Sahin et al. Scr Med 2023 Sep;54(3):267-72. DOI:10.5937/scriptamed54-45575

ORIGINAL ARTICLE

Endourologists vs Urologists: The Impact of Surgical Experience and Annual Case Volume on Percutaneous Nephrolithotomy Outcomes

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Abstract

Background/Aim: Surgeon experience, which is an important factor in reducing surgical complications, has been underestimated when analysing percutaneous nephrolithotomy (PNL) outcomes. Aim of this study was to investigate the impact of annual case volume (ACV) of endourologists and urologists on PNL outcomes including stone-free status (SFS) and complications.
Methods: A total of 530 patients who underwent PNL in the Clinic between January 2018 and January 2023 were retrospectively analysed. The patients were divided into two groups: those operated by endourologists (Group 1, n = 324) and by urologists (Group 2, n = 206). The two groups were statistically compared in terms of postoperative SFS and complications.
Results: There were two endourologists in Group 1 and four urologists in Group 2. The mean ACV was 73.56 ± 7.43 in Group 1 and 23.81 ± 9.09 in Group 2, indicating a statistically significantly higher rate in Group 1 ($p < 0.001$). There was no statistically significant difference in the postoperative SFS rates between the groups ($p = 0.064$). In the perioperative period, the mean estimated blood loss and nephrostomy dwell time were significantly lower in Group 1 than Group 2 ($p = 0.013$ and $p = 0.008$, respectively). In the logistic regression analysis, a cut-off value of > 24 for ACV and CROES scores were the significant predictors of SFS ($p = 0.004$ and $p < 0.001$, respectively). The complication rate was significantly lower among surgeons with an ACV of > 24 ($p < 0.001$).
Conclusion: Results from this study showed that an ACV of > 24 increases SFS rate by 2.13 with lower complication rates in patients undergoing PNL. Further multi-centre, large-scale studies are required to investigate the effect of surgical experience and ACV on postoperative outcomes and to predict PNL outcomes with high accuracy.

Key words: Percutaneous nephrolithotomy; Stone-free status; Annual case volume; Surgeon experience.

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ARTICLE INFO

Received: 18 July 2023
Revision received: 21 August 2023
Accepted: 22 August 2023

Introduction

The predictors of postoperative stone-free status (SFS) and complications are the most researched subjects regarding the percutaneous nephrolithotomy (PNL) procedure.[1-3] To date, several factors including access technique, patient position, size of nephroscope, stone characteristics (ie, size, density, number and localisation), patient characteristics (ie, body mass index [BMI], previous stone surgery, anatomical disorder, comorbidity), annual case volume (ACV) in the hospital have been implicated in predicting SFS and complications and even various scoring systems

This article should be cited as follows: Sahin Y, Sahin S, Yilmaz M, Yaser Muslumanoglu A. Endourologists vs urologists: the impact of surgical experience and annual case volume on percutaneous nephrolithotomy outcomes. Scr Med 2023 Sep;54(3):267-72.

including these factors have been developed.[4-6] In recent years, however, there is an uncertainty regarding the predictive values of these scoring systems for SFS and postoperative complications in patients undergoing PNL.[7-9] These scoring systems have been shown to be inadequate in predicting complications, particularly in specific patient groups such as those with staghorn calculi, kidneys with anatomical abnormalities or paediatric patients.[10-12]

Although stone- and patient-related factors seem to be useful in predicting SFS, they usually fail in predicting postoperative complications. In many studies, surgeon experience, which is an important factor in reducing surgical complications, has been underestimated for PNL outcomes. Currently, there is a limited number of studies investigating the effect of ACV of an individual surgeon or facility on PNL outcomes in the literature.[13, 14] The hospital's ACV parameter has been added to the Clinical Research Office of the Endourological Society (CROES) nomogram based on a single study result and does not reflect actual endourological experience.[13] In the present study, it was hypothesised that postoperative SFS and complication rates would be lower in patients operated by endourologists with a high individual PNL ACV than general urology specialists. Therefore, aim was to compare the SFS and complication rates after PNL performed by endourologists versus urologists in the Clinic.

Methods

This single-centre, retrospective study was conducted at Kidney Stone Centre, Department of Urology of a Tertiary Care Centre between January 2018 and January 2023. Medical data of patients who underwent PNL were retrieved from the hospital database. Demographic, clinical, operative, postoperative and radiological data of the patients were recorded. Patients aged below 18 years (n = 52), having chronic and acute renal failure (n = 45), having a history of endoscopic stone operation on the same side within the past six months (n = 33), incomplete radiological data (n = 92), undergoing miniaturised PNL (n = 155), or tubeless procedure (n = 260) were not included from the study. Finally, a total of 530 patients who met the inclusion criteria were recruited. A written informed consent was obtained from all patients. The study was approved by the institutional Ethics Committee (Decision No: 2023/05/05/024, Date: 10-May-2023) and conducted in accordance with the principles of the Declaration of Helsinki.

