Bci and.booi versus wfmax and ura.

Which combination of urodynamic parameters is more sensitive and specific in the urodynamic evaluation of detrusor contractility and benign prostatic obstruction, respectively?

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Abstract

Objectives:
The purpose of this retrospective study was to evaluate and compare the recommended BOOI and BCI with the urodynamic parameter URA and Watts graph, respectively. Is URA more sensitive and/or specific than BOOI in the diagnosis of BOO? Does the Watts factor graph give us more information on detrusor contractility than BCI?

Methods: Based on the hypothesis, that the specificity of two ideal urodynamic parameters which are used to independently calculate detrusor function and anatomic outlet resistance is increased when there is no correlation between them, we compared each other to the following urodynamic parameters: Bladder Outlet Obstruction Index(BOOI), Bladder Contractility Index (BCI), Urethral Resistance Factor (URA), Watts factor maximum (WFmax), Linear Passive Urethral Resistance Relation (LPURR), uroflow maximum flow (Qmax) and uroflow Post Void Residual (PVR) were also included in the analysis among 32 males with urodynamic diagnosis of benign prostatic obstruction (BPO) and recommendation for surgical treatment.

Results: Using the combination of urodynamic parameters PdetQmax≥45 cmH2O and Qmax<12 ml/sec as the gold standard of obstruction, the total sensitivity of BOOI≥40 and URA≥29 in the diagnosis of BPO was 87.5 % and 96.9%, respectively. Strong positive linear correlation, statistical significant was found between: URA-LPURR (P<0.0001, Pearson r =0.77), BOOI-LPURR (P<0.0001, Pearson r =0.75), BOOI-BCI (P<0.0001, Pearson r =0.85).
Moderate negative linear correlation, statistical significant was found between: URA-Qmax (P<0.0001, Pearson r = -0.60). Moderate positive linear correlation, statistical significant was found between: URA-PVR (P<0.0001, Pearson r = 0.63). Weak positive linear correlation, not statistical significant was found between: WFmax-Qmax (P=0.0214, Pearson r=0.4053), BOOI-PVR (P<0.0336, Pearson r = 0.3766). Weak negative linear correlation, not statistical significant was found between: WFmax-PVR (P<0.03, Pearson r = -0.3754). No correlation was found between: BCI-Qmax, BCI-PVR, BOOI-Qmax, WFmax-URA.

Conclusions: Based on our results, the strong positive linear correlation, statistically significant between BOOI and BCI, automatically reduces the specificity in both of them. On the contrary, we recommended the combination of URA and WFmax due to the absence of any correlation between them, an observation which theoretically increases the specificity in both of them in the differential diagnosis between obstruction and detrusor underactivity, respectively.

Key words
Bladder Outlet, Obstruction Index, (BOOI), Bladder, Contractility Index (BCI)

Περίληψη
Σκοπός-Υπόθεση: Η ειδικότητα δύο ουροδυναμικών παραμέτρων οι οποίες χρησιμοποιούνται για να αξιολογήσουν ανεξάρτητα την λειτουργία του εξωστήρα και τις παθητικές αντιστάσεις στην ροή των ούρων, αυξάνεται θεωρητικά όταν δεν υπάρχει συσχέτιση μεταξύ τους.

Ασθενείς και Μέθοδος: Αναδρομικά σε 32 ασθενείς με διάγνωση καλοήθους προστατικής απόφραξης (Benign Prostatic Obstruction, BPO) και αύσταση για χειρουργική αντιμετώπιση αυτής συσχετίστηκαν μεταξύ τους οι ουροδυναμικές παράμετροι της μελέτης πίεση ροής BOOI (Bladder Outlet Obstruction Index)-LPURR (Linear Passive Urethral Resistance Relation), URA (Urethral Resistance Factor) -LPURR, BOOI-Qmax, BOOI-PVR, URA-Qmax, URA-PVR, BCI (Bladder Contractility Index) -Qmax, BCI-PVR, URA-Qmax, URA-PVR, BOOI-BCI και URA-WFmax (Watts Factor maximum). Η στατιστική ανάλυση έγινε με την χρήση του λογισμικού graphpadprism 5 logistics (Linear regression analysis και Pearson’s correlation analysis.)

