PEDIATRIC UROLOGY

Endoscopic placement of double-J ureteric stents in children as a treatment for primary hydronephrosis

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Introduction: *The aim of this study was to determine the efficacy and potential complications of double-J ureteric stents in the treatment of primary hydronephrosis in pediatric patients.*

Materials and methods: *A retrospective case-records review of 133 patients (45 girls and 88 boys) treated because of primary hydronephrosis with double-J ureteric stents, in Department of Pediatric Surgery, Split University Hospital, between December 1997 and December 2014, was performed. Success of treatment, results of follow up investigations and complications were recorded. Patients were followed up clinically and radiologically for a minimum of 2 years following stent insertion.*

Results: *In all, 133 endoscopic double-J ureteric stents insertions were performed. Of the total number of patients, left-sided hydronephrosis was found in 82 patients, right-sided in 38, and bilateral in 13 patients. The median age of children was 2 years (range 0-17 years). Mean hospital stay was 2 days (range 1-10 days). In primary hydronephrosis, double-J ureteric stenting alone was effective with resolution of hydronephrosis in 73% of cases (97/133 insertions). Regarding the age of the patients the highest success of 83.5% was achieved in age group 0-4 years. Success in groups 5-9 years; 10-14 years and 15-17 years were 47%; 33.5% and 0%, respectively. Several complications have been recorded: symptomatic infections, migration in the renal pelvis and bladder, progression of hydronephrosis, spontaneously prolapse of prosthesis, bleeding and perforation of the renal pelvis. A significant, decreasing trend in success rates by age of participants was observed ($p < 0.001$).*

Conclusions: *Ureteric stenting is minimally invasive procedure that provides an alternative to open surgery in patients with primary hydronephrosis. Endoscopic placement of ureteric double-J stents should be considered as a first-line treatment in the management of primary hydronephrosis especially in children till 4 years of age, with success rate of 83.5% and without the need for conventional surgery. In a case of failure we are time-consuming to definitive surgery.*

Key Words: hydronephrosis, double-J stent, children, ureteric stent

Introduction

Hydronephrosis refers to distension and dilation of renal collecting system, usually caused by obstruction of the free flow of urine from the kidney. Although this is often used to denote ureteropelvic junction obstruction (UPJO), it is important to note that hydronephrosis is not a diagnosis in itself but a descriptive term denoting pathological dilatation of the renal pelvis and calyces. Congenital UPJO is the most common cause of upper urinary tract obstruction in children. UPJO is twice as common in males as females, particularly in the neonatal period, with 66% occurring on the left side.[1,2] Hydronephrosis is typically discovered

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during maternal-fetal ultrasound and accounts for approximately 0.5%-1% of all uropathies seen in the neonatal period.[2] In neonate with persistent hydronephrosis after birth, UPJO represents 44% of all postnatal causes of hydronephrosis, placing the incidence of UPJO at 1 in 1250 births.[2,3] In kidneys with high-grade UPJO, inadequate drainage results in hydrostatic distension with increased intrapelvic pressure and poor outflow of urine. Chronic increases in intrapelvic pressure can result in irreversible damage to the kidney. With the advent of prenatal fetal ultrasonography, most infants born with UPJO are detected antenatally. Most cases of prenatally diagnosed UPJO resolve spontaneously by postpartum, but approximately 25% will need surgery. The gold standard for treating UPJO is considered to be open-dismembered pyeloplasty, which has shown to have high success rates in several studies.[1-5] The use of the endoscopically inserted indwelling double-J stent for achieving internal drainage of the ureters was first described over 20 years ago.[6] Since then, many authors have reported their success, with the double-J stent in children as a safe and effective alternative to external drainage for many urological conditions. The aim of this study was to evaluate the management and outcomes of the utility of double-J stents in pediatric patients with primary hydronephrosis.

