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Development of a Biotensegrity Focused Therapy for the Treatment of Pelvic Organ Prolapse: A Retrospective Case Series

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ABSTRACT

Introduction: Pelvic organ prolapse (POP), the bulging of pelvic organs into the vagina, is a common condition thought to be caused by weak pelvic tissue. There is a paucity of evidence supporting current treatment approaches. This case series proposes a new biotensegrity-focused hypothesis that POP is caused by taut pelvic tissue and that releasing pelvic tension will improve POP.

Methods: Three retrospective patient cohorts are presented illustrating the development of the new biotensegrity-focused therapy (BFT) approach. All women received: postural assessment; pelvic tissue examination; and myofascial release of taut pelvic tissue, trigger points, and scar tissue. A standard assessment protocol (SOTAP) recorded patients' **S**ubjective experience, the therapist's **O**bjective assessment, the **T**reatment plan, **A**ssessment of treatment outcomes, and subsequent treatment and self-care **P**lans. Cohort three additionally self-reported symptoms using the short-form PDFI-20 questionnaire at baseline and after final treatment.

Results: Twenty-three women participated (Cohort 1 n=7; Cohort 2 n=7; Cohort 3 n=9). Fourteen (61%) presented with cystocele, 10 (44%) urethracele, 7 (30%), cervical descent, and 17 (74%) rectocele. Seven (30%) presented with single prolapse, 8 (35%) double, 6 (26%) triple, and 2 (9%) quadruple. Median treatments received was 5 (range 3-8). All women reported improved prolapse symptoms. Cohort 3 (n=9) reported clinically meaningful reductions (mean 56%) in PFDI-20 total after final treatment.

Conclusions: This case series offers preliminary evidence for the association between POP and pelvic tissue tension. Further research is needed to explore these findings and to determine the efficacy of BFT for treating POP in a wider sample.

Key words: pelvic organ prolapse, biotensegrity, myofascial release, pelvic tension

INTRODUCTION

Pelvic organ prolapse (POP), the bulging of one or more of the pelvic organs into the vagina, is a common condition with reported prevalence amongst women of approximately 32-41% (Handa et al 2004; Hendrix et al 2002). Symptoms typically include a sensation of a bulge in the vagina, pelvic pain, a dragging sensation, obstructive defecation, urinary incontinence or leakage, and sexual dysfunction (Chan et al 2012; Espuna-Pons et al 2014; Fritel et al 2009). There is some evidence suggesting that pelvic floor muscle training may help to elevate pelvic organs and reduce the symptoms of POP (Li et al 2016) but the efficacy of these exercises is limited with approximately 20-30% of women reporting benefit (Braekken et al 2010; Ouchi et al 2017). For severe and persistent POP, vaginal pessaries and surgery are typically prescribed to lift pelvic organs away from the vaginal wall. Vaginal pessaries are

recommended as a non-surgical option for women who experience symptomatic POP (NICE 2019). Complications of vaginal pessaries include persistent expulsion, bleeding, ulcers, vaginal discharge, and fistulas and between 16-45% of women are unable to sustain long-term use (Liu & Lee 2017; Robert et al 2017; Yimphong et al 2017). Surgical interventions are prescribed for around one in ten women with POP but success rates following surgery are variable, dependent on the location and degree of prolapse and the nature of the surgical intervention (Kurkijarvi et al 2017; Lo et al 2017; Lowenstein et al 2017; Schiavi et al 2017). Satisfaction post-surgery is reported to decrease over time, with reduced quality of life and poorer sexual function being commonly reported 12 months post-surgery (Rahkola-Soisalo et al 2017; Tyagi et al 2017). Reoperation rates are also high, with further surgery a significant risk of morbidity post prolapse repair (Clark et al 2003). With concerns about the safety of surgical procedures (FDA 2011) and the recent suspension of surgical mesh procedures in the UK, alternative, safe, and effective non-surgical treatments for POP are urgently needed.

Biotensegrity-Focused Therapy (BFT)

Current treatments for POP aim to correct what is believed to be a weakness of pelvic tissue (Hagen et al 2006; Word et al 2009). The authors propose an alternative perspective, aligning with the biotensegrity view of the musculoskeletal system (Levin 1981) that POP may be caused by pelvic tissue tension that disrupts pelvic tissue equilibrium and pulls organs out of alignment. Tensegrity is a structural principle (Fuller 1961) which is characterized as compression elements (e.g., bars or struts) suspended in network of tension elements (e.g., cables or tendons). Tensegrity principles observed in biological systems are referred to as 'biotensegrity' (Levin 1981). Human structures, such as the musculoskeletal system, are thought to be made strong and operate efficiently due to the unison of tensioned (e.g., muscles, tendons, fascia) and compressed (e.g., bone) parts (Levin 2002). Fascia is integral to human biotensegrity as the skeleton and organs are suspended within the web of fascia.