The procedure was performed as a standard PNL in the prone position after retrograde ureteral catheterisation under general anaesthesia. Stone fragmentation was performed using ultrasonic energy or pneumatics in all patients. In the postoperative period, when the urine draining from the nephrostomy tube was clear, nephrostomies were clamped and removed, if there was no pain or discharge. The patients were, then, discharged from the hospital. SFS was defined as the presence of residual stones less than 4 mm or none on X-ray or computed tomography (CT) at three months after PNL.

The patients were divided into two groups: those operated by endourologists with a higher ACV rate (Group 1, n = 324) and by urologists with a lower ACV rate (Group 2, n = 206). There were two endourologists in Group 1 and four urologists in Group 2. Mini-PNL and tubeless procedures were excluded, as they were performed rarely by Group 2 and the data were insufficient for statistical comparison with Group 1. Demographic, clinical, operative and postoperative data were compared between the two groups.

Statistical analysis

Statistical analysis was performed using the SPSS version 29.0 software (IBM Corp, Armonk, NY, USA). Descriptive data were expressed in mean ± standard deviation (SD) or number and frequency. The normality of distribution of variables was checked using the Kolmogorov-Smirnov test. The independent samples t-test was used to compare normally distributed continuous variables between the two groups, while the Mann-Whitney U test was used to compare non-normally distributed variables. The Chi-square test was carried out to compare categorical variables. Logistic regression analysis was performed to identify the predictors of SFS among multiple variables. A p value of < 0.05 was considered statistically significant.

Results

A total of 324 patients were operated by Group 1 surgeons and 206 were operated by Group 2 surgeons. The American Society of Anesthesiologists (ASA) score was significantly higher in Group 1 (p = 0.020). Other demographic and stone characteristics were comparable between the groups (p > 0.05). The mean ACV was 73.56 ± 7.43 in Group 1 and 23.81 ± 9.09 in Group 2, indicating a statistically significantly higher rate in Group 1 (p < 0.001) (Table 1).

There was no statistically significant difference in the postoperative SFS rates between the groups (p = 0.064). In the perioperative period, the mean estimated blood loss (EBL) and nephrostomy dwell time (NDT) were significantly lower in Group 1 than Group 2 (p = 0.013 and p = 0.008, respectively) (Table 2).

A cut-off value of > 24 for ACV was found to be associated with the increased SFS rates and lower EBL, shorter length of stay (LOS) in the hospital and shorter NDT (p = 0.013, p = 0.020, p = 0.013, and p = 0.011, respectively (Table 3).

Duration of procedure, CROES, S.T.O.N.E. and Guy's scores, size of stone and BMI were found to be significant predictors of SFS (Table 4).

Table 1: Patients' demographics, stone characteristics and surgeon volumes

Variable	Total (n = 530)	Endourologist (n = 324)	Urologist (n = 206)	p-value
Age, mean ± SD	48.41 ± 13.00	47.82 ± 13.00	47.75 ± 13.20	0.180
BMI (kg/m^2), mean ± SD	28.23 ± 5.20	27.78 ± 4.80	28.39 ± 5.60	0.096
Sex, (n)				
Male	329	202	127	0.872
Female	201	122	79	
Stone side, (n)				
Right	257	154	103	0.611
Left	273	170	103	
ASA score (n)				
1	398	229	169	**0.020**
2	114	84	30	
3	16	10	6	
4	2	1	1	
Previous procedure, (n)				
ESWL	70	43	27	0.806
URS	48	31	17	
PCNL	100	57	43	
Stone density (HU), mean ± SD	977.00 ± 303.40	975.50 ± 303.00	979.30 ± 304.00	0.433
Stone size (mm^2), mean ± SD	547.80 ± 464.20	567.60 ± 501.00	516.70 ± 396.00	0.098
Skin-to-stone distance (mm), mean ± SD	88.80 ± 21.60	87.76 ± 20.30	90.50 ± 23.30	0.074
Stone burden (stone size x 0.785) (mm^2), mean ± SD	430.50 ± 364.80	446.30 ± 394.00	405.50 ± 311.00	0.093
Preoperative haemoglobin (mg/dL)	13.60 ± 1.20	13.50 ± 1.20	13.70 ± 1.20	0.063
Preoperative creatinine (mg/dL)	0.83 ± 0.25	0.84 ± 0.24	0.82 ± 0.27	0.298
Case volume per year[a]	54.23 ± 25.59	73.56 ± 7.43	23.81 ± 9.09	**< 0.001**
Guy's stone score (n)				
1	168	104	64	0.265
2	231	134	97	
3	90	55	35	
4	41	31	10	
CROES score (0-350), mean ± SD	227.09 ± 59.20	224.83 ± 59.41	230.63 ± 50.05	0.136
S.T.O.N.E. score (4-13), mean ± SD	7.36 ± 1.62	7.37 ± 1.67	7.33 ± 1.53	0.358

