DISCUSSION

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The lower incidence of stone formation in children, the higher clearance rate of post shock wave lithotripsy stone fragments and concerns regarding the use of large ureteroscopes in small caliber ureters are the factors that have caused the adoption of ureteroscopy for the treatment of pediatric stone disease to lag behind that of adults.[138]

With the development of small caliber semi rigid ureteroscopes and ancillary instruments, ureteroscopy has become a more attractive treatment option for pediatric ureteral stones. The success in treatment of distal calculi has led to expanding its utility to the treatment of upper tract calculi.[139]

Azili et al[140] found differences in the distribution of symptoms in the age groups; UTI was higher in the 1–4 years age group and abdominal pain was seen mostly in children aged 5–14 years. In current study the most common presenting symptom was hematuria (40%), followed by abdominal pain (35%). Hematuria occurred commonest in preschool age (< 6 years), and abdominal pain mostly in elder children.

Bassiri et al[141] performed balloon dilation in 38% of 66 patients, and no patient had stenosis or stricture at 3-month follow up. Erturhan et al[142] reported ureteral dilatation in 41% of their cases because they used a larger 9.5 Fr semirigid ureteroscope. Smaldone et al.[143] reported ureteral dilatation in 70% of their cases, this high rate of ureteral dilatation was because of the large number of upper tract stones in their series (42%) and their policy of stone and gravels removal after disintegration which was not done in our series. Lesani and Palmer[144] reported their successful pediatric ureteroscopy without balloon ureteral dilatation in any case. In current series, balloon dilation was omitted due to availability of smaller endoscopic equipment (6.9 Fr semirigid ureteroscope) along with a vast array of accessory tools such as laser disintegration. In current study only hyderodilation was done to avoid mucosal injury or future occurrence of vesicoureteral reflux or ureteric stricture. However, difficulty was encountered in 2 cases in current series where DJ stents were inserted and left for 2 weeks then RIRS was done, in another 3 cases of our study DJ stent were inserted post management of lower urinary tract stones.

In current study avoiding fragments extraction in any patient was protocol, as it had many advantages. The first advantage is that there was no need for multiple entries through the delicate pediatric urethra and ureter. Secondly, even if the stone was small, it was slightly bigger than our expectation, so during its removal it may injure the ureter or the urethra. Thirdly, the multiple entries and gravels removal may make the visual field to be hematuric and not clear. The last advantage was that there is no need for ureteric orifice dilatation before the ureteroscopy as we did not intend to extract any stones or gravels. Unfortunately there were no stone fragments available for stone analysis and workup.

Smaldone et al[145] published a large series of pediatric URS in 100 patients up to 20 years old with urolithiasis. The study included 33 patients with renal stones and showed an overall 91% stone-free rate, but the results for renal stones were not mentioned separately. Minevich et al[146] later described their series of 65 ureteroscopic procedures for upper urinary tract calculi in children, with a success rate of 98%. Seven calculi were located in the kidney. Unsal et al[147] found the stone free rate in the RIRS group for stones less than 20 mm were 87.3% and 50% for stones more than 20 mm with no incidence of major complications. Another study reported a 76% stone-free rate after RIRS and no major

complications in 21 children with lower pole renal calculi and they found a similar stone-free rate in their series of prepubertal and postpubertal patients with intrarenal calculi.[148] In 2011, Resorlu reported RIRS series in children 7 years or younger with an overall complication rate of 5.8% and success rate of 88% after a single treatment and in only 1 patient who presented with multiple bilateral renal stones required an additional session of PCNL.[149]In 2005, Tan et al described 23 children with urolithiasis treated with ureteroscopy, with a success rate of 95%. However, only 2 calculi were present in the kidney.[150]

In current study stone free rate was 80% after single session of RIRS and 95% after the second session and failure in 5 % (one case having lower calyceal stone with acute infundibulopelvic angle) which was removed by doing mini PNL.

