

# Kidney Stones Recurrence and Regrowth after Extracorporeal Shock Wave Lithotripsy and Percutaneous Nephrolithotomy

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**Objective:** To estimate and compare the incidence rate of kidney stone recurrence and regrowth after ESWL with PCNL at one, two, and three years.

**Material and Method:** A retrospective cohort study was performed. The study recruited patients aged more than 18 years, diagnosed with kidney stones and treated by ESWL or PCNL between January 2006 and August 2010 at the urological unit of a university hospital located in the northern part of Thailand. Data were retrieved from medical records and analyzed using exact probability test or student's t-test. Poisson regression was used to compare the recurrence rate and the regrowth rate between ESWL and PCNL.

**Results:** During three years of follow-up, the overall stones recurrence and regrowth were 15.5% and 25.1% in ESWL group and 12.6% and 16% in PCNL group, respectively. At one, two and three years after treatment, stones recurrence rate in the ESWL group were 13.1, 7.5 and 7.3 per 1,000 patient-months while in the PCNL group were 11.3, 6.1 and 5.4 per 1,000 patient-months. After ESWL stones regrowth rates were 29.1, 12.3 and 11.9 per 1,000 patient-months, whereas after PCNL were 11.3, 6.9 and 6.9 per 1,000 patient-months, respectively. In comparison to PCNL, the relative recurrence rate after ESWL presented as incidence rate ratio (IRR) were 1.1 (95% CI; 0.4-3.2,  $p = 0.762$ ), 1.2 (95% CI; 0.6-2.6,  $p = 0.517$ ) and 1.4 (95% CI; 0.8-2.5,  $p = 0.271$ ) at 1, 2 and 3 years, respectively. For regrowth, the IRRs were 2.6 (95% CI; 1.1-6.5,  $p = 0.012$ ), 1.8 (95% CI; 0.9-3.4,  $p = 0.048$ ), and 1.7 (95% CI; 1.1-2.9,  $p = 0.017$ ) at 1, 2 and 3 years, respectively.

**Conclusion:** Patients after ESWL had a higher trend of recurrent rates and statistically significant higher regrowth rates, in comparison with those after PCNL.

**Keywords:** Recurrence, Kidney stones, Aftercare, Percutaneous, Lithotripsy

*J Med Assoc Thai* 2011; 94 (9): 1077-83

Full text. e-Journal: <http://www.mat.or.th/journal>

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Currently, extracorporeal shock wave lithotripsy (ESWL) and percutaneous nephrolithotomy (PCNL) are used widely for kidney stones management due to their minimal invasion, leading to the decrease of open surgery<sup>(1)</sup>. ESWL is a highly safe and an effective method as the first alternative for kidney stones less than 3 cm in diameter<sup>(2,3)</sup>. ESWL uses energy to penetrate the body and focuses shock waves, which

disintegrate a stone in the kidney into fragments<sup>(4,5)</sup>. On the other hand, PCNL is a technique to directly remove a stone through a tube with a nephroscope<sup>(6)</sup>. Fifty percent to 72.3% of patients were stone free after ESWL<sup>(7,8)</sup>. PCNL is a technique that has been usually implemented for kidney stones larger than 3 cm, most staghorn stones, hard stones, infected stones, complex urinary stones, including those that failed treatment by ESWL<sup>(9,10)</sup>. The success rate for large stones and stone free rate is higher than 90% after PCNL<sup>(11)</sup>.

After ESWL and PCNL, stones recurrence and regrowth were commonly found within 12 months. The stones recurrence varied from 10% to 100%<sup>(12-14)</sup>.

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The recurrence within 12-24 months after ESWL were 8.6% to 22.6%, and 34.8%<sup>(15-17)</sup>, whereas after PCNL were 4.2% and 22.6%<sup>(6)</sup>. Cumulative incidence of recurrence varied from 40% to 50% within five years and from 50% to 60% within 10 years<sup>(18)</sup>. The regrowth varied from 5.2% to 41% within 24 to 48 months after treatment<sup>(7,19,20)</sup>.

The earlier stated reports with respect to stone recurrence and regrowth were the results of studies in Western countries. However, no study reported the stone recurrence rate and regrowth rate after ESWL and PCNL in Thailand. Therefore, the present study aimed to estimate and compare the stones recurrence rate and stones regrowth rate after ESWL with those after PCNL at one, two, and three years in order to gain accurate information for planning stones management after each treatment, leading to the economic implications.

