

Prevalence and Causes of Meatal Stenosis in Circumcised Boys

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Abstract

The aim of this study was to investigate the prevalence and causes of meatal stenosis after circumcision in children. Between October 2018 and April 2019, we carried out a prospective cross-sectional study on 1031 circumcised boys, aged 5 to 8 years (mean age 6.1 years \pm 0.3 years), enrolled in the first level of primary school in Oran (Algeria). All enrolled children underwent a genitourinary examination. Moreover, an anonymous questionnaire was filled-in by one of the parents.

The screening revealed the presence of meatal stenosis in 185 children, representing a prevalence of 17.9 % of cases (95% CI = 15.6–20.3). Analysis of the results using both the univariate and multivariate mode brought out some common risk factors such as forceful retraction of the prepuce and the use of a healing product: Beta-sitosterol and Hydrocotyl (Centella Asiatica), rarely Trolamine. In addition, this study showed that boys circumcised during their first week of life are twice as likely to develop meatal stenosis than those circumcised between 7 and 12 months (OR = 2.08; 95% CI = 1.10–3.92, p = 0.021).

Conclusion: this study showed that stenosis of the urethral meatus is a frequent complication of circumcision. Circumcision in the first week of life, a foreskin that adheres to the glans, and the use of a healing product were associated with the risk of stenosis development.

"what Is Known – What Is New"

What is Known:

- The prevalence of meatal stenosis after circumcision remains unclear, and its causes are unknown.
- Several studies have reported that it was more common in children circumcised during the neonatal period.

What is New:

- **Meatal stenosis occurred in approximately 18% of children after circumcision.**
- Stenosis of the urethral meatus was more frequent in children circumcised during the first week of life than in those circumcised between 7 and 12 months

Introduction

Circumcision is the most practiced surgical act in the world, mainly for cultural or religious reasons. It is also one of the oldest surgical procedures. In some cultures and religions that practice male circumcision, there is no consensus on the age at which circumcision should be performed. However, it is mainly practiced between the neonatal period and the age of 4–5 years [2].

Like any surgical procedure, circumcision may be associated with potential operative and post-operative complications. These complications can be serious, such as glans amputation [3] or penile amputation [4], or much less serious such as meatal stenosis.

In the majority of cases, meatal stenosis remains asymptomatic. Thus, it is more often forgotten, because children do not consult after circumcision and its revelation is late [5]. However, the presence of urinary symptoms, such as a thin, discontinuous, or deviated urinary stream, pollakiuria, or recurrent pelvic pain, is very evocative of meatal stenosis.

The prevalence of meatal stenosis after circumcision remains unclear, and its causes are unknown. We report here the results of a cross-sectional study carried out on a large number of circumcised boys to determine the prevalence of meatal stenosis and to define its risk factors.

Materials And Methods

Patient population

After obtaining the approval of the Oran Health Directorate (in our country, the Health Directorate does not have an ethics committee to approve or not the study on humans), between October 2018 and April 2019, we carried out a prospective cross-sectional study on 1031 boys, aged 5 to 8 years (mean, 6.1 years \pm 0.3 years), enrolled in the first level of primary school. We used in the choice of those boys' two-level stratified sampling. For the first level, thirty-eight primary schools were selected by random sampling method from an exhaustive list of 586 elementary schools in the province of Oran, with a probability proportional to the size of schools. For the second level, in each school, a first-level class was randomly chosen from two or three. All boys in this class were included in the study (in our country, cases of uncircumcised boys enrolled in primary school are very rare). Thus, in each school, between 18 and 36 boys were examined.

Patients data

The study was carried out by two teams. Each team was composed of a pediatric surgeon, assisted by a school doctor, a resident, and a nurse. After obtaining the verbal consent of the parent, the genitourinary examination of the boys was carefully performed by a pediatric surgeon in the presence of one of the two parents; this examination began with the measurement of the diameter of the urethral meatus. The diagnosis of meatal stenosis was made when the diameter of the urethral meatus was equal to or less than 1 mm (Fig. 1). However, this diagnosis must be completed in all patients by an attempt to introduce into urethral meatus an F6 urinary catheter. During the clinical examination of the boys at the screening unit of the school, the presence of the parent was also necessary to fill in a pre-established anonymous questionnaire. This questionnaire contains information on the child: the age at the circumcision, presence of penile abnormalities including phimosis, the configuration of the urethral meatus, and information about circumcision, such as the competence of the person who performed circumcision, the circumcision was indicated by a pediatrician or requested by parents, forceful retraction of the foreskin during circumcision, accidents encountered during the circumcision, and local treatment applied postoperatively.

