

## DAY CASE MINI PERCUTANEOUS NEPHROLITHOTOMY (PCN): FIRST UK EXPERIENCE

Auer A, Abdelqader B, Glassey A, Rowbotham C, Ismail M  
Queen Alexandra Hospital, Portsmouth. UK.

Correspondence to: [Andreas.Auer@doctors.org.uk](mailto:Andreas.Auer@doctors.org.uk)

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### ABSTRACT

#### Background and Objective

To investigate the safety, efficacy, and feasibility of performing mini PCN (MIP-M Karl Storz) as a day case procedure. We report our experience and outcomes from our case series which to our knowledge is the first reported in the UK.

#### Material and Methods

Ten patients appropriate for mini PCN and day-case surgery were selected prospectively. All 10 patients underwent a mini PCN procedure in a prone position. Access was achieved by the operating surgeon under fluoroscopic guidance in 9 cases and by a consultant urologist under ultrasound guidance in 1 patient with a ureterosigmoidostomy using a Kellert needle and the MIP-M system (Karl Storz, Germany). Stones were fragmented with a 550um laser fibre and retrieved by both the Vortex effect and a grasper. Drainage was achieved with a 6 Fr antegrade stent in 9 cases and a 10 Fr nephrostomy tube in one patient. Stone related outcomes, duration of surgery, length of stay and complications were recorded.

#### Results

All cases were completed as planned. The mean operating time was 93 minutes. A day case rate of 80% was achieved. Two patients were admitted overnight for social reasons; one lived on a nearby island and was not ready for discharge in time to catch the last ferry and another no longer had a responsible adult at home to monitor him overnight. All patients were deemed radiologically stone free. No readmissions, transfusion, infections or other complications were recorded at 90 days postoperatively.

#### Conclusion

We have shown that day-case mini PCN is a feasible and safe procedure in selected patients. A larger number of cases are needed to establish our patient selection criteria and corroborate our early outcomes.

**Key Words:** *Mini PCN, day case, MIP-M, Nephrolithotomy*

Percutaneous Nephrolithotomy (PCN) was first described by Fernstrom and Johanson<sup>1</sup> in 1976 and quickly became the gold standard in the management of large (>20 mm) renal stones.<sup>2</sup> The introduction of PCN was a significant step in reducing the operative morbidity transfusion rates, length of stay and analgesia requirement associated with open nephrolithotomy.<sup>3</sup>

Recent advances in technology have led to miniaturization of the PCN equipment and the introduction of mini, ultra-mini and micro PCN<sup>4</sup>. The outcomes from these newer techniques have demonstrated a further reduction in transfusion rates, and analgesia requirements, whilst maintaining comparable stone clearance rates.<sup>3</sup> However, in early series, the reported mean hospital stay after mini-PCN is between 3.9 and 4.5 days which remains high in comparison to standard PCN.<sup>5,6</sup> In the UK, the median length of stay for all variants of PCN, by the department, is between 2 and 4 days (British Association of Urological Surgeons (BAUS) Section of Endourology outcome data).<sup>7</sup>

The National Institute for Health and Care Excellence (NICE) has recently published a specialist review of mini-PCN using the MIP-M system (Karl Storz, Germany).<sup>8</sup> According to NICE the estimated cost of a MIP-M procedure is £4,400 which includes the cost of two days of hospital stay. This is approximately £800 less than standard PCN, £3,200 more than shockwave lithotripsy and £1,500 more than flexible ureteroscopy. Stones up to 30 mm in size can be treated with this technique. The specialist review concluded that MIP-M is associated with less bleeding, reduced post-operative pain, and a shorter hospital stay and may be beneficial to the NHS. Performing the procedure as a day case was not discussed in the review. This has the potential to result in a further significant cost saving.

Like other departments in the NHS we are facing significant pressures concerning cost, bed availability and waiting times.<sup>9</sup> We felt that day-case mini-PCN using the MIP-M system in selected patients could form a useful part of a strategy to help address these issues. There are very few published reports on the day case PCN. A recent literature review reported on nine studies worldwide with a total of 502 patients. None of these studies were conducted in the UK. The

study included all types of PCN access, postoperative drainage modality was not specified and the daycase was defined as discharge within 23 hours of admission. The mean hospital stay was 17.5 hours, the stone-free rate 95% and the complication rate, mainly Clavien-Dindo I and II, 13.5%<sup>10</sup>.

This study aims to evaluate the safety and feasibility of MIP-M as a day case procedure. To our knowledge, this is the first reported UK case series to date.

