Spinal Cord (2015) 53, 310–313

www.nature.com/sc

ORIGINAL ARTICLE

Urethral strictures in men with neurogenic lower urinary tract dysfunction using intermittent catheterization for bladder evacuation

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Study design: Retrospective investigation.
Objectives: To investigate the occurrence, characteristics and clinical consequences of urethral strictures in men with neurogenic lower urinary tract dysfunction (NLUTD) using intermittent catheterization (IC) for bladder evacuation.
Setting: Spinal cord injury rehabilitation center.
Methods: The patient database was screened for men with NLUTD who had presented for a routine video-urodynamic investigation between 2008 and 2012. Patient characteristics, bladder diary details, the occurrence of urethral strictures and performed urethrotomy procedures were collected from patient charts. Urethral strictures were classified using the Wiegand scoring system modified for men with NLUTD.
Results: The occurrence rate of urethral strictures (that is, 25% confidence interval (CI) 21–30%) was significantly ($P=0.0001$) higher in men using IC ($n=415$) than in men using other bladder evacuation methods (that is, 14% CI 11–17%) ($n=629$). Urethral strictures had occurred after a median 5.9 years (range 0.5–48.9 years) of IC. There was no significant ($P>0.08$) effect of tetraplegia or catheter type on the stricture occurrence rate. Approximately one-third of the men suffering from urethral strictures underwent internal urethrotomies. The radiographic stricture severity score was not associated with the need for surgical correction of the stricture. The radiographic recurrence rate of urethral strictures in operated men was 100%, a median 14 years after the first urethrotomy.
Conclusions: The occurrence rate of urethral strictures is significantly higher in men using IC than in men using other bladder evacuation methods. Every fourth men using IC may be affected by urethral strictures. However, only every third stricture may require a surgical intervention.
Spinal Cord (2015) **53,** 310–313; doi:10.1038/sc.2015.15; published online 3 February 2015

INTRODUCTION

Intermittent catheterization (IC) is the gold standard for bladder evacuation in individuals with neurogenic lower urinary tract dysfunction (NLUTD) and adequate manual dexterity.[1] Bladder evacuation by IC in men with NLUTD is a safe and efficient method with minimal residual urine volumes.[2,3] The most common complication in patients using IC is lower urinary tract infection.[4] Second, occult urethral trauma as a result of repeated catheter introduction occurs regularly, especially in men, but most commonly does not have lasting consequences.[4,5] However, catheterization-related urethral trauma may lead to urethral strictures, stenosis or false passages.[4,6]

The occurrence rate of urethral strictures in men with NLUTD varies in the literature and has been reported to increase with time and a higher catheterization rate.[7,8] The main body of literature has been published more than a decade ago, and the reported stricture occurrence rate is generally lower (<10%) in earlier investigations[7–9] compared with more recent ones (~20%).[10,11] Over the years, different catheter materials and methods have been introduced. The catheter surface has been claimed to be an important factor in the development of urethral strictures.[12,13] However, there is a lack of current data concerning the occurrence and characteristics of urethral strictures in men with NLUTD using IC since the wide-spread use of hydrophilic catheters.

We have therefore retrospectively investigated the occurrence, characteristics and clinical consequences of urethral strictures in men with NLUTD using IC for bladder evacuation.

SUBJECTS AND METHODS

Subjects and collected data

The present study had been approved by the local ethics committee, and all applicable institutional and governmental regulations concerning the ethical use of the data were followed. The patient database of a single spinal cord injury rehabilitation center was screened for men with NLUTD who had presented for a routine video-urodynamic investigation between April 2008 and March 2012. In male patients, the control examination included a retrograde urethrography.

Patient characteristics, bladder diary details (for example, bladder evacuation method), the occurrence of urethral strictures and performed urethrotomy procedures were collected from paper and electronic patient charts.

