

**Ph.D., THESIS**

**ENDOUROLOGIC UPPER URINARY INTERVENTIONS IN  
THE CHILDHOOD**

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## INTRODUCTION

In cases of kidney- or ureteral stones, when there was not any chance for spontaneous removal, and the stone caused complaints, infection, or sepsis, after the introduction of safer narcosis at the beginning of the XX. century, there were only possibilities for open removal of the kidney, pyelolithotomy or ureterolithotomy. Renal pole resection was an improvement which was applied in larger series from the middle of XX. century. Nevertheless, this procedure was not free either of the well-known drawbacks of open surgical exploration. Renal resection, also in tumorous diseases, nowadays is made laparoscopically, but, when there is no possibility for this, open operations exist.

Surgery of urologic organs was revolutionized by introduction of the different endourologic interventions. Surgical approach of the kidney- or ureter was rendered possible without open procedure, while the effectivity of the interventions remains the same. These so-called minimally invasive interventions mean incomparably much less encumbrance for the patient, because they only involve hardly one centimeter skin incision and, if needed, they can be repeated.

With the introduction of *percutaneous nephrolithotomy* (PCNL) endoscopic removal of renal stone became possible. Method was expounded in the the late of the years of 70's, but it was worked out and performed in larger series at the beginning of the 80's. PCNL is still the less invasive operative stone removal intervention. Procedure was introduced into Hungary by Cs. Tóth in 1984.

*Ureteroscopy* (URS) is the method for endoscopic removal of stones stopped in the ureter and does not intend to pass spontaneously. By this procedure, which was introduced by Perez-Castro at the beginning of the 80's, it became possible for the diagnostic-optic investigation of the ureter as well as for therapeutic interventions. There is no skin-wound, stone, causing complaints and remained in the ureter, is removed by an instrument led through the urethra into the the ureter. First, in Hungary ureteroscopy was introduced by Cs. Tóth and his colleagues in 1985.

The most up to date, noninvasive treatment modality of urolithiasis is the achievement of the XX. century, called extracorporeal shock wave lithotripsy (ESWL). Intervention was first introduced in Germany in 1980, and is widely used all over the world. Now this method is applied in most cases of renal or ureteral stones, although, in several cases stone-free state

cannot be achieved. In the end these patients will undergo surgical (endoscopic) stone removal. ESWL was introduced into Hungary by G. Wabrosh in 1988.

There was also born an endoscopic method for the solution of pyeloureteral junction (PUJ) obstruction called endopyelotomy (EPT). Intervention was described first by Whitfield and Wickham. The procedure is minimally invasive, can be performed through a one centimeter skin incision. In case of unsuccessfulness, it can be repeated or open operation can be done. Success rate is comparable to open intervention. EPT became effective and acknowledged therapeutic method of PUJ stricture. In Hungary, percutaneous antegrade EPT was first introduced by Cs. Tóth in 1986. On the base of our experience with EPT, gained during adult operations, we perform EPT routinely also in the pediatric population.

One of the achievements of the last years is *laparoscopic pyeloplasty*. Initial results are encouraging, similar to open procedures. Intervention is less inconvenience than open operation, but more invasive than EPT.

Urinary stone disease can also occur in *childhood*, therefore, the above mentioned stone extracting interventions should also be made in these children. Nevertheless, there are only few publications in connection with pediatric endoscopic stone removal, several cases open operations of the kidney or ureter are performed. With becoming ESWL even more in the first line therapy of urolithiasis, number of pediatric operative interventions is decreased, because the composition of pediatric renal stones in most cases is calciumoxalate-dihydrate crystals, which can easily be fragmented. The difference is compared to the adult treatment, can be performed with modern instrument without anaesthesia on outpatient basis, is, that it needs narcosis for the immobility ensures the precise targeting of the stone.

There also can be occur renal caliceal or impacted ureteral stones, staghorn stones in the childhood, not intending to pass spontaneously, not responding to ESWL treatment. PCNL was also introduced in the pediatric population and, on the bases of experience, gained up to now, can be applied successfully similarly to adult patient. In Hungary E. Holman and Cs. Tóth published about pediatric PCNL. Ureteroscopic stone removal, despite it is rare when necessary, can also be performed successfully and without complications in children.