Αποτελέσματα: Ισχυρή θετική γραμμική συσχέτιση, στατιστικά σημαντική παρατηρήθηκε μεταξύ: URA-LPURR (P<0.0001, Pearson =0.77), BOOI-LPURR (P<0.0001, Pearsonr =0.75), BOOI-BCI (P<0.0001, Pearsonr =0.85). Μέτρια αρνητική γραμμική συσχέτιση, στατιστικά σημαντική βρέθηκε μεταξύ: URA-Qmax (P<0.0001, Pearsonr = -0.60). Μέτρια θετική γραμμική συσχέτιση, στατιστικά σημαντική βρέθηκε μεταξύ: URA-PVR (P<0.0001, Pearsonr = 0.63). Ασθενής θετική γραμμική συσχέτιση, μη στατιστικά σημαντική βρέθηκε μεταξύ: WFmax-Qmax (P=0.0214, Pearson=r=0.4053), BOOI-PVR (P<0.0336, Pearsonr = 0.3766). Ασθενής αρνητική γραμμική συσχέτιση, μη στατιστικά σημαντική βρέθηκε μεταξύ: WFmax-
INTRODUCTION

The most reliable method for investigating reduced urinary output in men with Lower Urinary Tract Symptoms (LUTS) is the Pressure-Flow study (P-F study). Internationally, it is considered as the gold standard in the differential diagnosis between Bladder Outlet Obstruction (BOO) and Detrusor Underactivity (DU)\(^1\). According to the International Continence Society (ICS), the urodynamic evaluation of BOO is supported by the Bladder Outlet Obstruction Index (BOOI = PdetQmax – 2 Qmax) while, at the same time, the detrusor contractility should be assessed by the Bladder Contractility Index (BCI = PdetQmax + 5Qmax). BOOI ≥ 40 is considered as BPO and BCI ≥ 100 as normal detrusor contractility\(^2\). The Urethral Resistance Factor (URA) with a value ≥ 29 is also regarded as obstruction suggestive\(^3\). The maximum Watts factor, WF max value ≥ 10.85, is considered as normal detrusor isometric contraction whereas the factor’s negative value W80-W20 as fading contraction\(^4\). The purpose of the present retrospective study was the comparative evaluation of all the aforementioned urodynamic indices and factors only in a sub-category of patients presenting anatomic prostatic obstruction, in men with confirmed BPO-induced prostate and clinical indications of surgical management, in accordance with the American Urological Association (AUA) and the Society of Urodynamics, Female Pelvic Medicine & Urogential Reconstruction (SUFU). The latter advises the P-F study solely prior to the surgical management of LUTS in male patients with Grade B evidence strength (AUA/SUFU Guidelines Statement 17, Grade B)\(^5\).

MATERIALS & METHODS

Retrospectively, the collection of the material necessary for the conduction of the study was elaborated in the functional urology office archives at the Urology Department, San Carlos Complutense University Hospital, Madrid, Spain. The search of patients was based on two criteria: the urodynamic diagnosis of BPO and the medical advice for surgical management; the urodynamic evaluation of the patients dated from 12/2009 to 4/2010. The aim of the
study was the comparison of urodynamic indices of an as much as possible homogenous sub-category of patients with BOO, namely that of BPO. Patients with other anatomic obstructions like urethral stricture or patients with functional urinary obstruction due to failure of the pelvic floor muscle to relax were not included in the study. Out of 43 archived patients who met the above criteria, 5 patients were excluded due to lack of urine output (micturition) during the P-F study and 6 more were excluded because of insufficient recorded values, [URA, BOOI, BCI, WFmax, W80-W20, Linear Passive Urethral Resistance Relation (LPURR grade), maximum urine outflow on uroflowmetry (free Qmax), post-void residual on uroflowmetry (free PVR)], required for the study of the urodynamic factors in the urodynamic investigation (Fig. 4). The remaining 32 male subjects were synchronously subjected to voiding cystourethrography (VCUG); benign prostatic hyperplasia (BPH) was determined as the cause of urinary obstruction (prostatic urethra lumen lengthening and narrowing). The urodynamic study was conducted via a 6Ch pressure recording intravesical catheter and an 8Ch pressure recording intrarectal catheter. The bladder filling rate with normal saline in room temperature was moderate (50ml/min). All patients, following a second filling cystometry (FCM) and retrieval of the pressure recording intravesical catheter, were then subjected to free uroflowmetry. The activity of the pelvic floor was recorded during FMC as well as during the P-F study and also in free uroflowmetry with surface electromyography (SEM) of the pelvic floor. The statistical analysis was performed on GraphPad Prism 5 logistics software (Linear regression analysis and Pearson’s correlation analysis).

