

Calyceal Plication with Pyeloplasty in the Treatment of Giant Hydronephrosis in Children

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Abstract

The relief of obstruction alone is frequently not sufficient to ensure renal salvage in giant hydronephrosis. We report on our experience with plication of the renal calyces used as an adjunct to dismembered pyeloplasty in patients with giant hydronephrosis. We describe the operative technique and outcomes in ten children after a follow-up period of six months. Ten patients (six girls and four boys) with a mean age of 8.1 years (range 2–14 years) with giant hydronephrosis caused by primary ureteropelvic junction obstruction underwent a dismembered pyeloplasty followed by plication of the dilated renal calyces. The preoperative evaluation included an excretory urography, ultrasonography, 99mTc-DMSA and 99mTc-DTPA scans. The same tests were repeated six months after the operation to evaluate the outcomes. There were no intraoperative or postoperative complications. Excretory urography and ultrasonography performed six months after the operation demonstrated a significant improvement of the morphology of the operated kidneys. The kidneys shrank in diameter from a mean of 149.5 mm (range 89–224 mm) to 93.6 mm (range 68–121 mm) and the mean diameter of the calyces was reduced from 26.9 mm (range 15–42 mm) to 14.7 mm (range 10–24 mm). Renal 99mTc-DTPA scans showed improved perfusion and renal function after surgery, with the mean elimination rate decreasing from 22.41 min (range 17.84–28.22 min) to 11.7 min (range 8.16–13.76 min). 99mTc-DMSA scans demonstrated no new scars and no deterioration of renal parenchyma after surgery. We believe that plication of the renal calyces is the method of choice to be used as an adjunct to the Anderson-Hynes pyeloplasty in the treatment of paediatric patients with giant hydronephrosis.

Key words

Giant hydronephrosis · pyeloplasty · calyces · plication · children

Résumé

La levée de l'obstacle seule est souvent insuffisante pour préserver la fonction rénale dans les hydronephroses géantes. Nous rapportons notre expérience de plicature des calices rénaux comme une procédure adjointe à la pyéloplastie de référence dans les hydronephroses géantes. Nous décrivons la technique chirurgicale et l'évolution sur une période de six mois. Dix patients (six filles et quatre garçons) avec un âge moyen de 8,1 ans (2–14 ans) et une hydronephrose géante liée à un syndrome primaire de la jonction pyélo-urétérale ont été traités par pyéloplastie conventionnelle suivie d'une plicature des calices dilatés. L'évaluation pré-opératoire a comporté une UIV, une échographie, une scintigraphie au 99mTc-DMSA et au 99mTc-DTPA. Les mêmes examens ont été réalisés six mois après l'intervention. Il n'y a pas eu de complication per- ou post-opératoire. La morphologie des reins était significativement améliorée sur l'UIV et l'échographie réalisés six mois après l'intervention. La taille des reins est passé pour le diamètre de 149,5 mm (89–224 mm) à 93,6 mm (68–121 mm) et le diamètre moyen des calices a été réduit de 26,9 mm (15–42 mm) à 14,7 mm (10–24 mm). Il existait une amélioration de la perfusion et de la fonction rénale sur la scintigraphie au 99mTc-DTPA avec un taux d'élimination moyen passant de 22,41 mn (17,84–28,22 mn) à 11,7 mn (8,16–13,76 mn). Il n'existait pas de cicatrice ou d'altération de la fonction rénale sur les scintigraphies au 99mTc-DMSA, réalisées après la chirurgie. Nous pensons que la plicature des calices est

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une méthode adjuvante de choix à la technique de pyéloplastie de Anderson-Hynes pour le traitement des hydronéphroses géantes de l'enfant.

