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Özgün araştırma / Original research

Büyük Koraliform Böbrek Taşlarının Tedavisinde Multitrakt Perkütan Nefrolitotripsi ve Sandviç Tedavi Yöntemlerinin Başarı ve Komplikasyon Oranları Açısından Karşılaştırılması

Multitrakt Percutaneous Nephrolithotripsy Versus Sandwich Therapy for Coralliform Kidney Stones

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Özet

Amaç: Perkütan nefrolitotripsi (PNL) ve ekstrakorporeal şok dalga litotripsisi (SWL), diğer yöntemler ile beraber uzun yıllardır üriner sistem taş hastalığının tedavisinde kullanılmaktadır. PNL operasyonları kliniğimizde 1987 yılından beri her çeşit ve boyuttaki böbrek taşlarına başarı ile uygulanmaktadır. Biz de bu çalışmada 4 yıllık süre içerisinde büyük koraliform taşları olan hastalara uyguladığımız PNL operasyonlarından tek seansta yapılan multitrakt uygulamaları ve SWL ile kombine ettiğimiz iki seanslı PNL operasyonlarını (sandviç tedavi uygulamaları) başarı ve görülebilen komplikasyon oranları açısından karşılaştırmayı amaçladık.

Gereç ve Yöntemler: 4 yıllık dönem içinde kliniğimizde böbrek taşı nedeniyle başvuran 462 hastaya PNL uygulandı. Bunların 126' sında koraliform taş mevcut idi. Bu 126 hasta içinden multitrakt PNL uygulanan 23 (16E/7K) hasta ile sandviç tedavi uygulanan 16 (12E/4K) hasta değerlendirildi. Bu hastalar; operasyon sonrası erken dönem ve 6. aydaki başarı oranları, görülen majör (kanama, komşu organ yaralanması vb.) ve minör (ateş, idrar yolu enfeksiyonu vb.) komplikasyonlar, hospitalizasyon süreleri, ek tadavi ihtiyaçları ve operasyon süreleri açısından karşılaştırıldı.

Bulgular: İki grup arasında hospitalizasyon süreleri (multitrakt PNL uygulanan grupta 9,74±3,19 gün, sandviç tedavi uygulanan grupta 22,12±10,19 gün), operasyon

Abstract

Objective: Percutaneous nephrolithotomy (PNL) and extracorporeal shock wave lithotripsy (SWL) are performed in treatment of kidney stone disease for a long period beside the other treatment methods. Since 1987 PNL procedure has been used successfully and safely in our clinic for treatment of kidney stones. We aimed to compare the success rates of multitract access and sandwich therapies (PNL+SWL+PNL) in staghorn kidney stones performed in four years period.

Material and Methods: During last four years 462 patients underwent PNL procedures in our clinic. 126 of the patients had staghorn kidney stones 23 of the patients (16male/7female) had multitract PNL while 16 (12male/4female) underwent sandwich therapy. We compare these two groups for postopertive early period and in 6th month success, major (bleeding and adjecent organ injury etc.) and minor (fever, urinary tract infections) complications, total hospitalization period, additional treatment requirements and total operation duration.

Results: Statistically significant differences were appearent between two groups while total hospitalization period (9,74±3,19 days in multitract PNL group and 22,12±10,19 days in sandwich therapy group), total operation duration (110,78±35,57 minutes in multitract PNL group and 176,87±31,51 minutes in sandwich therapy group)(p<0,001) and blood

süreleri (multitrakt PNL uygulanan grupta ortalama 110,78±35,57 dk, sandviç tedavisi uygulanan grupta 176,87±31,51 dk) (p<0,001) ve yapılan kan replasmanı (multitrakt PNL uygulanan grupta ortalama 1,86±1,63Ü, sandviç tedavisi uygulanan grupta 3,37±1,89Ü) (p<0,05) arasında anlamlı fark bulunurken postoperatif erken dönemdeki (multitrakt PNL uygulanan grupta %69,5 hastada tamamen taşsızlık, %17,4 klinik önemsiz rezidü fragman (KÖRF) ve %13,04 hastada rezidü taş kaldığı, sandviç tedavisi uygulanan grupta ise %62,5 tamamen taşsızlık sağlanırken %18,75 KÖRF saptandı ve %18,75 oranında rezidü taş kaldığı gözlendi.) ve 6. ay başarı oranları da birbirine yakın olarak saptandı (p>0,05). Ayrıca ek tedavi ihtiyaçları, komplikasyon (majör ve minör) oranları, taş analizleri konularında da karşılaştırmalar yapıldı ve iki grup arasında anlamlı bir fark olmadığı görüldü (p>0,05).

