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Overview of Antiretropulsion Devices for Prevention of Inadvertent Stone Migration during Pneumatic Lithotripsy for Ureteric Stone

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Book Chapter

Overview of Antiretropulsion Devices for Prevention of Inadvertent Stone Migration during Pneumatic Lithotripsy for Ureteric Stone

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Abstract

The purpose of the present chapter is to provide an update about the use of preventive devices used to stop retrograde stone

migration during pneumatic lithotripsy for ureteric stone management. The aim to reduce the cost, ancillary procedure, reduce the operative time and improve the stone free rate. The hunt for ideal cadget to stop retrograde stone migration is still continue in 21 century.

Keywords

Anti-Retropulsion Device; Ureteric Stones; Pneumatic Lithotripsy; Retrograde Stone Migration; Stone-Free Rates, Ureteroscopy

Introduction

Ureteroscopic pneumatic lithotripsy for the treatment of ureteric calculi is quite a common modality [1]. However, proximal migration of the calculi during lithotripsy has been reported to range from 3- 48% in literature [2]. The migration depends on variable factors; can be triggered by the jet of irrigation fluid, type of energy source used for intracorporeal lithotripsy, location of the calculus in the ureter and the degree to which it is impacted there, as well as the degree of proximal ureteral dilation [3]. Electrohydraulic and pneumatic lithotrites are more prone for retrograde migration of calculi compared to others like ultrasonic or holmium:yttrium-aluminum-garnet(Ho:YAG) lasers [4]. However, with the case of Ho:YAG lasers the rate of stone retropulsion increases proportionally to the rise in pulse energy used or diameter of the optical fibre. Proximal migration of the calculi are more when the stones are smaller or when the diameters of the proximal ureter is larger e.g. in hydronephrosis [3].

The migration of stone fragments when performing lithotripsy carries an increased morbidity and cost burden to the patient [2,5]. Retrieval of these fragments may require variable additional procedures. These include flexible ureterorenoscopy, further fragmentation, need special retrieval apparatus, ureteric stenting, or in some cases extracorporeal shock wave lithotripsy [3,4]. Moreover, these fragments act as a nidus for infection or further growth or may lead to colic. Various devices have been

developed to ease extraction or ureteric calculi and prevent their retrograde migration during lithotripsy. However, these devices are far from perfect with each carrying its own limitation and variable success [6,7,8]. There are a number of accessory instruments that have come up recently, to place above a calculus so as to prevent migration of fragments proximally during ureteroscopy. They also facilitate extraction of fragments upon removal of these devices [3,4].

The Stone Cone (Boston Scientific, Boston, MA) is coupling nitinol wire that's about 0.43-mm into a 3F polytetrafluoroethylene (PTFE) sheath. The nitinol has a specialized tip which is shaped in concentric coils. When these coils are open and placed proximal to the stone they prevent any migration of the stone or its fragments during lithotripsy [9]. Other option would be the use of 2cc of 2 percent lidocaine jelly that is instilled just proximal to the stone using a 5cc syringe to avoid migration of fragments to the proximal ureter [8]. The PercSys Accordion (Percutaneous System, Palo Alto, CA) is a unibody device of about 2.9F that has a Multifood polyurethane film backstop that can provide a 7-mm barrier when fully deployed [10].

A number of other devices are reported in literature however, of these occlusion devices; the Stone Cone (Microvasive; Boston Scientific Corp., Spencer, IN), N-Trap (Cook Urological, Spencer, IN) and lidocaine jelly installation proximal to ureteric stone, probably have the most successful profile [11,12]. In this review, we compared the safety and efficacy of these devices with lidocaine gel in minimizing retrograde migration of calculi and extraction of fragments during ureteroscopic lithotripsy.

Overview of Antiretropulsion Devices

Methodology

A Narrative literature search was performed using Medline, Google Scholar and The Cochrane database of systematic reviews (CDSR), to identify relevant studies. Searches were restricted to publications in English and in the adult population from 1994 to December 2019. Separate searches were done with

the following search terms: anti-retropulsion device, ureteric stones, pneumatic lithotripsy, retrograde stone migration, stone-free rates and ureteroscopy. Article selection proceeded according to the search strategy based on Preferred Reporting Items for Systematic Reviews and Meta-analysis criteria. Only studies comparing different anti-retropulsion devices during ureteroscopy to prevent retrograde migration were included for further screening. Cited references from the selected articles retrieved in the search were also assessed for significant papers. Conference abstracts were not included because sufficient detail for the study is not available in an abstract. All authors and one independent reviewers completed this process, and all disagreements were resolved by their consensus.

The Problem- Stone Migration during Ureteroscopy

One of the major challenges a urologist faces during ureteroscopic lithotripsy is stone migration or retropulsion. There are several factors that play part here. It could be due to the energy transmission into the calculi used to fragment the stone during lithotripsy or the irrigation flow used during ureteroscopy. Inadvertent push has been commonly observed with pneumatic lithotripsy, ranging from 3 to 48% in literature however this varies on the stones localization [2,13,14]. The risk of retrograde migration during Ho:YAG laser lithotripsy has been shown to be lower than other modalitiles [3]. There is a considerable higher risk of proximal migration when the ureter proximal to the stone is dilated. The risk of migration also increases the more proximal you are and depends on the operating surgeons experience with the procedure [11]. Higher volume centers with good experience in ureteroscopy have been able to achieve migration rates as low as 4–7% [12].

