W29: Digital palpation to imaging: How do or should pelvic-floor-muscle evaluation tools influence physiotherapy practice?

Workshop Chair: Chantale Dumoulin, Canada

27 August 2013 14:00 - 18:00

Start	End	Topic	Speakers
14:00	14:10	Introduction	• Chantale Dumoulin
14:10	14:30	Digital evaluation to measure pelvic floor muscle function	• Chantale Dumoulin
14:30	14:50	Manometry	• Melanie Morin
14:50	15:10	Dynamometry	• Melanie Morin
15:10	15:30	Electromyography	• Petra J. Voorham-van der Zalm
15:30	16:00	Break	None
16:00	16:20	US	• Jennifer Kruger
16:20	16:40	MRI	• Chantale Dumoulin
16:40	16:50	Questions	All
16:50	17:10	How do or should PFM evaluation tools influence our practice with UI?	• Chantale Dumoulin • Petra J. Voorham-van der Zalm
17:10	17:30	How do or should PFM evaluation tool influence our practice with POP?	• Jennifer Kruger
17:30	17:50	How do or should PFM evaluation tool influence our practice with perineal pain?	• Melanie Morin
17:50	18:00	Questions	All

Aims of course/workshop

Aims: to review evidence-based literature on PFM evaluation tools —from digital evaluation to MRI imaging— and their influence on clinical practice.

Objectives:

1. To review PMF evaluation tools —digital evaluation, pressure, EMG, dynamometry US and MRI— including their psychometric properties (reliability, validity…), advantages and disadvantages.
2. To present the known body of evidence on the relationships between (1) pelvic-floor morphological deficit and dysfunction and (2) symptomatology, diagnosis and therapy outcome predictions.
3. To examine the impact PFM evaluation literature has or should have on clinical practice for patients with urinary incontinence (UI), pelvic organ prolapse (POP) and vulvo-vaginal (perineal) pain.

Digital Palpation to Imaging: How Do or Should Pelvic-Floor-Muscle Evaluation Tools Influence Physiotherapy Practice?

1- Digital evaluation used to measure pelvic-floor-muscle function

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Aims of this topic:

1. To describe the digital evaluation technique used to measure pelvic floor muscle (PFM) function.
2. To present the PFM digital evaluation scales used to assess (a) passive strength, (b) active strength, (c) relaxation and (d) levator injury.
3. To outline the psychometric properties of digital evaluation scales and how these correlate with other PFM assessment tools.
4. To discuss the clinical recommendations for digital evaluation of the PFM function and the advantages and limitations of the technique.

Definition of the pelvic-floor-muscle digital evaluation:

Pelvic-floor-muscle digital evaluation is the evaluation of the PFM qualitative and quantitative functions through perineal, vaginal or anal palpation using one or two fingers (Dumoulin, 2011). PFM qualitative function is define by the qualitative/subjective determination of a PFM's size, symmetry, pain, trigger points (TP) and capacity to contract with isolation/compensation or facilitation. PFM quantitative function is defined by passive strength or tone, active strength and reflex contraction (Messelink, 2005; Haylen, 2010).

The **PFM digital evaluation encompasses**:

1- Good communication with and consent of the patient (Dumoulin, 2011)
2- Patient instruction on how to contract the PFMs correctly (Crotty, 2011)
3- A perineal assessment evaluation, including perineal elevation or descent on PFM contraction, cough and Valsalva (Haylen, 2010; Dumoulin, 2011)
4- A vaginal assessment evaluation: morphological integrity and functional assessment (Messelink, 2005; Haylen, 2010 ; Dumoulin, 2011)
5- An anal assessment evaluation: anal sphincter tone, strength and morphological integrity; perineal body deficiency; and the puborectalis, pubococcygeus, iliococcygeus and coccygeus tones and strengths (Dumoulin, 2011 ; Haylen, 2010)

PFM digital evaluation components and scales used to evaluate them:

1- Evaluation of pelvic floor passive force or tone (Simons, 1998)
    a. Scales for PFM tone and their psychometric properties (Devreese, 2004; Reissing, 2005; Boyle, 2007; Dietz, 2008; Gentilcore, 2010)
2- Evaluation of pelvic floor active force or strength
3- Scales for PFM active force or strength and psychometric properties (Isherwood, 2000; Laycock, 2001; Messelink, 2005)
    a. One or two fingers
    b. Positions in which the PFM strength is assessed (Frawley, 2006)
4- Evaluation of PFM relaxation and psychometric properties
    a. Scales for PFM relaxation (DeRidders, 1998; Reissing, 2005; Messelink, 2005)
5- Evaluation of levator (puborectalis) injury and psychometric properties (Dietz, 2008; Krugger, 2010)
6- Qualitative determination of PFM function (Dumoulin, 2011)
    a. Isolation of PFM contraction/compensation
    b. PFM volume at rest and during contraction
    c. Symmetry of left/right PFM fibres
    d. Pain, tension and TP
    e. Coordination with cough or Valsalva

Clinical advantages and limitations of a digital evaluation and how it correlates with other PFM assessment tools.

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Digital Palpation to Imaging: How Do or Should Pelvic-Floor-Muscle Evaluation Tools Influence Physiotherapy Practice?

Topic: Manometry

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Aims of this topic:

1. To describe the properties and functioning of manometric measurements used to assess the pelvic floor muscles (PFM).
2. To outline the psychometric properties of the manometry including reliability and validity.
3. To discuss the clinical recommendations associated with the uses of manometry. The advantages and limitations of manometry will be discussed.

Constituents and methodology associated with manometry

In 1948, Dr. Kegel (1948) developed an intravaginal device, the perineometer, to assess PFM strength. The vaginal pressure probe was connected to a manometer in order to measure the intravaginal pressure from the PFM in millimeters of mercury (mmHg). Since then, several types of pressure probes with different shapes and technical properties have been developed and studied (Dougherty et al. 1986; Bo et al. 1990; Laycock et al. 1994; Sanches et al. 2009). These tools can measure pressure in mmHg or cm H_2O. Several manometry units are commercially available and were developed in different countries: Camtech (Norway), Peritron (Australia), Miofeedback perina (Brazil), Gymna (Belgium), etc.