In cases of exploration of PUJ stricture in the childhood, in most cases open pyeloplasty is performed with fairly good, definitive results which means the same procedure applied in adult patients. EPT in the childhood can be performed also successfully, and nowadays the international literature presents the outstanding effectiveness of pediatric laparoscopic pyeloplasty.

Principle of ambition for minimally invasivity is to be even more succeeded in younger patients. In child the long skin and total muscle incision can basically determine, restrict the further activity, capability of work. If predisposing factors are still exist, it is highly probable that sometime later another operative intervention will be necessary. Therefore, in the childhood it is important to apply effective method, but if another procedure is needed sometime later, trails of the previous intervention do not worsen the chance of the forthcoming operation.

Endourologic procedures in the childhood demand significant skills, endoscopic operative experience, refined manuality and, pocessing the formers, professional courage. Their grade of difficulty is higher than in adult patients. Pediatric endoscopic procedures in the Department of Urology of the University of Debrecen, Medical and Health Science Center were introduced in 1995. by Cs. Tóth, though he had already performed these kind of interventions for 1987. In Hungary, pediatric endourologic operations, in the largest series, routinely are performed in our department. Outstanding in the world, experience with more thousands of successful adult interventions were considerably contributed to perform these methods safely, successfully and without any complication in pediatric patient. In Hungary, during the last 3 years, we apply singularly the so called „mini”-PCNL, which makes procedure even less invasive.

Our aim is, that on the base of our experience, gained during several years, to conclude that nowadays widely used endourologic procedures (PCNL, URS, EPT and laparoscopic pyeloplasty lately) which have got 20 years past, can be performed with good results and without complications in experienced hands with adult instruments also in the childhood. We woud like to reach by publishing our results and conclusions, gained during our long-term experience showing news in several consideration to the hungarian urology, that in cases of upper urinary tract pediatric diseases (renal, ureteral stones, PUJ stricture) when operative procedure is indicated it shall be done by minimally invasive, endoscopic way.

## **AIMS**

To prove, that

1. renal stones developed and causing complaints in the childhood, resistant against ESWL treatment can be removed during PCNL as successfully,

safetily and without any complication as in adult patients; the intervention does not demand different small sized instruments,

2. in cases of staghorn stones or more than one stone locate far from each other in the renal collecting system, child can become totally free of stones in one session, during one narcosis by PCNL,
3. our „mini”-PCNL is effective, as well as safe and even less invasive method for removing renal stones of 5-7 millimeter, not fragmented against previous ESWL treatment.
4. In case of congenital PUJ stricture, explored and causing complaints in the childhood, as primary therapy minimally invasive EPT or laparoscopic pyeloplasty shall be performed instead of open pyeloplasty, because invasiveness is much more less, effectiveness is similar to open intervention.
5. With becoming application of laparoscopic urologic operations even more routinely, number of laparoscopic pyeloplasty shall be increased, so that to evaluate exactly its successfulness, advantages and drawbacks comparing to open pyeloplasty and EPT.
6. Stones, stopped in the pediatric ureter not either intending for spontaneous removal even after ESWL treatment, shall not be removed by open ureterotomy, because stone can successfully be extracted without complications by URS with the same instrument is used in adults.

## **PATIENTS AND METHOD**

### ***Percutaneous nephrolithotomy in the childhood***

Between July, 1995 and March, 2004 we performed PCNL in 70 children. Youngest patient was 10 months old, the oldest was 17 years old at the time of the operation, mean age 11,5 years. In 5 patients „mini” stone removals were performed. Totally, 78 procedures were done. In 37 girls 42, and in 33 boys 36 interventions were performed. Stone location was right side in 42, left side in 38 cases. There were bilateral stones in 5 children. Of them 3 patients were operated in two, and 2 patients in one session. There were open stone removal in 5, open

pyeloplasty at the affected side in 1, and unsuccessful ESWL treatment in 26 children in the previous history.