Materials and methods

Patients

The case records of 133 children (45 boys and 88 girls), treated endoscopically with double-J stent insertion for primary hydronephrosis from December 1997 to December 2014 at the Department of Pediatric Surgery, Split University Hospital, were retrospectively reviewed. All patients enrolled in the study had primary hydronephrosis, as determined by ultrasound or nuclear scan. Indications for intervention included the following: worsening of the renal function, progression of hydronephrosis and severe dilation by ultrasound, severe obstruction on a diuretic renal scintigraphy, symptomatic hydronephrosis (mass, UTI), severe bilateral hydronephrosis (transverse pyelon diameter > 50 mm) and severe hydronephrosis in child with one kidney. The study included patients of both genders, aged 0 to 17, treated by insertion of double-J stent because of primary hydronephrosis. Special cases were the patients with bilateral hydronephrosis – the side with lesser function or more dilatation was treated by pyeloplasty and another side by insertion of double-J stent. Exclusion criteria were as follow: patients treated conservatively, patients treated surgically (Anderson-Hynes pyeloplasty or ureterostomy), patients with primary megaureter, patients with secondary hydronephrosis or ureterohydronephrosis and patients with incomplete follow up. The patient data are summarized in Table 1.

TABLE 1. **Demographic and clinical data in patients with hydronephrosis**

Patient data		
Median	2	(0-17)
Age (years)		
0-4	103	77%
5-9	17	13%
10-14	9	7%
15-17	4	3%
Sex		
Male	45	34%
Female	88	66%
Side		
Right	38	28%
Left	82	62%
Bilateral	13	10%
Hospital stay (days)		
Median	2	(1-10)
Duration of procedure (min)		
Median	21	(12-48)
Time from double-J stent placement to removal (months)		
Median	11	(10-13)
Follow up (months)		
Median	47	(24-202)

Hypothesis and outcome measures

The primary endpoint of this study was to test the hypothesis that hydronephrosis in some children may be resolved successfully with double-J stent insertion alone, without need of pyeloplasty. The primary outcome measure was success of the procedure (resolution of hydronephrosis). The secondary outcome variables were the intraoperative and postoperative complications, duration of the procedure, hospital stay and rate of pyeloplasty after removal of double-J stent.

Endoscopic double-J stent insertion

The stents used were Inlay Optima ureteric stent (Bard Medical, Covington, GA, USA) 3.0-4.7 Fr. Multi-length polyurethane double-J stents without valves. All procedures were performed with the children in the

lithotomy position under general anesthesia. A 9.5-Fr pediatric cystoscope (Richard Wolf GmbH, Knittlingen Germany) was used to visualize ureteral orifices. A flexible guidewire was inserted through cystoscope into the ureteral orifice and advanced up into the kidney. Double-J stent was advanced over the guidewire, once the double-J stent was pushed into the cystoscope, stent pusher was placed over the wire and double-J stent was pushed into the renal pelvis till the black line before the distal curl was at the level of ureteral orifice. Guidewire together with stent pusher were removed and position of the stent was visualized in bladder.

Follow up

In all patients renal ultrasonography was performed the day after endoscopic procedure to visualize double-J stent and to detect status of the hydronephrosis. In the case of regular double-J stent position the patients were followed up by ultrasound at 1, 3, 6, 9 and 12 months postoperatively. In case of failure depending on age and clinical condition of the patient Hynes-Anderson pyeloplasty or pyelostomy was performed. In patients with successful insertion double-J stent was removed after 12 months and the patient was followed up by ultrasound at 7 days, 1, 3, 6 and 12 months. In case of resolution of hydronephrosis the patient was followed up once a year by ultrasound, and in case of recurrence of hydronephrosis or complications Hynes-Anderson pyeloplasty was performed.

Statistical analysis

The data were analyzed using the Microsoft Excel for Windows Version 11.0 (Microsoft Corporation, USA) and SPSS 19.0 (IBM Corp, Armonk, NY) software programs. Distributions of quantitative data were described by means and standard deviations, or medians and ranges, whereas absolute rates and percentages were used to describe categorical data. The Cochran-Armitage test for trend was used to test the significance of trend in success rates by age group. All values of $p < 0.05$ were considered to indicate statistical significance.

