ARAŞTIRMA MAKALESİ / *RESEARCH ARTICLE*

The Role of Parenchymal Thickness in Predicting the Amount of Bleeding During Percutaneous Nephrolithotomy

Parankim Kalınlığın Perkütan Nefrolitotomi Esnasındaki Kanama Miktarını Predikte Etmekteki Yeri

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ABSTRACT

Aim: *Percutaneous nephrolithotomy (PCNL) is the approved first-line treatment for complicated kidney stones larger than 2 cm. One of the most prevalent problems during PCNL is bleeding. The majority of bleeding is managed with conservative methods. This study aims to investigate the potential effect of parencyhmal thickness on the likelihood of bleeding during PCNL surgery.*

Material and Method: *The results of patients who underwent PCNL to treat kidney stones in our clinic between May 2016 and May 2022 were subjected to a retrospective data analysis. Demographic data of patients, characteristics of stones, operation time, access technique, pre-and postoperative hemogram values, transfusion, and renal parenchyma thickness were recorded.*

Results: *Of the 181 patients included in the study, 127 were male, 54 were female, and the mean age was 45.22 (±14). The mean Charlson Comorbidity Index of the patients was found to be 0.93 (0–5). Right PCNL was performed in 75 patients, and left PCNL in 106 patients. The mean stone size was 26.16 mm (±9.9), stone surface area was 343.14 mm² (±81 - 1507), and the stone density was 1115.52 HU (±390.52). 27.1% of the stones were non-opaque. The average parenchymal thickness was measured at 18.82 mm (±4.68). Patients who received blood transfusion were excluded from the study. While all bleedings were managed conservatively, embolization and nephrectomy were not required. The mean decrease in hemoglobin was 2.02 g/dl (0–4.4). Four patients exhibited a postoperative fever. When Spearman's correlation test was performed between the groups, a moderate correlation was observed between parenchymal thickness and hemoglobin decrease (p<0.01), and a weak correlation between stone surface area and hemoglobin decrease (p<0.05).*

Conclusion: *As a result, the parenchymal thickness can guide surgeons in estimating bleeding and planning blood requirements before surgery.*

Key words: *percutaneous nephrolithotomy; bleeding; parenchymal thickness*

ÖZET

Amaç: *İki santimetre ve üzerindeki ve kompleks böbrek taşlarının tedavisinde perkütan nefrolitotomi (PNL) ilk sırada önerilen tedavi seçeneğidir. Perkütan nefrolitotomi sırasında en sık karşılaşılan komplikasyonlardan biri de kanamadır. Kanamaların çoğu konservatif yaklaşımlarla kontrol altına alınmaktadır. Çalışmamızın amacı PNL ameliyatına bağlı kanama olasılığını tahmin etmek, parankim kalınlığının kanamaya olası etkisini saptamaktır.*

Materyal ve Metot: *Kliniğimizde Mayıs 2016 – Mayıs 2022 tarihleri arasında böbrek taşı tedavisi için PNL yapılan hastaların sonuçları retrospektif bir veri analizine tabi tutuldu. Hastaların demografik verileri, taşların özellikleri, ameliyat süresi, akses tekniği, preoperatif ve postoperatif hemogram değerleri, transfüzyon yapılıp yapılmadığı, böbrek parankim kalınlıkları kayıt altına alındı.*

Bulgular: *Çalışmaya dâhil edilen 181 hastanın 127'ü erkek, 54'i kadın ve yaş ortalaması 45,22 (±14) olarak tespit edildi. Hastaların Charlson Comorbidity Index ortalaması 0,93(±0–5) bulundu. Yetmiş beş hastaya sağ, 106 hastaya sol PNL ameliyatı yapıldı. Ortalama taş boyutu 26,16 mm (±9,9), taş yüzey alanı 343,14 mm² (±81–1507), taş dansitesi 1115,52 HU (±390,52) olarak ölçüldü. Taşların %27,1'si non-opaktı. Parankim kalınlıkları ortalaması 18,82 mm (±4,68) ölçüldü. Kan transfüzyonu yapılan hastalar çalışma dışında bırakıldı. Tüm kanamalar konservatif olarak kontrol altına alınırken, embolizasyon ve nefrektomiye gerek duyulmadı. Hemoglobin düşüşü ortalama 2,02 g/dl (0–4,4)'di. Dört hastada ise postoperatif ateş gözlendi. Gruplar arasında Spearman's korelasyon testi yapıldığında parankim kalınlığı ile hemoglobin düşüşü arasında orta düzeyde (p<0,01), taş yüzey alanıyla hemoglobin düşüşü arasında zayıf düzeyde (p<0,05) korelasyon gözlenmiştir.*

