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Original Article

Micromotions of Bladder Wall in Chronic Pelvic Pain (CPP): A Pilot Study

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Abstract: The aim of the study was to investigate the occurrence and duration of micromotions of the bladder wall. Thirty women with CPP and 7 healthy women underwent micromotion detection (MMD). A latex balloon provided with eight electrodes was placed within the bladder through the urethra and filled with saline up to 200 ml. Micromotions (MM), pressure within the balloon, abdominal pressure and respiratory excursions of the abdomen were registered simultaneously. A significant difference in duration as well as frequency of occurrence was found for MM activity between subjects with CPP and controls. For the occurrence of variations in detrusor presure, the difference between groups tended towards significance. We conclude that there are indications that the bladder is involved in CPP.

Keywords: Chronic lower abdominal pain; CPP; Detrusor pressure; Micromotion; MMD; Urge

Introduction

Chronic pelvic pain (CPP) is defined as a more or less continuous pain in the lower abdomen of unknown cause that has lasted for at least 6 months [1–5]. Approximately 10% of patients visiting gynecologists do so in connection with CPP [6].

Depending on the diagnostic approach of the physician consulted, different concepts as to the origin of CPP have been introduced [7], such as disorders of the female genitalia and/or their ligaments [1,5,8–10] and of the gastrointestinal tract [11–18]. Urological causes have also been suggested [7,19], but have not so far been supported by conventional cystometry.

Gynecologists examining the clinical features of CPP invariably report some measure of pain experienced by patients during gynecological examination. It has therefore been postulated that the tissue surrounding the uterus, namely the parametrium, is involved in the pathogenesis of this syndrome [1]. However, it has not yet been proved that the related hyperalgia always has its origin in the parametrium of other parts of the female genitalia. It is obvious that during coitus or gynecological examination, pelvic organs and structures other than the genital organs and the parametrial tissue also undergo spatial changes. This could result in the sensation of reported lower abdominal pain. One of these organs is the bladder, which lies adjacent to the anterior wall of the uterus and the proximal vagina.

Smooth muscle tissue exhibits spontaneous contractions in vitro [20–32]. Micromotions (MM) in vitro are fine local spontaneous contraction patterns observed in pig bladder strips using the lighted glass fiber technique [20,23,28,30,31]. Strips of the bladder wall obtained from all locations of the cat bladder exhibit spontaneous activity, suggesting that the terrain of spontaneous activity covers the whole of the detrusor, from dome to the base [29].

Micromotion detection (MMD) equipment, introduced by Van Duyl [33], allows us for the first time to observe MM of the human bladder wall in situ [34–36]. The MMD equipment used in the present study has been further developed and has the potential to register MM

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signals emitted from 16 locations in the bladder wall [37–41]. MM in situ is defined as fine (local) mechanical activity of the bladder wall, not necessarily reflected in bladder pressure. It has therefore been postulated that micromotions may be a key factor in a better understanding of urinary urgency [42].

The primary objective of this study was to investigate whether the bladder wall in CPP patients exhibits spontaneous detrusor activity which can be observed as micromotions but not as variations in detrusor pressure.

Methods

This clinical pilot study was approved by the Medical Ethics Committee of the University Hospital. The CPP patients and healthy controls gave informed consent to participate in this study.

Thirty women were recruited from 34 consecutive Dutch-speaking caucasian women referred to our outpatient clinic in connection with chronic lower abdominal pain. All 34 women consented to participate in the MMD study if recruited after the selection phase. They were asked to complete a questionnaire addresing various symptoms in the pelvic region. The occurrence of symptoms was to be marked on a five-point scale (never or hardly ever, sometimes, often, almost always and always). Also, the duration of the symptoms was reported. The reliability of the answers was ascertained by an extensive interview within 2 weeks after the return of the questionnaire. Also a routine gynecologic examination, echoscopy and laparoscopy were carried out if a CPP patient had not undergone these examinations in the 3 months prior to investigation. The same applies for urodynamics and proctoscopy, in cases where voiding symptoms or evacuation problems were reported. These examinations were carried out at the relevant departments of our hospital.

We based our diagnosis of CPP on the presence of lower abdominal pain without disorders that could explain the pain. The pain, moreover, had to occur often, almost always or always, and had to have lasted longer than 6 months prior to investigation.