#### Material and Method

A cohort of patients treated by ESWL or PCNL between January 2006 and August 2010 at the urological unit, Chiang Mai University Hospital, were retrospectively studied. Medical records were reviewed through three years after treatment. Eligible patients were aged more than 18 years, with complete data of the follow-up plain kidney urinary bladder (KUB) and/or intravenous pyelogram (IVP). Plain KUB films were used to detect stones recurrence or regrowth at one, two, and three years following treatments. All films were reviewed by the same urologist and the same radiologist. The reappearance of stones on radiological examination after a certain stones free period post treatment was considered as stones recurrence. The increase in diameter of the original residual stone size post treatment was considered as stone regrowth. Overall stone size was calculated by adding the size of all stones within one kidney. The present study was approved by the medical ethics committees of the Faculty of Medicine, Chiang Mai University.

Four hundred twenty five patients were recruited for the present study. Due to loss to follow-up and incomplete plain KUB film, 382 patients remained eligible for the present study (Fig. 1).

#### Statistical analysis

Data were analyzed using the exact probability test for categorical data or student's t-test for continuous data. The poisson regression was used to distinguish and to compare the stone recurrence

rate and the stone regrowth rate between those after ESWL with those after PCNL. Cumulative incidence of stone recurrence or regrowth were analyzed and presented with Nelson-Aalen cumulative hazard estimates. A p-value of less than 0.05 was considered as statistical significance.

#### Results

Baseline characteristics of patients after ESWL were compared with those after PCNL (Table 1). Patient sex, age, BMI, stone number, and stone location were not different but stone size (mm) in the PCNL group was statistically larger (mean = 31.0, SD = 17.7 and mean = 14.4, SD = 5.3,  $p < 0.001$ ). The overall recurrence during three years were 15.5% after ESWL and 12.6% after PCNL ( $p = 0.420$ ), while the regrowth were 25.1% after ESWL and 16% after PCNL ( $p = 0.029$ ) (Table 2).

The recurrence rates at one, two and three years were 13.1, 7.5, and 7.3 per 1,000 patient-months in the ESWL group and were 11.3, 6.1 and 5.4 per 1,000 patient-months in the PCNL group. In comparison with PCNL, the incidence rate ratios (IRRs) of recurrence after ESWL were 1.1 (95% CI; 0.4-3.2,  $p = 0.762$ ), 1.2 (95% CI; 0.6-2.6,  $p = 0.517$ ), and 1.4 (95% CI; 0.8-2.5,  $p = 0.271$ ) at one, two, and three years, respectively (Table 3). However, the cumulative probability of recurrence compared between ESWL and PCNL did not reach statistical significance ( $p = 0.343$ ) (Fig. 2).

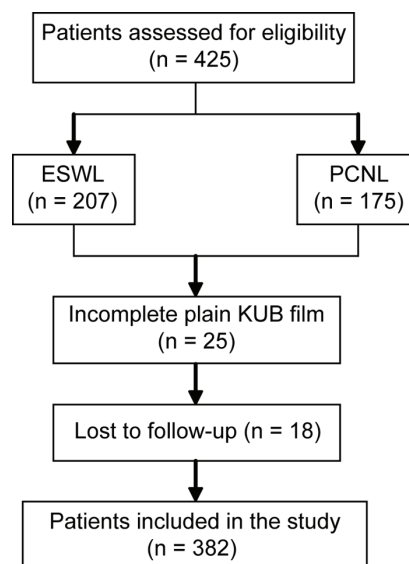


Fig. 1 Flow chart of patients included in the study

**Table 1.** Baseline characteristics of patients treated with ESWL and PCNL. Values are numbers (percentages) unless stated otherwise

Characteristics	ESWL (n = 207)	PCNL (n = 175)	p-value
Sex			
Male	121 (58.5)	104 (59.4)	0.847
Female	86 (41.5)	71 (40.6)	
Age (year)			
≤ 40	36 (17.4)	17 (9.7)	0.123
> 40	171 (82.6)	158 (90.3)	
Mean (SD)	51.1 (11.8)	52.9 (10.6)	
BMI (kgs/m <sup>2</sup> )			
< 25	111 (79.3)	43 (69.4)	0.121
≥ 25	29 (20.7)	19 (30.6)	
Mean (SD)	22.7 (3.5)	23.5 (3.6)	
Stone size (mm)			
< 10	54 (26.1)	0	<0.001
11-20	133 (64.3)	24 (13.7)	
21-30	20 (9.6)	65 (37.1)	
> 31	0	86 (49.2)	
Mean (SD)	14.4 (5.3)	31.0 (17.7)	
Stone location			0.823
Lower calyx	134 (64.7)	108 (61.7)	
Middle calyx	13 (6.3)	11 (6.3)	
Upper calyx	23 (11.1)	18 (10.3)	
Renal pelvis	37 (17.9)	38 (21.7)	
Stone number			0.261
Single	138 (66.7)	126 (72.0)	
Multiples	69 (33.3)	49 (28.0)	

