

ORIGINAL ARTICLE

Assessment of renal parenchymal damage by DMSA after PCNL procedure in children using adult-sized equipment

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Abstract

Aims Percutaneous nephrolithotomy (PCNL) is an established technique for the management of renal calculi. The recent advances in this procedure in children include miniaturizing the endoscopic instruments used for renal access. However, there is limited data on the functional effects of PCNL on the renal parenchyma, performed using adult-sized equipment in the paediatric population. This study was therefore aimed to determine the effects of PCNL on the renal parenchyma in children with renal calculi using technetium-99m labelled dimercaptosuccininc acid (^{99m}Tc-DMSA) scans.

Methods Pre and post-surgery DMSA scans of 26 paediatric patients who had undergone PCNL over a five-year period were reviewed. The ages of the patients ranged from 1 year to 12.5 years (median: 3.75 years) at the time of PCNL. The procedures were done with 18 Fr or higher sized Amplatz sheath. DMSA scans was performed from 1 day to 47 months before the PCNL and 2 months to 27 months after the procedure and interpreted by two independent observers. Regions-of-interest around each kidney were drawn to determine differential renal function (DRF) of the kidneys.

Results Twenty patients (77 %) showed no change or showed improvement in post-procedure scans. Mean±SD DRF was 44.1±9.7% before and 44.6±10.6% after the procedure (p=0.52, n=21).

Conclusion We conclude that the PCNL procedure in children undertaken with adult-sized equipment may show renal defects in nearly one-fourth of children but there is no significant change in their global renal function.

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Key words*: Percutaneous nephrolithotomy; ^{99m}Tc-DMSA; children; adult-sized equipment*

Introduction

Open surgery for the management of upper urinary tract calculi has been largely replaced by percutaneous nephrolithotomy (PCNL) or extracorporeal shock wave lithotripsy (ESWL). PCNL is a surgical procedure in which renal calculi are removed through a one centimeter skin puncture. A track down to the kidney is established under x-ray guidance and a nephroscope is passed into the kidney. Small stones are removed directly and the larger ones are broken into small pieces with an ultrasonic or electrohydraulic probe, or a holmium laser lithotripter. ESWL due to its lower morbidity is the procedure of choice but PCNL is preferred for calculi more than 2 cm in diameter. In children, the latter is performed cautiously due to the concerns of damage to renal parenchyma when it is pierced by nephroscope. PCNL was first performed in paediatric patient in 1985 and with the advances in the technique the frequency has significantly increased since then [1-3]. Nephroscopes of sizes ranging from 19.5 to 27-Fr were used initially while 17-Fr was introduced in late 1980s [2]. Today, 15-Fr nephroscopes are easily available. Smaller nephroscopes may theoretically cause lesser damage to the renal parenchyma; however, their benefit in children is yet to be established. Traxer *et al.* reported no significant difference in scar tissue measured in sacrificed pigs with right kidney nephrostomies by 30-Fr Amplatz sheath than left kidneys punctured with 11-Fr sheaths [4]. The growing child's kidney may be affected more by the PCNL size than full-grown kidneys. Although several studies have reported that the adult-sized PCNL equipment is safe in children [5-8], other researchers in contrast, have reported significant complications [9-11]. The assessment of safety of the procedure in all these studies was undertaken by measuring parameters like stone-free rates and the need for blood transfusions. Scanning with technetium-99m labelled dimercaptosuccininc acid (^{99m}Tc-DMSA) is a practical option for the assessment of renal parenchymal damage before and after the procedure. Identifying new photon-deficient areas or significant reduction in differential renal function of the operated side, indicates renal parenchymal damage. We visually and quantitatively compared pre- and post-PCNL ^{99m}Tc-DMSA scans of paediatric population who had procedures performed with adult-sized PCNL tracts.

Materials and Methods

Medical records of four consecutive years of Urology and Nuclear Medicine departments at Great Ormond Street Hospital, London, UK, were examined retrospectively from 1999 to 2003, and 37 patients who had undergone PCNL with ≥18-Fr Amplatz sheath were selected. Patients who had either preoperative with postoperative, or a normal postoperative DMSA scan were included. Eleven patients were excluded due to lack of adequate details of imaging. Twenty-six patients with ages ranging from 1 to 12.5 years (median: 3.75 years) were therefore available for the review. Twenty-one patients had both pre- and post-procedure scan available, while 5 patients had only post-procedure scans, which were normal. 62% patients had calculi in the left kidney.