RESULTS

All patients exhibited obstruction according to the urodynamic criteria of Jensen KME et al. [Maximum detrusor pressure (Pdetmax> 45 cmH20) and maximum urinary output rate (Qmax< 12ml/sec)]6. Strong positive linear correlation, statistically significant was reported between: URA-LPURR (P<0.0001, Pearson r =0.77), BOOI-LPURR (P<0.0001, Pearson r =0.75) and BOOI-BCI (P<0.0001, Pearson r =0.85). Moderate negative linear correlation, statistically significant was found between: URA-Qmax (P<0.0001, Pearson r = -0.60). Moderate positive linear correlation, was statistically significant between: URA-PVR (P<0.0001, Pearson r = 0.63). Weak positive linear correlation, not statistically significant was reported between: WFmax-Qmax (P=0.0214, Pearson r=0.4053), BOOI-PVR (P<0.0336, Pearson r = 0.3766). Weak negative linear correlation, not statistically significant was found between: WFmax-PVR (P<0.03, Pearson r = -0.3754). Absence of correlation was found between: BCI-Qmax (P=0.1435, Pearson r=0.2645), BCI-PVR (P=0.8334, Pearson r =0.038), BOOI-Qmax (P=0.1283, Pearson r = - 0.2746) and WFmax-URA (P=0.5336, Pearson r = 0.1142). (Fig. 1, 2 and 3).

The urodynamic diagnosis of DU, based on the proposed published urodynamic evaluation parameters, is depicted in Table 1. If only isometric contraction is regarded as confirmed DU (WFmax< 10.85), then only 18.75% (v=6/32) of our cohort would have manifested
synchronous BOO and DU in contrast with the 37.5% (v=12/32) calculated according to the index BCI<100. Despite the absence of a statistically significant difference (fishers exact test, two tailed, p=0.16), possibly due to the extremely low sample of patients, we observe a difference in the rates based on these two definitions of urodynamic hypocontractility. It is
worth mentioning that all patients with WFmax<10.85 simultaneously had BCI<100. It is also important to note that all 5 patients with LPURR≤ 2, according to Schafer’s nomogram, had BCI<100. Three of them exhibited normal isometric and fading contraction according to the Watts Factor graph, with mean PVR 5.6ml in free uroflowmetry, whereas the remaining 2 patients manifested combined isometric and fading hypocontractility with mean PVR 96ml. Out of the 5 patients with heavy BOO (LPURR=6), one had BCI=72 and WFmax=6.64 with PVR 181ml in uroflowmetry whereas the remaining four had BCI>100 but mean PVR 228.25ml. One out of these four patients presented normal isometric and fading contraction according to the Watts Factor graph and PVR 0ml in comparison with the remaining three patients who exhibited isotonic hypocontractility with PVR 304ml.