**Table 2.** Stone recurrence and regrowth after treated with ESWL and PCNL during 3 years of follow-up. Values are numbers (percentages) unless stated otherwise

Post-operation finding	ESWL	PCNL	p-value
Recurrence <sup>a</sup>	32 (15.5)	22 (12.6)	0.420
Regrowth <sup>b</sup>	52 (25.1)	28 (16.0)	0.029
Unchanged/stable <sup>a,b</sup>	123 (59.4)	125 (71.4)	0.014

<sup>a</sup> SF: stone free

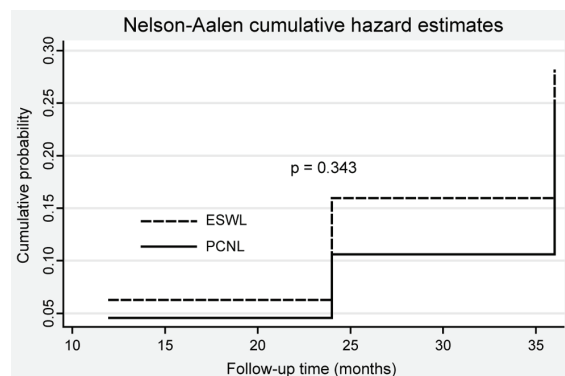
<sup>b</sup> CIRF: clinically insignificant residual fragment of overall diameter of 4 mm or less

The regrowth rates at one, two, and three years were 29.1, 12.3, and 11.9 per 1,000 patient-months in the ESWL group and were 11.3, 6.9, and 6.9 per 1,000 patient-months in the PCNL group. In comparison with PCNL, the IRRs of regrowth after

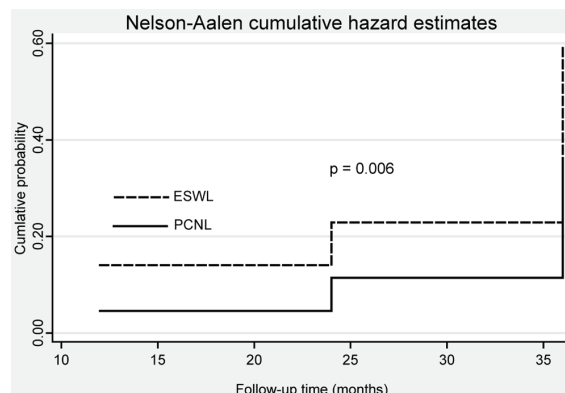
ESWL were 2.6 (95% CI; 1.1-6.5,  $p=0.012$ ), 1.8 (95% CI; 1.0-3.4,  $p=0.048$ ), and 1.7 (95% CI; 1.1-2.9,  $p=0.017$ ) at one, two, and three years, respectively (Table 4). The cumulative probability of regrowth compared between ESWL and PCNL was statistically significant ( $p=0.006$ ) (Fig. 3). The median time to stone recurrence was 24 months both after ESWL and after PCNL, while the median time to regrowth was 12 months after ESWL and 24 months after PCNL. The stones recurred most frequently in the lower calyx in both the ESWL group (75%) and PCNL group (90%). The stone regrowth was 71.2% in the ESWL group and 64.3% in the PCNL group (Table 5).

## Discussion

This present study showed that the recurrence rates at one, two, and three years after ESWL were higher than those after PCNL, but the statistical



**Fig. 2** Cumulative probability of stone recurrence in patients after ESWL and PCNL



**Fig. 3** Cumulative probability of stone regrowth in patients after ESWL and PCNL

**Table 3.** Incidence rate and incidence rate ratio (IRR) with 95% confidence interval (CI) of stone recurrence at 1, 2 and 3 years following ESWL and PCNL

Year/treatment	Recurrence	Follow-up time (month)	Incidence rate per 1,000 patient-months	IRR (95% CI)	p-value
First year					
ESWL	13	996	13.1	1.1 (0.4-3.2)	0.762
PCNL	8	708	11.3	Reference	
Second year					
ESWL	24	3,180	7.5	1.2 (0.6-2.6)	0.517
PCNL	14	2,316	6.1	Reference	
Third year					
ESWL	32	4,286	7.3	1.4 (0.8-2.5)	0.271
PCNL	22	4,080	5.4	Reference	

