



Anti retropulsive stone device technique during laser lithotripsy in treatment of upper ureteric stone with their effect on stone free rate and operative time(comparative study)

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Abstract

Background: Ureteroscopy fragmentation & extraction of ureteric stones is one of the most efficient minimal invasive treatment modalities, one of the drawbacks of this procedure, which occur specially during fragmentation of upper ureteric stones, is the proximal stone migration or retropulsion.

Objective: To assess the safety and efficacy of different method of anti retropulsive device technique during laser lithotripsy of upper ureteric stone and their effect on stone free rate.

Patients & Methods: This retrospective comparative study included 90 patients During the period from June 2025 to june 2026 90 patients, with symptomatic upper ureteral stones of greater than 10 mm in size were admitted in our urology unit and enrolled in this study.

Patients were randomized into 3 equal groups; Group (A) underwent ureteroscopic laser fragmentation with using of stone cone, group (B) with two guide wires and group (C) underwent ureteroscopic fragmentation with using of single safety wire.

Patient demographics, stone size, operative duration and complications, and success rates (complete stone disintegration with no upward migration) were reported and analysed statistically.

Results: There was no significant difference in stone size, and additional procedure among different groups

Stone migration was statistically significant different ($p=0.008$) in which (6.7%) in group A and (13.3%) in group B while there was high retropulsion rate in group C (36.7%), which lead to a stone free rates (93.3%)% in group A

& (86.7%)% in group B and the lowest in Group C (63.3%), significant difference ($p < 0.001$) observed between double wire (34.9 min) and stone cone (42.4 min) in operative time while it was lower in single wire group (31.2min), Complications were minimal and comparable in all groups and they were all amenable to conservative treatment.

Conclusion: We found that stone cone was the most effective method to prevent stone retropulsion with good stone free rate but with longer operative time in comparison with other technique.

Keywords: safety wire, Stone cone, cost, ureteroscopes, flexible, efficacy.

Introduction

Ureteric stone usually originate in kidney Once it is free from renal pelvis, it may pass into the ureter, and it can stuck anywhere in the ureter. The pain generated by renal colic is primarily caused by dilation, stretching, and spasm because of the acute ureteral obstruction (1).

The lifetime prevalence of kidney stone disease is estimated at 1% to 15%, varying according to age, gender, race, and geographic location. Around the world prevalence rates vary ranging from 7% to 13% in North America, 5% to 9% in Europe, and 1% to 5% in Asia (1).

Ureteric stone usually formed in the kidney and not arise denovo inside ureteric lumen so the risk factors increasing incidence of renal stones also increasing the ureteric stone like low fluid intake, environmental factors, genetic factors. The exact nature of the tubular damage or dysfunction that leads to stone formation has not been characterized (2).

Most research on the etiology and prevention of urinary tract stone disease has been directed toward the role of elevated urinary levels of calcium, oxalate, and uric acid in stone formation, as well as reduced urinary citrate levels (2).

The ureters are bilateral tubular structures measuring 22 to 30 cm in length with a wall composed of multiple layers, external longitudinal and internal helical arranged muscular layer.

The ureter can be divided into three segments, the (upper or proximal) ureter extends from the renal pelvis to the upper border of the sacrum. The middle ureter comprises the segment from the upper to the lower border of the sacrum. The lower (distal or pelvic) ureter extends from the lower border of the sacrum to the bladder the normal ureter is not of uniform caliber, with three distinct narrowings classically, described: the 1st is the pelviureteral junction (PUJ), the 2nd where crossing the iliac vessels, and the 3rd at vesicoureteral junction VUJ (3).

Normal ureteral peristalsis originates and is propagated from intrinsic smooth muscle pacemaker sites located in the minor calyces of the renal collecting system (4).

The autonomic nervous system may exert some modulating effect on this process, but the exact role is unclear.

The ureter receives preganglionic sympathetic input from the 10th thoracic through 2nd lumbar spinal segments.

Postganglionic fibers arise from several ganglia in the aortic-renal, superior, and inferior hypogastric autonomic plexuses.

Parasympathetic input is received from the 2nd through 4th sacral spinal segments (3).