Women with severe mental or psychological disorders in the past 6 months would be excluded. Patients with a hysterectomy in their medical history would be included. Four women with serious chronic lower abdominal pain were excluded on the ground of endometriosis (1), adhesions (1), ovarian carcinoma (1) and severe hypochondria (1).

Thirty patients aged 25–76 years (mean 46) diagnosed as having CPP by two investigators, were eligible. Of these, 9 had been referred to our university hospital by GPs to support the diagnosis of CPP, or after unsuccessful visits to other specialists. Fourteen women were referred to us by urologists, proctologists or gynecologists, and were already diagnosed or were suspected of having CPP.

Tenderness of the parametrial tissue was established by rectal and vaginal exmination in all CPP patients. Urethral, trigonal or bladder tenderness was absent in all. Although these patients had all presented with lower abdominal pain as the main complaint, their medical history revealed that 15 of them (50%) had two or more voiding symptoms that had lasted longer than 6 months and which ocurred often, almost always or always. Routine cystometry showed no abnormalities in 13 of these patients. Two had bladder instability, but this did not explain their lower abdominal pain.

Control Group

We asked the coordinator of a group of healthy female volunteers, regularly participating in educational programs for medical students, to approach the group to participate in the study. Seven Dutch women of caucasian origin, aged 19–50 years (mean 38), consented to complete the questionnaire and to undergo MMD. None of these women had lower abdominal pain, nor did they have mental or physical disabilities during the 6 months prior to MMD investigation. One women stated often having a strong need to void, but without incontinence. She did not experience enough discomfort to consult her physician and was not subjected to urodynamics or cystoscopy by us.

Materials and Procedure

The MMD probe (Fig. 1) [37–40], consists of an 14 Fr catheter through which eight thin wires are led. Electrode discs on the inner wall of a high-compliance

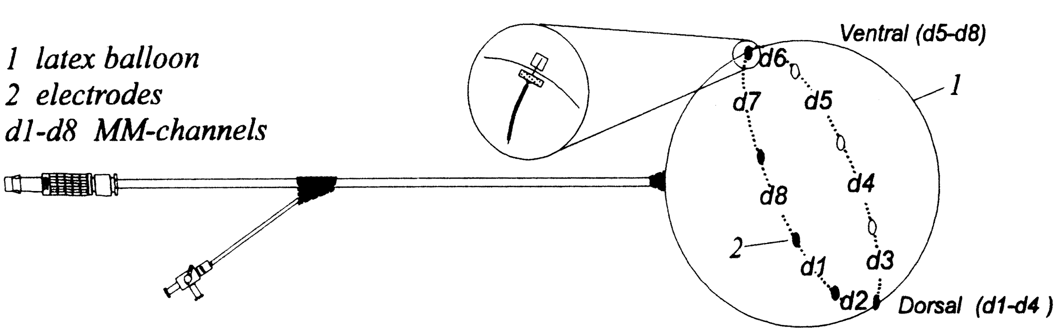

Fig. 1. Micromotion detection probe (From Kosterman et al. [37]).

latex balloon (condom) are connected to the bare ends of the wires. On the outer wall of the balloon there are eight cylindrical latex knobs (2 × 2 mm), next to the discs and arranged in a circular configuration. The approximate angle of the circle relative to the catheter is 60°, to facilitate easy introduction of the probe into the urethra. The catheter is long enough to protrude from the urethra after the insertion of the probe into the bladder and serves also to fill the balloon with saline. When the balloon is filled, the knobs are pressed on to the mucous membrane of the inner wall of the bladder, thus following local motions of the wall during the measurement. Local displacements of the knobs are recorded at eight different locations in the bladder wall as changes in electrical resistance between two neighboring electrodes, bathed in the saline content of the balloon. Changes in the distance between two electrodes are registered as changes in the voltage while the encompassing electrodes are injecting current. These voltage changes result from variations in resistance between the two electrodes with changing distance. The ratio between the above-mentioned displacements and measured voltages is used as a conversion factor to express voltages in displacements. This ratio, however, is volume dependent [41], and has been estimated for ideal conditions in vitro, where the balloon is spherical and at rest and the distances between neighboring electrode discs are equal.

During the recording the wires are connected to the MMD interface and a 486 PC by an ADC board. Signals are sampled at a rate of five per second.