Reliability

Several muscle parameters have to be defined to ensure a comprehensive assessment of the PFM and hence, a thorough understanding of the pathophysiology of incontinence, prolapse and pain conditions. Good intra-rater (test-retest) reliability has been demonstrated for maximal squeeze pressure (ICC ranging from 0.88 to 0.96) and resting pressure (tone) (ICC=0.74-0.77) (Bo et al. 1990; Kerschan-Schindl et al. 2002; Hundley et al. 2005; Frawley et al. 2006; Frawley et al. 2006; Rahmani et al. 2011). Acceptable inter-rater reliability for strength parameter was found by Ferreira et al. (2011). Regarding the endurance, Frawley et al. (2006), found the endurance measurement to be unreliable. Contrarily, Rahmani demonstrated good reliability when assessing the endurance during a sustained 60% maximal contraction (Rahmani et al. 2011).

One advantage of the pressure measurement is the possibility to perform the assessment in different positions (lying, sitting and standing). It has been argued that upright positions are more “functional” because urinary incontinence occurs in these circumstances. Yet, the clinical advantages of assessing women in a standing position have not been supported by scientific evidences and the effects these positions have on the muscles themselvesare controversial (Bo et al. 2003; Frawley et al. 2006). Overall, the parameters proved to be reliable in these positions, supine showing the highest reliability.

Validity and clinical uses

The validity of the measurement was studied by comparing the maximal squeeze pressure to other measurements. It was correlated with vaginal palpation, for instance, using:

- the Oxford scale (r=0.703-0.814) (Isherwood et al. 2000; Riesco et al. 2010; Da Roza et al. 2012) and
- the Brink scale (r=0.68-0.71) (Kerschan-Schindl et al. 2002; Hundley et al. 2005).

Ultrasound measurements were also correlated with maximal pressure:

- the correlation was good (ICC=0.72-0.81) when comparing the maximal pressure to the bladder base movement evaluated with transabdominal US (Chehrehrazi et al. 2009; Riesco et al. 2010)
- the correlation was moderate when comparing the maximal pressure to bladder neck movement (r=0.43) (Thompson et al. 2006) and muscle thickness (r=0.49) and levator hiatus area (-0.46) (Braekken et al. 2013) assessed by transperineal ultrasound.
- Levator hiatus area was correlated with resting pressure (r=-0.46) and endurance (r=-0.40) (Braekken et al. 2013).

The validity of the measurement is also supported by the capacity of the measurement to detect changes following treatment (Aksac et al. 2003) and to discriminate between groups, e.g. continent and incontinent women (Thompson et al. 2006).

Recommendations

There are a few known precautions to bear in mind regarding the uses of the pressure perineometry. Increases in intra-abdominal pressure, occurring if a patient co-contracts the abdominal muscles (rectus abdominis), or strain instead of contracting the PFM can interfere with pressure measurements.

Some recommendations can be applied to ensure the validity of the measurement:

1-performing vaginal palpation before using the perineometer to make sure the patient is able to correctly contract her PFM;

2-observing the cranial movement of the vaginal probe during measurement of the muscle contraction;

3-not considering the contractions associated with the Valsalva manoeuver or retroversion of the hip (Bo et al. 1990; Bump et al. 1996). It has been argued that manometry is not suitable to assess reflex contraction during a cough (Bo et al. 2011).

Moreover, it should be pointed-out that the use of perineometry is therefore difficult when a patient has a really low PFM strength, because no inward movement of the probe is possible in this case.

The size of the probe and the brand of the device were also demonstrated to influence the measurement (Bo et al. 2005; Barbosa et al. 2009). Barbosa et al (2009) compared the Peritron with two brazilian devices and Bo et al. (2005) compared the Peritron to the Camtech. Both studies conclude that, the measurements of vaginal squeeze pressure differ depending on the vaginal probe used. Results from published studies using various probes should, therefore, not be compared or combined in systematic reviews or meta-analyses.

The placement of the probe is another factor reported to be important. It was recommended to position the probe at the level of the PFM which corresponds to the high-pressure zone within the vagina (Guaderrama et al. 2005; Jung et al. 2007).

This presentation will draw upon these references:

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Digital Palpation to Imaging: How Do or Should Pelvic-Floor-Muscle Evaluation Tools Influence Physiotherapy Practice?

Dynamometry

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Aims of this topic:

1. To describe the constituents and the methodology associated with dynamometric measurement tools of the pelvic floor muscles (PFM).
2. To present the psychometric properties of dynamometers including reliability and validity.
3. The advantages and limitations of dynamometry will be discussed.

Constituents and methodology

In the past 20 years, several versions of PFM dynamometers have been developed:

- Caufriez- la pince tonimétrique (Caufriez 1993). This tonimetric device consists of two branches that can be opened following an angular excursion. It was initially designed to assess PFM tone following an antero posterior vector. Forces from active PFM contraction can also be registered.
- Row (Rowe 1995). This device comprises a rod with a movable rigid window section that the muscles can press against.
- Ashton Miller (instrumented speculum) (Ashton-Miller et al. 2002). This instrument is similar to a conventional speculum with two branches but it is equipped with strain gauges to measure PFM function.

