OPEN ACCESS
Saudi Journal of Biomedical Research
Abbreviated Key Title: Saudi J Biomed Res
ISSN 2518-3214 (Print) |ISSN 2518-3222 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

The Ureteral Stone Cone is A Useful Device for the Prevention of Calculi Retropulsion during Holmium Laser Lithotripsy for Proximal and Mid-Ureteric Stones. A Nigerian Experience

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DOI: 10.36348/sjbr.2022.v07i02.004 | **Received:** 12.01.2022 | **Accepted:** 19.02.2022 | **Published:** 24.02.2022

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Abstract

Background: Retropulsion and stone fragment migration is a problem with lithotripsy especially for proximal and mid-ureteric calculi during ureteroscopy, leading to increased operative time, costs, and additional procedures. To overcome this drawback, many strategies have been developed, one of which is the use of anti-retropulsion devices like the stone cone. ***Objective***: To describe our initial experience with the use of the stone cone during holmium laser lithotripsy in a patient with proximal and mid-ureteric stone for preventing retropulsion. ***Method:*** This is a retrospective study carried out on six consecutive patients with proximal with uncommon proximal ureteric stone over a 2year period ureteric stone. TPatients with distal ureteric stone were excluded. The Boston Scientific Stone Cone Nitinol Retrieval Coil was passed beyond the stone and deployed under fluoroscopy to prevent proximal stone and fragment migration. Holmium laser lithotripsy was then carried out. The fragments were removed with graspers and the stone cone was then removed. A double J stent was passed in all cases for about two to a month week and removed. The total operating time was noted. The data on the patient's age, sex, stone size, Hounsfield, and stone clearance was analyzed using SPSS version 20. ***Results:*** There were six patients, five male, and one female with a mean age of 37.5years with an age range between 27 – 54years. The stone sizes ranged from 7-15mm with a mean dimension of 11.17mm. The Hounsfield of the stones ranged from 539 to 1171HU with a mean of 765.5HU. The operating time ranged from 55 – 90minutes with a mean of 67.5minutes. None had retropulsion with 100% stone clearance. ***Conclusion***: The stone cone is a safe device and is useful during ureteroscopy and lithotripsy for mid-and proximal ureteric stone in preventing retropulsion and improving stone clearance.

Keywords: Anti-retropulsion devices, Holmium laser lithotripsy, Ureteric stones.

INTRODUCTION

Ureterorenoscopy (URS) and laser lithotripsy is the first-choice procedure in the management of ureteric stones with high patient preference and low morbidity compared to open surgery [1]. Technological advances in the ureteroscope, stone fragmentation equipment, and retrieval devices have increased the success rate to more than 90%. Among the stone fragmentation methods, holmium-laser lithotripsy is one of the most effective and popular methods of successful management of ureteric stone despite its higher cost compared to pneumatic lithotripsy [2]. A major complication of lithotripsy especially for proximal ureteric calculi irrespective of the stone fragmentation device used is retropulsion. Retropulsion reduces stone clearance, increases the surgical time and cost of the ureterorenoscopy, as there may be a need to use flexible ureterorenoscope which are expensive [1, 3]. Retropulsion rates can be up to 60% during ureteroscopy and it is highest with stones in upper ureters; when there is an associated hydroureter; and with pneumatic lithotripsy [4]. There are many categories of ureteric occlusion devices that have been used to prevent stone retropulsion and to achieve high stone clearance rates [3]. Laser lithotripsy is not commonly available in most developing countries and there is a paucity of data on the use of antiretropulsion devices in Nigeria.

AIMS AND OBJECTIVES

This study is aimed at describing our initial experiences in the effectiveness of the stone cone in preventing stone retropulsion during lithotripsy for proximal ureteric and mid-ureteric stones.

