

Feasibility of dusting and pop-dusting using high-power (100W) Holmium YAG (Ho:YAG) laser in treatment of paediatric stones: results of first worldwide clinical study

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Introduction As the role of paediatric ureteroscopy (URS) for stone disease increases, new methods of stone treatment such as dusting and pop-dusting have emerged. However, outcomes of treatment using these laser settings in paediatric age group is still largely unknown. We aimed to look at the feasibility and outcomes of URS and pop-dusting using a high-power 100W laser for paediatric stone patients.

Material and methods Outcomes from a prospective stone database were reviewed over a period of 30 months from February 2016–July 2018. All paediatric patients (≤ 16 years) treated with dusting and pop-dusting were included in our study. Dusting and pop-dusting were performed using Ho:YAG laser with the energy setting ranges of 0.2–0.5 J and 0.5–0.7 J respectively with a frequency of 20–50 Hz.

Results Twelve patients underwent URS and treatment using this method with mean age of 6.5 years and a male:female ratio of 7:5. The mean and cumulative single stone size was 7.1 mm (3–10 mm) and 11.9 mm (6–40 mm) respectively with half of all patients having multiple stones. Eleven patients were stone free on follow-up with no intra or post-operative complications noted.

Conclusions Pop-dusting using holmium laser is a new hybrid technique that allows for more efficient dust formation even for hard stones. This is the first clinical study demonstrating the safety and efficacy of this technique in paediatric patients. It is likely there will be wider adoption of these new laser techniques for stone treatment in the paediatric age group.

Key Words: dusting \leftrightarrow fragmentation \leftrightarrow laser \leftrightarrow pop-dusting \leftrightarrow popcorn \leftrightarrow stone \leftrightarrow ureteroscopy \leftrightarrow paediatric

INTRODUCTION

The incidence of stone disease in the paediatric population is increasing [1]. There has also been a similar rise in procedures performed for stone disease, especially minimally invasive percutaneous nephrolithotomy (PCNL) and ureteroscopy (URS) procedures [2, 3]. Paediatric URS has been shown to be a safe and effective technique for stone management in medium and high-volume centres with stone-free rates of over 90% and complications rates of approximately 11% [4]. With a rise in the number of URS procedures, there has been a modification in the technique of laser stone

treatment. While holmium: yttrium-aluminum-garnet (Ho:YAG) laser was initially used for stone fragmentation and retrieval, stone dusting and 'popcorning' has been increasingly reported [5–9]. Of late, the pop-dusting method has gained popularity – a two-stage treatment using a low-power, high-frequency, long-pulse Ho:YAG laser; initially in contact with the stone – 'dusting' (0.2–0.5 J / 40–50 Hz) followed by non-contact mode – 'pop-dusting' (0.5–0.7 J / 20–40 Hz) [5]. Dusting reduces operating time and potentially reduces complications as it avoids repeated retrieval of stone fragments [7, 8, 9]. While dusting might be adequate for some stones, pop-dusting improves

efficiency in forming small fragments from harder stones and enhances speed of clearance. Pop-dusting has shown to be safe and effective in the adult population [6]. However, little is known about its use in the paediatric population. We reviewed the role and outcomes of ureteroscopy and pop-dusting using a high-power 100W laser for a cohort of paediatric stone patients.

MATERIAL AND METHODS

Over a period of 30 months (February 2016 and July 2018), paediatric patients (≤ 16 years of age) treated with dusting and pop-dusting using a 100W high-power Ho:YAG system (Lumenis, Inc.) were included in our study. Pop-dusting was used for larger stones or when the stones could not be successfully treated by dusting alone. Outcomes were collected for patient and stone demographics, intra and post-operative details, stone-free rate (SFR) and complication rates. Stone dusting was performed using a 100W Ho:YAG system with an energy setting of 0.2–0.5 J and a frequency of 20–50 Hz. Pop-dusting was subsequently completed using energy of 0.5–0.7 J and a frequency of 20–50 Hz for completion of the procedure [5, 12]. We used a 200 μm reusable laser fiber (Lumenis, Inc.) for all our cases and ‘renewed the tip’ per clinical requirement using simple sterile scissors.

We used our standard ureteroscopy technique in paediatric patients as described previously [10]. All patients had a semirigid ureteroscopy with a 4.5–6 F (Richard Wolf) ureteroscope over a safety wire first, followed by flexible ureteroscopy (FURS) using Storz Flex X2. A 9.5–11.5 F (35 cm) Cook Flexor sheath access sheath was used for large stones provided the ureter was wide enough to accommodate it. This was assessed during passage of the semirigid URS. SFR was defined as complete absence of stones endoscopically and ≤ 2 mm on ultrasound scan 3 months postoperatively. Complications were recorded using the Clavien–Dindo grading system. Fragment removal was carried out using NGage nitinol stone extractor (Cook Medical, USA). At the discretion of the surgeon, a 4.7 F ureteric stent (Cook Medical) or an overnight ureteral catheter was inserted at the end of the procedure. Stents were subsequently removed under a general anesthetic 6–8 weeks postoperatively.

