Title

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Journal

Journal of Pediatric Urology, 11(1)

ISSN

1477-5131

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Publication Date

2015-02-01

DOI

10.1016/j.jpurol.2014.09.006

Peer reviewed

Journal of Pediatric Urology (2015) 11, 38.e1–38.e6

Meatal stenosis: A retrospective analysis of over 4000 patients

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Keywords
Stenosis; Circumcision male; Urethra; Complications; Anesthesia

Received 9 July 2014
Accepted 4 September 2014
Available online 4 February 2015

Summary

Objective
The literature on treatment of meatal stenosis is limited to single center series. Controversy exists regarding choice of meatotomy versus meatoplasty and need for general anesthesia. Our objective was to analyze treatment efficacy, current practice patterns and utilization of anesthesia. We hypothesized that meatoplasty would be associated with a lower re-operative rate.

Study design
We used a hospital consortium database to identify children who were diagnosed with meatal stenosis between January 1, 2009 and December 31, 2012. Both univariate and multivariate analyses were completed to evaluate correlations between patient, surgeon and hospital characteristics and type of procedure. The propensity of surgeons to operate with or without general anesthesia was analyzed.

Results
We identified 4373 male patients with a diagnosis of meatal stenosis treated by 123 surgeons. Fifty-percent of boys had procedural intervention during the 4-year period. Median follow-up was 25 and 22 months after meatotomy and meatoplasty, respectively. There was a re-operative rate of 3.5% and 0.2% for office meatotomy versus meatoplasty with general anesthesia. Multivariate analysis demonstrated that being White and living in the Northeast independently increased odds of intervention. Half of the surgeons treated meatal stenosis exclusively under general anesthesia.

Discussion
This study is limited by an inability to determine recurrence rates. Only patients having secondary surgery at the same institution within the time period captured by the database (6 months–4 years) could be identified. As such, the true recurrence of meatal stenosis is likely higher. Although the re-operative rate is not equivalent to the recurrence rate, the two are correlated. Likewise, the surgeon's propensity to operate could be biased by their propensity to diagnosis meatal stenosis and this could affect the rates cited.

In addition to the cost benefit achieved with avoidance of general anesthesia (estimated to be a 10-fold cost reduction, the 2012 Consensus Statement of the International Anesthesia Research Society has highlighted that there is increasing evidence from research studies suggesting the benefits of general anesthesia should be considered in the context of its possible harmful effects. Although this study and others have highlighted that in-office procedures are a viable alternative to meatoplasty with general anesthesia, there are multiple factors in being able to perform an office meatotomy. Arguably, the two most important are the patient's ability to cooperate and his anatomy.

Conclusions
The large sample size, over 4000 patients, allowed us to show that the hypothesis, that meatoplasty would be associated with a lower re-operative rate (0.2%), is true. With a low re-operative rate (3.5%), office meatotomy is a reasonable choice of surgical treatment if the child can cooperate and the anatomy is appropriate. On the other hand, if general anesthesia is utilized, formal meatoplasty is associated with a lower re-operative rate.

http://dx.doi.org/10.1016/j.jpurol.2014.09.006

Introduction

Male circumcision is the most common surgical procedure performed in the United States. Data from the National Hospital Discharge Survey in 2010 showed that 58% of neonatal boys in the United States were circumcised during their neonatal hospitalization as compared with 65% in 1979 [1]. National rates declined following the 1999 AAP policy revision that stated there was insufficient evidence to recommend routine newborn circumcision despite potential medical benefits [1].

Symptomatic meatal stenosis is seen in 3%—8% of boys after circumcision [2]. It is found in up to 20% of circumcised boys when defined anatomically as a meatal diameter less than 5Fr between the ages of 5 and 10 years [3]. One proposed mechanism is trauma to the exposed urethral epithelium from clothing or exposure to feces. Application of ointment after each diaper change for 6 months has been shown to significantly decrease the incidence of meatal stenosis [4]. Symptomatic boys often present after toilet training and may complain of a deviated, high-pressure stream or pain occurring with initiation of void. Although extremely rare, gross hematuria, urinary tract infection, decompensated bladder, vesicoureteral reflux and hydronephrosis have also been reported [2,3,5].

