Review Article

Urodynamics in the evaluation of lower urinary tract symptoms in young adult men: A systematic review

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ABSTRACT

Introduction: This review aims to systematically evaluate the available evidence on the different urodynamic diagnoses of lower urinary tract symptoms (LUTS) in young adult men aged 18–50 years and to summarize the various urodynamic parameters based on these diagnoses.

Methods: This systematic review was conducted according to the Preferred Reporting Items for Systematic Review and Meta-analysis statement and the search was performed in PubMed, Embase, and Cochrane library from inception till September 2021. A total of 295 records were identified using a combination of keywords such as LUTS, urodynamics (UDS), and young males. The review was registered in PROSPERO (CRD42021214045).

Results: All the ten studies, which were included in this analysis, categorised the patients into either of the four primary diagnoses after the UDS – primary bladder neck obstruction (PBNO), dysfunctional voiding, detrusor underactivity (DU), or detrusor overactivity. Five of these studies used the conventional UDS, and in the other five a video UDS was performed. The most common abnormality on the conventional UDS was DU with a pooled estimate of 0.24 (95% confidence interval [CI] - 0.104–0.463, I^2-95.35, (τ^2-1.07). The most common abnormality on the video UDS was PBNO with a pooled estimate of 0.49 (95% CI - 0.413–0.580, I^2-66.59, ^{2}-0.09). The point estimates of various UDS parameters were also recorded.

Conclusion: A urodynamic diagnosis was possible in 79% and 98% of the young men who underwent a conventional UDS or a video UDS, respectively. However, the men subjected to the conventional UDS and the video UDS had significant differences in their primary urodynamic diagnostic label. These results will help to plan future trials for the evaluation and management of LUTS in young men.

INTRODUCTION

According to the European epidemiological data, about one-fourth of the young men report lower urinary tract symptoms (LUTS) with an equal prevalence of storage, voiding, and post-micturition symptoms.[1] While a careful clinical evaluation is strongly recommended, it is seldom sufficient to make a working diagnosis, except in conditions such as phimosis, meatal stenosis, or acute prostatitis. Additional diagnostic evaluation recommended for all adult men, regardless of the age, includes a validated symptom questionnaire, a bladder diary, and a urinalysis (strong recommendation), as well as an estimation of the postvoid residual urine by ultrasonography and an uroflowmetry (both weak recommendations).[2] Most men are prescribed empirical treatment, including lifestyle changes, bladder training, and drug therapy for overactive bladder or voiding dysfunction based on these noninvasive investigations. However, a proportion of the young men have an unsatisfactory response to the treatment

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and undergo invasive urodynamics (UDS). In such men, the final urodynamic diagnosis might vary considerably from that determined by the noninvasive investigations.[3] A precise urodynamic diagnosis paves the way for additional therapeutic options in men with refractory bothersome LUTS.

Few researchers have evaluated the role of UDS in young men. Variations in the urodynamic technique and the inclusion of a relatively small number of patients has resulted in a lack of coherent data which could support the clinical decision-making. Hence, the authors embarked on this systematic review to critically appraise the available evidence regarding the UDS findings in young men with LUTS.

MATERIALS AND METHODS

Search strategy

This review was conducted and reported according to the Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) and Meta-analysis of Observational Studies of Epidemiology guidelines.[4] After the initial scoping searches, a systematic search of the PubMed, Embase, and Cochrane Central Register of Controlled Trials databases was performed, including studies from the inception to September 2021 to identify the relevant studies published in the English language. Secondary sources such as the guidelines and the citations were examined in the relevant articles and additional hand searches were performed. The review was registered in PROSPERO (CRD42021214045). This study is a systematic review of the available evidence and is exempted from the Institutional Review Board. The various search terms used a combination of LUTS, young males, UDS, and age 18–50 years.

The detailed search strategy used for each database is given in Supplementary Table 1.

Evidence synthesis

A systematic review was conducted, and the relevant quantitative and qualitative data were extracted from the eligible studies based on the inclusion and the exclusion criteria. Males between 18–50 years of age with LUTS in whom an invasive UDS was performed were included. Patients with neurogenic LUTS, those with neoplasms of the urinary tract or with structural obstruction such as urethral stricture disease, and the studies reporting data for heterogeneous group of patients without separately reporting the outcomes for young men were excluded. After searching all the accessible databases, a total of 295 studies were identified. After removing the duplicates, 285 studies were selected for screening. The title and the abstracts of these studies were screened and 18 studies were identified for the full-text screening. After following the inclusion and the exclusion criteria, ten studies were eligible for the analysis. A manual search of the references of each of the included study was also performed. Finally, ten studies were included in this systematic review. A meta-analysis could not be carried out due to the high heterogeneity among the included studies.

Figure 1 shows the flow chart of the steps taken to select the eligible studies based on the PRISMA guidelines. The first reviewer performed the data extraction, and it was independently cross-checked by the second reviewer using a predesigned data extraction pro forma. The pro forma was modified and adapted throughout the extraction process, according to the characteristics mentioned in the included studies. The extracted data included, but was not limited to, the study design, sample size, year of publication, and the outcome measures.

Risk of bias assessment

The methodological index for non-randomized studies (MINORS) was used to asses the risk of bias. It contains eight methodological items for the non-randomized non-comparative studies and an additional four items for the comparative non-randomized studies. The items are scored as 0 for the non-reported data, 1 for the reported but inadequate data, and 2 for the reported and adequate data. This index has an excellent inter-reviewer agreement, good internal consistency, and has high test–retest reliability. Studies with MINORS >50% were considered to be of high quality.[5] The studies included in this review were descriptive cohorts; therefore, the MINORS scale was modified as there was no data on the follow-up of the patients included in the studies. The risk of bias, as determined by MINORS is shown in Supplementary Table 2.

The MINORS scale was modified according to the studies in this review. The risk of bias was high in one study, intermediate in seven studies, and low in 2 studies.

The oxford level of evidence of the studies was also assessed. Three studies were level 2B studies, and seven were Level 4 studies.