**Table 4.** Incidence rate and incidence rate ratio (IRR) with 95% confidence interval (CI) of stone regrowth at 1, 2 and 3 years following ESWL and PCNL

Year/treatment	Regrowth	Follow-up time (month)	Incidence rate per 1,000 patient-months	IRR (95% CI)	p-value
First year					
ESWL	29	996	29.1	2.6 (1.1-6.5)	0.012
PCNL	8	708	11.3	Reference	
Second year					
ESWL	39	3,180	12.3	1.8 (1.0-3.4)	0.048
PCNL	16	2,316	6.9	Reference	
Third year					
ESWL	52	4,286	11.9	1.7 (1.1-2.9)	0.017
PCNL	28	4,080	6.9	Reference	

**Table 5.** Distribution of stone location for recurrence and regrowth. Values are numbers (percentages) unless stated otherwise

Location	Recurrence		Regrowth	
	ESWL (n = 32)	PCNL (n = 22)	ESWL (n = 52)	PCNL (n = 28)
Lower calyx	24 (75.0)	20 (90.9)	37 (71.2)	18 (64.3)
Middle calyx	2 (6.2)	0	5 (9.6)	2 (7.1)
Upper calyx	3 (9.4)	2 (9.1)	3 (5.7)	4 (14.3)
Renal pelvis	3 (9.4)	0	7 (13.5)	4 (14.3)

significance of this result was not found. Similarly, Carr et al reported that after ESWL tended to have a higher stone recurrence than after PCNL at two years. The recurrence were 34.8% after ESWL vs. 22.6% after PCNL ( $p = 0.190$ )<sup>(6)</sup>. In contrast, Kohrmann et al showed no greater recurrence after ESWL, in comparison with

other treatments<sup>(21)</sup>. A possible explanation of these results was that post ESWL, sand debris, or dust, which was too tiny to be seen on tomogram, migrated to calices in the collecting system of the kidney, and might reform a new stone formation or growth<sup>(16,22)</sup>.

Following these two treatments, small fragments are defined as clinically insignificant residual fragment (CIRF), which may be clinically significant in long-term follow-up. The present study also found that regrowth rates after ESWL were significantly higher than those after PCNL at one, two, and three years. An explanation for this result would be that ESWL might retain small fragments to further stone regrowth<sup>(16,22)</sup>, but PCNL provided direct access to the stone causing a high rate of stone free<sup>(6)</sup>. Therefore, the regrowth rates after ESWL were usually higher than those after PCNL.

In the present study, the stones located in lower calyx had higher recurrence and regrowth, in comparison with other locations. Previous studies

reported that after ESWL stone recurrence of 27% to 28.6% and stone regrowth of 41% to 90% in lower calyx were higher than those in other locations<sup>(5,20,23)</sup>. A possible explanation of these results was that the lower calyx was the lowest point of the kidney and the stone residual fragments gathered in this location, then the small stones were reformed to stone recurrence and regrowth<sup>(6,24)</sup>. Hence, the stone recurrence and regrowth was inclined to occur in the lower calyx after these two treatments.

There were some limitations in this present study. First, the total follow-up time covered only three years, whereas other studies included a longer follow-up time, ranging from five to 20 years. Although the three-year follow-up period may be sufficient to observe stone recurrence and regrowth, longer time of follow-up, higher rates of recurrence and regrowth. Second, the present study is a retrospective study, which may have loss of plain KUB records and loss to follow-up, thus the total of patients may not represent a population of stone recurrence or regrowth.

### Conclusion

Patients after ESWL had a higher trend of recurrent rates and statistically significant higher regrowth rates, in comparison with those after PCNL. The results of the present study demonstrated the stone recurrence and regrowth in patients after minimally invasive surgery in Thailand. This information is important for patient education and stone prevention strategies in the clinical practice. Patients post kidney stone treatments were normally re-examined every year. Thus, patients treated with ESWL should be appointed earlier in order to detect stone recurrence or regrowth and closely followed-up for a longer period of time.

### Acknowledgment

The authors wish to thank all the staff at the Urological Unit, Department of Surgery, Chiang Mai University Hospital, Trichak Sandu, MD, the head of Surgery Department for his support.

### Potential conflicts of interest

The present study was financially supported by the Faculty of Medicine and Graduate School, Chiang Mai University.

