Arab Journal of Urology (2015) **13**, 80–83

Arab Journal of Urology
(Official Journal of the Arab Association of Urology)

www.sciencedirect.com

STONES/ENDOUROLOGY
ORIGINAL ARTICLE

Balloon dilator versus telescopic metal dilators for tract dilatation during percutaneous nephrolithotomy for staghorn stones and calyceal stones

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Received 4 November 2014, Received in revised form 20 December 2014, Accepted 24 December 2014
Available online 23 January 2015

KEYWORDS

Percutaneous;
Nephrolithotomy;
Stones;
Dilators

ABBREVIATIONS

BD, balloon dilator (dilatation);
TMD, telescopic metal dilator (dilatation);
PCNL, percutaneous nephrolithotomy

Abstract ***Objective:*** To compare the results of balloon dilatation (BD) vs. telescopic metal dilators (TMDs) in establishing the tract for percutaneous nephrolithotomy (PCNL) in patients with calyceal stones or staghorn stones, but with no hydronephrosis.

Patients and methods: Data from selected patients over 4 years were recorded retrospectively. Patients with complex staghorn stones, an undilated targeted calyx, or the stone filling the targeted calyx, were included in the study. In all, 97 patients were included, of 235 undergoing PCNL between March 2010 and March 2014, and were divided into two groups according to the technique of primary tract dilatation. Group A included patients who had BD and group B those treated using TMDs.

Results: In group A (BD, 55 patients) dilatation was successful in 34 (62%). The dilatation failed or there was a need for re-dilatation using TMD in 21 patients (38%). In one of these 21 patients the dilatation failed due to extravasation. In group B (TMD, 42 patients) dilatation was successful in 38 (90%) patients, with incomplete dilatation and a need for re-dilatation in four (10%) patients, and no failed procedures. Group A had a significantly higher failure rate than group B ($P < 0.001$). Dif-

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Peer review under responsibility of Arab Association of Urology.

Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.aju.2014.12.004

ferences in operative duration, blood loss, stone-removal success rate and complication rate were statistically insignificant.

Conclusion: BD has a higher failure rate than TMD when establishing access for calyceal stones or staghorn stones that have little space around them.

Introduction

The technique of percutaneous nephrolithotomy (PCNL) was first established in 1976 by Fernstrom and Johansson [1]. PCNL rapidly became a routine procedure and with technological advances in endourological instruments over the last three decades it has gradually replaced open surgery for managing large renal calculi [2]. Currently PCNL should be the first option for treating large renal stones of >2 cm, multiple stones, staghorn stones or large lower calyceal stones [3].

The access tract can be dilated using a balloon dilator (BD), telescopic metal dilator (TMD), an Amplatz semirigid dilator or a single-step dilator [4,5]. TMDs, first introduced by Alken in 1985, comprise a series of sequentially enlarging coaxial metal rods that pass over an 8-F guide (central) rod. The rigid metal dilator system is considered the most effective dilator, especially if there are dense perinephric adhesions from previous renal surgery, and it is cheaper than other disposable dilators like the Amplatz and BD. However, it can cause perforation of the pelvicalyceal system if the dilatation is not well controlled [6].

BDs have the disadvantages of higher cost and lower efficacy than rigid TMDs and semirigid Amplatz dilators, especially in cases with perinephric adhesions due to previous surgery. There is evidence from previous reports that BDs are associated with less bleeding and lower blood transfusion rates than are other dilators [7–9].

There are particular cases where the limited space around the stone is a challenge for tract dilatation, with an increased risk of guidewire slippage and subsequent failure to dilate the tract. Such difficulty is mostly encountered in patients with calyceal stones, staghorn stones but no hydronephrosis, and an anteriorly located targeted calyx [10].

The aim of the present study was to compare the results of BD and TMDs in patients with calyceal stones or staghorn stones with a limited space around the stone in the targeted calyx.

Patients and methods

This was a retrospective study in which patients with complex staghorn stones or calyceal stones underwent PCNL. They were divided into two groups, being treated with BDs in group A and TMDs in group B as a primary dilatation technique. The records of patients over the 4 years from March 2010 to March 2014 were reviewed; all were operated on by one surgeon (M.E.-S.).

Patients were included if they had calyceal stones with no space around the stone (stone-casting calyx), anterior calyceal stones, or complex staghorn stones with little space around the stone. Patients were excluded if they had hydronephrosis or renal pelvic stones with the targeted calyx free of stones, uncorrected coagulopathies, previous renal surgery, or previous intercostal (supracostal) access, as it was reported previously that BD is inferior to TMD in these cases.

All patients were assessed using multislice noncontrast CT. Urine samples were cultured routinely before surgery and appropriate antibiotics given for 7 days before PCNL in patients with positive urine cultures or when infected stones were suspected.

All patients had a general anaesthetic. A ureteric catheter (5 F, open-tip) was fixed with the patient in the lithotomy position, and then the patient was turned prone. Access was established by a urologist, under fluoroscopic guidance, using a two-plane technique at 0° and 30°. A stiff guidewire was used, and sometimes a Terumo guidewire first, to find the space to pass the wire, and then the stiff guidewire was passed for dilatation. In group A two fascial dilators (6 and 8 F) were used, followed by the BD (30 F, length 55 cm, balloon length 15 cm; Cook, Spencer, Indiana, USA) inflated up to 1.4 MPa. Full inflation of the balloon throughout its length was confirmed in each case by using contrast medium for inflation. After 30 s the sheath (30 F, 17 cm; Cook) was passed over the inflated balloon. The balloon was then evacuated and removed.

In group B the first step in tract dilatation was to pass the 8-F guide (central) rod over a stiff guidewire. Then each successive metal rod was telescopically passed until the desired tract was achieved, mostly up to 26 F. Exposure to fluoroscopy during the sequential dilatation was limited, to decrease the fluoroscopy time.