Statistical analysis

The data management was performed using the Microsoft Excel for study characteristics, and the data was modified accordingly. A narrative synthesis of the data was undertaken for all the included studies. The studies were checked for the principle of homogeneity. I^2 test was used to test for the statistical heterogeneity among the studies. Comprehensive Meta-Analysis version 3 software was used for creating the forest plots of the selected studies for different outcome measures using a random-effects model. The results of the forest plots were reported along with the values of the I^2 test, and 95% confidence intervals (CIs) to depict the high heterogeneity among the studies. Different outcome measures were reported using appropriate statistics, such as mean and standard deviation or median

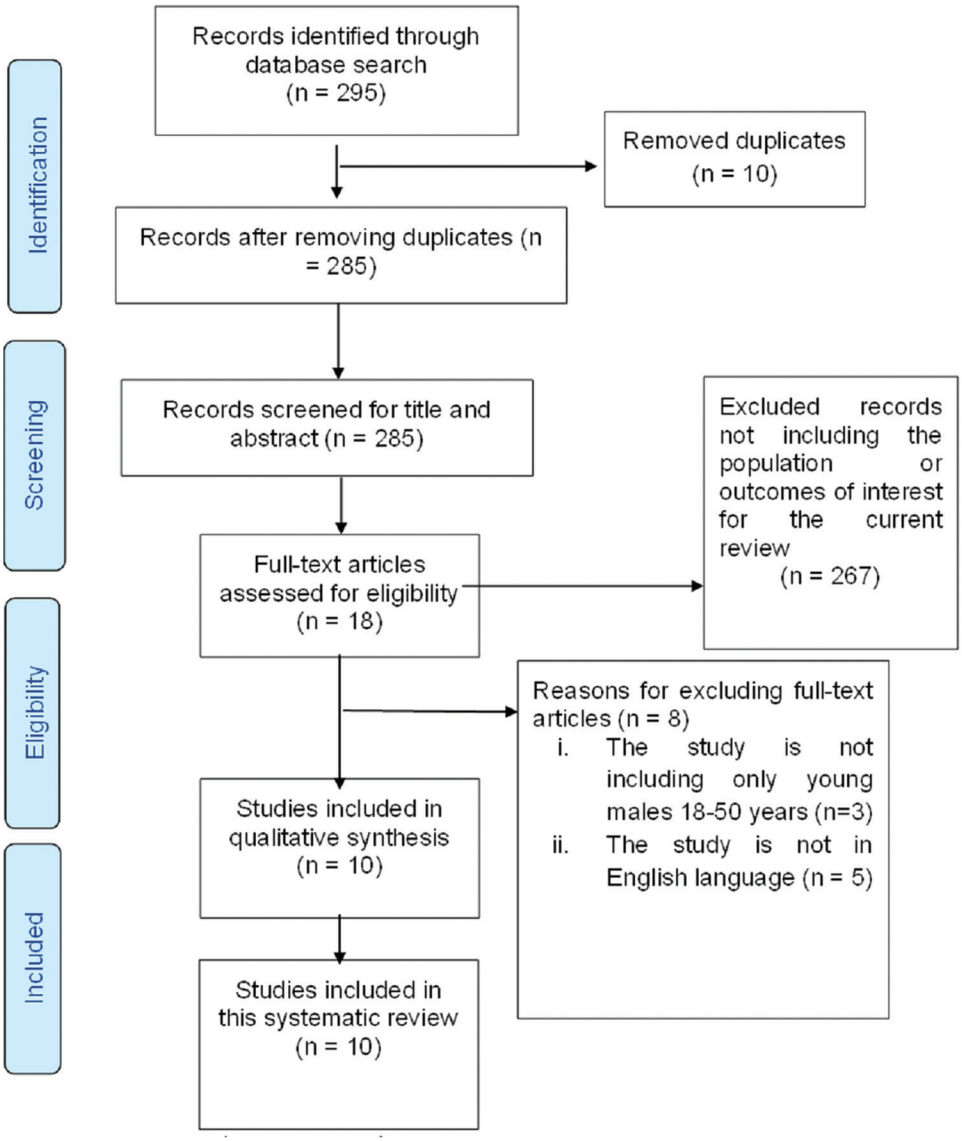

Figure 1: PRISMA flow diagram for selection of eligible studies. PRISMA = Preferred Reporting Items for Systematic Review and Meta-analysis

and interquartile range for the continuous variables and proportions or percentages for the categorical variables and other appropriate statistical parameters based on the data available in the studies. For the studies that reported means with the standard error or CIs, the standard deviation was calculated to determine the pooled estimates.

Outcome measures

Primary outcome:

1. The role of UDS for the evaluation of LUTS in young males
2. Identification of different urodynamic diagnosis in young males with LUTS.

Secondary outcomes:

The various urodynamic parameters in the different urodynamic diagnoses.

RESULTS

Overall study characteristics

This systematic review included ten studies with 1474 men between 18 and 50 years of age. Six of these studies were published between 2000 and 2020. The age group of the subjects varied in different studies [Supplementary Table 3]. The presenting symptoms were recorded in five studies but none mentioned whether the storage symptoms or the voiding symptoms were predominant. Five studies recorded the duration of the symptoms, and in 4 of these, the duration was over 24 months (mean 30.12 months). The conventional UDS was performed in five studies, while the remaining five used the video UDS.

Characteristics of individual studies

The characteristics of the individual studies are summarised in Table 1 and Supplementary Table 4. Four of the studies

Table 1: Characteristics of individual studies

Article reference	Age range	Number of patients	Mean duration of symptoms (months)	Mean IPSS	Pre-UDS treatment	Type of UDS	Post-UDS diagnosis				Post-UDS management	Follow-up
							PBNO	DV	DU	DO		
Crisp *et al*., 1976[6]	28-44	8	NA	NA	NA	Conventional	1	0	0	0	NA	NA
Abrams *et al*., 1981[7]	20-45	204	NA	NA	NA	Conventional	21	0	31	12	NA	NA
Kaplan *et al*., 1996[8]	21-50	137	37.6	17.6	Antibiotics-137 (100%), alpha blockers-98 (72%)	Video	74	33	7	0	NA	NA
Kaplan *et al*., 1997[9]	23-50	43	33.6	17.5	Antibiotics-43 (100%)	Video	30	0	0	17	Behavioural therapy and feedback	3 months
Nitti *et al*., 2002[3]	18-45	85	NA	19.3	NA	Video	40	12	1	5	NA	NA
Wang *et al*., 2003[10]	18-50	90	28.3	19.8	NA	Video	37	39	0	0	Multiple	NA
Toh and Ng, 2006[11]	17-49	56	NA	NA	NA	Conventional	14	1	5	9	NA	NA
Karami *et al*., 2011[12]	18-40	456	12.3	NA	Multiple	Conventional	96	69	59	62	NA	NA
Jamzadeh *et al*., 2014[13]	19-40	87	NA	NA	NA	Video	37	25	10	7	NA	NA
Jeong *et al*., 2014[14]	18-50	308	38.8	NA	NA	Conventional	80	72	39	41	NA	NA