Mots-clés

Hydronéphrose géante · pyéloplastie · calice · plicature · enfants

Resumen

La curación de la obstrucción sola no es siempre suficiente para asegurar la salvación del riñón en la hidronefrosis gigante. Presentamos nuestra experiencia con la plicatura de los cálices renales usada como complemento de la pieloplastia desmembrante en paciente con hidronefrosis gigante. Describimos técnica operatoria y los resultados en 10 niños tras un seguimiento de 6 meses. 10 paciente (6 chicas y 4 chicos) de una edad media de 8,1 años (rango 2–14) con hidronefrosis gigante causada por obstrucción primaria de la unión pieloureteral sufrieron una pieloplastia desmembrante seguida de plicatura de los cálices dilatados en el interior del riñón. La evaluación preoperatoria incluyó urografía excretora, ultrasonografía, DMSA y DTPA. Se repitieron las pruebas 6 meses después de la operación para evaluar los resultados. No hubo complicaciones intra ni postoperatorias. La urografía excretora y la ultrasonografía 6 meses tras la operación demostraron una mejoría significativa de la morfoloía de los riñones operados. Estos disminuyeron de diámetro desde una media 149,5 mm (rango 89–224) a 93,6 mm (rango 68–121) y el diámetro medio de los cálices se redujo desde 26,9 mm (rango 15–42) a 14,7 mm (rango 10–24). Los renogramas con DTPA mostraron mejor perfusión y mejor función renal tras la cirugía con un tiempo medio de eliminación que disminuyó de 22,41 minutos (rango 17,84–28,22) a 11,7 minutos (rango 8,16–13,76). La escintigrafía con DMSA demostró que no había nuevas cicatrices y que no hubo deterioro del parénquima renal tras la cirugía. Creemos que la plicatura de los cálices renales es el método de elección como complemento de la pieloplastia de Anderson-Hynes en el tratamiento de niños con hidronefrosis gigante.

Palabras clave

Hidronefrosis gigante · pieloplastia · cálices · plicatura · niños

Introduction

Giant hydronephrosis is a relatively rare lesion. In children, it is diagnosed when the volume of the collecting system exceeds 2–4% of body weight [27]. Giant hydronephrosis in children caused by primary obstruction of the ureteropelvic junction (UPJ) is characterised by hypertrophy of the kidney and marked dilatation of the calyces. The dilated calyces resemble cystic cavities and the thickness of the renal parenchyma is considerably reduced. Ultrasonographically, these findings correspond to grade IV hydronephrosis [24]. In contrast to adult patients with giant hydronephrosis where nephrectomy is indicated in 24–29%, in children, nephrectomy is performed relatively rarely (in 6–15% of patients) [5, 11, 12, 17, 23, 31]. Nephrectomy is only considered if the function of the affected kidney is less than 10%, and the other kidney is normal [23]. The gold standard for the repair

Zusammenfassung

Zielsetzung: Die alleinige Beseitigung der Obstruktion durch Anderson-Hynes-Plastik reicht bei sehr großen Hydronephrosen oft nicht aus, um das Nierenbecken ausreichend entleeren zu können. Wir berichten über unsere Erfahrungen mit der zusätzlichen Faltung von Nierenbeckenkelchen im Rahmen einer Pyeloplastik. Die operative Technik und der 6-monatige postoperative Verlauf bei 10 mit dieser Technik operierten Kindern werden beschrieben. **Methode:** Zehn Kinder, 6 Mädchen und 4 Knaben im Alter von 2 bis 14 Jahren (durchschnittlich 8,1 Jahre) wurden wegen massiver Hydronephrose auf Grund einer Obstruktion am pelvicoureteralen Übergang mit einer Pyeloplastik und Faltung der Nierenbeckenkelche behandelt. Die präoperative Diagnostik umfasste IVP, Ultraschall, 99mTc-DMSA- und Tc-DTPA-Scans. Die gleichen Untersuchungen wurden 6 Monate nach der Operation durchgeführt. **Ergebnisse:** Es gab keine intra- oder postoperativen Komplikationen. Sowohl die Sonographie wie das IVP ergaben 6 Monate nach dem Eingriff eine signifikante Verbesserung der Morphologie der operierten Nieren. Der Durchmesser der Nieren nahm von durchschnittlich 149,5 mm (89–224 mm) auf 93,6 mm (68–121 mm) ab. Der Durchmesser der Nierenbeckenkelche reduzierte sich von durchschnittlich 26,9 mm (15–42 mm) auf 14,7 mm (10–24 mm). Die renalen 99mTc-DTPA-Scans zeigten eine verbesserte Perfusions- und Nierenfunktion mit einer Clearance, die von 22,41 min (17,84–28,22 min) auf 11,7 min (8,16–13,76 min) sank. Die 99mTc-DMSA-Scans zeigten nach der Operation keine neuen Narben und keine Verschmälerung des Nierenparenchyms. **Schlussfolgerungen:** Wir glauben, dass die zusätzliche Faltung der erweiterten Nierenbeckenkelche als Methode der Wahl zusätzlich zur Anderson-Hynes-Plastik bei kindlichen Patienten mit massiven Hydronephrosen angesehen werden kann.