During preoperative investigations urine analysis, when pyuria was found urine culture, renal ultrasonography, kidney-ureter-bladder (KUB) X-rays and intravenous urography (IVU) were performed (20-50 ml, 300mgJ/ml concentration). Basic blood laboratory examinations (blood picture, creatinin, ionogram, heamostasis), pediatrics opinion was asked to the narcosis of the child.

Preoperative preparations in larger steps were the same as in adults, only there were little difference in some moments. Operations were performed in general anaesthesia. After introduction of narcosis in supine position with help of 12F pediatric cystoscope, a 4-5F ureteral catheter was inserted into the collecting system of the affected kidney which was fixed to 10-14F urethral catheter. In cases of bilateral stone operations, ureteral catheters were inserted into both kidneys. In 4 children, because of little size or contracted immobility of the lower extremities, ureteral catheter was not inserted. After that patient was turned into prone position, flank area was emerged. Through the ureteral catheter, collecting system was filled with water soluble ionic contrast material colored with methylen-blue, as well as ureteral catheter prevented drifting small stone fragments into the ureter. Puncture of the collecting system was through the lower or middle calix-bottom with 18G needle under momentary fluoroscopic control. Danger of bleeding is the least at this less vascularized area. When ureteral catheter was not inserted, puncture was directed towards the stone. A 0.035 inch in diameter guidewire with soft tip was inserted through the needle into the collecting system. A 10 millimeter skin incision was made and the pricking channel was gradually dilated with telescopic metal dilators up to 26F. For visualisation body-warm, physiologic saline solution was used. Forceps was led through the working channel of the instrument and the stones were removed. In cases of staghorn stones or stones larger than 1 centimeter in largest diameter, in 28 cases, ultrasound or electrokinetic intracorporeal stone fragmentation were applied. Small fragments were removed with suction part of the ultrasonic probe, larger fragments were removed by forceps. After making the collecting system stone-free, ureteral catheter was removed and nephrostomic drain was inserted for temporary diversion of urine. Urethral catheter was removed the day after the operation. In cases of bilateral stones, operated in one session, procedure was started on the side where the stone was larger, than, when there was not significant bleeding, procedure was continued with the other side. In case of „mini“-PCNL skin incision is only 5 millimeters, dilatation of the working channel stopped at 16F. 18F plastic tube was pulled onto the 16F metal dilator. Plastic tube was positioned near to the

stone under, momentary fluoroscopic control. Then forceps was inserted into the tube and stone was removed. Because there were not remained stone fragment in the kidney at the end of the intervention ureteral catheter was removed. Nephrostomic drain was not inserted either, because in consequence of thin working channel and short procedure there was no bleeding necessary for deviation.

### ***Endopyelotomy in the childhood***

Between January, 1990 and March, 2004 EPT was performed in 39 patients. Interventions before July, 1995 were done in the previous department of my tutor. Our youngest patient was 4,5, oldest was 17 years old at the time of the procedure (mean age 12 years). 22 girls and 17 boys were operated. All the disorders were primary, congenital strictures. The right and left side ratio was 26:15. One patient had bilateral stenosis, the two side were operated separately. First the more serious right, then half a year later the left side. Routine laboratory examinations, IVU were performed before the interventions. Pictures were taken regularly, till the renal pelvis was completely full with contrast material, so that we could clearly see the site of the stricture and degree of the dilatation of the collecting system. Retrograde ureteropyelography were performed in 4 cases because of the poor visualisation of the PUJ during IVU. Serum hemoglobin and creatinin levels were controlled right after the intervention, and on the second postoperative day.