NA=Not available, PBNO=Primary bladder neck obstruction, DV=Dysfunctional voiding, DU=Detrusor underactivity, DO=Detrusor overactivity, IPSS=International prostate symptom score, UDS=Urodynamics

were prospective and six were retrospective. The mean IPSS score was reported in four, and the pre-UDS treatment records of the patient population was reported only in three studies. Post UDS, all the studies classified patients in either of these four diagnoses – primary bladder neck obstruction (PBNO), dysfunctional voiding (DV), detrusor underactivity (DU), and detrusor overactivity (DO). Management options were also not properly evaluated in the studies and none reported the outcomes of the treatment which was advised based on the urodynamic diagnosis.[3,6-14] The study by Toh e*t al.* was included in this systematic review, despite the lower age limit of inclusion in their study being 17 years, as the patient population, aims, and objectives of their study was similar to those required by this systematic review.[11]

Synthesis of results

Diagnosis based on conventional urodynamics

Five (50%) studies used the conventional UDS to diagnose LUTS in young adult men. The pooled estimate was determined using the diagnosis made after the UDS by a random-effects model. The pooled estimate (95% CI, I^2, and ^{2}) of various diagnoses obtained from the conventional UDS for PBNO, DV, DU, and DO was 0.19 (0.138–0.262, 77.57, 0.13), 0.15 (0.094–0.240, 78.82, 0.21), 0.24 (0.104–0.463, 95.35, 1.07), and 0.19 (0.068–0.438, 97.49, 1.56), respectively. Normal findings were reported with a pooled estimate (95% CI, I^2, and ^{2}) of 0.21 (0.190–0.240, 43.41, and 0.02). Therefore, the relative frequency of PBNO, DV, DU, DO, and normal findings was 19%, 15%, 24%, 19%, and 21%, respectively [Figure 2].

Diagnosis based on video urodynamics

Five (50%) studies used the video UDS to diagnose LUTS in young adult males. The pooled estimate was determined using the diagnosis made after the video-UDS using a random-effects model. The pooled estimate (95% CI, I^2, and ^{2}) of various diagnoses obtained from the video UDS for PBNO, DV, DU, and DO was 0.49 (0.413–0.580, 66.59, 0.09), 0.23 (0.141–0.367, 83.76, 0.37), 0.03 (0.013–0.095, 64.34, 0.72), and 0.05 (0.011–0.207, 89.88, 2.50), respectively. Normal findings were reported with a pooled estimate (95% CI, I^2, and ^{2}) of 0.03 (0.011–0.100, 66.95, 0.95). Therefore, the relative frequency of PBNO, DV, DU, DO and normal findings was 49%, 23%, 3%, 5%, and 3%, respectively [Figure 3].

Urodynamic parameters

The urodynamic data were not reported in all of the studies. The forest plots were made according to the urodynamic data reported in the studies, as shown in Figures 4 and 5.

Storage phase

Primary bladder neck obstruction

The point estimate (95% CI, I^2, and ^{2}) of volume at first desire, strong desire, and maximum cystometric capacity was 190.3 ml (127.3–253.4, 82.8, 1661.3), 267.9 ml (235.87–300.1, 78.3, 421.1), and 387.1 ml (325.5–448.7, 88.7, 2230.3), respectively [Forest plots in Figure 4].

Dysfunctional voiding

The point estimate (95% CI, I^2, and ^{2}) of volume at first desire, strong desire and maximum cystometric capacity

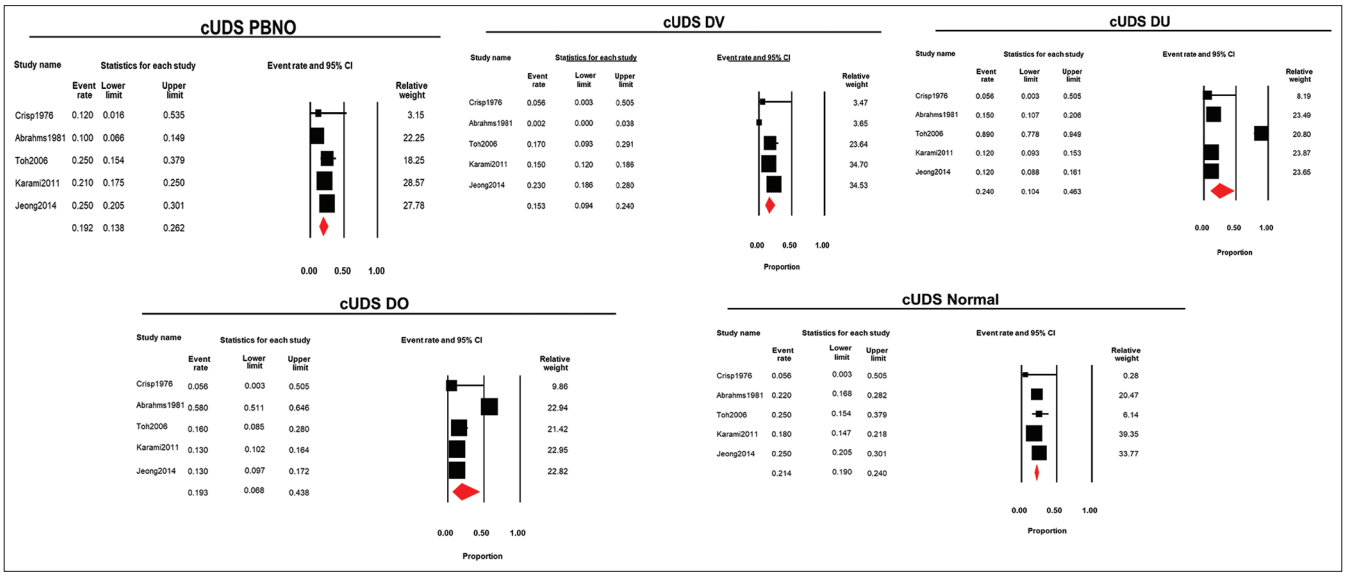

Figure 2: Forest plots of different diagnosis obtained using conventional urodynamics (PBNO = Primary bladder neck obstruction, DV = Dysfunctional voiding, DO = Detrusor overactivity, DU = Detrusor Underactivity)

