Have the Technological Advancements Changed the Distribution of Treatment Modalities for Urolithiasis?

Teknolojik Gelişmeler Ürolitiyazis Tedavi Modalitelerindeki Dağılımı Değiştirdi mi?

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ABSTRACT Objective: The aim of this study was to assess the current practice patterns and the distribution of treatment modalities in treatment of urolithiasis. **Material and Methods:** A retrospective study was conducted on the patients who underwent procedures for stone removal or fragmentation in 6 centers in İstanbul, between January 1, 2008 and December 31, 2009. Hospital and office charts, operative notes and records, and pertinent radiographic studies of all patients were reviewed. Patient characteristics, treatment modalities, lithotripter use, stone localization and the side were documented for each patient. **Results:** Of 1756 procedures, the majority was endoscopic surgery (80.7%, n=1417), while 21.6% (n=379) of the patients had percutaneous nephrolithotomy, 47.3% (n=831) had semirigid ureteroscopy, 7.6% (n=134) had cystolithotripsy, 2.2% (n=38) had retrograde intrarenal surgery, 1.4% (n=24) had flexible ureteroscopy, 0.3% (n=6) had laparoscopic ureterolithotomy, and 0.1% (n=2) had laparoscopic pyelolithotomy. Open stone surgery rate was 19.3% (n=339) which included pyelolithotomy (8.5%, n=150), ureterolithotomy (4.7%, n=82), cystolithotomy (2.4%, n=43), nephrolithotomy (2.2%, n=39), pyelonephrolithotomy (0.7%, n=13), anatrophic nephrolithotomy (0.5%, n=8), pyeloplasty (0.3%, n=5) and nephrectomy (0.1%, n=2). There were 1276 (72.7%) males and 480 (27.3%) females between the ages of 3-85 years (mean age 45.5±15.8 years). **Conclusion:** Although the advent of percutaneous nephrolithotomy and ureteroscopy in combination with lithotripsy technique has dramatically altered the management of renal and ureteral stones, open stone surgery maintains a small but continued role in the treatment of patients with renal and ureteral calculi.

Key Words: Lithotripsy; urolithiasis; urologic surgical procedures

ÖZET Amaç: Bu çalışmanın amacı ürolitiyazis tedavisinde uygulanan tedavi modalitelerinin güncel pratiğimizdeki dağılımını ortaya koymaktır. **Gereç ve Yöntemler:** 1 Ocak 2008 ile 31 Aralık 2009 tarihleri arasında İstanbul'daki 6 merkezde uygulanan taş cerrahi prosedürleri retrospektif olarak değerlendirildi. Hastalara ait dosya, ameliyat kayıtları ve radyolojik tetkikleri incelendi. Hastaların özellikleri, tedavi modaliteleri, lithotriptör kullanımı ve taş lokalizasyonu her hasta için kayıt edildi. **Bulgular:** Uygulanan toplam 1756 cerrahi prosedürün çoğunluğunu endoskopik cerrahi girişim (n=1417, %80,7) oluşturmaktaydı (perkütan nefrolitotomi: n=379, %21,6; semirigid üreteroskopi: n=831, %47,3; sistolitotripsi: n=134, %7,6; retrograd-intrarenal cerrahi: n=38, %2,2; fleksible üreteroskopi: n=24, %1,4; laparoskopik üreterolitotomi: n=6, %0,3; laparoskopik pyelolitotomi: n=2, %0,1). Açık cerrahi girişim 339 hastada (%19,3) uygulanmıştır [150 (%8,5) hastaya pyelolitotomi, 82 (%4,7) hastaya üreterolitotomi, 43 (%2,4) hastaya sistolitotomi, 39 (%2,2) hastaya nefrolitotomi, 13 (%0,7) hastaya pyelonefrolitotomi, 8 (%0,5) hastaya anatrofik nefrolitotomi, 5 (%0,3) hastaya pyeloplasti ve 2 (%0,1) hastaya nefrektomi]. Bu hastaların 1276 (%72,7)'sı erkek ve 480 (%27,3)'i kadındı, ve yaşları 3 ile 85 yıl arasında değişmekteydi (ortalama yaş: 45,5 ±15,8 yıl). **Sonuç:** Perkütan nefrolitotomi ve üreteroskopideki yeni gelişmeler böbrek ve üreter taşına yaklaşımı dramatik olarak değiştirmesine rağmen, güncel pratikte açık cerrahi yaklaşım azımsanmayacak bir oranda yerini korumaktadır.