The pain of ureteric colic is due to obstruction of urinary flow by stone impaction, with a subsequent increase in wall tension. Rising pressure in the renal pelvis stimulates the local synthesis and release

of prostaglandins (pG), and subsequent vasodilatation induces a diuresis which further increases intrarenal pressure. Prostaglandins also act directly on the ureter to induce spasm of the smooth muscle. Owing to the shared splanchnic innervation of the renal capsule and intestines, hydronephrosis and distension of the renal capsule may produce nausea and vomiting (4).

The classic presentation of a ureteric colic is acute, colicky flank pain radiating to the groin, sometimes associated with fever, nausea and vomiting. The pain is often described as the worst pain. Ureteric colic occurs as a result of obstruction of the urinary tract by calculi at the narrowest anatomical areas of the ureter. Location of pain may be related but is not an accurate prediction of the position of the stone within the urinary tract. As the stone approaches the vesicoureteric junction, symptoms of bladder irritability may occur. Gross or microscopic hematuria occurs in approximately 90% of patients; however, the absence of hematuria does not preclude the presence of stones (5).

The probability of spontaneous passage is based on a number of factors including stone size, stone position, degree of impaction and degree of obstruction. The likelihood of spontaneous stone passage decreases as the size of the stone increases. Most authors recommend that stone passage should not exceed 4-6 weeks due to the risk of renal damage (7).

Patients and methods

Study design

A prospective, single center, case control study, single surgeon experience, in which 90 patients with upper ureteric stone enrolled in the study and offered the standard of care (ureteroscopy lithotripsy for upper ureteric calculi based on indication for intervention) and randomized into three equal groups, as Group A, in which 30 patients offered ureteroscopic fragmentation with aid of stone cone, Group B 30 patients underwent ureteroscopic fragmentation with using of two safety guide wire, Group C (underwent ureteroscopic stone fragmentation as usual with single safety wire).

Study setting

The study was carried out in Alhussain teaching hospital. The study started from June 2025 till June 2026 {16 months duration}.

The inclusion criteria

- 1- Age older than 18 years and
- 2- Symptomatic unilateral stone
- 3- Stone size (10-20mm) located in the upper ureter not responding to conservative treatment.
- 4- All patients in the study were admitted for retrograde jj stent insertion 2-4 weeks prior to the procedure.

Preoperative workup

All patients selected for the study submitted to a detailed History associated with both general and focused urological examination, also all patients were sent for laboratory test which include:

- 1- General urine examination (culture and sensitivity included)
- 2- Biochemistry (Random blood sugar, blood urea nitrogen and serum creatinine)
- 3- Complete blood count, Erythrocyte sedimentation rate
- 4- Bleeding profile.

Radiological investigation

- 1- Kidney-ureter-bladder X-ray.
- 2- Ultrasonography for the abdomen and pelvis.
- 3- Native computerized tomography of abdomen and pelvis.
- 4- With/ without Excretory urography

Device and equipments;

Stone cone (Boston scientific), 3Fr:

It consists of an inner wire and the outer radio-opaque catheter the inner wire consists of a distal floppy tip, the cone, and the proximal wire. The cone consists of a stainless steel wire wound with a strand of nitinol and is baked in a mold to produce a spiral form. During introduction, the portion of the coil lies straight inside the carrying catheter. Advancing the double strand beyond the tip of the carrying catheter deploys the cone.

Instrument used

- 1- Camera, Monitor and light source (all from Karl Storz TM)
- 2- Cystoscope (Sheath 20 Fr., Telescope Lens 0o and 30o and Bridge)
- 3- An 7 Fr Semi rigid ureteroscope 40 cm length with 12° Lens and 5 Fr.

Working channel (Karl Storz TM)

- 4- Two Guide wires 0.035-inch Polytetrafluoroethylene (PTFE).
- 5- Stone cone (Boston scientific), 3Fr
- 6- Holmium YAG laser lithotripsy system (Quanta system TM) with 360 µm laser fiber
- 7- Irrigation with Normal saline (0.9%).
- 8- Stone grasper.
- 9- DJ stent,5 Fr. and Foleys catheter,16-18 Fr.



Figure (2.1): Setup of URS using 2 wires procedure.

