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ORIGINAL PAPER

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Filling cystoureterography facilitates stone visualization in patients with previously inserted double-J ureteral stents

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Abstract In our study, we assessed the ability of a filling cystogram to induce vesicoureteral reflux (VUR) and to evaluate its role in stone targeting during ESWL in the presence of a double-J ureteral stent (JJ-S). Filling cystoureterography was performed during ESWL in 17 patients with previously inserted 4.7 F JJ-S. The examination ended with stone localization. In every procedure, 3,500 shock waves were delivered with an energy range of 18–23 kV. Patients were evaluated 4 weeks after ESWL. A stone-free result was defined as no evidence of calculi in the first or second visits. Because contrast material was employed in this study, we also evaluated its possible interference with the results of lithotripsy. All radiolucent or poorly calcified stones were successfully localized. In four patients, rhythmic suprapubic manual pressure was performed to initiate VUR. Reflux was low grade in 35% and high grade in 65% of renal units. The efficiency quotient reached 59%. In vitro artificial stones were successfully disintegrated both in water and solutions of Ultravist. In the presence of a JJ-S, filling cystography can easily localize radiolucent stones during SWL. No special catheters or stents are required for this technique. Ultravist in particular does not affect the results of ESWL unfavorably.

Keywords Filling cystoureterography · Double-J ureteral stent · Stone visualization · Ultravist

Introduction

Previous studies have shown that in the presence of a double J stent (JJ-S), VUR occurs in a majority of patients during voiding cystourethrogram [1, 2]. However, nobody has used this fact to assist stone location during ESWL. Moreover, some authors passed the ureteral catheter (UC) alongside the stent and injected contrast material through this to locate stones during ESWL [3]. Our study is the first to assess the ability of filling cystoureterography to localize stones during ESWL. Because contrast material was employed in this study, we also evaluated its possible interference with the results of lithotripsy.

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Patients and methods

Fully informed patients who provided consent were invited to participate in this pilot study. Seventeen patients with radiolucent or poorly calcified renal stones were enrolled. Our practice before this study was to insert a 4 F UC alongside of the stent and to inject contrast material through this [3]; this is why we received clearance from the ethics committee.

All patients had a previously inserted 4.7 F JJ-S. Ten (59%) patients presented with renal and seven (41%) with upper ureteral stones. Stents were inserted 3–4 weeks before ESWL due to nine (53%) cases of intractable pain, five (29%) of severe obstruction, and three (18%) of UTI. We used 30% and 50% solutions of Ultravist-300 for filling cystoureterography (fluid height: 50–60 cm H_2O). In normal (18.5–24.9 kg/m^2) and overweight patients (25.0–29.9 kg/m^2), we used 30%, and in obese patients (>30 kg/m^2) we used 50% solutions. Patients were categorized according to World Health Organisation criteria for body mass index (BMI). A 14 F urethral catheter was inserted in all patients. The filling study ended with stone localization. We categorized reflux grade according to the International Classification System (devised in 1981 by the IRSC).

Stones were fragmented with an Econolith electrohydraulic lithotriptor: focal point depth 135–170 mm, focus area 60/13 mm length/width, spark voltage 15–22.5 kV (Medispec Group, Israel). In every procedure, 3,500 shock waves were delivered with an energy range of 18–23 kV. Patients were evaluated 4 weeks after

ESWL by renal ultrasound and plain abdominal x-ray (poorly calcified stones). If more than four residual fragments were present, the JJ-S was removed and the patient invited for an additional follow-up visit. A stone-free result was defined as no evidence of calculi in the first or second visits. Patients with a residual fragment of ≥4 mm and/or multiple fragments were invited for secondary lithotripsy. Ureteroscopy with consecutive stone extraction was considered as an auxiliary measure. All available fragments were sent for IR-analysis. The fact that VUR can increase intrarenal pressures led us to perform nuclear imaging with ^{99m} Tc-MAG3 before and 2 months after ESWL (to exclude renal damage).

To study the effect of contrast on the results of lithotripsy, we used 9-mm artificial gypsum stones (Medical Industries, Yushima, Bunkoyo-Ku, Tokyo, Japan) and disintegrated them in pure water, 30% and 50% solutions of Ultravist-300 (ten stones in each group). Stones were positioned in the center of the focus area and 400 shock waves (18 kV) were used per stone. The size of the stone fragments served as a criterion for the assessment of each group's success. We used the "sieve technique" for fragmentation measurements. Results were assessed at two levels according to the diameters of the fragments: 4 mm and 3 mm.

Results

All urinary stones were successfully localized: seven (41%) in the upper ureter and ten (59%) in the renal units. Reflux was low grade (1–2/5) in six (35%) and high grade (3/5) in 11 (65%) renal units. Grade 1 reflux was sufficient only for visualization of ureteral stones, while grade 2–3 reflux was useful for imaging proximal calculi (upper ureter and kidney). In four patients, rhythmic suprapubic manual pressure was performed to initiate VUR. Mean stone burden was 47.88 ± 38.98 mm^2. The stone-free rate in our study reached 76%, and the efficiency quotient was 59%. Most of the available fragments (9/13) were uric acid containing calculi (Table 1). Nuclear studies failed to detect any significant evidence of renal damage. All artificial stones were successfully disintegrated in vitro (Table 2).

