Original Articles/นิพนธ์ต้นฉบับ

Correlation between Posterior/Anterior Urethral Ratio from Voidingcystourethrography and Prognosis of Posterior Urethral Valves

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Abstract

Purpose: To determine the correlation between the posterior/anterior urethral caliber ratio and the renal and bladder function after definite treatment for posterior urethral valves (PUV), and to evaluate the prognostic variables affecting the renal function in the patients with PUV.

Material and Method: We retrospectively reviewed the medical records and voiding cystourethrography (VCUG) of the patients who were diagnosed as having PUV from January 2004 to June 2013. The posterior/anterior urethral caliber ratio was measured from VCUG at diagnosis and the data including age at diagnosis, clinical presentation of the disease, degree of vesicoureteral reflux (VUR), temporary urinary diversion type, renal function at diagnosis, the best renal function after temporary urinary diversion and at the latest visit were collected.

Results: Of 20 patients, mean±SD of age at diagnosis was 22.6±28.4 months (range 0.03-84 months). Mean±SD of posterior/anterior urethral caliber ratio at the time of diagnosis was 3.4±1.64 (range 1.3-6.4). Mean±SD of glomerular filtration rate (GFR) at diagnosis and at the latest visit were 39.5±39.7 ml/min/1.73m2 and 87.7±50.3 ml/min/1.73 m^2, respectively. VUR was found in 27 renal units. Valve bladder syndrome (VBS) was diagnosed in 13 patients (68%).No correlation was found between the posterior/anterior urethral caliber ratio and renal function at various time, and also between the urethral ratio and VBS. Only GFR nadir after diversion was related to the outcome of renal function.

Conclusion: Although the posterior/anterior urethral caliber ratio was not correlated with the renal function and bladder function after treatment of PUV, the significant factors that could predict the renal function after treatment was serum GFR after temporary urinary diversion.

Keywords: Posterior urethral valves, Posterior/anterior urethral caliber ratio, Voiding cystourethrography, Prognosis

Abbreviations: PUV, Posterior urethral valves; VCUG, Voiding cystourethrography; GFR, glomerular filtration rate

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Introduction

Posterior urethral valves (PUV) is a common congenital urinary tract obstruction. It is a devastating disease and resulting in drastic effects to genito-urinary tract.[1,2] Even though the patients receive the proper treatment immediately after birth, the consequences of the obstruction still occur such as voiding dysfunction and impaired renal function. Up to 50% of boys with PUV develop end stage renal disease in their lifetime and need for kidney transplantation.[3,4] Thus, the most common condition producing this degree of renal dysfunction is PUV.

At present, there are many predictors of renal function in patients with PUV such as ultrasound appearance of the kidneys[5], serum chemistries[6,7], age at diagnosis[8,9], and presence of reflux[10,11]. There are several studies that have demonstrated that posterior/anterior urethral caliber ratio can be used to assess the outcome of surgery for PUV. Thus, we wondered whether the posterior/anterior urethral caliber ratio from voiding cystourethrography (VCUG) could predict the prognosis or the outcome of PUV treatment in terms of renal function. Therefore, the aim of this study was to determine the correlation between the posterior/anterior urethral caliber ratio and the renal function after definite treatment for PUV.

Material and Method

After the approval by the Ethics Committee on Human Experimentation Involving Human Subjects of the Faculty of Medicine, Ramathibodi Hospital, Mahidol University, we retrospectively reviewed the medical records and VCUG of the patients who were diagnosed as PUV from January 2004 to June 2013. All patients included those who underwent transurethral valve ablation for the definite treatment. The posterior/anterior urethral caliber ratio was measured from the VCUG at diagnosis. This measurement was done by using the maximal anterior urethral diameter and the maximal posterior urethral diameter in oblique position of voiding phase images (Figure 1). We used the measurement calibration in DICOM conformance (Synapse version 3.2.0, FUJIFILM Medical systems USA's Synapse® PACS System, USA) and measured the posterior/anterior urethral caliber ratio twice and then calculated for the average value. In addition, we collected the data regarding age at diagnosis, clinical presentation of the disease, degree of hydronephrosis from VCUG, the temporary urinary diversion type (urinary catheter, vesicostomy, or ureterostomy), renal function at diagnosis, the best renal function after temporary urinary diversion and at the latest visit. Regarding the renal function, we calculated the glomerular filtration rate (GFR) using Schwartz formula. We also recorded the voiding symptoms, urodynamics and complications after the surgery.