Fascia functions as both compression-resistant and tension-generating elements (Swanson 2013) and undue stresses and strains on fascia can cause it to stiffen (Bordoni & Zanier 2014). Injury to tissues will cause changes in the tensional equilibrium, altering structural configuration and therefore function (Scarr 2016). The 'fascial continuity model' (de las Peñas & Pilat 2011) for example, explains how disruptions to pelvic fascia may disrupt balanced equilibrium in the pelvis, affecting load transfer and leading to numerous problems including prolapse of pelvic organs into the vagina. Applying

biotensegrity principles to POP would suggest that following pelvic injury (e.g., birth related scarring) excessive tension within pelvic tissues may pull organs into a place of discomfort or reduced functionality. Myofascial release (MFR) is one technique that is thought to reduce tensions and restrictions in tissue and several studies suggest it may be an effective treatment for a range of musculoskeletal conditions (Ajimsha et al 2015; McKenney et al 2013) including pelvic floor pain, interstitial cystitis, and prostatitis (Anderson et al 2011; Anderson et al 2005; FitzGerald et al 2012). The aim of the present study is to describe the stages of development of the biotensegrity-focused therapy method and to explore how this new treatment may benefit women living with POP.

METHOD

The clinical work described below was carried out by a qualified, registered, and insured women's health specialist physiotherapist. It is not appropriate for therapists to attempt internal vaginal treatment without comprehensive training and insurance. Patients undergoing this type of treatment must be fully informed as to what to expect and their explicit informed consent must be gained before treatment. A chaperone should be in attendance if the patient requests one. It is important to continuously monitor the patient's comfort while undergoing treatment and make sure that they understand and continue to consent to the therapy. Patients must feel safe and in full control throughout. This treatment requires sensitive care and respect and should only be carried out by appropriately qualified health professionals.

Study Design

This study is a retrospective clinical case series. Patients' clinical notes were reviewed retrospectively to gather information about each patients' presenting issue as discussed at their initial assessment, the nature of the treatment that was provided, and the therapist-assessed outcome at the final treatment session. Therefore the information recorded in patient records is not as systematic or complete as may be seen in prospective clinical research studies. The variability in data captured across patients and over time reflects the development of the therapists understanding and subsequent focus on the relationship between pelvic tissue tension and prolapse.

The BFT technique described in this clinical case series was developed between September 2015 and May 2018. There were three key stages of BFT development, which are described in this study as three patient cohorts. The first stage of BFT development (Cohort 1, September 2015 to September 2016) included patients who received traditional physiotherapy interventions that included guidance in pelvic floor contraction technique and external soft tissue work to optimize pelvic alignment, alongside BFT which was in early development. In Cohort 1, observations were made during pelvic tissue palpation that scarring and areas of tension may be associated with prolapse symptoms. For example, when investigating birth scars or bands of tension within the pelvis some patients commented that palpation of these areas replicated the same sensation as their prolapse symptom. This led to these areas being targeted for release during treatment. It was also observed in this cohort of patients that the side to which the prolapsing organ had moved often corresponded with the least elastic side of the pelvic floor.

Due to the above observations, there was increased focus on assessing and treating pelvic tissue tension in Cohort 2 (October 2016 to October 2017) and there was a reduced focus on the more traditional physiotherapy interventions. The therapist felt that the developments achieved in Cohorts 1 and 2 had resulted in improved patient outcomes, therefore in Cohort 3 (September 2017 to May 2018) patients were asked to self-report their experiences using a validated quality of life questionnaire, the short form Pelvic Floor Distress Inventory (PFDI-20) (Barber et al 2005) prior to treatment and after the last treatment session.

Documentation of each treatment session across all three cohorts was undertaken according to a standard physiotherapy assessment protocol SOTAP (Quinn & Gordon 2016), an extension of the original 'SOAP note' method of problem-oriented medical record (Weed 1968). SOTAP is the systematic documentation of the: **S**ubjective patient experience, **O**bjective therapist assessment, **T**reatment given, **A**ssessment of post-treatment outcomes, and ongoing therapeutic **P**lan. At the first therapy session all patients underwent full history-taking, which included documenting patients' symptomatic experience of prolapse, birth stories, and any areas of pain or injury. This was followed by global movement assessment including walking, single leg standing, squatting, and passive hip rotation in supine. Movement assessments were used to identify likely areas of tension within the pelvis. Following global movement assessment an internal (vaginal) pelvic examination was undertaken. Internal pelvic

examination aimed to evaluate the nature and extent of the pelvic organ prolapse and to identify areas of tension and scarring within pelvic tissue. A treatment plan was agreed following discussion with the patient, which focused on releasing identified areas of tension and scars. After each treatment pelvic organ alignment and global movement were reassessed and future treatments discussed with the patient.