Displacement signals are not a direct measure of the distance between two electrodes, as variations in the distance between neighboring electrodes contribute to the displacement signals. One true contraction could affect the outcomes of the neighboring displacement signals to such an extent that electrodes at non-contracting locations can emit displacement signals. We call this the ‘cross-talk phenomenon’. On the other hand, displacement signals recorded from any channel during a certain period are a certain indication that MM has occurred during at least the same period in a location in the bladder wall, which does not necessarily have to be the same as the location where the relevant electrode is situated. The pressure within the balloon is measured manometrically, variations being a measure of variations in intravesical pressure (p_{ves}).

Before the introduction of the MMD probe the bladder was emptied with the help of an 14 Fr catheter. During measurement, continuous drainage was carried out with a 6 Fr catheter which was inserted into the bladder, through the urethra and alongside the balloon. Another 6 Fr catheter, placed about 12 cm into the rectum, was used to register intrarectal pressure as a measure of the abdominal pressure. Disposable hydrostatic transducers were connected to the intravesical

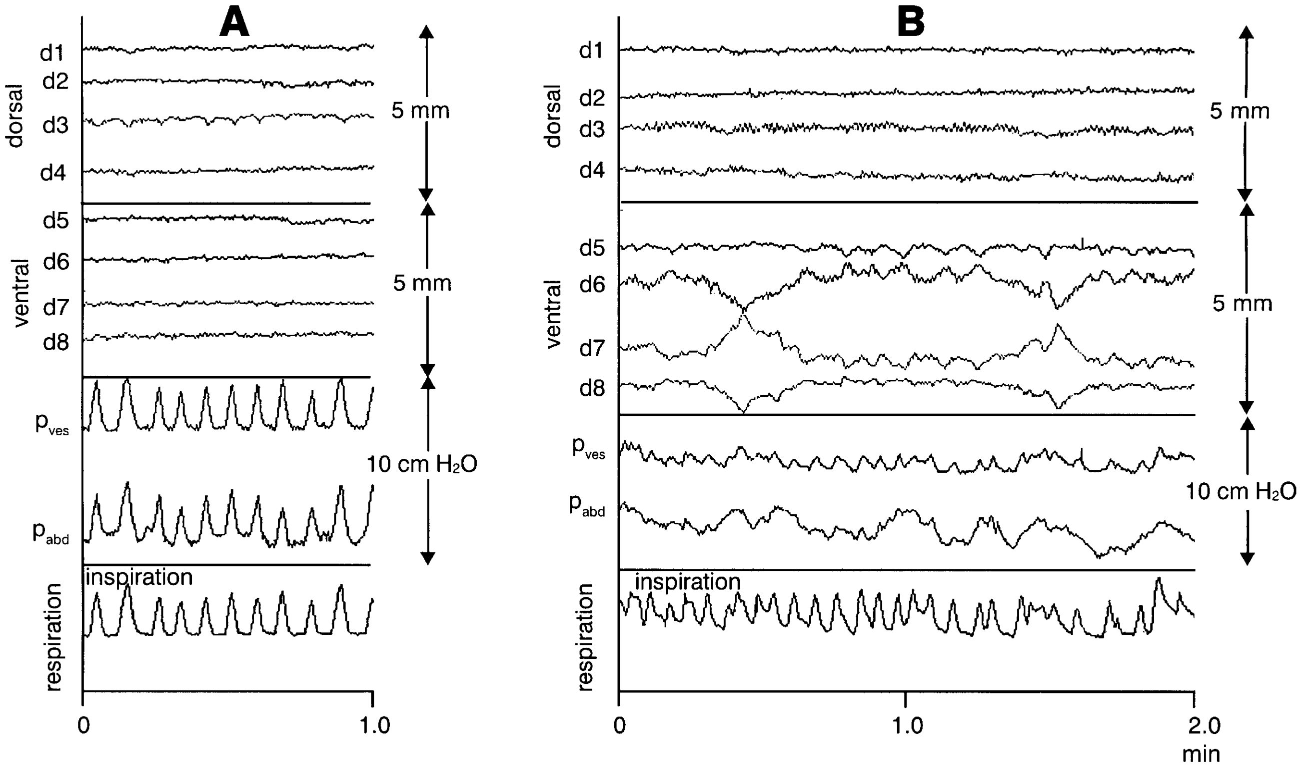

Fig. 2. A Example of an MMD recording from a healthy woman. The signals in the upper two windows represent 8 MM signals (d1–d8) [mm]. The third window is reserved for intravesical pressure (p_{ves}) and abdominal pressure (p_{abd}) [cmH_2O]. Respiratory excursions of the abdomen are seen on the lowest window. The rhythmic phasic activities observed in some MM channels of this recording reflect respiratory excursions ofthe abdomen. **B** Example of an MMD recording from a CPP patient with micromotions, not reflected in detrusor pressure.

and intrarectal catheters by standard intravenous extension tubes.