- Dumoulin (Montreal's dynamometer) (Dumoulin et al. 2003). This speculum is similar to the one above but it is mounted on a stabilizing plate so that, the evaluator cannot bias the device by moving the unit. This instrument has evolved in the last years. A mechanism to increase the vaginal opening smoothly in order to evaluate PFM passive properties during a dynamic stretch was developed. A third branch to verify if the PFM forces recorded are minimally influenced by intra-abdominal pressure was investigated. Finally, the size of the branches was reduced to the size of a little finger to allow the assessment of women with vaginal atrophy or vulvo-vaginal pain.
- Verelst & Leivseth (probe) (Verelst et al. 2004). This probe also comprises two branches that assess PFM forces in a latero-lateral position rather than the antero-posterior force vector.
- Constantinou (probe with "arms") (Constantinou et al. 2007). It consists of a rod with "arms" that open once in the vagina. There are different sensors to assess the spatial distribution of the force inside the vagina.
- Saleme (Probe with sensor) (Saleme et al. 2009). The Saleme's probe was designed for the same purpose with the only exception that the sensors are not mounted on "arms".
- Nunes (speculum) (Nunes et al. 2011). The Nune's speculum is basically a speculum equipped with strain gages.
- Kruger (elastometer) (Kruger et al. 2011). This instrument was designed to assess the passive forces (tone). The two branches are positioned to produce a latero-lateral stretch with the help of a motor inside the unit.

In sum, the PFM dynamometers differ in terms of size and shape, the force vector recorded (anteroposterior, latero-lateral or multi-directional forces) and other technical issues. Overall, during a PFM contraction, the lengthening or shortening of strain gauges glued on the speculum causes its electrical resistance to change. Voltage values from the strain gauge are then amplified, digitized and converted into units of force.

In vitro properties

Dynamometers have shown good linearity, repeatability and ability to measure the resultant force independently of its point of application on the branch of the speculum in in-vitro calibration studies (Rowe 1995; Dumoulin et al. 2003; Verelst et al. 2004). Some versions offer the advantage of evaluating multidirectional forces originating from the PFM (Constantinou et al. 2007; Saleme et al. 2009). Other dynamometers can be adjusted to measure the PFM function at different vaginal apertures (Dumoulin et al. 2003; Verelst et al. 2004; Morin et al. 2010; Kruger et al. 2011).

Reliability

The test-retest reliability of PFM strength was found to be good (ICC=0.83-0.89) (Dumoulin et al. 2004; Verelst et al. 2004; Miller et al. 2007; Nunes et al. 2011). Other parameters such as endurance (ICC=0.81), speed of contraction (ICC=0.92) and tonicity (passive forces and stiffness) (ICC=0.74-0.92) of the PFM also showed good test-retest reliability (Morin et al. 2007; Morin et al. 2008; Kruger et al. 2011).

Validity and clinical applications

Dynamometers have been shown to discriminate between stress urinary incontinent and continent women (Morin, 2004b; Dumoulin 2004). Various studies have been conducted to support the validity of dynamometric measurements. The maximal strength recorded with the dynamometer was correlated to vaginal palpation (Oxford scale, r=0.727) (Morin et al. 2004). Moreover, dynamometric measurements have been proven to be minimally influenced by increases in intra-abdominal pressure (Morin et al. 2006). Discriminant validity was also demonstrated because the dynamometer was able to distinguish between continent and incontinent women (Morin et al. 2004). Furthermore, good sensitivity to detect changes following treatment was also demonstrated (Dumoulin et al. 2011).

The dynamometers were proven to be reliable and valid. Some versions offer the possibility to assess the PFM in various positions (lying, sitting and standing). Multi-dimensional force vectors are also possible. The main limitation associated with PFM dynamometers is their lack of accessibility because these devices are mostly used by their designers and not commercially available.

This presentation will draw upon these references:

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Digital Palpation to Imaging: How Do or Should Pelvic-Floor-Muscle Evaluation Tools Influence Physiotherapy Practice?

3. Electromyographic registration of the pelvic floor musculature to measure pelvic floor muscle function

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Various clinical methods, each with its own advantages and disadvantages, have been used for the assessment of PFM contraction or function. These methods include observation, palpation, electromyography (EMG), ultrasound, magnetic resonance imaging (MRI), manometers and dynamometers.
Electromyography (EMG) is a tool currently used in clinical and research settings and in daily practice to assess the PFM. This hand-out will give an overview what is discussed in the presentation; “psychometric properties of EMG registration of the pelvic floor”. It will discuss the constituents and the methodology associated with EMG registration. Available research evidence about the psychometric properties of the currently available instruments will be reviewed. Their respective advantages and limitations will be discussed in order to enable clinicians and researchers to better select the appropriate tool and analyse.
In the psychometrics, reliability is used to describe the overall consistency of a measure. A measure is said to have a high reliability if it produces similar results under consistent conditions. For example, measurements of people’s height and weight are often extremely reliable. Inter-rater reliability assesses the degree to which test scores are consistent when measurements are taken by different people using the same methods.

Test-retest reliability assesses the degree to which test scores are consistent from one test administration to the next. Measurements are gathered from a single rater who uses the same methods or instruments and the same testing conditions. This includes intra-rater reliability. In psychometrics, validity has a particular application known as test validity: "the degree to which evidence and theory support the interpretations of test scores" ("as entailed by proposed uses of tests").
There are two types of electrodes used for assessing the EMG of PFM; needle electrodes or surface electrodes. With needle or wire EMG the electrodes are placed directly in the target muscle by puncturing them through the skin and/or other tissues surrounding the muscle. Podnar and Vodusek recommended concentric needle EMG as the most informative test to detect PFM denervation or reinnervation. Wire EMG and concentric needle EMG, therefore, are recommended for scientific purposes. Because this is an invasive and uncomfortable procedure it has fallen into relative disuse and is not suitable for use in daily practice in pelvic floor physiotherapy [1;2].

EMG registration of the PFM is used for Biofeedback. Biofeedback has been found to be effective for the treatment of pelvic floor dysfunction (PFD). Biofeedback (BF) is one physical therapy adjunct that might be useful in the treatment of pelvic floor dysfunction.

Many EMG devices developed to record intra-vaginal and intra-anal biofeedback during the treatment of PFD. The devices come in various shapes and sizes, and most comprise large plates or rings. Therefore, comparison of results from one device to another is not recommended [3;4]. These devices have all been developed empirically and are not specifically designed with the pelvic floor anatomy in mind. Consequently, the electrode covers multiple pelvic floor muscles and registers other muscles in the proximity, such as the abdominal muscles. Thus, current devices are not optimized for biofeedback registration of the pelvic floor musculature since they are not capable of registering the activity of a single component of the PFM. In addition, there is no scientifically validated standard for normal pelvic floor function measured with these devices. Non-invasive recording of surface-EMG from the pelvic floor muscles usually adopts either longitudinal or ring-shaped pairs of electrodes or perianal electrodes.