The current literature indicates that meatotomy with either general or local anesthesia may be equivalent in terms of short-term outcomes and complications [6]. In the literature there are multiple single center observational studies with short-term follow-up evaluating the treatment of meatal stenosis with either meatotomy or meatoplasty. The largest of these evaluated 100 patients who demonstrated no re-stenosis after meatoplasty performed under local anesthetic [5].

Our objective was to complete a population-based analysis to analyze current practice patterns, efficacy of treatments and to determine any correlation with patient characteristics. To our knowledge, this is the first analysis of such magnitude. We hypothesized that meatoplasty would be associated with a lower re-operative rate compared with meatotomy.

Materials and methods

For our data source, we used the Faculty Practice Solutions Center (FPSC) database. The FPSC was initiated by an alliance between the University Health System Consortium and the Association of American Medical Colleges in 2001 in an effort to collect benchmarking data on academic clinical practices throughout the country. Its goal is to improve performance and outcomes. The FPSC involves 120 participating institutions with more than 60 000 physicians nationwide. Coding data analyzed included hospital, de-identified provider and patient information, patient date of birth, gender, race, specialty, CPT codes, ICD-9 diagnosis billing codes, service date, location of service and payer category. FPSC is unique not only for its large scale of data capture but also for its role in tracking billing information, which offers a more reliable reflection of practice patterns through evaluation of both CPT and ICD-9 codes.

The FPSC database was queried to identify all individuals with a diagnosis of meatal stenosis (ICD-9598 and 598.9) entered into the database between January 2009 and December 2012. This includes all encounters billed by a provider where meatal stenosis was a diagnosis, but did not have to be the primary diagnosis. Patients with the diagnosis of hypospadias (ICD-9752.61) and/or surgical coding indicative of treatment of hypospadias (CPT 54322-52) were excluded. We excluded patients who underwent concurrent procedures or procedures performed within institutions that lacked complete data. Within this subset of individuals with a meatal stenosis diagnosis, we determined all who underwent a primary or secondary meatotomy (53020 or 53025) or meatoplasty (53450 or 53460) between January 1, 2009 and December 31, 2012 based upon any billing encounter with these codes. Of note, the type of procedure was rendered from the appropriate billing code not the description of the procedure, as this is not available. Concurrent general anesthesia codes that were reported on the same date as the penile procedure were recorded. To find major complications, we queried the database for any readmission and/or surgical or anesthesia code (CPT) within 48 h of meatotomy or meatoplasty.

Statistical analysis

For the univariate analysis, categorical variables were compared between surgery types using chi-square tests. Age at surgery was compared between surgery types using a two-sample t-test.

For the multivariable analysis, three separate mixed effects multiple logistic regression models were fitted to the data:

1. Model comparing probability of any procedure completion versus no procedure completion in all subjects with a meatal stenosis diagnosis.
2. Model comparing probability of meatotomy versus meatoplasty in all subjects who underwent either procedure.
3. Model comparing probability of meatotomy excluding meatotomy performed with general anesthesia versus meatoplasty in all subjects who underwent a procedure (secondary analysis).

We were concerned that a portion of the meatotomies coded concurrently with general anesthesia (57%) represented miscoded meatoplasties. To ensure a comparison between a pure population of office meatotomy (no general anesthesia) and operative meatoplasty (with general anesthesia), we excluded meatotomies performed under general anesthesia in the third model listed above (secondary analysis).

All models included fixed effects for race (white, black, other, or unknown) and region with a random effect for institution. Models were fitted using the GLIMMIX procedure in SAS (version 9.4). As indications for a diagnosis of meatal stenosis and a surgeon's decision regarding the need for intervention are not standardized, we evaluated a surgeon's propensity to operate. This propensity was defined as the number of individuals who proceeded to either meatotomy or meatoplasty divided by the total number of

patients the surgeon had seen with a diagnosis of meatal stenosis. A surgeon's propensity to use anesthesia was defined as the number of patients (with diagnosis of meatal stenosis) on whom they performed a meatotomy or meatoplasty using general anesthesia divided by the total number of meatal stenosis patients on whom they performed any procedure for this indication. Only surgeons who performed at least one meatotomy or meatoplasty were included in the analysis.