Anahtar Kelimeler: Litotripsi; ürolitiyaz; ürolojik cerrahi işlemler

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Urolithiasis is a common medical problem with a prevalence of approximately 2 to 3% in the general population.[1] Technological developments in endourologic techniques (ureteroscopy, percutaneous nephrolithototomy) and development of intracorporeal lithotripsy (pneumatic, ultrasonic and holmium-YAG laser) in the past 3 decades have caused a dramatic change in the management of renal and ureteral stones where minimal invasive endourologic interventions began to be commonly applied worldwide. These advancements, along with the increasing experience in this field of urology, have clearly changed the balance in favor of minimal invasive approaches, and the use of open surgery did decrease significantly in clinical daily practice over the years.[2] However, despite all these changes, the incidence of open surgery in the management of reno-ureteral calculi was reported to range between 1 and 5.4%.[2-4]

Taking all these facts and the limited data concerning the daily routine clinical practice in the management of urolithiasis in Turkish Urological Community into account, in this present study we aimed to evaluate the changes in the management of renal and ureteral stones by focusing on the distribution of available surgical treatment modalities in our country.

MATERIAL AND METHODS

Accumulated data derived from the clinical practice in urinary tract stone surgery in 6 different surgical centers over a 2-year period was evaluated. The records of 1,756 patients who underwent management of urolithiasis with different surgical approaches were reviewed. Between January 1, 2008 and December 31, 2009, a total of 11 454 surgical procedures were performed in these centers. Of all these procedures, 1,756 (15.3%) were different surgical interventions for urinary tract stones. Hospital and office charts, operative notes and records, and available radiographic studies of all patients were reviewed in detail. Preoperative radiological evaluation was performed with excretory urography (IVU), computed tomography (CT) and ultrasonography of the urinary system in these cases. Preoperative laboratory evaluation included urine analysis and culture-sensitivity tests, coagulation profile, serum blood urea-nitrogen and creatinine levels, and complete blood count values. Patient- and stone-related characteristics, treatment modalities, and lithotripter use were documented in detail in all patients.

The SPSS 11.0 software (SPSS Inc., Chicago, IL, USA) for Windows was used for data entry and descriptive analysis.

RESULTS

Evaluation of our findings revealed the following data:

Among 1,756 procedures performed for stone removal [1,276 (72.7%) males and 480 (27.3%) females with a mean age of 45.5 (SD± 15.8) years, age range 3-85 years], although endoscopic surgery was the most commonly preferred modality (80.7%, n= 1,417), 21.6% (n=379) of the cases underwent percutaneous nephrolithotomy, 47.3% (n=831) semirigid ureteroscopy, 7.6% (n=134) cystolithotripsy, 2.2% (n=38) retrograde intrarenal surgery, 1.4% (n=24) flexible ureteroscopy, 0.3% (n=6) laparoscopic ureterolithotomy and lastly 0.1% (n=2) cases were treated by laparoscopic pyelolithotomy. Open stone surgery was performed in 19.3% (n=339) cases including pyelolithotomy in 8.5% (n=150) of the cases, ureterolithotomy in 4.7% (n=82), cystolithotomy in 2.4% (n=43), nephrolithotomy in 2.2% (n=39), pyelonephrolithotomy in 0.7% (n=13), anatrophic nephrolithotomy in 0.5% (n=8), pyeloplasty in 0.3% (n=5) and lastly nephrectomy in the remaining 0.1% (n=2) of the cases (Table 1). Regarding the indications of open surgery in our study group, among 339 cases (19.3%) treated in this way, 170 cases (50.1%) were operated as a primary case due to the size as well as localization of the stone(s), 129 cases (38.1%) underwent open surgery for shock wave lithotripsy (SWL)- resistant stones and/or endoscopic surgery failure, 22 (6.5%) were operated due to anatomical abnormalities and lastly 18 cases (5.3%) were operated for the presence of distal obstruction (ureteropelvic junction and ureteral stenosis) in the urinary system.

TABLE 1: The distribution of the treatment modalities.

