Received: 18 Sep 2024 | **Accepted:** 14 Nov 2024 **Genel Tıp Derg. Volume** 35/**Issue** 2 (April), 226-231
DOI: 10.54005/geneltip.1552117

ORIGINAL ARTICLE

Evaluation of The Need for Angioembolization After Percutaneous Nephrolithotomy in Children and Adults

Çocuklarda ve Erişkinlerde Perkütan Nefrolitotomi Sonrası Anjiyoembolizasyon İhtiyacının Değerlendirilmesi

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How to cite ?

Sarikaya M, Kandemir E. Evaluation of The Need for Angioembolization After Percutaneous Nephrolithotomy in Children and Adults. Genel Tıp Derg. 2025;35 (2): 226-231

ABSTRACT

Aims: The present study aimed to evaluate the severe and resistant bleeding that may develop after percutaneous nephrolithotomy (PNL) operation and the need for transcatheter angioembolization (TAE) that may be required accordingly.
Methods: PNL operations performed in two clinics in the last eight years were evaluated retrospectively. Patients with persistent and severe bleeding and a need for TAE were assessed in terms of preoperative, perioperative, and postoperative findings.
Results: The number of patients who underwent TAE was 14. The mean age was 40.9 years. The mean duration of operation was 80.1 minutes. The duration of fluoroscopy was 7.7 minutes (2.2-16 min). The mean hematocrit decrease of the patients was 11.8% (4.4-22.1%). The mean time from surgery to embolization was 5.6 days (1-11 days). The mean nephrostomy time was 3.8 days (1-7), and the mean hospital stay was 4.9 days (2-10). 12 Fr access sheath was used in one patient, 20 Fr access sheath in one patient, 26 Fr access sheath in one patient, and 30 Fr access sheath in 11 patients.
Conclusions: Bleeding requiring intervention after PNL is a condition that should be managed and treated well. The patient's characteristics, PNL technique, and per-operative findings cannot predict this condition. Larger scale prospective randomized studies are needed for definitive results.

Keywords: Fluoroscopy, nephrolithiasis, percutaneous nephrolithotomy, transcatheter angioembolization,

ÖZ

Amaç: Perkütan nefrolitotomi (PNL) operasyonu sonrası gelişebilen şiddetli ve dirençli kanamalar ve buna bağlı gerekebilen transkatater anjiyoembolizasyon (TAE) ihtiyacının değerlendirilmesi amaçlandı.
Gereç ve Yöntem: Son sekiz yılda iki klinikte gerçekleştirilen PNL operasyonları retrospektif olarak değerlendirildi. İnatçı ve şiddetli kanaması olan ve TAE ihtiyacı olan hastalar ameliyat öncesi, ameliyat sırası ve ameliyat sonrası bulgular açısından değerlendirildi.
Bulgular: TAE uygulanan hasta sayısı 14, ortalama yaş 40.9, ortalama ameliyat süresi 80.1 dakika, floroskopi süresi 7.7 dakika (2.2-16 dakika) izlendi. Hastaların ortalama hematokrit düşüşü %11,8 (%4,4-22,1), ameliyattan embolizasyona kadar geçen süre ortalama 5,6 gün (1-11 gün), ortalama nefrostomi süresi 3,8 gün (1-7) ve ortalama hastanede kalış süresi 4,9 gün (2-10) olarak bulundu. 1 hastada 12 Fr erişim kılıfı, 1 hastada 20 Fr erişim kılıfı, 1 hastada 26 Fr erişim kılıfı ve 11 hastada 30 Fr erişim kılıfı kullanıldı.
Sonuç: PNL sonrası müdahale gerektiren kanama iyi yönetilmesi ve tedavi edilmesi gereken bir durumdur. Hastanın özellikleri, PNL tekniği ve per-operatif bulgular bu durumu öngöremez. Kesin sonuçlar için daha büyük ölçekli prospektif randomize çalışmalara ihtiyaç vardır.

Anahtar kelimeler: Floroskopi, nefrolitiazis, perkutan nefrolitotomi, transkateter anjioembolizasyon

Introduction

Urinary system stone disease, whose first records are as old as human history, is seen as endemic in a population including our country. In studies conducted in our country, the prevalence of stone was 11.1% (1). Treatment-related complications that occur in parallel with the frequency of the disease necessitate renewal and progress in the treatment options of the disease.

