Original Article

# Impact on clinical outcome of segmental vs diffuse parenchymal thinning in infants with prenatal urinary tract dilation

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**Keywords:**
Urinary tract dilation, parenchymal thinning, differential renal function

## Abstract

**Objective:** To determine the difference in renal function and rate of surgical intervention between neonates with diffuse and segmental parenchymal thinning.

**Materials and Methods:** First postnatal ultrasonography images of neonates with prenatal urinary tract dilation were evaluated and measurements taken. Neonates with parenchymal thinning were categorised into segmental and diffuse parenchymal thinning groups using the medullary to intermedullary ratio. A statistical correlation of differential renal function and rate of surgical intervention between the two groups was calculated and evaluated using an independent t-test and Kaplan-Meier curve with Log-rank test, respectively.

**Results:** Of the 20 neonates, 10 had segmental parenchymal thinning, while the other 10 had diffuse parenchymal thinning. Mean differential renal function was 49.3% in the segmental parenchymal thinning group compared to 45.8% in the diffuse group ($p = 0.400$). Five patients (50%) from the segmental parenchymal thinning group underwent pyeloplasty in comparison to seven patients (70%) from the diffuse group ($p = 0.430$)

**Conclusion:** There were no significant differences in renal function or rate of surgical intervention between neonates with segmental parenchymal thinning and diffuse parenchymal thinning. Neonates with segmental parenchymal thinning need to be monitored as closely as those with diffuse parenchymal thinning for early detection of renal deterioration and to identify potential need for surgical intervention.

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## Introduction

Dilation of the fetal renal collecting system, prenatal urinary tract (UT) dilation, is one of the most common abnormalities detected in prenatal ultrasonography.[1-3] Diagnosis of UT dilation occurs in 1-5% of all pregnancies.1-3 In the postnatal period, ultrasonography is often the first imaging modality effective in the evaluation of these infants.[3]

In 2014, a multidisciplinary consensus on the classification of prenatal and postnatal urinary tract dilation was achieved, thus showing a level of reliability in the assessment of UT dilation.[4] This classification organised postnatal urinary tract dilation into three groups: low, intermediate, and high risk, by using six ultrasonography parameters including anterior-posterior renal pelvic diameter (APRPD), calyceal dilation, parenchymal thickness, and parenchymal, ureter, and bladder appearance.

Focusing on the parenchymal thickness, a patient with parenchymal thinning will be classified as high risk for uropathy, which requires different management to low and intermediate risk categories. However, there are no guidelines that define parenchymal thinning in terms of which part of the parenchyma should be measured.

While several studies have reported that patients with parenchymal thinning have a higher risk of uropathy,[5,6] few studies provide information about the impact on the outcomes of severity for parenchymal thinning.

A previous study by H. Sibai reported that diffuse parenchymal thinning has a higher risk of a significant decrease in renal function compared to segmental parenchymal thinning.[6] The results, however, show some conflict in terms of anatomy, segmental parenchymal thinning predominantly affecting the medullary region, which might cause pressure on more glomeruli. Thus, the pressure on the glomeruli may not be the main factor that affects the renal function.

The purposes of this study were to determine the difference in renal function and rate of surgical intervention between neonates with diffuse and segmental parenchymal thinning.

## Materials and Methods

We conducted a retrospective cohort study of all neonates diagnosed with prenatal urinary tract dilation by ultrasonography at King Chulalongkorn Memorial Hospital based on electronic medical records dating from January 1st, 2010 to December 31st, 2016. The study protocol was approved by the institutional review board of the Faculty of Medicine, Chulalongkorn University, and informed consent was not required (IRB No. 334/62). We only included neonates who met the following criteria: (1) Neonates (≤ 1 month old); (2) diagnosed with hydronephrosis or urinary tract dilation as documented by a pediatric nephrologist or pediatric urologist, according to the medical records; (3) a report of parenchymal or cortical thinning by first postnatal ultrasonography (UTD P3, SFU grade IV or PCD grade IV). Patients were excluded from the study if they had: (1) contralateral significant urinary tract dilation (UTD P2 and P3), or (2) other congenital anomalies of the KUB system such as cystic kidney disease, duplication anomalies and ureteroceles, vesicoureteral reflux, ureterovesical obstruction, or urethral obstruction. Contralateral significant urinary tract dilation and congenital anomalies of the KUB system were excluded due to the possibility they could affect differential renal function. Patients were also excluded if (3) there was no renal function study or (4) there was loss to follow-up within 36 months, unless UT dilation had already resolved before then.

Ultrasonographic images from the Picture Archiving and Communication System (PACS) were used. Evaluation and measurement of the first postnatal ultrasonographic images were done in consensus by a pediatric radiologist and a radiology resident.

Predominate caliectasis at the medullary zone usually gives the appearance of segmental parenchymal thinning, while diffuse caliectasis at both the medullary and intermedullary zones usually gives the appearance of diffuse parenchymal thinning. Thus, the definitions of segmental and diffuse parenchymal thinning were categorised using the parenchymal thickness at the intermedullary and medullary zones.