Statistical analyses were done using SPSS version 17.0. Descreptive statistics was reported using mean, standard deviation and range. Clinical presentation and VCUG findings were described in percentage. The relationship between the posterior/anterior urethral caliber ratio and outcome of disease, together with the relationship between prognostic factors and latest GFR were analysed using the Pearson correlation with $P < 0.05$ considered as statistically significant.

Results

From January 2004 to June 2012, there were 26 patients who were diagnosed as having PUV at Ramathibodi Hospital. Six patients were excluded because 4 had no VCUG available in the PACS system and 2 were lost follow up after the surgery. Finally, there were a total of 20 patients included in

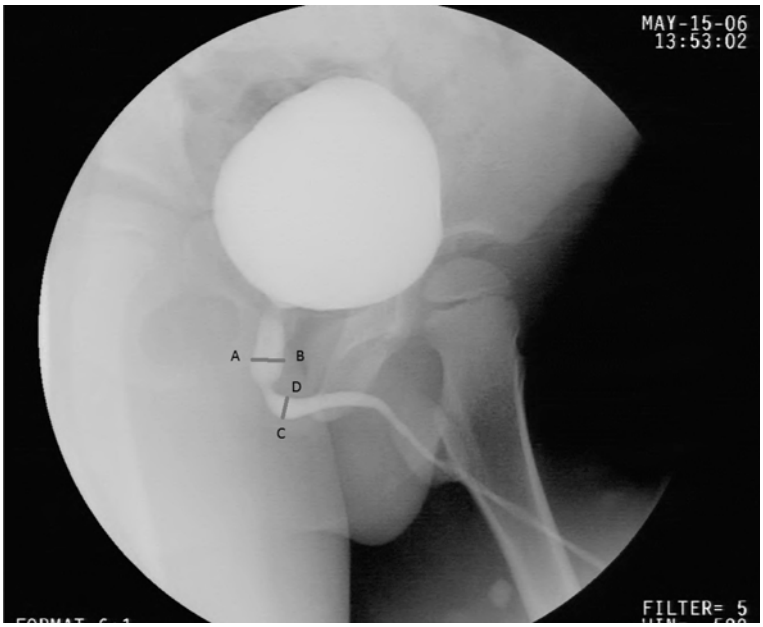

Figure 1. *The posterior/anterior urethral caliber ratio measurement from VCUG.*
The posterior/anterior urethral caliber ratio measurement was done by using the maximal posterior urethral diameter (A-B) divided by the maximal anterior urethral diameter (C-D) in oblique position of voiding phase images.

our study. Mean±SD of age at diagnosis was 22.6±28.4 months (range 0.03-84 months). Mean follow up was 61.95 months (range 7-150). Table 1 shows disease characteristics and initial urinary diversion of PUV at Ramathibodi Hospital. Most of the patients presented with the symptoms of the disease or its complications. Only one patient was diagnosed prenatally, but afterbirth he had difficult urination. The most common clinical presentation was urinary tract infection, followed by difficult voiding. Only 2 patients (10%) were diagnosed because of the abdominal mass and 1 patient (5%) had no symptom but it was accidentally found to have abnormal renal function. At the time of diagnosis, renal insufficiency was found in 11 patients (55%).

About the VCUG finding, all patients had a dilatation of posterior urethra and disproportion of the anterior urethra. Mean±SD of posterior/anterior urethral caliber ratio at the time of diagnosis was 3.4±1.64 (range 1.3-6.4). All except 3 patients had the vesicoureteral reflux (VUR). Among 17 patients with VUR, 10 patients had bilateral VUR (58.9%), whereas the other 7 patients had unilateral VUR (41.2%). Totally, VUR was found in 27 renal units. Of these, VUR grade 5 was found in 14 renal units (52%).

