Leak Point Pressures: Are they clinically useful?

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Abstract

Leak Point Pressure tests have been introduced based on the experience acquired after many years of videourodynamic studies performed in a wide variety of medical conditions, such as stress urinary incontinence and incontinence evolving in patients with neurological conditions. There are two tests available for use in the daily practice, the Abdominal Leak Point Pressure (ALPP), which provides information of the extent to which Intrinsic Sphincter Deficiency (ISD) is responsible for the incontinence and the Detrusor Leak Point Pressure (DLPP) which aims to predict the risk of upper urinary tract deterioration in patients with neurogenic bladder dysfunction. The importance of these tests is often questioned mainly because of coexisting substantial confounding factors. We herein review the literature about the role of Leak Point Pressures in the Urologist’s daily practice.

Introduction

Leak Point Pressures (LPPs) are the result of the experience acquired after many years of videourodynamic studies performed in patients with urinary incontinence, either neurogenic or non-neurogenic. The available data in the literature suggest that two leak point pressure tests may aid towards acquiring information about lower urinary function. Abdominal Leak Point Pressure (ALPP) is a dynamic test providing information about the degree of Intrinsic Sphincter Deficiency (ISD) involvement in the pathophysiology of Stress Urinary Incontinence (SUI). The Detrusor Leak Point Pressure (DLPP) may potentially predict the risk of upper urinary tract deterioration in patients with neurogenic bladder dysfunction. As these two measurements represent different expulsive forces and have different effects on the urethra they are evaluated separately. The aim of this paper is to review the available data regarding LPPs focusing on the clarification of their different aspects and clinical significance, if any.

Key words

Abdominal Leak Point Pressure; Detrusor Leak Point Pressure; stress incontinence; neurogenic bladder

Abdominal Leak Point Pressure (ALPP)

ALPP has been introduced as a useful diagnostic aid for determining the aetiology of urinary stress incontinence, in particular for the identification of urethral sphincter deficiency (Table 1). Intrinsic sphincter deficiency (ISD) has traditionally been considered one
of the underlying mechanisms of stress incontinence (the other being Urethral Hypermobility, UH), in particular that which defines type III SUI. It is very likely that all women with SUI have a degree of ISD with or without urethral hypermobility and the contribution of both does vary between individuals.

ALPP is defined as the minimum intravesical pressure, in the absence of detrusor contraction, at which leakage of urine occurs. It is obvious that, at the time of leakage, the most prominent component of intravesical pressure is the intra-abdominal pressure, as the detrusor component is very small. ALPP is usually recorded during a Valsalva manoeuvre (Valsalva Leak Point Pressure, VLPP) in a patient undergoing conventional cystometry or videocystometry and reflects the ability of the urethra to resist intra-abdominal pressure as an expulsive force. Alternatively coughing may be used as the provocation method allowing ALPP to be calculated (Cough Leak Point Pressure, CLPP).

The use of the ALPP for identification of ISD was first introduced in 1993 by McGuire et al. In their study of 125 patients, incontinence was graded according to patients’ description (grade 0, 1, 2, 3) as well as using videocystometry (type I, II, III). An inverse correlation between ALPP and the type and grade of incontinence was clearly demonstrated: 75% of patients with type III and 81% of patients with grade III stress incontinence had a ALPP less than 60 cmH₂O. The authors concluded that differentiation between types of stress incontinence could be made on the basis of the ALPP value without resorting to videocystometry. Similar results were reported by other investigators. Nitti and Combs found a strong correlation between the VLPP and the severity of stress incontinence, graded according to SEAPI-QMN classification. In another study, women with severe incontinence were found to be statistically more likely to have a low VLPP. Since the initial reports, the intravesical pressure of 60 cmH₂O has often been used as the cut-off value below which diagnosis of ISD can be safely made, whereas a VLPP value of >90cmH₂O is considered indicative of UH. There is however some debate over the threshold pressure for VLPP to be diagnostic of ISD. This can be deduced from the published data, where 25% of patients with a ALPP less than 60 cmH₂O have type III and grade III stress incontinence.

### TABLE 1

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### TABLE 2

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<th>ALPP</th>
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<td>Lack of standardisation of the technique</td>
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<td>Catheter calibre</td>
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than 60 cm H₂O do not have ISD² and 57% of patients without UH do not have a low ALPP.⁷

Although some studies have shown the test to be reproducible, there is no consensus in the literature about the methodology for ALPP calculation. No standardisation exists in terms of catheter size, intravesical volume at which ALPP should be calculated, provocation method and patient’s position during the test (Table 2). Furthermore, there has been substantial inconsistency in the way ALPP is calculated amongst studies. The total intravesical pressure from the baseline,⁶ ⁷ ⁸ ⁹ ¹⁰ the rise in intravesical pressure over the resting end-fill pressure¹⁰ ¹¹ ¹² or both⁷ ¹² have been used for ALPP evaluation.

