นิพนธ์ต้นฉบับ

การศึกษาความสัมพันธ์ของการวัดความดันของกระเพาะปัสสาวะด้วยการตรวจปัสสาวะพลศาสตร์อย่างง่ายเทียบกับการตรวจปัสสาวะพลศาสตร์มาตรฐาน

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บทคัดย่อ

ที่มาของปัญหา: การตรวจปัสสาวะพลศาสตร์เป็นมาตรฐานในการตรวจวัด และแนะแนวทางการรักษาภาวะกระเพาะปัสสาวะทำงานผิดปกติจากระบบประสาท ซึ่งในผู้ป่วยภาวะดังกล่าวควรควบคุมให้ระดับของความดันของกล้ามเนื้อกระเพาะปัสสาวะน้อยกว่า 40 เซนติเมตรน้ำ แต่อย่างไรก็ตามการตรวจด้วยวิธีดังกล่าวมีความซับซ้อนและข้อจำกัดหลายอย่าง ทั้งนี้ผู้นิพนธ์จึงได้คิดค้นวิธีการตรวจปัสสาวะพลศาสตร์อย่างง่าย ที่สามารถวัดความดันในกระเพาะปัสสาวะ ซึ่งจะระบุผู้ป่วยที่มีความเสี่ยงในการเกิดอันตรายต่อระบบทางเดินปัสสาวะส่วนบนได้

วัตถุประสงค์: เพื่อศึกษาหาความสัมพันธ์ระหว่างการตรวจปัสสาวะพลศาสตร์อย่างง่ายเทียบกับการตรวจปัสสาวะพลศาสตร์มาตรฐาน และหาเกณฑ์ขั้นต่ำที่เป็นข้อบ่งชี้ให้ผู้ป่วยควรได้รับการตรวจปัสสาวะพลศาสตร์มาตรฐาน

วิธีการศึกษา: ผู้ป่วยภาวะกระเพาะปัสสาวะทำงานผิดปกติจากระบบประสาท 30 ราย ที่ต้องได้เข้ารับการตรวจปัสสาวะพลศาสตร์มาตรฐานตามนัด ได้ทำการตรวจปัสสาวะพลศาสตร์อย่างง่ายในการติดตามการรักษาครั้งเดียวกัน และได้ทำการเก็บข้อมูลเกี่ยวกับความดันในกระเพาะปัสสาวะ (Pves) ความดันในช่องท้อง (Pabd) ความดันของกล้ามเนื้อกระเพาะปัสสาวะ (Pdet) ความจุกระเพาะปัสสาวะสูงสุด (maximal cystometric capacity) และความดันในกระเพาะปัสสาวะจากการตรวจปัสสาวะพลศาสตร์อย่างง่าย (E Pves)

ผลการศึกษา: จากข้อมูลของผู้ป่วยทั้ง 30 ราย (เพศชาย 14 ราย, เพศหญิง 16 ราย) มัธยฐานของอายุเท่ากับ 52.5 ปี พบมีความสัมพันธ์ระหว่างค่าความดันในกระเพาะปัสสาวะจากการตรวจปัสสาวะพลศาสตร์อย่างง่าย (E Pves) กับความดันในกระเพาะปัสสาวะ (p=0.41) แต่ไม่มีความสัมพันธ์อย่างมีนัยสำคัญกับดัชนีมวลกาย และความดันในช่องท้อง (p=0.57) และพบเกณฑ์ขั้นต่ำของความดันในกระเพาะปัสสาวะที่ได้จากการตรวจปัสสาวะพลศาสตร์อย่างง่าย ซึ่งมีความเสี่ยงในการเกิดอันตรายต่อระบบทางเดินปัสสาวะส่วนบน คือ 34 เซนติเมตรน้ำ โดยที่มีความไวของการทดสอบเท่ากับร้อยละ 100 และความจำเพาะของการทดสอบเท่ากับร้อยละ 91.3

สรุป: การตรวจปัสสาวะพลศาสตร์อย่างง่าย สามารถใช้ในการวัดความดันของกระเพาะปัสสาวะได้ไม่แตกต่างจากการตรวจปัสสาวะพลศาสตร์มาตรฐาน และพบว่าผู้ป่วยที่มีค่าความดันในกระเพาะปัสสาวะที่ได้จากการตรวจปัสสาวะพลศาสตร์อย่างง่าย ≥34 เซนติเมตรน้ำ มีความเสี่ยงในการเกิดอันตรายต่อระบบทางเดินปัสสาวะส่วนบน ควรได้รับการติดตามการรักษาที่ใกล้ชิดและการตรวจปัสสาวะพลศาสตร์มาตรฐาน