After the diagnosis of PUV, 12 patients (60%) underwent temporary urinary diversion, 2 patients (10%) with urethral catheter, 6 patients (30%) with vesicostomy, and 4 (20%) with ureterostomy. There were 8 patients who didn't undergo temporary urinary diversion because they presented at the later age and could have definite surgery immediately. Figure 2 shows mean GFR at diagnosis, after temporary diversion, and latest visit. Regarding renal function at the

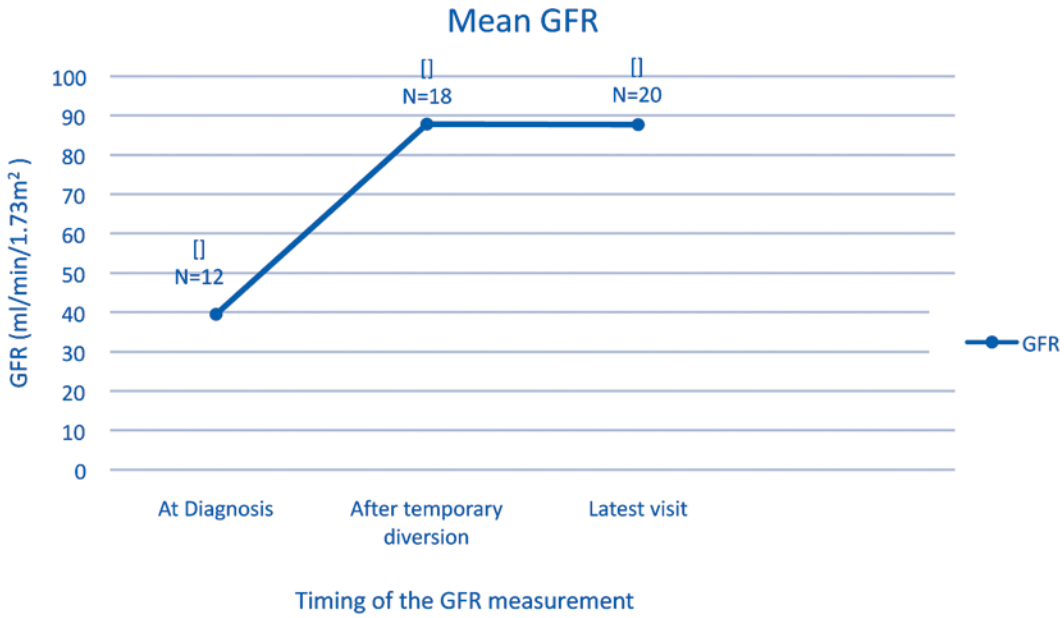

Figure 2. *Renal function (mean GFR) at diagnosis, after temporary diversion and the latest visit*