The first steps of kidney stone treatment were taken with nephrostomy in 1941 (2). Standard percutaneous nephrolithotomy (PNL) was defined by Fernastrom and Johansson in 1976 (3). In the approximately 40-year period that has passed until today, new alternatives in treatment have emerged, and new treatment modalities such as shock wave lithotripsy (SWL) and flexible ureterorenoscopy (F-URS) have come to the fore. In addition, PNL treatment has also been renewed, and the mini-PNL technique has been developed using smaller-diameter instruments (4). Despite other treatment modalities, PNL is currently considered the

Peer-Review: Double anonymized - Two External
Plagiarism Checks: Yes - intihal.net
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Selcuk University Press
Genel Tıp Dergisi | e-ISSN: 2602-3741
https://dergipark.org.tr/tr/pub/geneltip
https://yayinevi.selcuk.edu.tr/

gold standard treatment in selected cases of kidney stones larger than two cm (5).

Percutaneous access to the kidney to reach the collecting system also carries some risks. The current series reports 20.5% overall complication rates and 1%-55% transfusion rates due to bleeding (6-11). Although most of these bleedings regress with conservative treatment, 0.8% of resistant bleedings require additional intervention (12). The surgeon's ability to predict these types of bleeding can be essential in preventing and treating bleeding. The type of operation, duration, size, localization of the stone, access site, number, and many other parameters may be related to resistant bleeding.

Bleeding in the kidneys due to the operation can threaten vital functions due to the hypervascular structure of the kidneys. This situation can occur as a pseudoaneurysm affecting the arterial system, arteriovenous fistula, or bleeding into the collecting system and perirenal area, depending on the damage to the renal parenchyma. Rapid and effective lesion treatment is essential in resistant bleeding that can threaten hemodynamics and vital functions.

Transcatheter arterial embolization (TAE) or classical surgical methods are preferred during treatment. In TAE treatment, the renal artery is reached with the help of catheterization from the femoral artery. The renal arterial system is visualized with contrast material, and vascular pathology is detected. The lesion is visualized with the help of microcatheters, and occlusion is provided with embolizing agents (peripheral coil, glue-liquid embolizing agent Liquid Band MEDLOGIC, PVA) (13). Although parenchymal loss secondary to ischemia is observed in this treatment; this loss is equal to TAE in alternative surgical treatments, and more parenchymal loss or direct renal loss can often be observed (14). The cost of surgery and the risk of general anesthesia are also added to this picture. All these reasons make TAE treatment a priority today (15).

This study examined PNL operations performed by the same surgeons in different clinics in the last eight years, and cases requiring intervention after resistant hematuria were evaluated. Factors related to bleeding and the applied treatment methods were examined.

Material and Methods

Approval for the study was obtained from the local ethics committee (Etic number: 04-2021/17). Seven hundred eighty-one conventional and mini percutaneous nephrolithotomy operations performed by different surgeons in two State Hospitals were evaluated retrospectively between August 2016 and April 2024. Data from patients whose hematuria or hemorrhage continued in the postoperative period and who underwent additional treatment interventions to control bleeding were recorded. Preoperative demographic data preoperative and postoperative results of patients who required open surgery or TAE in the postoperative period were attempted to be examined. Patients who were referred for postoperative embolization but were reported as usual after embolization and patients whose necessary data could not be fully accessed were excluded from the study. Patients who underwent TAE represent a tiny portion of patients in the postoperative period. Therefore, the aim was to examine the general characteristics of patients who underwent TAE rather than compare these patients with the group that did not require TAE. Values were expressed as a number, mean, percentage, and standard deviation.

Results

Of the 781 patients who underwent PNL, 53 (6.7%) were children under the age of 18 years. The mean age of pediatric patients was 15.4±3.1 years (11-18). The mean age of adult patients was 41.2±8.3 years. When the patients who underwent PNL were analyzed, complete data on the TAE procedure performed in 14 patients were obtained and evaluated. It was remarkable that 13 (92.9%) of these patients were male. Only one patient was in the pediatric age group (15 years). The mean age was 40.9 years, while the patients' mean body mass index (BMI) was 26.9 kg/m2. The mean preoperative hematocrit values were calculated as 41.2, while the mean creatinine values indicating the preoperative renal reserves of the patients were seen as 1.02 mg/dl (range 0.78-2.0). The mean preoperative stone areas of the patients were seen as 8.6±6.4 cm2 (range 1.2-24 cm2 and median 8.35 cm2). Stone localization was noted as multiple calyceal localization in 78.6% of the patients, while only 14.3% had isolated lower calyceal localization, and 7.1% had isolated upper calyceal localization. In one of the stones located in the lower calyx, the stone area was 1.2 cm2, and in the other, 4 cm2.

