

## Primary Report of Totally Tubeless Percutaneous Nephrolithotomy Despite Pelvi-calyceal Perforations

Seyed Mohammad Kazem Aghamir MD<sup>1</sup>, Alborz Salavati MD<sup>1\*</sup>, Morteza Hamidi MD<sup>2</sup>, Asghar Fallahnejad MD<sup>1</sup>

**Purpose:** Nephrostomy tube insertion and/or a ureteral stent placement is advised when pelvi-calyceal perforations are encountered during percutaneous nephrolithotomy (PNL) nevertheless totally tubeless PNL is a possible exit strategy in percutaneous renal surgery therefore case series on the short term clinical outcomes of noninvasive management of iatrogenic pelvicalyceal perforations encountered during PNL is presented.

**Patients and Methods:** During retrospective analysis of 1271 PNL procedures, 25 incidents of accidental ureteral catheter/ JJ stent dislodgement during first 24 post-operative hours were identified in patient who had pelvi calyceal perforations and had no nephrostomy tube (tubeless). Thirteen patients could not be re-stented nor a nephrostomy tube could have been placed for them mainly due to patient refusal or comorbid conditions. The main outcome was rate of successful noninvasive management.

**Results:** Eighteen Patients bearing mucosal tears (grade I trauma) or visible peri-pelvic fat (grade II) successfully recovered without need for ureteral stenting or nephrostomy (72.0%). In seven (28.0%) cases of extension of the perforation into the peri-pelvic fat (grade III), either nephrostomy insertion or JJ stenting was needed for resolution of fever and urinoma. The major limitation was the necessity to exclude patients and manage them in the standard fashion according to clinical guidelines.

**Conclusion:** Iatrogenic perforations of the collecting system are quite diverse in terms of severity that result in different natural histories and not all might need urinary diversion via nephrostomy or ureteral stenting. Low grade perforations may be successfully managed in totally tubeless fashion nevertheless further prospective investigations seem warranted.

**Keywords:** percutaneous nephrolithotomy; iatrogenic renal trauma; collecting system perforation; renal pelvis injury; urinary diversion

## INTRODUCTION

Percutaneous nephrolithotomy (PNL) is the current mainstream procedure in nephrolithiasis management yet perforations of the collecting system are major complications which are routinely managed by nephrostomy and ureteral stent placement; except for the intra-peritoneal perforations that need more aggressive interventions. Incidence of such complications are reported to be about 3.4 % according to large scale studies<sup>(1)</sup>.

Over advancement of dilators further than the calyx, kinks in the guide wire, vigorous sheath manipulation in the vicinity of the pelvi-ureteral junction are known risk factors of collecting system perforation<sup>(2)</sup>.

Current literature suggests intra renal free drainage which in most cases incorporates nephrostomy placement and/or double j ureteral stent (DJ) insertion; as quoted in European guideline on renal trauma: "Termination of PCNL if the renal pelvis is torn or ruptured is a safe choice. Management requires close monitoring, placement of an abdominal or retroperitoneal drain, and supportive measures."<sup>(3)</sup>

The totally tubeless technique has been used at the end

of a uncomplicated PNL which does not incorporate use of any ureteral stent or nephrostomy tube and relies on physiologic function of the ureter<sup>(4,5)</sup> as the natural drain. In many trials carried out in the beginning era of totally tubeless PNL the perforation of the collecting system was an exclusion<sup>(6)</sup>.

In our center, any violation of pelvi-calyceal integrity is managed by ureteral stenting (or DJ), depending on the severity and nephrostomy is not a routine, therefore, there have been few unfortunate cases of ureteral stent or DJ dislodgement in post PNL settings bearing collecting system perforations and in many instances the patient fully recovered not requiring any urinary diversion (neither nephrostomy nor a ureteral stent) despite the pelvi-calyceal perforation.

Such observation inspired us to investigate characteristics of iatrogenic pelvis perforations to identify patients who might not need any invasive intervention and would recover without either nephrostomy or DJ stent (totally tubeless); according to the ongoing trial's protocol, details on complications were recorded and used to form a grading system for collecting system perforations during PNL to help the surgeon identify those who could safely benefit from a totally tubeless PNL.

<sup>1</sup>Sina Hospital, Imam Khomeini ave, Tehran university of medical sciences, Tehran, Iran.

<sup>2</sup>Imam Reza Hospital, Fatemi ave. Tehran, Iran.