All participants were requested not to drink for 2 hours before measurement in order to reduce urine production. Just before the start of measurement they were asked to empty the bladder. Measurements took place with patients in the lithotomy position. All equipment was tested before each session. The empty balloon of the MMD probe was then dipped in lubricating gel and folded in such a way to allow easy introduction of the probe into the urethra. The locations of the knobs were roughly established with the help of markings on the protruding part of the probe (channels 1–4 dorsal, channels 5–8 ventral) (Fig. 1). In this way we aimed to differentiate between possible preferential MM locations.

After the introduction of catheters for the continuous measurement of abdominal pressure and bladder drainage, a girdle made of a 30 cm bellows (diameter ± 7 cm) and both ends attached to a band, was put around the waist to register the respiratory excursions of the abdomen, observed as changes in pressure within the bellows. The probe was filled with 100 ml saline, approximately 1.5 ml/s, at body temperature. For the first 10 women this was done manually, but later a pump was used. The recording then began with a cough test. Women were instructed to cough three times to see whether the transducers were intact and to ensure sufficient pressure transmission.

An MMD recording was obtained by simultaneous registration of MM (eight channels) [mm], p_{ves} [cmH_2O], p_{abd} [cmH_2O] and respiratory excursions of the abdomen (resp). The signals are recorded in such a way that each arbitrary episode of recording exhibits four vertically arranged windows. The upper two windows are reserved for MM signals; p_{ves} and p_{abd} signals are seen on the third window; and respiration signals are on the lowest window (Fig. 2).

The above-mentioned signals were registered for about 10 minutes. This procedure was repeated at volumes of 150 and 200 ml. The total measurement session lasted 30 minutes. After the session the balloon was emptied and its contents measured again to make sure that the balloon was entirely empty and would not damage the urethra during withdrawal, and that there had been no leakage during measurement. The catheters and the probe were then gently withdrawn. Hereafter the bladder was drained with the help of a 6 Fr catheter to measure the volume of urine produced but not (properly) drained during recording.

Data Analysis

Because tonic variations in MM and p_{det} could have been the result of the difference between the temperature within the probe and that of the bladder wall, the analysis of MM and p_{det} results are based on phasic variations thereof only.

MM episodes, recorded simultaneously from different channels, were counted as one observation in this study, in view of the fact that we cannot yet with certainty eliminate the influence of the neighboring electrodes on the emitted signals from a certain channel. When two or more channels showed MM activity, partially occurring at the same time, the channel with the longest MM duration was used to establish the duration of MM. Signals from p_{ves} and p_{abd} channels were measured during all MMD sessions. Detrusor pressure (p_{det}) was calculated by deducting the abdominal presure from the intravesical pressure ($p_{det} = p_{ves} - p_{abd}$). When the occurrence of $p_{det} \geqslant 5$ cmH_2O in a recording was established, we measured the duration of p_{det} episodes in that recording to allow comparison with MM episodes.

We evaluated the duration and the frequency of occurrence of MM and p_{det} in CPP and in healthy women, and the relation between these outcomes and the instilled volume of the balloon within the bladder.

Statistical Analysis

In this prospective observational study percentages were compared between groups using Fisher's exact test. Between-group comparisons of continuous outcomes were done using the Mann–Whitney test. Within-group comparisons were carried out applying Wilcoxon's signed ranks test or Friedman's test. To assess correlations between variables, Spearman's correlation coefficients were calculated. The limit for statistical significance was set as $P = 0.05$ (two-tailed).

Inter- and Intraobserver Variability

As MM had to be detected visually from the recordings, some subjectivity might affect the result in the outcomes. For this reason we investigated the inter- and intraobserver variations performed by two investigators. Ten representative 3-minute recordings were selected from all recordings (CPP patients and healthy controls) by a third person, and independent analyses of each of the readings were performed three times by two investigators. The total duration of MM activity in each of the readings was determined. The results of both observers showed excellent agreement (intraclass correlation = 0.99). There was a minor difference between both observers regarding the within-recording variability of readings. The standard deviation of the repeated mesurements of observer A was on average 0.12. The corresponding value for observer B was somewhat greater, at 2.0 ($P = 0.03$; Wilcoxon's test), but could nevertheless be considered small. Observer A was the interpreting investigator.

