



## Ultrasound Parameters Changes after Pyeloplasty in Ureteropelvic Junction Obstruction: 6-Month Follow-Up

Shahram Nozarnezhad<sup>1</sup>, Sajede Karimi<sup>2\*</sup>, Leily Mohajerzadeh<sup>2</sup>, Amirhossein Faghihi<sup>2</sup>, Mehdi Sarafi<sup>2</sup>, Gholamreza Ebrahimi Saraj<sup>2</sup>, Behnaz Niroomand<sup>2</sup>

<sup>1</sup>Resident of Pediatrics, Department of Pediatrics, Mofid children's hospital, School of medicine, Shahid Beheshti University of Medical Science, Tehran, Iran

<sup>2</sup>Pediatric Surgery Research Center, Research Institute for Children's Health, Shahid Beheshti University of Medical Science, Tehran, Iran

**\*Address for Corresponder:** Dr Sajede Karimi, Pediatric Surgery Research Center, Research Institute for Children's Health, Shahid Beheshti University of Medical Science, Tehran, Iran (email: sara.karimi5477@gmail.com)

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### Abstract

**Introduction:** Ureteropelvic junction obstruction (UPJO) is one of the most common anomalies in children. The gold standard method for follow-up of these patients after pyeloplasty is a nuclear scan, but due to its high cost and limited access, it has recently been replaced with ultrasound. In this study, we want to assess ultrasound parameter changes after pyeloplasty.

**Materials and Methods:** In this cross-sectional analytical study, 124 patients from 2006 to 2012 who had undergone open pyeloplasty were enrolled. They were evaluated with ultrasound and nuclear scans before, 3, and 6 months after surgery.

We analogized the results of these two methods and described the modifications in ultrasound parameters.

**Results:** Of all 124 patients with a median age of 30 months, according to nuclear scan results, kidney functions have improved by 96.77%. The average AP(anteroposterior) diameter of kidneys before, 3, and 6 months after surgery were 34.28 mm, 18 mm, and 15.19 mm respectively. In patients with successful surgery; PI (percentage improvement) of AP was above 15% after 3 months and above 26% after 6 months, thickness of the cortex raised at least 10 percent, and a reduction of at least 16% and 18% was seen in pelvic/cortex ratio in 3, and 6 months respectively.

## Keywords

- UPJO
- Pyeloplasty
- Ultrasound
- nuclear scan
- DTPA

**Conclusion:** After pyeloplasty, a reduction in AP diameter, PI of AP, pelvic/cortex ratio, and an expansion in thickness of the cortex have been seen. Ultrasound in 3 months has high sensitivity but low specificity, and in 6 months have high sensitivity and specificity.

## Introduction

Ureteropelvic junction obstruction (UPJO) is the most common cause of anatomical fetal hydronephrosis. UPJO is a blockage where the ureter penetrates the kidney pelvis, which can be intermittent or partial. The reported incidence of UPJO is 1 in 500 live births, and this condition screen by routine antenatal ultrasound.<sup>1</sup> This disorder occurs twice in boys, and two-thirds of cases occur on the left side. Bilateral dilation occurs in 10-5% of patients and

usually younger patients.<sup>2</sup> In patients with congenital UPJO, most cases specify by ultrasound during the embryonic period. With less prevalence, patients with primary abdominal mass complaints, recurrent urinary tract infections, or in conjunction with other congenital anomalies are diagnosed (e.g. VACTERL =Vertebral, anal, cardiac, tracheoesophageal fistula, renal, limb). In older children, non-cyclic or acute abdominal pain with or without

nausea can be the first manifestation. Some of these children recognize initially by gastroenterologists, and hypertension may be seen at first, although hypertension is often associated with renin and may improve after surgery.<sup>3</sup>

UPJO can treat surgically or conservatively. Intermittent obstruction and pain are the most common indications of surgery. The outcomes of the surgeries have shown success, with a resolution of the obstruction in 90 to 98 percent of cases.<sup>4</sup> The recurrence rate after surgery is less than 1%, and the need for nephrectomy is less than 2%.<sup>5</sup> Typically, a functional assessment of the site of anastomosis 3-6 months after surgery perform by the nuclear scan. Additional evaluations are recommended 12-24 months after surgery.<sup>6</sup> A nuclear scan is a practical technique to assess hydronephrosis, kidney function, and drainage. Recently, surgeons tend to use ultrasound to ease the radiation and the cost imposed on the patient, with a success rate of more than 95%. Ultrasound can show pelvic and calyx dilatation and a decrease in the thickness of the kidney parenchym. Ultrasound can also show healthy kidneys, bladder, and ureters and distinguishes the pelvis abstraction from the bladder obstructions, but it cannot

provide information about kidney function.<sup>7</sup> Some experimenters have obtained good results from the patient's follow-up with ultrasound and recommend that a postoperative renal scan not be performed if the patient is asymptomatic.<sup>8-10</sup> Few studies have described exact ultrasound parameter changes, and there is no precise number to regard these changes as successful surgery.