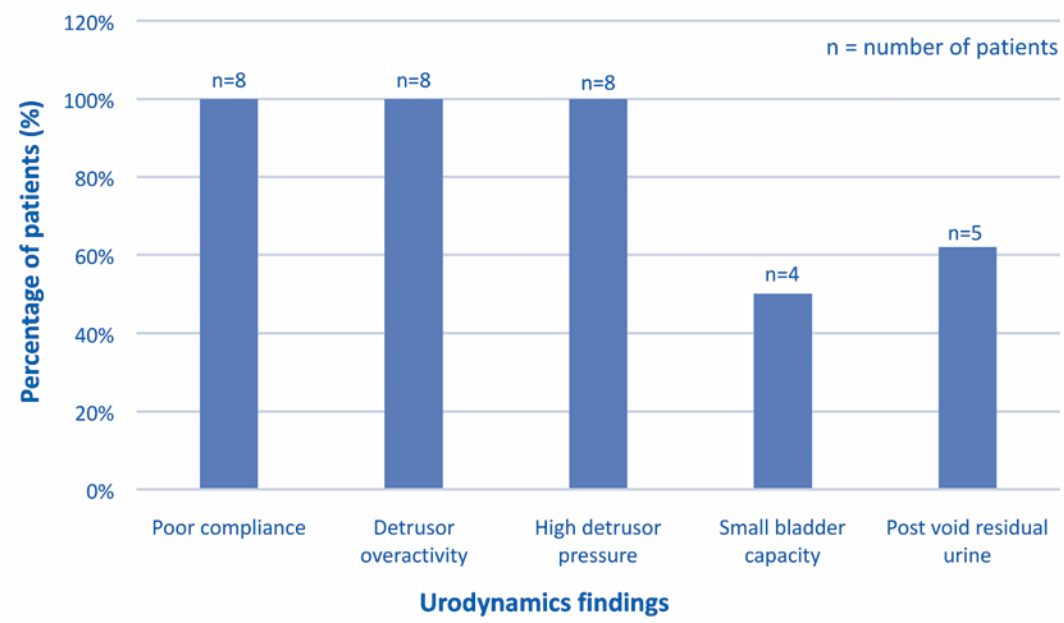

Figure 3. *Urodynamic findings in patients with abnormal voiding*

time of diagnosis, the data were missed in 8 patients. Eleven of 12 patients had renal insufficiency. Mean±SD of GFR at diagnosis was 39.5±39.7 ml/min/1.73 m^2 (range 9.8-135). After temporary urinary diversion, GFR was at the same level in 2 of 12 patients. The renal function improved in 10 patients, and the mean GFR increment was about 37 ml/min/1.73 m^2. Mean±SD of GFR after temporary urinary diversion was 87.8±44.9 ml/min/1.73 m^2 (range 14.9-168).At the latest visit after the patient underwent definite treatment by transurethral valve ablation, mean±SD of GFR was 87.7±50.3 ml/min/1.73 m^2 (Range 5.3-177).

Table 1. Disease characteristics and initial urinary diversion of PUV at Ramathibodi Hospital.

Disease characteristics	Number of patients (%)
Clinical presentation	Total N = 20 (100)
• Prenatal diagnosis+Difficult voiding	1 (5)
• Difficult voiding	5(25)
• UTI	7 (35)
• Difficult voiding +UTI	4 (20)
• Mass	1 (5)
• Difficult voiding +UTI+Mass	1 (5)
• Accidentally found renal insufficiency	1 (5)
Renal insufficiency at diagnosis	11 (55)
VCUG findings	
• No VUR	3 (15)
• Bilateral VUR	10 (50)
• Unilateral VUR	7 (35)
VUR grade	Total in 27 renal units (100)
• Grade 1	3 (11)
• Grade 2	3 (11)
• Grade 3	3 (11)
• Grade 4	4 (15)
• Grade 5	14 (52)
Type of temporary urinary diversion	
• No diversion	8(40%)
• Urethral catheter	2(10%)
• Vesicostomy	6(30%)
• Cutaneous ureterostomy	4(20%)

Regarding the voiding status after the definite treatment, there was no record about voiding status of 1 patient. All other 19 patients could void spontaneously during the follow up period. Only 4 patients (21%) could urinate completely normal but the others had the lower urinary tract symptoms. Urinary incontinence was found in 7 patients (37%). Four patients (21%) had to do clean intermittent catheterization because of the high post void residual urine (PVR). Six patients developed urinary tract infection later on. Valve bladder syndrome (VBS) was diagnosed in 13 patients (68%). The patients who had abnormal urination were sent for urodynamic testing, but only 8 patients were performed successfully. Figure 3 shows urodynamics findings in the patients with abnormal voiding. Poor compliance, detrusor overactivity and high detrusor pressure were found in all patients. Small bladder capacity was found in 4 (50%). High PVR was found in 5 (62%).

The correlation between posterior/anterior urethral caliber ratio and renal function at various times was calculated using Pearson correlation, and it was found that there was no correlation between these two factors. The posterior/anterior urethral caliber

Table 2 The correlation between the posterior/anterior urethral caliber ratio and outcome of disease.

Correlation between	N	P value	Roh
• Urethral ratio and GFR at diagnosis	12	0.356	-0.293
• Urethral ratio and GFR at latest visit	20	0.116	0.363
• Urethral ratio and valve bladder syndrome	19	0.980	-0.006

*statistically significant

Table 3 The correlation between prognostic factors and latest GFR.

Correlation between	N	P value	Roh
• Ratio and latest GFR	20	0.116	0.363
• Age at diagnosis and latest GFR	20	0.057	0.432
• Highest GFR after diversion and latest GFR	18	0.001*	0.731

*statistically significant

ratio could not predict the VBS either. Regarding the contributing factors to poor renal function, we found that age and posterior/anterior urethral caliber ratio were not associated with the latest GFR. Only GFR nadir after diversion could predict the renal function at the latest visit (Table 2 and 3).

Discussion

PUV is a common urethral obstruction in childhood which is congenital in origin. After the definite treatment, the results vary from normal renal function and normal micturition to devastating consequences. PUV is suspected to be the most common cause of end stage renal disease requiring kidney transplantation in children.