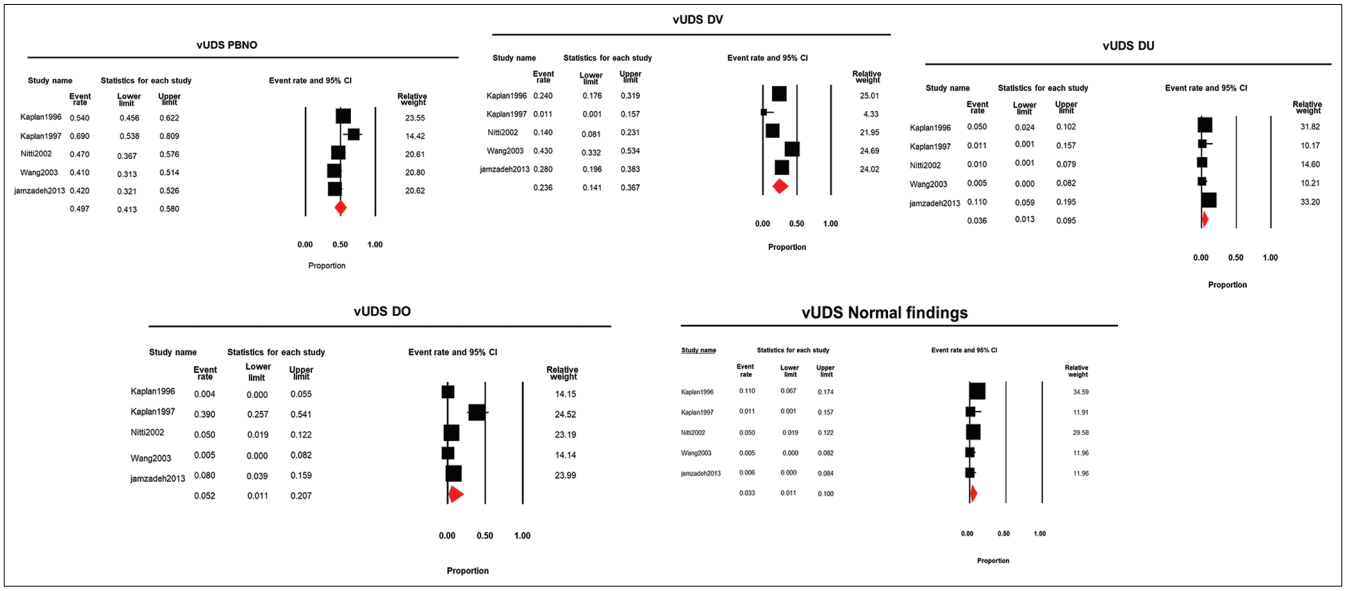

Figure 3: Forest plots of different diagnosis obtained using video urodynamics (PBNO = Primary bladder neck obstruction, DV = Dysfunctional voiding, DO = Detrusor overactivity, DU = Detrusor Underactivity)

was 188 ml (138.9–237.1, 86.65, 1089.6), 255.7 ml (237.0–274.2, 0.0, 0.0), and 330.2 ml (279.1–381.3,81.1, 1612.4), respectively.

Detrusor underactivity

The point estimate (95% CI, I^2, and ^{2}) of volume at first desire, strong desire, and maximum cystometric capacity was 194.8 (170.5–219.0, 18.4, 195.7), 281.4 (248.8–314.0, 0.0, 0.0), and 388 ml (241.7–534.2, 73.31, 8667.8), respectively.

Detrusor overactivity

The point estimate (95% CI, I^2, and ^{2}) of volume at first desire, strong desire and maximum cystometric capacity was 208 (126.9–285.1, 87.17, 2856.1), 292 (231.0–353.0, 80.47, 1586.8), and 409 ml (390.0–428.3, 0.0, 0.0), respectively.

Voiding phase

Primary bladder neck obstruction

The point estimate (95% CI, I^2, and ^{2}) of $P_{det.Qmax}$ was 60.7 cm H_2O (56.82–64.63, 31.90, 6.31), Q_{max} was 10.4ml/min (9.42–11.87, 85.72, 1.40) and Post void residue (PVR) was 73.7 ml (49.79–97.74, 98.66, 652.72) [Forest plots in Figure 5].

Dysfunctional voiding

The point estimate (95% CI, I^2, and ^{2}) of $P_{det.Qmax}$ was 42.6 cm H_2O (34.6–50.6, 93.1, 45.2), Q_{max} was 12.1ml/min (9.7–14.5, 91.9, 5.4), and PVR was 47.5 ml (27.3–67.7, 93.5, 337.5).

