



## ORIGINAL ARTICLE

# Thickness of the renal pelvis smooth muscle indicates the postoperative course of ureteropelvic junction obstruction treatment<sup>☆</sup>

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### KEYWORDS

Pyeloplasty;  
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Postoperative  
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improvement

### Abstract

**Objective:** To investigate the relationship between the histopathologic findings and the postoperative course of children surgically treated for ureteropelvic junction (UPJ) obstruction.

**Material and methods:** Twenty-eight patients operated for unilateral UPJ obstruction from 1998 to 2005 with adequate histopathologic specimens and postoperative follow up were retrospectively reviewed. Specimens were stained using elastic van Geisson to differentiate smooth muscle from collagen and elastin. Postoperative follow up included renal ultrasound (U/S) and diuretic renogram studies.

**Results:** Twelve patients with mean renal pelvis smooth muscle thickness (mRPSMT) of  $136.97 \pm 34.17$  improved on the 6th postoperative month. Nine patients that improved after 9 months postoperatively had mRPSMT =  $173.61 \pm 33.91$ . The rest 7 patients that improved on the 12th postoperative month had mRPSMT =  $258.78 \pm 96.09$ . Correlation between renal pelvis smooth muscle and time of postoperative improvement was extremely significant ( $r = 0.7928$ ,  $p < 0.0001$ ).

**Conclusion:** The thickness of the renal pelvis smooth muscle is significantly correlated to the postoperative course of patients with UPJ obstruction and can be used as a prognostic tool for the onset of their improvement.

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**PALABRAS CLAVE**

Pieloplastia;  
Músculo liso de la  
pelvis renal;  
Obstrucción de la  
unión ureteropélvica;  
Mejoría de la  
hidronefrosis  
postoperatoria

## El grosor del músculo liso de la pelvis renal indica el curso postoperatorio del tratamiento de la obstrucción de la unión ureteropélvica

**Resumen**

**Objetivo:** Investigar la relación entre los resultados histopatológicos y el curso postoperatorio de niños tratados quirúrgicamente por obstrucción de la unión ureteropélvica (UUP).

**Material y métodos:** Se examinó retrospectivamente a 28 pacientes operados por obstrucción unilateral de la UUP desde 1998 hasta 2005 con muestras histopatológicas suficientes, así como su seguimiento postoperatorio. Se tintaron las muestras utilizando la elástica van Gieson para diferenciar el músculo liso del colágeno y la elastina. El seguimiento postoperatorio incluyó la ecografía renal (EcoR) y estudios de renograma diurético.

**Resultados:** 12 pacientes con un grosor medio del músculo liso de la pelvis renal (GmMLPR) de  $136,97 \pm 34,17$  mejoraron en 6 meses después de la operación. Nueve pacientes que mejoraron 9 meses después tenían un GmMLPR de  $173,61 \pm 33,91$ . Los 7 pacientes restantes, al duodécimo mes, tenían un GmMLPR de  $258,78 \pm 96,09$ . La correlación entre el músculo liso de la pelvis renal y el tiempo de mejoría postoperatoria fue extremadamente significativo ( $p = 0,7928$ ;  $m < 0,0001$ ).

**Conclusión:** El grosor del músculo liso de la pelvis renal está considerablemente correlacionado con el curso postoperatorio de los pacientes con obstrucción de la UUP, y se puede utilizar como herramienta de pronóstico del comienzo de su mejoría.

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**Introduction**

Ureteropelvic junction (UPJ) obstruction is one the most common congenital anomalies of the urinary tract in pediatrics, occurring in 1/1000–1/2000 newborns, although its frequency is rising due to the prevalent use of maternal ultrasound.<sup>1,2</sup>

There are controversies regarding the natural history and treatment of the hydronephrosis caused by the UPJ obstruction. The date of the surgical intervention, if required, cannot be determined accurately in every case. There are cases that resolve spontaneously, and cases where the renal function deteriorates unexpectedly fast; with the majority of patients being in between the two extremes.<sup>2</sup> Based on these observations, there are surgeons that propose an early surgical intervention, others that operate for certain reasons, and the rest suggest that surgery is rarely needed.<sup>3</sup>

Regarding the above-mentioned controversy, the first author (together with others) has published an article that indicates which parameters should be taken into consideration in order to recognize earlier that the child will finally need to be operated.<sup>4</sup>

On the other hand, although there are many reports regarding the preoperative approach of patients with UPJ obstruction, the time to expected postoperative radiographic improvement has not been fully investigated. Up to date, there are some reports in the literature that try to identify any objective parameters indicative of which cases will have a delayed improvement at follow-up.

