ARAŞTIRMA MAKALESİ / *RESEARCH ARTICLE*

Is the Success and Safety of Retrograde Intrarenal Surgery Related to the Opacity Status of Kidney Stones? A Critical Evaluation

Retrograd İntrarenal Cerrahinin Başarısı ve Güvenliği Böbrek Taşlarının Opaklık Durumuyla İlişkili midir? Kritik Bir Değerlendirme

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ABSTRACT

Aim: *This present study aimed to investigate the possible effect of the opacity status of kidney stones on the success and complication rates observed during and after retrograde intrarenal surgery (RIRS).*

Material and Method: *This study analyzed the data of 642 kidney stone cases who underwent flexible ureteroscopy between February 2014 and April 2022. In all patients, non-contrast computed tomography and kidney-ureter-bladder (KUB) radiography were performed preoperatively to evaluate the anatomy of the collecting system and the structure of the kidney stone. The patients were divided into two groups as opaque and non-opaque according to the opacity evaluation based on the preoperative KUB image. While 359 patients had radiopaque stones, 283 patients had non-opaque stones. Both groups were compared in terms of certain preoperative data, postoperative outcomes, and complications.*

Results: *Cases with non-opaque stones were ahead of the other group in terms of the American Society of Anaesthesiologists (ASA) score, diagnosed diabetes mellitus, Charlson Comorbidity Index, and body mass index. In the third postoperative month, there was no statistically significant difference between the two groups in terms of stone-free status (72.1% vs 75.3%, p=0.212). Postoperative infective complications and hospital stays were comparable across the two groups, despite the non-opaque stone group being substantially older and farther along in terms of comorbidities.*

Conclusion: *This study's results showed that RIRS could be applied with successful outcomes regardless of the opacity status of renal stones.*

Key words: *opaque; non-opaque; RIRS; kidney stones*

ÖZET

Amaç: *Bu çalışmada, böbrek taşlarının opasite durumunun, retrograd intrarenal cerrahi (RIRS) sırasında ve sonrasında gözlenen başarı ve komplikasyon oranları konusundaki potansiyel etkisi araştırıldı.*

Materyal ve Metot: *Çalışmamızda Şubat 2014-Nisan 2022 tarihleri arasında böbrek taşı nedeniyle fleksibl üreteroskopi yapılan 642 hastanın verileri incelendi. Tüm hastalarda, preoperatif olarak toplayıcı sistemin anatomisini ve böbrek taşının yapısını değerlendirmek amaçlı kontrastsız bilgisayarlı tomografi ve böbrek-üreter-mesane grafisi uygulandı (KUB). Preoparatif dğerlendirmedeki KUB görüntüsü baz alınarak yapılan opasite değerlendirmesine göre hastalar opak ve non-opak olamak üzere iki gruba ayrıldı. Üç yüz elli dokuz hastada radyoopak taş bulunurken, 283 hastada non-opak taş saptandı. Her iki grup, belirli preoperatif veriler, postoperatif sonuçlar ve komplikasyonlar açısından karşılaştırıldı.*

Bulgular: *Non-opak taşlı olgular American Society of Anesthesiologists (ASA) skoru, Charlson Komorbidite İndeksi, diabetes mellitus tanısı ve vücut kitle endeksi açısından diğer grubun önündeydi. Ameliyat sonrası 3. ayda her iki grup taşsızlık açısından anlamlı bir fark göstermedi (%72,1'e karşı %75,3, p=0,212). Opak olmayan taş grubu ortalama yaş komorbiditeler açısından anlamlı olarak daha önde olmasına rağmen, postoperatif enfeksiyöz komplikasyonlar ve hastanede kalış süreleri her iki grupta da benzerdi.*

Sonuç: *Sonuçlarımız, böbrek taşlarının opasite durumuna bakılmaksızın RIRS'nin başarılı sonuçlarla uygulanabileceğini gösterdi.*

Anahtar kelimeler: *opak; non-opak; RIRS; böbrek taşları*

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Introduction

The interventional treatment of symptomatic urinary stones has changed tremendously in the last three decades due to advances in instrumentation and technology[1]. As a result of these advances, minimally invasive treatment alternatives such as extracorporeal shock wave lithotripsy (ESWL), retrograde intrarenal surgery (RIRS), and percutaneous lithotripsy (PCNL) have largely replaced open surgery with prominently safe and effective results[2]. Regarding the minimally invasive surgery of upper urinary system stones, PCNL is performed in a single session with significantly higher stone-free rates (SFR) for the treatment of large stones (>20 mm). On the other hand, ESWL and RIRS demonstrate comparable success rates to PCNL for moderate-sized (10–20 mm) stones and have a less invasive nature than PCNL[3]. The European Association of Urology (EAU) Urolithiasis Guidelines recognize ESWL and RIRS modalities as equally effective treatment modalities for kidney stones less than 20 mm in diameter; PCNL is still recommended as the first-line treatment for stones larger than 20 mm[4].