An ultrasound of the urinary system was performed in boys with meatal stenosis, who continued to cooperate with the medical team.

Statistical analysis

The sample size was calculated with an estimated prevalence of meatal stenosis at 0.7% [6]. We obtained a required number of subjects of 922 using the Statcalc module of Epi Info 7 (precision 1%, CI 99%) taking into account the cluster effect due to the inclusion of all children in the class. A total of 1031 cases were included in the study to reduce the number of cases lost to follow-up and the lack of data due to incorrectly completed questionnaires in the final analysis of the results. We used Excel software for data entry and SPSS v.20 for statistical analysis. Qualitative variables were presented as dichotomous variables. The descriptive step consisted of estimating the numbers and percentages for the qualitative variables and the means and standard deviations for the quantitative variables. A p-value < 0.05 was considered statistically significant.

Univariate analysis was used to look for an association between two independent variables or between a dependent variable (stenosis) and other independent variables, using the chi-square tests.

We performed a multiple logistic regression using the presence or absence of stenosis as dependent variable. Thus, we proceeded to the choice of explanatory or independent variables likely to be included in the model. This choice was guided by the clinical and functional relevance resulting from an in-depth bibliographical research. To arrive at the final model, we applied the “Global Enter” method, all the independent variables were included in the model (significant or not).

Results

Data collected from 1031 circumcised boys revealed the presence of meatal stenosis in 185 patients. Thus, the prevalence of meatal stenosis was 17.9 % of cases (95% CI = 15.6–20.3). There were two kinds of meatal stenosis: 1) Stenosis by a thin membrane (Fig. 2, A) and 2) pinpoint stenosis (Fig. 2, B). The stenosis by a thin membrane represented the majority of cases encountered in this study (78%). In most children, this membrane obstructed the lower part of the meatus, and in only two cases it closed the upper part of the meatus.

The age at the circumcision was accurately reported in 975 boys (Table 1), this allowed us to compare the percentages of meatal stenosis from different age groups. By comparing the modality presenting the highest proportion of meatal stenosis (23.6%: age range 0 to 7 days) with the modality presenting the lowest value of meatal stenosis (12.9% : age group 7 to 12 months), the difference was significant (p = 0.021) (OR = 2.08; 95% CI = 1.10–3.92). Thus, subjects circumcised during their first week of life are twice as likely to develop meatal stenosis than those circumcised between 7 and 12 months, and comparing

the value of the age group > 2 years (20.95%) versus the value of the age 0 to 7 days, the result was almost significant ($p = 0.05$).

Table 1
Characteristics of children with and without meatal stenosis

	Presence of meatal stenosis n (%)	Absence of meatal stenosis n (%)	OR	CI 95 %	p
Age at the circumcision					
0–7 days	30 (17.0)	97 (12.2)	1.47	0.94– 2.31	0.084
8–30 days	18 (10.2)	104 (13.1)	0.75	0.44– 1.28	0.303
2–6 months	24 (13.6)	99 (12.5)	1.11	0.68– 1.79	0.669
7–12 months	19 (10.8)	128 (16.1)	0.63	0.37– 1.05	0.075
13–24 months	41 (13.3)	201 (25.3)	0.89	0.61– 1.31	0.581
> 2 years	44 (25.0)	166 (20.9)	1.26	0.86– 1.85	0.271
Indication by paediatrician					
Presence of Urinary Tract Infection	11 (6.2)	57 (7.1)	0.86	0.44– 1.68	0.668
Presence of Dysuria	10 (5.6)	33 (4.1)	1.39	0.67– 2.87	0.385
Phimosis	3 (1.7)	15 (1.9)	0.90	0.26– 3.14	0.863
Circumcision requested by parents	7 (4.0)	19 (2.4)	1.69	0.70– 4.10	0.238
Circumcision campaign	165 (92.7)	744 (92.9)	0.96	0.53– 1.84	0.930
	7 (3.9)	57 (7.1)	0.53	0.24– 1.18	0.120
Circumcision : Who did it					
Pediatric surgeon or surgeon	99 (55.9)	462 (58.2)	-	-	0.642
General practitioner	64 (36.2)	298 (37.5)	-	-	0.798
Paramedical personnel	11 (6.2)	28 (3.5)	-	-	0.151
Traditional circumcisers	3 (1.7)	6 (0.8)	-	-	0.456