Urethrotomy procedures

The indication for a urethrotomy procedure were intractable difficulties with IC with an increased risk of urinary retention as a result of impaired catheter passage through the urethra combined with the presence of radiologic evidence

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Received 14 November 2014; revised 6 January 2015; accepted 8 January 2015; published online 3 February 2015

of urethral strictures (retrograde urethrography). Endoscopic internal urethrotomy was performed under visual endoscopic control (Sachse's procedure). The stricture area was incised with a cold knife at 12 o'clock with the patient in the lithotomy position, and an indwelling catheter was inserted subsequently. The catheter was removed after 24 h, unless bleeding required a longer drainage duration.

Stricture score

Retrograde contrast urethrography had been performed in a standardized way. The radiographs of all patients diagnosed with urethral strictures were reviewed. The stricture severity was classified by the senior author using the Wiegand scoring system[14] modified for men with NLUTD (Table 1): (a) number of strictures, (b) score for anatomic location and (c) score for length. The sum of these values represented the stricture score. The stricture score before and after an urethrotomy and at the last follow-up were determined.

Statistical analyses

The data were calculated as the median and the 95% confidence intervals (CI) or the range. The occurrence rate of urethral strictures was estimated for the different bladder evacuation methods, and the 95% CI were calculated using the Clopper–Pearson exact binomial method. The X^2-test or Fisher's exact test was used to test the differences in observed frequencies between groups. Furthermore, the odds ratios (OR) and 95% CI for the occurrence of urethral strictures in different cohorts were calculated. Statistical analyses were performed using the R software environment (version 3.1.0, Copyright 2014, The R Foundation for Statistical Computing). A *P*-value of <0.05 was considered significant.

RESULTS

Bladder evacuation methods and urethral strictures

A total of 1418 patients had presented at our department between April 2008 and March 2012 at least once for a routine urodynamic investigation: 1044 men and 374 women. The distribution of the different bladder evacuation methods and the occurrence rates of urethral strictures are presented in Table 2. IC was the most common (40%, 415/1044) bladder evacuation method. The occurrence rate of urethral strictures (that is, 25% CI 21–30%) was significantly ($P=0.0001$) higher in men using IC than in men using other bladder evacuation methods (that is, 14% CI 11–17%). The odds of an urethral stricture in men using IC were twice the odds (OR 1.8, 95% CI 1.3–2.5) in men using other methods for bladder evacuation. The occurrence rates of strictures were very similar among men using other bladder evacuation methods than IC, apart from men using sacral anterior root stimulation (Table 2). The occurrence rate of strictures in men using sacral anterior root stimulation was higher (that is, 21% CI 11–35%). Approximately 40% of these men had used IC for bladder evacuation prior to sacral anterior root stimulation.

Among men suffering from urethral strictures, there was no significant ($P=0.38$) difference in the frequency of internal urethrotomies between men using IC (that is, 38/105, 36% CI 27–46%) and men using other bladder evacuation methods (that is, 24/87, 28% CI 19–38%).

Table 1 Stricture score

Criteria	*Score*
Total number of strictures	1 point per stricture
Urethral patency	1 = patent urethra
	2 = non-patent urethra
Anatomic location	1 = bulbar urethra
	2 = penile urethra
	3 = panurethral or both bulbar and penile urethra
Length	1 = short stricture (⩽2 cm)
	2 = long stricture (>2 cm)
Stricture score	Sum of values

IC and urethral strictures

The median age of the 105 men using IC for bladder evacuation and suffering from urethral strictures was 41 years (range 19–74 years) at the time the first stricture occurred. The duration of NLUTD and IC was a median 5.0 years (range 0.1–48.9 years) and 5.9 years (range 0.5–48.9 years), respectively, when the first urethral stricture occurred. The etiology of NLUTD was mainly traumatic spinal cord injury (97/105, 92.4%). The other reasons for NLUTD were myelomeningocele (4/105, 3.8%), non-traumatic spinal cord injury (2/105, 1.9%) and multiple sclerosis (2/105, 1.9%). There were ten tetra- and 95 paraplegic patients. All men possessed adequate manual dexterity to perform IC efficiently. There was no significant ($P=0.08$) difference between the odds of an urethral stricture in tetraplegic men compared with paraplegic men (OR 0.5, 95% CI 0.2–1.1). The proportion of tetraplegics among men suffering from urethral strictures was 9.5% (10/105) and 16.5% (51/310) among men not suffering from strictures. Thirteen men (12.4%, 13/105) had used other bladder evacuation methods prior to IC: abdominal straining ($n=7$), reflex voiding ($n=5$) and sacral anterior root stimulation ($n=1$).

