

Evaluation of the Effect of Meatal Stenosis on the Urinary Tract by using Ultrasonography

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Purpose: Circumcision is one of the oldest surgical procedures that originated for religious purposes. Circumcision in infancy is a common procedure in our country and secondary meatal stenosis due to circumcision is a common complication. The aim of our study is to determine the effect of meatal stenosis on the lower and upper urinary tract of circumcised boys by using ultrasonography.

Materials and Methods: In this cross-sectional study, we enrolled 87 circumcised boys between 4 to 8 years old with severe meatal stenosis. Clinical findings of our subjects were gathered by a checklist that included: thin stream of urine, upward urine stream deviation, infrequent voiding, urinary tract infections, voiding dysfunction, and urge incontinency. In lab data analysis, complete blood cell count (CBC), urine analysis, urine culture, blood urea nitrogen (BUN), and plasma creatinine level were evaluated. Ultrasonography detected hydronephrosis, hydroureter, bladder wall thickening in a full and empty bladder, bladder volume, and residual urine volume.

Result: Narrowing of urine stream is commonly seen (about 54%) among patients with severe meatal stenosis, and similarly in sonographic evaluations the most common symptoms among patients was thickening of the bladder wall that increased in an empty and a full bladder (about 82%).

Conclusion: The author of this study recommends performing long-term follow up after circumcision and ultrasonography to detect meatal stenosis before permanent renal damage occurs.

Keywords: bladder; circumcision; meatoplasty; meatal stenosis; ultrasonography.

INTRODUCTION

Circumcision is one of the oldest surgical procedures that was originally used for religious purposes and religious circumcision is still done by Muslims and Jews worldwide⁽¹⁾. This surgery is also common in Christian Americans and is performed for cultural, medical, or aesthetic reasons among Africans and native Australians^(2,3). Hence, about one in three males worldwide are circumcised⁽³⁾.

In Iran, most boys are circumcised between infancy and the age of 4-5 years⁽⁴⁾. In North America, circumcisions are routinely performed in newborns⁽⁵⁾. The aim of circumcision is to excise sufficient foreskin (both penile shaft and inner preputial epithelium) to leave the glans uncovered⁽¹⁾. There are four well-known scientific techniques (dorsal slit, shield, clamp, and excision) for performing circumcision⁽¹⁾. Circumcision is also a protective procedure against urinary tract infection, acquired immunodeficiency syndrome (AIDS), other sexually transmitted diseases, and penile malignancy^(3,6).

Similar to other surgical procedures, circumcision has operative and postoperative complications⁽⁵⁾. Early and intraoperative complications such as pain, bleeding, swelling, wound infection, meatitis, and inadequate skin removal are mostly slight and treatable⁽³⁾. Early complications such as bleeding are reported in 0.1-35% of patients⁽⁵⁾, wound infection in 0.2-0.4%, and meatitis in 8-31%⁽²⁾. The possible explanation for this low complication rate is probably under-reporting or late diagnosis

⁽²⁾. Late complications include errors of emission and commission, concealed penis, meatal stenosis, inclusion cyst, secondary cordee, urethrocutaneous fistula, phimosis, lymphedema, wound infection, skin bridge formation between the penile shaft and the glans, urinary retention, meatal ulcer, loss of penile sensitivity, sexual dysfunction, and death from excess bleeding⁽⁵⁾. When circumcision is performed in the neonatal period meatal stenosis is one of the late-onset complications⁽⁷⁾. Meatal stenosis can be congenital primarily in neonates with hypospadias or acquired mainly after circumcision. During circumcision, removal of the foreskin may induce significant meatal inflammation and cicatrix formation. Frenular devascularization and chronic meatitis from diaper irritation of the exposed unprotected meatus and chemical dermatitis caused by urine after circumcision may be another cause of meatal stenosis⁽⁸⁾. The normal urethral meatus is 10 French before 4 years of age, 12 French from 4 to 10 years of age, and 14 French after 10 years of age. Meatal stenosis remains asymptomatic until urinary control is achieved⁽⁸⁾. Meatal stenosis should be considered in cases of reported urinary stream deviation in an upward direction resulting from a meatal baffle, narrow high velocity-stream, penile pain at the initiation of micturition, and the need to sit or stand back from the toilet bowl. In rare cases, severe symptoms are voiding dysfunction, urinary retention, urinary tract infection, decompensation of the bladder, vesicoureteral reflux, hydro-