As mentioned above, as a result of the developments in flexible fiberoptic endoscopy systems and the use of the Holmium-YAG laser in stone disintegration, RIRS has significantly altered the endourological management of medium-sized kidney stones in the last two decades[5]. Urologists perform many procedures, including ureteroscopy, under fluoroscopic guidance[6]. Fluoroscopy helps the surgeon to evaluate the anatomy of the involved reno-ureteral unit, the position of the ureteric access sheath, the location of the guidewire, and lastly, give information about the presence of kidney stones and fragments in the collecting system during the procedure. While most calcium-containing stones can be easily seen on X-ray, struvite, apatite, and cystine stones are semi-opaque and are not very clearly identifiable on the kidney-ureter-bladder radiograph (KUB) examination. However, radiolucent stones such as uric acid, ammonium urate, and xanthine stones can not be observed in KUB unless they contain other components[7]. Visibility of the stone on preoperative radiological images is highly helpful in determining the stone (s), monitoring the course of the procedure in terms of the efficiency of disintegration, and evaluating the presence/size of the residual fragments after the procedure, particularly during endourological stone removal procedures. For this reason, it has been a matter of interest whether the visualization of the stone in fluoroscopy during the operation is a condition that affects the success of the operation. Since the primary goal of the research was to look at how the stone's detectability in fluoroscopy during RIRS influences the surgery, the opacity was categorized using preoperative KUB, which has a technical infrastructure comparable to fluoroscopy.

This present study aimed to investigate the possible effect of the opacity status of kidney stones on the success and complication rates observed during and after retrograde intrarenal surgery (RIRS).

Material and Method

Patients who attended our clinic and were treated for kidney stones with RIRS between February 2014 and April 2022 were evaluated retrospectively. All experiments were conducted in accordance with the Helsinki Declaration and were sanctioned by our institution's ethical committee (80576354–050–99/93). Patients who had ureteral stents placed prior to surgery, those with ureteral strictures, those with a single kidney or an ectopic kidney, and those who had a ureteral rupture or avulsion during surgery were not included in the study. All study requirements were met for 642 patients.

Kidney-ureter-bladder radiography and non-contrast computerized tomography (NCCT) were conducted on all patients to analyze details about the collecting system's anatomy and the characteristics of the stones. Whenever it was deemed required, further radiological assessment procedures and urinary ultrasonography (USG) were carried out. Non-opaque stones' sizes were calculated using the greatest diameter established in the NCCT, whereas opaque stones' sizes were estimated utilizing KUB.

Before the operation, it was required that the patients' urine cultures were negative. Data from NCCT, KUB, and USG were examined in accordance with the opacity features of the stones to ascertain whether or not the stones had been cleared 3 months after surgery. Stone particles less than 3 mm in size were regarded to have been successfully removed.

These operations were all performed while the patient was in the lithotomy position and under general anesthesia. With the aid of fluoroscopy, a ureteral access sheath (UAS) was inserted (9.5/11.5 Fr; Cook Medical; Bloomington, IN). A fiberoptic flexible ureteroscope of 7.5 Fr diameter was used to access the collecting system (Storz FLEX-X2). The stones were disintegrated using a holmium laser and a 273 fiber.

Fragments >3 mm were retrieved from patients with a nitinol basket (ZeroTipTM; Cook Urological Inc.). A few of the smaller pieces were permitted to pass through on their own. During the preoperative examination, the KUB images of the patients were categorized into two groups according to the status of opacity shown by the stones. Group O is for cases whose stones are opaque in the KUB, while Group NO is for those whose stones are translucent.

Statistical Analysis

Utilizing IBM Statistical Package for Social Sciences (SPSS) program version 22.0, statistical analyses were carried out (IBM Inc, Chicago, IL, USA). To determine whether or not the data were normally distributed, we utilized the Kolmogorov-Smirnov test. The means were compared using an independent sample t-test with normally distributed data. When comparing non-normally distributed samples, the Mann-Whitney U test was utilized. The Chi-square or Fisher's exact test was used to evaluate categorical data. We used a cutoff of p 0.05 to indicate statistical significance.