	Presence of meatal stenosis n (%)	Absence of meatal stenosis n (%)	OR	CI 95 %	p
Places of circumcision					
At Hospital	41 (24.0)	150 (19.4)	-	-	0.220
At Outpatient clinic	21 (12.3)	109 (14.1)	-	-	0.616
At medical office	67 (39.2)	334 (43.3)	-	-	0.391
At home	42 (24.6)	179 (24.6)	-	-	0.774
The use of an antiseptic					
Eosin	141 (85.5)	656 (87.7)	0.83	0.51– 1.34	0.440
Sodium hypochlorite	82 (65.6)	383 (67.1)	0.96	0.62– 1.41	0.761
Betadine	4 (3.2)	7 (1.2)	2.66	0.77– 9.24	0.110
	23 (18.4)	111 (19.4)	0.93	0.57– 1.54	0.783
The use of a healing product	42 (25.5)	123 (16.6)	1.71	1.15– 2.56	0.008
The use of Butter	31 (18.0)	128 (15.8)	1.17	0.76– 1.80	0.568
The use of Olive oil	7 (4.1)	27 (3.3)	1.23	0.53– 2.87	0.814
Intraoperative incidents	5 (2.7)	11 (1.4)	2.03	0.7– 5.92	0.295
Forceful retraction of the prepuce	4 (2.2)	1 (0.1)	18.01	16.2 – 20	0.0001
Bleeding	3 (1.6)	10 (1.2)	1.33	0.36– 4.88	0.645

Among the 185 patients with meatal stenosis, only 47 children continued to cooperate with the medical team; 15 of them (32 % of cases) presented with urinary symptoms. The most common symptoms were narrowing of the urine stream detected in 7 boys (15 % of cases), and deviation of the urine stream in 4 (8.5%). Boys with pinpoint stenosis had discontinuous urine stream in 3 (6.4%), pollakiuria in 3 (6.4%), and recurrent pelvic pain in 2 (4.3%).

Of the few parents of boys with meatal stenosis who attended the circumcision, four were sure that the foreskin was entirely adhering to the glans, and it was difficult to release it from the glans. This confirms

the results of another study (unpublished) that we have been conducting for several years to discover the true causes of meatal stenosis, according to which boys with a foreskin fully attached to the glans frequently develop meatal stenosis.

Ultrasound of the urinary system showed that the majority of cases had a normal upper urinary tract. However, in two cases (4.3% of cases), there was a slight dilation of the upper urinary tract, signs of cystitis with thickening of the bladder wall in 5 cases (10 %), postmictional bladder residue in 1 case, and microlithiasis in one case.

Analysis of the results using both the univariate (Table 1) and multivariate model (Table 2) revealed some common risk factors such as forceful retraction of the foreskin and the use of a healing product: Beta-sitosterol and Hydrocotyl (Centella Asiatica), rarely Trolamine.

Table 2
Risk factors of meatal stenosis in children with multivariate analysis

Variable	OR _a	CI 95 %	p
Age ≤ 1 month	1.05	0.66–1.66	0.846
The use of an antiseptic	0.94	0.56–1.59	0.823
Sodium hypochlorite	2.76	0.76–10.03	0.122
Dysuria	0.56	0.09–3.50	0.533
Urinary tract infection	1.09	0.41–2.91	0.868
Phimosis	2.14	0.68–6.74	0.195
Forceful retraction of the prepuce	18.97	1.54–23.3	0.021
Bleeding	0.78	0.14–4.33	0.773
Traditional circumcisers	2.77	0.44–17.43	0.277
The use of a healing product	1.82	1.16–2.86	0.009

Discussion

The aim of circumcision is to excise enough foreskin to leave the glans uncovered [7]. A surgical procedure that seems to reduce the risk of urinary tract infection [8, 9]. The American Academy Of Pediatrics (AAP) has reported that circumcision can help prevent urinary tract infections, HIV infection, the transmission of certain sexually transmitted infections, and penile cancer [10]. In addition, circumcision is the main treatment for balanitis xerotica obliterans (Lichen sclerosus that affects the foreskin and glans), which remains a rare but potentially severe disease that can cause significant morbidity in children [11].

