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Are the Complication Rates for the Open Approach in the Surgical Treatment of Bladder Stones Higher Than Rates for Endoscopic Approaches? A Comparative Multivariate Analysis Study

Mesane Taşlarının Cerrahi Tedavisinde Açık Yaklaşımın Komplikasyonları Endoskopik Yaklaşımlardan Yüksek midir? Karşılaştırmalı Bir Multivaryan Analiz Çalışması

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What's known on the subject? and What does the study add?

The complication rates for open surgical approaches are significantly higher than the rates for endoscopic approaches in the management of bladder stone disease.

Abstract

Objective: To compare the effectiveness, safety and complication rates of open vs endoscopic approach for bladder stone surgery and investigate the predictive factor for success and complication rate in patients with bladder stone.
Materials and Methods: The records of 128 patients, who underwent stone surgery between November 2010 and June 2017, were analyzed. The patients were divided into two groups according to surgical approach as endoscopic or open group. Duration of surgery and catheterization and length of hospital stay were recorded. Multivariate analyses were done using logistic regression test to determine the risk factors for complications.
Results: A total of 130 procedures were performed in 128 patients included in the study. Of them, 93 were treated via endoscopic approach and 37 via open approach. The overall success rate in endoscopic and open groups was 92.5% and 100%, respectively (p=0.44). Increased age, type of surgical approach and using lithotripsy were found to be risk factors for complications in univariate analysis. Only the type of surgery was found to be an independent risk factor for complications in multivariate analysis (p=0.006).
Conclusion: Open and endoscopic approaches showed similar effectiveness in patients with bladder stone. The only significant risk factor for complications was the type of surgical approach.
Keywords: Bladder, Stone, Endoscopic, Open, Surgery

Öz

Amaç: Mesane taşı cerrahisinde açık ve endoskopik yaklaşımın etkinliğini, güvenliğini ve komplikasyon oranlarını karşılaştırmayı ve mesane taşı olan hastalarda başarı ve komplikasyon oranı için öngörü faktörünü araştırmayı amaçladık.
Gereç ve Yöntem: Kasım 2010 ve Haziran 2017 arasında 128 hastanın kayıtları analiz edildi. Hastalar, endoskopik veya açık grup olarak cerrahi yaklaşıma göre iki gruba ayrıldı. Operasyon süresi, kateterizasyon ve hastanede yatış süreleri kaydedildi. Multivaryan analizle komplikasyonlar için risk faktörleri lojistik regresyon testi kullanılarak belirlendi.
Bulgular: Çalışmaya dahil edilen 128 hastaya toplam 130 işlem uygulandı. Bunlardan 93'üne endoskopik yaklaşım ve 37'sine açık yaklaşım uygulanmıştır. Her iki grubun genel başarı oranı, endoskopik ve açık gruplar için sırasıyla %92,5 ve %100 idi (p=0,44). Artmış yaş, cerrahi yaklaşım tipi ve litotripsi kullanımı komplikasyonlar için univaryan analizde risk faktörleri olarak bulundu. Multivaryan analizde sadece cerrahi yaklaşım tipi komplikasyonlar için bağımsız risk faktörü olarak bulundu (p=0,006).
Sonuç: Açık ve endoskopik yaklaşımlar, mesane taşı tedavisinde benzer etkinlik göstermiştir. Komplikasyonlar için tek anlamlı risk faktörü cerrahi yaklaşım tipi olarak tespit edildi.
Anahtar Kelimeler: Mesane, Taş, Endoskopi, Açık, Cerrahi

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Introduction

Bladder stones are the most common lower urinary tract stones and constitute about 5% of all urinary tract stones (1). Bladder stones usually occur as bladder outlet obstruction, diseases causing urinary stasis such as neurogenic bladder dysfunction, or as a factor secondary to the formation of stones such as foreign bodies (2).

Bladder stones are surgically treated with an open or endoscopic approach such as percutaneous and transurethral techniques. Cystolithotomy is a very old operation that has been practiced for thousands of years. Hippocrates found that suprapubic approach was dangerous for bladder stones. He refered to bladder stones, "I will not cut even for the stone" (3).

Open surgery was the gold standard treatment in the past, but it has fallen from grace with rapidly evolving minimally invasive techniques (4). Developments in pneumatic and laser energy sources, which allow lithotripsy intracorporally, have made percutaneous and transurethral access increasingly common.

The aim of this study was to investigate the presence of independent risk factors predicting the outcome and complications of different surgical approaches in the treatment of bladder stones.