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Received February 2017 & Accepted April 2017

Table 1. Frequency of symptoms in meatal stenosis due to circumcision

	Number	Frequency
Painful urination and urine stream deviation	35	40%
Stream narrowing and infrequent voiding	47	54%
Urge incontinency and retention	5	5.7%
Mild hydronephrosis and bladder wall thickness	3	3.5

nephrosis, and renal failure^(4,6,9). Obstructive uropathy is reported as a rare complication of post-circumcision meatal stenosis⁽⁸⁾.

Meatal stenosis is divided into mild, moderate to severe, and severe. Mild types of meatal stenosis do not require any treatment, while in moderate to severe types treatment can be done using topical ointment or urethral dilation. In severe types, surgery such as meatotomy should be performed^(1,7) as a curative procedure⁽¹⁾. Urinary tract images, such as upper and lower urinary tract ultrasonography may not be necessary in every patient, but it may be useful for cases with associated urinary tract infection, voiding dysfunctions, urinary retention, and in cases of persistent symptoms^(8,9).

The aim of our study is to evaluate the effect of meatal stenosis on the upper and lower urinary tract by using ultrasonography in long-term follow up.

MATERIALS AND METHODS

This is a cross-sectional study that was conducted in the pediatric urologic surgery department of Doctor Sheikh Academic Hospital in the Mashhad University of Medical Sciences. We enrolled all meatal stenosis boys, aged 4-8 years old, who referred to the pediatric urologic surgery department between 2011-2015. Chief complaints of our subjects were thin stream of urine, upward urine stream deviation, infrequent voiding, urinary tract infections, voiding dysfunction, and urge incontinency. All of our patients were circumcised in infancy (under the first six months) and were diagnosed with secondary meatal stenosis. Other cases with a history of hypospadias repair or preputioplasty were excluded from this study.

Genitourinary examinations of all patients were done by a pediatric urologist. The diagnosis of meatal stenosis was confirmed by the inability to inserting an age matched Nelaton catheter into the urethral meatus and the distortion of the meatus from an ellipsoid to a pin-point shape. In Laboratory data analysis complete blood cell count (CBC), urine analysis, urine culture, blood urea nitrogen (BUN), and plasma creatinine level were evaluated. All patients were referred for urogenital upper and lower urinary tract ultrasonography before meatoplasty.

Hydronephrosis, hydroureter, bladder wall thickening

in full and empty bladder, bladder volume, and residual urine volume were evaluated by ultrasonography.

In 27 subjects, flowmetry was used before and after the meatoplasty was performed with the consent of their parents. During the study, voiding time, maximum flow rate, bladder volume, and flowmetry pattern were determined.

The Ethics Committee of the Mashhad University of Medical Science approved the initial study and all of the parents gave their parental consent before enrollment into the study.

Data was collected and analyzed by SPSS (version 11.5). Comparison of flowmetry results after the operation with basic data was performed by the paired t test. Data were expressed as mean or prevalence. McNemar test was used to compare qualitative data.

RESULTS

Data were collected on 87 circumcised boys with severe meatal stenosis between the ages 4 to 8 years old (mean \pm SD age: 6.18 ± 1.38 years). The age of circumcision for all of these boys were less than six months and the mean age of the patients was 5.5 years old. The most common symptoms were urine stream narrowing and infrequent voiding that were detected in 47 (54%) subjects. Thirty-five subjects (40.2%) complained of pain during the initiation of urination (painful urination) and urine stream deviation, and five patients (5.7%) suffered from urge incontinency and retention. Forty subjects (45.9%) were symptomatic for more than two years. (Table 1)

Laboratory findings in 33 cases (37.9%) showed microscopic hematuria in urine analysis. The CBC, BUN, plasma creatinine level, and other lab data were within normal ranges in all of our patients.