Treatment modalities	n (%)
Open Surgery	339 (19.3%)
Anatrophic nephrolithotomy	8 (0.5%)
Nephrolithotomy	39 (2.2%)
Pyelonephrolithotomy	13 (0.7%)
Pyelolithotomy	150 (8.5%)
Pyeloplasty	5 (0.3%)
Ureterolithotomy	82 (4.7%)
Nephrectomy	2 (0.1%)
Cystolithotomy	43 (2.4%)
Endoscopic Surgery	1417 (80.7%)
Percutaneous nephrolithotomy	379 (21.6%)
Laparoscopic pyelolithotomy	2 (0.1%)
Laparoscopic ureterolithotomy	6 (0.3%)
Retrograde intrarenal surgery	38 (2.2%)
Semirigid ureteroscopy	831 (47.3%)
Flexible ureteroscopy	24 (1.4%)
Cystolithotripsy	134 (7.6%)
Modalities of lithotripsy	**n (%)**
No lithotripsy	374 (21.3%)
Laser	135 (7.7%)
Ultrasonic	133 (7.6%)
Pneumatic	995 (56.7%)
Ultrasonic + pneumatic	117 (6.7%)
Electrohydraulic lithotripsy	2 (0.1%)

Table 2 summarizes the preoperative findings concerning the patients and the stone characteristics for 1756 procedures. The mean patient age was 45.5 (SD±15.8) years (range 3-85 years), with a male to female ratio of 2.7/1 (1276/480). Thirty-nine (2.2%) patients were under 18 years of age.

During the period, a total of 943 procedures were performed for the removal of ureteral calculi. Semirigid ureteroscopic lithotripsy was the most common method (88.1%, n=831), followed by open ureterolithotomy (8.7%, n=82), flexible ureteroscopic HO-YAG laser lithotripsy (2.5%, n=24) and laparoscopic ureterolithotomy (0.7%, n=6) (Figure 1).

The relative distribution of various treatment modalities applied for renal stones (n=636) is shown in Figure 2. Percutaneous nephrolithotomy (PCNL) was the most common modality (60%, n=379), followed by simple or extended pyelolithotomy (23.6%, n=23.6), radial nephrolithotomy (6.1%, n=39) and retrograde intrarenal surgery (RIRS) (6%, n=38) procedures.

Concerning the incidence and the type of intracorporeal lithotripsy; lithotripsy in addition to ureteroscopy was performed in 1,382 procedures where pneumatic lithotripter was the most commonly used lithotripter (72%) type, followed by holmium-YAG laser (9.7%), ultrasonic lithotripter (9.6%), pneumatic+ultrasonic combination (8.6%) and electrohydraulic lithotripter (0.1%).

DISCUSSION

Following the first percutaneous stone removal in 1976, renal stone surgery underwent dramatic changes in the last 35 years.[5,6] As a result of technological improvements, while the indications for open surgery decreased to a certain extent (1-2%), the majority of the calculi located in different parts of the kidney were successfully managed either with extracorporeal shock-wave lithotripsy (ESWL) or percutaneous surgery.[5,6] Again, as a result of such improvements on one side, the quality of the images obtained improved enormously, and

TABLE 2: The characteristics of the patients.

Age	n (%)
<18 years	39 (2.2%)
18-30 years	284 (16.2%)
31-50 years	759 (43.3%)
51-70 years	550 (31.3%)
>70 years	124 (7%)
Gender	**n (%)**
Female	480 (27.3%)
Male	1276 (72.7%)
Stone localization	**n (%)**
Kidney	636 (36.2%)
Ureter	943 (53.7%)
Bladder	172 (9.8%)
Urethra	5 (0.3%)
Stone side	**n (%)**
Right	763 (43.5%)
Left	783 (44.6%)
Bilateral	33 (1.9%)
NA (bladder and urethra)	177 (10.1%)

NA: not applicable

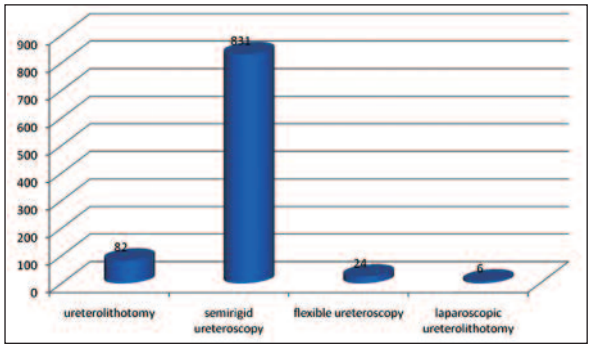

FIGURE 1: Distrubition of treatment modalities in ureter stone disease.
(See color figure at http://www.turkiyeklinikleri.com/journal/tip-bilimleri-dergisi/1300-0292/)