We also evaluated outcomes associated with the type of physician performing the procedure. The database specifies specialty, i.e. urologist, family practice, pediatrics, but does not specify some subspecialties such as pediatric urology. To be considered a pediatric urologist for our analysis, the physician had to be listed as "urologist" and had to perform at least 3 hypospadias repairs or 10 orchiopexies in 1 year. The probability of having secondary surgery was modeled using mixed effects logistic regression, with a random effect for institution.

Results

Within the FPSC database 4373 male patients with meatal stenosis were identified, 50% (2208) of whom were treated. Of all those who underwent a procedure for meatal stenosis, 76% (1689 patients) had a meatotomy and 24% (519 patients) had a meatoplasty (Table 1).

Univariate analysis

Patients undergoing meatoplasty were slightly older than those undergoing meatotomy ($p < 0.001$) (Table 2). Of patients having surgery, those in the south were most likely to undergo meatotomy ($p < 0.001$). Those in the northeast were most likely to undergo a meatoplasty ($p < 0.001$). Univariate analysis did not demonstrate an association of insurance type with type of procedure performed ($p = 0.69$). Second surgery was more common following meatotomy (2%) compared with meatoplasty (0.2%) ($p = 0.004$). No readmissions or procedures were found in any patient within 48 h of meatotomy or meatoplasty.

Secondary univariate analysis: office meatotomy

Excluding all meatotomies performed with general anesthesia, the secondary surgery rate after office meatotomy was 3.5%. This was a significantly higher rate when compared with a rate of 0.2% for meatoplasty ($p < 0.001$). Patients who initially had a meatotomy were also more likely to have a meatotomy (80%) as their second procedure. All other associations found in the primary univariate analysis with age and race remained significant, except that the northeast region no longer had a higher rate of meatoplasty compared with other regions.

Table 1 Univariate analysis: treatment and characteristics of patients diagnosed with meatal stenosis over a 4-year period. This includes all meatotomies with or without general anesthesia.

	Meatotomy ($n = 1689$)	Meatoplasty ($n = 519$)	No surgery ($n = 2165$)	P (meatotomy vs. meatoplasty)
Age at primary surgery (months)				
Mean (SD)	68 (35)	74 (35)	n/a	<0.001[a]
Median (range)	57 (0–214)	63 (7–213)		
Race (n, %)				
Black	151 (37%)	69 (17%)	192 (47%)	<0.001[b]
White	717 (45%)	149 (9%)	735 (46%)	
Other	60 (32%)	24 (13%)	103 (55%)	
Unknown	761 (35%)	277 (13%)	1135 (52%)	
Region (n, %)				
Midwest	380 (30%)	151 (12%)	717 (58%)	<0.001[b]
Northeast	388 (33%)	187 (16%)	596 (51%)	
South	753 (49%)	129 (8%)	671 (41%)	
West	168 (42%)	52 (13%)	181 (45%)	
Insurance type (n, %)				
Commercial	1022 (39%)	316 (12%)	1280 (49%)	0.694
Medicaid/Medicare	542 (39%)	162 (12%)	689 (49%)	
Self pay	21 (22%)	10 (10%)	67 (68%)	
All other	104 (39%)	31 (12%)	129 (49%)	
Had secondary surgery (n, %)				
No	98% (1655)	>99% (518)	n/a	0.004[b]
Yes	2% (34)	0.2% (1)		
Had anesthesia (n, %)				
No	43% (722)	0	n/a	
Yes	57% (967)	100% (519)		

[a] p value from two sample t-test.
[b] p value from chi-square test.

Table 2 Univariate analysis: treatment and characteristics of patients diagnosed with meatal stenosis over a 4-year period excluding patients who had meatotomy performed under general anesthesia.