Results

The results showed no significant difference between the two groups regarding gender distribution. However, Group NO has a significantly higher mean age value when compared with the cases with opaque stones. (48.43±14.71 vs 52.86±14.85, p<0.001). In addition, patients in Group NO had higher mean ASA scores and a higher rate of diagnosed DM (9.7% vs 21.6%, p<0.001) than the other group. Likewise, patients in Group NO were found to have higher Charlson Comorbidity Index (1.32±1.51 vs 2.04±2.03, p<0.001) values and higher mean body mass index values (27.44±4.39 vs 28.96±4.89, p<0.001). The rate of multiple stones was significantly higher (51.3% vs 43.1%, p=0.024) in Group O. Also, the patients in Group NO were found to have higher usage of anticoagulants (10.6% vs 18.7%, p=0.002) and alpha-blockers (5.0% vs 8.8%, p=0.039). The clinical characteristics and laboratory results of patients are detailed in Table 1. Considering the laboratory findings, although the preoperative hemoglobin value was higher in Group NO (14.48±1.97 vs 14.16±1.96, p=0.046), no significant difference was found in postoperative values (14.43±1.86 vs 14.18±2.08, p=0.064). Evaluation of the hospitalization (2.56±2.54 vs

Table 1. *Clinical characterization and laboratory findings of patients*

		Group O (n=359)		Group N (n=283)		p
Gender	Male	235	65.5%	180	63.6%	0.342
	Female	124	34.5%	103	36.4%	
Age		48.43	±14.71	52.86	±14.85	<0.001
ASA	ASA 1	129	35.9%	62	21.9%	<0.001
	ASA 2	209	58.2%	187	66.1%	
	ASA 3	21	5.8%	34	12.0%	
Diabetes mellitus		35	9.7%	61	21.6%	<0.001
BMI (kg/m²)		27.44	±4.39	28.96	±4.89	<0.001
Charlson comorbidity index [Median (IQR)]		1	0–2	2	0–3	<0.001
Stone size (mm)		12.72	±5.26	12.22	±5.87	0.255
Lateralization	Right	161	44.8%	135	47.7%	0.261
	Left	198	55.2%	148	52.3%	
Localization	Other calyxes	226	63.0%	180	63.6%	0.465
	Lower calyx	133	37.0%	103	36.4%	
Parenchymal thickness (cm)		25.84	±7.83	26.64	±8.16	0.208
Number of Stones	Single	175	48.7%	161	56.9%	0.024
	Multiple	184	51.3%	122	43.1%	
Infundibulopelvic angle (º)		46.47	±16.70	46.75	±15.30	0.825
Alpha-blocker use		18	5.0%	25	8.8%	0.039
Anticoagulant use		38	10.6%	53	18.7%	0.002
Hydronephrosis		143	39.8%	128	45.2%	0.098
Preop Hg (g/dL)		14.48	±1.97	14.16	±1.96	0.046
Preop Cr (mg/dL)		0.97	±0.39	1.01	±0.41	0.193

ASA: American Society of Anesthesiologists; Hg: Hemoglobin; Cr: Creatinine; Postop: Postoperative; Preop: Preoperative.

Table 2. *Postoperative follow-up data*

	Group O (n=359)		Group N (n=283)		p
Postop Hg (g/dL)	14.43	±1.86	14.18	±2.08	0.064
Postop Cr (mg/dL)	0.94	±0.38	0.98	±0.40	0.252
Hospitalization (Day)	2.56	±2.54	2.50	±1.80	0.724
Postop fever	13	3.6%	9	3.2%	0.469
SFR (Postop 3rd month)	259	72.1%	213	75.3%	0.212

Hg: Hemoglobin; Cr: Creatinine; Postop: Postoperative; Preop: Preoperative; SFR: Stone-free rate

2.50±1.80, p=0.724) period and postoperative fever (3.6% vs 3.2%, p=0.469) rates again did not show any significant difference between the two groups. Last but not least, the SFR of both groups, evaluated at the postoperative 3rd month, was comparable (72.1% vs 75.3%, p=0.212) between the two groups of cases. Postoperative follow-up data were given in Table 2.

Discussion

With promising developments in endourology, kidney stone treatment with RIRS has become a game changer[8]. Plain X-ray was recommended to provide additional information in the presence of computed tomography rather than being a primary diagnosis tool in urolithiasis[9]. The issue which should not be ignored is that not all patients with urinary tract stones detected by CT can be seen in KUB. In a study performed, only 59 % of the ureteral stones detected on CT could be visualized in the KUB[10].