Catheter size has been found to influence ALPP values. Bump et al. calculated VLPP by using two different sizes of urethral catheters (3F and 8F). Although there was an extremely high intracatheter correlation between the test-retest VLPP for both the 3F and the 8F catheters, the VLPP values recorded by the 8F catheters were significantly higher than the 3F measurements¹⁰. This may be attributed to the obstructive effect the larger catheters have on the urethra.

Numerous studies have reported that ALPP decreases with increasing intravesical volume¹¹. However, Petrou and Kollmorgen reported no statistically significant difference in VLPP determination using volumes of 150 ml, 300 ml and total bladder capacity⁴. Faerber and Vashi found that increasing intravesical volume affected the ALPP value only in patients with type II but not in those with type I or III incontinence¹⁵. The optimal volume for LPP calculation has not been defined yet, however McGuire suggested that the test should be carried out at a moderate volume, sufficient to provide a urinary bolus on which the intra-abdominal pressure can act, but not so great as to induce a rise in the detrusor pressure⁴. Currently, most authors recommend calculation of VLPP or CLPP at a volume of 150-250 ml or at half of bladder functional capacity as assessed by a voiding diary¹⁵. Another factor reported to influence ALPP values is the use of intravaginal instead of intravesical catheter. ALPP values obtained by a transvaginal catheter have been reported in one study to be significantly lower than those recorded transvesically¹⁰. However, others showed no difference between these two methods of ALPP calculation¹³.

ALPP may be determined either during a Valsalva manoeuvre or during coughing. The former is the most commonly used method as it allows for a gradual increase of the intra-abdominal pressure and hence more accurate recording of the leakage-producing pressure. In most studies cough is used as an alternative provocation method should the Valsalva manoeuvre be unsuccessful. However, despite the fact that cough is the only method to provoke leakage in women who are unable to increase their intra-abdominal pressure on a Valsalva manoeuvre, the recorded pressure may not be the lowest one to induce leakage. A possible explanation for this phenomenon would be either a reflex contraction of the external sphincter during coughing, which further occludes the bladder outlet thus increasing the recorded CLPP, or difficulty in achieving an accurate measurement because of the rapid and short duration of pressure change. Several studies have compared VLPP with CLPP and found CLPP to be significantly higher than VLPP in patients who leaked on both manoeuvres, although there was a strong correlation between these two values¹⁰,¹³,¹⁶. Also, CLPP has been reported to have a far greater diagnostic accuracy in diagnosing SUI; 36% of patients with leakage on coughing fail to leak during a Valsalva manoeuvre¹⁶. The inability of women to leak on a Valsalva manoeuvre is no doubt related not only to the greater magnitude of the pressure rise generated during a cough, but also to its episodic nature.

A difficulty possibly encountered during ALPP measurement is the presence of anterior vaginal wall prolapse. This may absorb some of the force of the abdominal contraction during a Valsalva manoeuvre and hence the patient may not leak until pressures are higher; ALPP is therefore artificially elevated and probably not representative of the normal circumstances in which a woman leaks⁶,¹⁷.

Currently, the importance of ALPP measurement during the diagnosis process of SUI has declined, not only because of the inconsistencies related to its calculation, but also because of the common practice to apply minimally invasive techniques, i.e. tension-free vaginal tapes, to any type of SUI without resorting to urodynamics preoperatively. The presence of ISD, which is indicative of a low-resistance urethra, is definitely associated with increased risk of surgical fail-
ure, nevertheless surgery is not contra-indicated in ISD-related SUI as the success rates of midurethral slings (especially of those placed retropubically) are acceptable\(^{18-19}\). The NICE (National Institute of Clinical Excellence) guidelines recommend that urodynamic investigations should be considered in all patients other than those with pure SUI (a small percentage of patients)\(^{20}\). There are however important urodynamic questions regarding ALPP clinical utility. Firstly, does the diagnosis of ISD vs. UH predict an unsuccessful outcome? Secondly, can ALPP assist in decisions regarding type and relative success of surgery? Whether diagnosing ISD helps towards predicting surgical outcome remains controversial, as the results of various studies are conflicting. In the retrospective review by Han et al., 88 patients who were cured of their SUI 6 months after a midurethral sling procedure, were followed for at least 12 years. A preoperative VLPP <60cmH\(_2\)O was found to be the only independent factor that predicted recurrence of incontinence (HR= 5.31)\(^{21}\). In contrast, others have shown preoperative ALPP not to be related to cure rate or quality of life\(^{22-24}\) and hence the evidence about its clinical utility is still unclear.

ALPP has also been studied in incontinent men (Table 1). Barnard et al. found a VLPP > 100cmH\(_2\)O to have a high degree of predictability of success of Advance™ sling placement in men with post-prostatectomy incontinence\(^{25}\). They concluded that VLPP offers an objective measure of the severity of post-prostatectomy incontinence compared with the 24-h pad use and pad weights and could therefore be useful as an aid in patient selection prior to male sling placement\(^{25}\). These results, however, have to be confirmed by others to support ALPP validity in the evaluation of post-prostatectomy incontinence.