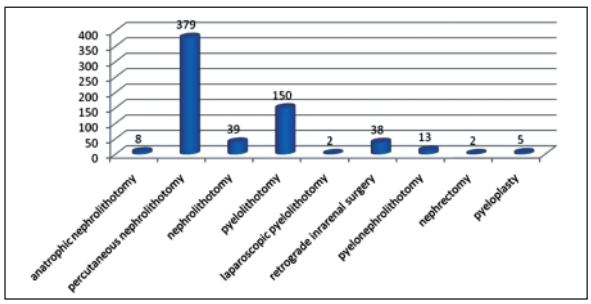

FIGURE 2: Distribution of treatment modalities in renal stone disease.
(See color figure at http://www.turkiyeklinikleri.com/journal/tip-bilimleri-dergisi/1300-0292/)

on the other side by using miniaturized equipment, the invasiveness of the procedures decreased significantly.[7]

Established guidelines in urolithiasis emphasize the importance of endourologic approaches in the minimal invasive management of urinary tract stones. At present, open surgical approach may be a reasonable alternative in selected cases with large and complex renal stones involving all calyceal cavities where ESWL, PCNL and ureteroscopy (URS) were unsuccessful in cases with intrarenal anatomical abnormalities (infundibular stenosis, calyx diverticulum, anterior calyceal location etc.). Additionally, morbid obesity, non-functioning kidney, ectopic kidneys, cases requiring simultaneous open reconstructive surgery (ureteropelvic junction stenosis) and/or in kidneys where endoscopic approach is not possible, are the other indications where open stone removal may be considered.[8]

Data regarding the possible impact of technologic improvements and established guidelines on routine urologic practice for stone removal is not sufficient. Additionally, the number of studies focusing on the changes in actual stone surgery data in both developed and developing countries are extremely limited. In a study from USA, management of urinary stones have been evaluated, and between 1998-2001, in a total of 986 cases, PCNL was performed in 30.2%, ESWL was performed in 29.8%, and URS was performed in the remaining 39.3 % of the cases, and additionally open surgery was performed in the remaining 0.7% of all cases.[9] While the abnormal anatomical factors (large and complex calculi, stones located in anterior calyces, infundibular stenosis, large stones in non-functioning lower calyx, and stones with evident hydronephrosis) were the main indications for open surgery in 85 % of the cases, open surgical approach was preferred in the remaining 15% of the cases due to an unsuccessful endourologic approach. In another study however, Paik et al. reported a 5% open surgery rate in all patients treated for urinary calculi.[4] In 1997, demonstrating the practice patterns in Europe, Bichler and his co-workers from Tubingen performed open surgery in 2.7% of the cases, and PCNL in 22% of the cases.[10]

In a study dealing with the actual basic management alternatives of kidney stones in our country, the representatives of the Ministry of Health reported that, of 13 347 procedures performed in 2008, 39.1% of the cases were managed by open surgery and the remaining 60.9 % of the cases were managed by PCNL.[11] Of those surgical interventions, 50 154 were performed in university hospitals, 3239 were managed in state training and research hospitals, 2661 in private hospitals and lastly 2433 were performed in state hospitals. While the percentage of open surgery were 897 (17.8%), 1055 (32.5%), 1359 (51.07%) and 1905 (78.1%) in these hospitals respectively, the percentages of PNL were 4117 (82.2%), 2184 (67.4%), 1302 (48.9%) and 528 (21.7%), respectively. In the present study, we demonstrated that, with respect to the surgical management alternatives for a successful stone removal, although PCNL was performed in the majority of the cases (59.5%), open surgery was performed in 34.1%, RIRS was per-

formed in 5%, and lastly, laparoscopic approach was performed in 1.5% of the patients. Although the high percentage of open surgery in patients with kidney calculi may be partly due to the exclusion of ESWL application data in our current study, other two more important causes for the frequent use of open surgery were the lack of necessary equipment and experience among urologists, particularly in the state hospitals. Moreover, greater number of stone patients referring with large and complex stones in our country led the urologists to perform open surgery more frequently than the usual tendency, particularly in research and training centers. Last but not least, taking the lack of endoscopic equipments especially in the state hospitals functioning in underdeveloped parts of the country in to account, it is necessary to teach open surgical approaches to all residents supposing that they may be obliged to perform these interventions in such hospitals.