All patients underwent urogenital upper and lower ultrasonography. In this study, 84 subjects (96.5%) had a normal upper urinary tract. Three cases (about 3.5%) aged 4, 5.5, and 6 years old showed bilateral mild hydronephrosis and bladder wall thickness. In 72 cases (82%), bladder wall thickness increased in an empty and full bladder, most of them were more than 6 years old (23 cases with an age range of 4.5-5.5 years old, 9 cases with an age range of 5.5-6 years old, and 40 cases with an age range of 6-8 years old).

Table 2. Results of the flowmetry study in 27 subjects before and after meatoplasty

	Before meatoplasty	After meatoplasty	Paired t test	P
Flow time (S)	26.38 \pm 10.11	22.71 \pm 6	2.21	0.03
Voided volume (CC)	290 \pm 132	292 \pm 93	0.19	0.8
Maximum flow rate (CC/S)	15 \pm 8.2	20.15 \pm 4.39	2.8	0.008

In 30 subjects (about 34.4%) residual urine was more than 20% of bladder volume after voiding (12 cases with an age range of 4-5 years old, 10 cases with an age range of 5-6 years old, and 8 cases were older than 6 years).

The flowmetry study showed significant improvement in flow time and maximum flow rate after meatoplasty (**Table 2**) and the obstructive pattern significantly decreased after meatoplasty (McNemar= 19.66, $P = .001$). Table 1. Frequency of symptoms in meatal stenosis due to circumcision

DISCUSSION

Circumcision is one of the most common surgical procedures in our country that is performed for religious reasons and can be done at all ages of a male's life; however, this surgery is often performed in infancy⁽⁴⁾. About one in three males worldwide are circumcised⁽³⁾ and this rate in Iran is far more because all Muslim boys are ritually circumcised⁽⁴⁾. In our study, narrowing of the urine stream was the most common symptom among patients with severe meatal stenosis, and in ultrasonographic evaluation, the most common symptom was thickening of the bladder wall that increased in an empty and full bladder.

Urinary tract infections are ten to twenty times more common in uncircumcised boys than circumcised ones⁽⁶⁾. Urinary tract infection can result in renal scarring in about 10 to 15% of infants and it can lead to renal insufficiency in about 2 to 3% of these patients⁽⁶⁾.

Like any surgical procedure, circumcision has operative and post-operative complications⁽⁵⁾, but few epidemiological studies have reported the frequency of adverse events⁽³⁾. Our literature reviews show that serious adverse events due to circumcision are rare. However, mild to moderate surgical complications are frequent and include: pain, bleeding, swelling, wound infection, meatitis, inadequate skin removal, secondary epispadias or hypospadias, fibrous bridge formation, urethrocutaneous fistula, cysts of glans, fibrotic phimosis, preputial cysts, lymphedema or elephantiasis of the penile skin, laceration of penile or scrotal skin, penile denudation, asymmetric removal of the foreskin, and surgical loss of the penis. However, most of these complications are minor and easily treatable⁽⁴⁾.

Meatal stenosis is one of the late complications of circumcision⁽⁴⁾, which is difficult to detect by clinicians because of its little clinical findings⁽³⁾, no adequate follow up after circumcision, and perhaps because of its similar symptoms to urinary tract infections^(4,8). On general examination, the length of the meatus should be 25 to 30% of the diameter of the glans and a physiologic eversion of the distal part of the urethral lip. In some cases, secondary meatal narrowing due to circumcision leads to deflection of the urinary stream upward⁽⁹⁾. In meatal stenosis, the lower moiety of the meatal slit is partially closed by a filmy membrane⁽¹⁰⁾.