The procedure was performed on the right kidney in 8 patients and on the left in 6 patients. When evaluated in terms of hydronephrosis, it was seen that 92.9% of the patients had mild (Grades 1 and 2) hydronephrosis.

Regarding stone opacity, it was seen that the stone was opaque in 92.9% of the patients. It was noticed that four (28.6%) patients had undergone a PNL operation before. It was noted that one of the patients with a history of PNL had bilateral kidney stones. PNL was performed from the other side three months ago, and the patient required PTE in the previous PNL. It was seen that another patient who underwent a PNL operation had previously undergone PNL from the other side; one patient had PNL from the same side three times before, and a resting stone remained, and the PNL operation performed on the same side of one patient was unsuccessful. The operation was terminated without being entered into the system or the stone removed. Of the patients with a history of open surgery, one had previously undergone open ureterolithotomy, one had previously undergone open nephrolithotomy, and one had previously undergone pyeloplasty. The preoperative demographic data of the patients are summarized in Table 1.

Table 1. Demographic data of the patients

		% or Range
Number of units	14	
Gender		
Male	13	92.9
Female	1	7.1
Age (mean - years)	40.9±12.2	15-61
Body mass index (mean-kg/m^2)	26.9±6.1	19.8-37.1
Preoperative hematocrit (mean-%)	41.2±4.7	32.2-49
Preoperative creatinine level (mean-mg/dL)	1.02±0.32	0.78-2.0
Stone size (mean-cm^2)	8.6±6.4	1.2-24
Stone localization		
Upper±Middle	1	7.1
Upper ±Lower	1	7.1
Middle±Lower	1	7.1
Lower	2	14.3
Upper	1	7.1
Complete coralliform	2	14.3
Pelvis±lower calyx	3	21.4
Pelvis±multiple calyx	3	21.4
Side		
Left	6	57.1
Right	8	42.9
Hydronephrosis (grade)		
1	8	41.2
2	5	35.7
3	1	7.1
Stone opacity		
Non-opaque	1	7.1
Opaque	13	92.9
Previous PNL surgery	4	28.6
Previous open surgery	3	21.4

PNL: Percutaneous nephrolithotomy

When the perioperative data of the patients who developed persistent hemorrhage were examined, it was seen that the mean duration of operation was 80.1 minutes (range 40-180 minutes, median 78.5 minutes), and the mean duration of fluoroscopy was 7.7 minutes (range 2.2-16 minutes, median 5.7 minutes). It was observed that only 3 of the patients (21.4%) had a hemorrhagic operation in the operation note. It was observed that a single percutaneous entry was made in 13 operations (92.9%), and two entries were made in one patient. It was observed that lower calyceal entry was made in 11 operations (78.6%), multiple (lower calyceal and middle calyceal entries) in one operation, isolated upper calyceal entry in one operation, and isolated middle calyceal entry in one operation. It was noted that the bleeding occurred from the middle calyceal entry during embolization in the patient who underwent multiple calyceal entries. In other words, two of the operations were seen to be hemorrhagic after the middle calyx, 11 after the lower calyx entry, and one after the upper calyx entry. 12 Fr access sheath was used in 1 patient, 20 Fr access sheath in one patient, 26 Fr access sheath in one patient, and 30 Fr access sheath in 11 patients. The perioperative data of the patients were summarized in Table 2.

Table 2. Perioperative data of the patients

		% or Range
Duration of operation (min)	80.1±35.0	40-180
Duration of fluoroscopy (min)	7.7±5.0	2.2-16
Severe bleeding during surgery	3	21.4
Number of access		
1	13	92.9
2	1	7.1
Access localization		
Multiple	1	7.1
Lower	11	78.6
Middle	1	7.1

Upper	1	7.1
Intercostal	2	14.3
Size of amplatz sheat		
12	1	7.1
20	1	7.1
26	1	7.1
30	11	78.6