Gucuk et al., on the other hand, adopted a different strategy and sought to determine the effect of Hounsfield Units (HU) found in preoperative NCCT on the ultimate success of PCNL[11]. When the CT HU was above 1000, the SFRs were supposedly higher. Stones with HU 1000, which includes both opaque and lucent stones in KUB, had the lower SFR. According to a different study, 630 was the appropriate cut-off value for HU evaluated in NCCT to be perceived as opaque in KUB[12]. In a study looking at ureteral stones, this value was 800[13]. In other words, it is obvious that there is no predetermined threshold value for the HU value established in NCCT that causes stones to appear opaque in KUB. As a result, we select the KUB, which shares the same technological background as fluoroscopy, to classify the stones' opacity. We thought that KUB would provide us with more useful information regarding how well we could see the stone under fluoroscopy. Gucuk et al. classified stones exceeding 350 as opaque in contrast to us based on the HU value determined by the NCCT. The mean SFR was similarly lower with non-opaque stones, according to this study's findings[11].

One of the main findings in our study was that the patients in Group NO consisted of older cases associated with more comorbidities. Uric acid stones are the most prevalent kind of radiolucent stone[14]. Age, metabolic syndrome, and diseases such as diabetes mellitus increase the frequency of these stones[15]. This may be one of the reasons why Group NO was found to have a higher mean age value, ASA, Charlson Comorbidity Indices, presence of diabetes, and use of anticoagulants in our study. However, it would be speculative to claim this assumption since we do not have the stone analysis results of the patients. In another study focusing on this subject, patient groups with radiopaque and radiolucent stones showed a similar age distribution[16]. Similarly, in a study investigating the effect of stone opacity characteristics on percutaneous nephrolithotomy results, patients with opaque and non-opaque stones were found to have similar values in terms of age and body mass index (BMI)[17]. Contrary to the findings of this research, our Group NO patients had considerably higher mean BMI values. In addition, alpha-blocker use was greater in Group NO, according to our findings.

Previous research compared the efficacy and complications of RIRS[16], the difference between the two groups in terms of SFR and complications was insignificant. Still, in this investigation, researchers counted stones smaller than 4 mm as residual stones. Despite including stones under 3 mm in size as residual fragments in our analysis, we still did not find a discernible difference in SFR between the two groups. Fever is a predictor of postoperative infective complications, but we found no measurable difference in its occurrence across the groups. Although one group in our research did have a greater mean age value and related comorbidities, it is interesting to see that success rates and consequences are similar.

On the other hand, regarding the number of stones, the percentage of multiple stones was higher for Group O

in our study. Multiple stones have been proven to have a lower SFR after RIRS than single stones had in another research[18]. After a single treatment session, there was no significant difference between the groups in terms of SFR regardless of stone opacity, which was the primary outcome we were examining. It was not looked at whether or if varying quantities of stones affected SFR.

This present study suggested that fluoroscopy did not contribute positively to the success and safety rates of RIRS, where the results were found mostly to be related to surgical experience[19]. Although the primary goal of endoscopic stone surgery is to remove the stone load from the collecting system as much as possible in a single session, it is critical to reduce radiation exposure throughout the procedure[20]. We were inspired to look for strategies to limit the use of fluoroscopy during flexible ureteroscopic surgery because we had similar success treating stones that were not apparent on fluoroscopy. Given our data and previous literature in the field of radiation-free endoscopic stone treatment, it is highly likely that this will not be the wrong choice[21,22].

This research has certain limitations. The most important limitation is that our study has a retrospective design. In addition, our groups differ from each other in terms of some clinical data and demographic inputs. We did not have stone or metabolic analysis results that may explain this difference. The fact that the two groups showed different results in terms of demographic data can be seen as a limitation, but it is still significant that the complications were comparable between the groups. Despite all these limitations, this study will contribute to the literature as it reaches a sufficient number of patients and seeks ways to use fluoroscopy less during the operation.

Conclusion

Our results showed that RIRS could be applied with successful outcomes regardless of the opacity status of renal stones. Although patients with non-opaque stones appear to be older with higher comorbidities, both groups were found to have similar postoperative infectious complication rates. This study shows that the capacity to recognize kidney stones in intraoperative fluoroscopy does not improve the efficacy of RIRS for renal calculus, hence we think additional research needs to be done on RIRS without fluoroscopy. We think that further prospective cohort studies are required, ideally with a bigger sample size and a wider range of other variables, to shed light on this important topic.

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