One study reported experience using 4.5, 6, and 8 Fr rigid ureteroscopes in treating proximal ureteral stones in 24 children with a mean age of 10.7 years. They did not perform ureteral dilation in any case, and 100% of children were rendered stone free.[151] In current series there was 3 patients with proximal ureteric stones and the stone free rate was 100% after single session of RIRS.

Kurzrock and colleagues [152] reported that a stent did not need to be inserted in all patients with only 29% requiring it, and it was removed after a short time. Thomas et al.[153] inserted stents in all cases postoperatively. However, Herndon et al.[154] reported that there was no need for postoperative stents in all cases but they inserted it in only 17.6% of their cases. In current series, insertion of ureteral stent at the end of the procedure in all patients was our protocol in spite of absence of ureteric orifice dilatation, complete disintegration of stones, use of small caliber ureteroscope, absence of multiple ureteral entries, and absence of ureteric injury except in one case.In current study stent placement in children had led to discomfort (the "stent syndrome" of frequency, urgency, lumbar, and flank pain) and necessitated repeated anesthesia for removal, however its insertion was beneficial in allowing passage of stone fragments and avoiding ureteric obstruction. Stenting allows better healing and resolution of local edema, and prevents postoperative pain and possible infectious complications secondary to obstruction.

One study reported also no intraoperative complications in their RIRS series; however, they reported early postoperative complications in the form of pyelonephritis in one case and stent migration in another case that required a second ureteroscopy for its removal. [155] In other study, another study. identified a ureteral perforation rate of 1.4% in 221 pediatric patients undergoing ureteroscopy for calculus disease.[156] Minevich et al.[103] reported no intraoperative complications but one patient developed a late postoperative ureteral stricture that was treated successfully endoscopically. This was mostly due to high rate of ureteral balloon dilatation in their series which was about 30%. Azili et al reported an overall major complication rate of 4.2% [140]. Bassiri et al. performed open reimplantation in two patients who had a severe ureterovesical injury and another with ureteral stricture. They documented the risk factors for the development of stricture formation are an impacted stone, ureteral perforation, and mucosal damage secondary to oversized instrumentation. Most of the early postoperative complications were infectious in nature. The reported incidence of pyelonephritis in the literature is 0-4 %.[157]

In current series, all of the complications were noted at beginning of the series. In current series, we did not encounter any case of ureteral avulsion, there was a single case of intraoperative ureteric orifice partial wall injury with no extravasation and it was managed by

stent placement, and there were two cases in which early postoperative fever on day 0 both cases were managed conservatively. Also, there were no cases of urinary tract obstruction postoperatively which could be attributed to the small gravels size, the absence of ureteral dilatation and our protocol of stent placement. In our series there was no incidence of stent migration.No one of our cases suffered from post procedure pyelonephritis.

As monotherapy, PCNL is considerably effective and safe. The reported stone-free rates in the literature are between 86.9% and 98.5% after a single session. These rates increase with adjunctive measures, such as second-look PCNL, SWL and URS. Even in complete staghorn cases, a clearance rate of 89% has been achieved following a single session.[78-83] Other series showed overall stone-free rate of 81.8% after a single PCNL, with subsequent repeated PCNL and SWL procedures, it increased to 95.4%. These results are within the previously reported range of 67%-100 %.[158] Unsal et al[86] found the stone-free rate after mini-perc in this his series similar to previous studies (75-100%), with success rates of approximately 85.9%. In our study the stone free rate was found near similar to the stone free rate after PCNL in other series for management of stones less than 2 cm in size.