When surface EMG is used clinically, interpretation of the signals must be done with caution because the risk of cross talk from other muscles is high and because of variability in electrode placement within the vagina or anal canal [3;4]. The validity and reliability of these devices will be discussed [4-7]. The PFM activity during running has been investigated. The specific goals were to describe and test the reliability of the PFM EMG activity and time variables during running. The periform was used to measure pelvic floor muscle activity. This study concludes that the EMG variables of good reliability could be shown, while poor evidence was gained for the reliability of time variables. In particular, further studies should consider adaptations regarding the vaginal probe[8].

Is PFM activation altered by changes in sensory feedback, muscle length or tissue position caused by two different vaginal probes used to record surface electromyography (EMG). Three conditions were compared (a) without any probe inserted into the vagina, (b) while a FemiscanTM probe was in situ, and (c) while a PeriformTM vaginal probe was in situ. There were no differences in peak EMG amplitude recorded during the MVCs across the three conditions. The authors stated that PFM muscle activation is not affected by different probes inserted into the vagina[9] The between-trial and between-day reliability of EMG data recorded from the PFM using two different vaginal probes was determined with the Femiscan and the Periform vaginal probes Overall, between-trial reliability was fair too high for the Femiscan and good too high for the Periform, however between-day reliability was generally poor for both vaginal probes). The results suggest that although it is acceptable to use PFM surface EMG as a biofeedback tool for training purposes, it is not recommended for use to make between- subject comparisons or to use as an outcome measure between-days when evaluating PFM function[5].
The retest reliability of repeated intravaginal surface electromyography (surface EMG) of the pelvic floor muscles in healthy women has been studied, who were able to perform correct pelvic floor muscle contractions. The study shows that surface EMG is a reliable method of assessing pelvic floor muscle activity in healthy women[10] The reliability and clinical predictive validity of pelvic floor muscle surface electromyography (sEMG) for use in early detection and prophylaxis of

urogynecologic disorders has been studied using an intravaginal sensor SEMG data demonstrated significant test-retest reliability ($P < .001$) and significant clinical predictive validity ($P < .05$) for undifferentiated urinary incontinence, stress incontinence, urge incontinence, menstrual status and parity on both initial and repeat examinations. Recent advances in sEMG technology make it cost-effective, convenient, non-invasive and easy to learn and administer by assisting staff. This technology is a powerful complementary tool for digital assessment of pelvic floor muscles and should be considered for use in gynaecologic practice[11].
This study validates surface EMG as a measure of pelvic muscle and abdominal activity by showing its high correlation to internal pressure data. A repeated measures multivariate analysis of variance demonstrated that visual and auditory biofeedback of EMG during pelvic floor contractions increases intravaginal pressure when compared with trials without biofeedback. Potential benefits of fabric electrodes include reduced invasiveness and risk and the ease with which patients can utilize this technology for home practice[7].

Recent developments

The purposes of this study were to compare: the reliability of electromyography (EMG) activity recorded from the pelvic floor muscles (PFMs) using a new differential suction electrode (DSE) to the reliability of EMG data recorded using other common electrodes, and (ii) motion artefact contamination of EMG activity recorded from the PFMs using the DSE and the FemiscanTM electrode. The DSE has excellent between-trial reliability and performs better than the FemiscanTM electrode in terms of motion artifact contamination. It does not perform as well as the FemiscanTM electrode in terms of between-day reliability--a result that is not unexpected given the localized region from which the DSE records activity.[6] A new vaginal device-a vaginal photoplethysmograph with build-in surface electromyography (EMG)--that allows simultaneous assessment of pelvic floor muscle activity and vaginal blood flow has been tested. The device is sensitive to changes in vaginal blood flow in response to sexual stimuli, and it is able to pick up small, involuntary changes in pelvic floor activity associated with anxiety. Also, the device is able to record changes in pelvic floor activity during voluntary pelvic floor contractions. This new device will be a valuable tool in further research on superficial dyspareunia[12]
One of our investigations was performed in order to validate the anatomical positioning of commonly used commercially available probes, positioned according to standard protocol as used in daily practice by pelvic floor physiotherapists. Based on our findings we conclude that the electrodes of the probes, as we use them now during electro stimulation and biofeedback training in the treatment of pelvic floor dysfunction, are not optimal for the structures we want to register[13].A new multiple array electrode probe (the MAPLe) has been developed for biofeedback registration of the individual (sides of the) pelvic floor muscles. A study was performed to determine the reliability and reproducibility of electromyography signals measured with the MAPLe in healthy volunteers. The conclusions of this study are that MAPLe appears to be very effective in measuring EMG values for individual muscular components at different sides of the pelvic floor men and women with different menopausal status, nulliparous or parous. It is the first time that the individual activity of the complex pelvic floor musculature has been measured and the results suggest that the MAPLe can be used to generate a healthy baseline data for the diagnosis and treatment of patients with pelvic dysfunction[4].