Interventions were performed in general anaesthesia. After pricking the middle caliceal bottom, dilation happened similarly as described at PCNL. The same 26F nephroscope was inserted and PUJ was visited. A flexible guidewire was inserted via the working channel of the nephroscope, beside the ureteral catheter down into the ureter through the PUJ. Then, the ureteral catheter was pulled out. A hooked, steel, cold knife was inserted beside the guidewire through the working channel of the nephroscope and a 10-20 millimeter in length incision was performed in dorsolateral direction under nephroscopic visual control. All tissue layers were cut, the periureteral fatty tissue should be seen. Finally, the PUJ was stented with the help of the guidewire by a 6-12F (depending the length and degree of the stricture) polyethylene transrenal drain or a double-J catheter, placed antegradeously. Afterwards the guidewire was removed. Transrenal drain was perforated by several small holes at its renal pelviceal part so that to divert safely the urine from the collecting system. In cases when double-J catheter were used, a transrenal drain were also left in place at the end of the procedure. Urethral catheter was removed the day after the operation. Transrenal drain

was closed when urine became clear, generally on the 2-3<sup>rd</sup> postoperative day and removed after 6 weeks. In cases of stenting with double-J, transrenal drain was removed on the 2-3<sup>rd</sup> postoperative day, double-J was removed cystoscopically after 6 weeks later in local anaesthesia or in short narcosis.

### ***Laparoscopic pyeloplasty in the childhood***

We have been performing laparoscopic pyeloplasty since March, 2003, two pediatric interventions were made. Years of age were 11 and 17, procedures were left sided in both children. Investigational methods were as same as described at EPT, retrograde ureteropyelography was not done.

Ureteral catheter was inserted at the beginning of the operations. Patient was fixed in lumbotomic position, patient was laid on the other side, flank area was emerged. Target organ was approached by retroperitoneoscopic way. In the middle armpit line, above the ileal crist, 1,5 centimeter long skin incision was made, then, subcutaneous tissues, lateral abdominal muscle layers and its fascias were pricked through by Pean instrument, which was signed by ending the resistance. Channel was widened by opening the Pean forceps. Place was enlarged by the little finger so that to separate the peritoneum from the abdominal muscles. Rubber gloves finger was knotted to the end of 20F Nelaton catheter. This type of „ballon catheter” was inserted into the retroperitoneum and gloves finger was filled with heated isotonic saline solution of 250 and 500 milliliters during 3-4 minutes. That way there was an arteficial space formed in the retroperitoneum. Ballon was deflated, catheter was removed and 10 millimeter laparoscopic port and 30 degree lens telescopic, previously heated optic were inserted. Retroperitoneal space was filled in with carbon dioxide gas up to 15 mmHg. At the left side above the iliac spina 5,5 millimeter, in the posterior armpit line 11 millimeter laparoscopic ports were inserted under eye-visual control. The narrow PUJ was prepared with laparoscopic tools and was incised longitudinally in laterodorsal direction. Ureteral catheter was removed. Stenting and untroubled healing of the ureter was ensured by antegrade placement of double-J catheter and wound of the ureter was sutured in transversal direction with atraumatic absorbable thread. Drain was placed beside the ureteral wound, after removing the gas skin wounds were closed. Urethral catheter was removed the day after, double-J catheter was pulled out 6 weeks later the operation. Then, renal ultrasound examination was performed to estimate the dilatation of the collecting system.

### ***Ureteroscopy in the childhood***

Ureteroscopic stone removal was performed in 7 children in cases of ureteral stones stopped in the ureter, not intending to pass spontaneously. First intervention was made in August, 1997. Youngest patients was 10 months old, oldest was 17 years old at the time of the procedure, mean age 11,6 years. Forging ahead and successfulness of ESWL treatment is signed by, that our last intervention was in February, 2002. Five girls and 2 boys were operated, totally 8 operations were performed. There were 3 right and 5 left sided of the removed stones. There were possibilities for previous ESWL treatment in 4 cases, which failed in each patients. In 1 patient after 4 years of successful URS, at the same side, PCNL was performed because of recidiv stone.

Interventions were performed in general anaesthesia. In lithotomy position, 9F semirigid ureteroscope was inserted through the urethra into the urinary bladder, where the ureteral orifice was found. In adults the same instruments is used. Separate ureteral orifice dilatation were not applied. After getting to the stopped stone, Dormia-basket was inserted into the working channel of the ureteroscope. Stone was caught into the metal-net of the basket, then pulling down carefully under optic-visual control and was removed together with the instrument. In three cases electrokinetic fragmentation was used. At the end of the intervention in six cases ureteral catheter was inserted for 24 ours, in two children double-J catheter was left in place which were removed after 2 weeks.

