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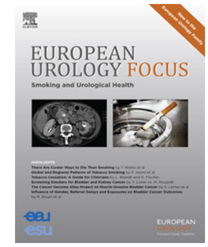

Review – Neuro-urology

Surgical Management of Anatomic Bladder Outlet Obstruction in Males with Neurogenic Bladder Dysfunction: A Systematic Review

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Article info

Article history:
Accepted February 20, 2018

Associate Editor: Christian Gratzke

Keywords:
Benign prostatic hyperplasia
Multiple sclerosis
Parkinson disease
Spinal cord injury
Transurethral resection of prostate
Urethral stricture

Abstract

Context: Surgical treatment of anatomic bladder outlet obstruction (BOO) may be indicated in males with neurogenic bladder dysfunction. A bothersome complication after surgery is urinary incontinence.

Objective: To identify the optimal practice in the surgical treatment of anatomic BOO in males with neurogenic bladder dysfunction, due to multiple sclerosis, Parkinson disease, spinal cord injury (SCI), spina bifida, or cerebrovascular accident (CVA).

Evidence acquisition: A systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement. Medline, Embase, Cochrane controlled trial databases, Web of Science, and Google Scholar were searched for publications until January 2017.

Evidence synthesis: A total of 930 abstracts were screened. Eight studies were included. The types of anatomic BOO discussed were benign prostate obstruction, urethral stricture, and bladder neck sclerosis. The identified surgical treatments were transurethral resection of the prostate (TURP) in patients with Parkinson, CVA or SCI, endoscopic treatment of urethral stricture by laser ablation or urethrotomy (mainly in SCI patients), and bladder neck resection (BNR) in SCI patients. The outcome of TURP may be highly variable, and includes persistent or de novo urinary incontinence, regained normal micturition control, and urinary continence. Good results were seen in BNR and endoscopic urethrotomy studies. Laser ablation and cold knife urethrotomy resulted in restarting intermittent catheterization or adequate voiding. Overall, a high risk of bias was found.

Conclusions: This systematic review provides an overview of the current literature on the outcome of several surgical approaches of different types of anatomic BOO in males with neurogenic bladder dysfunction. Identifying the optimal practice was impossible due to limited availability of high-quality studies.

Patient summary: The outcome of several surgical approaches in males with neurogenic bladder dysfunction with benign prostate obstruction, urethral stricture, or bladder neck sclerosis is overviewed. The optimal practice could not be identified.

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1. Introduction

Symptoms of lower urinary tract (LUT) dysfunction in patients with neurological disease have an effect on the quality of life [1]. The type of the neurological disease and the location of the lesion determine the pattern of the neurogenic bladder dysfunction, which can be shown in various urological symptoms [1,2]. Symptoms in the

https://doi.org/10.1016/j.euf.2018.02.009
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absence of infection or obvious pathology other than possible causes of outlet obstruction are suggestive for bladder outlet obstruction (BOO) [3]. Detrusor-sphincter dyssynergia is the most common form of BOO in people with a neurogenic bladder dysfunction [4]. However, BOO can also have an anatomic cause, such as benign prostatic hyperplasia (BPH) or urethral stricture. Surgical management of anatomic BOO may result in urinary incontinence (UI). Owing to the effects of neurological pathology on the LUT function, the surgical outcome in the treatment of anatomic BOO is expected to differ from that in the non-neurogenic population.

A feared complication in patients treated with intermittent catheterization (IC) is a urethral stricture due to repeated urethral trauma. IC is the gold standard for the management of neurogenic LUT dysfunction [2,5]. Benign prostatic obstruction due to BPH is a relatively common disease in older men. Fifty percent of the male population between 51 and 60 yr of age has LUT symptoms (LUTS) due to BPH [6]. Since male patients with a neurogenic bladder dysfunction can have an age of >50 yr and be at a risk of urethral strictures, treatment for BPH or urethral stricture could be necessary. Surgical interventions for anatomical BOO are transurethral resection of the prostate (TURP), open prostatectomy, bladder neck resection (BNR), endoscopic urethrotomy, and urethroplasty.

This systematic review focused on the surgical management of an anatomic BOO in males with a neurogenic bladder dysfunction due to multiple sclerosis (MS), Parkinson disease, spinal cord injury (SCI), spina bifida, or stroke/cerebrovascular accident (CVA) in order to identify the optimal practice.

2. Evidence acquisition

2.1. Study registration

This systematic review was conducted according to the Cochrane Handbook for Systematic Reviews of Interventions [7] and the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement [8]. The study protocol was registered on PROSPERO (CRD42017055229; https://www.crd.york.ac.uk/PROSPERO).

2.2. Literature search

The citation sources Web of Science and Google Scholar and the Medline, Embase, and Cochrane controlled trial databases were searched for all relevant publications until January 2017. No date restrictions were applied. Duplicates were removed. The reference list of the relevant reviews was searched for relevant articles. The complete search string is shown in the Supplementary material.