\*Correspondence: Tehran University of Medical Sciences, Sina Hospital, Imam Khomeini ave, Tehran University of Medical Sciences, Tehran, Iran.

Tel: +98 21 63120(481). E mail: alb\_salavati@razi.tums.ac.ir.

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**Table 1.** The Aghamir-Salavati grading for pelvi-calyceal perforations during PNL (based on nephroscopic assessment)

Grade 1	a laceration limited to detached mucosa and submucosa with no visible fat tissue.
Grade 2	the adipose tissue is visible but no intrusions has been made.
Grade 3	the nephroscope or dilator has protruded into the peri-pelvic fat (a visible tract or space inside fat tissue is visible).

## PATIENTS AND METHODS

### Study population

During February 2003 and June 2015 data on more than 1200 PNLs at Sina hospital - a referral urology center of the Tehran University of Medical Sciences, Iran - were gathered and retrospectively analyzed which identified 49 cases of collecting system perforations during PNL. Cases in whom nephrostomy tube was inserted at the end of operation (standard PNL technique) were excluded. The remaining 26 had either undergone tubeless PNL (no nephrostomy but a ureteral stent inserted) or had been planned to have a total tubeless PNL (no nephrostomy and no ureteral stent) as a part of another clinical trial<sup>(7)</sup> but had been converted to tubeless PNL with ureteral catheter insertion because of pelvicalyceal perforations during operation; both groups had left the operation room bearing a ureteral/ DJ stent; these cases were included in this case series.

### Study design

A retrospective re-analysis of totally tubeless percutaneous nephrolithotomy database<sup>(7,8)</sup> identified cases of iatrogenic pelvi-calyceal perforations that had been managed without use of nephrostomy tube or ureteral stents and data on baseline characteristics including depth of the perforation and short term clinical outcome of these patients were gathered to seek any correlation between the severity of the perforation and the clinical outcomes. The Aghamir-Salavati grading (**Table 1**) for pelvi-calyceal perforation during PNL (based on nephroscopic direct visual assessment of perforation site) is used to categorize patients in three subgroups and need for further urinary diversion was assessed in these subgroups.

Patients in the observation group (n=13) were closely monitored by repeated abdominal examination every 6 hour checking for generalized abdominal tenderness or guarding and ultraonographic examination for expanding urinoma every 12 hours; adequate intravenous antibiotics were administered at full therapeutic dose

(mainly cephalosporins plus aminoglycoside). In case of positive findings in abdominal examination or expanding urinoma, emergent intervention was contemplated (ureteroscopy and DJ insertion). All patients (n=25) had indwelling bladder catheters with free drainage until discharge.

Outcomes: Clinically significant urinomas as identified by local tenderness, localized peritoneal irritation signs, signs of systemic inflammatory response or sepsis (pulse rates over 100/min, blood pressure less than 100mmHg, temperatures above 38.0 C) and leukocytosis (WBC > 7500). The main outcome measure was rate of successful noninvasive management (full recovery in the same admission without re-stenting or the ureter or nephrostomy tube placement).

### Statistical analysis

Odds of successful conservative management of perforations in different perforation grades were investigated in control and totally tubeless observation groups using PASW v.18 software using crosstab.

## RESULTS

There was 49 pelvi-calyceal perforations in 1271 PNL operations (3.9%). Twenty-three of them had undergone standard PNL (with nephrostomy tube and ureteral stent) so the early dislodgement of ureteral stent did not change their clinical course. One patient underwent immediate laparotomy and repair beside nephrostomy, DJ and peritoneal drain placement.

The remaining 25 perforations with early stent dislodgement had either undergone tubeless PNL (only ureteral stent or DJ placed at the end of surgery) or were intended to have a totally tubeless PNL but were converted to tubeless and an externalized ureteral stent or DJ was placed at the end of their surgery because of a perforation in the renal pelvis or calyces. A grade III perforation was present in 7 (28.0%), there were 7 (28.0%) grade II and eleven (44.0 %) grade I injuries. Among these 25 perforation cases with ureteral stent dislodgement in the first 24 postoperative hours, 12 underwent immediate ureteroscopy and stenting (the

**Table 2.** Frequency of different trauma grades in observation and re-stenting groups.

Perforation grading	Observation group	Immediate re-intervention	Total
		Needing later DJ Insertion	
G1	6	0 (0%)	5
G2	4	0 (0%)	3
G3	3	3 (100%)	4
total	13	3 (23%)	12

control group) ; there were 4 ( 33.3 % ) grade III , three (25.0%) grade II and 5 (41.6%) grade I perforations (**Table 1**).The remaining 13 patients were not fit for immediate intervention due to comorbid conditions (Six ( 46.1 % ) had grade I , four (30.7%) had grade II and three (23.0%) had grade III perforations) were considered as the case group.