Meatal stenosis is one of the late complications of circumcision. Several hypotheses have been proposed to explain its formation. Among them, the naked urethral meatus theory : in the absence of a foreskin, the mucous membrane of the meatus undergoes chronic irritation due to rubbing against the diapers or by exposure of the meatus to ammonia and other irritants in wet diapers, with subsequent development of stenosis [12, 13]. Another hypothesis is that meatal stenosis develops after meatal ischemia following damage to the frenular artery at circumcision [5]. We believe that when the foreskin is attached to the glans, forced retraction of the prepuce most often causes a loss of the mucous membrane which covers the glans, making the glans less resistant to chemical attack, and therefore may play a role in the development of meatal stenosis.

In our study, the prevalence of meatal stenosis was 17.9 % of circumcised boys aged 5 to 8 years. In the literature, the prevalence of meatal stenosis remains unclear, it has been reported in a wide range, ranging from less than 0.01% [14, 15] to about 23% [16]. Joudi et al. [17] reported a prevalence of meatal stenosis of 20.4%, which is similar to the current results. This may be the result of a similar study design. We think that the low incidence reported in the review article by Morris and Krieger (< 1%) [6], can be explained by a high level of inter-study heterogeneity. In another study, El Bcheraoui et al [15] reported an extremely low incidence of meatal stenosis in circumcised men in the United States (< 0.01%). This study used administrative data from the processing of US health care insurance reimbursement claims, without personal human participants.

The difference in prevalence may also be influenced by the lack of consensus on the diagnosis and morphological definition of meatal stenosis: Mahmoudi [18] defined the anomaly as a distortion of meatus from an ellipsoid to a pinpoint shape, and also an inability to pass a 6 Fr catheter (equivalent to 2 mm of diameter) into the urethra. While according to Joudi et al [17] severe stenosis of the meatus is reported when the diameter of the meatus is less than 5Fr (approximately 1.67 mm in diameter). From this morphological definition, we considered as a diagnostic criterion for meatal stenosis, a diameter of the urethral meatus equal to or less than 1 mm in boys aged 4 to 8 years.

We observed two types of meatal stenosis: pinpoint-shaped stenosis, which was rarer, and stenosis by a thin membrane, which represents the majority of cases encountered in this study. Stenosis by a thin membrane has been reported by some authors [19]. The lower half of the meatal slit is partially closed by a filmy membrane. Rarely, this membrane closed the upper part of the meatus. This membrane can be break by a urinary catheter introduced into the urethra. However, in all cases, the stenosis reappeared about three weeks after its rupture.

Several studies have reported that meatal stenosis was more common in children circumcised during the neonatal period [18, 20]. In a study conducted by Van Howe on 329 circumcised boys aged 2 to 12 years, meatal stenosis was diagnosed in 24 boys, all circumcised during the neonatal period [20]. In another study, Mahmoudi found that meatal stenosis was frequent in males circumcised during the neonatal period [18]. In this study, meatal stenosis was more common in boys circumcised during their first week

of life than those circumcised between 7 and 12 months. Therefore, we recommend performing the circumcision between 6 and 12 months.

The meatal stenosis may be asymptomatic and damage the urinary system [17]. However, the diagnosis of meatal stenosis is mentioned in the presence of urine stream deviation, narrowing of the urine stream, penile pain at the initiation of urination, dysuria, hematuria, soaking of the feet in urine after each urination [12, 13]. In rare cases, the symptomatology may be more severe with urinary retention, urinary tract infections, vesicoureteral reflux, thickening of the bladder wall, and bilateral hydronephrosis [18, 21]. In our study, the narrowing of the urine stream, present in about 15 % of cases, was the most common finding.

Some data point out that the application of petroleum jelly for six months is associated with a significant decrease in the incidence of meatal stenosis [7]. Lubrication with petroleum jelly may act by reducing inflammation of the glans and meatus. And thus, reducing the infection risk and shortening the recovery time. We have sought to know the beneficial effects of using similar products, such as butter and olive oil, which are widely used in circumcised boys in our country. However, the results were not significant.

In our study, uroflowmetry was not used in children with meatal stenosis. Performing uroflowmetry remains a complicated gesture in young boys. It should be performed in children with adequate voiding volume (> 50% of the expected bladder capacity) to generate an adequate curve and improve the precision and the reliability of the interpreted test [22]. In addition, currently, there is a lack of accepted standardized values for the measured uroflowmetry parameters in children. Neheman et al [23] who used uroflowmetry in the long-term follow-up of symptomatic meatal stenosis, before and after meatotomy, concluded that it is unnecessary to perform uroflowmetry in the assessment of meatal stenosis. Thus, for meatal stenosis with a superficial location, a physical examination is sufficient.