METHOD

This is a retrospective study carried out on six consecutive patients with proximal ureteric stone over a 2year period from January 2020 to January 2022 at Rosivylle Clinic and Urology Centre. All the patients were evaluated with urine urinalysis, urine microscopy culture and sensitivity, abdominopelvic ultrasound scan, and abdominal computerized axial tomography and urography. *(Figure 1)* They all had a preoperative evaluation with the anaesthesiologist and counseled on the type of anaesthesia. Patients with mid-ureteric stones had subarachnoid block while those with proximal ureteric stones had general anaesthesia with endotracheal intubation. All patients with distal ureteric stone were excluded. Cystoscopy was done followed by semi-rigid ureteroscopy. The stone was identified and a straight tip 0.0035mm zebra guidewire is passed beyond the stone into the kidney under fluoroscopy guidance. The Boston Scientific Stone Cone Nitinol Retrieval Coil *(Figure 2)* was passed beyond the stone and deployed under fluoroscopy guidance. *(Figure 3)* Holmium laser lithotripsy was then carried out and all fragments were evacuated with a grasper, after which the stone cone was then removed. *(Figure 4)* A double J stent was passed in all cases for about two weeks to a month before removal. The total operating time was noted. The data on the patient's age, sex, stone size, Hounsfield, and stone clearance was analyzed using SPSS version 20.

Fig-1: Computerized Axial Tomography Urography showing non-functioning left kidney from a stone in left kidney

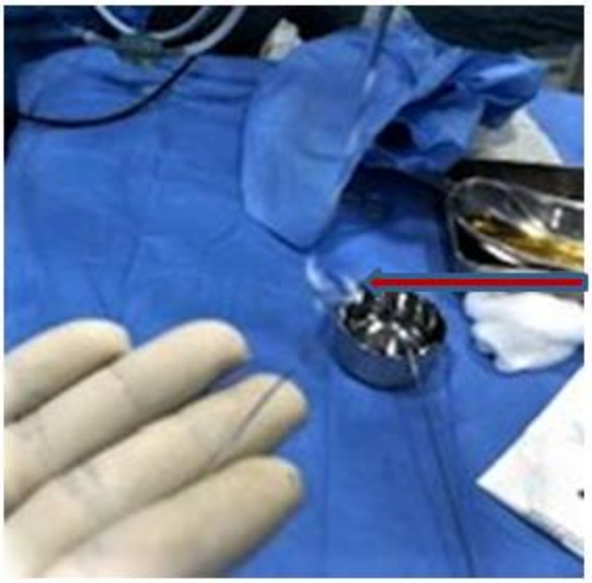

Fig-2: Nitinol Stone Cone (Red Arrow)

Fig-3: Fluoroscopic image showing deployed stone cone

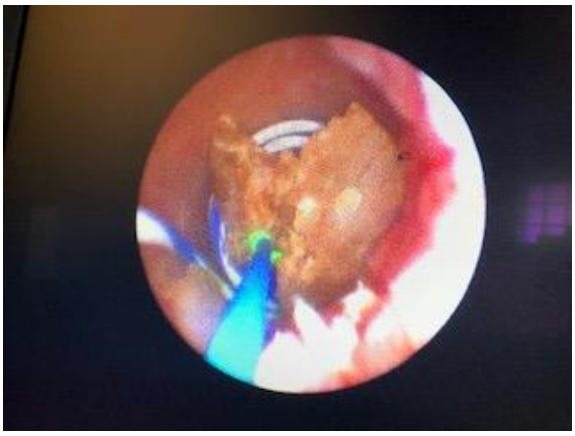

Fig-4: Endoscopic view of deployed stone cone preventing retropulsion during fragmentation by laser lithotripsy

RESULTS

There were six patients, five male, and one female with a mean age of 37.5years and an age range between 27 – 54years. The stone sizes were between 7-

15mm with a mean dimension of 11.17mm. The Hounsfield of the stones ranged from 539 to 1171HU with a mean of 765.5HU. The operating time was between 55 – 90minutes with a mean of 67.5minutes. Stone dusting was utilized in five patients and combined dusting and fragmentation in one patient. None had retropulsion with 100% stone clearance.

Table-1: The age, stone characteristics, and surgical operation time of the patients.