For the diagnosis of PUV, all patients have to do the VCUG. In our institute's ongoing research, Viseshsindh et al demonstrated that the posterior/anterior urethral ratio from VCUG can support the precised diagnosis of PUV. They found that the higher is the urethral ratio, the more specificity is it in diagnosis of PUV. The best cut-off for optimum sensitivity and specificity in diagnosis is the ratio of 2.0. In the aspect of the posterior/anterior urethral ratio and outcome of treatment, there are several studies that mentioned about this. Bani et al[12] reported about the usefulness of the posterior/anterior urethral ratio to measure successful treatment of PUV. They concluded that calculating urethral ratio in patients with PUV allows objective measurement of the technical success of valve ablation. Gupta et al[13] also reported that calculation of urethral ratio on VCUG as a method for assessment of outcome of fulguration is objective, reproducible, and allows preoperative and postoperative VCUG from different facilities to be compared. A post-fulguration urethral ratio of 2.5-3 represents an acceptable result postoperatively. Menon et al[14] assessed the changes in urethral morphology 3 months post fulguration of PUV on VCUG and correlated these changes with the clinical status of the patients. They concluded that adequacy of fulguration should be assessed by a properly performed VCUG. A postoperative posterior urethra/bulbar urethra ratio > 1.92 should alert to an incomplete fulguration or stricture. In addition, they found a strong correlation between incomplete fulguration and

persistent slow draining units, uremia, voiding dysfunction and urinary tract infections. However, none of these studies demonstrated the correlation between urethral ratio and the outcome in terms of renal function. Thus, the primary objective of our study was to determine the correlation of urethral ratio and the outcome of the disease after definite surgical treatment. We found no correlation between the urethral ratio and the latest renal function, and also between the urethral ratio and the bladder function after treatment of PUV.

Regarding the prognostic factors, many factors are implicated in the prognosis of the disease, but many of them are still controversial such as age at diagnosis. In the past, the patients presented at a younger age were believed to have a worse prognosis than those who presented later in life. But recent evidence has shown that some boys who present later in life suffer significant renal damage. El-Sherbiny et al[9] provided evidence of a less favorable outcome with delayed presentation of PUVs relative to those diagnosed in the first year after birth in respect to renal function and upper tract dilation. Bomalaski et al[15] reviewed the renal function of the patients with the late presentation of posterior urethral valves. They found that the patients who presented late with posterior urethral valves are at risk for progression to end stage renal disease. Thirty-five percent of boys who presented older than 5 years had renal insufficiency and 10% reached ESRD. Comparing with previous publications, our study revealed that age at diagnosis was not correlated with the renal function after treatment.

The other prognostic factor that we studied was GFR after diversion. We found that the highest GFR after diversion was the only factor that could predict the latest renal function. Our finding was similar to those of many studies. DeFoor W et al [16] found that patients with PUV and severe bladder dysfunction in whom nadir creatinine remains increased are at risk for upper urinary tract deterioration, requiring renal replacement therapy. Ansari MS et al[17] demonstrated that nadir serum creatinine and bladder dysfunction are the main factors affecting long-term renal outcome in cases of PUV. Baipai M et al [18] concluded that serum creatinine at presentation is not predictive of subsequent renal function, but the values after a period of urinary tract decompression are prognostically more useful.

There are several limitations in our study. Firstly, our study represents a retrospective review from single institute. Secondly, the data were incomplete in many patients. For example, the renal function at the time of diagnosis was omitted in many patients or some patients did not have VCUG including in the PACS system, especially in the cases that were referred from urban hospitals. Therefore, the definite conclusion of the value of the posterior/anterior urethral caliber ratio and the prognostic factors should be confirmed by a further well-designed study.

Conclusion

Although the posterior/anterior urethral caliber ratio was not correlated with the renal function and bladder function after treatment of PUV, the significant factor that might predict the renal function after treatment was serum GFR after temporary urinary diversion.

What is already known on this topic?

In the previous study, the posterior/anterior urethral ratio was used to predict the adequacy of fulguration and the success of the valve ablation for patients with PUV. No study mentioned about the

correlation between this ratio and the prognosis of the disease in terms of renal and bladder function. Furthermore, we evaluated the prognostic variables affecting the renal function in the patients with PUV.

What this study adds?

We found that the posterior/anterior urethral caliber ratio cannot be used to predict the renal function and bladder function after treatment of PUV. Only serum GFR after temporary urinary diversion can predict the renal function after treatment.

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Conflicts of interest

None.