Results

In selected study period, a total of 133 patients underwent double-J ureteric stenting for primary hydronephrosis. Of the total number of patients, left-sided hydronephrosis was found in 82 patients, right-sided in 38, and bilateral in 13 patients. The median age of children was 2 years (range 0-17 years). Mean hospital stay was 2 days (range 1-10 days).

The most common presentation was in patients with antenatally diagnosed hydronephrosis (72/133); the second largest group of patients were symptomatic patients (43/133); the remainder presented following an ultrasound for other reasons demonstrating an incidental finding (18/133).

The indications for operative intervention were diverse. The most frequent recorded indication for treatmant was progressive hydronephrosis with worsening of renal function on dynamic renal scan. All indications for surgery are presented in Table 2.

Before clear indication for treatment of hydronephrosis, the patients were followed up with serial renal tract ultrasound. The median length of time that the patients were followed before an indication for intervention arose was between 6-12 months from the time of presentation (range 0-84 months). Thirty-three out of 133 patients were followed up for less than 6 months; 65/133 patients were followed up between 6-12 months and 35/133 patients were followed for greater than 1 year before ureteric stenting was performed.

Follow up was performed routinely at 1, 3, 6 and 12 months following ureteric stent insertion. All the patients were followed up for a minimum of 2 years following double-J stent removal. The median time of follow up was 47 months (range 24-202 months).

Median time of resolution of hydronephrosis (double-J stent placement to removal) was 11 months (range 10-13

TABLE 2. **Indications for endoscopic treatment of hydronephrosis**

Indication	**n**	**%**
Worsening of renal function	64	48%
Progression of hydronephrosis and severe dilation by ultrasound	24	18%
Severe obstruction on a nuclear scan	10	7.3%
Symptomatic hydronephrosis (mass, UTI)	21	16%
Severe bilateral hydronephrosis (tpd > 50 mm)	13	10%
Severe hydronephrosis in child with one kidney	1	0.7%

TABLE 3. **Indications for pyeloplasty in children treated with double-J stenting**

Indication	n	%
Recurrent hydronephrosis after double-J stent removal	25	18.80%
Symptomatic infections	7	5.20%
Progression of hydronephrosis	2	1.50%
Perforation of renal pelvis	1	0.75%
Bleeding	1	0.75%
Total	36	27.00%

months). In total, double-J ureteric stenting alone was effective with resolution of hydronephrosis in 73% of cases (97/133 insertions). Other 27% of the patients (36/133) underwent pyeloplasty because of recurrent hydronephrois. Indications for pyeloplasty are presented in Table 3. Regarding the age of the patients the highest success of 83.5% was achieved in age group 0-4 years. Success in groups 5-9 years and 10-14 years were 47% and 33.5%, respectively. All of the patients in the group 15-17 years needed pyeloplasty after removal of the double-J stent, Table 4. We have observed a significant, decreasing trend in success rates by age of participants (Cochran-Armitage test for trend, Z = -5.36, p = 4*10-8).

Several complications have been recorded: symptomatic infections, migration in the renal pelvis and bladder, progression of hydronephrosis, spontaneously prolapse of prosthesis, bleeding and perforation of the renal pelvis. Complications and their incidence are presented in Table 5.

From the total number of treated children in 85% of the patients (113/133) double-J stent was implanted once, in 12% of the patients (16/133) double-J stent was removed once and changed with new and in 3% of the patients (4/133) double-J stent was changed twice. The most common reason for changing double-J stent was migration of the stent due to the growth of the child.