## METHODS

Patients suitable for a mini PCN without contraindications to day case surgery were selected prospectively (Table 1). The pre-operative selection criteria included an ASA Grade ≤2, WHO Performance Status ≤1, sterile preoperative MSU, unilateral procedure, stone size < 4cm, two functional renal units and a high probability of stone clearance with a single tract (Table 2).

All patients were given venous thromboembolism prevention in the form of Intermittent Pneumatic Compression (Flowtron, Huntleigh Healthcare Ltd). Intravenous antibiotics were administered according to our local antimicrobial guidelines. After induction of general anesthesia, a rigid cystoscopy and insertion of a 5 Fr ureteric catheter (Boston Scientific, USA) were performed in the lithotomy position in 9 cases. The ureteric catheter was secured to a 16 Fr urethral catheter (Cook Medical, Bloomington, USA). Patients were then repositioned in the prone position. Fluoroscopic guided access was achieved by the operating surgeon using a Kellet needle (Cook Medical, Bloomington, USA). One patient had previously undergone a cystectomy and Mainz II ureterosigmoidostomy and ultrasound-guided access was performed in the prone position by a consultant urologist. A Sensor guidewire (Boston Scientific, USA) was advanced to the distal ureter/bladder and the MIP-M (Karl Storz, Germany) access sheath used to establish the percutaneous tract.

Stones were fragmented using a holmium laser (The Sphinx Jr. Promed Cambs UK) in conjunction with a 550 um laser fibre and retrieved using a combination of the vortex effect and a stone grasper. Stone fragments were sent for biochemical and microbiological analysis.

**TABLE 1** Patients Suitable for A Mini PCN Without Contraindications To Day Case Surgery

Patient Data	
<b>Age</b>	
Mean	62.3 (41–83)
<b>Sex</b>	
Male	7
Female	3
<b>ASA Grade</b>	
1	5
2	5
<b>WHO Performance Status</b>	
0	7
1	3
<b>Blood Results</b>	
Preoperative eGFR Mean ml/min/1.72m <sup>2</sup>	77.6 (36–90)
Preoperative Hb Mean g/dL (range)	142.7 (131–156)
<b>Mean surgical time in minutes (including cystoscopy) (range)</b>	93.5 (75–140)

**TABLE 2** Selection Criteria

<b>Pre Operatively</b>
ASA Grades <=2 WHO performance status <=1 Negative pre OP MSU Preoperative computed tomography scan Absence of significant cardiac and respiratory comorbidity Social Support to facilitate Day case Surgery Unilateral Operation No Staghorn Calculi Stone size less than 4 cm Two functional renal units Feasibility of stone clearance via a single track
<b>Peri-operatively</b>
Absence of major complication Absence of significant blood loss minimal postoperative pain Clinically stone free Passed urine after catheter removal Responsible adult at home overnight

Post-operative drainage was achieved using a 6 Fr antegrade double J stent (Percuflex, Boston Scientific, USA). A 10 Fr percutaneous nephrostomy (Boston scientific, USA) was used in the patient with a previous ureterosigmoidostomy. Pressure was routinely applied to the track for five minutes, the skin infiltrated with 20 mL 0.5% chirocain and the incision closed with 2-0 vicryl rapide. The urethral and ureteric catheters were removed at the end of the procedure.

Patients were recovered in the day surgery unit and discharged to their home address if they had no intraoperative or immediate postoperative complications, were clinically stone-free, had passed urine, had minimal post-operative pain and had a responsible adult at home overnight.

### RESULTS

From our initial series of 10 mini PCN procedures, 8 were carried out as day case procedures. Two patients were admitted for social reasons; one did not have a responsible adult at home at the time of admission and the other lived on an island a short distance off the mainland but was not ready for discharge in time to catch the last ferry. Both were discharged the morning after surgery.

The average age of the 7 male and 3 female patients was 62 years (range 41 to 83 years). All patients were classified as either ASA grade 1 or 2 (50% ASA 1; 50% ASA II) and had a WHO performance status of either 0 or 1 (70% PS-0; 30% PS-1). The mean preoperative eGFR was 77.6 mL/min/1.72m<sup>2</sup> (range 36 to 90) and the mean preoperative haemoglobin concentration was 143 g/L (range 131 to 156). All preoperative MSU samples did not show any growth and all patients had a non-contrast CT: KUB before their operation.

In all cases, a single tract was required. In 9 cases a posterior lower pole calyceal puncture was performed and a posterior inter-polar calyx was targeted in the remaining case. Operating time was between 75 and 140 minutes including cystoscopy, insertion of ureteric catheter and repositioning of the patient. The mean and median operating times were 93.5 and 85 minutes respectively.

