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Comparison of different morphological parameters with duration of obstruction created experimentally in unilateral upper ureters: An animal model

Shasanka Shekhar Panda, Minu Bajpai, Saumyaranjan Mallick[1], Mehar C. Sharma[1]

ABSTRACT

Background: The objective of the following study is to determine and to compare the different morphological parameters with duration of obstruction created experimentally in unilateral upper ureters of rats. **Materials and Methods:** Unilateral upper ureteric obstruction was created in 60 adult Wistar rats that were reversed after predetermined intervals. Rats were sacrificed and ipsilateral kidneys were subjected for analysis of morphological parameters such as renal height, cranio-caudal diameter, antero-posterior diameter, lateral diameter, volume of the pelvis and average cortical thickness: Renal height. **Results:** Renal height and cranio-caudal diameter of renal pelvis after ipsilateral upper ureteric obstruction started rising as early as 7 days of creating obstruction and were affected earlier than antero-posterior and lateral diameter and also were reversed earlier than other parameters after reversal of obstruction. Renal cortical thickness and volume of the pelvis were affected after prolonged obstruction (> 3 weeks) and were the late parameters to be reversed after reversal of obstruction. **Conclusions:** Cranio-caudal diameter and renal height were the early morphological parameters to be affected and reversed after reversal of obstruction in experimentally created ipsilateral upper ureteric obstruction.

Key words: Antero-posterior diameter, cranio-caudal diameter, experimental upper ureteric obstruction, lumbotomy, renal height

INTRODUCTION

Pelviureteric junction obstruction is a common cause of hydronephrosis detected during antenatal ultrasound.[1] The antero-posterior pelvic diameter and Society of Foetal Urology (SFU) grading have been widely used to describe the severity of hydronephrosis on ultrasound although their usefulness have been widely debated when it comes to selection of patients for surgery.[2-5]

This study compared the different morphological parameters in the kidney with respect to the duration of obstruction after creating an ipsilateral ureteral obstruction for varying durations in rat models.

MATERIALS AND METHODS

This prospective study was performed at Department of Paediatric surgery and central animal facility at All India Institute of Medical Sciences, New Delhi. Clearance from the institute's animal ethics committee was taken for the study.

A total of 60 adult female Wistar rats (weighing 100-150 g) were procured. The rats were divided into two equal groups and each group was further subdivided in to three equal sub groups, depending on the duration for which the ureters were obstructed (7, 21 and 42 days respectively). The left ureter was ligated in each rat. In group 1, the rats were sacrificed at the end of 7, 14 and 21 days of obstruction. In group 2, ipsilateral ureteral obstruction was relieved at the end of 7, 21 and 42 days and the rats were then sacrificed 14 days following the reversal.

The rats were anesthetized using 50 mg/kg ketamine, administered intra-peritoneally using a 26 gauze needle. A dorsal lumbotomy incision was given on the left side as described previously.[6-8] The proximal ureter was tied (partial obstruction) with a flexible camera cover wire. This wire was then hitched to the psoas and the edges brought out through the incision's corner.[9] The kidney was reposited back after confirming the normal peristalsis in the ureter. The rats were sacrificed using Thiopental sodium intra-peritoneally at a dose of 20 mg/kg.

Departments of Paediatric Surgery, and [1]Pathology, All India Institute of Medical Sciences, New Delhi, India

Address for correspondence:
Dr. Minu Bajpai,
Department of Paediatric Surgery, All India Institute of Medical Sciences, New Delhi - 110 029, India. E-mail: bajpai2@hotmail.com

Morphometric measurements

The kidneys were split longitudinally and photographed along with a scale, using a 12.1 megapixels 4× optical zoom digital camera kept vertically overhead at a distance of 25 cm and an angle of 15 degree. The various dimensions vis the renal height, pelvic dimensions (antero-posterior, cranio-caudal and lateral) and renal cortical thickness at the upper and lower pole was measured with a least count of 0.01 mm using I-photo-measure software version 3.0 developed by DigiContractor Corp [Figure 1].

Statistical analysis

The data analysis was performed using STATA software version 9.0 Stata Corp LP, Texas, USA. Continuous data were compared using *t*-test and dichomatous data were compared using Chi-square test. $P < 0.05$ was considered to be statistically significant.

Observations

Morphometric analysis

Renal height

The renal height was significantly different between the subgroups (7 days vs. 21 days, 7 days vs. 42 days and 21 days vs. 42 days) in group 1 rats after fixed days of obstruction [Table 1]. In group 2 rats where obstruction was relieved for 14 days after fixed days of obstruction, renal height was significantly different between the subgroups 7 days versus 21 days and 7 days versus 42 days, but not significant between the subgroups 21 days versus 42 days [Table 2]. When comparisons were drawn on the basis of groups, there was significant difference between the groups in days 7 and 21 and not in 42 days subgroup [Table 3].

Pelvis diameters

The cranio-caudal diameter of pelvis was significantly different between the subgroups (7 days vs. 21 days, 7 days vs. 42 days and 21 days vs. 42 days) in group 1 rats after fixed days of obstruction [Table 1]. In group 2 rats where obstruction was relieved for 14 days after fixed days of obstruction, cranio-caudal diameter of pelvis was significantly different between the subgroups 7 days versus 21 days and 7 days versus 42 days but not significant between the subgroups 21 days versus 42 days [Table 2]. When comparisons were drawn on the basis of groups, there was significant difference between the groups in days 7 and 21 and not in 42 days subgroup [Table 3].