The PCNL tracts were established and the stones were disintegrated with ultrasonic probe and removed. The size of the Amplatz sheath used varied from 18-Fr to 28-Fr (median: 24-Fr). After the PCNL a nephrostomy tube was placed (range 6-Fr to 28-Fr; median 24-Fr) in 22 patients; 4 patients did not have a tube placed after the procedure. Thirty-three punctures were attempted, with 7 kidneys perforated both in the upper and the lower poles. Five perforations were made in upper poles only, 6 in lower only and 8 in the mid-portion of the kidneys. In those cases where both the poles were punctured, Amplatz sheaths of the same size were used except in one case in which upper pole was perforated with a 26-Fr and the lower with a 24-Fr sheath.

Table 1 *The visual interpretations of DMSA scans*

Pre procedure scan	Post procedure scan	No. of patients	Outcome
Normal	Normal	5	Favourable
No scan available	Normal	5	n=20
Abnormal	Normal	2	
Abnormal	No change from previous	8	
Normal	Abnormal	3	Deteriorated
Abnormal	Abnormal with new defects	3*	n=6

DMSA scans were performed from 1 day to 47 months (median = 2 months) before the PCNL and 2 months to 27 months (median = 3.5 months) after the procedure. The child was injected using an intravenous line, with a maximum of 80 MBq of ^{99m}Tc-DMSA and scintigraphy was started 2-4 hours after the injection. Images were acquired on one of two single-headed gamma cameras fixed with high-resolution parallel-hole collimators. Posterior and both posterior-oblique, i.e. left-posterior-oblique (LPO) and right-posterior-oblique (RPO) projections were recorded for 250-500 k-counts on digital matrix of 256×256.

Visually, DMSA scans were interpreted for any abnormality by two independent observers. The decision on any disagreement in interpretation was established after mutual consensus. The scans were also assessed semi-quantitatively by measuring differential renal functions (DRF) of the two kidneys and compared where both pre- and post-PCNL scans were available. Student's *t* test was applied for this comparison and *p*-value less than 0.05 was considered significant.

Results

Table 1 shows the patients grouped on the basis of visual interpretation and comparisons of pre-procedure and post procedure DMSA scans. Twenty patients (77%) had either normal post-procedure scans (n=12, 46%) or had no change in pre-procedure abnormal scans (n=8, 31%). In those with normal post-procedure scans, the pre-PCNL scans were normal in five, abnormal in two and not available in five patients. Remaining 23% (n=6) patients showed new areas of uptake defects in previously normal or abnormal