2.3. Eligibility criteria

All publications on surgical treatment of anatomic BOO caused by BPH, urethral stricture, or bladder neck sclerosis in male patients aged >18 yr and neurogenic bladder dysfunction due to MS, Parkinson disease, SCI, spina bifida, or stroke/CVA were eligible for full-text retrieval. The different types of interventions were TURP, open prostatectomy, endoscopic urethrotomy, urethroplasty, BNR, or any other surgical treatment for anatomic BOO. This review did not address surgical treatment of functional BOO due to neurogenic bladder dysfunction. Cancer was an exclusion criterion. Case reports with <10 adult neuro-urological (NU) patients, non-English text articles, conference abstracts, and reviews were excluded. The study population of all studies had to treat >90% adult NU patients, or the results for adult NU patients were separately reported.

2.4. Selection of studies

Two reviewers (T.N. and J.G.) independently screened the titles and abstracts in Endnote (EndNote X7; Thomson Reuters, Philadelphia, PA, USA). The full text of all potentially eligible publications was independently screened by the same reviewers using a standardized screening form. A third reviewer (B.B.) resolved any disagreements between the two reviewers.

2.5. Data extraction

The predefined data were independently extracted from the included full-text publications by two reviewers (J.G. and T.N.) using a standardized form. Any disagreements were resolved by the third reviewer (B.B.). General characteristics of the studies and study populations included the type of study, country, number of patients, age, neurological disease, type of anatomic BOO, type of intervention, and type of outcome measures.

2.6. Outcome measures

The measures of the outcome of the intervention were divided into primary and secondary outcomes.

Primary outcomes:

1. Degree of UI (pad use)
2. Results of invasive and noninvasive urodynamic measurements

Secondary outcomes:

1. Quality of life
2. Adverse effects after treatment
3. Surgical outcome measures
4. Renal function
5. Socioeconomic measures
6. Other outcomes: non-prespecified outcomes important when performing the review

2.7. Subgroup analyses

The predefined subgroups were type of anatomic BOO, type of intervention, and underlying NU pathology.

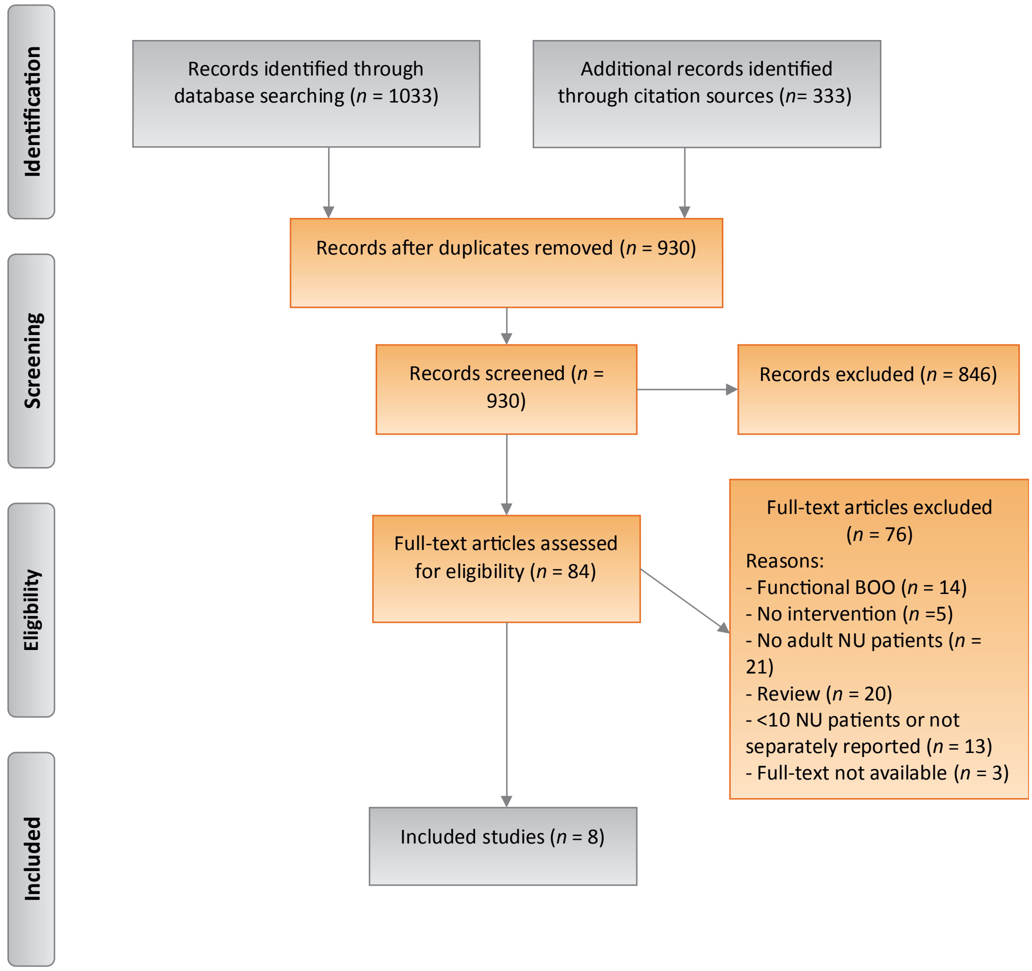

Fig. 1 – Literature search and study selection. BOO = bladder outlet obstruction; NU = neuro-urological; PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-analyses.