In this study, we want to assess ultrasound parameter changes and correspond them with the nuclear scan as a gold standard to follow-up patients after surgery.

## Materials and Methods

### Population Study

Between 2006 and 2012, about 160 patients underwent primary pyeloplasty in Mofid Children's Hospital due to UPJO. Patients were evaluated by ultrasound and nuclear scan (DTPA (Diethylenetriamine pentaacetate)) before, 3, and 6 months after surgery.

Patients excluded if they had a previous history of failed pyeloplasty, renal anomalies including vascular anomalies, horseshoe, and pelvic kidneys, tumor or an abdominal mass, patients with surgery contraindication, including active urinary tract infections or severe comorbidities,

preventing anesthesia and who have missing follow-up data. 124 patients met the criteria and enrolled in the study.

### **Treatment and Follow Up**

All the patients underwent standard open dismembered pyeloplasty by the same surgeon. The surgical technique was determined according to renal pelvic anatomy and stenosis length during the operation. For all patients, ureteral and urethral catheters were inserted. Foley catheters were removed 24–36 hours later, and the patient was discharged on the second or third day after the operation. Double J stents were removed about six weeks after surgery. 3, and 6 months after surgery, patients recalled and underwent ultrasound and DTPA to assess the success rate of pyeloplasty. On ultrasound, improvement, stability, or worsening of kidney function was based on changes in the anteroposterior (AP) diameter of renal pelvic, the thickness of the cortex, pelvic/cortex ratio, and percentage improvement of AP (PI of AP). The ultrasounds were performed by one radiologist, and the radiologist was blind to the first results. The results of a renal scan as the gold standard method determined the success rate of the pyeloplasty. The

ultrasound result was compared with the renal scan and pre-operation ultrasound results.

### **Data Analysis**

Finally, after gathering the required data from all 124 patients, we analyzed the data, and in this regard, we used SPSS statistical software version 25. For reporting quantitative variables in this study, mean, and standard deviation statistics, and for reporting qualitative variables percentage of frequencies were used. Then, to measure the relationship, we used paired T test. Significance level was 0.05. To control the confounding variable, we used logistic regression modeling.

### **Result**

In this study, the age of operated patients ranges from 2 months to 156, with a median age of 30 months. Most of these patients were boys (82.3%) and had intrinsic obstruction (96.8%). (P value > 0.05) The predominant symptom before surgery was cyclic pain (26.6%), but most were diagnosed by prenatal sonography (62.9%). However, most of them didn't have any associated anomaly (84.7%) but also vesicoureteral reflux was

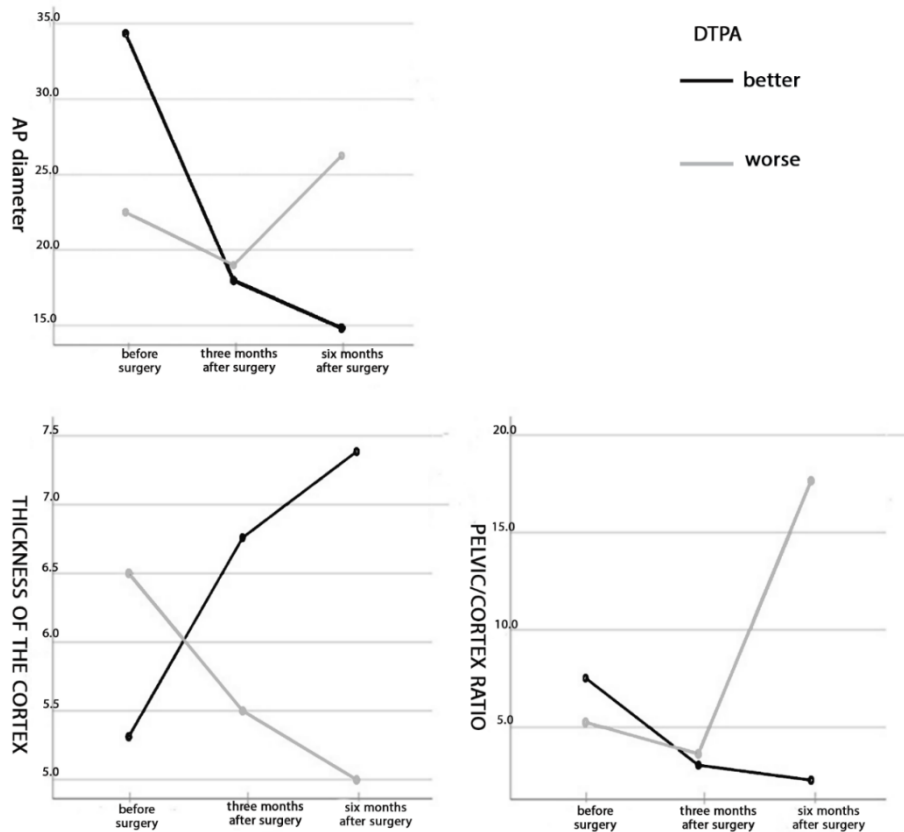
the most common anomaly (6.5%). (P value>0.05). (Table 1