RESULTS

Twelve patients underwent URS and treatment with the high-power laser using the stone dusting and pop-dusting method (Table 1). The mean age was 6.5 years (range: 3–14 years) with a male:female ra-

tio of 7:5. The mean and cumulative single stone size was 7.1 mm (3–10 mm) and 11.9 mm (6–40 mm) respectively with half of all patients having multiple stones (kidney, 82.6%; ureter, 17.4%).

A preoperative stent was present in 5 (42%) patients and a 9.5/11.5 F access sheath was used in 4 patients. A postoperative open ended ureteral access catheter and a ureteric stent was inserted in 4 patients each. While the former was removed the following day, the stent was removed after 6–8 weeks. The mean length of stay was 1.2 days (range: 1–2 days). Eleven patients (91.6%) were stone free at follow-up ultrasound scan 3 months post-surgery. Due to complex lower pole anatomy stone free status was not achieved in one patient. There were no intra- or postoperative complications noted. Stone analysis was available in nine patients (Table 1).

DISCUSSION

Successful laser lithotripsy using the pop-dusting technique in paediatric stone patients was achieved in 11/12 cases with a SFR of 91.6%. Difficult lower

Table 1. Patient demographics and outcomes

Mean age (years) (range)	6.5 (3–14)
Male:female	7:5
Mean single stone size in mm (range)	7.1 (3–10)
Mean cumulative stone size in mm (range)	11.9 (6–40)
Patients with multiple stones	50% (6/12)
Stone location	
Lower calyx	7
Renal pelvis	6
Middle calyx	4
Ureter	4
Upper calyx	2
Access sheath used (9.5 F)	4/12 (33.30%)
Ureteric stent (4.7 F)	
Preoperative	5 (42%)
Postoperative	8 (66%)
Mean length of stay (days)	1.2 (1–2)
Complications	0
Stone-free rate at follow-up ultrasound	11/12 (91.6%) (1 lower pole stone which was treated but due to difficult lower pole anatomy was not rendered stone free)
Stone composition	
Struvite (mixed)	4
Calcium hydrogen phosphate dihydrate	2
Calcium oxalate (mixed)	3

pole anatomy led to failure in one patient. Using this method, even large stones were successfully treated with no intra- or postoperative complications. Patients were discharged the following day with a mean hospital stay of 1.2 days. Some were admitted one day preoperatively due to travelling distance to the hospital.

Dusting, popcorning and now pop-dusting can be used with minimally invasive PCNL as well as URS techniques [11]. Perhaps the use of an access sheath allows for better drainage of dust achieving superior SFR [6]. In adults, dusting has been shown to reduce the overall operative time and ureteral trauma [12]. Dusting and pop-dusting have been shown to achieve excellent SFR even for large stones and are proposed to set a new benchmark for treating bilateral, multiple or large volume stones without the need for a second procedure in most cases [6].

In the paediatric setting, SFR with a traditional fragmentation and stone retrieval technique has been shown to have low re-operation rates [8, 13, 14]. In a randomised trial using fragmentation versus dusting for ureteral stones, comparable SFR and complication rates were seen [15]. Similarly, the Ho:YAG laser has become more efficient with adjustments of pulse length, energy and frequency leading to improved energy transmission and increasing stone ablation [16].

Our study was performed in a standardised technique using the two-surgeon technique published previously [10]. This decreased inter-user variability.

However, the low numbers and retrospective nature of this study limit conclusions regarding feasibility and safety in paediatric patients for this promising technique. Cost and quality of life measures were not included in our study [17, 18, 19]. Pop-dusting is a new hybrid technique that allows for more efficient dust formation even for hard stones and our study reports early results of this technique in the paediatric patients. Long-term studies however need to address whether 'dust' drains out or forms a precursor to further stone formation.

CONCLUSIONS

Pop-dusting using holmium laser is a new hybrid technique that allows for more efficient dust formation even for hard stones. This is the first clinical study demonstrating the safety and efficacy of this technique in paediatric patients. It is likely there will be wider adoption of these new laser techniques for stone treatment in the paediatric age group.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest from any of the co-authors.

No funding was received for this work.

ETHICAL APPROVAL

This was a departmental audit and was registered in our hospital. No formal ethical approval was necessary.

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