	Age	Stone dimension	Hounsfield	Operation Time
N	6	6	6	6
Mean	37.50	11.16	765.50	67.50
Median	35.00	11.00	666.50	60.00
Mode	31.00	15.00	539.00	60.00
Std. Deviation	9.99	3.43	246.14	14.05
Range	27.00	8.00	632.00	35.00
Minimum	27.00	7.00	539.00	55.00
Maximum	54.00	15.00	1171.00	90.00

Table-2: Relationship between type of anaesthesia with the patients' age, stone characteristics, and surgical operation time of the patients

	Mode of Anaesthesia		p-value
	GA	Spinal	
	Mean±SD	Mean±SD	
Age (years)	40.00±13.53	35.00±6.93	0.599
Stone dimension (mm)	14.00±1.73	8.33±1.53	0.013
Hounsfield	834.67±296.51	696.33±221.79	0.553
Operation time (s)	76.67±15.28	58.33±2.89	0.169

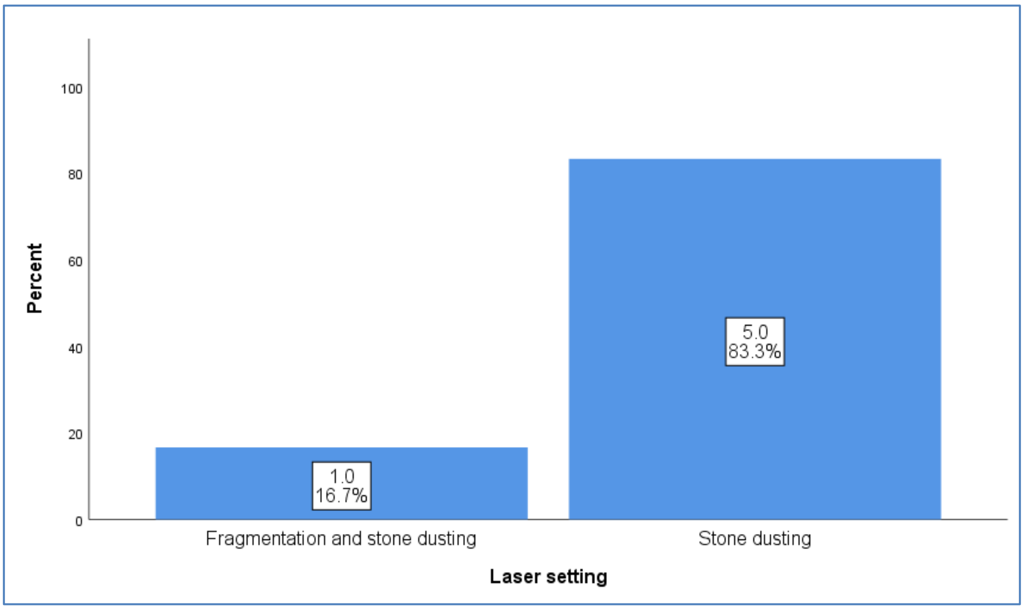

Fig-5: Laser settings used during lithotripsy

DISCUSSION

The majority of calculi are managed by open surgical approaches in developing countries like Nigeria, either because of the absence of resources or the training in endourology. This is in contrast to developed countries where ureteroscopy and laser lithotripsy is the gold standard in the management of ureteric stones with a stone clearance rate above 90% [4-6]. In our study, we considered patients with mid-and upper ureteric stones because of the peculiar challenges of managing calculi in these locations in developing countries, where cost is a significant consideration. The small sample size is partly due to a lack of awareness and the cost of the procedure, and the inclusion of only proximal and mid-ureteric stones.

Retropulsion leading to proximal migration of calculi or its fragment into the kidney during lithotripsy is a problem that can necessitate conversion to other endoscopic options to achieve stone clearance. It also leads to additional anesthesia, a second procedure, abandonment of the procedure, and reduced stone clearance rates. This increases the cost of the procedure with the attending economic burden on the patient [7, 8]. Options when retropulsion occurs into the kidney, include flexible ureterorenoscopy with laser lithotripsy, percutaneous nephrolithotomy, and extracorporeal shockwave lithotripsy. These both increase the risk of morbidity for the patient [7-9].