Bleeding was estimated from the decrease in the haematocrit value. Blood transfusions required during and after surgery were recorded. The dilatation time, total operative duration and success rates were recorded, the last being defined as the patient being rendered stone-free, or with clinically insignificant residual fragments of <4 mm. This was usually assessed using a plain abdominal film and ultrasonography, and in

selected patients by CT. Blood transfusion was considered if indicated by a decrease in haematocrit to <28%. Postoperative complications were collected and categorised using the modified Clavien grading system [10].

Data were analysed statistically using Fisher's exact test and the Mann–Whitney test as appropriate, with $P < 0.05$ taken to indicate a statistically significant difference.

Results

In all, 97 patients were included in the study and their demographics are shown in Table 1. In group A (55 patients) BD was successful in 34 (62%), but failed, requiring immediate dilatation by TMDs, in 21 (38%). The mechanism of failure was retraction or slippage of the balloon outside the pelvicalyceal system just after inflation, as there was no space around the stone. The dilatation failed in one of the 21 patients due to significant extravasation, and this patient had an unplanned second PCNL a week later. In group B (42 patients) the TMD was successful in 38 (90%), but failed in four, with successful re-dilatation in four (10%), and no failed procedures (Table 1). The difference in the failure rate of primary dilatation between the groups was statistically significant ($P = 0.001$; Table 1).

The differences in mean operative duration, fluoroscopy time, haematocrit decrease and blood transfusion rate were statistically insignificant (Table 1). According to the modified Clavien grading system, there were no grade VI or V complications (bleeding requiring angioembolisation; nephrectomy; sepsis; or death). There was no statistically significant difference between the groups in Clavien grade I, II or III complications (Table 1).

The success rate (stone-free + clinically insignificant residual fragments) was 84% in group A, vs. 86% in group B, and the difference was not statistically significant ($P = 0.467$).

Discussion

Since its introduction in 1975 there have been many advances in the equipment and techniques for PCNL, and it is currently the mainstay for managing large renal stones (>2 cm). There is increasing evidence that PCNL is advantageous for managing large renal stones and staghorn stones, with a high stone-free rate and a relatively low complication rate [11–13]. According to the AUA guidelines (2005) for staghorn stones, the overall estimated stone-free rate after treatment is the highest for PCNL (78%) [14].

Although it is a preferred less-invasive treatment option with a high stone-free rate, PCNL for staghorn stones is still challenging for the urologist. The main challenges are establishing proper access to the pelvicalyceal system, and rendering the patient with a large stone burden free of stone [15–17].

There are several different access dilators (Amplatz, TMDs, BDs or 'one-shot' dilators), and the superiority of BDs (less bleeding and shorter dilatation time, and thus fluoroscopy time) over Amplatz or TMD has been reported [18]. However, other studies reported less bleeding when using TMDs than BDs [19]. In the present study the statistically insignificant difference in fluoroscopy time might be due to the limited fluoroscopy exposure we used during TMD.

Establishing access to the pelvicalyceal system in patients with complex staghorn calculi is difficult because of the limited space around the stone. If there

Table 1 The patients' demographics, success or failure of dilatation, operative data, and complications according to the modified Clavien grading system.

Mean (SD) or *n* (%) variable	Group A (BD)	Group B (TMD)	*P*
Number of patients	55	42	
Age (years)	43.1 (12.24)	40.2 (11.26)	0.208
Male	31 (56)	25 (59)	0.459
Female	24 (44)	17 (41)	
Right side	29 (53)	22 (52)	0.568
Left side	26 (47)	20 (48)	
Success rate of dilatation	34 (62)	38 (90)	0.001
Failed (TMD + failed procedure)	21 (38)	4 (10)	
Fluoroscopy time (min)	5.9 (3.17)	5.7 (1.72)	0.315
Operative time (min)	77.6 (24.87)	72.1 (28.13)	0.392
Haematocrit decrease (%)	3.4 (2.56)	3.0 (2.59)	0.284
Need for transfusion	10 (18)	7 (17)	0.533
Complications			
Grade I*	14 (26)	11(26)	0.558
Grade II†	10 (18)	7 (17)	0.533
Grade IIIa‡	3 (5)	2 (5)	0.627

* postoperative pain, transient urine leak, re-clamping of the tube.
† Blood transfusion.
‡ Postoperative ureteric stent insertion due to persistent leakage.

is no hydrocalyx, passing a guidewire first, then the tip of the dilator into the pelvicalyceal system, can be difficult [19].

Well-designed comparative studies between different dilatation techniques are lacking. Joel et al. [20] reported a 17% dilatation failure rate using BDs as a primary dilatation method (from 99 patients). Osman et al. [19] reported a series of >300 patients treated with TMD, with a failure rate of <3.5%.

Similarly the present study showed a significantly higher failure rate when using BDs. We hypothesise that in staghorn and calyceal stones the limited space between the stone and the site of puncture in the targeted calyx makes the dilatation more difficult than usual. Because it has a flat metal end, the metal dilator is more effective for dilatation than the BD, while the BD, with its conical tip, can be pushed outside the pelvicalyceal system during balloon inflation, as we observed in some of our patients. These findings are in agreement with other reports [7,20].

The present study has some limitations, as it was retrospective and included relatively few patients, but it is one of a few studies comparing different dilatation techniques in such challenging cases. Further randomised controlled studies are needed to draw firm conclusions.

In conclusion, TMDs are a more effective and successful method of tract dilatation than BD when using PCNL for complex staghorn stones or calyceal stones (with no hydronephrosis). Both techniques are comparable in operative duration, stone-free success and complication rates.

Conflict of interest

None.

Funding

None.

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