How do or should PFM evaluation tools influence clinical practice for UI?
This will presents the known body of evidence on the relationship between (1) pelvic floor morphological deficit and dysfunction and (2) symptomatology, diagnosis and urinary incontinence outcome predictions for women with UI. It also examines the impact PFM evaluation literature has on treatment choice (exercise choice or parameters) for treating patients with UI.
Pelvic floor Physiotherapy is recommended in many published guidelines[14]. Pelvic floor muscle training has received Level-A evidence rating in the treatment of stress urinary incontinence in women, based on meta-analysis of numerous randomized control trials and is re in this review the authors stated that, the actual regimen of PFM training used varies widely in these RCTs. Hence, to date, the optimal PFM training regimen for achieving continence remains unknown and the following questions persist: how often should women attend PFM training sessions and how many contractions should they perform for maximal effect?
Is a regimen of strengthening exercises better than a motor control strategy or functional retraining? Is it better to administer a PFM training regimen to an individual or are group sessions equally effective, or better? Which is better, PFM training by itself or in combination with biofeedback, neuromuscular electrical stimulation, and/or vaginal cones? Should we use improvement or cure as the ultimate outcome to determine which regimen is the best? The questions are endless[15].
Feedback or biofeedback may provide benefit in addition to pelvic floor muscle training in women with urinary incontinence. However, further research is needed to differentiate whether it is the feedback or biofeedback that causes the beneficial effect or some other difference between the trial arms (such as more contact with health professionals)[16]. The two most recent Cochrane reviews on pelvic muscle exercises for urinary incontinence were focused on stress urinary incontinence (SUI). Physical therapy has been shown to be an effective therapy for SUI[17]. There is also some evidence that biofeedback is effective for Urge Urinary Incontinence (UUI) [17;18]. The included trials that combined pelvic floor muscle exercises with urge and/or frequency suppression strategies, adjuncts to pelvic floor muscle exercises such as biofeedback and vaginal weights, or pelvic floor muscle stimulation through vaginal electrical stimulation or magnetic therapy. There were found only three randomized controlled trials involving 401 women with UUI and MUI evaluated the efficacy of PME with biofeedback. Upon review of these trials, substantial variability of reported outcome measures and follow-up intervals existed. All studies reported significant reduction in UUI as compared to before treatment. Biofeedback treatment was associated with high patient satisfaction. Pelvic floor muscle strength was significantly increased with the biofeedback group but was not significantly different from the group that only received PME. The potential for study- level bias exists as none of these studies had adequate allocation concealment or blinding of subjects, therapists, or assessors. Although the outcomes measures for these trials were systematic measured, outcome bias may also be present [17;19;20] .

Conclusions We know that EMG registration with biofeedback is effective in the treatment of pelvic floor dysfunctions. However more randomized controlled trials are warranted with standardized treatment protocols and control groups and with the same equipment, in order to get more uniformity in diagnosis and treatment of pelvic floor dysfunctions. Followed by the possibility to compare different studies, which is impossible at this moment. With the validation study of the MAPLe we hope to contribute to make pelvic floor physiotherapy more evidence based. There is a need for well-designed randomized controlled trials with adequate sample sizes, validated outcome measures and long-term follow-up. In particular, studies should assess the effectiveness of different components of the package of care often called 'biofeedback'.

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Ultrasound

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Background/Constituents

The term ‘Ultrasound’ refers to very high frequency sound waves (>2MHz). The soundwaves are longitudinal compression waves which are modified by the medium through which they travel. The denser the material the faster the sound will travel. *Acoustic impedance* is a term which describes the difference in properties between two contiguous structures. The higher the acoustic impedance; the brighter the image. Bone has high acoustic impedance, producing a bright or hyperechoic image. Water and fat have a low acoustic impedance thus the image appears darker hypoechoic or anechoic. Images are produced in shades of gray on a black background, known as grayscale or B mode imaging. The soundwaves are generated from the transducer head which also then records echoes from structures which they encounter[1].

1.1 Transducers:

The transducer heads differ mainly by how the crystals are arranged within it i.e. annular array, linear array, curvilinear, etc., which in turn influences the depth, angle of penetration and field of view of sound waves. The crystals are piezoelectric elements which vibrate when subjected to electrical stimulation. Temporal characteristics of send/receive cycle in transducer allows for real time images(4D) to be produced. Different transducers are used for different imaging tasks: Obstetric and abdominal ultrasound: 2-5MHz curved array transducer, or transvaginal probes with a frequency of ≥5MHz. 3.5-7MHz with a wide field of view are used for 3D imaging. Linear array transducers tend to be used for abdominal scanning.

1.2 Ultrasound machines:

There are many different varieties and abilities of ultrasound machines, from simple 2D (B mode) imaging to very expensive machines which integrate image planes to produce rendered volume images and allow acquisition of ‘cine loops’. The image produced on the screen consists of multiple scan lines, which can be adjusted by adjusting the frame rate. Optimal real time imaging relies on high frame rates. Certain elements of the image can be adjusted on the screen; most commonly using the ‘depth’ button which allows deeper structures to be visualized by often with a loss of resolution. The gain button adjusts the brightness of the image, and ‘focus’ allows the focusing on a particular area. The more complicated the machine, the more you are able to manipulate the image. It is important that you know the characteristics of the ultrasound machine that you are using to optimize the image. Many ultrasound machines also have the ability to analyse images off line, using specialized software.

2. Methodology:

Ultrasound has been available for many years, although other imaging modalities such as computed tomography, and MRI have also been used to evaluate the pelvic floor. The advantage of ultrasound is that there is no ionizing radiation, it is cost effective and easy to use. Off line analysis has also hugely increased accessibility.

2.1 Abdominal ultrasound

Abdominal ultrasound can be used to assess pf muscle activation ([2-4]). The equipment requirements are less than that of 3/4D ultrasound: US machine needs cine loop capabilities and a 3-5MHz curved array transducer can be used (most commonly used transducer for abdominal work).
Patient can be imaged supine, crook lying or standing [2]. A comfortably full bladder is recommended in order to visualize movement of the posterior wall of the bladder. The mid-sagittal orientation of the transducer has shown better reliability than the transverse orientation for assessment of bladder base displacement[3]. Transducer is placed suprapubically angled in a 15-30% angle from the vertical. The posterior bladder should be clearly visible. Check that the patient can perform an adequate contraction first before commencing measurements. A marker is made on the screen using the ‘at rest’ image, (dual screen) then on maximum contraction the corresponding image is frozen. The distance from at rest position to the contracted position of the posterior bladder wall can be measured using on line calipers.