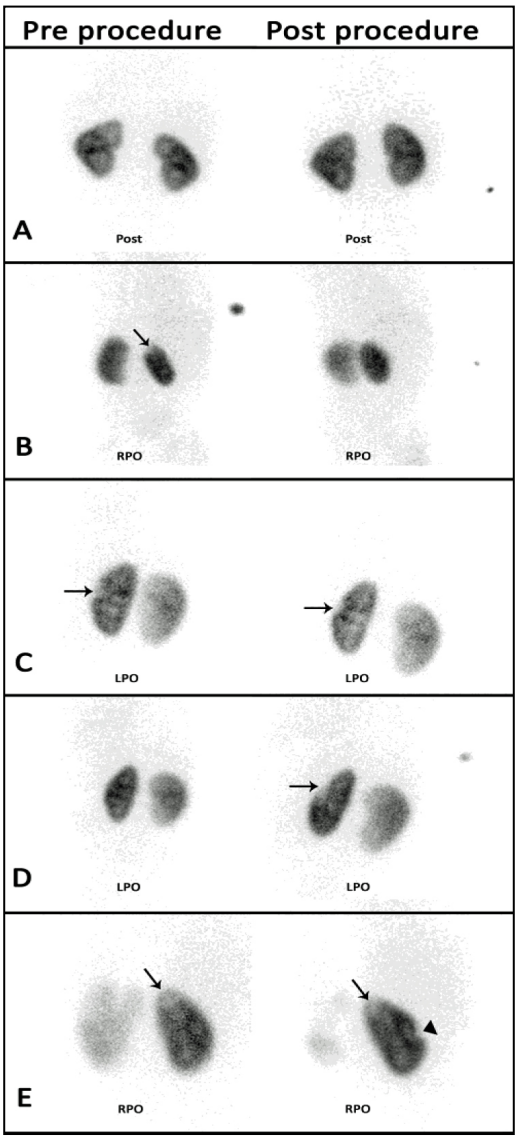

Figure 1 *^{99m}Tc-DMSA scans comparing pre and post PCNL images. (A) normal; (B) uptake defect in pre-procedure (arrow) and normal post-procedure; (C) same defect (arrow) in pre and post procedure; (D) normal pre-procedure and new defect (arrow) in post-procedure; (E) persistent defect in pre-procedure (arrow) and a new defect in post-procedure (arrowhead)*

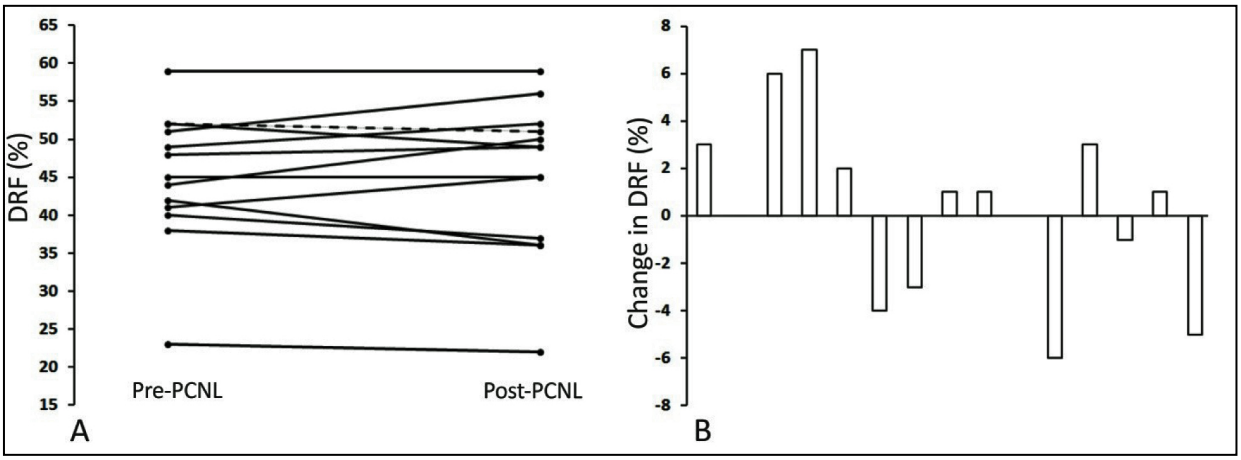

Figure 2 *(A) Values of differential renal function (DRF) in pre- and post-PCNL scans in patients that showed favourable outcome after surgery on visual analysis with the dotted line representing same data seen in two different patients; (B) difference in DRF between the two scans*