By LPURR≥3 determining BOO based on Schafer’s nomogram, the sensitivity of the BOOI≥ 40 and URA≥29 was 100%. With Pdetmax ≥ 45 and Qmax< 12ml/sec6 defining BOO, the total sensitivity of the parameters BOOI≥40 and URA≥29, was calculated at 87.5% (v=28/32) and 96.9% (31/32), respectively. In the sub-group of the 5 patients with LPURR≤ 2, the sensitivity of BOOI≥40 and URA≥29 was calculated at 20% (v=1/5) and 80% (v=4/5), respectively. However, all 5 patients of this group were relatively obstructed based on the index of Kranse R and Van Mastrandt R (Relative BOO=URA/W20>0.82)7.
DISCUSSION

Even though low urinary output is mainly suggestive of obstruction, whereas any PVR volume is mainly suggestive of underactivity, the ideal BOO index should correspond to a strong positive linear correlation to PVR and at the same time to a strong negative linear correlation to the maximum flow for a theoretically confirmed and stable production by the detrusor muscle and gradual increase of resistances in urinary flow. On the contrary, the ideal index for detrusor contractility should reflect a strong positive linear correlation to maximum flow and simultaneously a strong negative linear correlation to PVR for a theoretical stable and consistent resistance to flow and gradually increased detrusor contraction strength. Based on the hypothesis and our study’s outcomes, the parameter URA≥29, with the moderate negative linear correlation to the maximum flow and the moderate positive linear correlation to PVR, reaches the ideal BOO index compared to BOOI≥40 with no correlation to the maximum PVR and weak positive linear correlation to PVR. Respectively, the WFmax factor, with its weak negative linear correlation to PVR, reaches the ideal detrusor contraction index (DCI) to a greater extent than the bladder contractility index (BCI), exhibiting no correlation to the maximum urinary output and the PVR. BOOI and BCI urodynamic indices, albeit their great advantage (easy calculation), share the same two statistical parameters: detrusor pressure at maximum flow (PdetQmax) and maximum flow (Qmax). The application of the same statistical parameters in the differential diagnosis between obstruction and underactivity, theoretically reduces the specificity in both of them. The strong positive linear correlation of these two factors in the present study, confirms the theory that they interact though they reduce their specificity in this way.
Conversely, the absence of any correlation between WFmax and URA, enhances their specificity in the differential diagnosis between hypocontractility and BOO, respectively.

In the most complicated cases treated by functional urologists, i.e. male patients with debatable obstruction (LPURR ≤ 2), URA≥29 was found more sensitive compared to BOOI≥40. Aganovic et al. reached the same conclusion after a urodynamic investigation of 102 patients with benign prostatic enlargement (BPE).

According to R. Van Mastriigt et al., while significant statistical correlation was established between pre- and post-operative WFmax value to post-operative PVR, no significant correlation was found to pre-operative PVR. Likewise, in our study, only a weak correlation was identified between the pre-operative WFmax and pre-operative PVR. The observation seems logical, since pre-operative PVR in BOO patients depends on the obstruction grade as well as on detrusor contractility. In fading contraction (W80-W20 <0), in cases with debatable obstruction (LPURR≤ 2), it increases the sensitivity and specificity in DU diagnosis. In the present study, all patients with fading contraction and LPURR≤ 2, manifested synchronous isometric contraction (WFmax<10.85). In such cases, we can safely attribute fading contraction to structural detrusor failure and speculate the presence of zero or minimal post-operative contractility improvement. In contradistinction, in cases of heavy obstruction, LPURR≥5-6, an isolated fading contraction should not be diagnosed as DU for it is a consequence of severe BOO and not of detrusor contraction insufficiency. In cases of moderate obstruction, LPURR= 3-4, we cannot ascertain if the negative value of the W80-W20 factor is induced by obstruction or hypocontractility; the WFmax value will clarify the condition. If WFmax is <10.85, we can then diagnose obstruction accompanied with possible DU. However, in the present study no patient with moderate obstruction and fading contraction presented concurrent isometric hypocontractility. It seems that in BPO, isotonic hypocontractility precedes fading and if BOO is not early managed then the next stage is non-reversible isometric hypocontractility. As a result, the non-compensation of obstructive urination is evident by PVR and further reduction in maximum outflow. According to Cucchi et al., idiopathic DU seems to develop in two stages; the first stage, insufficient contraction duration, precedes that of additional reduction in the contraction strength. If this is the case in non-obstructed patients, then it should also be confirmed in obstructed patients. BCI appears to approach only the isometric detrusor contraction and merely in cases of moderated and severe obstruction. BCI was within normal range, BCI >100, in 80% (4/5) of the patients with severe obstruction (LPURR=6). But the fact is not particularly helpful. In patients with LPURR=5-6, we need neither BCI nor WFmax. By definition, the patients in question present normal contractility (Pdetmax ≥ 75 cmH2O). Additionally, BCI, as a statistical value, provides us with no information on fading contraction; we cannot evaluate the total detrusor behaviour throughout the micturition phase, as the case is with the Watts graph.