Study sample

Patients in this case series attended one of two private physiotherapy clinics in the North of England for treatment of POP. Treatment was provided to all patients by a single therapist (lead author, AC). Patient clinical records for a period of 31 months (September 2015 to May 2018) were retrospectively reviewed by the authors. Inclusion criteria were: a confirmed diagnosis of POP by the treating therapist, willingness of the patient to receive therapy to internal pelvic tissue, and willingness and capacity of the patient to consent to their data being presented in the current study. Women were excluded from this study if they had previously undergone pelvic organ prolapse repair surgery or hysterectomy.

As treatment was provided by a private clinic, which was not part of the National Health Service (NHS) patients were able to access therapy directly without being referred by their General Practitioner or gynecologist. As such, not all patients in the current study had received a formal diagnosis of a prolapse from an independent practitioner prior to treatment, some had self-referred based on their symptomatic experiences. Treatment goals and priorities were negotiated between the therapist and patient and the patient was responsible for booking ongoing treatments as long as they felt these were needed.

All patients gave their consent for assessment and treatment procedures and provided informed written consent for their data to be included in the current study. Institutional ethical review was not conducted as presentation of anonymized routine clinical data falls outside the remit of UK research ethics committees. During initial consultation all women were given a detailed explanation of what the treatment involved prior to providing consent. It was explained that women could stop treatment at any time. It is vital that all patients feel safe and well looked after during treatment. In the UK this treatment can only be carried out by qualified and insured women's health physiotherapists who are registered with the Health and Care Professions Council. Women seeking therapy should check the qualifications and credentials of their therapists prior to consenting to treatment.

BFT Methods

Assessment of pelvic organ prolapse

Prior to the start of treatment, the treating therapist assessed the nature, location, and degree of prolapse. Due to the private treatment setting, as described above, this assessment may or may not have been corroborated by an independent health care professional. Prolapse assessment was undertaken by the treating therapist prior to each treatment session and following the last treatment. Prolapse was assessed using a method similar to the Baden-Walker (Baden & Walker 1992) grading, with the patient in crook-lying position, however, patients were not asked to strain (Valsalva maneuver) during assessment as it was felt that this unnecessarily aggravated patients' symptoms. The clinical assessment of prolapse using either the full Baden-Walker grading or the POP-Q (Bump et al 1996) is not standard practice amongst most U.K. Physiotherapists (Hagen et al 2016). As such, the therapist graded prolapse as either mild, moderate, or severe. The focus of prolapse assessment was to determine the direction of displacement (for cystocele, urethrocele, and cervical descent) or the degree of deformation (for rectocele) of the organ. Prolapse was graded as 'mild', 'moderate', or 'severe' according to the following criteria:

> **Cystocele**. *Mild*: less than one finger width to left, right, or below expected position; *Moderate*: more than one finger width to left or right or below expected position; *Severe*: low on the anterior wall, at the hiatus.
> **Urethrocele**. *Mild*: slight deviation of urethra position from central alignment; *Moderate*: moderate deviation of urethra position from central alignment; *Severe*: urethra protruding from hiatus
> **Cervical descent**. *Mild*: slight deviation of cervix to left or right of central position but cervix remains high in the vagina; *Moderate*: cervix positioned to left or right of central position and lying lower in the vagina; *Severe*: cervix lying low in the vagina.
> **Rectocele**. *Mild*: bulge on rectum less than 2cm across; *Moderate*: bulge on rectum 2-4cm across; *Severe*: bulge on rectum more than 4cm across.

For patients who had been given a prolapse diagnosis by their GP or gynecologist these are also reported. In addition, cohort 3 patients self-completed the validated short form Pelvic Floor Distress Inventory, PDFI-20 (Barber et al 2005) at baseline and after the final treatment session. The PFDI-20 questionnaire includes 20 items within three subscales: pelvic organ prolapse distress (POPDI-6), urinary distress (UDI-6), and colorectal-anal distress inventory (CRADI-8). The minimal clinically important difference in scores, to demonstrate a clinically significant change in patients' symptoms, is

recommended as a change in the total questionnaire score of 45 points or 15 percent (Barber et al 2005).

Pelvic tissue assessment

Pelvic tissue tension was assessed digitally and involved a gentle stretch, with the therapist's gloved finger, multi-directionally into the pelvic floor and walls of the vaginal space. The therapist aimed to determine whether the pelvic tissue had some stretch and elastic recoil or whether it was stiff and resistant to gentle digital pressure (or somewhere in between). The presence of scar tissue from birth tears or episiotomies were detected by palpation of the pelvic floor as described in Valchouva & Lewit (2012). During assessment of pelvic tissue it was noted whether tissue stretched easily and whether there was any pain or replication of prolapse symptoms. Areas of tissue stiffness, such as scars and restrictions were noted as priority areas for treatment. The anatomical terms used to describe pelvic structures in the current study align with those first described by Whelan, in Chapter 13 of Chaitow & Lovegrove-Jones (2012).

