

## Ureteropelvic Junction Obstruction (UPJO)

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### ABSTRACT

Ureteropelvic junction obstruction (UPJO) is an abnormality in the canal that connects the renal pelvis to the ureter, leading to impairment of urinary flow. The use of maternal ultrasound has increased the number of UPJO during the antenatal period. Histopathological features in UPJO are important for establishing the diagnosis and understanding the pathogenesis of the condition. The current study aims to explain the irregularity of the muscularis propria and a decreased Cajal cells in the affected segment of the UPJO.

**Keywords:** Ureteropelvic junction obstruction, histopathology, diagnosis

## INTRODUCTION

Ureteropelvic junction obstruction is characterized by urinary flow impairment from the renal pelvis to the ureter and is one of the most common causes of antenatal hydronephrosis.<sup>1</sup> It occurs in 1/1000 to 1/2000 of newborns and may have increased due to the widespread use of maternal ultrasound.<sup>1-3</sup> Frequently, UPJO is seen more in boys than in girls, and the left side of the kidney is more often affected than the right side. Most cases of UPJO are congenital; however, some remain asymptomatic into adulthood.<sup>4,5</sup>

Generally, UPJO is classified as primary and secondary. Primary UPJO is caused by a congenital anomaly, while secondary UPJO is commonly caused by post-surgical strictures, calculi, or urothelial neoplasms.<sup>6</sup> The histopathological changes, which include discontinuity of smooth muscle, excessive collagen deposition, and a decrease in Cajal cells, may play an important role in the pathogenesis of UPJO.<sup>7</sup>

Pyeloplasty is the UPJO gold standard treatment.<sup>3</sup> This surgical technique is successful in more than 95% of UPJO cases. However, the remaining 5% require further interventions to manage the persistent obstruction. Early diagnosis and prompt treatment of UPJO are very important to prevent kidney damage and loss.<sup>3,6</sup> Although UPJO is diagnosed clinically, the pathogenesis remains unclear. As a result, a histopathological study from the affected area may broaden the pathogenesis of UPJO. This literature reviews the morphology features in UPJO specimens and their relation to pathogenesis.

## Epidemiology

The incidence of UPJO is 1 in 1000-2000 and compared to adults, UPJO is usually more prevalent in the pediatric age group. This condition is two times more common in boys than in girls, and the left side of the kidney is more often affected than the right side.<sup>1,2</sup>

## Definition

*Ureteropelvic junction obstruction* (UPJO) is an impairment of urinary flow from the renal pelvis to the ureter leading to dilatation of the affected area. This condition may cause renal

failure when unidentified and inadequately treated.<sup>1</sup>

## Diagnostic Criteria

The diagnosis of antenatal hydronephrosis (ANH) is based mainly on the anterior-posterior diameter (APD) measurement of the renal pelvis through prenatal and postnatal ultrasound. Further, the ultrasound examination can be considered in the presence of symptoms and a physical examination that are consistent with the UPJO clinical features.<sup>7,9</sup> Antenatal hydronephrosis is defined as APD  $\geq 4$  mm in the second trimester of pregnancy or APD  $\geq 7$  mm in the third trimester or postnatal period.<sup>7,9</sup> Based on the recommendation of EAU, when dilatation has been recognized via postnatal ultrasound, a voiding cystourethrography (VCUG) followed by diuretic renography is necessary to further identify the cause of the hydronephrosis so that adequate management can be carried out.<sup>7,9</sup>

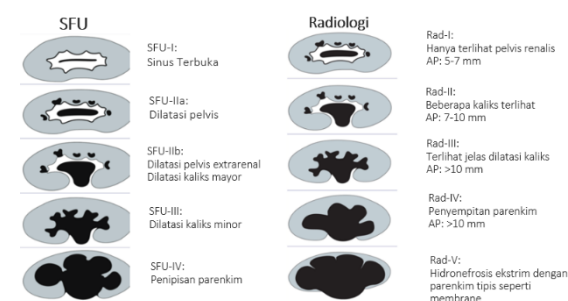


Figure 1. Classification of antenatal hydronephrosis based on SFU and the Radiology Grading System.

Ureteropelvic junction obstruction diagnosis criteria are as follows:<sup>7,9</sup>

- Persistent hydronephrosis without hydroureter with renal pelvis diameter  $>15$  mm on ultrasound examination.
- The presence of obstruction with/without split kidney function disorder using diuretic renography.
- CT-urography (CTU) or MR-urography (MRU) shows obvious anatomical obstruction in the ureteropelvic junction area based on intravenous pyelography.