2.8. *Risk of bias assessment*

The Cochrane Risk of bias Assessment Tool [7] together with an assessment of the main confounders following recommendations of the Cochrane handbook for nonrandomized comparative studies [9] were used to perform a risk of bias analysis for included nonrandomized comparative studies. We developed a list of main confounders. The identified confounders were age, underlying NU pathology, previous treatments for anatomic BOO, and previous surgeries of the LUT. During data extraction, the identified confounders were analyzed in the studies. Confounding bias was classified as "high" if the confounder was unadjusted during analysis, imbalanced between the groups, or not considered or described. To determine the risk of bias for noncomparative studies, the availability of a priori protocol, selective outcome reporting (reporting bias), and incomplete data outcome (attrition bias) was assessed. Review Manager (RevMan) version 5.3 (The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, 2014) was used to compute the risk of bias figure.

3. Evidence synthesis

3.1. *Search results*

The PRISMA flow diagram in Figure 1 shows the results of literature search and study selection. The initial literature search resulted in 930 abstracts. After reviewing 84 full-text articles, eight studies were included [10–17].

3.2. *Characteristics of included studies*

3.2.1. *Design of studies*

Table 1 shows the descriptives of the included studies. They were all retrospective and published between 1972 and 2017. The design of two studies was comparative, and the other six studies were single-arm studies. A total of 333 NU patients with an anatomic BOO were included in the studies, and 251 of them underwent a surgical treatment for anatomic BOO. All study participants were included consecutively.

Table 1 – Characteristics of the included studies.

Study	Study design	Recruitment period	NU patients/ study population BOO	Type of NU patients	Type of anatomic BOO	Type of intervention	Age (yr)	Median time since NLUTD (yr)	Urological history	Urological drug history	Preoperative incontinence	Follow-up time
Roth et al (2009) [10]	Retrospective single arm	1997–2007	23/23 (100%)	100% Parkinson disease	BPH	TURP	Median 73 (IQR 68–81)	Median 3 (IQR 1–5)	SPC in 11/23 TUC in 9/23 -Previous surgery NR	Alpha blockers for ≥2 mo	10/23 (43%) Urge incontinence, 17/23 (74%) detrusor overactivity	Median 3 (IQR 2–6) yr
Han et al (2014) [13]	Retrospective comparative	2009–2011	31/372 (8%)	8% CVA, 92% non-NU patients	BPH	TURP	NR	NR	NR (entire population 6/372 previous BPH operation)	NR (entire population 295/372 BPH/LUTS medication)	NR	≥3 mo in all
Moisey and Rees (1978) [15]	Retrospective single arm	1972–1976	22/22 (100%)	100% CVA (including 2 with CVA and Parkinson disease)	BPH	TURP	Range 58–93	<2 yr in 14/22, 2–11 yr in 8/22	13/22 Acute retention 3/22 Chronic retention 3/22 Symptoms of BOO -Previous surgery NR	NR	3/22 (14%) Urinary incontinence	NR
Staskin et al (1988) [17]	Retrospective comparative	1977–1984	50/50 (100%)	100% Parkinson disease	36/50 BPH	36/50 TURP	NR (entire population mean 67, range 50–82)	NR (entire population median 9.7, range 1–28)	NR	NR	6/36 (17%) Urinary incontinence (4 urge and 2 overflow)	Mean 9.2 (range 1–28) mo
Perkash (1997) [14]	Retrospective single arm	NR	42/42 (100%)	SCI 79% Complete 21% Incomplete	Urethral stricture: 30 bulbar, 4 bladder neck and bulbar, 5 anterior pendulous, 3 prostatic	Transurethral contact laser ablation	Mean 48 (range 26–69)	NR	24/42 Electrocautery incisions extending into the bulbar urethra	NR	NR	Mean 28.2 (range 12–46) mo
Cornejo-Dávila et al (2017) [11]	Retrospective single arm	2001–2016	14/14 (100%)	100% SCI	Urethral stricture: 12 bulbar, 1 penile, 1 meatus	12 Endoscopic urethrotomy of bulbar stricture, 1 meatotomy, 1 no surgery	NR	NR	IC in 14/14 -Previous surgery NR	NR	NR	Mean 1 yr
Krebs et al (2015) [12]	Retrospective single arm	2008–2012	105/105 (100%)	94% SCI 4% Spina bifida 2% MS	Urethral stricture: 10 bulbar, 20 penile, 8 multiple	38 Endoscopic urethrotomy	NR (entire population median 41, range 19–74)	NR (entire population median 5.0, range 0.1–48.9)	IC in 105/105 -Previous surgery NR	NR	NR	Median 14 (range 2–24) yr (entire population 15 [range 2–54] yr)