Results

Adverse Events During and After Measurements

During mesurements in 4 patients bladder drainage was hampered for 10–15 minutes, mainly at 200 ml volume. Judging by the ongoing MMD feature, this did not seem to have an effect on the recordings.

The healthy controls claimed to have experienced an unpleasant sensation during the insertion and withdrawal of the probe. Once the balloon was filled and recordings had begun, the MMD was experienced by these women as being unpleasant or 'boring' only.

Post-examination interviews of the CPP patients revealed that in the majority of cases probe insertion was experienced as unpleasant, painful or even very painful. The pain experienced during measurements had been recognized by these women as 'the well known own lower abdominal pain'.

In two cases urethral spasms did not permit the insertion of the probe or even the thin drainage catheter. In both cases we overcame this obstacle by first inserting a 14 Fr catheter, which almost instantly resulted in the relaxation of the urethra. We then pushed the drainage catheter and the probe, one after the other, gently into the bladder alongside the first catheter, which was then withdrawn.

In 3 women, although the insertion of the probe met with no difficulties, there were traces of blood on the balloon after withdrawal. Of these, 2 said they had traces of blood for about 24 hours after examination. Worsening of the pain during 2–3 days after examination was reported by 2 patients. One patient had to be treated for urinary infection 2 days after MMD.

All healthy controls said that they would not object to repeating the examination. The experiences of 10 CPP patients during MMD were comparable to those of the control group. Six women said they never wanted to repeat the MMD unless they absolutely had to, and 14 were willing to repeat the examination despite having experienced it as uncomfortable or even painful.

Observational Statistics

Occurrence and Duration of MM and p_{det} Episodes at Different Bladder Volumes

Phasic variations in MM, whether or not accompanied by variations in detrusor pressure (p_{det}), with a total duration of 0.4–29.8 minutes (mean 12.5, median 7.9) were observed in the recordings of 26 women with CPP. The recordings of 2 of the healthy controls showed MM activity. One woman had one episode lasting 3 minutes; in the other subject MM activity was present for 10 minutes. None of the MMD recordings of the controls showed variations in p_{det}, whereas the latter were seen in the recordings of 22 (73%) of the CPP patients.

One or more of the following basic (episodic) observations was encountered in an MMD recording:

1. MM^+ & p_{det}^-, i.e. MM activity without variations in p_{det};
2. MM^+ & p_{det}^+, i.e. simultaneously occurring MM and variations in p_{det};
3. MM^- & p_{det}^+, i.e. variations in p_{det} without MM activity;
4. MM^- & p_{det}^-, i.e. no MM p_{det} activity.

Here, MM^+ denotes MM activity irrespective of p_{det}, and p_{det}^+ denotes variations in detrusor pressure irrespective of MM. Analysis of the results, carried out on *all* recordings of CPP patients and healthy controls, separately at 100, 150 and 200 ml (10 minutes at each volume), reveals that the *total* duration of none of the above-mentioned episodes was significantly related to the bladder volume (data not shown). The number of MM episodes in CPP, as well as in the control group, was also not significantly dependent on the volume of bladder (data not shown).

Occurrence and Duration of MM and/or Variations in Detrusor Pressure in CPP and in Healthy Controls

Because the occurrence and the duration of MM and/or p_{det} were not found to be dependent on the volume of the bladder, as from now our data analyses are based on observations during the total recording time, i.e. 30 minutes for each woman.

We established the total time for each of the four basic types of episodes (MM^+ & p_{det}^-; MM^+ & p_{det}^+; MM^- & p_{det}^+ and MM^- & p_{det}^-), occurring during 30 minutes' recording time. Table 1 shows the frequencies and durations of the various types of events for CPP patients and controls. A significant difference in duration as well as frequency of the occurrence was found for MM activity. For the occurrence of variations in p_{det} (p_{det}^+ in Table 1) the difference between both groups tended towards significance ($P = 0.072$).

In conventional urodynamics special attention is given to the phasic variations in p_{det}, the presence of which justifies a diagnosis of bladder instability.