The mean stone size was 23.4 mm (range 10 to 34 mm) measured in the long axis. The stone volume ranged from 421 mm<sup>3</sup> to 8,054mm<sup>3</sup> (mean 3568mm<sup>3</sup>).

Stone density was between 650 and 1500 HU (mean 1085 HU). Single stones were encountered in 40% of cases with two stones in 40 % of cases and multiple stones in 20%. The majority of stones were located in the left kidney (70%). Seventy percent of stones were located in the renal pelvis, 30% in the lower pole and one patient had stones in both the proximal ureter and renal pelvis at the time of surgery. The Guy's Stone Score<sup>11</sup> was 1 (40%), 2 (40%) or 3 (20%). Complete stone clearance was achieved in all cases at the end of the procedure and on a post-operative CT KUB. Stone composition was calcium oxalate in 70% and struvite and calcium phosphate in 30% of cases (Table 3).

A tubeless procedure was achieved in 90% of cases; with the insertion of an antegrade double J ureteric stent that was removed 3 weeks post-operatively under local anaesthetic with flexible cystoscopy. In one patient drainage was achieved with a 10 Fr nephrostomy tube that was clamped before discharge and removed one week postoperatively.

Postoperative analgesia was achieved with either NSAIDs or codeine and paracetamol. NSAIDs were contraindicated in one patient because of a low eGFR. We observed that the level of pain experienced post-operatively by our patients was significantly less than flexible ureteroscopy however this was an observation rather than a measured outcome. No complications or readmissions were recorded within 90 days of surgery.

A cost analysis was performed. The initial outlay for 3 sets of Karl Storz MIP equipment was calculated at £24810.00. A projected per case acquisition cost was calculated at £64. This is based on a 10 year projected equipment lifespan, at current activity levels of 80 PCNL cases per year of which 48 would be suitable for mini PCNL. From our pilot data, 39 patients would be expected to be discharged on the same day with 9 unplanned 1-day admissions. There was no increase in service costs as this was already covered by our pre-existing service contract with Karl Storz. Additional costs and cost savings were recorded and a per case cost was calculated (Table 4). The net cost saving between MIP and our standard PCNL procedure for our case series was calculated at £872.00 per case with a projected annual cost saving of £42,063 at current activity levels.

**TABLE 3** Stone Characteristics

<b>Hounsfield Units</b>		
Mean	1085 (650–1500)	
<b>Stone Size</b>		
Length Mean (mm)	23.4 (10–34)	
Volume Mean (mm <sup>3</sup> )	3568.24 (421–8054)	
<b>Number of Stones</b>		
	Number of cases	%
Single	4	40
Two	4	40
Multiple	2	20
<b>Stone Location</b>		
Renal Pelvis	7	63.64
Lower Pole	3	27.27
Upper Ureter	1	9.09
<b>Guys Stone Score</b>		
Score 1	4	40
Score 2	4	40
Score 3	2	20
<b>Stone Side</b>		
Right	3	30
Left	7	70
<b>Stone Clearance</b>		
Clinical	10	100
Radiological	10	100
<b>Biochemistry</b>		
Stone Type	Present in	
Calcium Oxalate Dihydrate	60%	
Calcium Oxalate Monohydrate	40%	
Struvite	20%	
Calcium Phosphate	20%	

## DISCUSSION

Since the introduction of the first PCN procedure by Fernstrom and Johanson<sup>1</sup> in 1976 modifications have been made to decrease pain, morbidity, and length of hospital stay without compromising stone-free rates including the introduction of mini, ultra-mini and micro PCN.<sup>3</sup>

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**TABLE 4** Cost Analysis

<b>Equipment Acquisition cost</b>	
3× Stoz MIP sets (£)	24,810
Cost per Capita at current activity level (£) <sup>1</sup>	64
<b>Additional Consumable costs per case</b>	
Laser fibre cost (£)	177
JJ stent (£)	60
<b>Cost Saving in Consumables per case</b>	
Boston Scientific Nephromax balloon (£)	134
1st step Dilator (£)	21
Olympus Shockpulse, consumables and processing (£)	100
Nephrostomy tube + Bag (£)	50
Irrigation Fluid (£)	54
Suction Tubing and liner (£)	30
<b>Cost Saving due to decrease admissions per case</b>	
Decreased length of stay (£)	783
<b>Net Saving per case w/o initial Equipment outlay (£)</b>	935
<b>Projected net Saving per case with Equipment outlay (£)<sup>1</sup></b>	871
<b>Projected annual cost saving (£) <sup>1</sup></b>	42,069
<b>Projected annual cost saving (£) <sup>1</sup> (excluding bed stay savings)</b>	4,224