From ultrasonographic images of the kidney longitudinal axis, the measurement of parenchymal thickness was done at the upper, mid, and lower poles of the kidney for each medullary and intermedullary zone (Figure 1). Subsequently, the average thickness of the medullary zone and intermedullary zone was calculated as a ratio.

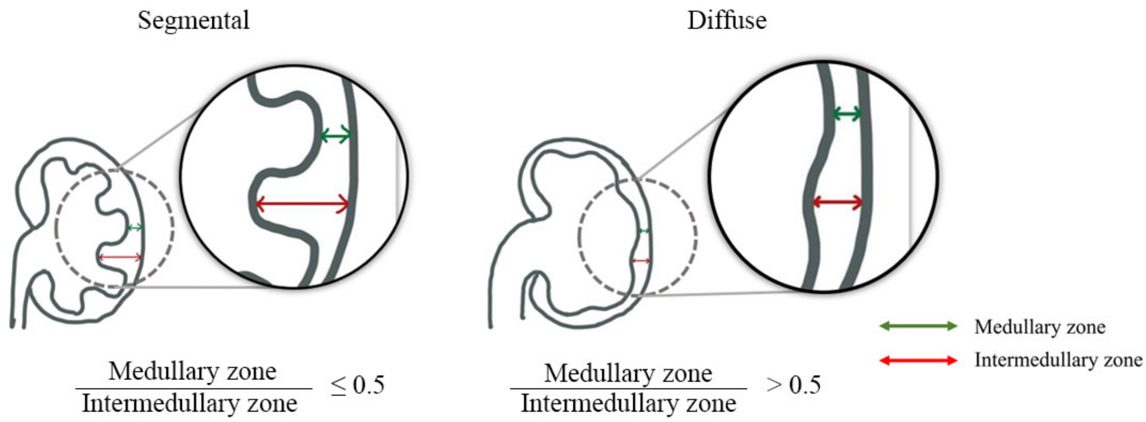


**Figure 1.** Measurement of parenchymal thickness in medullary zone and intermedullary zone

Based on appearance of segmental and diffuse caliectasis as mentioned above, we used a cut point ratio of 0.5. If the ratio of the medullary zone to intermedullary zone is equal to or less than 0.5, it was categorised as segmental parenchymal thinning. In contrast, it was categorised as diffuse parenchymal thinning if the ratio of the medullary zone to intermedullary zone was more than 0.5.

All neonates underwent diuretic renography using mercaptoacetyltriglycine (MAG3), which enables a calculation for differential renal function (DRF). The first differential renal function for each patient was collected. The differential renal function reflects the relative ability of the kidney to extract a radiotracer from the blood, a measurement ranging from 0 to 100 percent. A statistical correlation between the two groups of urinary tract dilation and differential renal function was performed using an independent t-test. SPSS version 22 was used for all statistical analyses.

We monitored the patients for up to 36 months to discover whether they underwent relevant surgery, specifically pyeloplasty. Indications for pyeloplasty were recorded. Difference in the rate of surgical intervention between the two groups was analysed using the Kaplan-Meier curve with Log rank test.

## Results

A total of 47 neonates met the inclusion criteria, 27 were excluded. A total of 20 neonates were evaluated. Measurements were taken from their first postnatal ultrasonographic images and then individuals were classified into segmental and diffuse parenchymal thinning groups. Examples of cases of segmental and diffuse parenchymal thinning are shown in Figures 2 and 3.

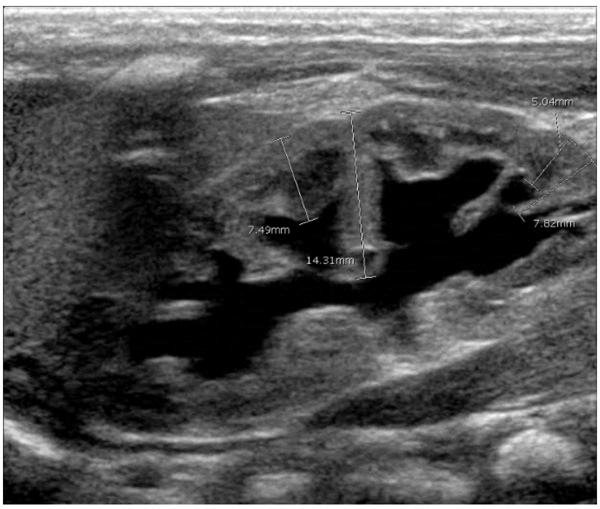


**Figure 2.** Segmental parenchymal thinning

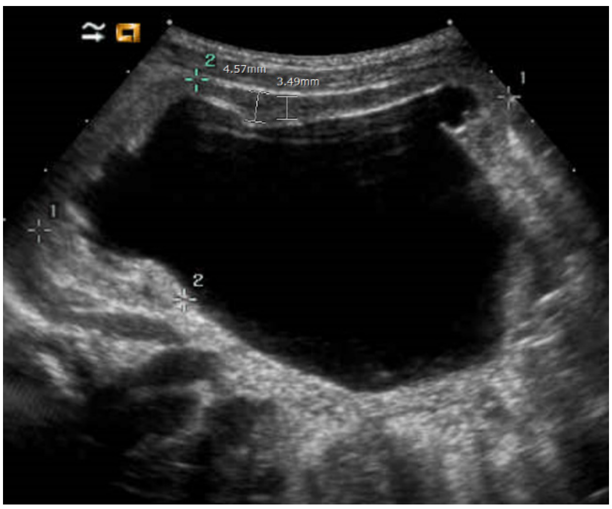


**Figure 3.** Diffuse parenchymal thinning

Demographic data and clinical characteristics are shown in Table 1.