	Office meatotomy ($n = 722$)	Operative meatoplasty ($n = 519$)	No surgery ($n = 2165$)	P (meatotomy vs. meatoplasty)
Age at primary surgery (months)				
Mean (SD)	67 (35)	74 (35)	n/a	0.003[a]
Median (range)	57 (0–214)	63 (7–213)		
Race (n, %)				
Black	37 (12%)	69 (23%)	192 (65%)	<0.001[b]
White	270 (23%)	149 (13%)	735 (64%)	
Other	27 (17%)	28 (18%)	103 (65%)	
Unknown	388 (22%)	277 (15%)	1135 (63%)	
Region (n, %)				
Midwest	103 (11%)	151 (16%)	717 (74%)	<0.001[b]
Northeast	246 (24%)	187 (18%)	596 (58%)	
South	286 (26%)	129 (12%)	671 (62%)	
West	87 (27%)	52 (16%)	181 (57%)	
Insurance type (n, %)				
Commercial	459 (22%)	316 (16%)	1280 (62%)	0.632[b]
Medicaid/Medicare	218 (20%)	162 (15%)	689 (65%)	
Self pay	12 (14%)	10 (11%)	67 (75%)	
All other	33 (17%)	31 (16%)	129 (67%)	
Had secondary surgery (n, %)				
No	697 (96.5%)	518 (>99%)	n/a	<0.001[b]
Yes	25 (3.5%)	1 (0.2%)		

[a] p value from two sample t-test.
[b] p value from chi-square test.

Multivariable analysis

After adjusting for region, black patients had a marginally lower, but statistically insignificant difference ($p = 0.07$), in odds of having a procedure performed for meatal stenosis than white patients (OR 0.8; CI 0.63–1.02). In other words, black patients, with the diagnosis of meatal stenosis, had 25% lower odds of treatment. Patients of races other than black or white had significantly lower odds ($p = 0.02$) of having either procedure than white subjects (OR 0.68, CI 0.48–0.95). In other words, non-black and non-white patients had 48% lower odds of treatment.

Multivariable analysis

After adjusting for region, black patients had a marginally lower but statistically insignificant difference in odds of having a procedure performed for meatal stenosis than white patients ($p = 0.07$; OR 0.8; CI 0.63–1.02). Patients of races other than black or white had significantly lower odds of having either procedure than white subjects ($p = 0.02$; OR 0.68, CI 0.48–0.95). Odds of having surgery did not differ significantly between black patients and patients of races other than black or white ($p = 0.39$).

After adjusting for race, odds of undergoing a procedure for meatal stenosis were marginally lower but a statistically insignificant difference for patients in the midwest compared with patients in the northeast ($p = 0.07$; OR 0.41; CI 0.15–1.07). Odds of surgery did not differ significantly between other regions.

After adjusting for region and including all patients who underwent either procedure, odds of treatment with meatotomy versus meatoplasty did not correlate with race ($p = 0.70$ for black versus white, $p = 0.99$ for other versus white, $p = 0.86$ for black versus other). Odds also did not differ significantly by region after adjusting for race. When adjusting for region but excluding meatotomies performed with general anesthesia, odds of having meatotomy versus meatoplasty continued to not differ significantly by race ($p = 0.63$ for black versus white, $p = 0.94$ for other versus white, $p = 0.73$ for black versus other). Odds of a particular procedure also did not differ significantly by region after adjusting for race.

Physician specialty

Of 123 physicians, 76 met criteria to be considered a pediatric urologist. Other specialties included 30 "non-pediatric" urologists, 16 pediatric surgeons and 1 general surgeon. Adjusting for race and type of primary surgery, the odds of requiring a secondary surgery did not differ significantly by whether or not the surgeon who conducted the surgery met our criteria for a pediatric urologist ($p = 0.69$). When evaluating patients who had an office meatotomy, adjusting for race and type of primary surgery, the odds of requiring a secondary surgery did not differ significantly by whether or not the surgeon who conducted the primary surgery met our criteria for a pediatric urologist ($p = 0.40$).

Secondary surgery

Adjusting for race and whether or not the primary surgeon was a pediatric urologist, meatotomy patients had odds of having secondary surgery 8.7 times higher than meatoplasty

patients ($p = 0.04$) and office meatotomy patients had odds of having secondary surgery 14 times higher than meatoplasty patients ($p = 0.02$).