## **RESULTS**

### ***Pediatric percutaneous nephrolithotomy***

Operations lasted between 3-45, on average 13 minutes from the puncture of the renal collecting system to the insertion of transrenal drain. „Mini” interventions lasted 3-7 minutes. Stone-free state, including bilateral cases, were achieved in all cases. It was proved by KUB X-rays and ultrasound examination performed on the first or second postoperative day. Size of the removed stones were between 5-52 millimeters. There were 12 staghorn stones, on of them was bilateral. There were calcium oxalate stones in 55 cases (70%), but in our series the most frequent matter of staghorn stones was cystine (13 cases, 17%). Struvite were removed in 9 (12%), mixed oxalate-uric acid stone was removed in 1 (1%) occasions. Bilateral stones

were formed from cystin, and 1-1 cases from calciumoxalate and struvite (the latter was bilateral staghorn stone).

There were no any significant complication during the operations or in the postoperative period, there was no need for open exploration in any case. There was no need for either blood transfusion or for other auxiliary intervention (another PCNL because of residual fragment, URS because of ureteral concrementum). There were not observed either postoperative bowel-passage disorder or persistence of the renal fistula, nephrostomic tract closed spontaneously within 24 ours after removal of the transrenal drain. Children walked on the day after the operation, hardly complained of pain. They went home on the 2-6<sup>th</sup> postoperative day (4<sup>th</sup> day on average). On the skin remained only a thin, slightly visible per primam healed scar. During control examinations, 3 time intervals in the first year urine analysis, renal ultrasound examination was performed in all cases, when it was necessary KUB X-rays and IVU were made. In stone-free state, control was adviced half yearly in the second year, then yearly. These examinations were performed often in a local department or office where the patient was lived near to. That way we could examined again 45 children (64%) at different time after the original intervention. Of them, in 9 children were observed recidiv stone formation, 5 of them were cystine, 3 calciumoxalate-dihydrate and 1 struvite. In 5 children, 4 with cystine and one with calciumoxalate, PCNL was repeated successfully, in four patient stones were removed by successful ESWL treatment.

### ***Pediatric endopyelotomy***

There were 41 operations in 39 patients. Mean manipulating time in the renal collecting system was 17 (9-35) minutes. In two children two and three days after EPT, the operated kidneys had to be explored through a lumbotomic incision because of slow, but permanent bleeding via the nephrostomic tract and into the perirenal space in the retroperitoneum, developing into growing hematoma. During open surgery bleeding crossing aberrant veins were found near to the endopyelotomic wound, which were clamped then ligated without any consequense. Perirenal hematoma was evacuated and PUJ was stented with transrenal drain.

EPT was not a great expense for the patients; they could get out of bed and walk on the first postoperative day. There were no need for blood transfusion in any cases. Postoperative hospital stay was between 2 and 10 days (average 5 days). Among the 39 patients, procedure had to be repeated in one case, because the transrenal drain, stenting the

pyeloureteral junction, slid back to the renal pelvis. After the second intervention patient cured without any complication. Also two weeks after of EPT a 7 year-old boy was referred back to our department in rather bad, acute septic conditions. After a short evaluation of the situation we decided to perform open nephrectomy so that to remove the the septic focus. During the operation pyonephrosis was found. Also in one case, one year later of EPT, diameter of the renal pelvis increased, patient had symptoms and persistent pyuria in spite of antibiotic treatment. Renal ultrasound examination showed severe hydronephrosis with thin, hardly perceptible renal parenchyma, which suggested that this kidney was in end-stage. We performed isotope renography (using <sup>99m</sup>Tc-technetium-traced dimercaptosuccinate) which showed no renal function at this side. Contralateral organ was intact. Open nephrectomy was performed. During follow up, renal ultrasonography was performed at 3 month intervals in the first year and 6 month intervals in the second year, then yearly. This examination was capable of following the gradual decrease of renal pelvis dilatation. Results were based on radiomorphologic changes of the renal collecting system, obtained during the comparison of the preoperative intravenous urograms with postoperative ones, performed one year after EPT. The success of the operation was evaluated according to the followings: - *good*, if on IVP performed 1 year after the intervention the time of appearance of the contrast material in the collecting system was shortened, the PUJ stricture was not seen, the renal pelvis dilatation disappeared or decreased and the ureter filled good with contrast material. Of the 40 operated renal units results were good in 32 (80%) cases. Result was *satisfactory*, if the time of appearance of the contrast material in the collecting system was shortened, but renal pelvis dilatation persisted, the ureter filled good with contrast material, patient had no symptoms and pyuria. Satisfactory result was achieved with 4 operations (10%). This means, that good or satisfactory result was achieved in 36 renal units. So, our overall success rate was 90%. In 4 cases the original procedure *failed*. After two years of the original intervention, patients are followed yearly by renal ultrasonography and urine examination and are without any complaints at the moment.