There are known risk factors for retropulsion during ureteroscopy and lithotripsy. Knispel *et al*. observed in their study that the retropulsion rate was higher in stones located in the proximal ureters [6]. The presence of hydroureter, the use of pneumatic and electrohydraulic lithotripsy [10] are other risk factors for retropulsion. Laser lithotripsy has been observed to be associated with a lower risk of retropulsion compared to other methods of stone fragmentation [4, 11]. The Dusting Mode uses low energy and high frequency, reducing the kinetic energy transfer to the stone with less retropulsion. The fragmentation Mode utilizes higher energy and lower frequency and is useful for hard stones such as calcium oxalate monohydrate calculi, and is associated with higher stone kinetic energy with the attendant risk of retropulsion [1, 11].

Many different materials and devices have been recommended for preventing retropulsion especially during lithotripsy for proximal ureteric calculi. These include lidocaine gel, ureteric baskets, and the stone cone [7, 12-17]. In our study, we utilized the Boston Scientific Stone Cone Nitinol Retrieval Coil. The mean operation time was 67.5mins. Several studies have observed that the use of anti-retropulsion devices decreases the mean operating time of ureteroscopy and improves stone clearance rates [9, 14, 18]. Still others have not demonstrated any significant difference in surgery duration with their use [14, 15, 19].

There are measures during standard ureteroscopy and lithotripsy that reduce the risk of retropulsion. Supine position and injudicious irrigation can predispose to retropulsion during lithotripsy. A 10-15^{o} reverse Trendelenburg position and gentle irrigations reduce the risk of retropulsion. Newer lasers technology such as the MOSES are designed with features to mitigate retropulsion [20].

In our study, there was no retropulsion observed in all six patients, even though they had stones in the proximal and mid-ureters where retropulsion is frequent. Preparation for ureteroscopy and lithotripsy for stones in this location will usually include counseling for a potential additional cost, making available a flexible ureteronephroscope, and utilizing general anaesthesia with paralysis. The stone cone when deployed occludes the segment of the ureter proximal to the stone and prevents migration of calculi and fragments into the kidneys. Some studies have reported a stone clearance rate approaching 100% using ureteric occlusion devices [1, 11, 14, 21, 22].

In our study, five of the patients had lithotripsy using the Dusting Mode while one was carried out with combined Dusting and Fragmentation Mode. All the three patients with upper ureteric stone had lithotripsy by stone dusting under general anesthesia with endotracheal intubation. The patients with mid- ureteric calculi had awere done under combined spinal-epidural anaesthesia. This was enabled because the deployed stone cone also had the additional advantage of stabilizing the ureter for effective lithotripsy without the need for breath-holding during laser firing.

Calculi retropulsion and the presence of residual fragments of more than 3 mm could be symptomatic with the potential requirement for second anesthesia and procedures. This can reduce the patient's overall treatment satisfaction. The additional cost of acquiring the stone cone to ensure complete stone clearance and avoid retropulsion seems justified considering the near 100% stone clearance [17, 23].

Ureteric trauma is a possible complication using the stone cone. Minor lesions are not uncommon, mostly ureteric abrasion, with a reported rate of up to 15.4% [6, 18]. Most injuries are managed by ureteric double J stenting. We routinely pass a stent for all our patients primarily to improve stone clearance.

Finally, in developing countries where lasers are not readily available, the use of ureteral occlusion agents and devices can prevent retropulsion also during pneumatic lithotripsy [9]. Utilizing the stone cone especially for proximal and mid-ureteric calculi can reduce retropulsion and increase stone clearance rate.

CONCLUSION

The stone cone is a safe device and is useful during ureteroscopy and lithotripsy for mid-and proximal ureteric stone in preventing retropulsion and improving stone clearance.

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