**Table 1:** variables frequencies

Variables	Percent
Gender	
male	82.3%
female	17.7%
Type of UPJO	
intrinsic	96.8%
extrinsic	3.2%
Associated anomalies	
No	84.7%
Vesicoureteral reflux	6.5%
Undescended testis	3.2
Multicystic dysplastic kidney	1.6%
Neurogenic bladder	1.6%
Hemophilia	1.6%
Kidney stone	0.8%
Presentation	
Prenatal sonography	62.9%
Cyclic pain	26.6%
Acute abdomen	4.8%
Fever	1.6%
Irritability	1.6%
Abdominal mass	1.6%
Hematuria	0.8%

According to DTPA results, out of 124 patients, 121 patients had decreased renal function before surgery, and for 3 cases normal renal function was reported. DTPA 6 months after surgery demonstrated for 4 patients less kidney function (3.2%), which means no recovery after surgery, and for 120 cases better renal function (96.77%). According to **Figure 1**, patient for whom DTPA has shown improvement, AP

diameter and pelvic/cortex ratio decreased in 3, and 6 months and the thickness of the cortex expanded. In patients whom DTPA has shown a failure to improve, AP diameter and pelvic/cortex ratio decreased in the first 3 months, then raised in the first 6 months (even higher than the initial value). The thickness of the cortex in these patients decreased in both phases.



**Figure 1:** nuclear scan/ultrasound

Ultrasounds results are as follows:

Before surgery, the AP diameter of the pelvis was reported 34.28 mm on average (17 mm to 60 mm). After the surgery, a significant improvement in this diameter is evident, which can indicate the success of

the surgery: 3 months after the surgery, the average diameter of the AP has reached 18 mm (3mm to 46mm). (p value<0.05) 6 months after surgery, the average has reached 15.19 mm (2 mm to 32 mm) (p value<0.05). (**Table 2**)

**Table 2:** AP diameter

AP diameter	Median(mm)	Std. deviation	T score	P value
preoperative	34.28	11.18		
3 months after surgery	18	7.57	16.62	0.000017
6 months after surgery	15.19	5.92	18.67	0.01

A recently considered indicator is the PI of AP. After 3 months, the index was above 15% in 92.74% of patients (Sensitivity: 94.16% Specificity: 50%). After 6 months PI of AP in 95.96% of patients was above 26% (sensitivity:99% and specificity:100%).

Another parameter check in ultrasound is the thickness of the cortex. The average before surgery was 5.40 mm (2mm to 12mm). 3 months after surgery raised to

6.71 mm (2.7 to 12 mm) and in 6 months 7.30 mm (2.7 to 12 mm). (p value<0.05). After 3 months this parameter enhanced in 81.45% of cases by at least 10% and an average of 24% with a sensitivity of 82.5% and specificity of 50%. Also, after 6 months this parameter expanded in 89.5% of cases by at least 10% and an average of 35% with a sensitivity of 92.5% and specificity of 100%. (**Table 3**)

**Table 3:** thickness of cortex

Cortex thickness	Median(mm)	Std. deviation	T score	P value
preoperative	5.40	2.10		
3 months after surgery	6.71	2.06	-8.28	0.000001
6 months after surgery	7.30	2.22	-10.91	0.00001

Another index examined in this study is the pelvis/cortex. This ratio averaged 7.50 before surgery (1.5 to 24). After three months, the average raised to 3.07 (0.3 to 9.1) and after 6 months raised to 2.77 (0.2 to 32.5) (p value<0.05). We have observed that after 3 months, in 96.77% of patient, pelvis/cortex ratio decreased by at least