TABLE 5. **Complications of endoscopic treatment of hydronephrosis**

Complication	n	%
Urinary tract infections	12	9.00%
Migration of the double-J stent in the renal pelvis	2	1.50%
Migration of the double-J stent in the bladder	1	0.75%
Prolapse of double-J stent through uretra	2	1.50%
Progression of hydronephrosis	2	1.50%
Bleeding	1	0.75%
Perforation of the renal pelvis	1	0.75%
Total	21	15.75%

Discussion

The surgical management of a kidney with obstruction at the UPJ has many nuances with respect to approach, degree of invasiveness, and timing of surgery. The objectives remain the same: to relieve the obstruction and thus preserve or improve the overall renal function and to maintain normal development while lessening the morbidity to the patient and yet not compromise the surgical outcome. Treatment options for ureteropelvic junction obstruction encompass the urologic spectrum. Watchful waiting, balloon dilation, endopyelotomy, laparoscopic pyeloplasty, robotic pyeloplasty, and open pyeloplasty are all current approaches. Since its introduction in 1978, the double-J stent has been commonly used to manage urinary obstruction for many indications. It provides drainage of the urine from kidney to the bladder.[6-8] Ureteral stents are functionally used to reestablish or maintain the patency of the ureter. Ureteral stents passively dilate the ureter; urine flows through the center of the hollow stent as well as around the stent, facilitating the passage of debris.

TABLE 4. **Success rate of double-J stent treatment regarding age of the patient**

Age	n	Success	%	Unsuccess	%	p value*
0-4	103	86	83.5%	17	16.5%	
5-9	17	8	47.0%	9	53.0%	< 0.001
10-14	9	3	33.5%	6	66.5%	
15-17	4	0	0%	4	100.0%	

*Cochran-Armitage test

Stent insertion initially increases ureteral peristaltic activity, but with time, the frequency and amplitude of ureteral peristalsis decreases.[9] The ideal ureteral stent has not yet been designed. The ideal ureteral stent should demonstrate optimal flow characteristics, have excellent tensile strength, be resistant to migration, be biocompatible and should be well tolerated by the patient. Radiopacity, visibility on ultrasound, ease of insertion and removal are also important features. Moreover, resistance to infection, corrosion and encrustation are characteristics that are crucial for long-term ureteral patency. A stent providing long term ureteral patency and combining the above features represents the ultimate goal of urological stent research.[8]

The Anderson-Hynes dismembered pyeloplasty, the most commonly used type of repair for UPJO was first described as a stent less procedure.[4] Over the years, drainage techniques were added as perianastomotic leakage of urine and infection were thought to be the cause of stenosis or stricture formation requiring re-operation.[6] Double-J stent is commonly inserted during pyeloplasty to avoid above mentioned complications although insertion of double-J stents may also cause complications.[6,7]

Previously published studies showed that that ureteric stenting is a useful option in the management of primary obstructive megaureters requiring surgical intervention. The majority of patients who would have previously been subjected to ureteric reimplantation were successfully managed by double-J stent insertion with success rate of 65%-73%.[10-12]