We attempted to examine the possible relationship between the histopathologic findings of the excised renal pelvis and the postoperative course of surgically treated patients with UPJ obstruction in order to determine a possible pattern of the onset and timing of their improvement.

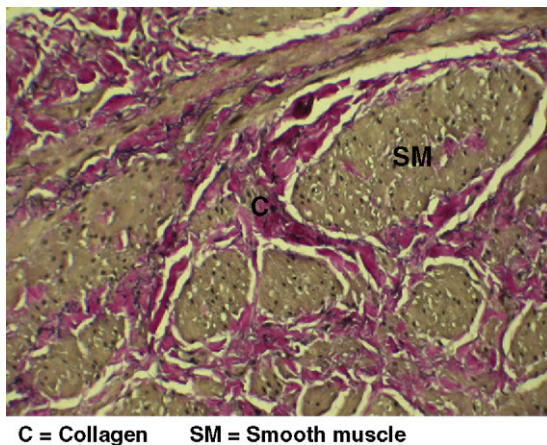
**Materials and methods**

The medical files of all the children that were surgically treated for UPJ obstruction from 1998 to 2005 in a single tertiary Pediatric Surgery Unit were retrospectively reviewed. Data collected included age at diagnosis, gender, side of the lesion, age at operation, time and results of postoperative radiographic examination, and time of definite improvement. The existence of adequate histopathologic specimens in our Pathology Department, and complete postoperative follow-up were inclusion criteria to the study.

Patients with prenatal diagnosis were evaluated initially at the age of 1 month with renal ultrasound, and at the age of 3 months with diuretic renogram. The protocol for the management of patients with confirmed diagnosis of unilateral UPJ obstruction was initial observation with regular follow-ups with renal ultrasound and diuretic renogram every 6 months for 1 year, and every year thereafter. Criteria for the change to surgical intervention were further increase of the anteroposterior renal pelvis diameter, worsening of the obstructive curve in the diuretic renogram, and drop of relative renal function (RRF) below 40%, as it was published in a previous report.<sup>4</sup>

All the patients were operated with the Anderson–Hynes dismembered pyeloplasty technique. Excised UPJ complex specimens were sent to the Pathology Department. Upon completion of the operation, the patient had a nephrostomy tube and an additional tube of appropriate diameter in the upper ureter that served as a stent. The stent was removed on the 8th postoperative day, and a pyelography was performed through the nephrostomy tube that confirmed the surgical success.

Follow-up consisted of a renal U/S at the third postoperative month followed by a repeated renal U/S and diuretic renogram at the sixth postoperative month. If the



**Figure 1** Histopathologic sample-pre-stenotic renal pelvis stained with elastic van Giesson 40×

radiographic results were not satisfactory, the same examinations were repeated every three months. A fully successful surgical management was defined in normal values of the renal pelvis diameter in the renal U/S, combined with a diuretic renogram washout pattern not indicative of UPJ obstruction.

For the purpose of this study, the histopathological samples were examined and appropriately managed by our Pathology Department. These were fixed in 10% buffered formalin for 24h, and then embedded in paraffin blocks maintaining the native orientation. Afterwards, the samples were horizontally sectioned in 4  $\mu\text{m}$  slides and were stained using elastic van Geisson to differentiate the renal pelvis smooth muscle from collagen and elastin. This highlights the smooth muscle as red-light brown, collagen as shiny orange, and elastic fibers as black (Fig. 1). The measurement of pre-stenotic renal pelvis smooth muscle thickness was performed with an intraocular ruler under 40 $\times$  magnification. The widest thickness of the lamina muscularis propria was measured from the luminal to adluminal surface.