### ***Pediatric laparoscopic pyeloplasty***

Operations lasted 200 and 175 minutes. There were not observed any complication during the operations, children bore good the prolonged narcosis. There was no need for blood transfusion. Postoperative period was also was undisturbed. Patients could walk on the first postoperative day, there were only hardly need for decreasing pain. Children went home

on the third postoperative day. Places of laparoscopic ports healed with per primam, slightly visible 1 centimeter long scar.

Follow up time is rather short (3 and 6 months) number of patients is little, therefore, we can only report short-term result. In the case of the first patient 6 months after the procedure IVU was performed. Our results are encouraging, patients have been without any complaints by this time. Nevertheless, to evaluate long-term result, as well as compare them to open pyeloplasty or EPT, both increasing number of patients and more years experience are necessary.

### ***Pediatric ureteroscopy***

Operations were lasted 5-28 minutes, mean operating time was 12 minutes. Intraoperative complications, perforation of the ureter were not observed. Stone-free state was achieved in all cases. In two patients middle part, in five children lower part ureteral stone were removed. Our youngest patient had bilateral lower part ureteral stone. Stone size was between 5-17 millimeters. Postoperative period was uneventful. Stone-free state was proved by KUB X-rays performed on the first or the second postoperative day. Patient went home on the second or on the third postoperative day, signs referring either ureteral stricture or vesicoureteral reflux were not observed.

## **DISCUSSION**

In our department we do not perform open surgery because of either renal or ureteral stone disease, revealed in the childhood. In case of congenital PUJ stricture, as first intervention EPT is made both in adult and pediatric patients. Minimally invasive laparoscopic interventions were introduced in our department in November, 2000. On the base of international experience, laparoscopic approach is extremely capable of solving PUJ strictures caused by aberrant vessels. Successfulness is similar to open procedures, because during laparoscopy the same movements can happen as when open pyeloplasty is performed. We first introduced laparoscopic pyeloplasty in Hungary and perform it in the childhood too.

*Upper urinary urolithiasis in childhood* occurs more rarely as observed in adults, but, in these cases removal of the stone causing complaints, not intending to pass spontaneously becomes a task similarly to adults. Traditional, open surgical removal can be done in any

time. The most up to date treatment, advised as first line intervention for renal or ureteral stones developing in the childhood, causing complaints, not intending to pass spontaneously, is ESWL. The instrument has been continuously available for us for 3 years, but its availability had been restricted in the previous times. The most frequent, softer in its structure calciumoxalate-dihydrate, struvite are suitable subjects for the treatment. Nevertheless, pediatric ESWL is more invasive than the adult procedure, because painless, necessary for precise targeting of the stone during the treatment has to be ensured by narcosis. This is acceptable for one renal or ureteral stone suitable for ESWL treatment, because pediatric PCNL happens also in narcosis. However, if the stone does not pass spontaneously or only fragmented partially, if another ESWL treatment is indicated, child has to undergo another general anaesthetic procedure. If more stones locate far from each other in the collecting system, preferring ESWL, it is sure, that more treatments just as many narcosis are demanded. It is also sure, that treatment of staghorn stone needs several sessions, removal of the fragments can be prolonged and can cause complication. Taking it all into consideration, it can be concluded that now, ESWL is the least invasive method for removing renal or ureteral calculi, nevertheless, it cannot be declared undoubtedly in any stones that will entirely pass from the patient in consequence of the treatment. Size of stone fragments developing during the treatment depends on several conditions, but it is not regulable. Fragments, sliding into the ureter can cause complication. In childhood narcosis is demanded.