Literature on issues about the use of double-J stents in the management of primary hydronephrosis in children is very insufficient. Li SQ et al reported success in 92% of the ureters (25/27) treated with double-J stent because of pelvis-ureter junction stricture, with mean follow up of 36 months.[13] In our study success was achieved in 73% of the patients (97/133). In these children after mean follow up of 47 months there were no signs of significant hydronephrosis and renal function has been improved, so these children does not required any additional surgery. Highest success of 83.5% (86/103) was achieved in age group 0-4 years. Conversely, all of the patients in the age group 15-17 years needed pyeloplasty after removal of the double-J stent. Success was inversely proportional to the age of the patient. The rates of success were lover as the child is older. We can explain this high success in newborns and infants with the fact that pyeloureteric junction for some time after birth is not defined, but this narrowing may recanalize during the time and with double-J stents we are keeping the kidney of pressure and time-consuming to occur natural process of recanalization.[14] Our results are similar with the results in children treated with double-J stent because of primary obstructive megaureter. In addition to this, patients treated with double-J stenting require longer and more intensive follow up than those treated with pyeloplasty. This success is tempered by the knowledge that ureteric stenting is not trouble free and major complications may occur.[6-8,15,16] The widespread use of ureteral stents has corresponded to the increase in possible complications, including stent migration, stone formation, irritation of the bladder, pain, disuria, temperature, UTI, obstruction and fragmentation. Complications associated with the use of ureteral stents are primarily mechanical. Stent occlusion may be frequent and requires simple catheter exchange.[6,8] Double-J stents have been known to migrate in 2.5% to 16.6% cases.[6,12,15] Stents with full coils are less prone to migrate than those with a J-shape which can occur due to inadequate length.[6] In our study incidence of migration was 2.25% (proximal migration in two and distal migration in one patient). In literature there are reports about mechanical irritation of the bladder trigone and urinary urgency in some patients caused by double-J stent.[6,12] In our study there were no recorded significant complications due to mechanical irritation of the bladder, probably because of low incidence of stent migration. These problems are usually related with stent migration into the urethra beyond the external sphincter. In children with double-J stent, flank pain could occur due to reflux which can lead to pyelonephritis. Encrustation or infection of stent can lead to suprapubic pain.[12] Persistent fever with positive urine culture was recorded in 5% of the patients in our study. Similar findings have been reported in other studies.[6,12,15] In these patients double-J stent was removed, and after the infection was curred pyeloplasty was performed. Calcifications and infection of the stent can cause suprapubic pain.[16] In our study there were no recorded cases of calcification of the stent. Perforation of the renal pelvis or ureter as a complication is quite uncommon.[17] Injuries and renal parenchyma and formation of hematoma resulting from inserting of double-J stent are also reported.

In our study, a perforation of the renal pelvis with consequent formation of urinoma was recorded in one patient. Stent was removed and patient was treated with pyeloplasty.

Spontaneous protrusion of double-J stent through urethra is rare complication. In our study two cases of spontaneous protrusion of double-J stent through urethra were recorded, in these patients new stent was inserted. Garg et al reported similar findings in their study.[6]

Recently there has been significant progress in developing of materials and design of double-J stents to reduce complications. The goal is to develop biodegradable stents. Fu WJ et al in their experimental study showed that biodegradable stent could effectively prevent hydronephrosis and hydroureter secondary to ureteral injury. Moreover all biodegradable stents gradually degraded and discharged completely in 120 days. They also performed analysis of the surface of the double-J stent and found calcification at 80 days and calcific plaque at 120 days, while no signs of calcification were found in the biodegradable stent group.[18] Children well tolerate double-J stent, with fewer complications than adults. About 30% of them required replacement of the stent.[19] In our study 15% of the children required replacement of the double-J stent. In 12% of the patients double-J stent was replaced once and in 3% of the patients twice. The most common reason for replacement of double-J stent was migration of the stent due to the growth of the child without of complete resolution of hydronephrosis. Median time of hydronephrosis resolution was 11 months in our study. At that time double-J stent was removed.

Since after the removal of the double-J stent the absence of symptoms, remission of hydronephrosis and improved kidney function during follow up was noted in most of the patients, double-J stent should be considered as the first choice in the treatment of primary hydronephrosis, especially in young children with success rate of 83.5%. In this way, using minimally invasive procedure, we are releasing the kidney from the harmful effects of elevated pressure in the pelvis, and in children, which will not reach the full resolution of hydronephrosis we are time-consuming to a definitive surgery.

Conclusion

In conclusion, all children should be approached on an individual manner taking into account the indications and possible complications of the method chosen. Ureteric stenting is minimally invasive procedure that provides an alternative to early surgery in patients with primary hydronephrosis. Endoscopic placement of ureteric double-J stents should be considered as a first-line treatment in the management of primary hydronephrosis especially in children till 4 years of age, with success rate of 83.5% and without the need for conventional surgery. In a case of failure we are time-consuming to definitive surgery. Due to the fact that a significant decreasing trend in success rates by age of participants was observed, this method is not recommendable in children older than 10 years of age. □

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