On the other hand, regarding the modern management of ureteral calculi, due to the technological advances in endourologic instruments and the increasing experience in the application of this particular technique, ureteroscopic stone disintegration and/or removal became the preferred alternative in the majority of cases.[8] Clinical introduction of the flexible, fine instruments has further decreased the use of open surgery in such cases by enabling the urologists to manage the majority of the stones located in different parts of the ureter. Open surgery is nowadays rarely reported in papers published from developed countries.[4,9,10] Instead of highly invasive open surgical approach, a less invasive laparoscopic approach with successful outcomes became the first alternative especially in large and impacted ureteral calculi where SWL and URS had been unsuccessful. In a recently published study from Iran, the authors compared the efficacy of retrograde URS, laparoscopic ureterolit-hotomy and percutaneous antegrade approach in proximal ureteral calculi larger than 1.5 cm, and found similar efficacy rates where only 2 cases required open surgery for stone removal.[12] Again, a non-randomized paper from India evaluated the data obtained with retroperitoneoscopic laparoscopy and open ureterolithotomy for calculi larger than 2.5 cm, and despite similar stone free rates for both approaches, the authors found that laparoscopic approach was more advantageous than open surgery due to shorter hospital stay, decreased analgesic requirement, earlier return to work and evident cosmetic appearance of the skin after the intervention.[13]

Impacted ureteral calculi constitute the other types of stones where endoscopic approach fails to bring the patients stone-free in the majority of cases. In a study, the authors evaluated the efficacy of ureteroscopic management in large and impacted stones, and although this approach was successful in 85.7 % of the cases, open surgery was applied in 14.3 % of the cases. Laparoscopic approach was included in the armamentarium.[14] In an original study, authors from Pakistan reported their 10 years experience in the management of ureteral calculi, and parallel to the technologic advancements, the rate of open surgery decreased from 26 % between 1987 and 1995 to 8% between 1996 and 1998. However open surgery has been regarded as the management of choice in cases where endoscopic approach fails, with associated abnormalities requiring open correction, and lastly in cases with large and impacted stones.[15] Again a study from our country reported the data related with the management of 654 ureteral calculi, and open surgery was performed in 9% of the cases where the endoscopic approach was unsuccessful. The authors did not consider laparoscopic ureterolithotomy in the management of such stones.[16]

A recent report from Ministry of Health in our country reported the rates of management alternatives in ureteral stones in 2008.[11] In a total of 33,272 ureteral stone cases, although 8.22% were managed with open surgical approach, 91.78% of the cases were managed with ureteroscopic lithotripsy. Evaluation of the open surgery rates with respect to hospital types revealed percentages as 8.7%, 11.7%, 5.7%, and 8.8%, in university hospitals, state education and training hospitals; private hospitals and state hospitals, respectively. These rates were 91.2%, 88.2%, 94.2%, and 91.1% for ureteroscopic approach in these hospitals, respectively. In our study, open surgery was found to be applied in

8.6% (82 cases) of 943 cases. This percentage was found to be similar to the rates reported from studies from Greece, Portugal, and a similar additional study from our country.[14-16] While semirigid and/or flexible ureteroscopy was successful in the majority of the cases (90%), in 6 cases (0.6%) laparoscopic ureterolithotomy was performed.

Our general tendency for choosing open surgery is presence of large and impacted ureteral stones resistant to SWL, and patients with congenital and/or acquired anatomical urinary tract abnormalities or large and complex stones in kidney (filling all major calyces of the involved kidney).

Although its efficacy has been accepted throughout the world, Ho-YAG laser was utilized only in 7.7% of the cases in our study due to its high cost, particularly in the state hospitals with relatively limited economic opportunities when compared to private hospitals. Pneumatic and combined systems are relatively cheaper and production of these systems in our country again made them reasonable choices in the intracorporeal disintegration of these calculi.

Our study has some limitations that should be taken into account while interpreting the reported data. First of all, the data reported in the text have been derived from 6 different centers in Istanbul, and do not reflect the tendency of whole country. Since the aim of the trial was to evaluate the surgical management of ureteral calculi, the data obtained by ESWL application in these stones has not been included and compared with the existing data. The underlying causes for open surgical approach in each center have not been reported in detail which makes it difficult to evaluate the reasons for high open surgery rates in such stones.

CONCLUSION

In the light of the present data focusing on the surgical management of upper urinary tract stones obtained from 6 different centers in Istanbul/Turkey, it is clear that while the standards for ureteral stone management is quite similar to the generally accepted principles of the developed world, open surgery still remains as a common alternative in the removal of particularly renal stones due to certain reasons mentioned above. We believe that these centers should evaluate the derived data in detail, and re-consider their management policies in order to catch the world standards in all but especially for kidney calculi.

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