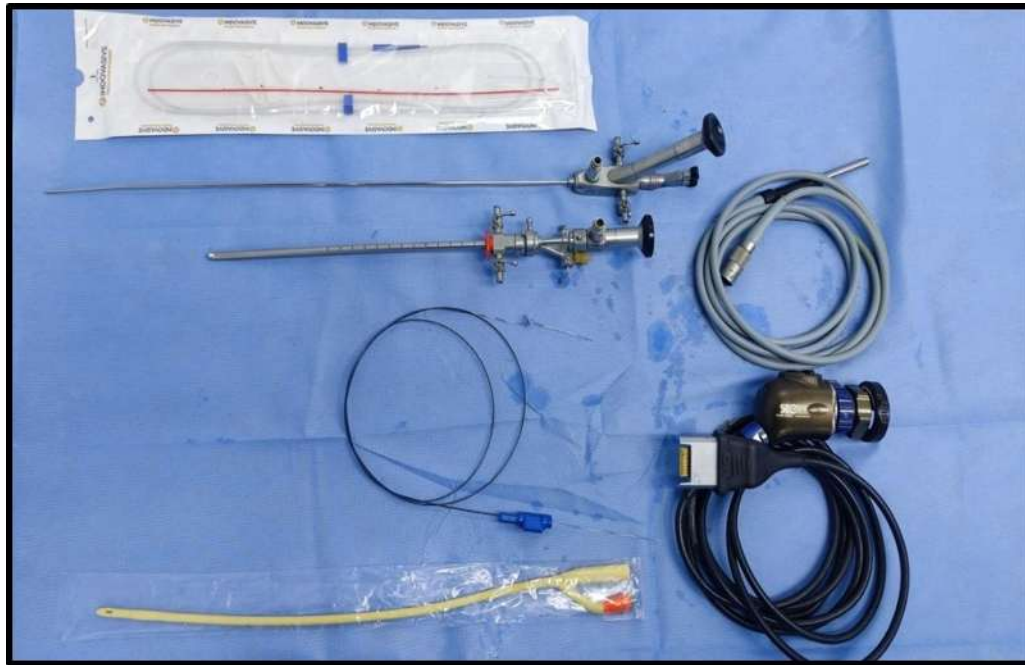


Figure (2.2): Setup of URS using stone cone.

Intra-operative

All patient received prophylactic antibiotic 30 min pre-operatively, 3rd generation cephalosporin (ceftriaxone vial 1 gm intravenous) and amikacin vial (500 mg) in penicillin-allergic patients.

Technique;

The proximal ureter was considered as the ureteral portion between the ureteropelvic junction (UPJ) and the proximal edge of the sacroiliac joint. The distance from the UPJ to the superior edge of the stone, length, width and depth of the stone and dilatation of the ureter and kidney were all assessed on the abdominal CT scan, and the evaluation was performed by a radiologist.

All patients underwent ureteroscopy under general anesthesia, and all of them received a single dose of broad spectrum antibiotics parenterally at time of induction of anesthesia.

Patients were placed in lithotomy position, cystoscope inserted and previously inserted jj stent was has been removed, the 7 fr Uretroscope was Passed into the ureter with aid of a (0.035 inch guide wire PTFE) in most of patients without a need for ureteral dilation, Cases of failure of introduction of the ureterscope were managed by DJ stenting and were excluded from our study. In the same way small stones retrieved by graspers only without the need for laser lithotripsy were excluded from our study too.

After placing a guide wire and reaching the stone with the semi-rigid ureterscope

In group A patients, stone cone advanced through the working channel, until it reached beyond the stone, at this point, we drive the ureterscope to the level of the stone and to pass the Stone Con retrieval coil beside it under direct vision until the stone is between the two black lines on the Stone

Cone sheath, Coaxial traction on the Stone Cone sheath allows the cone to reform. In this way the cone can be activated, pulled down to the stone and minor adjustments

can be made under endoscopic control. The endoscope is then backed off the Stone Cone device.

Next the ureteroscope is maneuvered beside the Stone Cone device to the level of the calculus and the Cone retrieval coil sometimes requires minor adjustments to keep the stone and the cone within the center of the lumen. And subsequently laser lithotripsy of the calculus has been started.

Residual fragments are pulled down by ureteric grasper. Continuous low-pressure fluid flow was necessary to maintain visibility of stone, and was used in all groups.

In group B patients, the 7fr Ureteroscope was Passed into the ureter with aid of a 0.035 inch guide wire till reaching the stone ,bypass it to the kidney and reintroduce the ureteroscope again with another 0.035 inch guide wire and also passed behind the stone till the kidney under vision, so the stone trapped between two safety wires and then reintroduce ureteroscope again with laser fiber through working channel and start firing laser with setting 1.0-1.2 J and 10-15 Hz frequency to dust stone into powder or small gravels comparing with fiber tip.