Sonuç: Her cins ve boyuttaki taşların tedavisinde başarı ile uygulanan PNL, koraliform taşların tedavisinde de etkili ve güvenli bir yöntemdir. Bu yöntem şartlara bağlı olarak tek seansta multitrakt giriş şeklinde uygulanabileceği gibi, SWL ile kombine edilerek sandviç tedavisi şeklinde de uygulanabilir. Biz de kliniğimizde yaptığımız çalışmada iki tedavi yöntemini karşılaştırdık, yapılan replasman miktarları, hospitalizasyon ve operasyon süreleri dışında, başarı sonuçları ve komplikasyonlar açısından iki yöntem arasında anlamlı bir fark olmadığı sonucuna vardık ve sonuçlarımızın da literatür ile uyumlu olduğunu gördük.

Anahtar Kelimeler: Böbrek taşı, Perkütan nefrolitotripsi, PNL, sandviç tedavi, ESWL

replacement volumes (1,86±1,63 IU in multitract PNL group and 3,37±1,89 IU in sandwich therapy group) (p<0,05).

The early postoperative period results (69,5% stone free rates, 17,4% 'clinically insignificant residual fragments' (CIRF) rates and 13,04% residual stone rates in in multitract PNL group and 62,5% stone free rates, 17,4% CIRF rates and 13,04% residual stone rates in days in sandwich therapy group) and in 6th month success findings were similar between two groups (p>0,05). Also additional treatment requirements, complication (major and minor) rates, stone analysis are compared and we did not find statistically significant differences between two groups (p>0,05).

Conclusion: PNL is successfull and safe treatment method of staghorn stones. It can be performed with multitract technique in one session or with sandwich therapy technique which can be combined with SWL due to conditions. Besides the blood replacement volumes, hospitalization period and the ooperation, the comparison of these treatment modalities did not exhibit any significant differences for success and complication rates. Our outcomes are compatible with the literature.

Keywords: Kidney stone, Percutaneous nefrolitotomy, PNL, sandwich therapy, SWL

INTRODUCTION

Urinary system stone disease is one of the ancient entities. It is the third most common urinary system pathology following urinary tract infections and prostate pathologies {Smith, 1989 #826}[1, 2]. It has a great influence on social life and public health since the ancient times. This is the reason why the research about the causes and treatment of urinary stones are important and ongoing [3].

Prevalence of urolithiasis shows differentiation at the different regions of the world. It is affected by the climate and environmental conditions. In our country, this rate is about %15 [4]. Beside dietary treatments, the treatment alternatives for urinary stones are medical therapy, extracorporeal shock wave lithotripsy (SWL), retrograde intrarenal surgery (RIRS), ureterorenoscopy (URS), percutaneous nephrolithotomy (PNL) and open surgery [5]. Technologic progress came along with improved and better endoscopic devices. It made the treatment of most of the urinary stones possible solely with endoscopic interventions.

Percutaneous nephrolithotomy is a technique which was invented in 1976 and has been performed in almost every urology clinic ever since with a success rate over 95% [6]. It is mostly used for the treatment of renal calculi. The renal pelvis is reached with a needle under fluoroscopy. After reaching the pelvis, the tract is carefully dilated until it is wide enough for the nephroscope. Finally, the calculi are fragmented and extracted [6]. Since the introduction of the procedure, countless improvements have been made and different plans have been successfully suggested.

The method is sandwich therapy (PNL-SWL-PNL), which is first reported at 1992 [7] . The method is described as SWL session(s) between PNL sessions. After lowering total stone burden with the first session PNL followed by SWL to rest stones. Then fragments are cleared with a second PNL session.

In this paper we aim to compare two different treatment modalities; multitract PNL and sandwich therapy for larger coralliform kidney stones that were applied in the operations performed at four years period in our clinic. Stone free and complication rates have been compared.

MATERIAL AND METHODS

We scanned 462 (305males/157females) PNL operations retrospectively which were performed in our clinic for four years period. 126 (83 males/43 females) of these had coralliform stones. Multitract PNL has been performed on 23 of 126 patients (16 males/7 females). 16 patients (12 males/4 females) were treated with sandwich therapy (SWL session(s) in between two separated PNL surgeries) because of the high stone burden and the rest stones they had.