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## การกลับเป็นซ้ำและการเพิ่มขนาดของนิวไนโตภายหลังรักษาด้วยวิธีสลายนิวและวิธีเจาะนิวผ่านเนื้อไต

วิไลวรรณ จงรัชต์สัจย์, บรรณกิจ โฉจนาภวัฒน์, ชไมพร ทวีชศรี, สมบูรณ์ ไพจิตรวิเชียร, จันทิมา เอื้อตรงจิตต์, วรรณ ชุมสาย ณ อยุธยา, ชัยนัครธร ปทุมานนท์

**วัตถุประสงค์:** เพื่อประมาณและเปรียบเทียบอัตราอุบัติการณ์การกลับเป็นซ้ำและการเพิ่มขนาดของนิวไนโตภายหลังการรักษาด้วยวิธีสลายนิวและวิธีเจาะนิวผ่านเนื้อไต ในปี 1, 2 และ 3

**วัสดุและวิธีการ:** การศึกษานี้เป็นการศึกษาย้อนหลัง โดยศึกษาจากผู้ป่วยอายุ 18 ขึ้นไปที่ได้รับการวินิจฉัยเป็นนิวไนโตและรักษาด้วยวิธีสลายนิวและวิธีเจาะนิวผ่านเนื้อไต ระหว่างเดือนมกราคม พ.ศ. 2549 ถึงเดือนสิงหาคม พ.ศ. 2553 ณ หน่วยระบบทางเดินปัสสาวะ โรงพยาบาลมหาวิทยาลัยเชียงใหม่ซึ่งตั้งอยู่ในภาคเหนือของประเทศ เก็บรวบรวมข้อมูลจากเวชระเบียนผู้ป่วยวิเคราะห์ข้อมูลโดยใช้สถิติ exact probability test และ student's t-test นอกจากนี้ สถิติ Poisson regression ถูกใช้เพื่อเปรียบเทียบอัตราการกลับเป็นซ้ำ และการเพิ่มขนาดของนิวไนโตระหว่างวิธีสลายนิวและวิธีเจาะนิวผ่านเนื้อไต

**ผลการศึกษา:** ในช่วงระยะเวลาการติดตาม 3 ปีพบว่า การกลับเป็นซ้ำและการเพิ่มขนาดของนิวไนโตโดยรวมในกลุ่มรักษาด้วยวิธีสลายนิวเท่ากับ 15.5%, 25.1% และในกลุ่มที่รักษาด้วยวิธีเจาะนิวผ่านเนื้อไตเท่ากับ 12.6%, 16% ตามลำดับ ในปี 1, 2 และ 3 พบอัตราการกลับเป็นซ้ำภายหลังรักษาด้วยวิธีสลายนิว 13.1, 7.5 และ 7.3 ต่อ 1,000 คน-เดือน ในขณะที่วิธีเจาะนิวผ่านเนื้อไตพบ 11.3, 6.1 และ 5.4 ต่อ 1,000 คน-เดือน ตามลำดับ นอกจากนี้ยังพบอัตรา การเพิ่มขนาดของนิวไนโตภายหลังการรักษาด้วยวิธีสลายนิว 29.1, 12.3 และ 11.9 ต่อ 1,000 คน-เดือน ตามลำดับ ในขณะที่ภายหลังการรักษาด้วยวิธีเจาะนิวผ่านเนื้อไตพบอัตราการเพิ่มขนาดของนิวไนโต 11.3, 6.9 และ 6.9 ต่อ 1,000 คน-เดือน ตามลำดับ ในการเปรียบเทียบกับวิธีเจาะนิวผ่านเนื้อไต ความเสี่ยงสัมพัทธ์ของการกลับเป็นซ้ำของวิธีสลายนิวจะรายงานเป็นอัตราอุบัติการณ์ (IRRs) 1.1 (95% CI 0.4-3.2,  $p = 0.762$ ), 1.2 (95% CI 0.6-2.6,  $p = 0.517$ ) และ 1.4 (95% CI 0.8-2.5,  $p = 0.271$ ) ในปี 1, 2 และ 3 ตามลำดับ สำหรับ IRRs ของการเพิ่มขนาดของนิวไนโตพบ 2.6 (95% CI 1.1-6.5,  $p = 0.012$ ), 1.8 (95% CI 0.9-3.4,  $p = 0.048$ ) และ 1.7 (95% CI 1.1-2.9,  $p = 0.017$ ) ในปี 1, 2 และ 3 ตามลำดับ

**สรุป:** ผู้ป่วยที่รักษาด้วยวิธีสลายนิวมีแนวโน้มที่จะมีอัตราการกลับเป็นซ้ำสูงกว่า รวมทั้งมีอัตราการเพิ่มขนาดของนิวไนโตสูงกว่าอย่างมีนัยสำคัญทางสถิติเมื่อเปรียบเทียบกับวิธีเจาะนิวผ่านเนื้อไต

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