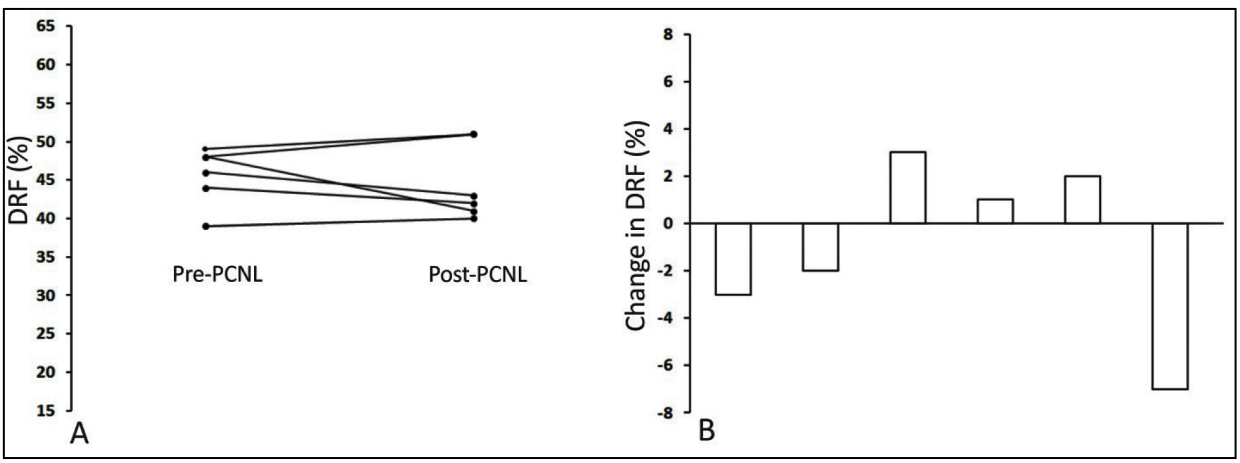

Figure 3 *(A) Values of differential renal function (DRF) in pre- and post-PCNL scans in patients that showed deterioration after surgery on visual analysis; (B) difference in DRF between the two scans*

scans. Images of selected case are shown in Figure 1.

Pre-procedure scans had 44.1±9.7% DRF which after the procedure was 44.6±10.6% (p=0.52, n=21). DRF of the cases having favourable outcome on visual analysis was 43.5±11.3% before and 44.3±12.1% after the procedure (p=0.83, n=15). Those cases showing deterioration of DMSA scans on visual analysis had DRF 45.7±3.7% before and 44.7±5.0% after PCNL (p=0.54, n=6). Figures 2 and 3 demonstrate these changes individually.

Discussion

The pros and cons of Percutaneous Nephrolithotripsy (PCNL) versus Extra-corporeal Shockwave Lithotripsy (ESWL) have often been highlighted when one discusses the management of renal stones. ESWL has an

advantage over PCNL of not requiring general anaesthesia. However, this advantage does not exist in case of children. There are controversial reports published regarding the safety of renal parenchyma during ESWL in adults as well as children [12, 13]. In case of PCNL, there is limited data available regarding the direct assessment of renal parenchymal damage caused when adult-sized nephroscopes are used.

^{99m}Tc-DMSA is an effective and reproducible method for evaluating regional and global renal function [14, 15]. It has been used for assessing damage to the renal parenchyma that may follow the PCNL procedure [16-18]. Regional assessments on ^{99m}Tc-DMSA scans are usually performed by identifying the photon-deficient areas in the renal parenchyma. Global function may be assessed by visual analysis as well as quantitative analysis by measuring differential renal function [19-21].

After evaluation of our study data, it was found that 5 patients had normal scans before and after the procedure; 5 patients had only one normal post procedure study available; 2 patients showed improvement and 8 had abnormal pre-procedure scans with no change seen on the post- procedure scans. All of these 20 (77%) cases had a favourable outcome in renal function after PCNL. The other group consisted of 3 patients with normal pre-procedure scans and photon-deficient areas in scans done after the procedure and 3 patients with previously abnormal scan and deterioration seen visually in the renal scans after PCNL. In our study 23% of the patients showed new or additional regions of absent uptake of DMSA. This is in contrast to Samad *et al.* who demonstrated only 5% [22], but their data was based on only four children who had a pre-procedure scans available. In contrast, our study was designed to compare pre- and post-procedure scans. Pre-procedure scans were not available in our study only where they were not required, i.e., normal post-procedure scans. Moreover, Samad *et al.* used 17-Fr nephroscopes in 75% of their population while we used Amplatz sheaths of more than 18-Fr in all our patients. To our knowledge there is no study that compares pre- and post-PCNL DMSA scans in children where adult sized equipment has been used. Many studies have evaluated the use of such equipment in children by assessing the stone-free rates and complications like the need for blood transfusions, but the reported results are conflicting [5-11].

DRF of both pre and post studies were available in 19 patients. There was no significant change seen in DFR in the operated kidneys before and after the procedure. There was a slight increase in DRF in patients who showed favourable changes visually but was not statistically significant ($p=0.83$). Similarly, the DRF decrease in the patients showing deterioration visually was also not significant. In a study performed in an adult population, Demirtas *et al.* found significant differences in differential functions before and after PCNL [23]. The possible reason is the growing kidneys in children. This may cause compensatory change in overall renal function despite the fact that the scars may persist regionally.

Conclusion

The study demonstrated that PCNL procedure with adult-sized equipment may cause regional uptake defects on the DMSA scan in nearly one-fourth of children without a significant change in global differential function.

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