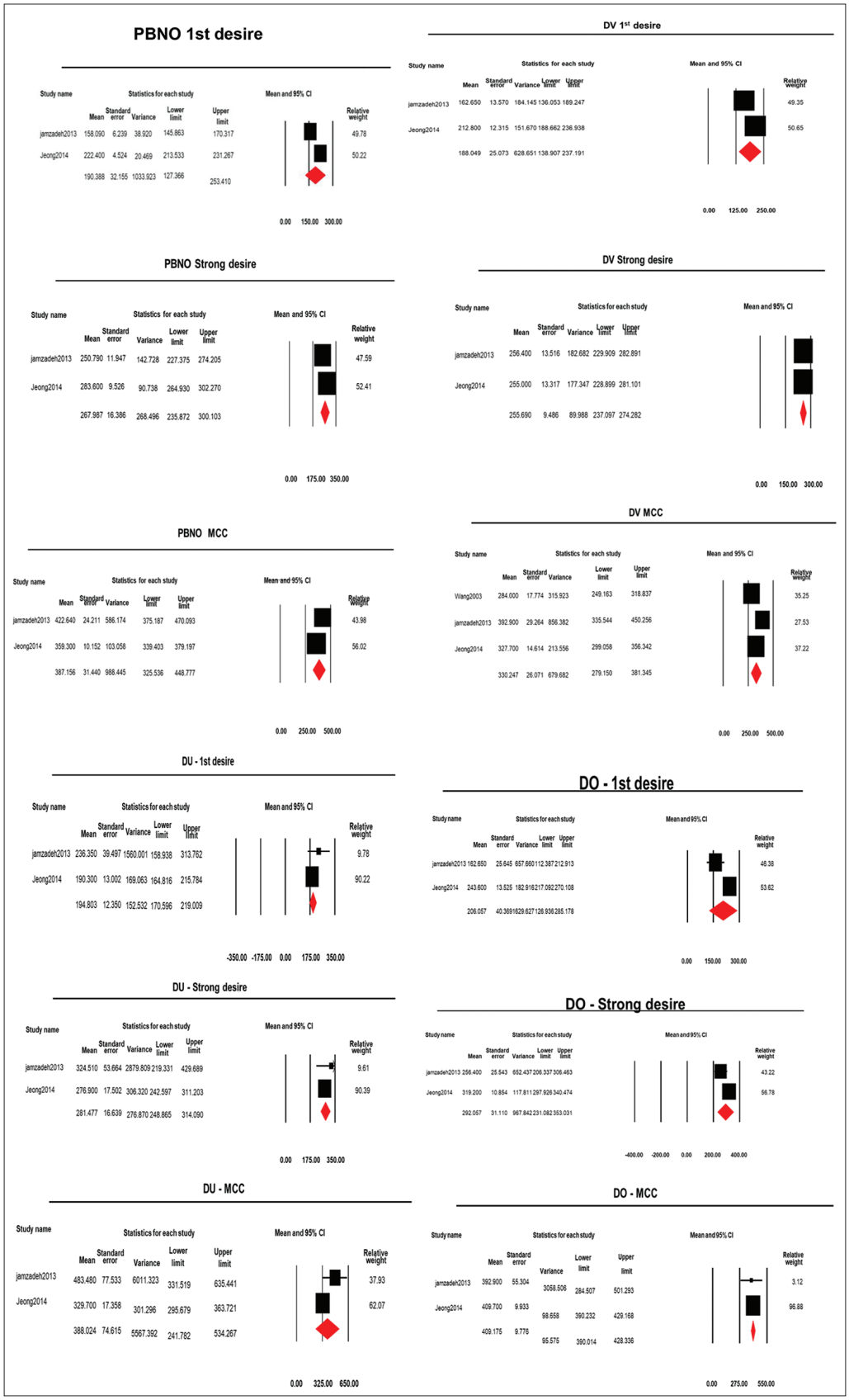

Figure 4: Forest plots of urodynamic parameters in storage phase of different urodynamic diagnosis (PBNO = Primary bladder neck obstruction, DV = Dysfunctional voiding, DO = Detrusor overactivity, DU = Detrusor Underactivity)

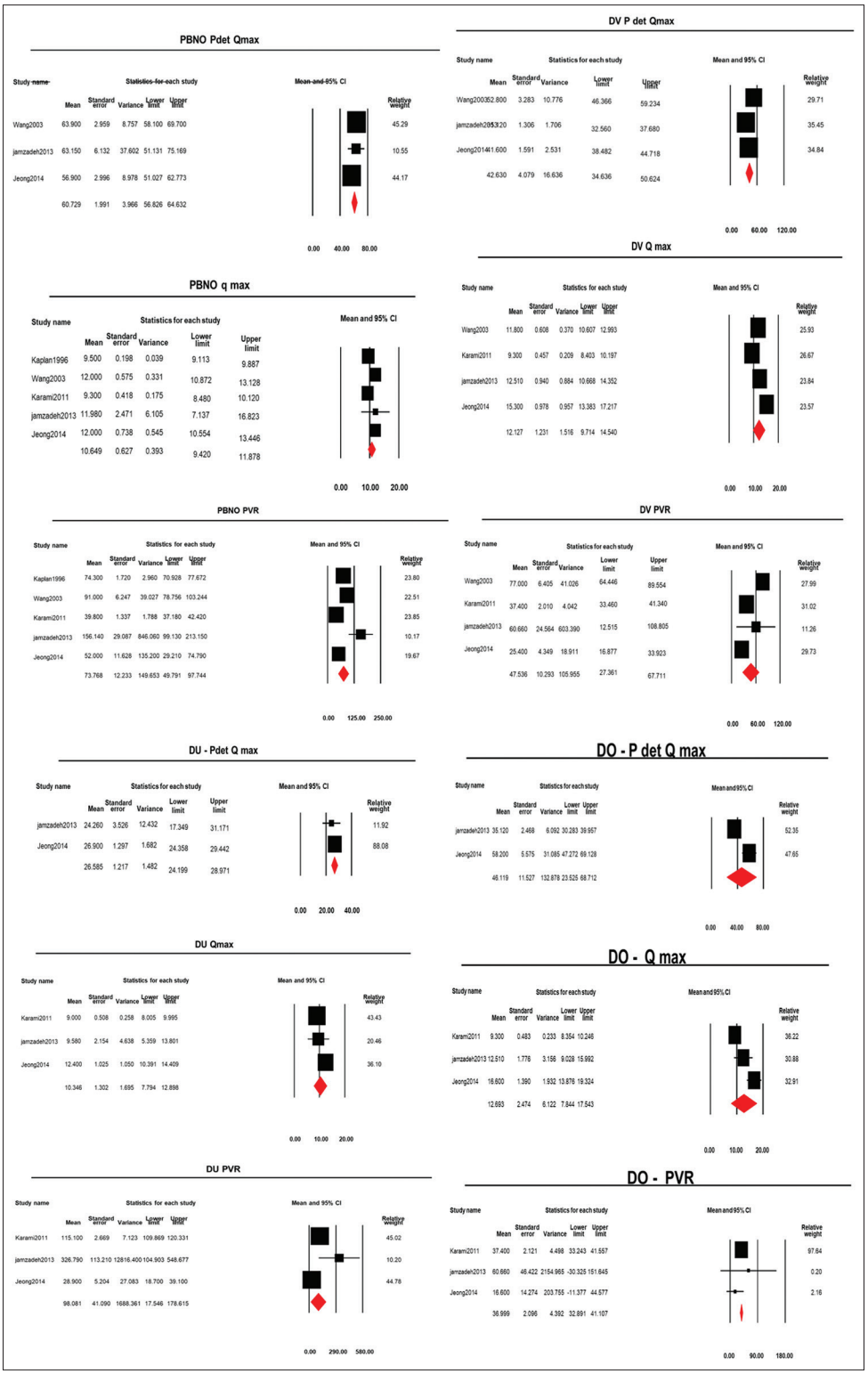

Figure 5: Forest plots of urodynamic parameters in voiding phase of different urodynamic diagnosis (PBNO = Primary bladder neck obstruction, DV = Dysfunctional voiding, DO = Detrusor overactivity, DU = Detrusor Underactivity)

Detrusor underactivity

The point estimate (95% CI, $I^{2,}$ and ^{2}) of $P_{det.\ Qmax}$ was 26.5 cm H_2O (24.1–28.9, 0.0, 0.0), Q_{max} was 10.34 ml/min (7.7–12.8, 77.3, 3.64), and PVR was 98 ml (17.5–178.6, 99.1, 3743.0).