Materials and Methods

We retrospectively reviewed data of patients who underwent surgery with bladder stone diagnosis between 2010 and 2017 in our department. A total of 128 patients enrolled in 130 approaches were included in the study. Demographic data, such as age and sex, and pre-operative and peri-operative data were recorded. The patients were divided into two groups according to surgical approach as endoscopic group and open group.

The patients were also divided into two groups according to the presence of complications. Peri-operative complications were classified according to the Satava classification (5) and the post-operative complications according to the Clavien classification (6).

This study was executed in a retrospective design and all patients provided written informed consent. Ethics committee approval was not applied because of the retrospective design of the study.

Statistical Analysis

Multivariate analysis was performed to investigate independent predictive factors for complications. A chi-square test and the Fisher's exact test were used for the difference between the categorical variables, while the Kruskal-Wallis and Mann-Whitney U tests were used for the difference between the means. The data were analyzed using the Statistical Package for the Social Sciences version 16 (SPSS Inc., Illinois, USA). A p value of less than 0.05 was considered statistically significant.

Results

The mean age of the patients was 53.02±24.15 years. Endoscopic approach was used in 93 (71.5%) patients and open approach in 37 (28.5%) patients. The demographic data is given in Table 1. The overall success rate was 92.5% and 100% in endoscopic and open groups, respectively (p=0.44). Patients with residual stones were treated with endoscopic approaches and 4 with transurethral and 3 with percutaneous cystolithotripsy. The

Table 1. Characteristics of patients and demographic datas

Characteristic	All	Endoscopic			Open	p value
		Transurethral	Percutan	T+P		
Number	130	62 (47.7%)	31 (23.8%)	93 (71.5%)	37 (28.5%)	-
Age (year, mean)	53.02±24.15	50.4±25.5	49.7±23.6	50.16±24.1	60.2±21.2	**0.012***
Gender						
Male	119 (92%)	54 (45.4%)	29 (24.4%)	83 (69.7%)	36 (30.3%)	0.17
Female	11 (8%)	8 (72.7%)	2 (18.2%)	10 (90.9%)	1 (9.1%)	
Stone burden (cm^2)	5.88±5.72	3.33±0.50	8.41±1.36	4.98±1.22	8.05±0.76	**0.006***
Primary disease						
BPO/urethra str.	87 (67%)	38 (29.3%)	19 (14.6%)	57 (44%)	30 (23%)	-
Neurogen bladder	16 (12.4%)	6 (4.6%)	6 (4.6%)	12 (9.3%)	4 (3.1%)	-
Upper UT Stone	21 (16.2%)	15 (11.6%)	4 (3.1%)	19 (14.7%)	2 (1.5%)	0.21
Foreign body	1 (0.8%)	0 (0%)	1 (0.8%)	1 (0.8%)	0 (0%)	-
Other	5 (3.8%)	3 (2.28%)	1 (0.76%)	4 (3.04%)	1 (0.76%)	-

BPO: Benign prostatic obstruction, Urethra str.: Urethral stricture, UT: Urinary tract, T: Transurethral, P: Percutan
* Student's t-test, other p values from chi-square test, all p values for T+P vs open data

Table 2. Peri- and post-operative complications

Variable	Grade	All	Endoscopic	Open
Post-operative complications according to the Clavien classification	1	2 (18%)	0 (0%)	2 (29%)
	2	8 (73%)	3 (75%)	5 (71%)
	3	1 (9%)	1 (25%)	0 (0%)
	4	0 (0%)	0 (0%)	0 (0%)
Post-operative complications	-	**11 (8.5%)**	**4 (4.3%)**	**7 (19%)**
Peri-operative complications according to Satava classification	1	3 (43%)	3 (75%)	0 (0%)
	2A	2 (28.5%)	0 (0%)	2 (66.7%)
	2B	2 (28.5%)	1 (25%)	1 (33.3%)
	3	0 (0%)	0 (0%)	0 (0%)
Peri-operative complications	-	**7 (5.4%)**	**4 (4.3%)**	**3 (8.1%)**
Overall complications (patients)	-	18 (14%)	8 (8.6%)	10 (27%)

Table 3. The univariate analysis outcomes

Characteristic	Complication +	Complication -	p value
Number	18 (13.8%)	112 (86.2%)	-
Age (year, mean)	62.5±21.2	51.8±23.8	**0.021***
Approach			
Endoscopic	8 (8.6%)	85 (91.4%)	**0.006**
Open	10 (27%)	27 (73%)	
Lithotripsy			
Yes	7 (8.4%)	76 (91.6%)	**0.018**
No	11 (23.4%)	36 (76.6%)	
Stone burden (cm^2)	4.78±2.92	6.06±6.04	0.771*
Primary disease			
Non-neurogen	16 (14%)	98 (86%)	0.868
Neurogen	2 (12.5%)	14 (87.5%)	
Concurrent procedures			
Yes	10 (16.1%)	52 (83.9%)	0.472
No	8 (11.8%)	60 (88.2%)	
Anesthesia type			
Generel	15 (13.8%)	94 (86.2%)	0.949
Regional	3 (14.3%)	18 (85.7%)	

mean stone burden (3.33±0.5 cm^2) in patients undergoing transurethral cystolithotomy was lower than in the other two groups (percutaneous-8.41±1.36 cm^2 and open-8.04±0.76 cm^2). The difference was statistically significant (p=0.001).