The recordings of 18 patients and all of the healthy controls showed no phasic variations in p_{det} (p_{det}^- group) throughout the session (Table 2). These recordings, however, were not free from events: in this group 14 CPP women and 2 healthy controls had at least one episode of MM activity. The recordings of the remaining controls (5 women) showed neither MM nor p_{det}. The remaining 12 CPP patients had recordings with at least one episode of p_{det}^+.

In all recordings of the p_{det}^+ group MM was observed accompanying variations in p_{det} (Table 2). However, in three of these recordings episodes of increase in p_{det} were also observed without MM occurring simultaneously.

There is a trend that in all p_{det}^- women MM is more likely to be observed in the recordings of women with CPP than in those of healthy subjects (Table 2; $P = 0.058$). There is also a trend that women with CPP are more likely than the healthy to have (a) p_{det}^+ episode(s) (Table 1; 12/30 vs. 0/7; $P = 0.072$).

Table 1. Occurrence and duration of MM and p_{det} in 30 women with CPP and 7 healthy controls. Different types of MM and p_{det} episodes are often observed in the same recording

Observation	Number of women			Total duration of MMD episodes (min)		
	CPP n (%)	Controls n (%)	P value*	CPP Mean Median (Range)	Controls Mean Median (Range)	P value†
MM^+	26(87)	2(29)	0.005	10.8; 3.8 (0.0–29.8)	1.9; 0.0 (0.0–10.0)	0.015
p_{det}^+	12(40)	0(0)	0.72	5.1; 0.0 (0.0–30.0)	–	–
MM^+ & p_{det}^-	21(70)	2(29)	0.080	6.4; 1.5 (0.0–29.0)	1.9; 0.0 (0.0–10.0)	0.128
MM^+ & p_{det}^+	12(40)	0(0)	0.073	4.5; 0.0 (0.0–29.8)	–	–
MM^- & p_{det}^+	3(10)	0(0)	1.000	0.6; 0.0 (0.0–12.0)	–	–
MM^- & p_{det}^-	28(93)	7(100)	1.000	18.6; 26.3 (0.0–30.0)	28.1; 30 (10.0–30.0)	0.015

*Fisher's exact test.
†Mann–Whitney test.

Table 2. Presence or absence of MM and p_{det} in MMD recordings of 30 women with CPP. In the p_{det}^+ group at least one episode of increase in p_{det} ($\geqslant 5$ cmH_2O, duration $\geqslant 0.1$ min) is registered during 30 min of measurement

	p_{det}^-		p_{det}^+	
	CPP (n = 18)	Controls (n = 7)	CPP (n = 12)	Controls (n = 0)
MM^+	14 (47%)	2 (29%)	12 (40%)	–
MM^-	4 (13%)	5 (71%)	0 (0%)	–
Total	18 (60%)	7 (100%)	12 (40%)	–
	P = 0.058 (Fisher's exact test).		–	

As mentioned earlier the recordings of one subject may exhibit various types of MMD episodes. This is particularly the case in recordings with episodes of p_{det}^+ (Table 2). In this group, for 82% of the total time during which MM was recorded, p_{det}^+ was observed simultaneously.

Discussion

It is remarkable that no relation was found between the occurrence and the duration of MM and/or p_{det}, and bladder volume. It goes without saying that the 'normal' desire to void is volume dependent, with the expulsion phase of the bladder being the eventual motor response. We speculate that spontaneous contractions are premature efforts of the bladder control system to empty the bladder, which in turn would stimulate afferents specifically involved in the conduction of noxious and other stimuli.

With the exception of occasional Paccinian and Pacciniform corpuscles, no receptors have been identified in the human bladder that could be denoted with certainty as stretch pressure or tension receptors. Perhaps phasic motions stimulate volume-independent afferents in the detrusor muscle coat. This view is in accordance with the receptor model introduced by Iggo [43], where the receptors in bladder wall are stimulated by phasic contractions.

The independence of the results of MMD of the filling state of the bladder would make measurements at different volumes superfluous. Recordings could be carried out at a low bladder filling, for example 100 ml or less.

It is interesting to observe that MM, even if it had been triggered by MMD, had a significantly longer duration in CPP than in the healthy controls. This could be due to a heightened bladder sensitivity to mechanical stimulation in these pelvic neuralgia patients. Although the methods and procedures in this study, including the measurements of p_{det}, differ from those of conventional urodynamics, we have found it justified to give special attention to p_{det}, which is the pressure within the MMD probe deducted by abdominal pressure, and which is an indirect mesure of detrusor pressure (P_{det}).