Schlüsselwörter

Massive Hydronephrose · Anderson-Hynes Plastik · Faltung der Nierenbecken-Kelche · Kindesalter

of ureteropelvic junction obstruction is open pyeloplasty with complete dismemberment, such as with the Anderson-Hynes technique [1]. However, even though the reported success rates for hydronephrosis are higher than 90%, in patients with giant hydronephrosis, the results of this technique alone are not always optimal, often making it difficult to salvage the affected kidney [27,21]. Therefore we decided to modify the standard technique by performing plication of the renal calyces as an adjunct to dismembered pyeloplasty in our patients with giant hydronephrosis.

Patients and Methods

Between 1989 and 1999, 224 children were treated for hydronephrosis at the Division of Paediatric Surgery, Clinical Hospital Center Zagreb. Ten of them had giant hydronephrosis. Mean age of the 10 patients with giant hydronephrosis was 8.1 years (range 2–14 years). There were six girls and four boys. Eight patients had right-sided and two had left-sided hydronephrosis. The initial diagnostic work-up included an excretory urography (IVU), ultrasonography and renal scans with ^{99m}Tc -DTPA and ^{99m}Tc -DMSA. The same tests were performed six months after surgery which included Anderson-Hynes pyeloplasty and plication of the renal calyces.

Operative Technique

Anderson-Hynes pyeloplasty was performed in a standard fashion. Pelvic repair and ureteropelvic anastomosis were done with 3–0 chromic catgut sutures. After completion of the ureteropelvic anastomosis, the dilated calyces were plicated by placing sutures in the regions of maximal torsion. The lumina of the calyces were not opened. The sutures ran parallel to the shorter axis of the kidney, through the walls of the dilated calyces and avoiding the remaining active parenchyma between the intercalyceal septa. In this fashion, the dilated, circularly shaped calyces were modelled into oval or ellipsoid structures, oriented perpendicularly to the long axis of the kidney. The resulting reduction of the “dead space” has a strong effect on the urodynamics of the calyces and results in decreased stasis and a better flow of urine towards the ureteropelvic anastomosis. The plication is performed on the anterior and posterior surface of the kidney and the resulting shape of the kidney resembles a deflated bellows (Fig. 1).

Results

The results of the IVU performed before surgery were interpreted according to Newling et al. [21]. Preoperatively, the initial nephrogram (first visualisation of contrast excretion) was observed within the first hour after contrast application in seven children and in three children during the second hour. Six months after surgery, the contrast medium was excreted within the first 20 minutes in 9 children and in one child during the first hour after the application (Table 1).

On ultrasonography, kidney, pelvis and calyx sizes and thickness of the parenchyma were analysed. Values of all parameters had improved on follow-up examination, with the mean kidney size decreasing from 149.5 mm (range 89–224 mm) to 93.6 mm (range 68–121 mm), the mean pelvis diameter from 58.3 mm (range 30–129 mm) to 38.9 mm (range 21–74 mm), the mean calyx size from 26.9 mm (range 15–42 mm) to 14.7 mm (10–24 mm) and the mean parenchyma thickness increasing from 4 mm (range 3–5 mm) to 10 mm (range 7–16 mm) (Table 2).

^{99m}Tc -DTPA scans were used to analyse kidney perfusion, function and morphology. The mean radioisotope transit time through the parenchyma of the healthy kidney was 3.62 ± 1.05 min;

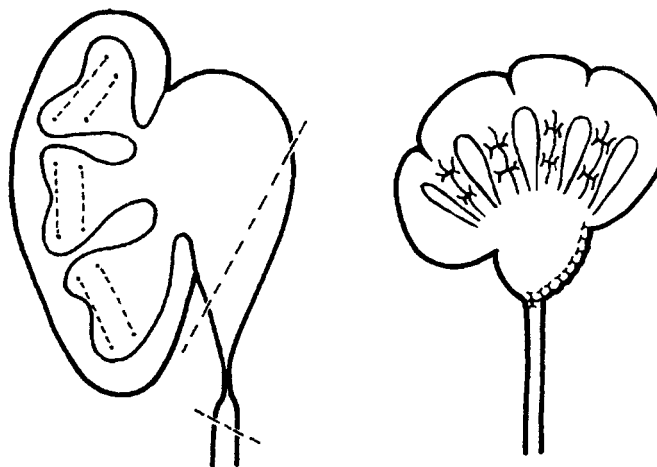


Fig. 1 Schematic representation of the kidney before and after the pyeloplasty with calyceal plication