คำสำคัญ: การตรวจปัสสาวะพลศาสตร์, ความดันกล้ามเนื้อกระเพาะปัสสาวะ, การเกิดอันตรายต่อระบบทางเดินปัสสาวะส่วนบน, มานอมิเตอร์

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ORIGINAL ARTICLE

Comparison of Easy Urodynamic Study and Standard Urodynamic Study in Measuring Intravesical Pressure

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ABSTRACT

BACKGROUND: Urodynamics (UDS) is the gold standard for evaluating lower urinary tract dysfunction and guiding treatment in neurogenic bladder patients to maintain proper pressure; however, standard UDS is often time-consuming and expensive. We hypothesized that "easy urodynamics" could be used to accurately measure bladder pressure (Pves) and identify patients at risk of upper tract deterioration who may benefit from early standard UDS re-evaluation.

OBJECTIVES: To assess the correlation between easy UDS and standard UDS measurements and identify the cut-off value to undergo early standard UDS.

METHODS: Thirty patients were recruited for Easy UDS in order to record Pves, intraabdominal pressure (Pabd), detrusor pressure (Pdet), maximal cystometric capacity, and Pves by easy UDS (E Pves). The descriptive study, correlation value, and significance of the data were analyzed.

RESULTS: A total of 30 patients (14 males, 16 females) with a median age of 52.5 years. E Pves were correlated with Pves (p=0.41). There was no significant relationship between body mass index (BMI) and Pabd (p=0.57). E Pves cut-off ≥34 cmH_2O were associated with the risk of upper tract deterioration (Pdet ≥30 cmH_2O), with a sensitivity of 100% and a specificity of 91.3%.

CONCLUSIONS: Easy UDS could be used to measure Pves similarly to standard UDS, and the E Pves cut-off ≥34 cmH_2O can help identify patients at risk of upper tract deterioration (Pdet ≥30 cmH_2O) who may benefit from early standard UDS re-evaluation and closer follow-up.

KEYWORDS: urodynamics, detrusor pressure, upper tract deterioration, manometry

INTRODUCTION

Urodynamic study (UDS) aims to evaluate how capable the bladder, sphincters, and urethra are for storing and releasing urine. UDS allows the direct assessment of lower urinary tract function through the measurement of relevant physiological parameters. Currently, UDS is used not only for diagnosing and guiding treatment in neurogenic bladder patients, but also for predicting the long-term function of the kidneys. Although evidence indicates that UDS is generally tolerated well, the study procedure results in pain and embarrassment. Younger patients have been identified as a group that may experience more pain and apprehension[1] associated with depression, anxiety and/or bladder pain syndrome[2]. In addition, UDS can be done only in some areas in developing countries due to costly instruments. The major goals of managing neurogenic bladder are to preserve kidney function, prevent urinary tract infection, and maintain the patients' high quality of life. To prevent kidney deterioration, detrusor pressures should be maintained at below 30 cmH_2O or as low as possible[3, 4]. Currently, it is recommended that UDS be performed routinely in neurogenic patients[4]. After UDS, the physician can create a protocol decreases or maintains intravesical pressure (Pves)[5]. It should be noted, however, that UDS has several problems associated with it. It is invasive, costly, and time-consuming; in addition, the paucity of the instrument is troublesome.

We hypothesized that easy urodynamic study could be used to accurately measure Pves (in a manner similar to standard UDS equipment) and assist in identifying patients at a high risk of upper tract deterioration and thus require closer follow-up.

METHODS

Population

Patients with a history of neurogenic bladder problems who had indications for UDS were enrolled prospectively in the study between October 2017 and April 2018. We estimated a sample size of 16 participants to give 80% at the 5% significant level to detect the diagnosis, which is equivalent to an absolute increase of 7% with favorable outcomes. Patients were excluded if they had a urinary tract infection, incontinence at the time of performing UDS, or a history of urethral stricture. The ethics committee of Mahidol University approved this experiment and granted prior to the study. The patients or their parents provided informed consent.

