

# Comparison of Lower Pole Renal Calculi Clearance after Extracorporeal Shock Wave Lithotripsy with and without percussion, diuresis and inversion maneuver

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## ABSTRACT

**Aims:** To determine whether Percussion, diuresis and inversion (PDI) maneuver following shock wave lithotripsy (SWL) can enhance stone clearance from lower calyx as compared to SWL alone.

**Methods:** 60 Patients with lower pole stones (8-15 mm) were randomized to SWL plus PDI (group A) or SWL alone (group B). Shock waves were delivered to all patients according to a standard protocol. Group A patients underwent PDI maneuver immediately after SWL session. Stone clearance was determined by digital KUB x-ray 2 weeks after SWL.

**Results:** Stone clearance rate (SCR) was 65.5% in SWL plus PDI patients as compared to 34.5% in SWL only Patients. This difference is statistically highly significant ( $p < .02$ ). Relative Risk (RR) of stone clearance with PDI is 1.9 (95% CI 1.07-3.35) as compared to SWL alone.

**Conclusion:** PDI in conjunction with SWL significantly improves stone clearance (65.5%) from lower pole of kidney. This means 1.9 times improvement in SCR with virtually no additional cost.

**Keywords:** Renal calculi, shock wave lithotripsy, PDI, urolithiasis

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## INTRODUCTION

Renal stone disease is a major health problem worldwide. The incidence of urolithiasis in western countries ranges from 5 to 15%<sup>1</sup>. Pakistan is situated in the stone belt region and here incidence (per 100,000) ranges from 7.4 to 200<sup>2,3,4</sup>. Extracorporeal shock wave lithotripsy (ESWL) has revolutionized the treatment of stone disease. Because of its non invasive and cost effectiveness, it is the treatment of choice for renal stones  $\leq 2\text{cm}$ <sup>4,5</sup>. Here its overall success is about 77.8 -90.6%<sup>4</sup>. However, one place where its success is low (26-48%) is in lower calyx<sup>4,6</sup>.

A number of factors have been identified as being responsible for this low stone clearance rate (SCR)<sup>7</sup>. Dependent position of the lower calyx supposedly impedes the migration of stone fragments as they have to travel against the gravity. Besides dependent position of lower calyx, other anatomical factors such as infundibular length and diameter, infundibulopelvic angle and pelvicalyceal height are also considered important. In favorable anatomy, shorter infundibular length ( $<30\text{mm}$ ), wide infundibular neck ( $>5\text{mm}$ ), an obtuse infundibulopelvic angle ( $>90$  degree) and shorter pelvicalyceal height ( $<15\text{mm}$ ), stone clearance rate following ESWL is significantly better than in unfavorable anatomy<sup>8,9</sup>.

Not only lower calyceal stones have low clearance rate following ESWL, their incidence has increased substantially following the introduction of ESWL since 1980s. Whereas it was estimated to be 2% in mid eighties, it is between 30 to 40% since 1990s<sup>10</sup>. The obvious explanation for this is migration of stone fragments from other parts of kidney to dependent lower calyx during ESWL. In lower calyx, these fragments act as nucleus for further stone growth. Lower calyceal stones thus constitute a significant problem for patients and urologists.

Researchers have tried different methods to enhance stone clearance from lower calyx in conjunction with ESWL<sup>11,12</sup>. Percussion, diuresis and inversion (PDI) is one such adjunctive maneuver. We conducted a randomized controlled trial in which a modified form of PDI was employed.

## PATIENTS AND METHODS

From January 2011 to July 2014, patients seeking treatment for lower calyceal stones at Urology Department Mayo Hospital Lahore were recruited into this randomized controlled clinical trial. Patients were included if their lower pole stone size ranged between 8 to 15mm. This also included those patients who had residual calculus only in the lower calyx from previous treatments (open surgery, PCNL, ESWL etc.).

Patients were excluded from study if: renal function was compromised (serum creatinine  $> 3.0\text{mg \%}$ ), renal anatomy was disturbed (pelviureteric

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junction obstruction, ureteric stricture, grossly narrow calyceal neck etc.). Also excluded were those who could not tolerate head down position and forced diuresis (significant cardiac problems, uncontrolled hypertension) or in whom ESWL is contraindicated (pregnancy, bleeding diathesis etc.)

Patients were divided into two groups of 30 each. Group A patients were to receive PDI in addition to shock wave whereas Group B patients were treated with shock waves only. Random Number Generator was used to allocate patients to either group.

All patients had intravenous urogram prior to delivery of shock waves. Only radio opaque stones were selected as we had problems with our ultrasound localization apparatus. Moreover, radiolucent stones are easy to treat with medical therapy. Shock waves were delivered by Storz Modulith SLX machine according to discretion of the operating doctor who was blinded to the subsequent PDI maneuver.