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Table 1 (*Continued*)

Study	Study design	Recruitment period	NU patients/ study population BOO	Type of NU patients	Type of anatomic BOO	Type of intervention	Age (yr)	Median time since NLUTD (yr)	Urological history	Urological drug history	Preoperative incontinence	Follow-up time
Elsaesser and Stoephasius (1972) [16]	Retrospective single arm	1969–1971	46/46 (100%)	100% Traumatic SCI	21 BPH, 7 meatus stenosis, 4 urethra stricture, 14 bladder neck sclerosis	21 TURP, 7 meatotomy, 4 urethroplasty, 14 bladder neck resection	NR	BPH: 4–6 mo ($n = 6$), 7–12 mo ($n = 9$), 1–15 yr ($n = 6$) Bladder neck sclerosis: 4–6 mo ($n = 2$), 7–12 mo ($n = 7$), 1–13 yr ($n = 5$)	NR	NR	NR	NR

BOO = bladder outlet obstruction; BPH = benign prostate hyperplasia; CVA = cerebrovascular accident; IC = intermittent catheterization; IQR = interquartile range; LUTS = lower urinary tract symptoms; MS = multiple sclerosis; NLUTD = neurogenic lower urinary tract dysfunction; NR = not reported; NU = neuro-urological; SCI = spinal cord injury; SPC = suprapubic catheter; TUC = transurethral catheter; TURP = transurethral resection of the prostate.

3.2.2. *Underlying neurological disease*

Of the 333 included patients, neurogenic bladder dysfunction was due to SCI in 201 men [11,12,14,16], Parkinson disease in 73 men [10,17], CVA in 53 men [13,15], spina bifida in four men [12], and MS in two men [12].

3.3. *Identified treatment*

The interventions reported in the included studies were TURP, endoscopic urethrotomy, BNR, urethroplasty, and meatotomy. One single treatment was applied in six studies. More than one treatment modality was applied in two studies. However, in these studies, urethroplasty and meatotomy were performed in <10 cases, and the results will therefore not be discussed here [11,16]. Most of the studies reported the results of a surgical treatment in one hospital. One study reported the results of eight institutions [13]. In the studies of Perkash [14] and Roth et al [10], one surgeon performed the interventions. The number of surgeons in the other studies was unclear.

3.3.1. *Transurethral resection of the prostate*

In five studies, results of TURP in men with BPH were described.

Roth et al [10] reported the outcome in 23 patients with Parkinson disease. All patients had refractory LUTS despite alpha blockers for $\geq$2 mo. The median age was 73 yr, and the median time since Parkinson disease was diagnosed 3 yr at the moment of TURP.

Han et al [13] evaluated which factors were associated with continued use of LUTS/BPH medication after TURP in 372 patients, including 31 with CVA.

Elsaesser and Stoephasius [16] described 46 SCI patients with anatomic BOO. This was due to BPH in 21 patients, who underwent a TURP. The time between the SCI and the TURP varied from 4 mo to 15 yr.

Moisey and Rees [15] described the results of a TURP in 22 men with a history of CVA, including two who also had Parkinson disease. Age ranged from 58 to 93 yr.

Staskin et al [17] performed a TURP in 36 Parkinson patients. Comparing this group with 14 unobstructed patients, risk factors for post-TURP incontinence were considered.

3.3.2. *Endoscopic treatment of urethral strictures*

Endoscopic treatment of urethra strictures was reported in three studies. The underlying neurological disease was SCI in almost all men.

In the study of Cornejo-Dávila et al [11], an endoscopic internal urethrotomy was performed in 12 SCI patients who mentioned any difficulty in IC and had a urethroscopically confirmed bulbar urethral stricture of $\leq$10 mm. A single cut at 12 o'clock with a conventional straight blade was performed. Two weeks after the procedure, the 16-Fr silicone Foley catheter was removed and IC with the same intervals was resumed.

Krebs et al [12] identified 105 men who used IC for bladder evacuation and had urethral strictures. This group included 99 SCI patients, four patients with spina bifida, and two patients with MS. An endoscopic internal urethrotomy was performed if there were intractable difficulties with IC with an increased risk of urinary retention as a result of impaired catheter passage through the urethra and a confirmed urethral stricture by a retrograde urethrography. This was the case in 38 men, in whom the underlying neurological disease was not further specified. A cold knife incised the stricture at 12 o'clock. If there was no bleeding, the catheter was removed after 24 h.

Perkash [14] performed endoscopic neodymium:YAG contact laser urethrotomy in 42 SCI patients with strictures approximately 1–4 cm (<2 cm in 39 patients). The stricture was identified through a 23F cystoscope, and a guide wire was passed through the stricture. A contact laser chisel probe, 2.5 or 3.5 mm, screwed at the end of a semirigid fiber was used for endoscopic laser ablation. To achieve complete ablation, the fibrous tissue was vaporized circumferentially. The catheter was removed the next day.

