In a study approved by the Institutional Review Board (Protocol # 1810295735), we performed a

retrospective review of ten total patients who underwent ureteroscopy with biopsy, nine of which who also underwent nephroureterectomy, for upper tract tumors between the years of 2016 and 2019 by four board-certified attending surgeons at our tertiary care institution (Ruby Memorial Hospital at West Virginia Medicine in Morgantown, WV). Informed consent from participants was not required, as this was a retrospective study. Data extracted from the electronic medical record were patient demographics and general characteristics, number of biopsy specimens and specimen size, presence of muscularis propria within biopsy specimens, and final pathology results of tumors after subsequent nephroureterectomy [Tables 1-3]. Ureteroscopy was performed with a flexible ureteroscope, and biopsies were taken with either the Piranha biopsy forceps [©2021 Boston Scientific Corporation, 300 Boston Scientific Way, Marlborough, MA 01752-1234; Figure 1] or the Cook Medical nitinol stone retrieval basket [© 2022 Cook Medical LLC, P. O. Box 4195, Bloomington, IN 47402-4195; Figure 2] depending on surgeon preference. Ureteral access sheaths were not utilized, as their insertion could have potentially sheered ureteral masses not visualized on computed tomography urography and result in not identifying ureteral masses during ureteroscopy. After tissue specimens were collected successfully, the ureteroscope and biopsy device were removed as a single unit. This was done to avoid specimen loss in the narrow working channel of the ureteroscope. Repeat biopsies were taken until we had obtained a grossly visible specimen in the biopsy device. Specimens were labeled based on their respective biopsy device. The decision to place a ureteral stent was based on surgeon preference.

Biopsy sizes were determined by the measurements provided in their respective pathology reports. Pathology reports from each biopsy were used to determine



**Figure 1:** Piranha biopsy forceps

muscularis propria presence, as well as the tumor grade. An instrument's sensitivity of malignancy detection value was determined by comparing the initial biopsy tumor grades of each biopsy to the final pathology results after respective nephroureterectomy. Average biopsy sizes from the two biopsy devices were compared using a two-tailed *t*-test; a Fisher exact test was performed to compare the instruments' biopsy specimen muscularis propria presence as well as the sensitivity of malignancy detection. The cutoff *P* value to determine statistical significance was set at 0.05.

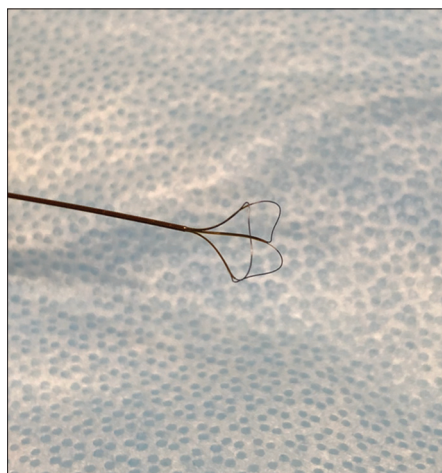
## RESULTS

Of the ten total patients, five patients underwent biopsies with both the nitinol stone retrieval basket and the biopsy forceps, and five patients underwent biopsies with the nitinol stone retrieval basket only. There were five and 13 total biopsy specimens obtained by the biopsy forceps and nitinol stone retrieval basket, respectively. Some biopsies contained multiple pieces of tissue, so there were nine total pieces of tissue obtained with the biopsy forceps and 32 with the nitinol stone retrieval basket. Of the ten patients, six had a ureteral stent placed after their procedure, two patients were admitted overnight for nephrostomy tube placement, and

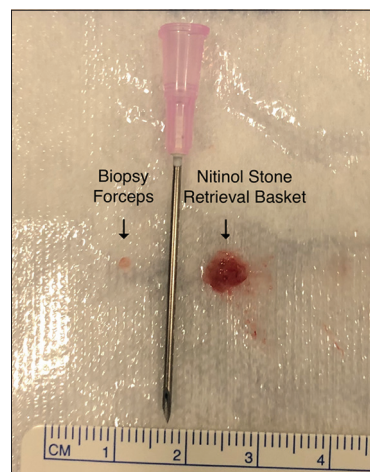
two patients were left without a stent or nephrostomy tube. In the two cases in which a nephrostomy tube was placed, guidewire placement was prevented due to tumor obstruction [Table 2].

The biopsies obtained by the nitinol stone retrieval basket were approximately nine times larger than those of the biopsy forceps, with average sizes being 0.0075 cm<sup>3</sup> with the biopsy forceps and 0.0674 cm<sup>3</sup> with the Nitinol stone retrieval basket [Figure 3]. This was the only statistically significant result in our study (*P* = 0.00017). None (0/5) of the specimens obtained with the biopsy forceps contained muscularis propria, whereas 31% (4/13) specimens obtained with the nitinol stone retrieval basket contained muscle tissue (*P* = 0.2778). Two patients reported hematuria, and one patient reported flank pain at their postoperative clinic visits. There were no other reported complications.