Due to the ongoing procedures of our center, which is highly experienced in stone surgery, it was decided at during and after the surgery which treatment method to be applied to which patient .

All PNL operations were performed with standard 28 Fr nephroscope and according to this all access sheets were appropriated to 28 Fr nephroscope also in multitract PNL operations.

Twentythree renal units treated with multitract PNL and 16 renal units treated with sandwich therapy throughout four years were analyzed in this paper. Then they were compared regarding their early postoperative stone-free rates, 6th month stone-free rates, intraoperative and postoperative complications, blood transfusions, total operation times and extra treatment needs.

All patients have been administered through general and systemic disease examination. Then blood testing and imaging have been performed. Stones filling renal pelvis and all calices are evaluated as coralliform stones.

We assumed under 4 mm stones as clinically insignificant residual fragments (CIRF) as stated in guidelines [8, 9].

Statistical analysis were performed with SPSS 16 (SPSS Inc, Chicago, IL). Data were presented as mean± SD or median. Parameters were compared using the Chi-square and Fisher exact tests for success and complication rates, the t-test for independent variables. Statistical significance was set as $p<0.05$.

RESULTS

One hundred and twenty six (83males/43females) of 462 patients had coralliform stones. 23 patients of these 126 have been performed multitract PNL (16males/7females). Sixteen patients have been performed sandwich therapy (12 males/4 females) because of their high stone burden, rest stones after first session or complications.

In multitract PNL group; ages were between 26-66 years, median age was 51 years, the mean±SD age was 47,77±12,70 years. In sandwich therapy group; ages were between 27-70 years, median age was 54 years, the mean±SD age was 51,87±13,44 years.

Initial serum creatinine level of the multitract group was between 0,5mg/dl and 2,2mg/dl, the median was 1mg/dl and the mean±SD was 1,02±0,33 mg/dl. In sandwich therapy group it was between 0,6 mg/dl and 1.7mg/dl, the median was 1,05mg/dl and the mean±SD was 1,08±0,33mg/dl. The number of patients who had serum creatinine above 1,5mg/dl was two patients (9%) in the multitract group, and two (12,5%) patients in the other group.

In the multitract group, 19 patients have been performed with two tracts, two patients with three tracts, and one patient with four tracts. In sandwich therapy group every patient has been treated with mean 2,62±1,14 sessions of SWL (1-5 sessions) after the first surgery. After SWL second PNL has been performed.

The demographics of patients are shown in table 1.

During multitract PNL operations mean 1,08±1,04 units (0-4IU) of blood transfusion has been done, the mean value was 0,82±1,07 units (0-4IU) transfusion has been done after first surgery. In sandwich therapy group transfusion amounts during the first operation and postoperatively was mean 1,25±1IU and 0,75±0,85IU respectively. Transfusion amounts for the second surgery were 1±0,73IU and 0,5±0,5IU respectively. Comparing two groups in regard to their transfusion amounts with T-test, the difference has been found significant (P<0,05).

Operation durations

Duration of preoperative preparations (ureteral catheterization in lithotomy position, urethral catheterization, changing to prone position) and operation times are evaluated separately. Preoperative preparation time was mean 23±4,88 minutes in the multitract PNL group, and 52,62±9,66 minutes in the sandwich therapy group (two sessions of PNL). The difference was statistically significant (p<0,001). Operation durations were mean 110,78±35,57 minutes and 176,87±31,51 minutes respectively and found to be significant (p<0,001).

Complications

considering major complications in both groups, in multitract group two patients (8,7%) had hemorrhage, one patient (4,35%) had hydropneumothorax and one patient (4,35%) had cerebrovascular accident in 2nd day after surgery. In sandwich therapy group one patient (6,25%) had hemorrhage, one patient (6,25%) had nephrocutaneous fistula and one patient (6,25%) had acidosis. These results are found insignificant using Chi-square test (p>0,05). Considering minor complications, three patients from both groups had fever (multitract 13,04%, sandwich 18,75%). It was statistically insignificant (p>0,05).

Hospitalization Durations

In multitract group mean hospital stay was 9,74±3,19 (5-17) days while in the other group it was 22,12±10,19 (14-46) days. When compared using T-test, the difference has been found statistically significant (p<0,001). Twelve patients in the sandwich therapy group have been operated twice and got SWL treatment in single hospitalization. This data is greatly influenced by their long stay in our clinic.