Mean differential renal function was 49.3% in the segmental parenchymal thinning group and 45.8% in the diffuse group. Statistical analysis showed no significant differences in differential renal function between neonates with diffuse and segmental parenchymal thinning (p = 0.400).

There were 5 patients (50%) from the segmental parenchymal thinning group and 7 patients (70%) from the diffuse parenchymal thinning group who had undergone associated surgery, which was pyeloplasty. Every patient underwent surgery as advised by our institution including 9 patients with less than 40% differential renal function on the affected side, 2 patients with a higher than 5% decrease in differential renal function on serial renography and 1 patient with progressive urinary tract dilation on serial ultrasonography. As illustrated by the Kaplan-Meier curve (Figure 4) with Log rank test, there was no significant difference in the incidence of pyeloplasty between neonates with diffuse and segmental parenchymal thinning (p = 0.430).

## Discussion

From our data, it is apparent that urinary tract dilation was more common in the left than the right kidney, findings similar to a study by Carlo C. Passerotti, who reported that hydronephrosis was more prevalent on the left side.[5]

Our results showed that there is no significant difference in differential renal function between segmental and diffuse parenchymal thinning. The results of our study differ from a prior study by Sibai H, which indicated that patients with diffuse parenchymal thinning experienced a significant decrease in differential renal function in comparison to segmental parenchymal thinning.[6]

There is no significant difference in the rate of surgical intervention between segmental and diffuse parenchymal thinning.

The results indicated that, even with parenchymal thinning only in the intermedullary zone, there might be cause for concern and the need for close follow-up due to a significant risk of renal deterioration and the need for surgical intervention, to the same extent as in diffuse parenchymal thinning.

**Table 1.** Demographic data and clinical characteristics

| Demographic data | Segmental | Diffuse |
|---|---|---|
| Patients (n) | 10 | 10 |
| Sex | | |
| - Male | 9 | 5 |
| - Female | 1 | 5 |
| Birth | | |
| - Term | 9 | 9 |
| - Preterm | 1 | 1 |
| Average age of 1st ultrasound (days) | 18 | 13 |
| Average age of 1st diuretic renogram (days) | 669 | 527 |
| Laterality | | |
| - Right | 2 | 2 |
| - Left | 8 | 8 |

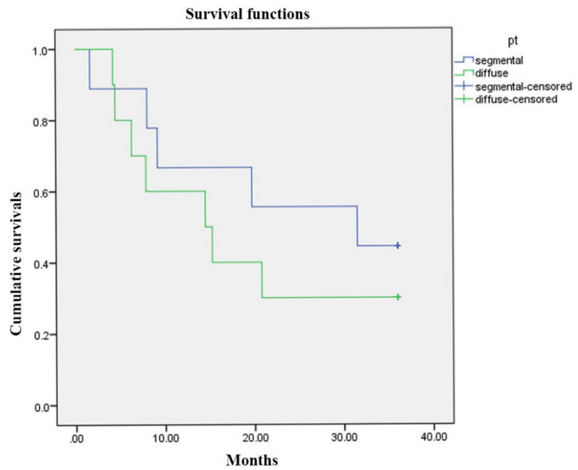


**Figure 3.** Kaplan-Meier curve showing time to pyeloplasty in segmental parenchymal thinning vs. diffuse parenchymal thinning group

There were some limitations to this study. Firstly, this is a retrospective study and data was extracted from medical records in which investigations had been carried out by a range of professionals leading to some variation. In addition, some images did not clearly focus on each part of the kidney leading to some difficulties in taking measurements. A future prospective study should be conducted with an increased sample size as in this study the numbers were restrictive as we excluded contralateral significant urinary tract dilation which may affect the differential renal function. A prospective study could focus on the measurements for each part of the kidney giving more consistent data. A future study using other cut point values for the medullary to intermedullary ratio may also show significant differences between the two groups.

## Conclusion

Neonates with segmental parenchymal thinning and diffuse parenchymal thinning tend to have no significant differences in renal function or rate of surgical intervention. However, as the sample size in this study was small, the results should not be construed as being precise. It is clear that neonates with segmental parenchymal thinning should be monitored as closely as those with diffuse parenchymal thinning for the early detection of renal deterioration and the need for surgical intervention.

## Conflict of Interest

The authors declare no conflict of interest.

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