Recurrent pyelonephritis and obstructive uropathy is an under-recognized complication of meatal stenosis following circumcision^(4,8). This condition may be a strong risk factor for renal damage and renal failure⁽⁸⁾. Radiologic studies like ultrasonography may not be necessary in every patient, but it is recommended to be performed in cases with associated urinary tract infection, voiding dysfunctions, urinary retention, and in cases of persistent symptoms⁽¹⁰⁾.

The definite incidence rate of meatal stenosis and its clinical manifestation following circumcision is unclear, but some studies have evaluated this condition. In a cross-sectional study, which was conducted by Yeganeh et al. in 2006 to detect the prevalence of late complications of circumcision, late complications' rate was reported in about 7.39% of cases and the incidence rate of meatal stenosis was reported in about 0.9%⁽⁴⁾. In a study by Weiss et al. in Nigeria on 141 circumcised boys, they reported meatal stenosis in 3.5% of patients during 6-week post operation follow up⁽³⁾. In most studies, there is a difference in the reported prevalence of meatal stenosis and this may be due to inadequate post-surgical follow-up. In the present study, we recommend long term follow-up by using ultrasonography for early diagnosis of meatal stenosis before permanent renal damage occurs.

In a study that was performed over a period of three years by Persad et al. from 1991 to 1993, 8% of circumcised patients presented with meatal stenosis with symptoms that included pain at initiation of micturition and narrow high velocity urine stream⁽¹⁰⁾. These are the most common symptoms and it is similar to the manifestations of our patients.

In another study by Joudi et al. in 2010, careful physical examination and laboratory tests were performed to determine the incidence of meatal stenosis after neonatal circumcision during one-year period. In this study, 20.4% of patients had severe meatal stenosis with a penis diameter of below 5 French, thickening of the bladder wall, and bilateral hydronephrosis in 11.1% of patients, and renal scarring in 0.75% of patients⁽⁷⁾. The incidence of hydronephrosis in this study is more than our study and this can be due to their follow up and early diagnosis of meatal stenosis before its clinical presentation.

In the University of Kansas Medical Center, Lishaw et al. reported two infants with obstructive renal disease due to post circumcision meatal stenosis. One of them presented with severe dysuria and intermittent urinary stream and palpable large left kidney, and the other presented with hematuria, which are similar to manifestations of our patients. In both cases, bilateral hydronephrosis and hydroureters were detected using ultrasonography⁽¹²⁾.

Obstructive uropathy is one of the few renal diseases that are treatable and reversible at the beginning. Due to the ability of meatal stenosis to make an obstruction in the urinary tract, in cases of proven meatal stenosis, we recommend postoperative follow up to screen patients for obstructive uropathy and treat them before permanent renal damage occurs.

The limitations of our study were: 1) Post treatment ultrasonography was our plan, but for optimal evaluation, we needed more time after meatoplasty. Therefore, we decided to plan another study to evaluate long-term results. 2) We planned to do flowmetry for all subjects before and after the surgery, but Western pattern voiding is not routine for our children and so we could not obtain the proper co-operation for this test. Hence, we could not perform this evaluation for all subjects. 3) Differentiation between primary and secondary meatal stenosis due to circumcision was impossible. According to the rare prevalence of primary meatal stenosis in non-hypospadias subjects, we considered all subjects as having secondary meatal stenosis.

CONCLUSIONS

As we described, long-term meatal stenosis can induce voiding dysfunction, bladder wall thickening, increased residual volume, and renal scarring. Early diagnosis and correction of meatal stenosis may prevent these complications and voiding dysfunctions in the future. We recommend performing long-term follow up after circumcision to detect meatal stenosis before permanent symptoms and voiding dysfunctions occur, and using ultrasonography as a useful modality in this regard.

CONFLICT OF INTEREST

None declared.

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