This method has shown good inter-rater reliability 0.86-0.88[3], however there are several caveats:

- There is no bony reference, so the actual distance that the bladder moves is not relative to a fixed anatomical point.
- The bladder wall is a surrogate for pelvic floor muscle – it is not the muscle
- Movement of the bladder may be confounded by abdominal wall activation –
- Functionality best assessed with TPU[4].

Nonetheless, this method is easy, there is no need for fancy machines and it is useful for biofeedback. It is also possible to assess increases in bladder base lift pre and post physio treatment.

2.2 Transperineal ultrasound(TPU)

Transperineal (translabial) or transvaginal ultrasound is the most common method for investigating pelvic floor disorders[5]. This approach enables the entire pelvic floor muscle area to be visualized, and if using a 3D ultrasound machine, the boundaries of the muscle can be seen in the axial orientation – previously the domain of Magnetic resonance imaging.

2.2.1 2D/B Mode ultrasound imaging

Usually readably available, easy. Only need a simple machine with cine loop capabilities, and a 3.5- to 6-MHz curved array transducer. Patient is usually examined in the supine position, knees comfortably flexed after voiding. The transducer is covered in a glove or condom for hygienic reasons. Ultrasound gel applied to the transducer then placed firmly on the perineum in the midsagittal orientation (Fig 1). Still widely used[5-7]

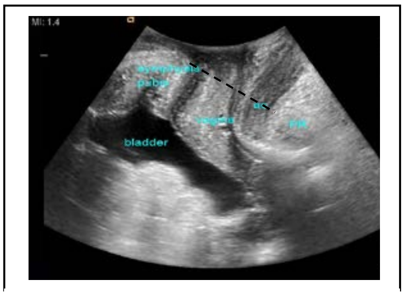


Figure 1: 2D Pelvic floor ultrasound. AC- anal canal, PR- puborectalis muscle. Dotted line =AP diameter of hiatus

Clinical use of 2D ultrasound

- Measure the anterior-posterior diameter from edge of symphysis pubis to ano-rectal angle at rest, on contraction and on valsalva
- Assess residual bladder volume (apxtransversex5.6)
- Assess movement of the bladder neck during cough and valsalva (cine loop)
- Assess activation (or not) of the pelvic floor muscle prior to cough
- Assess any damage to insertion site of the puborectalis muscle. (easier on 3D imaging)
-

Reliability of 2D ultrasound ranges from (ICC - 0.93 for PFMC) and (ICC 0.87 on valsalva maneuver)[8]. However, if you are going to use transperineal ultrasound, and have access to a 3D probe then it useful to use 3/4D function in order to visualize the anatomy in the axial plane.

2.2.2 3D/4D Ultrasound

3D ultrasound popularized by obstetric scanning – proved very suitable for pelvic floor muscles. Involves the integration of 2D sectional images into rendered volume images, and allow access to the axial plane[5]. Require a minimum of a curved array volume transducer (8-4MHz) with a wide angle of acquisition (≥70°). Protocol as for 2D. Use the symphysis pubis as reference point during movement.

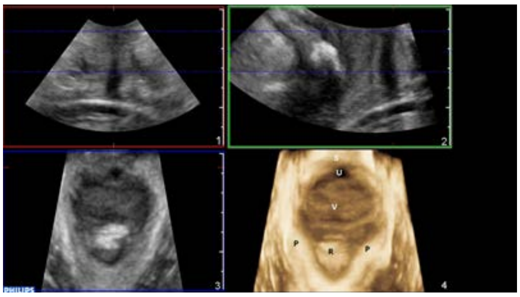
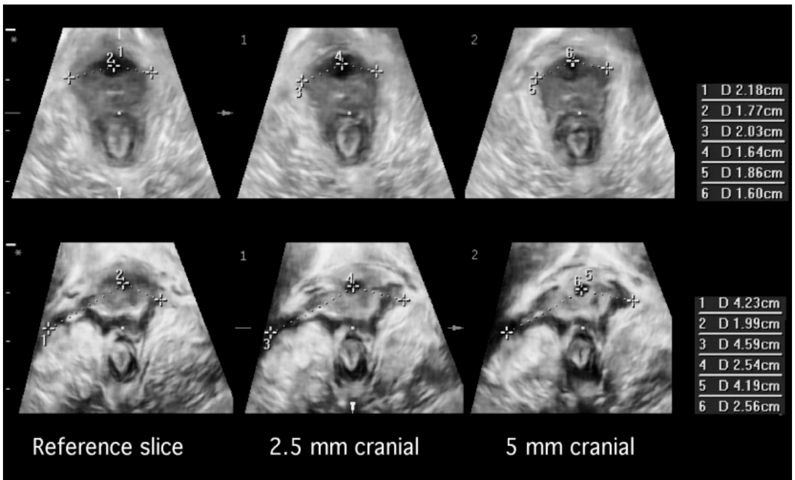


Figure 2: Standard acquisition screen of 3D pelvic floor image 1, Coronal, 2, Midsagittal, and 3, axial planes and 4, rendered axial plane (ie, semitransparent representation of all pixels in *box* [region of interest] seen in1- 2). *P*, puborectalis muscle; *R*, rectum, *S*, symphysis pubis; *U*, urethra; *V*, vagina.

Clinical use of 3D/4D ultrasound

- Measure hiatal biometry: ap diameter, transverse diameter and hiatal area at rest, on contraction and valsalva.
- Highly reproducible[9-11]
- Able to look for signs of levator damage using tomographic imaging(TUI) (Figure 3)
- Published protocol's on how to identify avulsion using TUI[12]
- Measurement of the urethral-levator gap (>2.5cm) in the central three slices – diagnostic for damage(Fig 4)[13]Robust measurement, very unlikely to result in false positives[14] –



Advantages:

- Proved reliable, and reproducible in the measuring functionality of the pelvic floor
- Access the axial plane - visualize the entire pf muscle.
- Ability to use tomographic imaging – determine muscle injury (may affect your treatment)
- Able to measure pelvic organ descent on valsalva – determination of prolapse
- Off line processing and ability to share images and volumes – increased accessibility

Disadvantages:

- Need a 3/4D capable ultrasound machine
- More uncomfortable than abdominal ultrasound
- Probably requires more time to learn how to acquire images

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Digital Palpation to Imaging: How Do or Should Pelvic-Floor-Muscle Evaluation Tools Influence Physiotherapy Practice?