3.3.3. *Bladder neck resection*

Fourteen BNRs in SCI patients were described in the study of Elsaesser and Stoephasius [16]. When an optically prominent obstruction in the bladder neck was revealed by a cystoscopy, the sclerotic ring was resected between 3 and 9 o'clock or full circle.

3.4. Results on outcome

The outcome measures are summarized in Table 2. None of the studies measured the pad use to obtain an estimate of UI severity, and none of the studies reported on renal function. We added two non-prespecified outcome measures: "recurrence of anatomic BOO" and "definition of success of intervention used by the study."

3.4.1. *Primary outcome of TURP*

Two Parkinson patients with overflow UI became dry, and UI persisted in the cases with urge UI [17]. Most of the patients (5/6) with abnormal sphincter control in preoperative urodynamic study became incontinent after TURP. Just one out of 24 patients who had normal sphincter control became incontinent [17]. De novo UI after TURP was reported in patients with Parkinson [17] in contrast to the study of Roth et al [10]. In this study, UI was resolved or improved or persisted after TURP, and de novo UI was not seen [10].

Moisey and Rees [15] observed a regained normal micturition control in 16 (73%) out of 22 CVA patients. Han et al [13] (CVA patients) and Elsaesser and Stoephasius [16] (SCI patients) did not report the outcome on continence. The latter authors considered the outcome of TURP good or improved in 16 out of 21 patients, with postvoided residues of <100 or <200 ml, respectively [16]. No urodynamic data for CVA patients were provided [13,15].

3.4.2. *Primary outcome of endoscopic treatment of urethral strictures*

UI was not observed in the three studies [11,12,14]. Cornejo-Dávila et al [11] and Krebs et al [12] mentioned that IC was restarted in all patients after endoscopic urethrotomy. The study population of Krebs et al [12] needed one to five procedures. The possibility of adequate voiding after laser ablation was seen in 39 of 42 patients (93%). The pre- or postoperative way of bladder empting (IC or spontaneous voiding) was not reported [14].

3.4.3. *Primary outcome of BNR*

A postvoid residue of <100 ml could be obtained in 11/14 SCI patients after one or more procedures, while the procedure failed completely in three patients [16].

3.5. Subgroup analyses

A subgroup analysis was not possible to perform or contributive. The studies included a small number of patients with different types of anatomic BOO, intervention, and underlying NU pathology.

3.6. Risk of bias assessment

The risk of bias assessed by the Cochrane Risk of Bias Assessment Tool and confounding factors was classified high for the two comparative studies. The included studies were assessed as having a high or unclear risk of bias (Fig. 2).

3.7. Discussion

3.7.1. *Principal findings*

To our knowledge, this is the first review with the focus on surgical management of anatomic BOO in NU patients. The identified surgical treatments were TURP in patients with Parkinson, CVA or SCI, endoscopic treatment of urethral stricture by laser ablation or urethrotomy (mainly in SCI patients), and BNR in SCI patients. The results of TURP in the different types of NU patients varied. De novo UI after TURP in Parkinson patients ranged from 0% to 20% [10,17]. Bladder function had improved after TURP in 76% of SCI patients, defined as postvoiding residue <200 ml [16]. In CVA patients, poorer results on bladder function were seen in case of more severe neurological impairment [15]. Additionally, CVA appeared to be a risk factor for persistent voiding dysfunction and continued medical therapy after TURP [13]. Good results were seen in BNR and endoscopic urethrotomy studies in SCI patients. Both laser ablation and cold knife urethrotomy resulted in restarting IC or adequate voiding. However, studies with a follow-up of >1 yr showed that one or more reinterventions due to recurrence were sometimes necessary [12,14].

3.7.2. *Interpretations of findings*

First of all, our interpretations are based on a limited number of included studies with low level of evidence. The surgical outcome of TURP in NU patients may be highly variable and includes persistent or de novo UI, regained normal micturition control, and urinary continence. A urodynamic study could have a predictive value. Staskin et al [17] described an association between postoperative continence and the degree of voluntary sphincter control in

Table 2 – Primary and secondary outcome measures.