16% and an average of 50% with a sensitivity of 98% and specificity of 50%. After 6 months, 96.77% of patients had a decrease by at least 18% and an average of 63% in this criterion, this time with a sensitivity and specificity of 100%. (**Table 4**)

**Table 4:** pelvic/cortex ratio

Pelvic/cortex ratio	Median(mm)	Std. deviation	T score	P value
preoperative	7.50	4.23		
3 months after surgery	3.07	1.84	13.26	0.000005
6 months after surgery	2.77	4.04	9.94	0.04



## Discussion

Hydronephrosis and ureteral malformations are among the most common anomalies in the urinary tract in children. Open pyeloplasty with a success rate of 90-98% is a standard method of UPJO treatment.<sup>4</sup> The gold standard method for follow-up of these patients after surgery is a nuclear scan. However, this technique's diagnostic accuracy is more than 95% but due to its high cost and limited access, some experimenters have questioned the value of routine nuclear scan and considered ultrasound alone for the initial assessment after pyeloplasty, and renal scan reserved for those patients who do not show advancement on ultrasound.<sup>9-11</sup> Nicolas GC demonstrates that at-risk patients can be identified with a sentinel ultrasound and selectively select who needs further nuclear scan analysis.<sup>9</sup> Hamedanchi S evaluated color Doppler sonography changes in the follow-up of these patients and achieved good results.<sup>12</sup> ultrasounds parameter's changes have been evaluated in some studies but there is no precise ratio to regard these differences as significant. Babu R has concluded that in 3 months follow-up P/C ratio could be used as an early marker of success.<sup>13</sup> Rickard et al demonstrated that a decline in AP diameter

of more than 40% was a useful indicator of successful pyeloplasty.<sup>10</sup> Similarly, Romao RL has concluded that in 3-month follow-up an improvement in AP diameter of 38% or greater or postoperative AP diameter of 11.5 mm or less was associated with success, with a sensitivity of 100% and specificity of 61% and 55%, respectively.<sup>14</sup> according to Rim Kiblawi's study, a reduction in the AP diameter of the renal pelvis on an ultrasound could be sufficient to rule out the recurrence of obstruction. The renal scan appears to be indicated only in cases with an increase in the AP diameter.<sup>15</sup> Virote Chalieopanyarwong suggested that the renal parenchymal cortex could gain thickness after pyeloplasty, especially among those with good baseline renal function parameters.<sup>16</sup> In this study, we evaluated different parameters of ultrasound before and after surgery. Reduction of AP diameter is one of the appropriate criteria to predict surgical success. However, considering that the desired specificity may not be achieved within three months, it is recommended that an ultrasound be followed at least 6 months after pyeloplasty. The PI of AP can be a suitable criterion to predict the improvement of

kidney function so that the increase of more than 15% (Number 15 according to Maria Fernandez-Ibieta 2016.<sup>17</sup> After three months of surgery with a sensitivity of 94.16% and specificity of 50% and also an increase of at least 26% of this index (according to the findings of this study) 6 months after surgery, with a sensitivity of 99% and specificity of 100% could be a good criterion for evaluating the success of the surgery. An increase in the thickness of the cortex can also be a good criterion for the success of the surgery. There was an increase of at least 10 percent with a sensitivity of 82.5% and specificity of 50% in 3 months and also, an increase of at least 10 percent with a sensitivity of 92.5% and specificity of 100% in 6 months. Reduction of pelvic/cortex ratio by at least 16% after 3 months with a sensitivity of 98% and specificity of 50% and reduction of this index by at least 18% 6 months after surgery with sensitivity and specificity of 100% was observed. These numbers may be obtained differently in further research and studies. Type of surgery, age of children at the time of surgery and ultrasound examinations, and sonographic and device errors can be considered confounding factors for these numerical

changes. Also, due to the low specificity of 3-month ultrasound results, at least a 6-month follow-up of patients is recommended.<sup>18</sup>

## Conclusion

After pyeloplasty, a reduction in AP diameter, PI of AP, pelvic/cortex ratio, and an expansion in thickness of the cortex have been seen. Ultrasound in 3 months has high sensitivity but low specificity, and in 6 months have high sensitivity and specificity.

The gold standard method for follow-up of these patients after surgery is a nuclear scan. However, this technique has high cost and associated with some problems for children.

So, ultrasound alone can consider for the initial assessment after pyeloplasty, and renal scan reserved for those patients who do not show advancement on ultrasound.

## Ethical Consideration

The study was reviewed and approved by the ethics committee of Shahid Beheshti University of Medical Sciences (Ethics approval reference number: IR.SBMU.MSP.REC.1400.709).

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Not applicable

**Conflict of interests**

There is no conflict of interest

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