Standard urodynamic study (standard UDS)

Standard UDS was conducted with the patient in a supine position with a double lumen urethral catheter for filling and measuring Pves and a rectal catheter for measuring abdominal pressure (Pabd). The water-charged intravesical and abdominal catheters were connected to an Aquarius® TT Urodynamic processor built-in pump (Laborie Urodynamic System). The UDS system transducer position was leveled with the symphysis pubis. Urodynamic evaluation was performed by an experienced UDS registered nurse who followed the guidelines of the International Continence Society (ICS)[6,7]. The patient's urinary bladder was then emptied and recorded for residual urine at the conclusion of the standard UDS.

Easy urodynamic study (Easy UDS)

Easy UDS was conducted after finishing the standard UDS with the patient in a supine position. The patients were instructed to be completely relaxed in a supine position. The urologist and nurse then filled the 0.9% saline into the bladder at the same rate as that of standard UDS via the double lumen urethral catheter that was used for standard UDS. The bladder was filled until it reached the maximal cystometric capacity. Then the catheter was connected to the three-way stop-cock and extension

tube. At maximal cystometric capacity, the extension tube was held upward, making it perpendicular to the abdomen. A ruler was aligned so that the zero level was at the symphysis pubis. The height of the column of 0.9% saline was recorded as easy UDS Pves (E Pves). The urinary bladder was then emptied after the easy UDS was finished. The procedure was performed by a single urologist and an experienced urology nurse. The results from both tests were not blind to the operators.

Statistical analysis

The analysis was performed using Stata version 14. Descriptive study was performed where appropriate, and it used median, IQR, and percentage. The association between E Pves and intravesical pressure by standard UDS (Pves) was tested using the Wilcoxon rank sum. The cut-off value of E Pves that indicated high-risk patients was analyzed by ROC curve.

RESULTS

33 patients (14 males and 19 females) were included in this study. Three female patients were excluded due to incontinence during the procedure (Figure 1). The median age was 52.5 (IQR 10.0 to 65.0) years, and the median body mass index (BMI) was 21.2 (IQR 18.8 to 25.5). The demographic characteristics of the patients are shown in Table 1. The study was performed from October 2017 to April 2018.

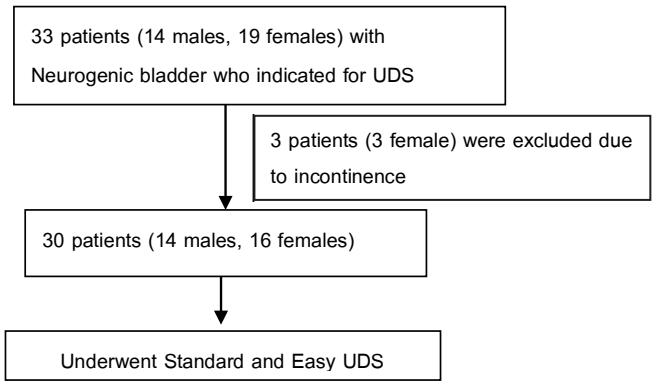

Figure 1 Flow chart protocol

The mean E Pves was not statistically significantly different from the mean intravesical pressure by standard UDS (Pves) using Wilcoxon rank sum test (p=0.41) with a Pearson's correlation coefficient of 0.923 (p<0.001). The relationship between BMI and intra-abdominal pressure (Pabd) had no significant correlation (p=0.57). The area under the ROC curve between E Pves and Pdet is 0.989, as shown in Figure 2. The most reliable value of E Pves cut-off correlated with Pdet of more than 30 cmH_2O is 34 cmH_2O with a sensitivity of 100% and a specificity of 91.3%.

There were no adverse events from performing both easy UDS and standard UDS.

Table 1 Demographic data

Participant (n)	Values
	30
- Male	14 (46.7%)
- Female	16 (53.3%)
Age (year): median (IQR)	52.5 (10.0-65.0)
Body weight (kg): median (IQR)	51.0 (27.2-62.0)
Height (cm): median (IQR)	154.2 (124.6-160.0)
BMI (kg/m^2): median (IQR)	21.2 (18.8-25.5)