Study	Type of NU study population	Primary outcomes			Secondary outcomes					
		Degree of incontinence	(Non)invasive urodynamics and bladder evacuation	Quality of life	Adverse effect after treatment	Surgical outcome measures	Renal function	Socioeconomic measures	Other: recurrence of anatomic BOO	Other: definition of success used in the stud
Anatomic BOO due to BPH										
Roth et al (2009) [10]	Parkinson disease	- Preoperative urge urinary incontinence in 10/23 (43%) → Postoperative restoration of continence in 5/10, improvement in 3/10; no de novo urinary incontinence - Preoperative indwelling catheter in 14/23 (61%) → Postoperative restoration of voiding in 9/14	In 9 patients who were voiding preoperatively, a significant increase in maximum flow rate and voided volume, and a significant decrease in IPSS, daytime frequency, and nocturia was seen postoperatively Maximum flow rate median 5 → 15 Voided volume median 110 → 330 IPSS median score 19 → 7 Daytime frequency median 8 → 5 Nocturia median 4 → 2	IPSS QoL ($n = 9$) Preoperative median 4 (IQR 2–5) Postoperative median 2 (IQR 1–2), $p = 0.026$	NR	NR	NR	NR	NR	Success was defined as complete urinary continence, normalization of urinary frequency (<8 micturations per 24 h) and no further need of IC or indwelling catheter - In 16/23 (70%) patients, TURP was successful
Han et al (2014) [13]	CVA	NR	Not specified for CVA patients (CVA, older age, diabetes, and preoperative antimuscarin drug use are possible risk factors of persistent voiding dysfunction after TURP)	Not specified for CVA patients (IPSS QoL postoperative higher in nonmedication group)	Not specified for CVA patients (urethra strictures 21/372, bladder neck stenosis 4/372, stress urinary incontinence 6/372)	Not specified for CVA patients (no significant difference in operation time between non medication and medication groups)	NR	NR	Not specified for CVA patients (urethra strictures 21/372, bladder neck stenosis 4/37)	NR
Moisey and Rees (1978) [15]	CVA, including $n = 2$ with CVA and Parkinson disease	- Preoperative incontinence rate 3/22 → Postoperative incontinence rate 6/22 (7 became continent after strict bladder training and using anal plug electrode continence devices)	Regained normal micturition control in 16/22 patients; 6/22 patients had incontinence and required an indwelling catheter or an incontinence appliance	NR	NR	NR	NR	Inpatient days: 5–9 d in 8, 10–15 d in 6, >25 d in 8	NR	NR

Table 2 (*Continued*)

		Primary outcomes			Secondary outcomes					
Study	Type of NU study population	Degree of incontinence	(Non)invasive urodynamics and bladder evacuation	Quality of life	Adverse effect after treatment	Surgical outcome measures	Renal function	Socioeconomic measures	Other: recurrence of anatomic BOO	Other: definition of success used in the stud
Staskin et al (1988) [17]	Parkinson disease	- Preoperative incontinence rate 6/36 (4/36 urge and 2/36 overflow) → Postoperative incontinence rate 10/36 (kept urge incontinence 4/6, de novo urge urinary incontinence 6/30)	Urodynamics: 26/36 (72%) showed normal voluntary sphincter control preoperative; preoperative 2 were incontinent and became postoperative continent; 23/24 kept continent postoperatively; postoperative 5/6 patients who were continent preoperatively with abnormal voluntary sphincter control became incontinent; 1/4 patients with incontinence and abnormal voluntary sphincter control preoperative became continent postoperative	NR	NR	NR	NR	NR	NR	NR
Anatomic BOO due to urethral strictures										
Perkash (1997) [14]	SCI	NR	Adequate voiding after laser ablation was seen in 93% of patients	NR	-Treatment failure ($n = 1$) -Urinary retention 5 d postoperatively who required single catheterization at home ($n = 1$)	-Operation time: mean 25.6 min (range 10–50) -Blood loss: estimated 25–50 ml -Perioperative complications: problems to define the urethral opening and resulting in extravasation ($n = 2$), loss of the crystal tip ($n = 1$)	NR	1 Catheter day	3/42 (7%) had successful reinterventions with contact laser (during mean 28.2 mo follow-up)	Success was defined as the possibility of adequate voiding - 39/42 (93%) was successful
Cornejo-Dávila et al (2017) [11]	SCI	NR	After endoscopic urethrotomy all 12 patients restarted IC	NR	NR	NR	NR	14 Catheter days	No recurrence 1 yr after endoscopic urethrotomy	NR

Table 2 (*Continued*)

Study	Type of NU study population	Primary outcomes			Secondary outcomes					
		Degree of incontinence	(Non)invasive urodynamics and bladder evacuation	Quality of life	Adverse effect after treatment	Surgical outcome measures	Renal function	Socioeconomic measures	Other: recurrence of anatomic BOO	Other: definition of success used in the stud
Krebs et al (2015) [12]	Underlying NU not specified (mostly SCI, could be spina bifida, MS)	NR	After endoscopic urethrotomy all 38 restarted IC	NR	14/38 (37%) patients required more than one (2–5) urethrotomy due to recurrence	NR	NR	1 Catheter day	-14/38 $\geq$ 1 redo urethrotomy -38/38 radiological evidence recurrent stricture, median 14 yr follow-up	Success was when IC was possible - Preoperative IC was not possible in 38 patients; after 1–5 procedures IC was possible in all patients
Anatomic BOO due to BPH, bladder neck sclerosis, or meatus stenosis										
Elsaesser and Stoephasius (1972) [16]	SCI	NR	Outcome classified as: good with sterile urine, good = RU <100 ml, improved = RU 100–200 ml, or not improved - TURP: good with sterile urine 3/21, good 9/21, improved 4/21, not improved 5/21 - BNR: good with sterile urine 3/14, good 8/14, not improved 3/14	NR	TURP: perform postresections of apical residues ($n = 2/21$) BNR: 3/14 failed completely (1 died of urosepsis, 2 received external sphincterotomy)	NR	NR	NR	NR	Achieve regulated vesical function, not further defined - Not clarified

BNR = bladder neck resection; BOO = bladder outlet obstruction; BPH = benign prostate hyperplasia; CVA = cerebrovascular accident; IC = intermittent catheterization; IPSS = International Prostate Symptom Score; IQR = interquartile range; MS = multiple sclerosis; NR = not reported; NU = neuro-urological; QoL = quality of life; RU = residual urine; SCI = spinal cord injury; TURP = transurethral resection of the prostate.