The remark that the WFmax factor is independent from the BOO degree, has already been highlighted by Lecamwasam et al., in adult canine models. They concluded that any
increase in the WFmax value in patients with chronic outlet obstruction reflects the true increase in detrusor contractility. According to Ronchi Pet al. 12 and Abrams P. et al.13, in patients with simultaneous detrusor overactivity (DO) and DU12 and simultaneous DO and BOO13, who were managed with antimuscarinics (solifenacin and tolterodine, respectively), a BOOI reduce was observed during the urodynamic follow up while on antimuscarinic medication. Consequently, the administration of antimuscarinics either improves, even to a certain extent, the anatomic urinary obstruction ? or BOOI is not duly specific to index anatomically increased flow resistances. So, acknowledging that BOOI cannot identify mild resistance increase in urine flow due to dysfunctional voiding, functional obstruction from anatomic obstruction, the encouraging results of Kaplan et al. regarding the safety of antimuscarinics and a-blockers combined medication in obstructed urination could be tempered14. It is reminded that in the above study of Kaplan et al., the weak definition of obstructed urination assessed by BOOI (cut-off value 20) and the non-measurement of the prostate gland may have also included, in the final analysis of the results, a significant number of male subjects not with anatomic but rather with moderate dysfunctional obstructed voiding. Also, according to Al-Hayek S et al., BCI was higher in conservatively managed obstructed patients compared to surgically managed obstructed patients upon their 10-year urodynamic follow up15. The remark constitutes indirect evidence that BCI is significantly affected by obstruction. Surgical treatment of BOO, possible results in low detrusor pressures urination with subsequent BCI value reduction. It is a theoretical paradox that BOO transurethral treatment reduces the true detrusor contractility, as it seems to happen in ageing16, whereas conservative treatment of obstruction preserves it, according to Al-Hayek S et al.

Despite the limited number of BPO patients and the study’s retrospective aspect, URA and WFmax urodynamic factors possibly approximate the theoretical ideal obstruction and contractility index to a higher degree than BOOI and BCI, respectively. Moreover, the absence of any linear correlation between URA and WFmax, theoretically increases their specificity in contrast with the strong linear correlation of BOOI and BCI which reduces the differential diagnostic specificity of their combination (obstruction versus hypocontractility). In our opinion, the rename of BCI from Bladder Contractility Index to Bladder Compensate Index, with prognostic value upon the post-operative outcome, would correspond better to the facts. Also in theory, it seems to have limited value in the assessment of detrusor contractility, secondary to obstruction surgical treatment, because it presumably directly and linearly depends on the obstruction degree. Recently, Elliott CS and Comiter CV reached to a similar conclusion during the video-urodynamic (VU) study of isometric detrusor contraction in males with urinary incontinence following radical prostatectomy, i.e. the procedure with the greatest possible reduction of passive resistances exercised by the prostate during micturition17. Detrusor contractility after the surgical treatment of obstruction should possibly be evaluated only according to the Watts graph.
CONCLUSION

Based on the present study, the values of parameters URA≥29 and BOOI≥40 were found equally sensitive to the diagnosis of pure obstruction (LPURR≥3), with URA being more sensitive in cases of debatable obstruction. In addition, URA is closer to the theoretically ideal evaluation index of passive resistances in urine flow. At the same time, WFmax factor is seemingly closer to the ideal evaluation index of detrusor contractility. Albeit the small cohort, it appears that the combination of URA-WFmax parameters is more specific compared to BOOI-BCI combination and we suggest its inclusion in the P-F study assessment, especially in cases of debatable BOO.

REFERENCES