Below is the differential diagnosis of UPJO as the cause of hydronephrosis in children:

- Transient physiologic hydronephrosis
- Urethral valves (anterior or posterior)

- Urethral stricture
- Ureteric stricture
- Neurogenic Bladder
- Cloacal anomaly
- Megacystis-microcolonintestinal hypoperistalsis syndrome (MMIHS)
- Intra-abdominal mass
- Polycystic kidneys
- Abdominal neuroblastoma
- Ureteral polyps
- Pelvic tumors
- Hydrocolpos
- Urachuan cyst
- Urethral atresia
- Ureteral polyps
- Urterocele
- Ectopic Ureter
- Retrocaval ureter

### Etiology and Classification

Ureteropelvis junction obstruction is classified as primary (congenital) and secondary (acquired) with the earlier being the more frequent cause.<sup>10,11</sup>

#### a. Congenital

1. Ureteral hypoplasia may result in an aperistaltic segment of the ureter leading to functional obstruction due to the impairment of urinary flow from the renal pelvis into the ureter.
2. High insertion of the ureter into the renal pelvis may lead to the inability of the pelvis to empty urine into the ureter as a result of acute angulation in the ureteropelvic junction causing functional obstruction with hydronephrosis. This may be a primary or secondary result of renal scarring or hypoplasia of the ureter.
3. A crossing renal vessel that entrap the ureter, usually from the lower pole, may prevent urine to flow freely due to the kinking of the proximal ureter.
4. Malrotated kidney (rarely)

#### b. Acquired

1. Extrinsic factor: external pressure on the ureteropelvic junction or proximal ureter due to retroperitoneal fibrosis, retroperitoneal lymphadenopathy (cancer, lymphoma, testicular), or the presence of a retroperitoneal mass (sarcoma).

2. Intrinsic factor: strictures of the ureteral and peri-ureteral walls due to impacted stone, radiation, or chronic inflammation, tumors of the urethra, or postoperative strictures (iatrogenic).

### Pathophysiology

The majority of UPJO cases are considered due to partial obstruction since total obstruction may lead to rapid renal failure. Hydronephrosis in congenital UPJO may be caused by obstruction of urinary flow due to anatomical or functional abnormalities.<sup>11,12</sup> The two main factors that control urinary flow from the renal pelvis to the ureter are (1) the pressure inside the renal pelvis and its compliance, which is influenced by urine production volume, the internal diameter of the ureteropelvic junction, and the collecting system. (2) The peristaltic activity of the ureter may be influenced by the arrangement of smooth muscle, its absence, or hypertrophy in the proximal ureteral wall with the latter is the primary reason for congenital UPJO. Generally, UPJO occurs in one kidney. As interleukin (IL)-5 and eotaxin-2 from the urothelium act as chemoattractants for leukocytes and cause inflammatory cell infiltration, the production of vasoactive peptides and cytokines is increased in this partial obstruction. The monocytic infiltration is believed to influence the renal blood supply and lower total GFR in the affected kidney while increasing single-nephron GFR through altering eicosanoid elaboration in the kidney. Similar to this, the vasoconstrictor action of the renin-angiotensin system's activation may result in a lower GFR in the affected kidney.<sup>12</sup>

### Histopathology

The bladder, ureters, and pelvis mostly show a similar anatomical arrangement: the innermost layer is the epithelial cell, the next layer is the lamina propria or subepithelial connective tissue, smooth muscle (muscularis propria), and the outermost layer is adventitia (Figure 1). The superior surface of the bladder contacts the parietal peritoneum, and as a result, it has a serous lining. This arrangement is used as a staging reference in urothelial cancer to determine therapy and predict the prognosis.<sup>7</sup>

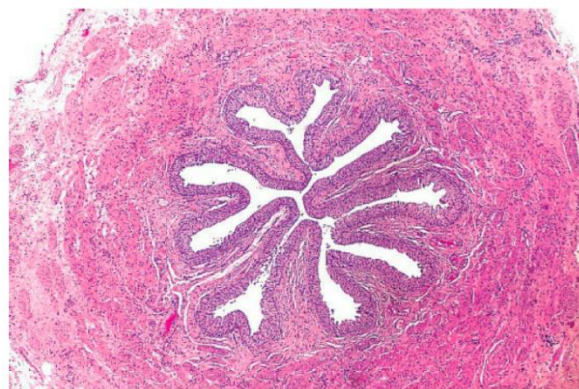


Figure 1. The cross-section of the ureter shows the elastin fibers and connective tissue in the lamina propria and the distinct layered orientation of the muscularis propria.

The muscularis propria of the bladder is composed of three layers of smooth muscle: the inner longitudinal, middle circular, and outer longitudinal layers. In the ureter, the proximal part has two layers of smooth muscle and thickens distally. The arrangement of smooth muscle in the renal pelvis becomes thinner, and there is no clear muscle orientation in the major and minor calyces.<sup>7</sup>

The histopathological features of UPJO have not been extensively studied. This may be due to not all UPJO specimens obtained being sent for pathologic identification. Therefore, there is still a limited understanding of UPJO. The current theory describes the chronic inflammation of the tissue followed by changes in muscle arrangement: the absence or decrease in muscle mass, irregularity of the muscular layers, and thickening of the collagen connective tissue (Figure 2). However, the wall thickness of the tunica mucosa (uroepithelium) is not significantly increased.<sup>8</sup>