Bozkurt et al[159] retrospectively compared the outcomes of PCNL and RIRS in 79 patients with lower pole calculi with diameters of 15 to 20mm. The authors concluded that RIRS is a good alternative to PCNL, with a stone free rate of 89.2%. Akman et al.[160] reported a stone free rate of 92.8% in the RIRS treated patients and 96.4% in the PCNL group, with overall complication rates for the RIRS and PCNL groups of 7.1% and 10.7%, respectively. Unsal et al[147] reported stone free rate in the mini-perc group for stones less than 20 mm was 100% and 83.9% for stones more than 20 mm .So they concluded that mini-perc and RIRS are highly effective methods of treatment for children with stones up to 2 cm. Although PNL is effective, its biggest drawback is its invasiveness and the possibility of some blood loss. Hospital stay, radiation exposure, operative time and morbidities of mini-perc can be reduced significantly with RIRS technique. This results were similar to current study with total stone free rate of 95% after two session of RIRS and no incidence of major complication or blood loss.

The mean postoperative hospital stay after PCNL is not different from adults; it has been reported as 2 days in all the fore-mentioned studies and is exceedingly shorter than open surgery. The lesser invasive nature of this technique should make it become a promising alternative to open surgery in treatment of renal calculi in children.[98] In current study the mean postoperative hospital stay was shorter than in PCNL patients 1.25 ± 0.64 days as it is less invasive than PCNL with more rapid convalescence.

Although stone-free rates are higher than 75% after a single PNL in children, complications, including urosepsis, bleeding requiring transfusion, renal pelvis perforation, and injury to adjacent organs, is not uncommon. Potential complication of PCNL is hypothermia, especially in this young age group. Hypothermia during anesthesia produces potentially severe complications such as impaired platelet function and coagulation, decreased drug metabolism, increased wound infection rate and cardiac arrhythmias, and prolonged post anesthesia unit stay.[161] The decrease in body temperature is correlated with the duration of the procedure and preoperative preparation.[162] Also, using a high volume of room temperature irrigation fluids could produce heat loss in patients by some intravascular absorption through open injured veins and by soaking of internal organs after leakage of the fluids into the perinephric space.[163] In current study there was no incidence of hypothermia in our patients and there were no intravascular absorption of warmed irrigants used and there was smooth recovery from anesthesia.

Localization of the calculi has been described as a significant factor affecting the success rates in different ESWL studies. Stones in renal pelvis and upper ureter seem to respond better to SWL. In these mentioned sites, the stone clearance rates are nearly 90%. However, SWL was found to be less effective for caliceal stones particularly the lower caliceal stones. Several studies reported stone-free rates for isolated lower caliceal stones varying between 50% and 62 %.[57-60] Muslumanoglu et al.[164] found a 50% stone free rate for lower calyceal calculi (compared to a stone free rate of 71% for upper, 75% for mid-calyceal and 73% for pelvis renal stone). Aksoy et al.[52] reported stone-free rates for renal pelvis; upper, middle and lower calyceal calculi 90, 92, 92 and 88%, respectively) and Elsobky et al.[165] reported stone free rates for renal pelvis and lower calyceal calculi of 89 and 87%, respectively. An acute lower infundibulopelvic angle, complex calyceal pattern, anatomical abnormalities, a narrow infundibulum diameter and a long infundibulum are generally accepted as the most adverse prognostic factors for stone clearance.[166] Pearle et al.[167] compared the efficacy of RIRS to ESWL in a prospective randomized trial on lower pole stones up to 1 cm. On follow-up imaging, 35% of ESWL treated patients versus 50% of RIRS treated cases were stone free. Muslumanoglu and coworkers[168] reported a retreatment rate of 53.9%, and their patients needed on average of 1.9 SWL sessions per stone to achieve a stone free rate of 79.9% with 13.2% of the patients showing residual fragments <4 mm. Some studies showed the need for additional intervention in 7% to 33% of cases.[169]

In current study the stone free rate in upper ureteric, middle and upper calyceal stones was 100% after single session of RIRS, however in renal pelvis SFR was 76.9% after single session of RIRS and 100% after a second session of RIRS. In lower calyceal stones SFR was 35% after single session of RIRS as we were not able to find the stone due to very acute infundibulopelvic angle and SFR raised to 70% after the second session. In current series, patients required single session to achieve 80% stone free rate and 2nd session of RIRS was required in 15% and miniperc in 5%, achieving total SFR of 95%.