BMI, body mass index; ASA, American Society of Anesthesiologists; ESWL, extracorporeal shock wave lithotripsy; URS, ureterorenoscopy; PCNL, percutaneous nephrolithotomy; HU, Hounsfield unit; Bold, statistically significant; a Two endourologists of a total of six surgeons;

Table 2: Perioperative data in patients undergoing percutaneous nephrolithotomy

Variable	Endourologist (n = 324)	Urologist (n = 206)	p-value
ORT (min)	97.34 ± 32.21	93.95 ± 32.54	0.168
EBL (g/dL)	2.02 ± 1.19	2.26 ± 1.23	**0.013**
SCR	93.27 ± 19.11	91.50 ± 14.34	0.127
CSF (3rd postoperative month)	48.90 ± 126.00	59.12 ± 136.00	0.190
SFS			
Yes	225	127	0.064
No	99	79	
LOS	2.59 ± 1.98	2.73 ± 1.50	0.168
NDT	2.00 ± 2.31	2.46 ± 1.75	**< 0.008**

CSF, clinically significant fragment; EBL, estimated blood loss; LOS, length of stay; NDT, nephrostomy dwell time; ORT, operation room time; SCR, stone clearance rate; SFS, stone-free status; Bold, statistically significant;

Table 3: Comparison of postoperative outcomes according to cut-off value of annual case volume

Variable	Case volume per year < 24	Case volume per year ≥ 24	p-value
ORT (min)	95.83 ± 35.37	96.07 ± 31.61	0.596
EBL (g/dL)	2.38 ± 1.34	2.04 ± 1.17	**0.020**
SCR	90.39 ± 15.34	93.12 ± 17.87	**0.007**
CSF (3rd postoperative month)	61.89 ± 153.20	50.64 ±124.10	**0.022**
SFS			
Yes	59	293	**0.013**
No	46	132	
LOS	2.80 ± 1.63	2.60 ± 1.85	**0.013**
NDT	2.30 ± 1.51	2.15 ± 2.25	**0.011**

ORT, operation room time; EBL, estimated blood loss; SCR, stone clearance rate; CSF, clinically significant fragment; SFS, stone-free status; LOS, length of stay; NDT, nephrostomy dwell time; Bold, statistically significant;

Table 4: Predictors of stone-free status in patients undergoing percutaneous nephrolithotomy

Variable	Provided SFS	Non-provided SFS	p-value
Age	48.11 ± 12.97	48.99 ± 13.33	0.231
ORT (min)	90.80 ± 29.61	106.29 ± 35.01	**< 0.001**
Stone density	978 ± 308	975 ± 294	0.456
CROES score	247.63 ± 54.00	186.47 ± 46.81	**< 0.001**
S.T.O.N.E. score	6.97 ± 1.36	8.13 ± 1.82	**< 0.001**
GSS	1.77 ± 0.81	2.48 ± 0.86	**< 0.001**
Stone size	426.34 ± 324.00	787.93 ± 590.00	**< 0.001**
BMI	28.34 ± 5.33	27.39 ± 4.88	**0.024**

ORT, operation room time; CROES, Clinical Research Office of the Endourological Society; GSS, Guy's stone score; BMI, body mass index; Bold, statistically significant;

However, the binary logistic regression analysis revealed that only a cut-off value of > 24 for ACV and CROES were significant predictors of SFS (p = 0.004 and p < 0.001, respectively). Using a cut-off value of > 24 for ACV, the likelihood of SFS increased by 2.13 folds (Table 5).

Table 5: Binary logistic regression analysis for stone-free status in patients undergoing percutaneous nephrolithotomy

Variable	OR	95 % CI	p-value
Case volume per year ≥ 24	2.13	1.274-3.576	**0.004**
ORT (min)	0.99	0.988-1.002	0.139
CROES score	1.02	1.015-1.029	**< 0.001**
S.T.O.N.E. score	1.01	0.816-1.247	0.930
GSS	1.18	0.797-1.754	0.400
Stone size (mm^2)	1.00	0.999-1.001	0.550
BMI (kg/m^2)	1.01	0.968-1.059	0.597

ORT, operation room time; CROES, Clinical Research Office of the Endourological Society; GSS, Guy's stone score; BMI, body mass index; Bold, statistically significant; OR, odds ratio; CI, confidence interval;

The complication rates of surgeons with > 24 versus ≤ 24 ACV were compared according to the Clavien grading system (Table 6).