In group C patients ureteroscope advanced with aid of single safety wire left behind the stone to reach pelvicalyceal system and subsequently laser fragmentation of the stone started the same like another groups.

Insertion of 5 fr JJ stent was done in all patients groups and kept 2-3 wks, Foley catheter inserted also and kept for 12 hrs, Parenteral antibiotics were continued for two days post-operatively and replaced by oral antibiotics for 5-7 days.

Patients in all groups were sent for abdominal ultrasonography in next day to check the residual stone fragments that push backed to the kidney and the position of the DJ stent. Most our patients discharged at post op. day 1 except for patient with complication who kept in hospital decision was made after results for auxiliary procedures before patient discharge. Patients with residual fragments ≥ 5 mm were considered as surgical failures. Patients with stone-free status or with residual fragments < 4 mm were accepted as surgical success (30).

Stone free status is defined as radiological (ultrasound) clearance of stone fragments at the time of DJ stent removal.

The pre-operative data collected in three groups were: patient age, gender, stone size, stone laterality, and duration of symptoms.

Post-operative data were: operative time, stone free rate, proximal stone migration and complications related to the intracorporeal lithotripsy or Stone cone.

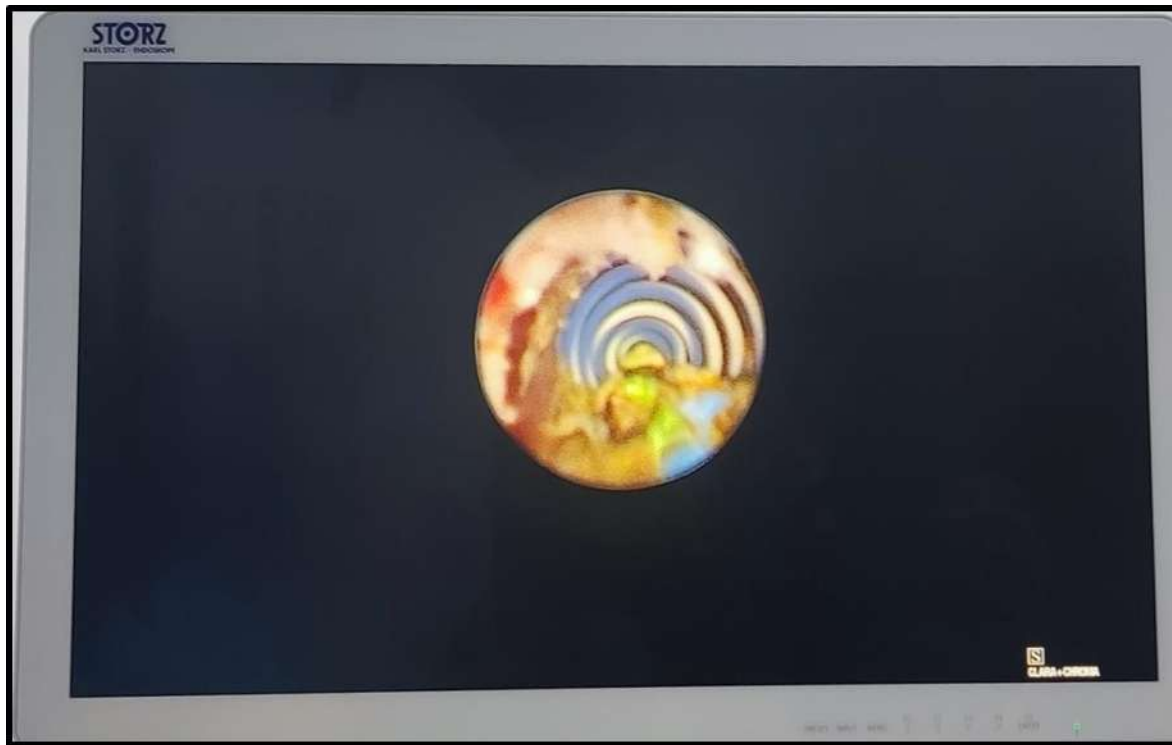


Figure (2.3): Stone cone during lithotripsy.