When the information obtained from the patient's postoperative follow-ups was examined, it was seen that the mean nephrostomy time was 3.8 days (range 1-7 days, median four days) and the mean hospital stay was 4.9 days (range 2-10 days, median five days). In the postoperative blood values, it was seen that the mean hematocrit decrease of the patients was 11.8% (range 4.4-22.1%), and all of these patients were transfused at least one unit of erythrocyte suspension (ES). The mean transfusion amount was 2.57 units, and it was seen that the patient with the most transfusions was five units of ES. It was seen that two patients underwent open exploration for the treatment of bleeding and hemodynamic disorders that developed in the postoperative period, three patients underwent nephrectomy, and nine patients underwent PTE. It was seen that 3 of the patients who underwent open surgery had a history of previous open surgery. The mean time from surgery to the onset of symptoms related to bleeding was 3.1 days (0-11 days). The mean time from surgery to embolization was 5.6 days (1-11 days). When evaluated regarding postoperative stone-free status, it was noted that the operation resulted in residual stones in 50% of the patients. In addition to bleeding, chest tube placement due to pulmonary effusion or hemothorax was observed in the patient who underwent only upper calyceal access and intercostal access as additional complications. Information on the results of the operation is summarized in Table 3.

Table 3. Postoperative results

		% or Range
Duration of nephrostomy (days)	3.8±1.9	1-7
Duration of hospitalization (days)	4.9±2.2	2-10
Hemoglobin drop (mg/dL)	3.1±2.2	0.4-6.7
Hematocrit drop (%)	11.8±5.4	4.4-22.1
Number of patients transfused	14	100
Transfusion units (mean)	2.57±1.4	1-5
Intervention		
Exploration or nephrectomy	5	35.7
Transcatheter arterial embolization	9	64.3
Duration from surgery to the onset of severe Hematuria (days)	3.1±4.7	0-11
Additional postoperative complications		
Pulmonary effusion and chest tube insertion	1	7.1
Duration from surgery to intervention (days)	5.6±3.9	1-11
Success		
Residual stone	7	50
Stone-free or CIRF	7	50

CIRF: Clinically insignificant residual fragment

Discussion

PNL is widely used today as a minimally invasive method in treating kidney stones. Its effectiveness in treatment stands out with features such as less postoperative pain, smaller incisions, shorter hospital stays, and faster return to daily life compared to open surgery (16). Despite all these advantages, it should be remembered that PNL surgery has serious complications that may require additional intervention.

PNL complications include extravasation (7.2%), bleeding requiring blood transfusion (11.2-17.5%), fever (21-32.1%), septicemia (0.3-4.7%), colon injury (0.2-4.8%) and pleural injury (0-3.1%) (17). To standardize all these complications, complications were classified according to the Clavien grading system in the study conducted by Tefekli et al (18).

Resistant bleeding seen after PNL is one of the most important conditions to manage and treat correctly. Procedures such as calyceal puncture, dilatation, lithotripsy, and manipulation with a nephroscope, which are among the steps of the operation, can lead to bleeding from renal parenchymal sources. In studies, transfusion rates can reach up to 23% (7-10,12,19-23).

In bleeding requiring transfusion, additional intervention is required in resistant patients who do not respond to conservative treatment. Since it is an infrequent complication in the literature (0.3% - 1.4%) (7-10,12,19-23). A limited number of patient groups will inevitably be obtained in our study. Instead of comparing patients with the group without bleeding, it seems more appropriate to examine their current characteristics.

An essential point for the operation is determining the patient's current stone burden. In cases where there is an increased stone burden in the patients,

the operation time is extended, or a second access is needed since it is aimed at achieving complete success. This situation may create an additional bleeding risk. Erbin et al. In a study conducted by Ateş et al. with 2300 patients, the average stone size was 7.5±4.1 cm2 (24). In another study conducted by Ateş et al., when the data of 194 patients who underwent PNL were evaluated, it was seen that the average stone size was 3.87-4.75 cm2 in different groups (25). In our study, the average stone size was 8.6±6.4 cm2. Although the average stone burden in our patients who required additional intervention after resistant bleeding was seen to be larger than in the general patient group, the increased stone burden may increase the risk of bleeding.

Another essential condition for the operation is the localization of the stones. In parallel with the increased stone burden, the presence of stones in more than one localization instead of isolated calyces affects the operation time and necessitates manipulation in the calyceal system. In our study, stones were seen in more than one calyces in 11 patients (78.5%). It is thought that this situation may be related to increased bleeding risk.

In studies examining the effect of obesity on PNL success and complications, it is seen that PNL does not lead to an increase in complications in obese patients (26). When the demographic data of the patients were evaluated in our study, the average BMI was found to be 26.9 kg/m2, and obesity and resistant bleeding could not be associated.