MRI evaluation as a tool to measure pelvic-floor-muscle function

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Aims of this topic:

1. To present the magnetic resonance imaging (MRI) evaluation technique used to measure pelvic-floor-muscle (PFM) function.
2. To present the PFM MRI measurements used to assess PFM morphology (a) at rest, (b) during an active pelvic floor contraction, and (c) a Valsalva manoeuvre.
3. To discuss how pelvic floor MRI evaluation compares with other PFM assessment tools.
4. To present and discuss the advantages and limitations of the digital evaluation technique.

Pelvic floor muscle MRI:

This section presents the pelvic-floor-muscle MRI technique, a relatively new imaging technique that provides an excellent visual image of the PFM, the bladder and urethral anatomy in women. Two types of pelvic floor MRI acquisition will be discussed: static (a high-resolution acquisition showing the morphology at rest) and dynamic /cine view (a low-resolution acquisition that shows structural displacements on movement).

Pelvic-floor-muscle MRI measurements include those taken from the sagittal plane (the pubococcygeal line, the anorectal angle, H-line, M-line, PCL/H-line angle, ureterovesical (UV) junction height, uterocervical junction height, UV junction approximation, bladder neck funneling occurrence [yes/no], funneling width, funneling length, and posterior UV angle) and the axial plane (the hiatus length, hiatus width, and striated urethral sphincter morphology, both inner and outer diameters).

MRI advantages:

1- Less invasive than other imaging techniques
2- Reliable imaging technique with good psychometric properties
3- Not operator-dependant
4- Fewer artefacts due to operator movements

5- High resolution images and good contrasts without anatomical distortions
6- No ionizing radiation (magnetic field)
7- No probes are needed, only a pelvic coil centered on the pubis
8- The three compartments and two bony references are visible simultaneously
9- Multi-plane: axial, sagittal and coronal
10- 3D reconstruction modeling
11- Static (physiologic state) and dynamic assessments are possible

MRI disadvantages:

1- Does not allow for real-time function tasks (e.g., cough tasks)
2- Cannot be used as a biofeedback tool
3- Expensive
4- Most units designed for non-physiological positioning (supine). However, studies show that the supine position is effective for evaluate PFM morphology and function.

Discussion and presentation of the psychometric properties of the MRI morphological measurements and how these correlate with other PFM assessments. MRI has been used to study normal and abnormal female PFM morphology at rest, during a PFM contraction and during Valsalva manoeuvres. Parameters such as PFM volume, shape, integrity and displacement have been shown to differ between continent and incontinent young and middle-aged women; hence, will be reviewed. Finally, the changes in PFM morphology following PFM rehabilitation will be presented.

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Digital Palpation to Imaging: How Do or Should Pelvic-Floor-Muscle Evaluation Tools Influence Physiotherapy Practice?

Topic: **How do PFM evaluation tools influence clinical practice for urinary incontinence?**

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Aims of this topic:

1. To discuss the known body of evidence on the relationships between pelvic floor morphological deficit and dysfunction and aging.
2. To present the known body of evidence on the relationships between pelvic floor morphological deficit and dysfunction and urinary incontinence (UI) symptomatology.
3. To review the known body of evidence on the relationships between pelvic floor morphological deficit and dysfunction and diagnosis and outcome predictions for UI.
4. To examine the impact of PFM evaluation literature on treatment choices (types of exercises) for treating patients with UI.

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How do or should PFM evaluation tools influence clinical practice for POP?

Pelvic organ prolapse (POP)

- Epidemiological studies have defined statistical associations between prolapse and identified risk factors, including: (i) sustained increases in abdominal pressure; (ii) loss of muscle function; and (iii) increases in size of the hiatus[15].
- POP is a common condition – reports of 20% women will require surgery[16]
- Surgery – controversial, costly and with high recurrence rates.

Symptoms include:

- Lump/dragging sensation in the vagina
- Feeling like 'something is coming out'
- Can be felt digitally on valsalva (POP_Q)

Evidence of morphological change associated with POP

No definitive cause of POP> but unequivocal evidence from imaging studies that damage to the levator ani (pelvic floor muscle) is strongly correlated to prolapse. 55% of women who presented with prolapse (>stage2) had damage 'major' damage to the levator ani muscle from MR images-corroborated by ultrasound imaging development[17 18].

Associated morphological changes include:

- Enlargement of the levator hiatus at rest and on valsalva (>25cm^2)[19]
- Decrease in PFM strength[20]
- Presence of avulsion injury[18].

These changes are visible using TPU imaging (2D and 3/4D) [5 6].

Be aware of confounders:

- Full bladder/rectum
- Co-activation of levator ani during valsalva

- Ineffective valsalva

TPU Parameters to measure:

- bladder neck descent, hypermobility is often associated with urinary incontinence [5] (cystocele)
- Funnelling of the bladder neck also indicative of leakage (not always though)
- Uterine descent (enterocele)
- Descent of the rectal ampulla (rectocele)
- Hiatal biometry

Insert images

PFM's pre and post vaginal delivery

Vaginal birth is significantly implicated in the development of levator ani trauma[21-25]

A woman who has had 4 children is 8x more likely to present with symptoms of prolapse that require correction[15].
Stretch of the PFM is significant during vaginal birth – up to 3X normal length – would be injurious for other skeletal muscle[26].

Inevitable that there will morphological changes associated with the physiology of childbirth. Most cases – the anatomy and physiology will be able to return to a functional state.

Evidence pre and post delivery shows changes in all measured parameters of the PFM.[24] General decrease in PFM strength and resting pressure[24.] Increase in PFM hiatal area post partum (more so in women with avulsion)[27 28.]