Conclusions

This study showed that stenosis of the urethral meatus is a common complication of circumcision in children aged 5 to 8 years. In the majority of cases, this stenosis was formed by a thin membrane obstructing the lower part of the meatus, rarely a pinpoint shape. This study also allowed us to define some risk factors, such as circumcision in the first week of life, a foreskin that adheres to the glans, and the use of healing products.

Abbreviations

CI: confidence interval

OR : odds ratio

Declarations

Funding: None.

Conflicts of interest/Competing interests: None

Ethics approval: The study was approved by The Health Directorate of Oran and consent was signed by the parents of all participants. The consent to publish the pictures was obtained from the parents of the children.

Consent to participate: An oral consent was obtained by one of the parents.

Consent for publication: N/A

Availability of data and material: Yes

Code availability: N/A

Authors' contributions:

- **S A:** Protocol/project development, Data collection, Data analysis, Manuscript writing

- **N A:** Data collection, Data analysis

- **L D:** Data collection

- **N B:** Data analysis

- **J M:** Data collection, Manuscript writing

- **M A A:** Data collection, Manuscript writing

- **Y B:** Data collection

- **N H:** Data collection

- **A Y:** Data collection, Manuscript writing.

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Figures



Figure 1

Diameter of urethral meatus equal to or less than 1 mm

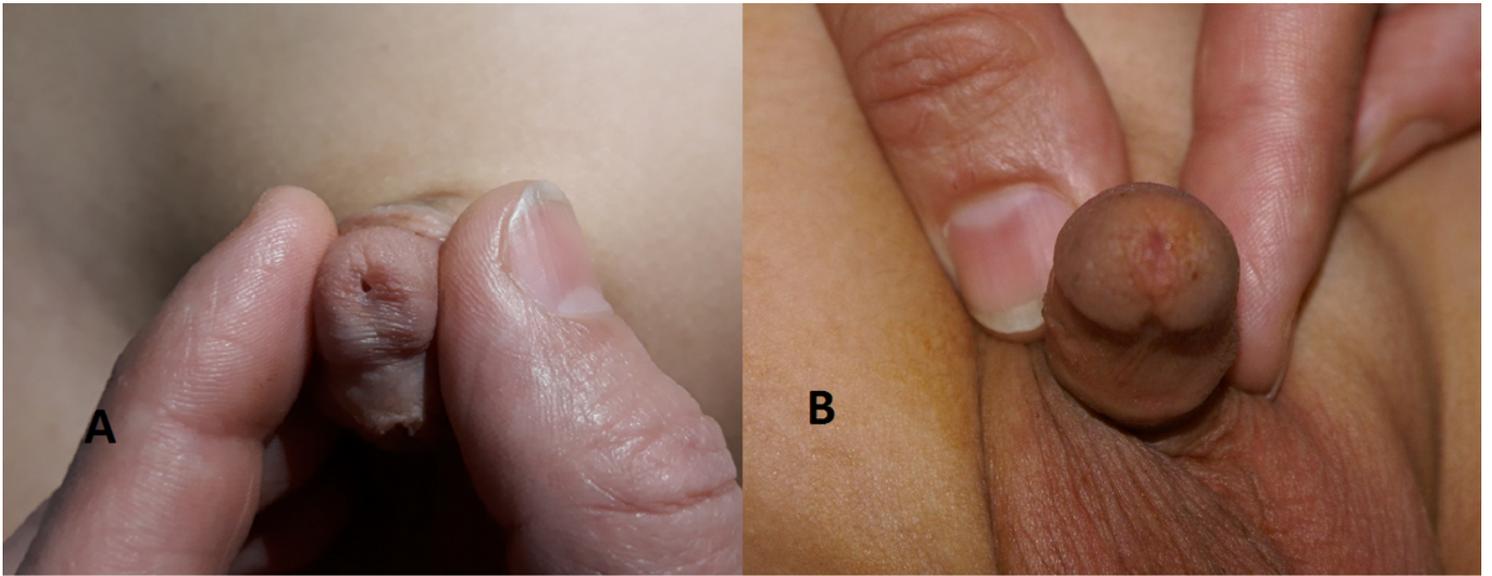


Figure 2

Meatal stenosis was represented in the majority of cases by a thin membrane obstructing the lower part of the meatus (A), rarely there was pinpoint stenosis of meatus (B): meatus loses its elliptical shape to become circular.