Additional Treatment Needs

Six patients from the multitract group and five patients from sandwich group needed additional treatments in total. When compared, the difference was insignificant (p>0,05). Nevertheless, additional treatments in the multitract group have been found less invasive.

Success Rates

In early postoperative period 16 patients (69,5%) were completely stone free, four patients (17,4%) had clinical insignificant residual fragments (CIRF) and three patients (13,04%) had residual fragments. In the other group, 10 patients (62,5%) were stone free, three patients (18,75%) had CIRF and three patients (18,75%) had residual fragments. None significant difference has been determined when this data is compared using Pearson Chi-Square test (p>0,05).

At 6th month postoperatively, stone free patient count increased to 19 (82,6%) in the multitract group and it increased to 12 (75%) in the sandwich therapy group. The number of patients who had CIRF was two (8,7%) in the first group and it stayed the same (18,75%) in the second group. Two patients (8,7%) from the multitract group and one patient (6,25%) from the sandwich group had residual stones. There was no statistically significant difference when comparing success rates (p>0,05).

The comparison of these two methods are shown in table 2.

DISCUSSION

In the treatment of kidney stone disease beside the other treatment methods, PNL, which was first described 40 years ago, is being used ever since as a revolutionary method with its big advantages like high success rate, safety, short hospitalization need, fast recovery, a small incision and almost no scar formation [6].

In the treatment algorithm of kidney stone disease, although SWL is one of the treatment option with RIRS in the treatment of kidney stones bigger than 2 cm but the PNL is the first option for theese kind of stones, especially refractory to SWL because of their localization or hardness. For coralliform stones, guidelines suggest a similar approach as it does for the stones bigger than 2cm [10].

In past some physicians believed that the best way of treating coralliform stones was to leave them untreated [11]. In 1977 Blandy and Singh compared 60 untreated patients with 125 patients who had been treated for their coralliform stones. They determined a mortality rate of 28% in untreated group to 7,2% in the treated group [12].

Table 1: Demographic data of patients.

	multitract PNL	**sandwich therapy**
n (m/f)	23 (16/7)	16 (12/4)
age (years) mean±SD/ range	47,77±12,70 26-66	51,87±13,44 27-70
serum creatinine level (mg/dl) mean±SD /range	1,02±0,33/ 05-2.2	1,08±0,33/ 0.6-1.7
Operation method	one session PNL	PNL+SWL+PNL
two tracts	19	0
three tracts	2	0
four tracts	1	0
SWL sessions mean±SD range	0	2,62±1,14 (1-5)

Table 2: Comparison of multitract PNL and sandwich therapy

	Multitract PNL	**Sandwich Therapy**	**p value**
Operation durations			**<0,001***
• Preoperative preparation time (min)	23±4,88	52,62±9,66	
• Operation duration (min)	110,78±35,57	176,87±31,51	
Blood transfusion requirement (IU)			**<0,05***
mean±SD range			
• in first operation	1,08±1,04 (0-4)	1,25±1 (0-4)	
• after first operation	0,82±1,07 (0-4)	0,75±0,85 (0-3)	
• in second operation	-	1±0,73 (0-3)	
• after second operation	-	0,5±0,5 (0-2)	
Complications (total)	4 (17.4%)	3 (18.75%)	>0,05
major	2(8,7%)	1(6,25%)	
• hemorrhage	1(4,35%)	-	
• hydropneumothorax	1(4,35%)	-	
• cerebrovascular accident	-	1(6,25%)	
• nephrocutaneous fistula	-	1(6,25%)	
• acidosis			
minor	3(13,04%)	3(18,75%)	
• fever			
Hospitalization durations (days)	9,74±3,19 (5-17)	22,12±10,19 (14-46)	**<0,001***
Additional treatment requirement	6 (26.1%)	5 (31.25%)	>0,05
Success Rates			
Early	16(69,5%)	10(62,5%)	>0,05
• completely stone free	4(17,4%)	3(18,75%)	
• CIRF	3(13,04%)	3(18,75%)	
• residual fragments			
Postoperative 6th month	19(82,6%)	12 (75%)	>0,05
• stone free rate	2(8,7%)	3(18,75%)	
• CIRF	2(8,7%)	1(6,25%)	
• residual fragments			

CIRF: Clinical insignificant residual fragments, ***:** Significant p value

In the results of our study, 26% of the patients in multitract group and 25% from the sandwich group had infection stones. Even if the numbers are different than expected we determined higher infection stone ratios from coralliform stones compared to smaller ones.

