

Pelvic floor exercises according to the Integral Theory - strengthening the 3 directional muscle forces improves chronic pelvic pain, bladder & bowel dysfunctions

PATRICIA M. SKILLING MB ChB (St And.)

Formerly Head of Pelvic Floor Rehabilitation, Kvinno Centre Perth Western Australia

Abstract. Background: By 1995 it was evident from the surgical data that a substantial percentage of chronic pelvic pain, bladder & bowel dysfunctions in the female could be cured by surgical repair of the pelvic suspensory ligaments. **Aims:** Using a squatting-based regime, we aimed to strengthen the 3 directional muscle forces and the ligaments against which they contract, to improve urethral closure (incontinence) opening (bladder emptying), support of the bladder base stretch receptors (urge incontinence) and, Frankenhauser and Sacral nerve plexuses (chronic pelvic pain). **Results:** The standard regime comprised four visits in 3 months. HRT was administered to all patients, electrotherapy 20 min per day for 4 weeks with a 50Hz probe placed into the posterior fornix of the vagina, squeezing 3x12 per day, reverse pushdowns 3x12 per day and squatting or equivalent up to 20 min per day as part of daily routine (such as household tasks). Of 147 patients (mean age 52.5 years), 53% completed the programme. Median QOL improvement reported was 66%, mean cough stress test urine loss reduced from 2.2 g (range 0-20.3 g) to 0.2 g (range 0-1.4 g), $p < 0.005$, and 24-h pad loss from a mean of 3.7 g (range 0-21.8 g) to a mean of 0.76 g (range 0-9.3 g), $p < 0.005$. Frequency, nocturia and pelvic pain were significantly improved ($p < 0.005$). Residual urine reduced from mean 202 ml to mean 71 ml ($p < 0.005$). This method extends indications for nonsurgical therapy beyond stress incontinence, and the results appear to encourage this approach. Approximately 3% of patients reported worsening of their stress incontinence and these were referred for surgery. **Conclusions:** The 50% dropout rate was a concern. Subsequently we performed a small pilot study (unpublished) using a simpler regime: electrotherapy, situps before getting out of bed, developing a "squatting culture" as part of a daily routine, sitting on a round fitball instead of a chair. The initial results suggested better compliance and equivalent improvement. This method, though promising, awaits rigorous scientific assessment.

Key words: Integral Theory; Pelvic floor rehabilitation; PFR; Urge; Nocturia; USI; Constipation.

INTRODUCTION

Current pelvic floor rehabilitation (PFR) methods in the female address mainly stress incontinence. Though it is implicit that pelvic floor rehabilitation exercises cure stress incontinence by strengthening the pelvic floor muscles, how this occurs is rarely mentioned in the literature. Though many variations involving various abdominal muscles have been added from time to time, "squeezing" upwards, or upward pulling of the pelvic diaphragm, as described by Kegel¹ is the core element of all modern methods. Squeezing upwards, figure 1, is unidirectional and is not the natural closure mechanism, so it must be learnt. The natural closure mechanism, figure 2, is activated by 3 opposite directional forces as described in the 1990 Integral Theory².

As regards urge, frequency and nocturia, the current view is that such symptoms should be treated with "bladder training", a methodology which trains the inhibitory circuits of the brain. The patient is taught to 'hold on'. Pain treatment depends on site. It consists of biofeedback, identifying and treating 'trigger points' in the pelvis and often 'psychological' treatment.

Origins of the pelvic floor exercises based on the Integral Theory

Because the normal pelvic floor functions as a balanced synergistic system composed of muscle, ligaments, connective tissue, we reasoned that if we could strengthen the 3 directional forces, figure 2 using a squatting-based regime, it would also strengthen the suspensory ligaments, in particular pubourethral (PUL) and uterosacral (USL), figure 2. In deciding to proceed with squatting as an exercise, we were encouraged by Zacharin's findings of thickened collagenous muscle insertions of levator ani in patients who squatted as part of their daily routine³.

As regards urinary stress incontinence and bladder evacuation

The extra muscle strength would pull on PUL and USL to strengthen them. Stronger muscles improve the strength of urethral closure (incontinence) and also stretch open the posterior wall of the urethra more strongly, improving bladder emptying.