The peri-operative and post-operative complication rates in our patients were 5.4% and 8.5%, respectively (Table 2). In the peri-operative period, according to the Satava classification, urethral injury occurred in 3 patients (grade 1) and transurethral resection (TUR) syndrome occurred in 1 patient (grade 2B) in endoscopic group. In open group, 3 patients had peri-operative complications. One patient developed respiratory distress (grade 2B) and 2 patients had bleeding (grade 2A). In the post-operative period, according to the Clavien classification, two patients had high fever (grade 1) and urinary tract infection occurred in 8 patients (grade 2). After the necessary conservative treatment, all 10 patients were discharged without any problems. We performed internal urethrotomy in 1 patient at the post-operative period due to the urethral stricture (grade 3). There were statistically significant differences between the groups in terms of age, approach and lithotripsy (p=0.021, p=0.006 and p=0.018, respectively) in the univariate analyses by separating the two groups according to complications (Table 3). The patients with complications were older. There was no significant difference between the two groups in terms of stone burden, primary disease (neurogenic and non-neurogenic), concomitant procedure, and anesthesia (spinal and general anesthesia). The type of surgical approach was found to be independent risk factor for complications in multivariate analysis (Table 4). The open surgical approach was associated with more complications than the endoscopic approach (p=0.006).

Table 4. The multivariate analysis outcomes

Variables	Number	Odds ratio	Adjusted odds ratio (95% CI)		p value
			Lower	Upper	
Age	130	1.02	0.99	1.04	0.248
Gender					
Male	119	-	0	-	0.999
Female	11				
Method					
Endoscopic	93	1	-	-	**0.009**
Open	37	3.94	1.41	10.97	
Lithotripsy					
No	47	1	-	-	0.699
Yes	83	1.45	0.22	9.45	

CI: Confidence interval

Discussion

There are several surgical techniques for treating bladder stones including open surgery and endoscopic surgeries such as percutaneous and transurethral approaches (7,8). The stone burden, experience of the surgeon and concomitant surgery are the main factors to determine the type of treatment modality (9). Nowadays, new surgical techniques have taken the place of the open approach. Especially, developments in endoscopic and lithotripsy equipment in the last 20 years have achieved

the treatment of most bladder stones by minimally invasive procedures. Nevertheless, open approach is most commonly considered when transabdominal prostate surgery is planned. The aim of any procedure is to provide complete stone free status in the optimal surgery duration with no complication. In our study, the primary outcome showed that the satisfaction rates were similar both with open or endoscopic approaches (p=0.44). As a secondary outcome; both univariate and multivariate analyses showed that the open approach was an independent predictive factor for increased complication rates for bladder stone surgery (p=0.009).

After introducing endoscopic methods for the treatment of bladder stone, effective fragmentation with various energy sources made the transurethral method more preferred. However, transurethral access may not always be easy. When the duration of transurethral procedure is prolonged, the risk of iatrogenic urethral injury will increase. In addition, the risk of fibrosis and urethral stricture will also increase, leading to impairment of urethral perfusion. As a result, in late 1980s, percutaneous cystolithotripsy practices began to be an alternative to open surgery (10,11,12). The absence of urethral injury and no injury to mucosal unit, short operative duration and low complication rates have made the method popular (5). The method is also used in patients with concomitant benign prostatic obstruction (BPO); it can provide simultaneous TUR of the prostate without increasing complication and operation time (13). In this study, endoscopic approach was performed in 93 (71.5%) patients and, transurethral and percutaneous methods were used in 62 (47.7%) and 31 (23.8%) of them, respectively. Residual stone was detected in 7 patients. Four of them were in transurethral group and 3 in percutaneous group.