Even if the consensus about management of coralliform stones is to treat them in the presence of acute symptoms, this is still controversial up to this day [13].

During 20 years of follow-up of patients with untreated coralliform stones, the mortality rate was 28%. Vargas et al reported severe complications on 17 of 22 patients who had coralliform stones but no surgical intervention. They also reported that two of them died during their 1-6 years follow-up. Therefore patients with coralliform stones should not be left untreated [14].

Treatment of coralliform stones consists of three stages. First, the stone must be completely removed. Then it must be supported with medical therapy to prevent recurrent urinary tract infections. At the same time, all types of metabolic disorders must be treated if present [13].

Definitive treatment for infection stones is completely removal of stone burden. Until 1980s open surgery was the gold standard method for treatment of infection stones. Even if many patients retained their renal functions after removal of intrarenal obstruction, 30% had recurrent stones and 40% had recurrent urinary tract infections (UTIs) [15].

Following Rupel and Brown's obstructive stone extraction through the nephrostomy tract which they had surgically constructed [16], Fenstrom and Johansson published the new surgery method for kidney stones with the name percutaneous pyelolithotomy [6]. After that the method quickly became popular and it was suggested that every patient who needed open surgery was a viable candidate for percutaneous technique. But this technique has some contraindications such as; active UTI, unmanageable bleeding diathesis, tumor in the presumptive access tract area, potential malignant kidney tumor, pregnancy or an orthopedic anomaly that prevent the patient from getting into the desired position [10].

As the success of treatment was equal to stone-free rate, development and common usage of endoscopic methods for treatment of rest stones changed this opinion and added a new aspect. It brought the concept of clinically insignificant residual fragments alive and made people question the value of nonobstructive small stones that don't cause pain or infections on the success of the surgery. In this concept, the stone size is restricted to 4mm and it has been decided that the stones smaller than that have no effect on the outcome because it has been determined that 85% of these stones are expulsed without symptomatic pain. Residual CIRFs after metabolic stones are important [17].

Multiple SWL sessions are necessary for %13 of all patients who take SWL treatment. SWL has highest success rates for renal pelvis stones. On the other hand it is reported that lower pole stones are harder to treat compared to other localizations. Uric acid stones are the easiest type to break with 85% followed by calcium oxalate dihydrate 80% and calcium oxalate monohydrate 70%. On the other hand cystine stones over 2cm make up the most resistant group to SWL. In case of multiple, over 2cm, cystine, lower calyx, calyceal diverticulum stones success rate of SWL decreases [18]. Lingeman et al reported 96% success rate for kidney stone treatment with SWL [19].

Success rate of PNL varies between 72-98% on large series published [20-22]. First large serie on the topic has been published in 1985 by Segura and he reported 98% success rate on a series of 1000 cases [21]. On another serie published by Merberger at the same year, like Segura's, success rate of 98% on 1122 cases has been reported [20]. On the paper published by Goldwasser et al in 1986, factors effecting the success rate of PNL have been investigated [22]. In this paper the influence of stone size, composition and history of open surgery have been investigated and the importance of stone size and localization have been pointed out as the biggest factors on success [22].

In 1992 Steem et al published the data belonging to the method that they used treating coralliform stones and named it "sandwich therapy" [7]. After lowering total stone burden with the first session PNL followed by SWL to rest stones. Then fragments are cleared with a second PNL session.

Segura et al reported 84% success rate on infected coralliform stones performing only PNL [23]. As latter series supported these results, it has been concluded that one session PNL is not inferior against sandwich therapy. Netto et al reported significant increase on success and mild increase on complication rates with supracostal and multitract PNL for coralliform stone treatment [24]. Aron et al reported a success rate of 84% for the series about multitract PNL in coralliform stones in 2005 [25]. Moreover they observed that the success rate goes up to 94% when combined with SWL. In our series nevertheless, we detected a stone-free rate of 69,5% in the multitract group after initial

operations and a CIRF rate of 17,5%. We also observed an early period success rate of 62,5% and a CIRF rate of 18,75% for the sandwich therapy. Our stone-free rate in the 6th month was determined 82,6% and 75% and our CIRF rates 8,7% and 18,75% respectively. If the patients with CIRF are assumed stone free, we also achieved an early period success rate of 80% in both groups, even a success rate of 90% in the 6th month with the help of additional treatments.