In this way we were able to divide our population into two groups: women with p_{det} (p_{det}^+ group), and those without (p_{det}^- group). The MMD results in the p_{det}^- group are particularly important because spontaneous bladder activity of the p_{det}^+ group could have been detected by urodynamics anyway. The trend ($P = 0.058$) that in women with no variations in p_{det} MM is more likely to be seen in CPP than in the healthy controls, make it worth extending this investigation to a larger group of women with CPP. However, looking at the total time when MM is recorded in the p_{det}^+ group, we find that reflections of MM in p_{det} are observed during 82% of the total measurement time. If these results are confirmed in a larger group of p_{det}^+ CPP patients, such patients should thereafter be excluded by conventional urodynamics to minimize unnecessary investigations and costs. Perhaps in a subgroup of CPP patients there is a symptomatic overlap with bladder hyperreflexia. We speculate that in hyperreflexia there is a synchronized contraction of detrusor tissue leading to measurable variations in P_{det}, and that the absence of the latter in the presence of MM is due to the non-synchronized local contractions as observed in vitro [20,22,23]. Morever, we do not exclude the possibility that the two syndromes might be different aspects of the same problem.

Although MM was also recorded from the bladders of the healthy control group, the duration thereof was significantly less than in the CPP group. Perhaps long-duration mechanical activity of bladder wall is typically pathological. The existence of MM^+ & p_{det}^- episodes shows that variations in detrusor pressure as a means to detect spontaneous bladder contractions cannot always be relied upon. The number and the total duration of MM^+ & p_{det}^- episodes exceed those of MM^- & p_{det}^+ episodes overwhelmingly. A follow-up study of MM^+ healthy individuals would be useful to find out whether these women run a greater risk of developing chronic lower abdominal pain.

Micromotion activity as means of communication between bladder and central nervous system may constitute a key factor in comprehending some types of pathological bladder behavior [42].

We conclude that, for the first time, an objective and measurable somatic phenomenon, i.e. MM, has been demonstrated in chronic pelvic pain.

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EDITORIAL COMMENT: Dr Van Os-Bossagh et al. report on a new technology which has yet to be fully studied in normal, healthy, asymptomatic women. Micromotion analysis will need intense further study before our readers should apply this technique clinically in patients with pain or symptoms of an overactive bladder. Although micromotion analysis is not a clinical tool, this research investigation may bear fruit in the future.

Review of Current Literature

A Three-Year Follow-up of Tension-Free Vaginal Tape for Surgical Treatment of Stress Urinary Incontinence

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Pre- and postoperative evaluation was performed in 50 consecutive women. This included a thorough history of stress incontinence; a provocative stress test, both supine and standing, with 250 ml in the bladder; a 24–48 hour pad test; quality of life evaluation (QoL); urodynamic evaluation; and review of surgical time and complications. Urge incontinence was excluded and all procedures were primary. Procedures were performed according to previous techniques described, under local anesthesia, with tape placement at the midurethra without tension. Outcome was evaluated at 2–6 months, and at 12, 24 and 36 months. The definition of cure was no incontinence by pad tests (10 g/24 h), no incontinence on stress provocation test, and over 90% satisfaction on a visual analog scale. There would be no voiding problems and normal residual urine. Cure was observed in 43, improvement in 6 and failure in 1. There were no significant complications, and 45 women voided on the afternoon of surgery.

Comment

This operative procedure is gradually working its way into community and academic centers as a viable one for primary stress incontinence. A 3-year follow-up is reassuring in terms of no long-term complications, especially tape rejection, which has not been reported. The ease of performing the procedure under local anesthetic is appealing, especially in the elderly. The study as reported has a few areas of concern. There are no timelines presented to show that all patients were followed the full 3 years after surgery. No objective results are given other than one postoperative pad test report, showing 9 g/24 h compared to 109 g/24 h preoperatively. It might have been more informative to have a 20-minute pad test in a controlled environment with specific stress activity. Nine grams of loss can be significant if it occurs on one or two occasions associated with a physical stress. I am disappoointed to see no chart of urodynamic, pad test, stress test and QoL scores at each of the preoperative, 12, 24 and 36-month time intervals. A study with objective data is needed in order to allow this procedure access to the critical thinking surgeon.