Detrusor overactivity

The point estimate (95% CI, I^2, and ^{2}) of $P_{det\cdot Qmax}$ was 46.1 cm H_2O (23.5–68.7, 93.0, 247.7), Q_{max} was 12.7 ml/min (7.8–17.5, 92.4, 16.7), and PVR was 36.9 ml (32.8–41.1, 14.4, 32.1).

DISCUSSION

This review suggests that UDS is as an effective tool for arriving at a diagnosis in young men with refractory non-neurogenic LUTS.[3,8-13] An abnormality was noted in 79% of the men undergoing a conventional UDS and 97% of those who underwent a video UDS, with the remaining being normal. Of note, there were no inconclusive reports. The commonest abnormality noted in men who underwent a conventional UDS was DU (24% of patients) whereas it was PBNO (49% of patients) in those subjected to the video UDS. However, these studies do not represent the real-world scenario as they are from the specialized centers.

Men under 50 years of age form a significant proportion of all the adult men who undergo an UDS evaluation, accounting for about a quarter of all the studies.[15] In the population based studies, up to 0.7% of the young men have been noted to need an alpha-adrenergic antagonist for the voiding symptoms.[16] Literature suggests that one-third to half of all the men with PBNO are refractory to alpha-adrenergic blockers.[17,18] Current guidelines, such as the European Association of Urology Guidelines, recommend UDS before invasive intervention in men under the age of 50 years with a weak strength rating.[2] In addition, overactive bladder affects about 1.3% of men under the age of 50 years.[19]

An unknown proportion of these men will ultimately be refractory to the medical management. While not universally recommended, some of these men might also be candidates for UDS evaluation.[20] Hence, the UDS can be useful in a wide spectrum of young men with LUTS, both with storage as well as voiding symptoms.[3,13]

The difference in the primary diagnostic label between the two urodynamic techniques is striking. About one-third of the men undergoing a conventional UDS were reported to be obstructed, against two-thirds of the men undergoing a video UDS. To determine whether this apparent difference might be attributable to the differences in the patient population, an evaluation of the clinical background of the cohorts is essential. Unfortunately, only four of the ten studies provided a standardized symptom score and all these studies performed the video UDS. Of note, the IPSS score of men in these four studies was very similar [Table 1]. It is uncertain whether one can assume that this consistent clinical presentation can be taken as representative for all the young men with refractory LUTS. Differences in the clinical spectrum of the other six studies might account for some of the observed differences in the final diagnostic label.

Conventional UDS can differentiate bladder outlet obstruction from impaired detrusor contractility and relies on the sphincter EMG and the clinical judgment to define the exact level of obstruction. Video UDS can localize the level of obstruction by simultaneous fluoroscopic imaging and provides a precise anatomical information about the lower urinary tract, including bladder morphology and reflux, which might influence the interpretation of the UDS findings.[10] As the management strategy would differ for each of the urodynamic diagnosis, an accurate diagnosis is vital for planning an invasive management.

Differences in the technique and philosophy of UDS are likely to be an important reason for some of the observed differences in the diagnosis. The diagnosis of DV and PBNO, on the conventional UDS, rests on the sphincteric activity during the voiding phase as detected by the EMG.[14] Bladder outflow obstruction by DV or PBNO can be differentiated by the abnormal, excessive EMG activity and the sphincteric silence during the voiding phase, respectively, on the conventional UDS. However, EMG remains the least reliable and the most subjective part of the UDS investigation. Some men might have received an erroneous diagnosis of PBNO or DV on the conventional UDS due to the erratic performance of the EMG during the test.[21] Karami *et al*. have made the diagnosis of bladder neck dysfunction based on the urodynamic observation of obstructive symptoms and an absence of urethral stricture, prostatic enlargement, and striated sphincter dyssynergia.[12] Centers offering video UDS tend to ignore the findings of sphincter EMG or altogether avoid its use and instead rely on the fluoroscopy data for making the diagnosis. Existing evidence is insufficient to draw conclusions regarding the accuracy of each of these approaches.

Further, a study of large cohorts of men undergoing UDS has shown that detrusor underactivity is common in young men. The median Bladder Contractility Index (BCI) has been reported to be about 100 in several studies.[22,23] This would imply that about half of all the men undergoing UDS technically have "underactivity." However, many of these men might not get a primary label of underactivity if they have concomitant obstruction. A man with $P_{det.\ Qmax}$ 50 cm H20 and Q_{max} 5 ml/s, implying a BCI of 75 (underactive) and BOOI of 40 (obstructed), is very likely to be labeled as bladder outlet obstruction (and subsequently DV or PBNO depending on the outlet function). However, in men with equivocal obstruction, this is by no means so certain. Another man with $P_{det.\ Qmax}$ 40cm H20 and Q_{max} 5 ml/s, implying a BCI of 65 and BOOI of 30, might get labeled as "underactive" unless the diagnosis of (equivocal) obstruction can be made confidently. Video UDS might offer the additional confidence required to make the primary diagnosis in such a patient as PBNO or DV instead of just "underactive." Overall, the video UDS appears to offer a more "actionable" primary diagnosis and enables the specific therapeutic pathways of management. An alternate approach might be to offer a standalone voiding cystourethrogram to these men and

combine the findings with conventional UDS intuitively. This approach has been considered acceptable in some circumstances.[12,14] However, there is a lack of evidence regarding this combination in young men with refractory non-neurogenic LUTS.

Clinical symptoms are adequate to make a working diagnosis and initiate the noninvasive treatment. However, the predictive value of symptoms alone is inadequate to make the decisions concerning the invasive interventions, perhaps except for overactive bladder. Patients presenting with voiding symptoms may not demonstrate bladder outlet obstruction,[3] and in some young men with refractory storage symptoms, the symptoms might be associated with subclinical obstruction.[3,13] UDS offers the most accurate assessment for establishing an unequivocal diagnosis, however, the choice of the technique of the UDS remains an unresolved question. The urodynamic diagnosis has important implications in the patient care. Men with a diagnosis of DV can be confidently offered pelvic floor relaxation training sessions, intrasphincteric botulinum toxin, or neuromodulation, while those with PBNO could potentially undergo a curative bladder neck incision. Misdiagnosis can lead to the appropriate treatment being withheld or the delivery of an inappropriate treatment.

