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Original Research / Özgün Araştırma

Effect of Renal Function Reserve on Results of Percutaneous Nephrolithotomy

Böbrek Fonksiyonunun Perkütan Nefrolitotomi'de Başarı ve Komplikasyonlar Üzerine Etkisi

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Özet

Amaç: Bu çalışmada böbrek taşları sebebiyle perkütannefrolitotomi (PNL) yapılan hastaların operasyon öncesi glomerüler filtrasyon hızlarına (GFR) göre PNL'nin başarı ve komplikasyon oranlarının karşılaştırılması amaçlanmıştır.

Gereç ve Yöntemler: Ocak 2012-Aralık 2016 tarihleri arasında böbrek taşı nedeniyle PNL yapılan 794 hasta geriye dönük olarak incelendi. Hastaların operasyon öncesi GFR değerleri Cockcroft–Gault formülüne göre hesaplandı. Operasyon öncesi GFR değerleri >90 ml/dk olanlar grup-1, 60-90 ml/dk arasında olanlar grup-2 ve 30-60 ml/dk olanlar grup-3 olarak tanımlandı. Gruplar arasında operasyon öncesi ve esnasındaki değerler,taşsızlık oranları ve komplikasyon oranları karşılaştırıldı. Operasyon sonrası <4 mm taş saptanması başarı olarak tanımlandı.

Bulgular: Grup-1 de 466, grup-2 de 259 ve grup-3 de 67 hasta mevcut idi. Hastaların ortalama operasyon öncesi GFR değerleri grup-1, grup-2 ve grup-3 de sırasıyla 118.53 ml/dk, 77.76 ml/dk ve 48.52 ml/dk idi (p<0.001). Hastaların ortalama yaşları grup-1, grup-2 ve grup-3 de sırasıyla 43.48±11.47,51.86±11.10 ve 60.31±12.7 idi (p<0.001). Hastaların ortalama taş yükleri grup-1, grup-2 ve grup-3 de sırasıyla 497.34±518.60 mm2, 517.6±493.8 mm2 ve 711.06±679.07 mm2 idi (p=0.013). İki yüz elli ml üzeri kanama gözlenen hasta sayısı grup-1, grup-2 ve grup-3 de sırasıyla

Abstract

Objective: In this study, we aimed to compare the success and complication rates of percutaneous nephrolithotomy (PCNL) according to preoperative glomerular filtration rates (GFR) of patients who underwent PCNLdue to kidney stones.

Material and Methods: Between January 2012 and December 2016, 794 patients who underwent PCNL due to kidney Stones were evaluated retrospectively. Preoperative GFR values of patients were calculated according to Cockcroft –Gault formula. The patients with preoperative GFR values>90 ml/min, 60-90 ml/min, 30-60 ml/min were respectively defined as group-1, group-2 and group-3. Preoperative and perioperative values, Stone free rates and complication rates were compared between the groups. Postoperatively , <4 mm residual stone was identified as success.

Results: There were 466 patients in Group-1, 259 in Group-2 and 67 patients in Group-3.

The mean preoperative GFR values of the patients were 118.53 ml/min, 77.76 ml/min and 48.52 ml/min, respectively in group-1, group-2 and group-3 (p <0.001).The mean age of the patients was 62.8±11.47, 51.86±11.10, and60.31±12.7, respectively, in group-1, group-2 and group-3 (p<0.001).The mean Stone burden of the patients were 497.34±518.60 mm2, 517.6±493.8 mm2and 711.06±679.07 mm2, respectively, in group-1, group-2 and group-3 (p=0.013). The number of

This study was conducted retrospectively. All research was performed in accordance with relevant guidelines/regulations, and informed consent was obtained from all participants.

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183 (%39.3), 92 (%35.5) ve 22 (%32.8) idi (p=0.348). Gruplar arasında operasyon sonrası başarı saptanan hasta sayısı grup-1, grup-2 ve grup-3 de sırasıyla 355 (%86.2),195 (%76.1) ve 50 (%74.6) idi (p=0.542). Komplikasyon gelişen hasta sayısı ise grup-1, grup-2 ve grup-3 de sırasıyla 114 (%24.65),57(%22)ve 11 (%16.4) idi (p=0.310).

Sonuç: Operasyon öncesi GFR değerleri PNL sonrası başarı ve komplikasyonları öngörmede tek başına yeterli bir faktör değildir.

Anahtar Kelimeler: Perkütan nefrolitotomi, böbrek fonksiyonu, böbrek taşı, glomerüler filtrasyon hızı

patients identified with success after surgery was 355 (86.2%), 195 (76.1%) and 50 (74.6%) in group-1, group-2 and group-3, respectively (p = 0.542). The number of patients who develop complications was 114 (%24.65), 57 (%22) and 11 (%16.4) in group-1, group-2 and group-3, respectively (p=0.310).