<sup>1</sup> Based on a 10 year projected equipment lifespan, at current activity levels of 80 PCNL cases per year of which 48 would be suitable for mini PCNL. Based on our pilot data 39 patients would be expected to be discharged on the same day with 9 unplanned 1-day admissions

Advances have also been made in post-operative drainage with a transition from stiff, large diameter nephrostomy tubes in all cases towards smaller diameter more compliant nephrostomy tubes and, more recently, ‘tubeless’ procedures (where a ureteric stent is placed without a covering nephrostomy) and ‘totally tubeless’ procedures where no external or internal drainage is placed at the end of the procedure.<sup>12</sup> In this initial series, we decided to place a ureteric stent in all ‘tubeless’ procedures despite the fact all patients were clinically stone free at the end of the procedure and irrespective of the nephroscopic appearances of the PUJ. Our practice may change as our experience grows.

Performing PCN procedures as a day case is still a relatively new concept and relatively little has been published on the subject.<sup>13,14,15</sup> A Canadian study by Sharour et al. described 10 cases using a 30 Fr access sheath.<sup>13</sup> However, their criteria for performing a day case were heavily reliant on intraoperative factors such as the number of punctures required to establish a tract, minimal intraoperative bleeding, and adequate postoperative analgesia. A further series of 84 patients were reported by Adhalla et al.<sup>16</sup> All procedures were performed under spinal anesthesia again utilizing 30 Fr access sheaths. This study reported an ambulatory admission rate of 71% however “ambulatory admission” in this study was defined as discharge within 24 hours of surgery and patients were admitted overnight. Finally, a recent Canadian study has demonstrated stone-free rates and readmission rates were acceptable and comparable to standard PCN cases.<sup>15</sup> Utilizing a mini PCN approach, as reported in our series, has the benefit of reducing the risk of significant bleeding and postoperative pain compared to surgery using a 30 Fr access sheath, and the potential to increase the likelihood of a true day case procedure (avoiding an overnight stay).

Increasing demand for limited resources and UK Cancer Waiting Time (CWT) rules which prioritize cancer surgery have placed significant pressures on our stone service.<sup>9</sup> These pressures are compounded by problems with the availability of inpatient beds which has resulted in planned surgical cases being cancelled on the day of surgery, especially if the indication for the surgical procedure is a benign disease. Partly in response to these pressures more than 90% of our ureteroscopic surgery, 75.2% of our bladder outflow obstruction surgery<sup>17</sup> and 80.1% of our bladder tumour resections are already performed on a day case basis<sup>18</sup>. As a consequence, all facets of our day case pathway, including our waiting list team, preoperative assessment service, and a dedicated urology rapid access clinic staffed by skilled urology nurse practitioners, function in an integrated way and are highly experienced. The importance of this should not be underestimated in achieving successful day case surgery ( and may affect other units ability to replicate our experience.<sup>17,18</sup>

The recently published review of the MIP system by NICE has shown a cost-benefit of £800.00 when

performed as an inpatient procedure compared to standard PCNL. Our cost analysis has shown a broadly similar cost-benefit when comparing both modalities. Given the current financial pressures on most NHS trusts, adopting the MIP system to perform day case PCNL procedures offers a route to potentially significant cost saving. In our setting, this was calculated at £42,063 per annum. This is especially topical given the recent increase in financial constraints on the NHS.

It is important to ensure patients are suitable for day case surgery concerning general medical, stone specific and social factors. In our study, we limited patient selection to ASA grades I and II and WHO performance status 0 and 1. It would also be prudent to consider excluding patients with significant cardiac and respiratory comorbidity, obesity, concurrent antiplatelet and anticoagulant therapy and single functioning kidneys from day case PCN surgery. With regards to stone specific factors, we have shown that day case surgery is feasible for stones up to 1500 HU, stones up to 34 mm and more complex stone configurations such as our patients with Guys Stone Score 3 disease. We do not believe that cases involving staghorn calculi or requiring multiple tracts would be suitable for day case surgery.

Our two admissions in this series were due to social factors, one being the absence of overnight support at home, the second being the remoteness of the patient's home. It was disappointing that our day-case surgery pathways did not identify these problems before the day of surgery. It is our usual practice to schedule islanders for day case surgery late morning or early afternoon to facilitate their transportation requirements. These cases underline the importance of social factors in choosing patients for day surgery and the flexibility to admit patients to the hospital overnight if required.

### CONCLUSION

We have shown that day-case mini PCN utilizing the MIP-M system is a feasible, safe and cost-efficient procedure in selected patients in keeping with the conclusions of the recent NICE specialist review. A larger number of cases are needed to establish our patient selection criteria and corroborate our early outcomes.

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