An important caveat in interpreting this review is that the analysis is based on the primary urodynamic diagnosis and disregards the importance of the ancillary findings. Such additional findings are typical and might influence the treatment decisions or the prognosis. Jeong *et al*. showed that half of the patients with voiding phase disorders had associated storage phase disorders on the urodynamic assessment, while two-thirds of those with storage phase disorders had associated voiding phase disorders.[14] Similarly, Nitti *et al*. showed that 85% of men with DO had concomitant voiding phase disorders.[3] Further studies are required to elucidate the appropriate treatment options in patients with such mixed disorders.

The long duration of symptoms before subjecting the men to UDS is noteworthy. On an average, men had symptoms for 2-and-a-½ years before being offered an UDS test. The lack of response to alpha-adrenergic blockers would have become apparent within days of the commencement of the therapy. Since tachyphylaxis is not a common finding in men on treatment with an alpha-adrenergic blocker, the long duration of waiting might reflect the deferment of the invasive testing until an invasive treatment was "on the table," gradual progression of the disease, or a general reluctance to offer an invasive testing. In general practice, one would offer UDS if it has therapeutic implications. Of note, UDS can pave the way for alternative therapies such as pelvic floor relaxation training or intrasphincteric botulinum toxin injection when DV is identified.

An essential finding of this review is the lack of good-quality evidence regarding the role of UDS in young men. There is considerable heterogeneity in the studies evaluating young men with LUTS. Despite being a common clinical problem, there were only a handful of studies on the subject with a small number of patients. None of the studies compared the clinical and UDS-based management outcomes and none compared the conventional UDS with the video UDS. Centers appeared to offer the video UDS or the conventional UDS based on the availability rather than as an evidence-based choice. None of the studies examined the harms of UDS in this patient population. More data are required regarding the safety, tolerability, and acceptance of UDS and video UDS in young men. This would help to identify subgroups of men in whom the benefits of an invasive UDS evaluation outweighs the risks and will also clarify which young men (or whether all young men) undergoing UDS should be offered a video UDS.

CONCLUSION

This systematic review shows a paucity of evidence regarding the clinical role and technique of UDS in young men with refractory LUTS. Available studies are limited by the lack of adequate data on the clinical presentation as well as the treatment. A urodynamic diagnosis is possible in most of the young men who undergo the study. However, men subjected to the conventional UDS and the video UDS appear to demonstrate significant differences in their primary urodynamic diagnostic label, the reasons for which remain uncertain. While the video UDS might provide greater precision and a more actionable primary diagnosis, it remains uncertain whether this apparent difference is due to the differences in the patient characteristics. There is also a lack of data regarding the harms of UDS in this patient population.

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Supplementary Table 1: Search strategy for selection of eligible studies to be included in the systematic review

Database	Search terms	Number of studies identified
PubMed	(Lower urinary tract symptoms OR LUTS OR prostatism) AND (young males OR males less than 50 years OR aged 50 years and younger) AND (urodynamics OR video urodynamics OR ambulatory urodynamics) NOT prostate cancer NOT benign prostatic hyperplasia NOT BPH NOT women NOT children	177
Embase	(Lower urinary tract symptoms OR LUTS OR prostatism) AND (young males OR males less than 50 years OR aged 50 years and younger) AND (urodynamics OR video urodynamics OR ambulatory urodynamics) NOT prostate cancer NOT benign prostatic hyperplasia NOT BPH NOT women NOT children	36
Cochrane	(Lower urinary tract symptoms OR LUTS OR prostatism) AND (young males OR males less than 50 years OR aged 50 years and younger) AND (urodynamics OR video urodynamics OR ambulatory urodynamics) NOT prostate cancer NOT benign prostatic hyperplasia NOT BPH NOT women NOT children	82

Supplementary Table 2: Methodological index for nonrandomized studies bias assessment

Author	Clearly stated aim	Inclusion of consecutive patients	Prospective collection of data	Endpoints appropriate to the aim of study	Unbiased assessment of the study endpoints	Prospective calculation of study sample	Total MINORS score	Oxford level of evidence
Crisp, 1976[6]	0	0	0	1	1	0	2	4
Abrams, 1981[7]	0	0	2	2	2	0	6	4
Kaplan, 1996[8]	2	0	0	2	2	0	6	4
Kaplan, 1997[9]	2	0	0	2	2	0	6	4
Nitti, 2002[3]	2	2	2	2	2	0	10	2B
Wang, 2003[10]	2	2	2	2	2	0	10	2B
Toh, 2006[11]	2	0	0	2	2	0	6	4
Karami, 2011[12]	2	0	2	2	2	0	8	2B
Jamzadeh, 2014[13]	2	0	0	2	2	0	6	4
Jeong, 2014[14]	2	0	0	2	2	0	6	4

MINORS Scale interpretation

Interpretation of individual factors	Score of individual factors
Not reported	0
Reported but inadequate	1
Reported and adequate	2

MINORS >50% is considered high-quality study. MINORS=Methodological index for nonrandomized studies

Supplementary Table 3: Overall characteristics of the included studies

Characteristics of the studies	Number of studies, *n* (%)
Year of publication	
1970-2000	4 (40)
2001-2020	6 (60)
Lower age limit (years)	
17	1 (10)
18	4 (40)
19	1 (10)
20	1 (10)
21	1 (10)
23	1 (10)
28	1 (10)
The upper limit (years)	
40	2 (20)
44	1 (10)
45	2 (20)
49	1 (10)
50	4 (40)
Sample size (range)	
0-100	6 (60)
100-200	1 (10)
>200	3 (30)
Duration of symptoms (months)	
<24	1 (10)
>24	4 (40)
Data not available	5 (50)
Mean duration of symptoms	30.12 months
Urodynamic technique	
Conventional	5 (50)
Video urodynamics	5 (50)

Supplementary Table 4: Definitions of urodynamic diagnoses used in different studies