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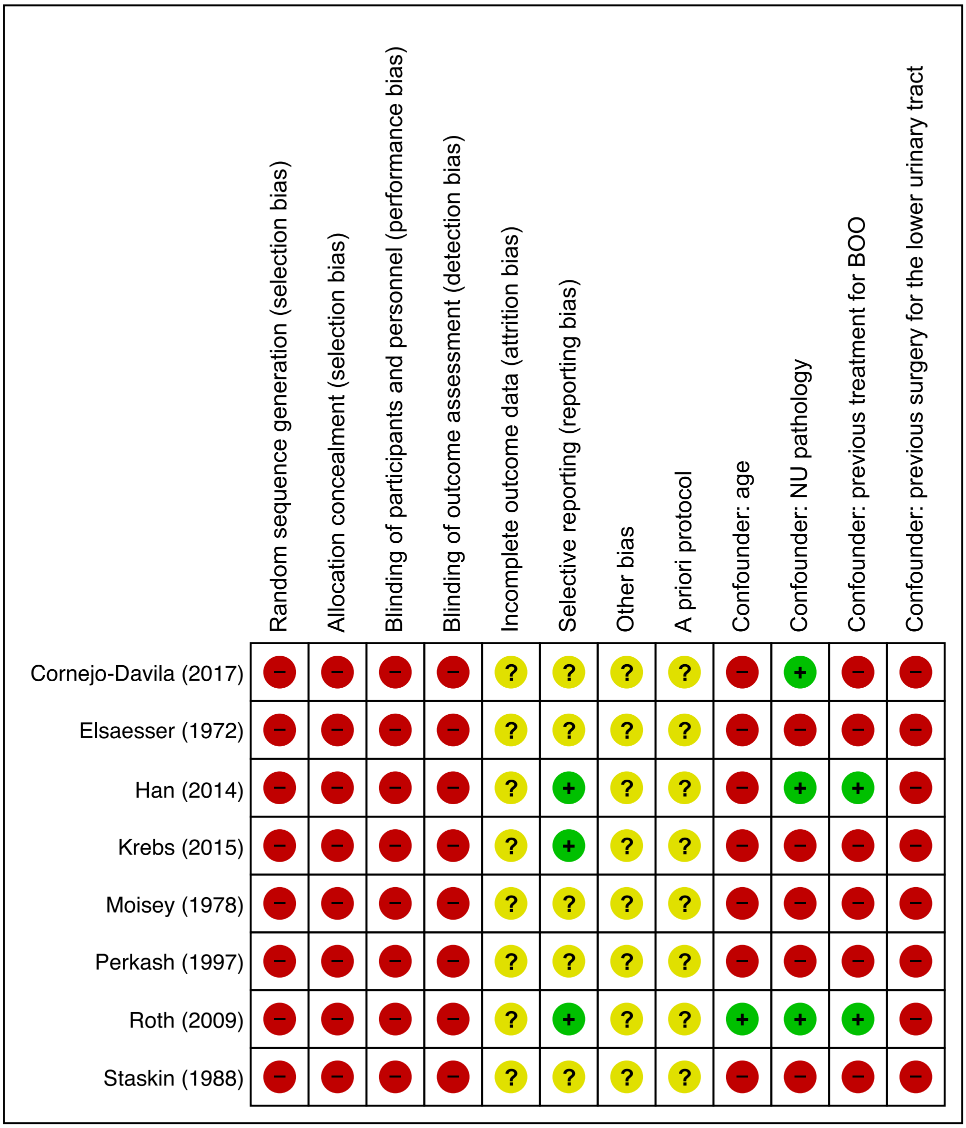

Fig. 2 – Risk of bias summary. + = low risk of bias; ? = unclear risk of bias; – = high risk of bias; BOO = bladder outlet obstruction; NU = neuro-urological.

Parkinson patients. In NU patients, an invasive urodynamic study is necessary to determine the exact type of neurogenic LUT dysfunction, recommended by the European Association of Urology guidelines [2,5]. A recent systematic review and meta-analysis reported a significant association between preoperative urodynamically proven BOO and better surgical outcome after TURP [18]. However, this was not specified for NU patients. If a urodynamic study is of value in non-NU patients, it will definitely be important for NU patients in order to distinguish a functional BOO from an anatomic BOO.