Discussion

The primary therapeutic option for the treatment of lithiasis (proximal ureter and kidney) is in situ ESWL. However, in the presence of criteria for urinary diversion (severe obstruction, obstruction associated with urinary tract infection, large stone and solitary kidney), a JJ-S is placed in selected patients. In patients with radiolucent or poorly calcified stones, retrograde injection of contrast medium is used to visualize the calculi during ESWL. To facilitate this procedure in the patients with previously inserted stents, some authors proposed advancing a 4 F whistle tip ureteral catheter alongside of these stents [3]. Gross and Brannen recommended another technique that incorporates passing a JJ-S over a 3 F ureteral catheter, which is used for the injection of contrast material [4].

In our lithotriptor, an adjustable C-arm fluoroscopic system is the primary imaging modality. The primary advantages of this fluoroscopic system include its familiarity to urologists, the ability to visualize radiopaque calculi throughout the urinary tract, and the ability to use iodinated contrast agents to aid in stone localization and the determination anatomic detail. Ultrasonic localization is optional for this machine. However, sonographic localization of a kidney stone requires a highly trained operator, localization of stones in the ureter (especially in the middle part) is difficult or impossible, and monitoring the completeness of stone fragmentation is problematic [5, 6]. Unfortunately, these disadvantages greatly overshadow the advantages of ultrasound imaging. Consequently, we do not use this

Table 1 General data from the study. UU upper ureter, RU renal units, VUR vesicoureteral reflux

Place	Cm H_2O	Volume ml	VUR-grade	Stone burden mm^2	Stone composition	Second ESWL	Auxiliary procedures	Stone free(±)
UU	60	300	2	<10	Uric acid/oxalate	0	0	+
UU	50	350	3	>20	Struvate	0	0	+
UU	50	150	3	10–20	Uric acid	0	0	+
UU	50	400	2	10–20	Uric acid	0	0	+
RU	50	350	3	>20	Uric acid	0	0	+
RU	60	350	4	>20	Brusite /uric acid	1	1	–
UU	50	400	2	10–20	Uric acid	0	0	+
RU	50	400	4	10–20	Non available	0	0	+
RU	60	450	3	>20	Non available	1	0	–
UU	60	400	2	10–20	Uric/oxalate	0	1	–
RU	50	450	2	>20	Uric/oxalate	1	0	–
RU	60	500	3	>20	Struvate	0	0	+
RU	60	500	3	>20	Non available	0	0	+
RU	50	350	3	>20	Brusite/uric acid	0	0	+
UU	50	350	2	10–20	Struvate	0	0	+
RU	60	350	3	>20	Brusite	0	0	+
RU	60	250	3	>20	Not available	0	0	+

Table 2 Artificial stones and lithotripsy

Solutions	No. artificial stones	No. residual fragments	Fragments of 4 mm	Fragments of 3 mm
Pure water	10	83	14 (16.87%)	69 (83.13%)
30% Ultravist	10	46	7 (15.2%)	39 (84.8%)
50% Ultravist	10	53	11(20.75%)	42(72.25%)

option. Some would argue that in a partially obstructed system, the administration of intravenous contrast leads to an opacified column of contrast that "points" to the stone [7]. However, even with this maneuver radiolucent ureteral calculi do not become clearly visible [5, 6]. It could be very difficult to create a contrast medium column in the presence of a JJ-S.

The technique we describe does not need any additional endoscopic manipulation. The quantity of contrast medium required for the procedure is comparable to drip infusion, which is why it is inexpensive. The stone-free rate and efficiency quotient in our study were comparable with those in a published study dedicated to ESWL for stones ranging from 3 to 20 mm and located in the upper and middle ureter [8, 9]. The results of nuclear studies showed that intraoperative VUR did not cause renal damage.

All in vitro artificial stones were disintegrated, but it must be emphasized that lithotripsy performed in Ultravist solutions was more successful. In fact, lithotripsy in water produced more fragments that failed to pass through the sieves of 4 and 3 mm. To insure the results of the primary experiment, in which we used five stones in each group, we increased the number of stones to ten each. In general, we obtained the same results. Other studies showed that the results of in situ ESWL performed in the presence of contrast medium were better than in the control groups [5, 10]. This fact could not be explained by the better visualization of stones, because calculi in the control groups were radiopaque. Furthermore, stone-free status 2 months after ESWL was significantly superior in the "contrast" group [10]. This might deserve additional study.

Conclusions

During ESWL, filling cystoureterography can easily localize radiolucent stones in the presence of a JJ S. Intraoperative VUR does not cause renal damage. Ultravist solutions could be used during ESWL and do not interfere with its results.

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