Table 1 Preoperative and postoperative results of excretory urography

Patient Number	Preoperative initial nephrogram			Postoperative initial nephrogram		
	20 min	1 hour	2 hours	20 min	1 hour	2 hours
1		+	–	+		
2		+	–	+		
3		–	+	+		
4		–	+	+		
5		–	+	–	+	
6		+	–	+		
7		+	–	+		
8		+	–	+		
9		+	–	+		
10		+	–	+		

1.9 ± 2.1 min through the pelvis and 5.51 ± 2.83 min through the entire kidney. In affected kidneys, prior to surgery, mean transit times through the parenchyma, the pelvis and through the entire kidney were 16.69 (range 12.52–19.24), 6.12 (4.06–10.02) and 22.41 min (17.84–28.22), respectively. The separate renal function was 34.96% (24.32–42%). After surgery, the results improved with mean values of 7.38 (range 5.12–10.67), 4.29 (range 2.65–5.5) and 11.7 min (range 8.16–13.76). The mean kidney function increased to 42.42% (33.8–46.58%) (Table 3).

Cortical ^{99m}Tc -DMSA scan was used to visualise the renal parenchyma and to differentiate small cortical lesions and parenchymal scars [4, 8, 30]. The kidney was divided in three zones (upper, intermediate and lower calyceal group). Parenchymal scars were mostly present in the lower calyceal group, less in the intermediate group and in three cases in the upper group (Table 4). After surgery, the parenchymal thickness increased, but the position and sizes of the scars remained unchanged.

Table 2 Preoperative and postoperative ultrasonography results

Patient Number	Preoperative				Postoperative			
	Pelvis (mm)	Calyces (mm)	Kidney (mm)	Parenchyma (mm)	Pelvis (mm)	Calyces (mm)	Kidney (mm)	Parenchyma (mm)
1	72	35	165	4	38	20	79	11
2	52	34	148	4	39	13	103	12
3	129	42	224	3	74	20	114	16
4	38	15	92	5	38	14	68	9
5	58	28	174	3	37	15	96	8
6	43	22	142	5	31	24	89	9
7	35	24	132	4	29	14	86	10
8	62	26	175	4	44	16	112	9
9	64	25	154	3	38	10	121	7
10	30	18	89	5	21	10	68	9
Mean value	58.3	26.9	149.5	4	38.9	14.7	93.6	10

Table 3 Results of preoperative and postoperative dynamic renal scans with 99mTc-DTPA

Patient Number	Preoperative				Postoperative			
	Separate DTPA	Mean DTPA transit time (minutes)			Separate DTPA	Mean DTPA transit time (minutes)		
	Flow (%)	Kidney	Pelvis	Parenchyma	Flow (%)	Kidney	Pelvis	Parenchyma
1	29.60	23.30	4.06	19.24	33.80	13.32	2.65	10.67
2	42.00	22.34	5.34	17.00	46.30	13.76	5.00	8.76
3		28.22	10.02	18.20		8.16	3.04	5.12
4	32.33	21.42	6.64	17.78	41.24	11.28	3.24	8.04
5	38.42	25.34	6.88	18.46	42.80	13.46	3.48	6.78
6	41.20	19.66	5.44	14.22	44.56	12.36	5.22	7.14
7	24.32	24.32	5.16	19.16	38.86	11.88	5.34	6.54
8	31.30	17.84	5.32	12.52	42.36	13.24	5.04	8.20
9	36.20	22.34	7.22	15.12	45.34	9.68	4.44	5.24
10	39.34	19.34	5.14	15.20	46.58	12.86	5.50	7.36
Mean value	34.96	22.41	6.12	16.69	42.42	11.70	4.29	7.38

Discussion

In 1939 Stirling defined giant hydronephrosis as the presence of more than 1000 ml of fluid in the collecting system of the kidney. In children, it is diagnosed when the volume of the collecting system exceeds 2–4% of body weight. UPJ obstruction is the commonest cause of giant hydronephrosis in children [21,27]. Hydronephrosis occurs more commonly in boys and it predominantly involves the left kidney [2,5,7,11,13,26,31]. However, in our small group of 10 patients with giant hydronephrosis, the girls predominated, with the right side affected in eight cases. Also, our patients were diagnosed at a mean age of 8.1 years, considerably later than the usual age for hydronephrosis, which ranges from between six months and five years [5,18,26].