Physician propensity to use anesthesia

The total number of surgeons included in the study was 123. When evaluating how often individual surgeons operate for meatal stenosis, most surgeons performed either meatotomy or meatoplasty on less than half of their patients seen for meatal stenosis (Fig. 1). Half of the surgeons only treat meatal stenosis under general anesthesia (Fig. 2).

Discussion

To our knowledge, this is the largest evaluation of the treatment of meatal stenosis in the literature capturing 4373 boys with the diagnosis and 2208 boys who subsequently underwent treatment. No study to our knowledge has compared the outcome of meatotomy with formal meatoplasty on such a scale. In 1996, Cartwright et al. published one of the first large series of patients treated with office meatotomy using topical anesthetic cream (2.5% lidocaine/2.5%prilocaine) and demonstrated feasibility of this approach. Discomfort was reported in 3 patients. Two patients in the office received pre-procedural midazolam. One patient during the study period was taken to the operating room because of behavioral concerns and two for concurrent planned procedures. Only one of the 58 patients experienced recurrent stenosis with a minimum follow-up of 3 months [7]. At approximately the same time in 1995, el-Kasaby et al. published a series of 100 cases of eversion meatoplasty without any occurrence of restenosis and described the use of injected 1% lidocaine into the ventral glans for local anesthetic [5].

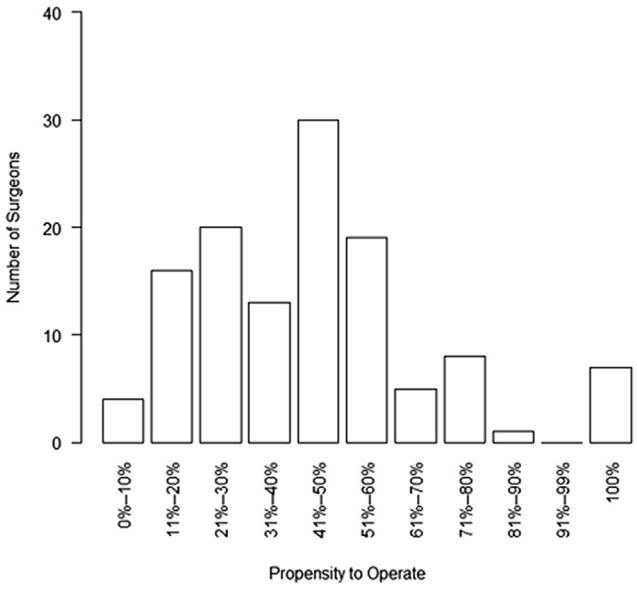

Figure 1 Chart describing surgeon propensity to treat meatal stenosis with surgery. X axis represents the percentage of patients with the diagnosis who were treated surgically.

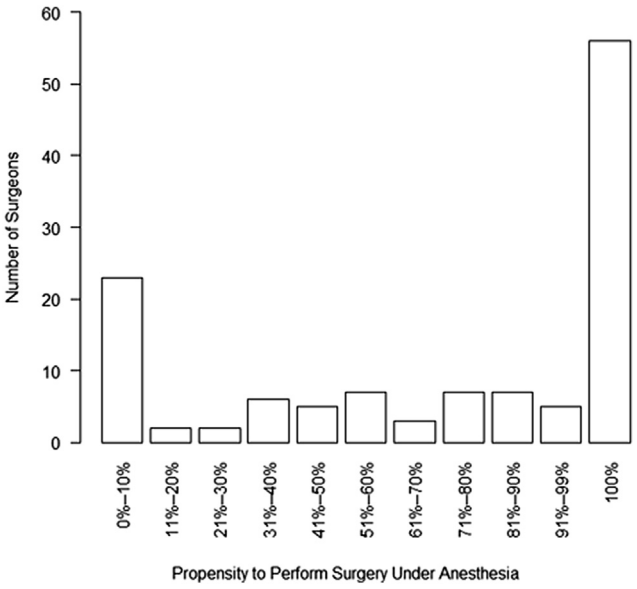

Figure 2 Chart describing surgeon propensity to use general anesthesia when treating meatal stenosis surgically. X axis represents the percentage of patients who were treated surgically and received general anesthesia.