According to the literature the requirement rate of additional treatments after PNL is approximately 10% [26-28]. According to our study, the additional treatment rate can be summarized as the following: applying SWL with a JJ catheter to 21,7% of the multitract group and performing URS to two of them, and applying SWL with JJ catheter to four patients (25%) of sandwich therapy group with again an additional URS operation to two of them.

Even though PNL is a treatment with high success rates, it is important to remember that severe, even life-threatening complications can occur during or after the operation.

In the study by Segura, which was published in 1985 and is one of the first studies about the topic, 3,2% major complication rate is reported [23]. The most common major complication is intraoperative haemorrhage requiring termination of six (0,6%) surgeries. In addition, six (0,6%) patients have been performed embolisation because of arteriovenous fistula, one patient has been performed nephrectomy because of postoperative haemorrhage but no deaths have been reported. In 1987 Smith and Lee reported a major complication rate of 6,8% and a minor complication rate of 50% in their study in which the complications of 582 PNL patients were thoroughly investigated [29]. In this serie -with death of two (0,3%) patients- major complications were; early postoperative period hemorrhage needing intervention in six (1%) cases, severe infection in two (0,3%), pneumothorax in 17 (2,9%), urinoma formation in two (0,3%), renal pelvis laceration in five (0,9%), ureter avulsion in one (0,2%) and ureteral stricture in five (0,9%) of the cases. The most common minor complication is fever with a rate of 22%, 11,2% of the patients needed blood transfusion, 7,2% had extravasation, 5,8% of the nephrostomies came out prematurely, 6% had temporary urinary obstruction, 2,6% had paralytic ileus, 1,5% had urine leakage going on over one week through their nephrostomy tract.

We observed a major complication rate of 17,4% in the multitract group and 18,75% in the sandwich therapy group. There was no adjacent organ injury occurred except one patient who had hydropneumothorax. There were no deaths intra and postoperatively but one patient had acidosis and one patient had CVA in the postoperative period. 13,04% of the patients from the first group and 18,75% from the second group had a fever as a minor complication.

This data shows that using PNL, we can treat kidney with a high success rate but we must keep in mind that life-threatening complications may develop during or after the surgeries.

We used Amplatz® dilatation sets in all of our surgeries. They are cheaper from balloon dilatators and easier to use compared to telescopic metal dilatators. These are the most important reasons of our choice.

Studies point out that that diameter of the tract affects the haemorrhage rates. Making a small tract especially for patients who have a narrow or undilated infundibulum leads to less trauma and less bleeding. In 2001 Lahme et al reported that tracts under 22F lead to less haemorrhage compared to wider tracts [30]. We made 30Fr tracts in all of our cases because our nephroscope was administrated in 30Fr diameter sheet. Even 30Fr tracts can be traumatic and cause difficulty for manoeuvring in the kidney, they provide faster stone removal with bigger fragments.

Thanks to Sampaio's studies, we have detailed information about caliceal blood supply of kidney. He determined that the posterior segmental artery supplies blood for upper and middle posterior calices. He also observed a vascular injury rate of 67% and an arterial (interlobar) injury rate of 17% for the interventions to upper calices [31]. Lower calix approaches are found to be the safest, considering these anatomical features of the kidney. Still, Kukreja et al reported in

2004 that the position of entrance has no influence on the complication rates. In our study, the position of the entrance had no effect on the success rate but there was a statistically significant increase in the complication rates [32]. During upper pole accesses, there is an injury risk to the posterior segmental artery resulting with function loss of the kidney in that region. During supracostal accesses, extreme caution is needed not to damage the pleura and the lungs shouldn't be fully inflated. Even if it is known that the pleura ends at the level of 10^{th}-11^{th} costas, the risk of pleura injury must be always kept in mind during 11^{th} -12^{th} costa accesses.

With PNL lower success and higher complication rates are obtained for complex and coralliform stones compared to simple stones. Multiple tracts are usually needed for removal of these stones. Stoller and Martin reported that use of multiple tracts leads to higher haemorrhage rates. We also observed higher transfusion needs in the multitract group per operation compared to the sandwich group even it was statistically insignificant [33, 34]. The stone burden is usually high with complex and coralliform stones. Kukreja et al reported that the stone burden did not have a significant effect on blood loss but the transfusion rates were higher [32]. We also think we did more transfusion during PNL sessions for bigger stones compared to smaller ones. That can be explained with longer operation durations because of greater stone burden.