When the hemoglobin and creatinine values of the patients were examined, almost all of them were seen to be within the standard value range. (Table 1) When the gender distribution is examined, it is seen that M/F is 13/1. There may be an increased risk for bleeding in male patients, but larger-scale prospective studies are needed.

The number, location, and diameter of the accesses applied during the operation are becoming increasingly important today. Our study observed that single access was used in 13 patients (92%), and lower calyceal access was applied in 11 patients (78.5%). It was thought that this situation could not be attributed as a risk since standard operations are usually performed with the lower calyceal-single access technique. Studies have shown that bleeding and morbidity decrease with the decrease in percutaneous tract width (27,28). In parallel, the effectiveness and reliability of mini PNL performed using a smaller diameter Amplatz sheath in adult patients has been demonstrated (29). In our study, it was observed that 26Fr and 30Fr Amplatz sheaths were used in 12 patients (85.7%), 12Fr in one patient, and 20Fr in one patient. Although the number of operations performed using 12Fr and 20Fr Amplatz sheaths is low, it has been noted that this type of complication can be seen even in operations performed with small-diameter access sheaths. Another issue that the surgeon will pay attention to during the operation is per-operative bleeding. This situation often causes the operation to be terminated early and may affect the success. In our study, per-operative bleeding was reported in three patients (21%). This situation suggests that not all bleeding resistant to conservative treatment can be predicted with per-operative findings. The mean hemoglobin decrease of the patients was 3.1±2.2%, and the mean hematocrit decrease was 11.8±5.4 g/dl. In a study by Çalışkan et al., the hemoglobin cut-off value was reported as 10 mg/dl, and angiographic control and treatment were recommended for bleeding below this value (13). The time until severe hematuria after the operation was found to be 3.1±4.7 days, and all patients received transfusion. Caution should be exercised, especially in hematuria, which requires transfusion at a late stage.

Among the treatment options, TKE stands out. Diagnosing the lesion causing bleeding and its rapid and effective treatment are possible in this way. In addition, the morbidity and general anesthesia risks added by surgical treatment are also prevented. It should be considered that the parenchymal losses observed after TKE occlusion are equal to or less than those observed with surgical treatment (14,15). In our study, TAE treatment was applied to 9 patients (64%), and open surgery was preferred in 5 patients (36%) due to deterioration in hemodynamics. It is thought that TAE treatment should be applied as a priority in hemorrhages where hemodynamics are stable.

Among the limitations of our study is that it is retrospective. In addition, since hemorrhages requiring intervention are rare in PNL, the comparison could not be made with the group without complications.

In conclusion, bleeding requiring intervention after PNL is a condition that should be managed and treated well. The patient's characteristics, PNL technique, and per-operative findings cannot predict this condition. However, caution should be exercised in patients with complex stones. Larger scale prospective randomized

studies are needed for definitive results.

Author Contributions

MS conceived the study, and all authors participated in the study design. EK collected and analyzed the data. EK and MS drafted the manuscript. All authors commented on the earlier versions of the manuscript. All authors edited the manuscript and approved the final version.

Conflict of Interest

The authors declare no conflict of interest.

References

1.Muslumanoglu AY, Binbay M, Yuruk E, Akman T, Tepeler A, Esen T, et al. Updated epidemiologic study of urolithiasis in Turkey. I: Changing characteristics of urolithiasis. Urol Res. 2011 Aug;39(4):309-14

2.Rupel E, Brown R. Nephroscopy with removal of stone following nephrostomy for obstructive calculous anuria. J Urol 1941;46: 177-82

3.Fernstrom I, Johansson B. Percutaneous pyelolithotomy: a new extraction technique. Scand J Urol Nephrol 1976;10:257-9

4.Helal M, Black T, Lockhart J, Figueroa TE. The Hickman peel-away sheath: an alternative for pediatric percutaneous nephrolithotomy. J Endourol. 1997; 11(3):171-2

5.Guidelines on Urolithiasis, European Urology Association, 2013, pp 1-100

6.Labate G, Modi P, Timoney A, Cormio L, Zhang X, Louie M, et al. The percutaneous nephrolithotomy global study: classification of complications. J Endourol 2011;25:1275-80

7.Lee WJ, Smith AD, Cubelli V, Badlani GH, Lewin B, Vernace F, et al. Complications of percutaneous nephrolithotomy. AJR Am J Roentgenol 1987;148:177-80

8.Stoller ML, Wolf JS Jr, St Lezin MA. Estimated blood loss and transfusion rates associated with percutaneous nephrolithotomy. J Urol 1994;152(6 Pt 1):1977-81