Conclusion: Preoperative GFR valuesare not lonely sufficient to predict success and complications after PCNL.

Keywords: Percutaneous nephrolithotomy, renal function, renal stone, glomerular filtration rates

INTRODUCTION

The incidence of adult kidney stones is increasing all over the world day by day. The prevalence of stone disease is between 2% and 20% in the world. Urinary stone disease causes varying degrees of damage to the kidney due to infection and obstruction. However, it is known that chronic diseases such as hypertension, diabetes and metabolic syndrome have effects on stone formation (1). Therefore, urinary system stone disease with renal failure is often encountered together today. The prevalence of chronic kidney failure with kidney stones is known as 17% (2).

Successful treatment of kidney stones with minimally invasive methods such as extracorporeal shock wave lithotripsy (SWL) and percutaneous nephrolithotomy (PCNL) has reduced the rates of open surgery by up to 3%.In the presence of stones larger than 2 cm thatcannot be treatedwith SWL treatment or are not suitable for this treatment, PCNL is recommended as the first-line treatment (3). The success rates of PCNL vary between 51% and 100% in various studies and complication rates were reported at rates ranging from 0% to 38% (4).

The prevalence of chronic kidney disease (CKD) in surgical patients is increasing in accordance with the aging of the population. Today, these patients can be referred to surgery due to the possibility of surgery with less invasive surgical techniques (5). Chronic kidney disease has been shown to be associated with cardiovascular mortality and morbidity in surgical patients and the normal population (6). In addition, CKD is a chronic disease that increases the risk of complications that may occur due to anesthesia as well as the risk of complications that may occur after surgery. Even small increases in serum creatinine levels after major surgical procedures have been strongly associated with cardiorespiratory, infectious and hemorrhagic complications. (7).

In this study, we aimed to evaluate how the pre-op GFR values affect the operation results of patients who undergo PCNL surgery.

MATERIAL AND METHODS

Study Design

Between January 2012 and November 2016, 794 patients who underwent PCNL due to kidney stonesin a single center were retrospectively analyzed. The data were driven from the electronic medical records of the patients. Patients with bleeding diathesis, patients who were Gfr < 30 and operation data were not available as they were excluded from the study. Preoperative creatinine clearance of all patients was calculated according to Cockcroft–Gault formula (8). Patients were defined as group-1 with preoperative GFR values> 90 ml/min, group-2 with 60-90 ml/min, and as group-3 with 30-60 ml/min.

Operation Technique

After general anesthesia, a 5 or 6 F ureteral catheter was inserted and fixed to a Foley catheter. PCNL was performed in prone position. Access was obtained under fluoroscopy using an 18-gauge needle, and tract was dilated with Amplatz dilatators to 30 F caliber. Stone fragmentation was accomplished using a pneumatic lithotripter (Vibrolith; Elmed, Ankara, Turkey). At the end of the procedure, 14 F nephrostomy tube was inserted, and antegrade pyelography was performed.

Postoperative Follow-up

Demographic information (age, gender, body mass index (BMI)) and perioperative data of the patients were recorded after surgery. Perioperative data were the operation side such as stone burden, number of access, duration of the operation, the length of hospital stay and amount of blood loss. In addition, complications were classified according to the Clavien scoring system. Postoperative pain was controlled with narcotic analgesics and nephrotoxic drugs which were not given to patients in the perioperative period. Ceftriaxone treatment was given to patients as prophylaxis. Ceftriaxone treatment was discontinued when postoperative nephrostomy tube was taken.

Perioperative values stone-free rates and complication rates were compared between the groups. In the case of stone-free and ≤4 mm stone remaining, the operation was described as successful.Also, postoperative complications were noted according to the Clavien scoring system (9).

Statistical Analysis

Data were analyzed using the Statistical Package for Social Sciences, version 20.0 (SPSS, Chicago, Ill) software program. The Kruskal-Wallis test and Pearson Chi-square test analyses were used to compare the groups. Data are given as mean ± SD. However, results of analysis are given as median data. Statistical significance was defined as $p<0.05$.