In the literature, there are conflicting papers about the results of PNL performed to the patients with the history of open surgery or SWL. Netto et al reported that the history of open surgery is a risk factor for bleeding for PNL patients [24]. On the other hand, Stoller et al pointed out that history of open surgery of SWL has no influence on haemorrhage during PNL with their retrospective analysis of their cases [34]. In 2004 Kukreja et al reported less haemorrhage during PNL in patients with a history of open surgery or PNL [32]. Smith et al observed less haemorrhage in patients with scarred kidneys which have thin parenchyma during PNL [35]. In 2003 Basiri et al reported that history of open surgery has no effect on the success or complication rate of PNL [36]. Also in our study history of open surgery and/or SWL treatment were not significant factors influencing the outcome of PNL procedure for the seven patients from both groups.

Presumably, death is the most freightening complication during the treatment of urinary system stones. Several deaths due to bleeding were reported in the first published series. In the series published by Lee et al in 1987, one death due to respiration insufficiency caused by the prior lung disease (0,2%) and another one due to acute myocardial infarction (0,2%) have been reported [29]. We have not observed any deaths during or after the surgeries.

In the course of PNL operation, indwelling infections may be reactivated with the puncture of the needle or the extraction of fragments. Bacteriuria is detected in the urine of quarter of the patients who undergo PNL with sterile urine cultures before surgery. This is explained with the reactivation of nesting bacteria after fragmentation of the stone. Lee et al reported a 0,3% urosepsis rate which was treated with appropriate antibiotics afterwards [29]. In our study 13,4% of, the patients from the first group and 18,75% from the second group (three patients per each group) had fever over 38 degrees and they were treated with appropriate antibiotics according to their urine and blood culture results.

Intestinal injury during PNL is a rare complication with serious consequences. In 1985 Vallaniven et al reported two intestinal perforations in their PNL series of 250 cases, which were treated with open surgery [37]. It was also concluded that intestinal injury risk was higher with patients who have mobile kidneys and especially with lateral entries. It should also be kept in mind that there is a higher risk of intestinal injury in the presence of retro-colon. In the absence of organomegaly, liver and spleen injuries are rare complications. In our series, we encountered no intestinal, liver or spleen injuries.

Percutaneous nephrolithotomy is a fine procedure where millimetres define the difference between success or complications. In such a procedure there is al-

ways the risk of injury to the urinary tract. Clayman et al observed an extravasation rate of 26% in their PNL series [38]. In this series, retrograde pyelography with a ureteral catheter was not performed, but antegrade pyelography was performed using a Chiba® needle for visualizing the pelvicalyceal system. In series in which the pelvicalyceal system was contrasted with a ureteral catheter, lower extravasation rates were determined. It has also been concluded that extravasation was not as important as pelvic lacerations, ureteral avulsions and urinomas [38].

In our series, we observed neither urinomas nor extravasations excluding one patient who has presented with nephro cutaneous fistula after being discharged. Which was treated with fistula repair, applied a JJ catheter with uretero renoscopy. Followed up by no other complications.

In the series of Lee et al, 0.9% pelvic laceration, 0.2% ureteral avulsion has been observed and in 1% of the patients the stone retreated to retroperitoneum and 0.3% of urinoma progressed [29]. Ureteral avulsions and pelvic lacerations are treated with surgery whereas urinoma and retroperitoneal stone retreatments are treated conservatively. In 1985 Segura et al reported one (0.1%) ureteral perforation and one (0.1%) ureteral perforation followed by stone retreatment to retroperitoneum [23]. In the same series, two (0.2%) patients developed parenchymal laceration during dilatation in which they ended up switching to open surgery. In our series, we haven't encountered with such complication.

CONCLUSION

PNL surgery is a safe and effective way of treating renal stones of all kinds and larger sizes. This also applies to the treatment of coralliform stones. This technique can be used in combination with SWL or with multitract access depending on the circumstances. In our study, we compared these two methods. We concluded that there was no significant difference in success and complication rates between the two methods except transfusion amounts, hospitalization and operation durations. Our results were in coherence with the literature.

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