Anderson-Hynes pyeloplasty is considered to be the gold standard in the treatment of hydronephrosis, with excellent outcomes reported in over 90% of patients. The results of this technique alone in giant hydronephrosis are not always favourable [9,21,27]. In contrast to the usual course in cystic hydronephrosis occurring in newborns and infants, in giant hydronephrosis pyeloplasty alone often does not result in calyceal regression and recovery of renal function. Despite relief of the obstruction, drainage of the dilated calyces after the surgery is frequently poor and the residual urine within the dilated calyces causes further damage to the remaining parenchyma. Infection is a common complication, discouraging the surgeons from attempts at renal salvage and frequently prompting a primary nephrectomy [9,27].

Table 4 Results of preoperative and postoperative scans with ^{99m}Tc-DMSA

Number	Preoperative						Postoperative					
	Upper calyces		Intermediate calyces		Lower calyces		Upper calyces		Intermediate calyces		Lower calyces	
	S**	RP**	S**	RP**	S**	RP**	S**	RP**	S**	RP**	S**	RP**
1	+	+	-	+	+	*	+	+	-	+	+	+
2	+	+	+	+	+	*	+	+	+	+	+	+
3	+	+	-	+	+	*	+	+	-	+	+	+
4	-	+	-	+	-	*	-	+	-	+	-	+
5	+	+	-	+	+	*	+	+	-	+	+	+
6	-	+	+	+	+	*	-	+	+	+	+	+
7	-	+	+	+	-	*	-	+	+	+	-	+
8	-	+	+	+	+	*	-	+	+	+	+	+
9	+	+	-	+	+	*	+	+	-	+	+	+
10	-	+	-	+	+	*	-	+	-	+	+	+

*S: scarring; **RP: reduced parenchyma

Previous attempts to improve calyceal drainage in giant hydronephrosis included calyco-cystostomy, calyco-ureterostomy and Boari flap calyco-vesicostomy [15,19]. Nephroplasty and nephroplication, combined with pyeloplasty, were also reported to be effective in reducing collecting system dilatation in adult patients with giant hydronephrosis [9,25]. We found no cases in the literature in which calyceal plication was used as an adjunct to primary surgery in children with giant hydronephrosis.

With the plication of the renal calyces as an adjunct to Anderson-Hynes pyeloplasty we wished to reduce calyceal stasis and increase drainage, thus improving the outcome in patients with difficult forms of giant hydronephrosis. A comparison of the results of excretory urography before and after surgery showed an improvement in the morphology of the kidney and of its excretory potential (Table 1). The 90% success rate of our operation is indicated by the presence of reduced dilatation of the pelvis and calyces and excretion of the contrast within 20 minutes in 9 out of ten children. Even in the patient whose kidney was excreting with delay, the result can be considered good because there was no postoperative stenosis or urinary stasis. Ultrasonographic findings confirm good postoperative results: the sizes of the kidneys, pelvis and calyces all significantly decreased and the parenchymal thickness increased (Table 2).

^{99m}Tc-DTPA renal scan is considered to be the method of choice for investigations of kidney perfusion, function and morphology [6,14,20,28,32]. Due to the stasis of urine in the effluent system of the kidney both before and after surgery, ^{99m}Tc-DTPA renograms were performed with the use of a diuretic [3,10,22,33]. The preoperative scans showed an obstructive type of curve; after surgery no signs of organic obstruction were visible. The mean radioisotope transit times through the parenchyma and pelvis both improved after surgery. The mean separate flow of ^{99m}Tc-DTPA through the affected kidney increased from 34.96 to 42.42%. The results of the dynamic kidney scans with deconvolution imply that the global function of the operated kidneys improved by about 50%. After relief of the obstruction, the af-

fected kidneys largely regained their function and some became completely normal (Table 3).

The postoperative ^{99m}Tc-DMSA scans did not change significantly compared to the preoperative results. The scars did not disappear. However, the follow-up of this group of patients is rather short (six months) for significant parenchymal regeneration to occur [29]. However, there was no deterioration and no new parenchymal scars or defects appeared.

In conclusion, we believe that plication of the renal calyces used as an adjunct to the Anderson-Hynes pyeloplasty is a safe and successful procedure for the management of paediatric patients with giant hydronephrosis.

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