Table 6: Comparison of complications according to annual case volume in patients undergoing percutaneous nephrolithotomy

Clavien grading system	Case volume per year		Total
	< 24	≥ 24	
No complication	46	303	349
Grade 1	39	61	100
Grade 2	9	38	47
Grade 3a	10	14	24
Grade 3b-4b	1	9	10
Total	**105**	**425**	**530**

In the Chi-square analysis, the expected number of six cells was less than 5 and, therefore, Grade 3b and higher complications were combined and analysed. Accordingly, with a χ^2 = 41.616, there was a statistically significantly difference between the groups in terms of complications. With an ACV of > 24, both the overall and categorical complication rates were statistically significantly lower (without complication 71.3 % vs 43.8 %, p < 0.001).

Discussion

Currently, several technical variations and approaches have been attempted to improve the postoperative results of PNL. Despite all these efforts, there is no standardisation in the surgical technique and every endourologist continues to use his/her own technique.[15] The main reason for this approach may be the high individual experience of each urologist regarding the technique applied and the high success of surgery. Apart from the ACV of the hospital or clinic, the ACV of

an individual surgeon is the cornerstone of surgical experience.[16] In the present study, the SFS and complication rates after PNL performed by endourologists versus urologists in the Clinic was compared. Study results showed no significant difference in the SFS rates between the endourologists and urologists; however, the mean EBL and NDT were significantly lower in the procedures performed by endourologists. With an ACV of > 24, the SFS rates significantly increased and postoperative complication rates significantly decreased. Based on these findings, inclusion of the individual ACV of the surgeon as a parameter in the nomograms which can be used to predict the PNL outcomes may be useful in predicting the post-procedural results correctly.

In a multi-centre study investigating the effect of ACV of hospitals on PNL outcomes, higher ACV was associated with higher SFS rates and lower complication rates and shorter LOS.[13] However, in the aforementioned study, there was a high variability in age and comorbidities of the patients, stone complexity, procedural position and access site. In addition, there was no information about the number of surgeons in the centres and their surgical experience. In presented study, surgical experience of two endourologists and four general urologists was compared. It was found significantly lower EBL rates and shorter NDT in the patients operated by endourologists. Using a cut-off value of > 24 for ACV, higher SFS rates and lower complication rates were obtained.

In a nationwide study including inpatients, Kadlec et al[17] observed no significant relationship between the case volume and PNL outcomes; however, they reported shorter LOS in larger-volume centres. In this study, patient-reported statements in the registry at the time of hospital readmission were used and the demographic and stone characteristics of most patients were unknown. Also, there was no information regarding the surgeon volume and technical approaches used. In another nationwide study, the higher ACV of the surgeon was associated with lower medical expenditures and shorter LOS, although it did not significantly affect the complication rates.[14] Of note, no information regarding demographic and clinical characteristics of the patients was provided in this study. In addition, large and complex stones with higher medical expenditures and a high probability of requiring reintervention were not assesses separately. In presented study, the effect of ACV among endourologists and urologists on PNL outcomes was compared, as well as urologists with ACV below and above 24 in terms of PNL outcomes. The demographic and stone characteristics of the patients were similar between the groups in the current study, except for ASA scores. An ACV of > 24 increased the SFS rate by 2.13 with significantly lower complication rates, EBL and NDT in patients undergoing PNL.

Study limitations

To the best of authors' knowledge, this is the first study to compare the effect of ACV of endourologists and urologists on PNL outcomes in the literature. Nonetheless, there are some limitations to mention. In their review, de la Rosette et al[18] emphasised that at least 40 PNL procedures solo were required to reach a plateau in the learning curve. In this study, however, urologists were not divided into subgroups according to their PNL years and experience. Although the ACV of the urologists remains stable over the years, their surgical experience tends to increase. Therefore, the first and last years of performing PNL of each urologist may widely vary in terms of experience, which may mislead the surgical results. Furthermore, mini-PNL and tubeless procedures were excluded from this study due to the small sample size in Group 2 and only the effects of ACV on standard PNL outcomes were analysed. Finally, the single-centre, retrospective design of the study may have resulted in selection bias.

Conclusion

In conclusion, no significant difference in the SFS was observed between the endourologists and urologists after PNL procedure; however, the EBL rate was significantly lower and the NDT was significantly shorter in the operations performed by endourologists. In addition, the higher ACV was associated with the increased SFS rates after PNL and decreased complication rates. Further multi-centre, large-scale studies using different techniques are warranted to investigate the effect of surgical experience and ACV on postoperative outcomes and to predict PNL outcomes with high accuracy.

Acknowledgement

None.

Conflict of interest

None.

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