BMI: Body mass index

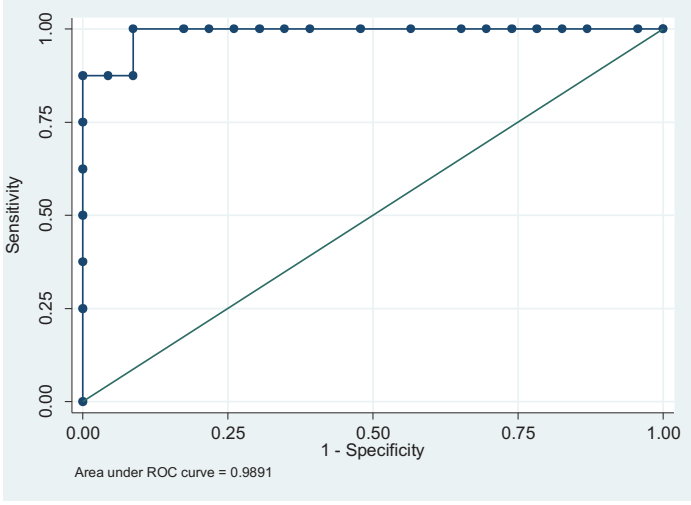

Figure 2 Plot of receiver operator curves to demonstrate the relationship between E Pves and Pdet. The area under curve was calculated, and specificity and sensitivity were noted

DISCUSSION

It is known that increased detrusor pressure is associated with an increased risk of urinary tract infection, incontinence, and upper urinary tract and bladder deterioration[8,9]. This is especially true when Pdet is above 40 cmH_2O[10]. Punctual intervention in patients with high detrusor pressure can help prevent kidney function[11]. Pdet can be monitored using standard UDS; however, there are no guidelines on the ideal frequency for repeat UDS testing. Among the other issues with follow-up with standard UDS aside from embarrassment are that it is a time-consuming and expensive process. We believe that easy UDS is a simple, cost-efficient (standard UDS costs around 4000 baht, while easy UDS costs around 30 baht) and reproducible screening method to identify patients with high intravesical pressures that have risk for upper tract deterioration who may benefit from early standard UD re-evaluation and closer follow-up. In our study, by setting the E Pves threshold to 34 cmH_2O, will were able to detect patients with Pdet over 30 cmH_2O with a sensitivity and specificity of 100% and 91.30%, respectively. Studies by Andros et al. and Damaser et al. demonstrated that home monitoring of bladder pressure for CIC-dependent patients is possible[12,13]. Hence, with this simple, cost-efficient, and reproducible method that may be assigned to a caregiver, easy UDS can help detect upper urinary tract and bladder deterioration over time and assist in monitoring the effect of different treatments or self-dose adjustments of medications without strict dependence on standard UDS follow-up,

which is the most accurate tool for monitoring patients with neurogenic bladders[3,10].

Guy Hidas et al. identified several difficulties in keeping younger children supine and relaxed; they found that children often needed an additional caregiver to help precisely measure the column of urine with a ruler[14].

Unfortunately, as this is an inceptive study, the idea of implementing easy UDS to the caregiver still did not initiate. The author wishes to conduct a prospective study with a higher case volume, which would prevent biases and provide much more accurate results. In our study, we did not change the double lumen catheter to Foley's catheter to perform easy UDS; this process would eased the participant's pain from the reinsertion and removal of the new Foley's catheter. However, due to the mechanics of fluid, even when the different catheter was used, the pressure (height) would have remained the same.

We would like to emphasize that our study has some limitations. First, this is a small prospective study to identify the threshold. Second, despite standardized instruction and methods of measurement, there may be some diversity in results due to the level of cooperation of each patient, especially for those in preschool. Third, easy UDS cannot identify the cause of the rise in intravesical pressure that contributes from Pdet or Pabd.

CONCLUSION

The results of this study show that easy UDS can be used to accurately measure bladder pressure (E Pves) in a manner similar to standard UDS. The study also indicates a cut-off value of E Pves at ≥34 cmH2O to identify patients with high detrusor pressures (Pdet ≥30 cmH_2O) that are at risk of upper tract deterioration who may benefit from early standard UDS re-evaluation and closer follow-up. The entire procedure is easily reproduced and adapted to primary hospitals or trained caregivers, serving as a method to assess bladder function and prevent upper tract deterioration at a lower cost while being easy to operate.

What is already known about this topic?

Urodynamics is the gold standard for evaluating lower urinary tract dysfunction and guiding treatment in neurogenic bladder patients to maintain low detrusor pressure, however, the process is expensive and time-consuming.

What does this study add?

Easy UDS could be used for monitoring bladder pressure by caregivers or primary hospitals without complicated procedures, providing comparable outcomes to standard UDS.

Conflicts of interest: None

Financial support: None

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