Nine out of the ten patients in this study ultimately underwent nephroureterectomy to determine final pathology; one patient passed away before nephroureterectomy [Table 3]. Of the nine patients who underwent nephroureterectomy, three were found to have high-grade UC on final pathology, five had low-grade UC, and one patient had no identifiable



**Figure 2:** Cook medical nitinol stone retrieval basket



**Figure 3:** Example of biopsy specimen size comparison between the biopsy forceps and nitinol stone retrieval basket

**Table 1: General patient characteristics**

	Male	Female	Total
Number of patients (%)	5 (50)	5 (50)	10
Age	68.0±13.49	72.4±16.32	70.2±14.30
BMI	29.29±4.26	26.11±9.25	27.70±6.99
ASA number*	3.0±0	3.2±0.45	3.1±0.32
Number of smokers (%)	4/5 (80)	5/5 (100)	9/10 (90)
Pack years	28.0±19.24	53.4±33.20	40.70±28.87
Ureteral stent placed intraoperatively (%)	2/5 (40)	4/5 (80)	6/10 (60)
Nephrostomy tube placed intraoperatively (%)**	1/10 (10)	1/10 (10)	2/10 (20)

\*Recorded 1 month prior to biopsy, \*\*Due to tumor obstruction. BMI: Body mass index, ASA: American Standards Association

**Table 2: Comparison of biopsy quality parameters between the piranha biopsy forceps and cook medical nitinol stone retrieval basket**

	Piranha biopsy forceps	Nitinol stone retrieval basket	Total	P*
Specimens biopsied	5	13	18	N/A
Total tissue pieces obtained	9	32	41	N/A
Specimen size**	0.00756±0.011	0.0674±0.067	0.0375±0.064	0.0001631
Muscularis propria presence within specimen (%)	0/5 (0)	4/13 (30.7)	4/18 (22.2)	0.2778
Malignancy detection sensitivity (%)***	2/5 (40%)	12/12 (100)****	15/18 (83.3)	0.4134

\*P values determined by a two-tailed *t*-test for biopsy size comparison and Fisher's exact tests for both muscularis propria presence and sensitivity value comparisons; cut-off P value for statistical significance was 0.05, \*\*Units are cm<sup>3</sup>, \*\*\*Sensitivity values calculated using biopsy specimen pathology results and final pathology results after nephroureterectomy, \*\*\*\*One of the patients passed away prior to nephroureterectomy, so no subsequent pathological evaluation to confirm malignancy was performed. N/A: Not available

**Table 3: Biopsy specimen pathology results of each instrument compared to final pathology results status-postnephroureterectomy**

Piranha biopsy forceps	Nitinol stone retrieval basket	Final pathology results
Minute fragments of crushed urothelial tissue	Low-grade UC	High-grade UC
No malignancy identified	Low-grade UC	Low-grade UC
Low-grade UC	Low-grade UC	Low-grade UC
Low-grade UC	Low-grade UC	High-grade UC
Crushed urothelial tissue	Low-grade UC	Low-grade UC
	Low-grade UC	No malignancy identified*
	Low-grade UC	Low-grade UC
	Low-grade UC	Low-grade UC
	Low-grade UC	High-grade UC
	High-grade UC	N/A**

\*Likely due to low tumor burden resolution with biopsy and holmium laser prior to nephroureterectomy, \*\*Patient deceased prior to nephroureterectomy. UC: Urothelial carcinoma, N/A: Not available

malignancy. In the three cases in which high-grade disease was found after nephroureterectomy, all of the biopsy specimens demonstrated low-grade disease, regardless of the instrument used. In the patient who did not undergo nephroureterectomy, the biopsy with the Nitinol stone retrieval basket revealed the high-grade disease. In the eight patients found to have UC on final pathologic diagnosis, malignancy was identified in all biopsies taken with the nitinol stone retrieval basket (100% sensitivity), whereas only two of the five biopsies taken with the biopsy forceps revealed malignancy (40% sensitivity) ( $P = 0.4134$ ). In the three patients whose biopsies either demonstrated no malignancy or crushed urothelial tissue with the biopsy forceps, the nitinol stone retrieval basket demonstrated UC. In the single patient who had no identifiable malignancy after nephroureterectomy, the nitinol stone retrieval basket biopsy revealed low-grade disease; the base of the mass was fulgurated with holmium laser after this biopsy was performed.

## DISCUSSION

The management of UTUC has evolved over the years, with neoadjuvant chemotherapy becoming increasingly important. Previously, radical nephroureterectomy was the standard treatment for all cases of UTUC. Although this method is effective in achieving oncologic control, renal

function deterioration and morbidity from the operation itself are important considerations. Nephron-sparing therapies such as endoscopic resection or segmental ureterectomy are now considered viable treatment options in certain patient populations (i.e., low-grade tumors, many co-morbidities).<sup>[7,8]</sup> Since multiple potential treatments exist, early detection and accurate diagnosis of UTUC is crucial for optimal management. Ureteroscopy with biopsy remains the standard for grading and staging UTUC; however, obtaining adequate biopsies is often challenging due to the small instrument size.<sup>[3,4]</sup> We attempted to address this issue by comparing multiple biopsy quality parameters of two instruments commonly used for upper tract mass biopsy.