As regards urinary urge incontinence

The extra muscle strength would stretch the vaginal membrane to better support the bladder base stretch receptors, thereby preventing the micturition reflex from being inappropriately activated, and so improve urge incontinence, figure 3.

In the normal patient, figure 3, central inhibition (white arrow) and reflex stretching of the vagina by opposite muscle forces (arrows) to support the stretch receptors 'N'. Connective tissue laxity in the suspensory ligaments or vaginal membrane (figure 3) may not transmit the forces applied and so the vagina cannot be adequately stretched; the stretch receptors (N) may 'fire off' at a lower hydrostatic pressure (smaller bladder volume) and the cortex interprets this as urgency. At night, there is nocturia. The sensitivity of the stretch receptors is clearly an important variable.

The original aim was to address a wide range of pelvic floor dysfunctions by strengthening all possible components of the system, in particular ligaments and muscles, as much as possible. We aimed for minimal time loss, weaving every element of treatment seamlessly into a daily routine. On this basis, we included the Kegel regime, even though the muscle responsible for squeezing upwards, puborectalis muscle, does not contract against the suspensory ligaments, but directly against the pubic bone, figure 1.

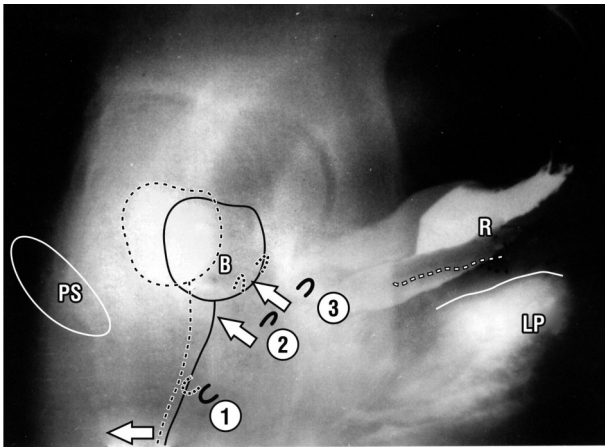


Figure 1. – Squeezing. ‘Kegel Exercise’. Standing lateral xray, the squeezing film (broken lines) is superimposed on the resting film (unbroken lines). Vascular clips have been applied to the anterior vaginal wall: ‘1’ to midurethra; ‘2’ to bladder neck; ‘3’ to bladder base. The unbroken lines represent the resting position and the broken lines the squeezing position. The muscle movements during ‘squeezing’ elevate vagina, bladder ‘B’, rectum ‘R’ and levator plate ‘LP’ upwards and forwards. Note the difference with the movements in figure 2. Because ‘squeezing’ is not the natural mechanism, it must be learnt (Kegel 1948).

RATIONALE FOR THE TREATMENT PROTOCOL

As one can never be certain of the contribution of a particular component in pathogenesis, we aimed to strengthen each of these components where possible, the rationale being that even a few percentage points from each component can achieve a significant total improvement. Kegel-type exercises and endovaginal electrotherapy are proven staples of PFR, and they were in this study. We hypothesized that electrotherapy stimulates the neuromuscular junction, and that “squeezing” stimulates the puborectalis and the for-