The antero-posterior diameter of pelvis was significantly different only between the subgroups 7 days versus 42 days in both group 1 and group 2 rats [Tables 1 and 2]. It was insignificant between other subgroups. When comparisons were drawn on the basis of groups, there was no significant

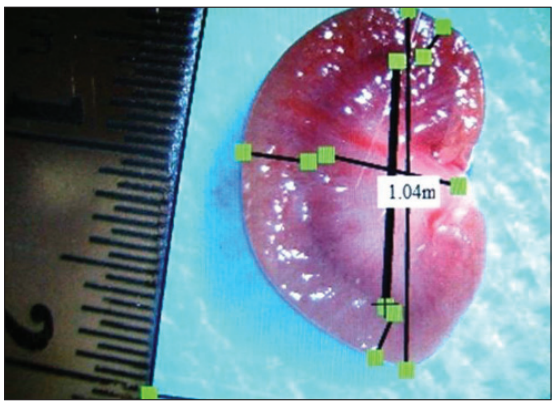


Figure 1: Various dimensions for measurements on I-photo measure software

Table 1: The *P* values comparing the various morphological changes amongst the subgroups separately i.e., 7, 21 and 42 days in group 1 rats

P value	7 versus 21 (days)	7 versus 42 (days)	21 versus 42 (Days)
Renal height	0.032	0.002	0.046
Cranio-caudal diameter	0.028	0.01	0.042
Antero-posterior diameter	0.12	0.040	0.26
Lateral diameter	0.46	0.164	0.86
Volume of the pelvis	0.084	0.034	0.142
Average cortical thickness: Renal height	0.108	0.030	0.168

Table 2: The *P* values comparing the various morphological changes amongst the subgroups separately i.e., 7, 21 and 42 days in group 2 rats

P value	7 versus 21 (days)	7 versus 42 (days)	21 versus 42 (days)
Renal height	0.010	0.004	0.078
Cranio-caudal diameter	0.024	0.012	0.064
Antero-posterior diameter	0.104	0.032	0.261
Lateral diameter	0.084	0.126	0.240
Volume of the pelvis	0.096	0.026	0.184
Average cortical thickness: Renal height	0.108	0.033	0.266

Table 3: The *P* values comparing the various morphological changes between group 1 and 2 with fixed duration of obstruction i.e., 7, 21 and 42 days

P value	7 days	21 days	42 days
Renal height	0.018	0.030	0.132
Cranio-caudal diameter	0.020	0.022	0.248
Antero-posterior diameter	0.068	0.091	0.261
Lateral diameter	0.093	0.096	0.346
Volume of the pelvis	0.242	0.132	0.163
Average cortical thickness: Renal height	0.466	0.208	0.366

difference between the groups in days 7, 21 and 42 days subgroups [Table 3].

The lateral diameter of pelvis was insignificant between the subgroups in both group 1 and group 2 rats [Tables 1 and 2]. There was no significant difference between the groups in days 7, 21 and 42 days subgroups [Table 3].

Volume of pelvis

The volume of pelvis was significantly different only between the subgroups 7 days versus 42 days in both group 1 and group 2 rats [Tables 1 and 2]. It was insignificant between other subgroups in both groups. When comparisons were drawn on the basis of groups, there was no significant difference between the groups in days 7, 21 and 42 days subgroups [Table 3].

Average cortical thickness: Renal height

The cortical thickness was measured at the upper and lower pole and average of the two was drawn and this was shown as a ratio between the cortical thickness and the renal height to avoid disparity borne by rat-to-rat kidney size variation.

The average cortical thickness: Renal height was significantly different only between the subgroups 7 days versus 42 days in both group 1 and group 2 rats [Tables 1 and 2]. It was insignificant between other subgroups in both the groups. When comparisons were drawn on the basis of groups, there was no significant difference between the groups in days 7, 21 and 42 days subgroups [Table 3].

DISCUSSION

Although antero-posterior fetal renal pelvic diameter has been the most common parameter used to indicate the need for postnatal investigation, there has been considerable controversy regarding this issue.[10,11] Neither an SFU grading system nor measurement of antero-posterior diameter of renal pelvis is the gold standard in determining the severity of hydronephrosis. Both methods may fail, particularly in children with intrarenal pelvis configuration or SFU-4 hydronephrosis.[3]

In the current experimental study, renal height and cranio-caudal diameter of renal pelvis after ipsilateral upper ureteric obstruction started rising as early as 7 days of creating obstruction and the changes were significant irrespective of the duration of obstruction. Renal height and cranio-caudal diameter of renal pelvis were affected earlier than antero-posterior and lateral diameter [Table 1] and also were reversed earlier than other parameters after reversal of obstruction [Table 3]. Significant reversal of changes in renal height and cranio-caudal diameter were seen when the obstruction was relieved early [Table 2]. Antero-posterior diameter was affected late after creation of obstruction and also reversed late after reversal of obstruction.

Renal cortical thickness and volume of the pelvis were affected after prolonged obstruction (>3 weeks) of upper ureter [Table 1] and also were the late parameters to be reversed after reversal of obstruction [Table 2].

CONCLUSIONS

Cranio-caudal diameter and renal height were the early morphological parameters to be affected and reversed after reversal of obstruction in experimentally created ipsilateral upper ureteric obstruction.

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