First, it is important to note that our study was limited by a sample size of ten total patients. This small sample size was likely the primary reason for the lack of statistical significance in some of our results. Another consideration is that one of the ten patients passed away before nephroureterectomy and final pathologic diagnosis; this particular patient had high-grade disease based on nitinol stone basket biopsy pathology. In the patient with no detectable malignancy on final pathology, the nitinol stone basket biopsy revealed low-grade UC. This patient had a 0.5 cm mass visualized during ureteroscopy in the renal pelvis, which was fulgurated at the base with the holmium laser after the biopsy was performed. In this case, it is likely that the combination of biopsy and subsequent laser fulguration of the base led to the successful removal of the patient's entire tumor burden before nephroureterectomy.

Despite these considerations, we were still able to achieve notable findings within our study. Difference in biopsy tissue size held statistical significance in favor of the nitinol stone retrieval basket, which yielded an average biopsy size nearly nine times larger than the biopsy forceps ( $P = 0.00017$ ). This result is especially meaningful since the gross size of tissue material obtained via biopsy is likely the most important factor with regards to malignancy detection and accurate tumor grading in UTUC.<sup>[4,8]</sup> Results for our other variables—muscularis propria presence within biopsy

samples and sensitivity of malignancy detection— also favored the nitinol stone retrieval basket over biopsy forceps, although these were not statistically significant. With regard to malignancy detection, the nitinol stone basket produced an impressive sensitivity value of 100% compared to 40% demonstrated by the biopsy forceps. We consider this result to be noteworthy since diagnostic modalities with higher sensitivities are particularly useful in the detection of detrimental diseases, like UTUC, in which prompt treatment has a more favorable prognosis. The combination of the nitinol stone basket's ability to obtain larger biopsy samples and muscularis propria presence within specimens likely contributed to its higher sensitivity value when compared to biopsy forceps.

All in all, our findings support the notion that biopsies obtained by the nitinol stone retrieval basket are useful in the diagnostic evaluation of upper urogenital tract tumors. However, due to our small sample size and lack of statistical significance in multiple parameters, specific instrument superiority (or lack thereof) is yet to be established. Further studies to determine this are warranted since early disease detection and diagnostic accuracy of UTUC are crucial for optimal patient care.

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Nil.

#### Conflicts of interest

There are no conflicts of interest.

#### REFERENCES

1. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2017. *CA Cancer J Clin* 2017;67:7-30.
2. Wein A, Kavoussi L, Novick A, Partin A, Peters C. *Campbell-Walsh Urology Tenth Edition*. Elsevier 2012;53:1516-53.
3. Rouprêt M, Zigeuner R, Palou J, Boehle A, Kaasinen E, Sylvester R, *et al.* European guidelines for the diagnosis and management of upper urinary tract urothelial cell carcinomas: 2011 update. *Eur Urol* 2011;59:584-94.
4. Pathologists C of A. Protocol for the Examination of Biopsy Specimens from Patients with Soft Tissue Tumors; August, 2020. p. 1-12. Available from: <https://www.cap.org/cancerprotocols>. Accessed 23 April 2021.
5. McCarron JP Jr, Chasko SB, Gray GF Jr. Systematic mapping of nephroureterectomy specimens removed for urothelial cancer: Pathological findings and clinical correlations. *J Urol* 1982;128:243-6.
6. Guarnizo E, Pavlovich CP, Seiba M, Carlson DL, Vaughan ED Jr, Sosa RE. Ureteroscopic biopsy of upper tract urothelial carcinoma: Improved diagnostic accuracy and histopathological considerations using a multi-biopsy approach. *J Urol* 2000;163:52-5.
7. Pal SK, Agarwal N, Boorjian SA, Hahn NM, Siefker-Radtke AO, Clark PE, *et al.* Re: National comprehensive cancer network recommendations on molecular profiling of advanced bladder cancer. *J Urol* 2019;201:858.
8. Vashista V, Shabsigh A, Zynger DL. Utility and diagnostic accuracy of ureteroscopic biopsy in upper tract urothelial carcinoma. *Arch Pathol Lab Med* 2013;137:400-7.
9. Kaag MG, O'Malley RL, O'Malley P, Godoy G, Chen M, Smaldone MC, *et al.* Changes in renal function following nephroureterectomy may affect the use of perioperative chemotherapy. *Eur Urol* 2010;58:581-7.
10. Kleinmann N, Healy KA, Hubosky SG, Margel D, Bibbo M, Bagley DH. Ureteroscopic biopsy of upper tract urothelial carcinoma: Comparison of basket and forceps. *J Endourol* 2013;27:1450-4.
11. Abdel-Razzak OM, Ehya H, Cubler-Goodman A, Bagley DH. Ureteroscopic biopsy in the upper urinary tract. *Urology* 1994;44:451-7.