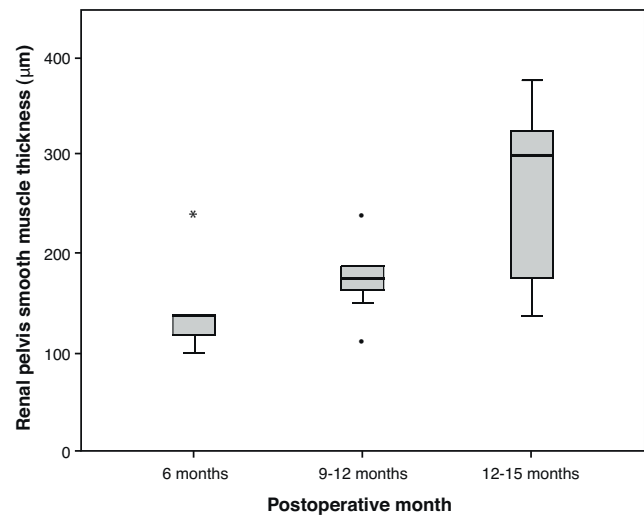
## Statistical analysis

Statistical evaluation of any relation between the histopathologic findings and the patients' postoperative course, this being defined from the time of final improvement, was performed by the use of the Pearson correlation coefficient. A two-sided  $p$  value of  $\leq 0.05$  indicated statistical significance. Statistical analysis was performed by using the Statistical Package for the Social Sciences SPSS for Windows (Edition 17.0, Chicago, IL, USA).

## Results

Thirty-four patients were operated on for unilateral UPJ obstruction from 1998 to 2005. 28 of them had adequate histopathological specimens and complete follow-up radiographic examination, and they constituted our study group. The rest of the patients were either lost during the follow-up or their histopathological samples could not be retrieved.

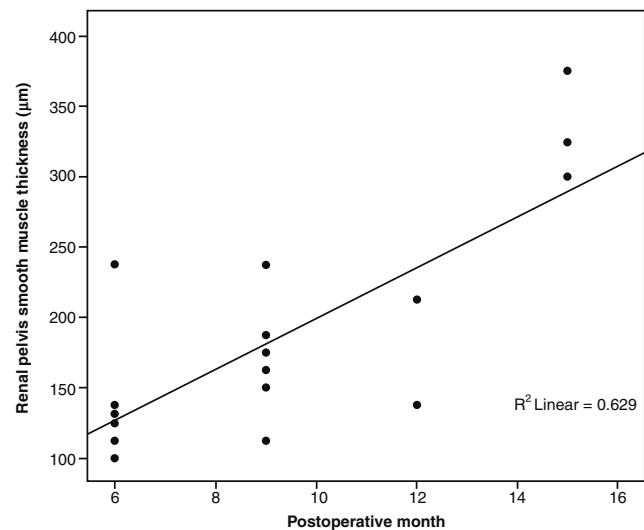
17 male and 11 female patients were identified (male to female ratio = 1.5:1). The left to right side of the lesion



**Figure 2** Range of patients' renal pelvis smooth muscle thickness.

ratio was 1.5:1, and the median age at operation was 2 years (range: 3 months to 13 years).

Improvement was noticed in all patients. No recurrence or further deterioration was noted, hence, no re-operation was needed. The time over which improvement was observed according to radiological findings ranged from the sixth and the twelfth postoperative month. Interestingly, the 12 patients that improved at the sixth postoperative month had a mean renal pelvis smooth muscle thickness (mRPSMT) =  $136.97 \pm 34.17$  (range: 100  $\mu\text{m}$  to 237.5  $\mu\text{m}$ , mean: 137.5). The 9 patients that improved at the ninth postoperative month had a mRPSMT =  $173.61 \pm 33.91$  (range: 112.5  $\mu\text{m}$  to 237.5  $\mu\text{m}$ , mean: 175  $\mu\text{m}$ ). The 7 patients with improvement at the twelfth postoperative month had a mRPSMT =  $258.78 \pm 96.09$  (range: 137.5  $\mu\text{m}$  to 375  $\mu\text{m}$ , mean = 300  $\mu\text{m}$ ) (Fig. 2).