In current study RIRS has advantage over PCNL in term of the intra-operative position of the patients with its impact on the respiratory status of the patient, absence of major complication, shorter operative time, less radiation exposure, shorter hospital stay and more rapid convalescence. However stone free rate after single treatment is higher in PCNL than in RIRS and PCNL can be chosen in children with large stone burden (> 2cm), PCNL has also less steep learning curve and cheaper armamentarium than in RIRS. No postoperative complications such as ureteral stricture or hydronephrosis were observed after a follow up period of average 4 months (3-6 months).

Current results demonstrated that operative time, patient age, institutional experience, orifice dilation, stenting and stone burden are important risk factors for complications. Despite its minimally invasive nature, RIRS is not free from complications, and the learning curve of the technique is an important factor contributing to success and avoidance of the major complications.

SUMMARY

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Renal stones in childhood are rare in the developed world, representing 1% to 5% of all urinary tract stones. However, in developing countries, the occurrence of renal urolithiasis in children is 30% of all urinary tract stones.

The lower incidence of stone formation in children, the higher clearance rate of post shock wave lithotripsy stone fragments and concerns regarding the use of large ureteroscopes in small caliber ureters are the factors that have caused the adoption of ureteroscopy for the treatment of pediatric stone disease to lag behind that of adults. With the development of small caliber semi rigid ureteroscopes and ancillary instruments, ureteroscopy has become a more attractive treatment option for pediatric ureteral stones. The success in treatment of distal calculi has led to expanding its utility to the treatment of upper tract calculi.

In the present study, we prospectively evaluated our experience with use of flexible ureterorenoscopy in the management of upper urinary tract stones in children in urology department, Alexandria University.

Twenty children (24 renal units) underwent retrograde intrarenal surgery for renal stones were included in this study. Study was done using both semiregid and flexible ureteroscopy. Only hyderodilation of ureteric orifices was used with no mechanical dilatation. Stones were fragmented in place using holmium yag laser with no trial of fragments extraction. At the end of the procedure DJ ureteric stents were inserted in all patients.

The stone free rates for upper calyceal, middle calyceal and proximal ureteric calculi were 100% after single session of RIRS. The stone free rate for lower calyceal stones was 50% and 76.9% after for renal pelvic stone after single session of RIRS. The total stone free rate after single session of RIRS was 80% and rose to 95% after the 2nd session.

In current series, all of the complications were noted at beginning of the series. We did not encounter any case of ureteral avulsion, there was a single case of intraoperative ureteric orifice partial wall injury with no extravasation and it was managed by stent placement, and there were two cases in which early postoperative fever on day 0 both cases were managed conservatively. Also, there were no cases of urinary tract obstruction postoperatively which could be attributed to the small gravels size, the absence of ureteral dilatation and our protocol of stent placement. In our series there was no incidence of stent migration. No one of our cases suffered from post procedure pyelonephritis. There was no incidence of hypothermia in our patients and there were no intravascular absorption of warmed irrigants used and there was smooth recovery from anesthesia. There was no incidence of major blood loss or need for blood transfusion.

The results of our study have demonstrated that the flexible ureterorenoscopy use is a safe and effective method for the treatment of renal and proximal ureteric stones in children. It reduces the morbidity and hospital stay and thus the overall cost of treatment.

CONCLUSIONS

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Flexible ureterorenoscopy is rapidly becoming a major part of the urologist's therapeutic armamentarium. As with any sophisticated new technique, the operator must have a detailed knowledge of the features and perfect control of the instruments used. Over the past 2 decades flexible ureterorenoscopes (F-URS) continue to evolve and improve significantly including F-URS design, deflection capabilities, irrigation flow, imaging equipment, and durability.

In the present study, we demonstrated that the flexible ureterorenoscopy is a safe and effective method for the treatment of renal and proximal ureteric stones. In current study the stone free rate after single session of RIRS was 80% and 95% after the second session. Surgeon experience and instrumentation are key to complete stone clearance with minimal morbidity.