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Original Articles/นิพนธ์ต้นฉบับ

ความสัมพันธ์ระหว่างอัตราส่วนความกว้างของท่อปัสสาวะส่วนหลังต่อท่อปัสสาวะส่วนหน้าจากเอกซเรย์ฉีดสีกระเพาะปัสสาวะและท่อปัสสาวะและการพยากรณ์โรคลิ้นอุดกั้นท่อปัสสาวะส่วนหลัง

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บทคัดย่อ

วัตถุประสงค์: การศึกษานี้มีวัตถุประสงค์ในการหาความสัมพันธ์ระหว่างอัตราส่วนความกว้างของท่อปัสสาวะส่วนหลังต่อท่อปัสสาวะส่วนหน้าจากเอกซเรย์ฉีดสีกระเพาะปัสสาวะและท่อปัสสาวะและการพยากรณ์โรคลิ้นอุดกั้นท่อปัสสาวะส่วนหลังหลังการรักษาโดยผ่าตัดส่องกล้องทำลายลิ้นอุดกั้น โดยประเมินการพยากรณ์โรคในด้านการทำงานของไตและการทำงานของกระเพาะปัสสาวะ นอกจากนี้ยังศึกษาถึงปัจจัยอื่นๆ ที่ส่งผลต่อการทำงานของไตอีกด้วย

วัสดุและวิธีการ: ศึกษาเวชระเบียนและภาพเอกซเรย์ฉีดสีกระเพาะปัสสาวะและท่อปัสสาวะของผู้ป่วยเด็กที่ได้รับการวินิจฉัยยืนยันว่าเป็นโรคลิ้นอุดกั้นท่อปัสสาวะส่วนหลัง ตั้งแต่เดือนมกราคม 2547 จนถึงเดือนมิถุนายน 2556 โดยวัดอัตราส่วนความกว้างของท่อปัสสาวะส่วนหลังต่อท่อปัสสาวะส่วนหน้าจากภาพเอกซเรย์ และเก็บข้อมูลการทำงานของไตตั้งแต่เริ่มวินิจฉัย, หลังการระบายปัสสาวะชั่วคราวในเบื้องต้นและหลังรักษาโดยผ่าตัดส่องกล้องทำลายลิ้นอุดกั้นแล้วคำนวณหาปัจจัยที่มีความสัมพันธ์กัน

ผลการศึกษา: ในผู้ป่วยโรคลิ้นอุดกั้นท่อปัสสาวะส่วนหลัง จำนวน 20 ราย พบว่าค่าเฉลี่ยของอายุที่ได้รับการวินิจฉัยคือ 22.6 เดือน ค่าเฉลี่ยอัตราส่วนความกว้างของท่อปัสสาวะส่วนหลังต่อท่อปัสสาวะส่วนหน้าจากเอกซเรย์ฉีดสีกระเพาะปัสสาวะและท่อปัสสาวะคือ 3.4 ค่าเฉลี่ยการทำงานของไต (glomerular filtration rate; GFR) เมื่อวินิจฉัยโรคและหลังผ่าตัดรักษาได้แก่ 39.5 และ 87.7 มิลลิลิตร/นาที/1.73 ตารางเมตร ตามลำดับ ไม่พบความสัมพันธ์ระหว่างอัตราส่วนความกว้างของท่อปัสสาวะส่วนหลังต่อท่อปัสสาวะส่วนหน้าจากเอกซเรย์ฉีดสีกระเพาะปัสสาวะและท่อปัสสาวะและการพยากรณ์โรคลิ้นอุดกั้นท่อปัสสาวะส่วนหลังทั้งในแง่การทำงานของไตและการทำงานของกระเพาะปัสสาวะ

สรุป: อัตราส่วนความกว้างของท่อปัสสาวะส่วนหลังต่อท่อปัสสาวะส่วนหน้าจากเอ็กซเรย์ฉีดสีกระเพาะปัสสาวะและท่อปัสสาวะไม่สัมพันธ์กับการทำงานของไตและการทำงานของกระเพาะปัสสาวะหลังการรักษาโรคลิ้นอุดกั้นท่อปัสสาวะส่วนหลัง ส่วนปัจจัยที่สามารถพยากรณ์การทำงานของไตหลังการรักษาได้ ได้แก่ GFR หลังการระบายปัสสาวะชั่วคราวในเบื้องต้น

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