RESULTS

A total of 792 patients who underwent PCNL due to kidney stones were included in the study. Of these patients, 466 were in group-1, 259 were in group-2 and 67 were in group-3. The mean preoperative GFR values of the patients were 118.537 ml/min, 77.76 ml/min and 48.52 ml/min in Group-1, group-2 and group-3 respectively ($p<0.001$).The mean ages of the patients were 43.48±11.47, 51.86±11.10 and 60.31±12.7 in group-1, group-2 and group-3 respectively ($p<0.001$). The mean body mass indices of the patients were 27.35±4.54, 25.35±4.26 and 25.39±4.29 kg/m2 in Group-1, Group-2 and Group-3, respectively ($p<0.001$)(Table 1). The number of patients with bleeding over 250 ml was 183 (39.3%), 92 (35.5%) and 22 (32.8%) in group-1, group-3, respectively. There were no statistically sig-

Table 1. Demographic Data of Patients

	Group-1 (n:466)	Group-2 (n:259)	Group-3 (n:67)	P
Age (years) (m±sd)	43.48±11.47	51.86±11.10	60.31±12.7	<0.001
Gender (male/female)(n/n)	319/147	169/90	37/30	0.092
BMI (kg/m^2) (m±sd)	27.35±4.54	25.35±4.26	25.39±4.29	<0.001
No. Metabolic Syndrome (n/%)	40 (%8,58)	21 (%7,8)	4 (%5,97)	0.797
Side (left/right) (n/n)	251/215	122/137	32/35	0.420
Solitary Kidney (n/%)	6 (%1.28)	10 (3.71)	6 (%8.9)	0.001
No. Stone Localization (n/%)				
Single	192 (%41.2)	96 (%37.0)	17 (%25.4)	
Partial Staghorn	60 (%12.9)	41 (%15.8)	17 (%25.4)	0.408
Staghorn	58 (%12.4)	40 (%15.4)	13 (%19.4)	
Multiple	156 (%33.4)	82 (%31.7)	30 (%44.7)	
Stone burden (mm^2) (m±sd)	497.34±518.60	517.6±493.8	711.06±679.07	0.013
Stone density (HU) (m±sd)	1031.5±315.2	1047.4±323.5	993.67±446.6	0.518
Previous ipsilateral surgery (n/%)	128 (%27.5)	79 (%30.5)	23 (%34.3)	0.420
Previous ipsilateral ESWL (n/%)	82 (17.59%)	46 (17.76%)	12 (17.91%)	0.997
Mean Preoperative GFR (mL/min)	118.537	77.76	48.52	<0.001

m: *mean,* ***sd:*** *standard deviation*

BMI: *body mass index,* ***HU:*** *Hounsfield unit,* ***SWL:*** *extracorporeal shock waves,* ***GFR:*** *Glomerular filtration rate*

nificiant differences. The number of patients with residual stones was 111 (23.8%), 62 (23.9%) and 17 (25.4%) in group-1, group-2 and group-3, respectively (Table 2). There were no statistically significiant differences. The number of patients without complications was 352 (75.6%), 202 (78%) and 56 (83.6%) in group-1, group-2 and group-3, respectively (Table 3). There were no statistically significant differences between the groups in terms of complication development. The developing complications are shown in Table 3 in detail.

Table 2. Perioperative Data of Patients

	Group-1 (n:466)	Group-2 (n:259)	Group-3 (n:67)	P
No. Number of Accesses (n/%)				
One	420 (%90.1)	251 (%93.3)	61 (%91.0)	0.110
Two	45 (%9.6)	17 (%6.3)	6 (%8.9)	
Three	1 (%0.2)	1 (%0.39)	0 (%0.0)	
Operative time (min) (m±sd)	100.64±38.8	103.4±40.74	109.40±45.9	0.214
Fluoroscopy time (sec) (m±sd)	85.56±65.5	76.46±56.2	84.6±70.2	0.171
Length of hospital stay (d) (m±sd)	3.76±2.77	3.9±2.08	4.36±3.13	0.134
Estimated blood loss (>250 cc) (n/%)	183 (39.3%)	92 (35.5%)	22 (32.8%)	0.348
Residual stone (n/%)	111 (23.8%)	62 (23.9%)	17 (25.4%)	0.542

m: *mean,* ***sd:*** *standard deviation,* ***min:*** *minute,* ***sec:*** *second,* ***d:*** *day*

Table 3. Classification of Complications According to Clavien Score System

Grade	Complications	Group-1 (n)(%)	Group-2 (n)(%)	Group-3 (n)(%)	P
0	Total: 610	352(%75.6)	202 (%78)	56(%83.6)	0.310
1	• Postoperative pain managed by opioid	28	14	5	0.299
	• Deranged renal function that requires IV fluid management only	5	2	1	
	• Bleeding that can be controlled by clamping nephrostomy	4	1	-	
	• Bleeding not requiring blood transfusion	20	5	1	
	Total: 86	57(%12,2)	22 (%8,5)	7(%10,4)	
2	• Bleeding requiring blood transfusion	35	17	7	0.473
	• Postoperative fever (>38^{0}C) managed with antibiotics in the ward	63	29	7	
	Total: 43	24(%5.2)	17(%6.6)	2(%3)	
3A	• Febrile UTI or suspected sepsis without organ failure requiring supportive therapy and enhanced monitoring	11	6	1	0.361
	• Hydrothorax managed by intercostal draining under local anesthesia	2	2	-	
	• Renal pelvic perforation managed by prolonged nephrostomy tube or postoperative placement of nephrostomy	5	1	-	
	• Urine leakage managed by ureteric stenting without general anesthesia	8	4	-	
	Total: 40	26(%5.6)	13(%5)	1(%1.5)	
3B	• Bleeding managed by angioembolization	1	1	1	0.906
	• Colon perforation managed by colostomy	1	-	-	
	• Ureteric stricture managed by balloon dilation	4	3	-	
	• Perirenal abscess managed by open drainage	1	1	-	
	• Total: 13	7(%1.5)	5(%1.9)	1(%1.5)	