Subsequently, studies were performed with varying results in terms of the ability to perform meatotomy in the office utilizing various topical anesthetics. In a prospective study of meatotomy comparing EMLA and LMX (4% lidocaine), Smith and Gjellum evaluated pain outcomes using the Wong-Baker face scale. Pain scores post procedure with both agents ranged from a mean of 1—3 on a 10-point scale, highlighting the overall tolerability of the office procedure [8]. To evaluate a subset of patients using local anesthetic with sedation versus general anesthesia, Ben-Meir et al. prospectively evaluated outcomes of 76 patients who were randomized to one of three groups (surgery with sedation and topical lidocaine/prilocaine versus general anesthesia with or without penile block). All underwent meatotomy by a single pediatric urologist. There was no difference in pain levels among the groups during the procedure or prior to discharge home by visual analog scale. When parents were contacted 24 h postoperatively, there was no significant difference in parental report of pain, use of analgesia or parental satisfaction between the 3 cohorts. Follow-up exams occurred at 1 month post operatively. No repeat procedures were necessary and no significant re-stenosis on exam occurred during that time [6].

In our study, we found an overall low rate of repeat procedures. Only 2% of all patients undergoing meatotomy required a repeat intervention. The odds of a patient who underwent meatotomy having a repeat operation was 8.7 times higher than for meatoplasty, and was 14 times higher when evaluating those who underwent an office meatotomy compared with meatoplasty. We did not find any significant difference in repeat procedure rate when comparing surgeon types.

This study is limited by an inability to determine recurrence rates. Only patients having secondary surgery at the same institution within the time period captured by the

database (6 months—4 years) could be identified. As such, the true recurrence of meatal stenosis is likely higher. Also, the type of procedure identified is dependent upon accurate coding. That is why we did a subset analysis on office meatotomy. Yet, there are many variations of both meatotomy and meatoplasty with respect to extent of incision and use of sutures, respectively. Although the re-operative rate is not equivalent to the recurrence rate, the two are correlated. Likewise, the surgeon's propensity to operate could be biased by their propensity to diagnosis meatal stenosis and this could affect the rates cited. Although we did not find any readmissions or surgical CPT codes which would be associated with major complications within 48 h of either meatotomy or meatoplasty, we were not able to determine if either procedure had a higher incidence of bleeding, infection or pain.

In addition to the cost benefit achieved with avoidance of general anesthesia (estimated to be a 10-fold cost reduction by Cartwright et al. [7]), the 2012 Consensus Statement of the International Anesthesia Research Society has highlighted that there is increasing evidence from research studies suggesting the benefits of general anesthesia should be considered in the context of its possible harmful effects [9]. The anesthesia literature reports that immature rodents or primates exposed to anesthesia demonstrate apoptotic neurodegeneration with long-term cognitive deficits [10—12]. There is currently no conclusive link between developmental outcomes and anesthesia exposure [13—15]. Prospective trials to evaluate for developmental risk in children are ongoing.

Although the above studies have highlighted that in-office procedures are a viable alternative to meatoplasty with general anesthesia, there are multiple factors in being able to perform an office meatotomy. Arguably, the two most important are the patient's ability to cooperate and his anatomy. There are patients who may have meatal stenosis so severe that it may not be possible to place anesthetic cream inside the meatus, and thus sufficient numbing cannot be achieved [7]. We have also found a subset of patients who do not appear to have classic meatal stenosis. These boys may describe two urine streams and/or pain with initial urination as the stream forces the skin edges apart. As such, their symptoms tend to be intermittent. Often, they have a normal appearing meatus or it is erythematous and dry. This has been termed either "inflammatory" meatal stenosis or "meatitis". These boys may respond to treatment with a lubricating ointment.

Conclusions

With a low re-operative rate (3.5%), office meatotomy is a reasonable choice of surgical treatment if the child can cooperate and the anatomy is appropriate. On the other hand, if general anesthesia is utilized, formal meatoplasty is associated with a lower re-operative rate.

Funding

None.

Conflict of interest

None.

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