Sonuç: *Sonuç olarak parankim kalınlığı cerrahlara ameliyat öncesinde kanamayı tahmin etme ve kan gereksinimini planlamada rehberlik edebilir.*

Anahtar kelimeler: *perkütan nefrolitotomi; kanama; parankim kalınlığı*

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Introduction

The percutaneous nephrolithotomy (PCNL) method is accepted as the first choice in the surgical treatment of kidney stones larger than 2 cm according to stone guidelines[1]. Although advances in laser technology and flexible ureteroscopes continue rapidly, PCNL remains the gold standard in treating large stones. As an invasive method, bleeding is a frequent complication during PCNL surgery[2]. In PCNL, the caliceal papilla is desired for successful access and the infundibulum of the calyceal system is avoided to minimize bleeding. However percutaneous access is a controlled grade 4 trauma for the kidney and management of the bleeding is essential for PCNL[3]. Although a conservative approach is sufficient in most of the bleeding after PCNL, some patients (0.5–2.4%) may have severe bleeding requiring surgical intervention[4,5]. Our study aims to predict the probability of bleeding during and after PCNL surgery, determine risk factors, and reveal the relationship between parenchymal thickness and bleeding.

Materials and Methods

The whole methodology of the study complies with the Declaration of Helsinki. Our study was approved by the ethics committee of our institute (Ethics committee decision number: 80576354-050-99/166). Patients who underwent PCNL to treat kidney stones in our clinic between May 2016 and May 2022 were included in our study. Surgical procedures were performed by endourologists who are experienced in PCNL.

The study did not include patients with multiple calyx access, receiving blood transfusions, using anticoagulants or antiaggregants, and patients with anatomical variations such as horseshoe kidney, ptotic kidney, or malrotated kidney.

Non-contrast computed tomography and plain radiography were used for preoperative radiological evaluation in all patients. Renal parenchyma thickness measurements were taken from the thickest point of the axial section. The use of general anesthesia was standard practice in all procedures. All patients were positioned prone after placing the ureteral catheter on the side of the stone in the lithotomy position. The anatomy of the calyceal system was seen by introducing a contrast agent into the renal collecting system via the ureteral catheter. Then, access was obtained from the posterior calyx using an 18-gauge needle under C-arm fluoroscopy. Amplatz dilators up to 30 Fr were used to dilate the tract. After placing the Amplatz sheath, a 26 Fr nephroscope was inserted into the collecting system (Storz Medical AG, Kreuzlingen, Switzerland). Renal stones were disintegrated using pneumatics (Vibrolith®, ELMED). The stone fragments were extracted using forceps. In all patients, a 16 Fr nephrostomy was inserted in the renal pelvis after the procedure. When there were no complications, the nephrostomy was taken out on the third day. Plain radiographs of the kidney, ureter, and bladder were taken on the first postoperative day. The nephrostomy tube was clamped on the 3rd postoperative day. Nephrostomy catheters were removed in patients without pain. Antegrade nephroureterography was performed in patients with pain, and the nephrostomy catheter was removed after the insertion of a double-J catheter in patients with ureteral obstruction. Patients were checked out with non-contrast computed tomography in the third month after surgery. Remaining fragments ≤4 mm in diameter that did not cause occlusion, pain, or infection were considered clinically insignificant. Preoperative hemograms were obtained from the patients, and hemogram follow-up was performed during and after the operation. The difference between preoperative and postoperative (1st and 24th hour) hemograms was calculated and compared with parenchymal thickness, stone surface area, operation time, and residual stone size. The preoperative Charlson Comorbidity Index score of the patients was calculated.