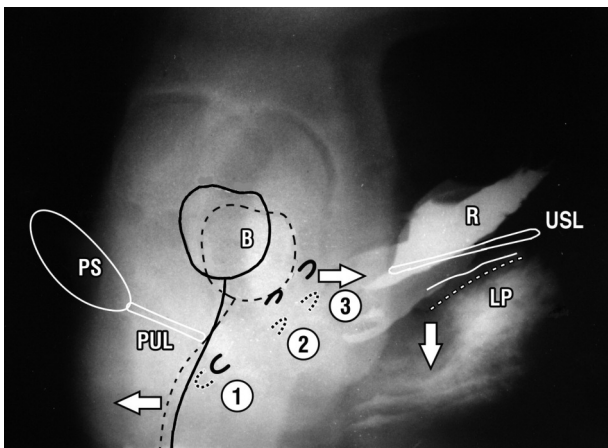


Figure 2. – Same patient and labeling as figure 1. The 3 directional movements which close the urethra during effort. Standing lateral xray, the squeezing film (broken lines) is superimposed on the resting film (unbroken lines). Vascular clips have been applied to the anterior vaginal wall: ‘1’ to midurethra; ‘2’ to bladder neck; ‘3’ to bladder base. The unbroken lines represent the resting position and the broken lines the straining or coughing position. Reflex muscle movements stretch the distal urethra ‘1’ forwards and downwards around the pubourethral ligament ‘PUL’ to close it. The bladder neck ‘2’ and bladder base ‘3’, are stretched backwards against PUL by LP and downwards by the downward angulation of levator plate ‘LP’, (downward arrow). This action closes proximal urethra and bladder neck. The downward forces (arrow) pull against the uterosacral ligaments (USL).

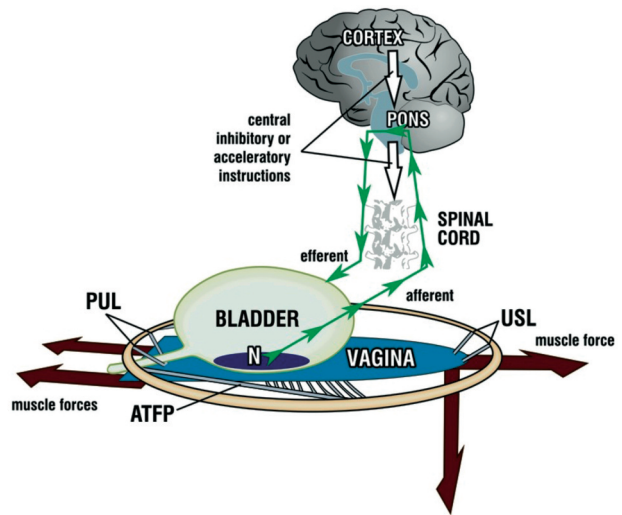


Figure 3. – Trampoline analogy- Function. How the muscle forces control peripheral neurological function. Like a trampoline, laxity in even one suspensory ligament, PUL, ATFP or USL, may prevent the muscle forces (arrows) from tensioning the vaginal membrane. The stretch receptors ‘N’ cannot be supported, and fire off prematurely. The cortex perceives the afferent impulses as urge symptoms.

ward closure forces (Figure 1). Prolonged squatting “squatting culture” as part of a normal daily routine and downward reverse pushdowns were introduced to strengthen the natural slow and fast-twitch components of all three directional muscle closure forces (Figure 2). These are the natural movements of closure as proven during radiological studies, figure 1. Squatting not only strengthens the muscle, it also strengthens its collagenous (ligamentous) insertion points. How these exercises may improve urge, frequency and nocturia is explained by the trampoline analogy (Figure 3). Good posture was emphasized, as it promotes optimal muscle leverage. All postmenopausal patients were encouraged to take estrogen, systemic or local, to thicken vaginal mucosa and decrease collagen loss. Time efficiency was addressed by limiting attendance at the clinic to a total of four visits in 3 months, by making the pelvic floor methods part of the fabric of a patient’s daily routine, and enlisting the patient’s participation in planning the treatment.

TREATMENT PROTOCOL

Much of the next sections have been reprinted, by permission, from the publishers. Age, activity, hormonal status and posture were assessed. Some types of HRT oral or vaginal estrogens were prescribed. General exercise and good posture were encouraged. To assist compliance, the patient was required to complete a daily diary.

Electrotherapy

Electrotherapy was introduced at the 1st visit, along with squatting and squeezing exercises. A simple low-cost battery-operated electrical stimulator, the Pelvitorner 2000 (Medhealth Pty Ltd, Perth,WA), was used for 4 weeks. This delivered a square 50-Hz pulse every 2 s. Positioning of the probe was guided by a pictorial algorithm which diagnosed whether symptoms originated from ligament looseness in the front or back of the vagina. For purely posterior defects (e.g. pelvic pain, high residual urine, nocturia), the probe was inserted into the posterior fornix for 20 min per day. Bladder suppressant drugs were never used.