**Detrusor Leak Point Pressure (DLPP)**

Detrusor Leak Point Pressure (DLPP) is defined as the lowest detrusor pressure at which urine leakage occurs in the absence of either a detrusor contraction or increased intra-abdominal pressure\(^{26}\). It is the measure of the resistance of the sphincter to detrusor pressure as an expulsive force\(^{27}\) and is associated with low bladder compliance, which in turn is dependent on the viscoelastic properties of the detrusor, normal bladder wall composition and normal neural mechanisms\(^{17}\). The test can be performed during a standard urodynamic procedure, where the assessment of leakage is made by either observation or fluoroscopy, which is more accurate. DLPP was originally described by McGuire et al. in the evaluation of children with myelodysplasia\(^{28}\). In their study of 42 patients, the authors found that patients with a DLPP > 40cmH\(_2\)O were at a greater risk for developing upper urinary tract deterioration, compared to those with a DLPP < 40cmH\(_2\)O (Table 1). This was subsequently confirmed by Wang et al., who also demonstrated that a DLPP > 40cmH\(_2\)O, along with decreased bladder capacity and acontractile detrusor, were the main urodynamic parameters predicting the risk of upper urinary tract dilatation\(^{29}\). Juma et al. showed patients with spinal cord injuries and a DLPP > 40 cmH\(_2\)O to have a 37% risk of developing significant upper urinary tract complications; the risk increased to 50% in those with DLPP > 70cmH\(_2\)O\(^{30}\). The higher intravesical pressures which are transferred upwards and the co-existing vesico-ureteric reflux are deemed responsible for the resulting upper urinary tract dilatation and the ensuing renal impairment in these patients. The gradual loss of detrusor compliance, inevitably resulting from the elevated urethral pressure,\(^{31}\) is another contributing factor. An impaired external sphincter may potentially act protectively by permitting urine leakage during periods of high intravesical pressure. Taken all together, these results indicate that evaluation of DLPP during UDS may theoretically aid in identifying neurological patients in whom an early surgical intervention to decrease the urethral outlet resistance could probably be beneficial.

The accuracy of the standard DLPP measurements have been disputed by some authors. Combs et al., in their study of a modified technique for DLPP measurement, reported no deterioration of the upper urinary tract in several patients with DLPP > 40cmH\(_2\)O and suggested that the absolute values of the test reported previously were unreliable for treatment decision-making because of the lack of standardisation in determining values\(^{32}\).

Like in ALPP, several factors in the DLPP measurements have been recognised as potentially confounding (Table 2). Firstly, catheter size has been shown to influence DLPP, with large calibre catheters recording higher DLPP values, possibly because of urethral obstruction. This emphasises the need for using a small...
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Περίληψη

Οι Πιέσεις Διαφυγής (Leak Point Pressures) εισήχθησαν, ως διαγνωστικά εργαλεία, στην κλινική πράξη του Ουροδυναμικού ελέγχου με σκοπό την πληρέστερη διερεύνηση των ασθενών. Έχουν περιγραφεί 2 πιέσεις διαφυγής: η Κοιλιακή Πίεση Διαφυγής (Abdominal leak point pressure, ALPP), η οποία παρέχει πληροφορίες για την παθοφυσιολογία της ακράτειας ούρων προσπαθείας και συγκεκριμένα για τον βαθμό συμμετοχής στην ανεπάρκεια του ενδογενούς σφιγκτήρα (Intrinsic sphincter deficiency, ISD), και η Πίεση Διαφυγής του Εξωστήρα (Detrusor Leak Point Pressure, DLPP), η οποία βοηθά στην εκτίμηση του κινδύνου βλάβης του ανώτερου ουροποιητικού στους ασθενείς με νευρογενή δυσλειτουργία της κύστης. Η κλινική σημασία των 2 αυτών διαγνωστικών εργαλείων πολλές φορές αμφισβητείται, κυρίως λόγω των πολλών συγχυτικών παραγόντων που επηρεάζουν τον ακριβή υπολογισμό τους. Στο παρόν άρθρο ανασκοπείται η βιβλιογραφία για τον ρόλο των Πιέσεων Διαφυγής στην καθημερινή κλινική πράξη.

Λέξεις ευρετηριασμού

Κοιλιακή πίεση διαφυγής, Πίεση διαφυγής εξωστήρα, Ακράτεια ούρων προσπαθείας, νευρογενής κύστη

Conclusions

Despite the extensive investigation of Leak Point Pressures over the last two decades and the plenty of data about their significance there is still much debate about their clinical applicability. ALPP still remains a test with inconsistencies in methodology and lack of standardisation which often fails to accurately differentiate ISD from UH. DLPP appears to be less controversial, nevertheless the repeat validity of the originally suggested cut-off values is limited and hence video-urodynamics remain a critical investigation in the diagnosis and follow up of patients with neurogenic urological conditions. The role of Leak Point Pressures in daily clinical practice will undoubtedly increase with the standardisation of the used methodology which will allow the tests to provide more reproducible results.

Conflicts of interest

The authors declared no conflicts of interest.
References

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