Outcome prediction and physiotherapy for prolapse

Recent evidence that target physiotherapy may be effective for treatment of early stage prolapse:

Braekken et al (2010) RCT (109 women 59 PFMT and 50 controls)
Target pelvic floor muscle training (PFMT) improved outcome measures of prolapse including measures on ultrasound:

- Bladder neck elevation and elevation of the rectal ampulla improved
- PFM strength also improved in treatment group
- PFMT group felt their symptoms improved.

PFMT – intensive (6/12mths). 1x a week for first 3/12mths the 1x fortnight for second 3/12
Measures were done immediately post intervention[29]

Cochrane review (2011) –

- Some evidence of positive effect for PFMT on prolapse symptoms and severity.
- No evidence yet on the effectiveness of different intensity of PFMT
- No evidence yet on the benefit of combining PFMT before surgery[30]

Ultrasound is a useful tool to aid with biofeedback and diagnosis of pelvic floor muscle dysfunction. Can help determine treatment options and as a reliable outcome measure for that treatment.

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Digital Palpation to Imaging: How Do or Should Pelvic-Floor-Muscle Evaluation Tools Influence Physiotherapy Practice?

Topic: **How do PFM evaluation tools influence our practice with vulvodynia**

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Aims of this topic:

1. To define and describe symptomatology of vulvodynia.
2. To discuss pathophysiological mechanisms of vulvodynia and emphasise the importance of the PFM function.
3. To present the findings in the literature when comparing PFM function in women with and without vulvodynia.
4. To discuss the impact of PFM physiotherapy on the PFM in women with vulvodynia.

Definition and Symptomatology

Vulvodynia is a neglected and important health problem affecting 12 to 21% of women in community samples (Arnold et al. 2006). It is defined as « Vulvar discomfort, most often described as burning pain, occurring in the absence of relevant visible findings or a specific, clinically identifiable, neurologic disorder » by the International Society for the Study of Vulvovaginal Disease (ISSVD) (Moyal-Barracco et al. 2004). Vulvodynia can be categorized into generalized and localized pain. It can be further subdivided into provoked, unprovoked and mixed pain (Moyal-Barracco et al. 2004).

Pathophysiology

The pathophysiology of vulvodynia remains poorly understood. Several causes have been suggested including embryologic abnormalities (Burrows et al. 2008), genetics or immune factors (Witkin et al. 2002; Witkin et al. 2002; Babula et al. 2004), hormonal factors (Bouchard et al. 2002; Bohm-Starke et al. 2004), and central and peripheral neurogenic changes (Bohm-Starke et al. 1998; Westrom et al. 1998; Pukall et al. 2002; Bornstein et al. 2004). In addition to the biomedical factors, psychosocial variables have been identified (Desrochers et al. 2009; Rosen et al. 2012). Among the different mechanisms, the involvement of the pelvic floor muscles (PFM) has been proposed as a predominant role in several conceptual models (Zolnoun et al. 2006; ter Kuile et al. 2010; Hoffman 2011).

Implication of the PFM function in women with vulvodynia

Increase in PFM tone is suggested to play an important role in vulvodynia. However, terminology associated with PFM tone lacks standardisation and muscle physiology associated with muscle tone is often not well understood. Simons and Mense (1998) described that general muscle tone in skeletal muscles comprises the measures of the viscoelastic properties of the muscular tissue, physiological contracture (more commonly defined as trigger point), electrogenic spasm (which includes unintentional muscle contraction with or without pain that could be controlled voluntarily) and normal electrogenic contraction (involves resting activity in normally relaxed muscles and also myotatic reflex during stretching).

Electromyography (EMG): Viscoelastic properties and physiological contractures are not detectable using EMG. EMG signals represent electrogenic contraction and spasm. Hence, only a portion of general muscle tone is assessed. The role of the electrogenic component in the pathophysiology of vulvodynia has been shown by comparing women with vulvodynia to asymptomatic controls (White et al. 1997; Glazer et al. 1998; Gentilcore-Saulnier et al. 2010). However, the results are controversial because some studies found a non-significant difference between the two groups (van der Velde et al. 2001; Engman et al. 2004; Reissing et al. 2004).

Palpation: All the components of general muscle tone evaluation are measured when using palpation. Women with vulvodynia showed higher tonicity and lower flexibility (Reissing et al. 2004; Gentilcore-Saulnier et al. 2010). Although palpation remains a subjective tool, the ability to detect myofascial trigger points represents an important advantage. The assessment of trigger points is important in a pain condition and was demonstrated to play a key role in chronic pelvic pain (Weiss 2001).

Dynamometry : Women with vulvodynia were found to have higher general PFM tone compared to asymptomatic controls (ref). This methodology offers the advantage to assess the PFM during a dynamic stretch.

Ultrasound: PFM morphometry differs in women with and without vulvodynia, suggesting an increase in general muscle tone (Morin et al. 2011). Transperineal ultrasound offers a great advantage in women with pain because it is pain-free (no vaginal insertion is required). Therefore, it was shown that these impairments are not limited to a protective defense reaction to the painful assessment but are rather present chronically.

The importance of parameters other than PFM tone has be shown in the pathophysiology of vulvodynia (Glazer et al. 1998; Reissing et al. 2004; Reissing et al. 2005; Morin et al. 2010). Women with vulvodynia also demonstrated lower PFM strength, rapidity of contraction and endurance (Glazer et al. 1998; Reissing et al. 2004; Reissing et al. 2005; Morin et al. 2010). Therefore, the assessment of the PFM should not be limited to PFM tone.

Impact of PFM physiotherapy on the PFM in women with vulvodynia

Physiotherapy interventions may include different modalities such as education, manual therapy, biofeedback, electrical stimulation and dilation technique (Hartmann et al. 2007). Effectiveness of physiotherapy has been shown in many studies to reduce pain (Bergeron et al. 2002; Holland 2003; Downey et al. 2006; Fisher 2007; Gentilcore-Saulnier et al. 2010). Significant effects on muscle function have been reported by several authors (Bergeron et al. 2002; Gentilcore-Saulnier et al. 2010).

This presentation will draw upon these references:

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Notes