The types and sizes of catheters used for IC by the study subjects are presented in Table 3. There was no significant ($P=0.5$) difference in the distribution of the three most commonly used catheter types between men with and without strictures.

Strictures mainly occurred in the bulbar urethra (51.4%, 54/105), followed by the penile urethra (37.1%, 39/105), but were rarely panurethral (12.4%, 13/105) (Table 4). Twelve men had more than one stricture (two or three strictures), and four strictures resulted in a non-patent urethra. In one patient with a non-patent urethra, bladder evacuation via a suprapubic catheter was established and no urethrotomy was performed.

The indication for a urethrotomy procedure were intractable difficulties with IC with an increased risk of urinary retention as a result of impaired catheter passage through the urethra. A total of 38/105 men (36.2%, 95% CI 27.0–46.1%) underwent internal urethrotomy to facilitate urinary catheterization. The probability of a urethrotomy procedure in all men using IC was thus 9.2% (95% CI

Table 2 Occurrence rates of bladder evacuation methods and urethral strictures

Evacuation methods	*Strictures*				
	N	%	n	*Rate*	*CI*
IC[a]	415	39.8	105	25%[a]	21–30%
Other methods	629	60.2	87	14%	11–17%
Triggered reflex voiding	236	22.6	35	15%	11–20%
SPC	116	11.1	10	9%	4–15%
Physiologic	81	7.8	12	15%	9–24%
Abdominal straining	65	6.2	9	14%	7–25%
Spontaneous	63	6.0	8	13%	6–23%
SARS[b]	52	5.0	11	21%	11–35%
TC	16	1.5	2	13%	2–38%
Total	1044	100	192	18%	16–21%

Abbreviatons: CI, 95% confidence intervals; IC, intermittent catheterization; SARS, sacral anterior root stimulation; SPC, suprapubic catheterization; TC, transurethral catheter.
[a]The occurrence rate of urethral strictures in men using intermittent catheterization was significantly ($P=0.0001$) higher than in men using other bladder evacuation methods.
[b]Prior to SARS, ~40% of these men have used IC for bladder evacuation.

Table 3 Types and sizes of catheters used

Type	*Stricture*	*Size*			*Total*	
		12 Ch.	*14 Ch.*	*misc. Ch.*	N	%
SpeediCath/Coloplast	Stricture	7	30	3	40	25.8[a]
	No stricture	28	82	5	115	74.2
LoFric/Wellspect Healthcare	Stricture	8	16	2	26	27.4[a]
	No stricture	26	39	4	69	72.6
IQ Cath/Manfred Sauer	Stricture	0	23	0	23	20.9[a]
	No stricture	3	83	1	87	79.1
SafetyCat/Teleflex	Stricture	1	4	1	6	—
	No stricture	3	6	0	9	—
Advance/Hollister	Stricture	1	1	0	2	—
	No stricture	1	3	1	5	—
Actreen/B. Braun	Stricture	0	2	0	2	—
	No stricture	1	4	0	5	—
Miscellaneous	Stricture	1	4	1	6	—
	No stricture	5	10	5	20	—

Abbreviations: Ch., Charrière; misc. miscellaneous.
[a]no significant ($P=0.5$) difference between the catheter types.

Table 4 Comparison of stricture characteristics between men treated surgically and conservatively

Characteristics	*Urethrotomy*	*No urethrotomy*	*Total*
Multiple strictures	21% (8/38)	6% (4/67)	11% (12/105)
Bulbar strictures	26% (10/38)	64% (44/67)	51% (54/105)
Penile strictures	53% (20/38)	28% (19/67)	37% (39/105)
Panurethral strictures	18% (7/38)	9% (6/67)	12% (13/105)
Long strictures	18% (7/38)	6% (4/67)	10% (11/105)
Non-patent urethra	8% (3/38)	1% (1/67)[a]	4% (4/105)

[a]Subrapubic catheterization was established.