With PCNL, we have such a minimally invasive, endoscopic stone removal method when with one procedure, - although surgically – totally stone-free state can be achieved, even in cases of staghorn stones. On the base of the formers, in certain cases, PCNL can be more advantageous solution, than ESWL. Procedure is definitive regarding the stone, there is not remain any stone fragment in the collecting system. Child becomes stone-free during one intervention, that is the most important advantage of the procedure. As a consequence of little wound, abdominal muscle remains intact, the kidney does not suffer. If necessary, in another stone formation, operation can be performed as successfully as in the primary intervention, this was also justified in our work. Now, on the base its prompt availability, we indicate ESWL treatment in even more children, but, if the procedure fails we advise percutaneous removal. To summarize it all our indications for pediatric PCNL were: renal pyelic or caliceal stone less than 2 centimeters in largest diameter, after failed ESWL therapy; stone, larger than 2 centimeters; more stones locate far from each other in the collecting system; partial or total staghorn stone; bilateral stones; bilateral staghorn stones. Stone-free state was achieved in all of our operations. There were neither any complication needed auxiliary intervention nor open

exploration. Elasticity, caused by the higher water and elastic fibre content of pediatric tissues, allowed us to use the same 26F rigid nephroscope which is applied in adults. After removing the instrument renal parenchyma, with its elasticity, stick closely together preventing and tamponing bleeding. With our interventions we did not make any permanent condition restricting further activity if the child. For removing stones, 5-7 millimeters in largest diameter, not intending to pass spontaneously, „mini” stone removal was worked out fastening the process of procedure and decreasing towards its invasiveness.

In pediatric ureteral stones, causing renal colics because of occlusion, not intending to pass spontaneously, also ESWL treatment is the first line therapy, which is successful in most cases, namely, the most frequent soft stone fragments and passes in little pieces without causing complaint. Nevertheless, there are some, obviously rarely occurring, cases when the previous process do not happen. Open exploration can also be avoided, because of the presence of small stones detected in most patient. These stones can be removed successfully without cutting, by URS. On the base of experience, gained during several years, URS in adult is effective, minimally invasive stone removal method. Thin instruments used in adults, making dilatation of the ureteral orifice unnecessary, can be also used without complication and safely in children. Our youngest patient was 10 months old. We did not see any complication during the operations or in the postoperative period, during further control examinations sign of ureteral stenosis and vesicoureteral reflux were not observed.

Till the middle of the 1980s, open pyeloplasty had been the only surgical solution of PUJ stricture. Success rate of the intervention can be nearly 100% both in adults and children. Its backward issues from the open exploration, but open pyeloplasty is still exists and has to be performed on the base of appropriate indications. EPT minimally invasive treatment of PUJ stricture in adults with proven effectivity and safety. The narrow PUJ can be cut by using cold knife as we do, electrocautery or laser fibre. Direction of incision is posterolateral, the chance of vessel injury is the least that way. In case of failure of the first intervention, it can be repeated or open pyeloplasty can be done. EPT can also be performed successfully even after failed open pyeloplasty. According to the literature, the success rate of EPT moves between 72-92% with a mean value of 85%. In spite of the advantages and good result with EPT in adult patients, there are only some places where the intervention is successfully applied in the pediatric population. In pediatric PUJ stricture, traditional „gold standard” treatment is open pyeloplasty. Results are fairly good, but similar results can be achieved with EPT too, without incision of the abdominal wall of the patient. On the base of our experience, EPT can be applied with the instrument we use above 4 years of age without any damage.