Pelvic floor exercises

Squatting and Kegel-type pelvic floor squeezes were introduced at the 1st visit, the latter performed with legs apart according to the methods of Bo⁵. Co-ordination with the electrical stimulator light (biofeedback) was encouraged if possible. At the 2nd visit, a reverse downward thrust was introduced (3 sets of 12 per day) to alternate with squeezing (3 sets of 12 per day). The patient pushed vigorously downwards while pressing upwards with one finger placed on one side of the urethra, approximately 2 cm from the introitus. These exercises aimed to strengthen the tridirectional fast twitch muscle fibres (Figure 2, arrows). The “reverse pushdown” exercises were not well tolerated in 2/3 patients, and these patients were told to substitute Kegel exercises.

Squatting was encouraged as a universal slow-twitch exercise, 20 min per day in divided segments, preferably while performing some household task. In patients who could not or would not squat, sitting on a large rubber “fitball” during work or household duties was encouraged. Time management was improved by encouraging patients to perform one group of twelve exercises on waking, retiring, and on visiting the toilet. Also, to substitute squatting for bending at all times. If a patient had arthritis, she was encouraged to sit on the end of a chair or a fitball with legs apart.

The 3rd and 4th visits checked patient compliance (diary), discussed how the patient had incorporated the programme into her daily routine, and reinforced the aims and principles of the programme.

Maintenance PFR

By the end of 3 months, it was assumed that the patients had incorporated the exercises into their normal routine. Maintenance electrotherapy was to be performed for 5 days per month. The patient was advised to continue this routine on an ongoing basis. If the patient came to surgery, then it was advised that the PFR be recommenced 12 weeks after surgery.

RESULTS

The 1st study Results of the First study⁶. Sixty patients completed the study. Improvement was defined as >50% improvement in their symptoms (see Table 1).

The 2nd study One hundred and forty-seven patients, mean age 52.5 years (range 25-76) and mean parity 2.25 (range 0-5), commenced the full regime. Ten patients were

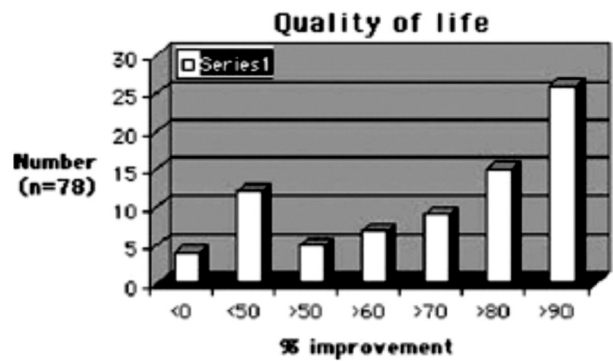


Figure 4. – Quality of life improvement. The vertical axis represents actual numbers, and the horizontal axis represents % improvement of that particular group. Thus 25 patients improved their QOL by 90%, 11 patients by 50% and so on. On a total symptom basis, the median QOL improvement reported was 66%. In such patients, improvement was evident by the 2nd visit (4 weeks).

condition	>50% improvement
stress incontinence (n=69)	57 (82%)
urge incontinence (n=44)	33 (68%)
frequency only (n=12)	10 (83%)
nocturia (n=32)	29 (90%)
pelvic pain (n=17)	13 (76%)

nulliparous. Surgery included, the dropout rate was 1st visit 17%; 2nd visit 19%; 3rd visit 11%; Total 47%.

The principal reasons for non-compliance were lack of time, or insufficient motivation. Quality of life (QOL) improvement rate is summarized in Figure 4 and symptom improvement in Table 2. QOL was a separate question which the patient was asked to answer: Has your quality of life improved/not improved and by what percentage? The symptoms improvement was based on the same self-administered questionnaire filled in by the patient prior to her 1st visit. Improvement rates for individual symptoms are summarized in Table 2. Urine loss for cough stress testing reduced from a mean of 2.2 g (range 0-20.3 g) to 0.2 g (range 0-1.4 g), p = <0.005 (Student’s t test), and 24-h pad loss from a mean of 3.7 g (range 0-21.8 g) to a mean of 0.76 g (range 0-9.3 g), p = <0.005.