Article reference	PBNO	DV	DU	DO
Crisp *et al*., 1976[6]	NA	NA	NA	NA
Abrams *et al*., 1981[7]	An obstructed bladder was shown by maximum flow rates of <15 mL/s with a maximum detrusor pressure in excess of 70 cm H20	NA	The diagnosis of an underactive detrusor was made when flow rates were below normal secondary to a maximum flow detrusor pressure of <30 cm H_20	An unstable bladder was defined as a bladder which, during filling, showed contractions of at least 15 cm. of water above resting bladder pressure, which occurred while the patient was trying to inhibit micturition
Kaplan *et al*., 1996[8]	BOO was defined as a sustained detrusor contraction of >45 cm H2O and a catheterized uroflow of <12 mL/s	Pseudodyssynergia (voluntary closure of the membranous urethra during voiding) was made based on a number of criteria, including electrical activity of the external sphincter during voiding in the absence of abdominal straining, and brief and intermittent closing of the membranous urethra during voiding. This was detected by both EMG and	Impaired detrusor contractility (IC) was defined by low detrusor contractions (<30 cm H_2O) and a catheterized uroflow of <12 mL/s	DI was defined as a nonvolitional, phasic increase in detrusor pressure of at least 15 cm H_20 or a rise in detrusor pressure associated with increased sensation of urgency
Kaplan *et al*., 1997[9]	BOO was defined as a sustained detrusor contraction of >45 cm and a catheterized uroflow of <12 mL/s	Pseudodyssynergia was diagnosed based on several criteria, including electrical activity of the external sphincter during voiding in the absence of abdominal straining and brief, intermittent closing of the membranous urethra during voiding detected on EMG and fluoroscopy	Impaired detrusor contractility was defined as low detrusor contractions (<30 cm water) and a catheterized urine flow rate of <12 mL/s	Detrusor instability was defined as a nonvolitional, phasic increase in detrusor pressure of at least 15 cm. water or an increase in detrusor pressure associated with increased sensation of urgency
Nitti *et al*., 2002[3]	NA	NA	Impaired contractility was diagnosed when BOO index was <20 and uroflow was <12 mL/s. Fluoroscopic images of the bladder outlet during voiding were taken with specific attention to opening (or nonopening) or focal narrowing of the bladder neck	Detrusor instability was considered present if there was an acute increase in detrusor pressure (involuntary contraction) associated with an urge regardless of pressure, or an increase in detrusor pressure of 15 cm. H_2O or greater without an urge
Wang *et al*., 2003[10]	Primary bladder neck obstruction is defined as narrowing only at the vesical neck on fluoroscopic voiding cystourethrogram, sustained detrusor contraction during voiding, low peak flow rate, obstructive flow pattern and relaxed external sphincter EMG. The diagnostic criteria of benign prostatic obstruction are similar to those of primary bladder neck obstruction except the narrowing was noted at the prostatic urethra	Dysfunctional voiding is defined as obstruction at the external sphincter determined by intermittent increase in sphincter EMG and/or intermittent narrowing of membranous urethra on fluoroscopy	Impaired detrusor contractility is defined as detrusor pressure <30 cm H_2O, Qmax <15 mL/s and no obstruction identified radiologically	Idiopathic detrusor overactivity is defined as an increase in detrusor pressure (involuntary contraction) associated with an urge regardless of pressure, or an increase in detrusor pressure of 15 cm H_2O or greater without an urge
Toh *et al*., 2006[11]	NA	NA	NA	NA
Karami *et al*., 2011[12]	The diagnosis of bladder neck dysfunction was made indirectly by the urodynamic findings of outlet obstruction in a typical clinical situation in the absence of urethral stricture, prostatic enlargement, and striated sphincter dyssynergia	Dysfunctional voiding was defined as an intermittent and/or fluctuating flowrate due to involuntary intermittent contractions of the peri-urethral striated muscle during voiding, in neurologically normal individuals	Detrusor underactivity was defined as a contraction of reduced strength and/or duration, resulting in prolonged bladder emptying and/or a failure to achieve complete bladder emptying within anormal time span	Detrusor over activity is a urodynamic observation characterized by involuntary contractions during the filling phase which may be spontaneous or provoked

Contd...

Supplementary Table 4: Contd...

Article reference	PBNO	DV	DU	DO
Jamzadeh *et al*., 2014[13]	BOO was defined as a sustained detrusor contraction of >45 cm H_2O and a catheterized uroflow of <12 mL/s	Dysfunctional voiding (voluntary closure of the membranous urethra during voiding) was made based on a number of criteria, including electrical activity of the external sphincter during voiding in the absence of abdominal straining, and brief and intermittent closing of the membranous urethra during voiding. In addition, to make the diagnosis of dysfunctional voiding, a uroflow measurement performed in a private setting showing intermittent increases and decreases in flow in an undulating fashion was required	Detrusor underactivity was defined by low detrusor contractions (<30 cm H_2O) and a catheterized uroflow of <12 mL/s	DO was defined as a nonvolitional, phasic increase in detrusor pressure of at least 15 cm H_2O or a rise in detrusor pressure associated with increased sensation of urgency
Jeong *et al*., 2014[14]	BOO, defined as an AG number of 40 or greater or 20-39.9 with a slope of the linear passive urethral resistance ratio of >2 cm H_2O/mL/s, where the AG number was calculated as the PdetQmax-2 Qmax, was present concomitant with EMG evidence of external sphincter relaxation, and neither urethral stricture nor prostatic enlargement was observed	DV was diagnosed on the basis of the EMG activity of the external sphincter/pelvic floor during voiding in the absence of abdominal straining. If DV was diagnosed during a PFS, a free uroflow measurement was performed in a private setting to identify undulating intermittent increases and decreases in flow	DU was diagnosed when the AG number was <20 and the Qmax was <12 mL/s during a PFS and no obstruction was recognized in urethrocystoscopy or TRUS	Patients were regarded as positive for idiopathic DO if a spontaneous or provoked involuntary detrusor contraction was observed during the filling cystometry

NA=Not available, PBNO=Primary bladder neck obstruction, DV=Dysfunctional voiding, DU=Detrusor underactivity, DO=Detrusor overactivity, BOO=Bladder outlet obstruction, EMG=Electromyography, AG=Abrams-Griffith, DI=Detrusor instability, PdetQmax=Detrusor pressure at maximum flow, PFS=Pressure flow study, TRUS=Transrectal Ultrasound, IC=Involuntary contraction, AG=Abrams-Griffith number