Statistical Analysis

Statistical Package for Social Sciences (SPSS) program version 22.0 was used for the statistical analysis (SPSS Inc., Chicago, IL, USA). Factors affecting the decrease in hemogram were investigated using Spearman/Pearson correlation. In addition, mean and frequency information of other information was obtained.

Results

When our results were evaluated, the following data were reached:

The study comprised 181 patients, 127 of whom were male and 54 of whom were female, with a mean age of 45.22 (14) years. The mean Charlson Comorbidity Index of the patients was found to be 0.93(0–5). In 75 patients, right PCNL was performed, and in 106 patients, left PCNL was conducted. The mean stone size

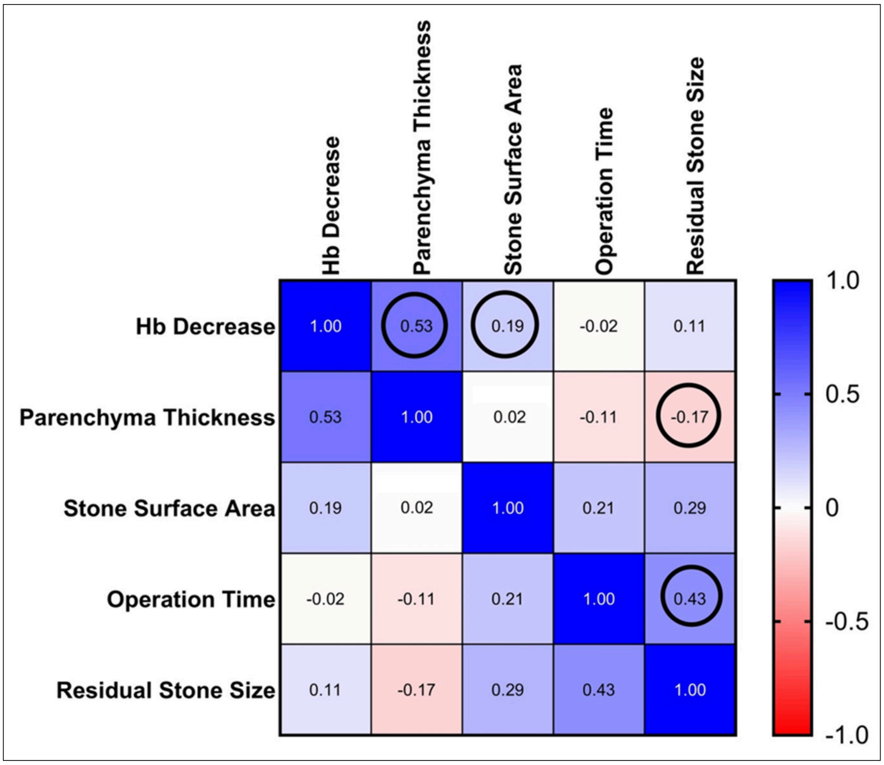

Figure 1. *Comparison of parenchyma thickness with hemoglobin decrease, stone surface area, operation time and residual stone size.*

was 26.16 mm (±9.9), the stone surface area was 343.14 mm^2 (±81–1507), and the stone density was 1115.52 HU (±390.52). 27.1% of the stones were non-opaque. Access was made using the bull's eye method in 53% and the triangulation method in 47%. The average operative time was 173.71 min (±46.2) was detected. In their 3-month CT follow-up, 48.6% of the patients had a residual greater than 4 mm. The average parenchymal thickness was measured as 18.82 mm (±4.68). While all bleedings were managed conservatively, embolization and nephrectomy were not required. Hemoglobin decreased by an average of 2.02 g/dl (0–4,4). Post-op fever was observed in 4 patients (Table 1).

When Spearman's correlation test was performed between the groups, a moderate correlation was observed between parenchymal thickness and hemoglobin decrease ($p<0.01$), and a weak correlation between stone surface area and hemoglobin decrease ($p<0.05$). In addition, a weak inverse association between parenchymal thickness and residual size was detected ($p<0.05$). As the operation time increased, the residual stone size increased significantly ($p<0.01$). Also, a moderate positive correlation was observed between the stone surface area and the residual stone size ($p<0.01$). No correlation was found between the duration of the operation and the decrease in hemoglobin (Fig. 1).