Figure (2.4): Double guide wire during lithotripsy.

Success: defined as a safely completed procedure with no retropulsion of stone nor fragments, and no need for any auxiliary maneuvers.

Retropulsion was considered when the whole stone or sizeable fragments migrated upwards to the kidney retropulsion of stone fragments of ≥ 5 mm.

Stone free rate (SFR): the absence of sizeable particles over 4 mm in post-operative kidney, ureter, and bladder radiography in radio-opaque calculi and NCCTS just in the radiolucent stone because of cost saving.

Operative time: (time elapsed from endoscope insertion into the patient's body to procedure completion).

Results

The study included 90 participants, divided into three groups each contain 30 participants. There was no significant difference in age, BMI, and gender among the different groups, as illustrated by table 3.1.

Table (3.1): Assessment of demographic data

Variable	Single wire	Double wire	Stone cone	p-value
Number	30	30	30	-
Age	41.9±12.5	39.9±12.3	34.4±12.7	0.063
Gender				
Female	9 (30.0%)	10 (33.3%)	13 (43.3%)	0.532
Male	21 (70.0%)	20 (66.7%)	17 (56.7%)	
BMI	28.0±3.4	27.5±3.2	27.4±3.5	0.785

There was no significant difference in stone size, and additional procedure among different groups, as illustrated in table 3.2 and figure 3.1.

Operation time was significantly different in which it was higher in stone cone group compared to both double wire and single wire groups, while no statically difference observed between double wires and single wire, as illustrated in table 3.2 and figure 3.2.

Both SFR and stone migration was significantly different among different groups, in which the SFR was higher in stone cone, followed by double wire and least in single wire, as illustrated by table 3.2 and figure 3.3.

Table (3.2): Assessment of operative related outcomes

Variable	Single wire	Double wire	Stone cone	p-value
Number	30	30	30	-
Stone size (mm)	14.6±2.3	14.1±2.9	15.8±2.9	0.055
Operation time (min)	31.2±4.5	34.9 ± 3.9	42.4±12.2	<0.001
SFR	19 (63.3%)	26 (86.7%)	28 (93.3%)	0.008
Stone migration	11 (36.7%)	4 (13.3%)	2 (6.7%)	0.008
Additional procedure				
ESWL	6 (20.0%)	2 (6.7%)	1 (3.3%)	0.052
FURS	2 (6.7%)	0 (0.0%)	0 (0.0%)	