Evaluation of the success of our interventions were based on simple radiomorphologic changes of the operated renal collecting system. We were satisfied with this method and it was sufficient for us to evaluate the results achieved by EPT. The newest, bringing revolutionary changes, dynamically developing, rapidly expanding achievement of the modern urology is introduction of laparoscopy into the surgery of urologic organs. Method is mainly is the alternative of open surgery. Nowadays all urologic organs can be successfully operated by laparoscopy, moreover, oncologic radical interventions also can be performed. In Hungary, first time E. Holman and Cs. Tóth performed laparoscopic intervention in 1992, nevertheless, laparoscopic operations are applied only sporadically in our country. In Hungary, at that time, most frequently, routinely, laparoscopic procedures are used in our department. On average, 3-4 laparoscopic procedures happen weekly, of them 2-3 on the kidneys. At that time in our department laparoscopic interventions are used by every urologist as well as by the only resident physician. T. Flaskó reported more than 240 successful interventions in the second half of 2003. The newest therapeutic method for the solution of PUJ stricture is laparoscopic pyeloplasty, which is applied in even more centers. Laparoscopic pyeloplasty is expensive, technically challenging, needs advanced laparoscopic skills and expensive method. This endoscopic intervention is, apart from the longer narcosis time, minimally invasive, its advantages are mostly the same as in cases when EPT is performed. When EPT demands only one, laparoscopy needs more entry-side on the skin, according to the number of ports. On the base of interventions have been performed, also regarding the international literature, results are mostly as excellent as when open pyeloplasty is performed. If aberrant, crossing vessel is present, it can be clearly seen during the procedure and the best solution can be chosen to solve the problem. Laparoscopic pyeloplasty seems to combine the advantages of open pyeloplasty and EPT, that is why, regarding the fairly good results, the intervention can become the best therapeutic option not only in adult, but also in children. On the base of international data, results of pediatric laparoscopic pyeloplasty can reach the 100% as in adult patients, but further evaluations are needed for getting long-term results. In Hungary, laparoscopic pyeloplasty was performed in our department first time both in adult and children. At that time patients are free of symptoms, the few number of patients and short follow up time do not allow to establish long-term results, but our initial experience is promising.

## CONCLUSIONS

1. On the base of my work, I determined the rational indications of pediatric PCNL. I declare, that on the base of indications reviewed by me, PCNL is minimally invasive endoscopic therapy in all pediatric nephrolithiasis when ESWL fails because of any reason, and can be performed in one session successfully, without complications. Intervention is capable of removing bilateral renal stones either in two or even in one session too.
2. With my work I prove, that it is unnecessary to perform open exploration neither in cases of pediatric staghorn stones nor in cases of renal stones locate far from each other in the renal collecting system. In the latter cases, child possibly can be made stone-free by ESWL in some more sessions, which means the same number of narcotic procedures. By PCNL, pediatric patient becomes totally stone-free in one session, during one narcosis in both cases. Using appropriate operative technique stone fragment does not remain in the collecting system.
3. In Hungary, we worked out and introduced the method of „mini”-PCNL, which was proved to be safe, can be done without complications in removing 5-7 millimeters renal stones not intending to pass spontaneously after ESWL treatment. Width of the working channel is only 18F by these interventions, nephroscope is unnecessary to use. Nephrostomic drain is not left in the collecting system at the end of the procedure („tubeless” operation) decreasing further the invasiveness of the original percutaneous intervention.
4. I appoint, that results with percutaneous antegrade EPT is comparable to open pyeloplasty in cases of PUJ stricture, causing complaints, revealed in the childhood. Nevertheless, invasiveness is far more less than open operation, therefore, as primary intervention we advice to perform EPT. On the base of our results we suggest open pyeloplasty in the cases when endoscopic operations are unsuccessful.
5. Referring to international data, and our initial results I certify, that pediatric laparoscopic pyeloplasty also can be performed successfully, may be the alternative of

open intervention by its minimally invasiveness, though, its place and role can be determined, both inland and internationally, after more time by increasing number of patients.

6. With my work I verify, that in cases of stones, stopped in the pediatric ureter, not intending to go spontaneously even either against of previous ESWL treatment, unnecessary to perform explorative operation. Stone, with thin ureteroscope used nowadays in adult, can be removed safely, without complications. I state, that neither ureteral stricture nor vesicoureteral reflux do not develop after the procedure.

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