**Figure 3** Correlation between renal pelvis smooth muscle thickness, and time of postoperative improvement.

The correlation between the renal pelvis smooth muscle thickness and time of postoperative improvement proved to be extremely significant ( $r = 0.7928$ ,  $p < 0.0001$ ) (Fig. 3).

We also measured the percentile presence of collagen and elastin content of the obstructed UPJ, and no correlation was detected between those and the postoperative time of recovery of hydronephrosis.

Finally, no correlation was identified between the time of postoperative radiologically confirmed improvement, and the ages at operation, the presence of prenatal diagnosis, gender, or side of the lesion.

## Discussion

The success rate of the surgical intervention in UPJ obstruction is reported to be greater than 95%.<sup>5</sup> However, the post-operative course of these patients until they achieve a satisfactory non-obstructive pattern of renal function is not always uneventful. It is not uncommon in such cases that the initial postoperative radiographic examinations are not suggestive of a successful surgical management, leading both the parents and the surgeon with increased anxiety.

Reasons for initially unresolved hydronephrosis include irreversible histopathological changes in the renal pelvis and the caliceal collecting system, transient obstruction due to edema at the site of repair, and persistent obstruction because of failed pyeloplasty.<sup>6</sup> In most cases, however, hydronephrosis resolves, and an improvement in renal function and drainage is achieved in subsequent studies during the follow-up.

More specifically, the upper urinary tract responds to the obstruction with a series of histological changes. The compliance of the renal pelvis is determined by the structure of the smooth muscle tissue, as well as the extracellular matrix collagen deposition, and that compliance is lost when the renal pelvic wall smooth muscle thickness and collagen increase.<sup>6</sup>

With regard to the renal pelvis smooth muscle thickness that follows UPJ obstruction, previous studies describe conflicting results. There are investigators that report that UPJ obstruction is associated with hypotrophy of the smooth muscle of the obstructed segment, or even atrophy that follows nerve fibers depletion.<sup>7-9</sup> On the other hand, there are those that report an increased proportion of smooth muscle cells in the obstructed UPJ leading to hypertrophy/hyperplasia.<sup>1,10</sup>

In this study, although we did not compare the thickness of the renal pelvis smooth muscle of patients with obstructed and non-obstructed UPJ, when we compared it to that reported in the literature, we too concluded that there was an increased thickness of the lamina muscularis propria.

Kim WJ et al. and Kim DS et al. have reported that collagen to smooth muscle ratio and elastin content of the renal pelvis determine post-pyeloplasty recovery.<sup>8,11</sup> They have found that increased collagen to smooth muscle ratio and increased elastin content in the obstructed UPJ contributes to inelasticity and low compliance, resulting in slower recovery of the hydronephrosis after pyeloplasty.

On the other hand, Han et al. have reported that the thickness of the lamina muscularis propria can be used as a predictive parameter of the time of the post-pyeloplasty

hydronephrosis recovery.<sup>6</sup> They reported that the increased thickness of the UPJ smooth muscle correlates with slower improvement.

Our results keep up with those of Han et al. We found that the increased renal pelvis smooth muscle thickness correlates with delayed postoperative radiographic improvement. No correlation between the percentile presence of collagen or elastin content with the time of postoperative radiographic improvement was observed.

These results clearly indicate that important information can be obtained by the histopathological examination of the obstructed UPJ samples after a dismembered pyeloplasty. During the time of the patient's postoperative recovery, and until the first postoperative radiographic examination, the surgeon can retrieve useful information regarding the patient's postoperative course and expected timing of hydronephrosis improvement, based on the thickness of the renal pelvis smooth muscle.

This way, the parents and the treating surgeon should only be worried about possible persistent obstruction if the appropriate time interval is prolonged. Such knowledge can be extremely helpful and reassuring, not only for the surgeon but for the patients' families as well.

All of the above indicates that in patients that are operated on for UPJ obstruction, the pattern of postoperative improvement correlates with the thickness of their renal pelvis smooth muscle. This is significantly correlated with the postoperative course of patients with UPJ obstruction, and it could be used as a prognostic tool for the onset of their improvement.

## Conflict of interest

The authors declare that they have no conflict of interest.

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