Out of 13 patients in the no drainage group, six patients with grade I injury (46.2%) and four patients with grade II injury (30.8%) were successfully managed conservatively without further need for intervention (77%) (P=.003; CI, 0.000-0.030). The longest hospital stay was 7 days. All grade III patients (23.0%) developed abdominal guarding and expanding urinoma on ultrasonographic exam and underwent ureteroscopy and stenting between 3rd - 5th postoperative days and were discharged on the 9th or 10th postoperative days.

## DISCUSSION

In this retrospective study, data on conservative management ( no drainage ) of accidental early ureteral stent dislodgement in PNL patients with iatrogenic pelvi-calyceal system perforations were gathered and compared with a similar group of patients in whom immediate re-insertion of a DJ stent was performed to describe different natural history of injuries of different depths.

Considering the possible ethical issues in designing a prospective study to observe the natural history of pelvi-calycea perforations of different severity, retrospective analysis of such cases is being presented comprising 13 cases of no drainage versus another group of 12 patient who had immediately undergone ureteroscopy and DJ insertion after stent dislodgement. Ten (77%) out of 13 totally tubeless (no drainage catheter) patients fully recovered without the need for re-stenting or nephrostomy; only three (23%) of them needed ureteroscopy and Dj insertion for control of the urinoma and other adverse clinical conditions. All these three had grade III Aghamir-Salavati pelvicalyceal trauma (visible fat at the trauma site which the nephroscope or grasper or lithotripter had intruded inside). Six patient s bearing grade I (mucosal laceration/flap) and 4 grade II (visible but intact fat at trauma site) finally recovered without need for re-intervention.

The PNL procedure is a Grade IV sharp renal trauma that in many instances could be managed without any ureteral stent or nephrostomy tube<sup>(9,10)</sup>; it is proposed that the tract is sealed off by the recoil of the renal parenchyma and clot formation. Currently totally tubeless percutaneous nephrolithotomy is considered a safe variant in selected cases<sup>(8,11)</sup> and perforations in the collecting system have been a known exclusion criteria to such exit strategy during PNL .

In a retrospective large scale PNL complication reports<sup>(12)</sup> perforation rates were reported to be around 2% and peri-renal hematoma were observed in 7.5 % of PNL cases. Not all perforations are clinically symptomatic. Unfortunately reliable uniform data on conservative management of extra peritoneal iatrogenic pelvicalyceal perforations are rare in contrast to gastrointestinal complications of PNL<sup>(13)</sup> albeit there is a large body of evidence on conservative management of blunt and closed high grade renal traumas<sup>(2,14)</sup>.

Similar reports of successful management of traumatic urinomas are available in pediatric trauma patients<sup>(15,16)</sup>. It has been mentioned that many of these blunt traumat-

ic cases needed angiographic intervention for bleeding control<sup>(17)</sup> but urinomas rarely needed any intervention other than antibiotics. Unfortunately, these type of studies- mostly case reports- consider DJ stenting as a conservative approach and does not clarify the outcome of the group of patients who underwent stenting versus those that despite a urinoma had not undergone ureteral stenting or percutaneous drainage.

The grading proposed here is based on results of the current case series that is a mere initial step toward differentiating those iatrogenic closed collecting system perforations which would not result in clinically symptomatic urinomas and therefore could be managed in a totally tubeless setting.

Ethical issues hindered us from designing an interventional human or animal survey nevertheless this observational study implicates that all iatrogenic perforations during PNL does not share the same natural history and if further investigated and correctly categorized might be managed differently according to the severity. Such approach might relieve the need for DJ stent placement after all perforations occurred during PNL. Further investigations are warranted to clarify natural history of different types of iatrogenic pelvi-calyceal trauma which is the beginning of a change in post PNL complication management.

## CONCLUSIONS

Iatrogenic perforations of the collecting system during PNL are quite diverse in terms of severity that result in different natural histories and not all might need urinary diversion via nephrostomy or ureteral stenting. Low grade perforations may successfully be managed in totally tubeless fashion nevertheless further prospective investigations seem warranted.

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## CONFLICT OF INTEREST

The authors report no conflict of interest.

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