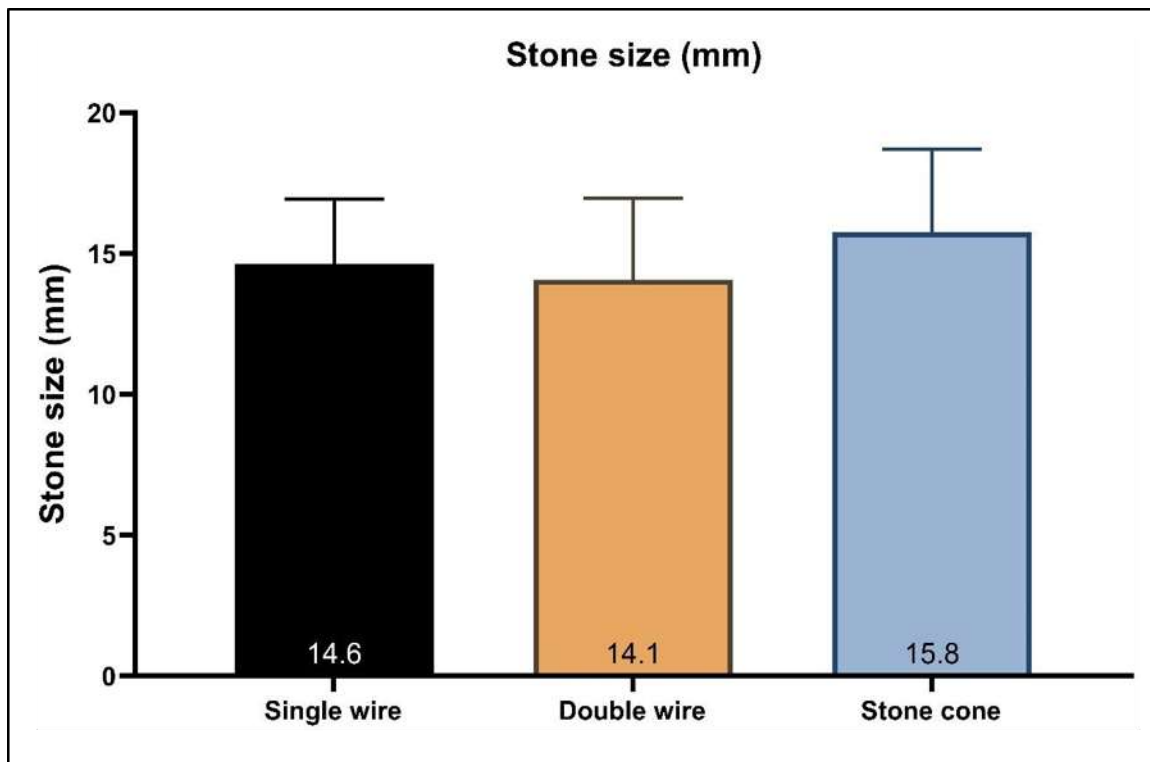


Figure (3.1): Assessment of stone size.

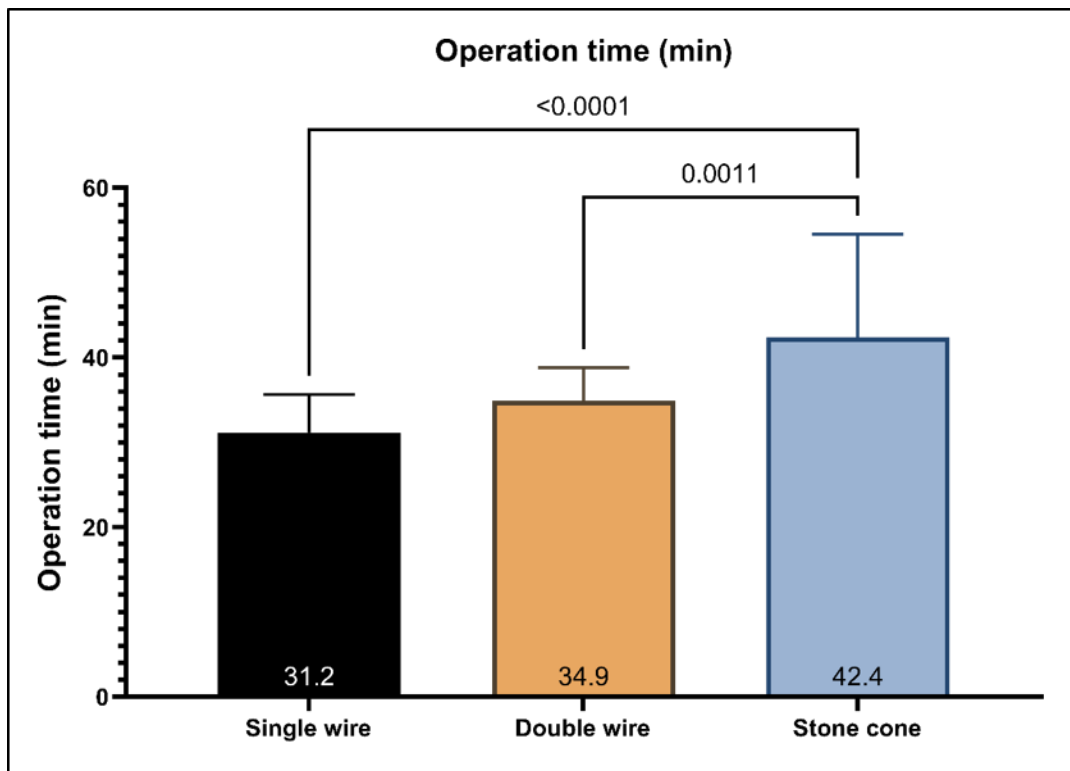


Figure (3.2): Assessment of operation time.