Table 1. *Patient demographics and pre- and post-operative parameters*

		Count	% or ± SD
Gender	Male	127	70.2%
	Female	54	29.8%
Age		45.22	±14
Charlson comorbidity index (min-max)		0.93	0–5
Lateralization	Right	75	41.4%
	Left	106	58.6%
Size (mm)		26.16	9.9
Hydronephrosis		143	79%
Access technique	Bull's eye	96	53%
	Triangulation	85	47%
Stone surface area (mm^2) (min-max)		343.14	81–1507
Localization	Single calyx or pelvis	143	79%
	Multicalyxel	38	21%
Hounsfield unit		1115.52	±390.52
Parenchyma thickness (mm)		18.82	±4.68
Opacity	Opaque	132	72.9%
	Non-opaque	49	27.1%
Operation time (min)		173.71	±46.20
Hb decrease (g/dL)(min-max)		2.02	(0–4.4)
Length of stay in hospital (day)		4.34	(2–28)
Postoperative fever		4	2.2%
Residual stone		88	48.6 %

Discussion

Until 30 years ago, open surgery was the standard treatment for urinary tract stones. Advances in ESWL, ureterorenoscopy and PCNL have enabled these methods to replace open surgery to treat stones. In treating large, multiple, and staghorn kidney stones, PCNL is recommended as the first choice instead of open surgery. Percutaneous nephrolithotomy is a safe and reliable method for treating kidney stones[1,6–10].

However, according to the results of different studies, a wide range of complication rates have been reported between 20.5% and 83%[2,6,11,12]. This shows that although PCNL is an endourological procedure, it is an invasive method with high complication rates. One of the most severe complications is bleeding. As long as bleeding can be controlled in PNL stages (renal puncture, tract dilatation, use of rigid nephroscopy, stone fragmentation), bleeding is a natural consequence According to studies, blood transfusion rates range from 1% to 34%.[4,6,13–15]. Fortunately, bleeding is controlled chiefly with conservative methods in most cases. Renal embolization and nephrectomy rates are as low as 0.5–2.4%[4,5]. In our study, no patient underwent nephrectomy or embolization due to bleeding.

In the literature, many factors that cause bleeding in PNL surgery have been investigated. These are stone size, type, stone surface area, hydronephrosis degree, number and technique of access, operation time, presence of diabetes mellitus in the patient, and BMI[14,16–21].

One of the criteria whose relationship with bleeding has been investigated is the parenchymal thickness[14,16,17]. Congenital and subsequent causes influence the parenchyma thickness of the kidney. The most common cause affecting renal parenchyma thickness is urinary tract obstruction. Urinary tract stones are the most typical cause of urinary tract obstruction. In wholly or partially obstructed systems, the thickness of the parenchyma becomes thinner. Concurrent infection of the blocked system causes a decrease in kidney functions and renal parenchyma thickness[22,23].

Rifaioglu et al. found that parenchyma thickness did not affect bleeding[18]. However, there was a positive correlation between parenchymal thickness and bleeding during PCNL in other studies[14,16,17]. In our study, in parallel with other studies, a moderate positive correlation was observed between parenchymal thickness and decrease in hemoglobin ($p<0.01$). Another factor affecting the decrease in hemoglobin in our study was the stone surface area. A weak correlation was observed between the stone surface area and the decrease in hemoglobin ($p<0.05$). This is because as the stone surface area increases, the bleeding may have increased due to repetitive manipulations for stone removal. In addition, our study determined that the duration of the operation and the presence of residual stones did not affect the amount of bleeding.

Limitations

One limitation of this study was that it was a retrospective single-institution study.

The findings may also have been influenced by the fact that many surgeons with varying degrees of experience performed the surgeries.

Despite all these negativities, it will contribute to the literature predicting intraoperative and postoperative bleeding before surgery.

Conclusion

As a result of our study, it was seen that the thickness of the parenchyma affects the bleeding. Parenchymal thickness can guide surgeons in estimating bleeding and planning blood requirements before surgery.

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