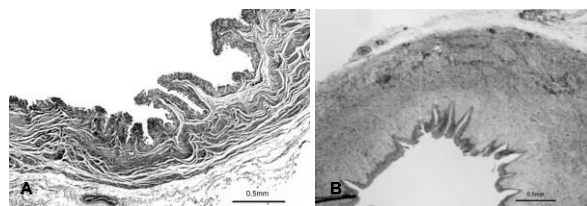


Figure 2. A. The morphology of the normal ureteropelvic junction. B. thickening of collagen in UPJO<sup>8</sup>

Other studies also found a decrease in the number of interstitial Cajal cells, which play an important role in peristalsis movement from the renal pelvis to the ureter due to chronic obstruction in the UPJO (Figures 3 and 4). However, the Cajal cells may increase in response to compensatory changes in peristalsis in the early phase.<sup>4,5</sup>

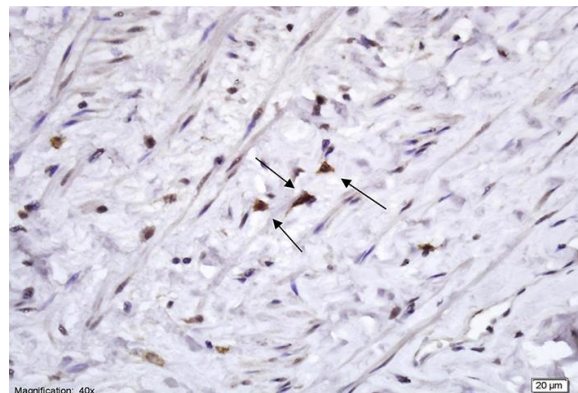


Figure 3. Cajal cells (arrow) in a patient with ureteropelvic junction obstruction (UPJO).<sup>4</sup>

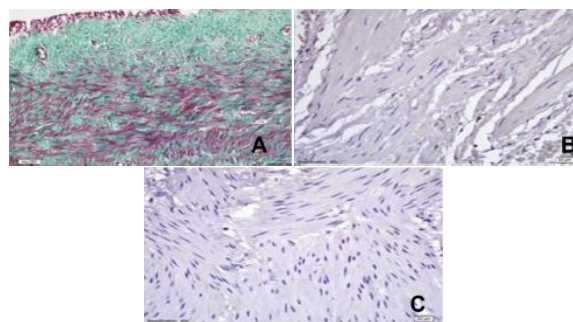


Figure 4. A. The subepithelial connective tissue with sclerotic fibrosis. B. A few Cajal cells. C. The absence of Cajal cells in the UPJO specimen.<sup>4</sup>

### Management

Regular monitoring is required in patient with split renal function <10% and asymptomatic. If indicated below, pyeloplasty is the gold standard for UPJO.<sup>9,10,11</sup>

1. Symptomatic obstruction (recurrent low back pain) or associated with an abdominal mass
2. Recurrent urinary tract infection despite taking prophylactic antibiotics
3. The atrophy of bilateral renal parenchymal due to severe UPJO

4. Ureteropelvic junction obstruction with split renal function >40% in the affected kidney based on a diuretic renogram, increased anteroposterior diameter of the renal pelvis on ultrasonography (USG), and grade III and IV hydronephrosis based on the Society of Fetal Urology (SFU)

### Complication

Ureteropelvic junction obstruction is frequently diagnosed at an advanced stage, with hydronephrosis being the most common complication, which shows as a dilatation of the renal pelvis and calyces due to stagnation or reflux of urine. Hydronephrosis in children may be physiological or pathological, which occurs due to congenital abnormalities that can be detected during antenatal care. This condition is known as antenatal hydronephrosis (HNA) or congenital hydronephrosis. Besides UPJO, hydronephrosis may occur due to obstruction of the ureterovesical junction (UVJ), and vesicoureteral reflux (VUR). Congenital abnormalities of the urinary tract, such as the posterior urethral valve (PUV), ureterocele, ectopic ureter, double collecting system, prune-belly syndrome, and urethral atresia, may also present with hydronephrosis.

Other complications of UPJO include recurrent bladder tract infections with perinephric stranding, chronic low back pain, secondary kidney stone formation, and partial or complete kidney damage due to continuous obstruction.<sup>11-13</sup>

### Prognosis

Pediatric and adult UPJO may have different prognoses. Ureteropelvic junction obstruction with hydronephrosis in children has a different prognosis depending on the time of diagnosis (20%-50% of hydronephrosis cases show improvement after birth), the degree of hydronephrosis complication, parenchymal damage, and systemic abnormalities.<sup>14-16</sup> Symptomatic UPJO in adulthood requires surgical intervention in order to recover renal function. Pyeloplasty shows a >90% of success rate for correcting UPJO.<sup>17</sup>

### CONCLUSION

Histopathological features may provide sufficient information for the diagnosis and management of UPJO. Currently, studies show that muscular irregularity and a decrease in Cajal cells occur in UPJO. Further research into the histopathological features of UPJO is required to have a more comprehensive understanding of its pathogenesis.

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