IC is part of regular treatment of NU patients who cannot effectively empty their bladders. It may however cause a urethral stricture, which in turn may necessitate a surgical intervention. The presentation and management of a urethral stricture is less uncertain in comparison with BPH in NU patients. The presence of a urethral stricture should be assessed when inability or difficulty with IC occurs. Repeated urethral dilation or endoscopic urethrotomy or urethroplasty are possible initial treatments, especially for short bulbar strictures, according to the American Urological Association guidelines [19]. Repeated urethral dilatation and endoscopic urethrotomy (cold knife or laser incision) have similar outcomes. Better outcome but higher morbidity is seen in urethroplasty [19]. Nonetheless, in patients who are not candidates for urethroplasty, endoscopic urethrotomy should be followed by at least 4 mo of IC to maintain urethral patency and reduce the recurrence rate [19]. Most of the NU patients already perform IC.

Endoscopic reinterventions in the included studies were all successful [12,14]. The American Urological Association guideline recommends a urethroplasty when a urethral stricture treated with urethrotomy recurs [19]. This recommendation is based on a retrospective study without NU patients, which showed an association between repeat transurethral manipulation of urethral strictures and increased complexity of the stricture, complicating definitive urethroplasty [20]. To our knowledge, no study discussing the results of urethroplasty after a recurrent urethral stricture of an endoscopic treatment in NU patients is available. In contrast to non-NU patients, even though the risk of strictures remains, IC is necessary in the management of neurogenic LUT dysfunction and will be continued after either urethrotomy or urethroplasty.

Good results of BNR were seen in 11/14 SCI patients with a cystoscopically observed sclerotic ring [16]. In two men, successful outcome was obtained only after a transurethral external sphincterotomy after two failed BNRs. This may indicate that a cystoscopy insufficiently discriminates between anatomic and functional BOO.

3.7.3. *Implication for research and clinical practice*

The available data, presented here, are insufficient to determine the optimal practice in the surgical treatment of anatomic BOO in NU patients. A urodynamic study should not lack in the work-up of BOO in NU patients. In patients with inability or difficulty with IC, the presence of a urethral stricture should first be assessed. Implications of neurological bladder dysfunction on the surgical outcome of anatomic BOO cannot be determined in our review. Future studies should compare different surgical and medical therapies of benign prostatic obstruction in NU patients and focus on possible predictors of the outcome, especially concerning UI. In addition, optimal treatment of urethral strictures has yet to be determined.

3.7.4. *Strengths and limitations*

Our study gives an overview of the current literature on surgical treatment of anatomic BOO in NU patients. Despite the use of strict guidelines when conducting this systematic review, several limitations should be addressed. First, all included studies were retrospective and had poor scientific quality. Second, the limited number of included studies, and the small number and heterogeneity of the patients between and in the studies made a subgroup analysis impossible. None of the studies compared interventions in the management of the same type of anatomic BOO. Finally, different terminologies and parameters of outcome were used. A recently published systematic review found considerable heterogeneity in outcome parameters to report of surgical interventions in NU patients [21]. To improve the quality of studies and draw meaningful conclusions, standardized terminologies and definitions of outcome in accordance with the International Continence Society should be used [3,22].

4. Conclusions

The eight included studies, with relatively poor scientific quality, demonstrated outcomes of various surgical approaches in different types of anatomic BOO and in heterogeneous NU study populations. Therefore, identifying the optimal practice in surgical treatment of these NU patients was not possible in this review with limited availability of eligible studies. However, our study provides an overview of the current literature on the surgical treatments. Future studies in NU patients with anatomic BOO should focus on the outcome of the surgical intervention for continence and preoperative noninvasive and invasive urodynamic measurements. Furthermore, standardized terminologies and definitions of outcomes should be used.

Author contributions: Toscane C. Noordhoff had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Noordhoff, Scheepe, Blok.
Acquisition of data: Noordhoff, Groen.
Analysis and interpretation of data: Noordhoff, Groen.
Drafting of the manuscript: Noordhoff, Groen.
Critical revision of the manuscript for important intellectual content: Groen, Scheepe, Blok.
Statistical analysis: Noordhoff, Groen.
Obtaining funding: None.
Administrative, technical, or material support: None.
Supervision: Scheepe, Blok.
Other: None.

Financial disclosures: Toscane C. Noordhoff certifies that all conflicts of interest, including specific financial interests and relationships and affiliations relevant to the subject matter or materials discussed in the manuscript (eg, employment/affiliation, grants or funding, consultancies, honoraria, stock ownership or options, expert testimony, royalties, or patents filed, received, or pending), are the following: None.

Funding/Support and role of the sponsor: None.

Acknowledgments: We would like to thank Wichor Bramer for the literature search.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.euf.2018.02.009.

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Please cite this article in press as: Noordhoff TC, et al. Surgical Management of Anatomic Bladder Outlet Obstruction in Males with Neurogenic Bladder Dysfunction: A Systematic Review. Eur Urol Focus (2018), https://doi.org/10.1016/j.euf.2018.02.009