The patients reported that control of urine loss, when achieved, happened even when not “en garde”. The cutoff point for determining frequency improvement was eight times per day and nocturia two times per night. Total number of frequency events for the twelve patients with only frequency reduced from 140 to 80 per day (P=<0.005). Total number of nocturia events for the 32 patients reduced from 98 events per night to 25 per night (P=<.005). In 23 patients with residual urines greater than 50 ml (pre-treatment mean 202 ml, range 50-550 ml), post-treatment residual was reduced to 71 ml (range 15-450 ml) (p=<0.005). Thirteen patients (9% of total) elected to have surgery prior to completion of their course for non-improvement or worsening of stress incontinence. Three patients reported significant worsening of their stress symptoms, and no improvement was noted in nine others. Three patients report-

condition	>50% improvement
stress (n=42)	78%
urge (n=39)	61%
frequency (n=53)	62%
nocturia (n=24)	75%
pelvic pain (n=20)	65%
leakage (n=50)	68%
bowel problems (n=28)	78%

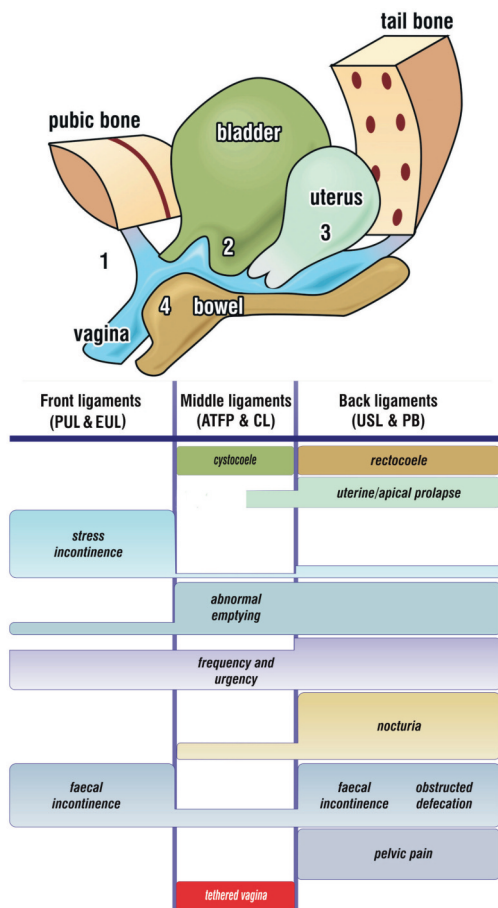


Figure 5. – Simplified Pictorial Diagnostic Algorithm. Relates structural damage (prolapse) to symptoms: 1: stress incontinence; 2: cystocele; 3: uterine prolapse; 4: rectocele. The size of the bar gives an approximate indication of the prevalence (probability) of the symptom. Ligaments which can be surgically repaired and therefore potentially strengthened by squatting are: External urethral ligament (EUL), pubourethral ligament (PUL); CX ring/cardinal ligament (CL); arcus tendineus fascia pelvis (ATFP); uterosacral ligament (USL); perineal body (PB).

ed worsening of their urge symptoms, and no improvement was noted in six others. It was not always possible to predict an outcome. The highest cough stress test loss, 20.3 g reduced to 0 g on re-testing. The highest 24-h test loss, 21.8 g reduced to 2.3 g. Yet other patients with far less objective loss required surgery. All patients complied with HRT treatment during the 3-month period

DISCUSSION

As a general rule, the younger the patient, the better the results. Very rarely were good results seen in older post-menopausal women, certainly in those who were beyond the late 60s.

Though the emphasis of this review was originally chronic pelvic pain, the data from Tables 1&2 confirms that pelvic symptoms occur in groups, figure 5, and that chronic pelvic pain (CPP) in the female co-occurs with other posterior zone symptoms, nocturia, urgency, abnormal bladder emptying, fecal incontinence and obstructive defecation. The rationale for squatting PFR cure of CPP is that as the USLs strengthen, they better support the sympathetic T11-12 and parasympathetic S2-4 nerve plexuses which are contained within them. The distribution of the pain varies with these nerves. T11-12, lower abdomen, groin. S2-4 vul-

va (vulvodynia), bladder, pelvic muscles, low sacral back-ache, deep impact dyspareunia, interstitial cystitis. All of these sites were variously improved as per Tables 1&2.