In a study comparing percutaneous and transurethral approaches in patients with secondary bladder stones >2.5 cm, following BPO; the duration of transurethral method was longer (14). In addition, residual stones and urethral stricture were reported to be more frequent at the post-operative period. Aron et al. (13) reported similar findings in their retrospective study. It is also possible to draw a conclusion from the data of these studies that urologists prefer percutaneous approach in larger stones (13,14). On the other hand, the results of a recent randomized clinical trial are not similar (15). It has been reported that percutaneous cystolithotripsy was associated with a longer hospital stay and more post-operative complications, as the duration of operation was similar in percutaneous and transurethral approaches (15). There are also authors who argue that the transurethral approach can be performed as an outpatient procedure under local anesthesia (16,17). In our study, lesser complications were seen in patients with intracorporeal fragmentation of the stone with laser and pneumatic energy sources, compared to that in patients in whom the stone was removed without fragmentation (cystolithotomy-23.4% and cystolicotripsy-8.4%). In addition, the mean stone burden (3.33±0.5 cm^2) in patients undergoing transurethral approach was lower than in those who were treated with percutaneous and open approaches (percutaneous-8.41±1.36 cm^2 and open-8.04±0.76 cm^2). The difference was statistically significant (p=0.001).

Bladder stone surgery is often performed with prostate surgery. In fact, the type of prostate surgery mostly determines the type of the approach for bladder stone in these cases. For instance, surgeons prefer open prostatectomy with open cystolithotomy in patients with a large prostate. In our study, 87 patients underwent bladder stone surgery with prostate surgery. In this patient group, 57 (65.5%) of them were in endoscopic group and 30 (34.5%) in open group. It was thought that high complication rates in open group may be due to additional open approaches such as open prostatectomy made in the same session. However, we have not enough evidence.

A significant proportion of bladder stone patients are also neurogenic. A retrospective study done by Bartel et al. (18) in 2014 presented long-term results of bladder stone development in patients with spinal cord trauma. In a cohort of 2825 patients with bladder stones, the rate of spinal cord trauma was reported to be 3.3%. In that study, persistent urethral catheter was emphasized to be the most common risk factor for stone formation, the fastest stone formation and frequent recurrence. In another study, the relationship between bladder stones development and persistent urethral catheterization lasting one month in the acute period after spinal cord trauma was established (19). In our series, 6% of patients were with spinal cord injury. The complication rate for cystolithotomy in patients with spinal cord injury and other neurogenic cases with secondary bladder stones was similar to that in other patients in our study (p=0.868).

In this study, the peri-operative and post-operative complication rates were found to be 5.4% and 8.5%, respectively. In the peri-operative period, according to the Satava classification, urethral injury occurred in 3 patients (grade 1) and TUR syndrome occurred in 1 patient (grade 2B) in endoscopic group. Also, 3 patients in open group had peri-operative complications; 1 patient developed respiratory distress (grade 2B) and 2 patients had bleeding (grade 2A). Concomitant prostatectomy was performed in both patients with bleeding. In the post-operative period, according to the Clavien classification, 2 patients had high fever (grade 1), and urinary tract infection (grade 2) occurred in 8 patients (5 in open group, 3 in endoscopic group). After necessary conservative treatment, all the 10 patients were discharged without any problem. We operated one of our patients in endoscopic group at the post-operative period with internal urethrotomy, after development of urethral stricture (grade 3). Iatrogenic urethral stricture can be seen after transurethral approach. Okeke et al. (20) proposed pre-operative dilatation with transurethral Amplatz sheath to prevent urethral

injury. It has been reported that the rate of complications associated with percutaneous approach was lower than that with transurethral approach (21). In our study, the patients with complications were relatively older (p=0.021). There was no significant difference between open and endoscopic groups in terms of stone burden, primary disease (neurogenic and non-neurogenic), concomitant procedure and anesthesia (spinal and general anesthesia). However, the type of surgical approach was found to be an independent risk factor for complications in multivariate analysis. The open surgical approach was associated with more complications than the endoscopic approach (p=0.006).

Study Limitations

This multivariate analysis study showed that the complication rates for open approach in the surgical treatment of bladder stones were higher than that for endoscopic approaches. Both endoscopic and open approaches showed similar satisfaction rates. However, our study has some limitations. The data were collected longitudinally and were verified retrospectively. In fact, our results suggest that endoscopic and open approaches are safe and feasible treatment modalities in the management of bladder stone. Future prospective studies are warranted.

Conclusion

Open and endoscopic approaches showed similar effectiveness in the management of bladder stone. The only significant risk factor for complications was the type of surgical approach.

Ethics

Ethics Committee Approval: Retrospective study.

Informed Consent: Consent form was filled out by all participants.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: Ç.D., Z.T., Concept: Ç.D., O.Ö., Design: Ç.D., S.Ç., B.Ö., Data Collection or Processing: Ç.D., Z.T., S.Ç., B.Ö., Analysis or Interpretation: S.Ç., O.Ö., B.S., Literature Search: O.Ö., B.S., Writing: Ç.D., Z.T., O.Ö.

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