9.Turna B, Nazli O, Demiryoguran S, Mammadov R, Cal C. Percutaneous nephrolithotomy: variables that influence hemorrhage. Urology 2007;69:603-7

10.Segura JW, Patterson DE, LeRoy AJ, Williams HJ Jr, Barrett DM, Benson RC Jr, et al. Percutaneous removal of kidney stones: review of 1,000 cases. J Urol 1985;134:1077-81

11.Liatsikos EN, Kallidonis P, Stolzenburg JU, Ost M, Keeley F, Traxer O, et al. Percutaneous management of staghorn calculi in horseshoe kidneys: a multi-institutional experience. J Endourol 2010;24:531-6

12.Kessaris DN, Bellman GC, Pardalidis NP, Smith AG. Management of hemorrhage after percutaneous renal surgery. J Urol 1995;153(3 Pt 1):604-8

13.Çalışkan KC, Ulusay SM, Tanrıverdi O, Çakmakçı E, Sönmez NC, Arısan S. Iyatrojenik Renal Hemorajilerde Transkateter Embolizasyon Ne Zaman ve Nasıl Yapılmalı? Yeni Bir Algoritim. Okmeydanı Tıp Dergisi 28(2):84-93, 2012

14.Clark RA, Gallant TE, Alexander ES. Angiographic management of traumatic arteriovenous fistulas: clinical results. Radiology 1983;147:9-13

15.Heyns CF, van Vollenhoven P. Increasing role of angiography and segmental artery embolization in the management of renal stab wounds. J Urol 1992;147:1231-1234

16.White EC, Smith AD. Percutaneous stone extraction from 200 patients. J Urol 1984;132:437-8

17.Michel MS, Trojan L, Rassweiler JJ. Complications in percutaneous nephrolithotomy. Eur Urol 2007;51:899-906

18.Tefekli A, Ali Karadag M, Tepeler K, et al. Classification of percutaneous nephrolithotomy complications using the modified Clavien grading system: looking for a standard. Eur Urol 2008;53:184-90

19.el-Kenawy MR, el-Kappany HA, el-Diasty TA, Ghoneim MA. Percutaneous nephrolithotripsy for renal stones in over 1000 patients. Br J Urol 1992;69:470-5

20.Sacha K, Szewczyk W, Bar K. Massive hemorrhage presenting as a complication after percutaneous nephrolithotomy (PCNL). Int Urol Nephrol 1996;28:315-8

21.Patterson DE, Segura JW, LeRoy AJ, Benson RC Jr, May G. The etiology and treatment of delayed bleeding following percutaneous lithotripsy. J Urol 1985;133:447-51

22.Martin X, Murat FJ, Feitosa LC, Rouviere O, Lyonnet D, Gelet A, et al. Severe bleeding after nephrolithotomy: results of hyperselective embolization. Eur Urol 2000;37:136-9

23.Srivastava A, Singh KJ, Suri A, Dubey D, Kumar A, Kapoor R, et al. Vascular complications after percutaneous nephrolithotomy: are there any predictive factors? Urology 2005;66:38-40

24.Erbin A, Berberoğlu Y, Sarılar Ö, Akbulut MF, Özgör F, Sönmezay E, et al. Percutaneous Nephrolithotomy: Our Results of a Single-Centre Analysis in 2300 Cases. Haseki Tıp Bülteni 2014; 52: 19-24

25.Ateş M, Karalar M, Tüzel E, Pektaş F, Yıldırım B. Safety and efficacy of percutaneous nephrolithotomy in obese patients. Üroloji Dergisi 2011;37(2):105-111

26.Carson CC, Danneberger JE, Weinerth JL. Percutaneous lithotripsy in morbid obesity. J Urol 1988;139:243-247

27.Bader MJ, Gratzke C, Seitz M, Sharma R, Stief CG and Desai M: The "all-seeing needle": initial results of an optical puncture system confirming access in percutaneous nephrolithotomy. Eur Urol 2011; 59: 1054-9

28.Desai MR, Sharma R, Mishra S, Sabnis RB, Stief C and Bader M: Single-step percutaneous nephrolithotomy (micro-perc): the initial clinical report. J Urol 2011; 186: 140-5

29.Akbulut MF, Küçüktopçu O, Kandemir E, Sonmezay E, Şimşek A, Gürbüz ZG. Experiences of mini percutaneous nephrolithotomy in adult patients: Results of the pilot study. New J Urol 2015; 10 (1): 29-33