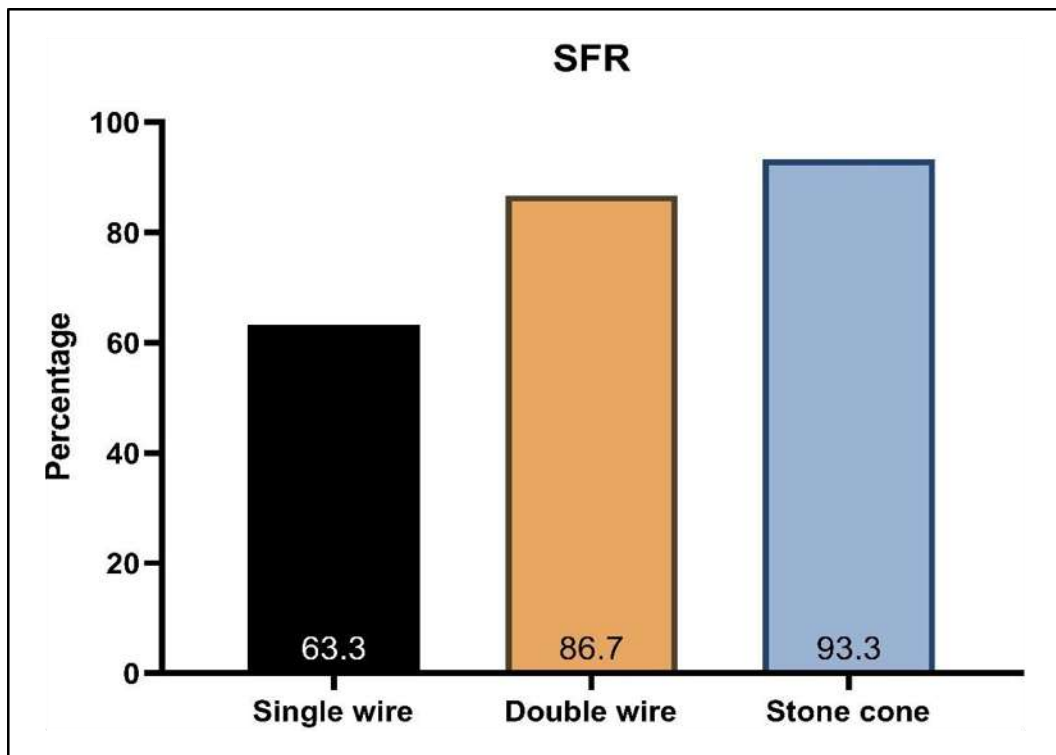


Figure (3.3): Assessment of SFR.