The methods used in this study appear to extend the scope of PFR beyond stress incontinence to urge, frequency, nocturia, abnormal emptying and pelvic pain. This was attributed to the squatting exercise and reverse pushdowns, both of which are needed to strengthen the uterosacral ligaments (USL), the key posterior support of the vaginal membrane. According to Petros and Ulmsten⁴, damaged USL may cause posterior zone defects, expressed as FNU pelvic pain and abnormal emptying (Figure 1). On the negative side, if the damage extends beyond a critical point, as we suspect it did with some older patients, there may be no improvement or in some cases, worsening of symptoms because the now strengthened muscles may further weaken the ligaments.

Those patients improved of their stress incontinence symptoms reported that they did not leak even when caught “off guard”, in contrast to improvement with Kegel exercises. Kegel patients almost invariably leak when caught “off guard”.

Almost 70% of patients who completed the treatment seemed unwilling to perform the reverse pushdown exercises. Squatting, Kegel and electrotherapy were well received.

Dropout

We attribute the high dropout rate principally to our attitude to treatment, placing responsibility entirely on the patient. Our rationale was that if such a programme was to have any lasting benefit, it needed a disciplined long-term commitment by the patient and a close to zero time impact on her lifestyle. Continuation rate was 52%, inferior to the results from Bo’s intensive approach⁵, but a median figure compared with other reports which vary between 10 and 80%⁷. The high dropout rate led to a 3rd pilot study.

Future directions the 3rd (unpublished) study -towards a more time efficient method for pelvic floor rehabilitation.

Despite conscientious application and follow-up, the dropout rate for the PFR methods used in the 1st and 2nd studies was 50%. On analysis, it appeared that a principal reason many of the patients discontinued was lack of time. It was reasoned that sitting on a rubber “fitball” would strengthen the same pelvic muscles and ligaments as the squatting exercise. Therefore patients were advised to use a rubber “fitball” instead of a chair at work or at home. It was also reasoned that the Kegel exercises could be dispensed with, as they did not address the natural closure muscles (figure 1). Instead, patients were encouraged to do core sit-up exercises immediately before getting out of bed. The rationale for this is that the anterior abdominal muscles and pelvic floor muscles have a common embryological origin. Therefore strengthening the abdominal muscles simultaneously strengthens the pelvic floor muscles. Electrotherapy using a small portable unit which could be used discreetly was also advised, according to the protocols detailed below. The anecdotal results in more than 30 patients appeared to be equivalent to the more involved techniques used in the studies 1&2. Clearly this method needs to be fully tested with an RCT.

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Correspondence to:

Patricia M Skilling MB ChB (St And.)
Email: patriciamskilling@gmail.com

Commentary

This study leads us to reflect on the characteristics of the connective tissue, which is not often considered by physiotherapists. According to Integral Theory, almost all pelvic floor disorders, such as stress incontinence, urgency but also pelvic pain, fecal incontinence, and defecatory difficulties are related to a change in connective tissue. The ligament laxity can therefore affect the strength of the muscles so making it responsible for prolapse of the organs and dysfunctions of the pelvic floor.

According to this theory, a rehabilitation protocol was thought including not only Kegel's exercises but also HRT, electrotherapy, squatting and squeezing exercises. In particular, patients were encouraged to introduce squatting as part of daily routine.

The rehabilitation process takes place in 4 meetings, leaving patients managing rehabilitation by themselves at home. Perhaps for that reason a significant percentage (almost 50%) of the study group leave the protocol. As in all types of rehabilitation, the constant relationship between patient and therapist is not only important to perform a good exercise but also to maintain and increase the compliance, keeping focus on rehabilitation goals. The results of the study are however encouraging and show significant improvements in stress and urgency and, above all, a reduction in pelvic pain. The protocol's limitation is related to the high number of patients leaving the rehabilitation path. The continuity of the relationship with the therapist is so important that can be crucial in carrying out rehabilitation.

Also important is to increase all strategies aimed to preserve the structure of connective tissue and collagen, its main constituent. New frontiers can also be explored for stimulation of collagen reshaping in the direction of a dense collagen through the activation of collagenase and HSP by the heat given in various modalities e.c. Radiofrequency and Laser.

ELENA FRIGHETTO
Physiotherapist, Padova, Italy
email: elena@dentalfisioderm.it