UTI: *Urinary tract infection*

DISCUSSION

Renal function decreases with aging and is also closely related to chronic diseases that lead to poor perioperative outcomes, such as diabetes mellitus, dyslipidemia and hypertension. Chronic kidney disease (CKD) is defined as the estimated GFR<60cc /min/1.73m2 and has been associated with an increase in all-cause deaths and especially cardiovascular deaths (10). Chronic kidney disease (CKD) significantly increases the risk of death, cardiovascular disease and hospitalization of adult patients (11).In our study, no deaths were reported.Duration of hospital stay was higher in group-3 compared to other groups but there was no statistical difference between the groups. We attribute the longer hospital stay in this group-3 to our desire to follow up more stringent GFR.

Various serious complications may occur in patients with impaired renal function, such as disruption of drug metabolism and excretion, edema in tissues as a result of impaired water-electrolyte balance, delay in wound healing and difficulties in infection control (12,13). It has also been reported that immune deficiency is common in patients with CKD (14).In our study, the number of patients who developed postoperative infection was similar between the groups. Antibiotic therapy was sufficient to control the infection in these patients.

Sairam et al. (15) found that there was a significant difference between the total complication rates in their articles comparing patients with CKD 0-2 and 4-5. (18.5% vs. 33.8%) p<0.001.In the article by Kilinc et al. (16) comparing the diagnostic RIRS (Retrograde intrarenal surgery) results of patients with chronic hemodialysis patients and normal kidney function; while there was no statistically significant difference between the overall complication rates (10.5% vs. 4.8%; p=0.16). In our study, complications were classified according to the Clavien-Dindo classification system. We found no statistical significiant difference between the complication rates of both total and subgroups.

Seitz et al. (17) reported there were 7% blood transfusion requirement in patients with normal kidney function during PCNL operation. In a review, Jones et al. (18) investigated the efficacy and safety of PCNL in CKD patients, the need for transfusion was 20%. This rate increase was associated with high preoperative anemia prevalence and presence of platelet dysfunction in CKD patients.In the CROES study, when they compared the transfusion requirement ratio in patients with Level 4/5 to those with Level 3 CKD, they found 18.4% and 6.1%, respectively. They also found statistically significant difference among these ratios (p<0.001) (19). In our study, we evaluated the mean amount of bleeding, not the transfusion rate, because the preoperative hemogram values of all patients were not at the same rate. We found no statistical significiant difference between the groups when the amounts of bleeding were compared.

In the CROES study, the stone-free rates were 71.2% in patients with stage 4-5 CKD and 76.9% in patients with stage 0-2 CKD (15). Yuruk et al. (20) compared the patients with CKD stage 4-5 and patients with normal kidney function with RIRS due to kidney stones. The third month stone-free rates were 87.1% and 86.2%, respectively (p=0.75).Srivastava et al. (221) investigated SWL results in patients with GFR <30 ml / min and reported that retreatment requirement was 84.4% and stone-free rates were 34.4%. In our study, stone-free rates were similar among the groups (p=0.542).Stone-free rates in our study were also similar to other studies (74.6-76.2%), and there was no statistically significant difference between the groups.

The main limitations of the current study are its retrospective design which could possibly cause some bias, and using serum creatinin evalueto calculate GFR may not be the best method. TheCockcroft–Gault formula is a widely used and shows GFR changes with appropriate error.However, the aim of our study was not to define the most accurate GFR measurement. We use GFR only for preoperative classification. So, we think that the Cockcroft–Gaultformula will not cause significant errors in terms of the results. Our study has some potential advantages. Firstly, the same surgeons performed PCNL in our clinic with the same protocol so there was no surgery-effect bias.

CONCLUSION

The success and complication rates of the operation depend on multiple variables. GFR is only one of these multiple variables which does not lonely affect success and complications in PCNL operation.

Conflict of Interest

All authors declared that there is no conflict of interest.

Financial Disclosure

None.

Ethical Approval

This study was conducted retrospectively. The study protocol conformed to the ethical guidelines of the Helsinki Declaration.

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