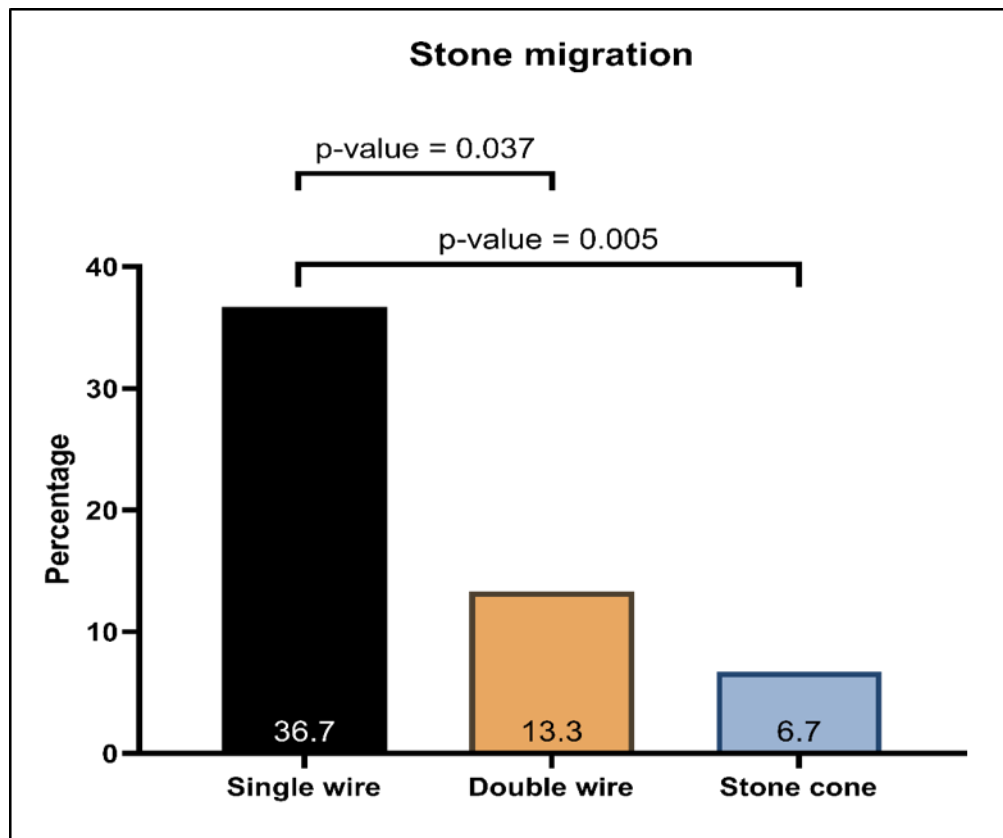


Figure (3.4): Assessment of Migration rate.

Migration rate was not statistically different between both stone cone and double wire groups, while it was higher in single wire group.

All complications were not statistically different among various groups, as illustrated by table 3.3.

Table (3.3): Assessment of complications

Variable	Single wire	Double wire	Stone cone	p-value
Number	30	30	30	-
Mucosal injury	2 (6.7%)	5 (16.7%)	3 (10.0%)	0.593
Turned wire	0 (0.0%)	1 (3.3%)	0 (0.0%)	0.999
Hematuria	2 (6.7%)	3 (10.0%)	5 (16.7%)	0.593

Statistical analysis

All analysis was carried out using SPSS version 26 (Chicago), and Graph Pad Prism version 9.1. All variables followed normal distribution, and ANOVA test used to assess the level of significance, while post hoc Tukey test used to the asses the pair wise comparison between each pair. Chi square test used to analyze the categorical variable when valid and if not valid, Fisher exact test used. P-value was considered to be significant if less than 0.05.

Discussion

One of the major concerns in upper ureteric stones management is the proximal stone fragments migration to the kidney or retropulsion.

Migrating stones and residual fragments usually require auxiliary procedures involving SWL or flexible ureteroscopy. In addition, untreated residual fragments may serve as a source of recurrent stone growth, persistent infection, and renal colic, further increasing patient morbidity and costs (32). Many Sorts of efforts have been made to reduce or avoid retropulsion. Patel RM et al. conducted an in vitro trial and reported that ureteral stone gravity worked well in the proper position. They suggested increasing the patients incline angel, Trendelenburg position, negative pressure and forced diuresis (28).

For this reason, many kinds of anti-retropulsive devices have been used. They mostly work in a similar way, either block the ureter or fix the stone. The subtle difference between them lies in convenience, cost, availability, materials, etc.

In seeking to get the minimum retropulsion rate and best stone free rate with the lowest possible complications related to various device manipulation within the ureter during endoscopic procedure, we adopt the method of using two guide wires as they are readily available, easily inserted without significant manipulation, and to prevent stone movement as possible by logging it with the ureteral wall.

To eliminate the bias and confirm the success of our adopted procedure, we compare it with the single safety wire which used routinely nearly in every ureteroscopic procedures and stone cone device.

Dilated proximal ureter and stone size are parameters that influence lithotripsy success and stone migration, pre-procedure stenting to all patients aid in dilating upper ureter and help us to sufficiently entrapping the stone between the wires.

In our patients, we find a stone retropulsion rate in single wire group was (36.7%) and in stone cone group (6.7%) with unsurprisingly significant statistical difference between them.

Our results in these groups were comparable to Allameh F. et al (29) who had a stone free rate in single wire of (35%) and with stone cone (5.5%), and Farahat et al (30) with (24.1%) retropulsion rate with single wire group and (3.1%) with stone cone group.

Better result published by Shabana et al, (31) who reported (15.4%) retropulsion rate using wire only and (2.1%) with cone device.

Stone retropulsion rate with using two guide wires to prevent stone migration in our patients found to be (13.3%), which is slightly higher than stone cone group (6.7%) but still much lower than single wire group (36.7%).

This is thought to be due to the two guidewires occupy and block most of ureteral lumen, holding the stone in place as they pass beyond it and leaving no area for stone migration and moving up.

Regarding duration of procedure in the groups studied, using single wire (31.2 min) was lower than seen in cone group (42.2 min) and two wires group (34.9 min) and all groups taking shorter operative time in comparison to Fathelbab TK. et al (50.9 min) (32) and Dreger NM. et al (33) (61.0 min) and so use two wires during intracorporeal lithotripsy didn't significantly increase operative time.

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