Different studies have shown various stone migration rates, with higher rates for stones in the proximal ureter when pneumatic intracorporeal lithotripsy was used. A study by Knispel et al found they had a migration rate of 40% for stones in the proximal ureter vs only 5% when the calculus presented in the distal ureter [13]. Robert et al also reported a 48% migration rate of stones in the proximal ureter [2]. Recently, Chow et al noted that this risk wasn't eliminated with newer techniques, such as

laser lithotripsy or flexible ureteroscopy. Even they had 25% retrograde migration for proximal ureteric stones [15]. Most of the migrated stones or residual fragments need secondary procedures like shockwave lithotripsy or another ureteroscopy. Moreover, these residual fragments act as nidus for recurrent stone growth, renal colic or even infections. Additionally they increase costs and morbidity to the patient [3,16,17].

Various Options- Merits and Demerits

An arsenal of devices and strategies have been developed in recent years to prevent proximal stone migration and aid extraction of stone fragments. These include Parachute (Microvasive; Boston Scientific), stone baskets Lithocatch (Microvasive; Boston Scientific), Lithovac (Microvasive; Boston Scientific), Passport Balloon (Microvasive; Boston Scientific), NTrap (Cook Urological) and the Stone Cone (Microvasive; Boston Scientific) [8,12,16,17,18]. These devise have a number of limitations that prevent regular usage in lithotripsy. A major limiting factor is the need for all these devices to leave the device in the working field which is already limited; hence limiting maneuverability of the scope. The Lithocatch and Parachute are basket mesh-based models. The disadvantage of this model is that their basket may unintentionally trap fragments making it difficult to disengage them and potentially may cause ureteral injury [11]. Studies have demonstrated that ball-bearing ability to retrieve of the Parachute is similar to a basket [19]. Studies have also reported that using the 0.038- inch Passport balloon compromises the success rate of advancing a flexible ureteroscope past the stone [16].

Another effective device to retrieve smaller fragments is The Dretler stone cone. This device has an additional safety feature, such that its coils begin to unwind in case the volume of fragments in the cone exceed the safety limit [20]. Moreover, the Dretler rotates ad unwinds when traction is applied to it. This process produces lower traction as compared to simple traction.

Among other strategies used to prevent proximal migration is the use of baskets. There are some reported cases of wire or basket

damage during lithotripsy. Removal of these damaged baskets or parts is very challenging even the most experienced hands. Similarly, obstructing balloons may be used to prevent proximal migration. However, they work best in a system that is not dilated. If the proximal system is dilated, then the balloon may be too small to work effectively. Damage to the balloons by lithotripters have also been reported.

Stone Cone (Boston ScientiWc, Natick, MA, USA) and N'Trap (Cook Urological, Bloomington, IN, USA) are more recent stone trapping devices that form proximal barriers to prevent stone migration. They have been shown to be effective by many studies. However, like other devices they too have some limitations. The N-Trap device unwinds by the force of the lithotripsy or if higher flows of irrigation are used. They too may not be able to fully occlude the ureters in cases where there is significant ureteric dilation beyond the diameter of its barrier.

Cost Implications

Retrograde migration of stone fragments carries with it several morbidities from prolonged operative time, to need for supplementary procedures, all increasing costs to various degrees. Most of these devices are disposable, so one must fairly justify their added cost for benefit. A study by Ursiny et al showed reviewed occlusion devices including BackStop, NTrap, Stone Cone and Lidocaine jelly and found that these devices would be cost effective when the proximal migration rate is greater than 6.3%. However, they reported that these data should be interpreted with caution because in reality there would be various treatment options for the retropulsed fragment. From observation, to use of flexible ureteroscopy or perhaps a secondary procedure, most often SWL or ureteroscopy. The limitation of their study was the assumption that all patients with proximal stone migration of stone fragment would undergo secondary procedures. Though the cost implications of each treatment modality would very, each modality could easily surpass the cost of these devices as shown in Table 1 [20, 21].

Table 1: Antiretropulsion devices with cost.

Device	Manufacturer	cost
NTrap	Cook Urological	$100
PercSys Accordion	Percutaneous system	$325
BackStop	Boston Scientific	$50
Parachute	Boston Scientific	$99
Lithocatch	Boston Scientific	$80
Passport Balloon	Boston Scientific	$230
Stone Cone	Boston Scientific	£215
Lidocaine gel	AstraZeneca pharma	$3

Lidocaine Gel Instillation

Instillation of lidocaine high viscosity, jelly proximal to ureteral stones to prevent stone migration is a technique that has been reported. Once the procedure is done, the jelly can be washed off with irrigation or at times even let to dissolve on its own. There have been some studies that showed significantly higher stone free survival rates when compared to placebo that by Zehri et al [8]. However, a study by Sen et al. could not show that lidocaine was superior to other occlusive devices. On must also keep in mind that this technique too has its drawbacks like difficulty to wash the jelly with irrigation and jelly obscuring the view of the ureteroscopy [21].

Conclusion

Hunt for ideal anti-retrograde migration device still continue in 21st century, each tool as drawbacks and benefits, multiple gadgets as driven successful results, but one has to look for a device which is easy to place, overcome fragment migration and allow the passage of intracorporeal lithotriptors, guidewires and stents following stone fragmentation. More importantly cost effective to the patient as compare to ancillary procedures, xylocaine jelly has low cost and easily available with comparable stone free rate and reduce auxiliary procedure rate but high volume studies are required to justify the benefits.

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