6.6–12.4%). More than one (2–5) urethrotomy was performed in 14/38 (36.8%) men. In eight operated men, urethral strictures were still evident on the post-operative radiographs, despite good patency for IC. At the last follow-up, a median 14 years (range 2–24 years) after the first urethrotomy, there was radiological evidence of strictures in all operated men. However, IC was possible in all these men, and no further urethrotomies were planned.

Urethral stricture scoring

The urethral stricture scores for the different evaluation time points are presented in Table 5. There was no significant (0.096) difference in the stricture score initially between men who underwent urethrotomy and men who did not. However, at the last follow-up, the stricture score of men who had undergone urethrotomy (6, 95% CI 5–6) was significantly (<0.001) higher compared with the score of and men who had not (4, 95% CI 4–5). The follow-up time in men not undergoing urethrotomy was a median 15 years (range 2–54 years). The stricture score of men who underwent urethrotomy decreased significantly (<0.001) postoperatively but had increased significantly at the last follow-up.

DISCUSSION

We have investigated the occurrence, characteristics and clinical consequences of urethral strictures in men with NLUTD using IC

Table 5 Urethral stricture score

Group	*Time point*	*Score*			P
		Median	*95% CI*	n	
Urethrotomy	Initial	5	4–5	26	0.096[a]
No urethrotomy		4	4–5	65	
Urethrotomy	Post-op	0	0–0	35	<0.001[b]
No urethrotomy		NA	NA	NA	NA
Urethrotomy	Last FU	6	5–6	38	<0.001[a]
No urethrotomy		4	4–5	64	

Abbreviations: CI, confidence interval; FU, follow-up; NA, not applicable; post-op, post-operative.
[a]Comparison between urethrotomy and the no-urethrotomy group.
[b]Comparison between initial and post-operative values, as well as between post-operative values and those at the last follow-up.

for bladder evacuation. Men using IC were affected by urethral strictures significantly more often (that is, approximately every fourth men) compared with men using other bladder evacuation methods (that is, approximately every fifth men). The odds of a urethral stricture in men using IC were twice the odds in men using other bladder evacuation methods. Approximately one-third of the men suffering from urethral strictures underwent internal urethrotomies. Thus, approximately every tenth men using IC for bladder evacuation will undergo a urethrotomy intervention as a result of urethral strictures. The radiographic stricture severity score was not associated with the need for surgical correction of the stricture.

The occurrence rate of urethral strictures was 25% in our cohort of men using IC. The rate of urethral strictures with IC reported in the literature is in general considerably lower and ranges from 5 to 9%.[7–9] However, in more recent studies,[10,11] rates of 18 and 22% were observed. Differences in the severity of reported strictures (all strictures vs solely strictures requiring a surgical intervention), the method for stricture evaluation (endoscopic or radiographic examination, telephone interview) and the follow-up time account for the discrepancies between the different investigations. The occurrence of urethral strictures increases with time, with most events occurring after 5 years of IC.[7,8] This is in accordance with the present investigation, where the first urethral strictures occurred after 6 years of IC. We did not observe any significant effect of impaired manual dexterity (that is, tetraplegia) or catheter type used for IC on the occurrence of urethral strictures. In patients with cervical spinal cord injury and sufficient manual dexterity, IC is a feasible, safe and effective bladder evacuation method with the benefit of increased independence and reduced risk of complications associated with other methods, such as indwelling urethral or suprapubic catheterization.[15] The use of hydrophilic catheters has been reported to reduce urethral trauma and complications.[13] However, the current evidence is limited, especially regarding the optimal catheter type for decreasing the occurrence of urethral complications and urinary tract infections.[16]

The occurrence rate of urethral strictures in men using IC was significantly higher (25 vs 14%) and the odds of an urethral stricture were twice the odds in men using other bladder evacuation methods. There is only sparse data concerning urethral strictures in men using other bladder evacuation methods than IC. Guenther *et al.*[10] observed no significant difference in the stricture rates between men using IC (that is, 22%) and men using spontaneous or triggered reflex voiding (that is, 24%). Singh *et al.*[11] reported higher stricture rates with IC (that is, 18%) compared with other evacuation methods, such as normal, spontaneous or reflex voiding and suprapubic

catheterization (that is, 2%). However, no statistical comparison was performed between these groups.