After ESWL, Group A patients, once they felt comfortable, were required to drink 500 ml of water and take 20 mg tablet of furosemide. After about 20 minutes, they were put on a table which was then tilted head down, 15 to 30 degree, depending upon their level of tolerance. Percussion was performed by tapping the relevant renal area for about 10 minutes.

Patients were recalled after two weeks with digital x-rays KUB. Patients were declared stone free if no fragment larger than 2mm was visible on x-ray.

**RESULTS**

In group A, 19(65.5%) patients had complete stone clearance as compared to 11(34.5%) in group B. Applying chi sq, this difference is statistically highly significant (p <.02). The RR is 1.9(95% CI 1.07 to 3.395). Results are shown in tabular form below.

Table 1:

Stone clearance	ESWL and PDI	ESWL only	Total
Yes	19(65.5%)	10(33.3%)	29
No	11(34.5%)	20(67.7%)	31
Total	30(100%)	30(100%)	60

**DISCUSSION**

If asymptomatic, lower calyceal stones can be left alone. However, they become symptomatic (infection, obstruction etc) at the rate of 10% per year<sup>13</sup>. Larger the stone size (i.e.,>10mm) more likelihood of their becoming symptomatic.

Percutaneous nephrolithotomy (PCNL) is considered the gold standard treatment for clearing the lower calyceal stones (> 95%) regardless of

stone size<sup>14</sup>. However, this is an invasive procedure requiring hospital stay, blood transfusion, technical expertise etc. Technical advances in newer flexible ureterorenoscopy and Ho:YAG lasers have resulted in comparable stone clearance rates when treating lower calyceal stones<sup>15</sup>. But these are costly undertakings, not available commonly.

Catheters have been placed in lower calyx (in both ante and retrograde fashion) to irrigate/flush stones fragments during ESWL<sup>16</sup>. Fluoroscope is required for placement of these catheters. Invasiveness and cost prevents their widespread use.

ESWL remains an attractive option because of its non invasiveness and common availability. An adjunctive procedure, PDI (percussion, diuresis and inversion) has been proposed to enhance SCR from lower calyces in conjunction with ESWL. Concept is relatively simple and physiological. Patients are hydrated to increase urine production so as to flush stone fragments. Head down position counteracts the effect of gravity while simultaneous percussion in the concerned renal area agitates stone fragments, thus increasing their chances of getting out of lower calyx.

There is great variation in methods of PDI application by different researchers.<sup>11,17-18</sup>. Some have used intravenous hydration and mechanical vibrators for percussion. We simplified the procedure by employing oral fluids and applying manual percussion by hands to the concerned renal area. Timing of application of PDI is also different in these studies. Some authors have applied PDI during delivery of shock waves whereas others have recalled patients several days after ESWL. We have applied PDI soon after ESWL once patient felt comfortable. This seems rational and makes sense to us. First, method of shock wave application remains unencumbered as no table tilting is required. Moreover, involved physician remains blinded to the adjunctive procedure and hence no possibility exists for varying the voltage / frequency of shockwaves. Second, patient does not have to come back for PDI, thus saving cost and enhancing compliance.

In our study, 33% had stone clearance on ESWL alone whereas it climbed to 65% when adjunctive procedure of PDI was applied. Stone clearance rate almost doubled because of this simple and cheap maneuver (RR 1.9 95%CI 1.07- 3.395). This was statistically highly significant. Leong et al.<sup>11</sup> reported a 72% stone clearance rate without and 76% with simultaneous inversion and diuresis. Percussion was not applied in this study. 72% is a very high SCR even without PDI in spite of the fact that their stone size was even larger (up to 20mm) than our study. No explanation was given for this unusually high SCR.

Chiong et al<sup>17</sup> reported a 35.4% without and 62.5% with PDI in their randomized controlled study of 108 patients. These figures closely match our results. Percussion was manual as in our study but it was applied 1 to 2 weeks after ESWL session. Stone size was larger in this study (up to 20mm) and on average up to 4 sessions of PDI were applied as opposed to single session in our study. Pace et al<sup>18</sup> reported a prospective study in which SCR was 40% with PDI and only 3% with SWL alone. However, when SWL alone patients were crossed over to PDI, similar success rate was achieved. Surprisingly, stone size was only up to 4mm in this study.

It should not come as a surprise that results are so different in these studies. Not only there is difference of methodology but time of application of PDI also varies. There is need to consider other factors such as type of lithotripter, number of sessions applied, calyceal anatomy, composition and size of stones etc<sup>4,19</sup>. Consequently, it is difficult to control all the variables affecting stone clearance. Perhaps it is more productive to compare one study's intervention group with its own control.

Limitations of our study are lack of data on stone composition, limited number of patients and relatively short period of follow up.

## CONCLUSION

Stone clearance rate with PDI almost doubled as compared to shock wave lithotripsy alone. We strongly recommend PDI in all patients undergoing SWL for lower pole renal stones as it requires little effort and almost no cost.

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