The percentage of strictures requiring a surgical intervention for facilitating urinary catheterization was substantially higher in our cohort (IC: 36%, other evacuation methods: 28%) compared with an earlier report (IC: 3%, other evacuation methods: 4%).[10] The shorter follow-up time in this previous report (4 years), compared with the present investigation (14 years), may be the reason for the lower percentage of strictures requiring a surgical intervention.

Approximately two out of five men undergoing urethrotomy required more than one intervention. Wyndaele *et al.*[8] reported a similar reoperation rate of 29% (2/7 patients) within 2 years after the initial intervention. At the last follow-up, 14 years after the first intervention, radiological evidence of stricture recurrence was present in all operated men of our cohort. Nevertheless, urethral patency was sufficient for IC, except in one patient in whom a suprapubic catheter was introduced. To our knowledge, there are no other reports on the recurrence rate of urethral strictures following internal urethrotomy in men with NLUTD. The long-term success rate of internal urethrotomy interventions in able-bodied men has been reported to approach 0%, and urethroplasty interventions have thus been recommended.[17] However, repetitive urethral micro-traumata in men using IC represent a potential risk for stricture recurrence even after open surgery.[18] In our opinion, internal urethrotomy is indicated in this group of patients despite the observed recurrence and reoperation rates. In contrast to able-bodied men, re-urethrotomy in men with NLUTD using IC is required only if the patency and ease to safely perform IC is impaired.

A score for the objective assessment of the severity of urethral strictures would facilitate surgical decision-making and analysis of surgical outcomes. We have therefore modified the urethral stricture score proposed by Wiegand *et al.*[14] for men with NLUTD and assessed the strictures in our cohort of men using IC for bladder evacuation. The first component of the Wiegand score is the stricture etiology, which was the same in all of our patients and therefore omitted. The measurement of the stricture length was simplified to a categorization into 'short' and 'long', because the reliability of the true length measurement in cm was insufficient. The analysis of our data revealed no significant difference in the initial stricture score between men who underwent urethrotomy and men who did not. However, at the last follow-up, the stricture score of men who had undergone urethrotomy was significantly higher compared with the score of men who had not. The reason for the discrepancy between the stricture score and the clinical severity (that is, urethrotomy) was that the indication for urethrotomy was based on the patency for urinary catheterization and not on radiographic presentation. The association between stricture score and clinical severity should be investigated using the stricture presentation under endoscopic inspection. However, these data were not available in the present investigation.

The retrospective and single-center design pertains to the limitations of the present study. Prospective, longitudinal multicenter studies including different clinical severity assessments and potential risk factors for the development of strictures should be performed. The stricture rate for transurethral catheterization (Table 2) should be considered with caution because of the low sample number ($n = 16$).

Bladder evacuation using IC is a reliable and effective long-term option in men affected by NLUTD who are able to master the technique appropriately.[4,19] However, the occurrence rate of urinary strictures in men with NLUTD using IC for bladder evacuation seems to be higher than previously reported, and the odds of sustaining a stricture are increased in this population. Approximately 25% of men with NLUTD using IC for bladder evacuation can be affected. This is not an argument against IC, because not all of these strictures required a surgical intervention (30% in our cohort). However, thorough patient education and training, regular follow-up controls and using up-to-date materials are crucial for the successful long-term application of IC. On the basis of our data, routine radiologic evaluation of the urethra in men with NLUTD performing IC is not required in individuals with no difficulties with performing IC. The patency and ease for urethral catheterization is clinically relevant and not the radiographic presentation.

CONCLUSIONS

The odds of urethral strictures are significantly increased in men using IC compared with men using other bladder evacuation methods. Every fourth men using IC may be affected by urethral strictures; however, only every third stricture may require a surgical intervention. Impaired manual dexterity (that is, tetraplegia) or catheter type used for IC do not seem to affect the stricture occurrence rate.

DATA ARCHIVING

There were no data to deposit.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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