Pelvic floor strength assessment

Pelvic floor strength was assessed digitally determining patients' ability to close and lift their pelvic floor including how equal (comparing left and right), smooth, and quick the contraction and relaxation was (Stein & Hughes 2016). The Modified Oxford Grading Scale for pelvic floor strength (Laycock 1994) was applied: 0 = no contraction, 1 = flicker, 2 = weak, 3 = moderate, 4 = good (with lift), and 5 = strong. In Cohort 3 Modified Oxford Grading Scale was documented independently for the left and right sides of the pelvic floor (e.g., L2 R3) as the therapist had become aware of the importance of documenting tension across different sides of the pelvis.

Treatment of taut pelvic tissue

The nature of palpation used to release taut pelvic structures in this study was 'direct' or 'sustained' myofascial release (MFR) (Lesondak 2017), as taught by the JING college of advanced myofascial release. This is the style of MFR that involves meeting the motion barrier of the fascia with specific gentle touch, then moving slowly into it as the fascia releases (Chaitow & Lovegrove-Jones 2012). The importance of palpation and engagement of the fascial barrier for scar assessment and treatment is

highlighted by Valchouva & Lewit (2012). The differentiation between 'normal' versus 'pathological' feel of tissue can be learned through repeated exploration of 'normal' tissue (Chaitow & Lovegrove-Jones 2012).

Treatment focused on MFR into areas of tissue restriction and tension identified during assessment. Therapy was continued through a series of one-hour sessions until all palpable areas of tension were released and there was improvement in pelvic organ alignment. The number of treatments was not pre-determined at the start of therapy but was decided in discussion with the patient in consideration of her symptoms and function as treatment progressed. Treatments were typically scheduled 2-3 weeks apart. At the point when patients felt their symptoms and functional goals had been met, they discharged themselves from treatment. All patients were given an open invitation to return for further therapy if symptoms returned.

RESULTS

Patients

Twenty-three female patients received BFT for POP (Cohort 1 n=7, Cohort 2 n=7, cohort 3 n=9). Table 1 summarizes the clinical and demographic characteristic of the study sample. The majority of women in this study were of childbearing age and all reported at least one prior birth. A high proportion of women reported an episiotomy during at least one birth. Rectoceles were most common followed by cystoceles. Double organ prolapses were most common and two patients (9%) had quadruple prolapses. The most commonly reported symptoms were bowel dysfunction and a sensation of a bulge in the vagina, which aligns with the greater proportion of women presenting with rectocele.

Table 1. Baseline patient demographics and clinical characteristics

Age years, mean (SD), range	43.22	(11.22)	31-67
Parity, mean (SD), range	2.30	(1.04)	1-5
Episiotomy, n (%)	16	(70)	
Cesarean, n (%)	2	(9)	
Clinical diagnosis			
Cystocele, n (%)	14	(61)	
Urethrocele, n (%)	10	(44)	
Cervical descent, n (%)	7	(30)	
Rectocele, n (%)	17	(74)	
Number of prolapsed organs			
1, n (%)	7	(30)	
2, n (%)	8	(35)	
3, n (%)	6	(26)	
4, n (%)	2	(9)	
Patient reported symptoms			
Urinary incontinence, n (%)	9	(39)	
Defecatory dysfunction, n (%)	15	(65)	
Sensation of bulge in vagina, n (%)	10	(44)	
Sensation of dragging, heaviness, or pressure in pelvis, n (%)	5	(22)	
Hip or buttock pain, n (%)	8	(35)	
Sexual dysfunction, n (%)	5	(22)	

Cohort 1

The first cohort of patients (Table 2) included seven women who received a mixture of external and internal treatments. External treatment included soft tissue release to adductors, gluteals, piriformis, and abdomen. Internal treatments included tissue release of birth scars, anterior and posterior walls, pubococcygeus, iliococcygeus, and transverse perineal. Whilst most patients presented with complex symptoms some potential associations between musculoskeletal issues, such as hip and back pain, the location of birth scars, and the nature of prolapse were observed. For example, Patient 1.1 had a right sided episiotomy scar, right sided hip pain, and restricted right medial hip rotation. She presented with right sided cervical descent. Patient 1.4 had puckering of a scar at the perineal body, which was associated with a pulling down of the posterior wall of the vagina, towards the perineum. This patient also reported stool pocketing and the need to add manual perineal support to allow full bowel

emptying. These symptoms were reported by the patient to have resolved following scar tissue release. The final prolapse assessment, undertaken by the treating therapist, indicated that four (57%) of the seven women had no detectable prolapse following treatment. Two of these patients also reported that they had no prolapse symptoms. The remaining two patients reported minor sensation of their prolapse in the vagina but reported improved symptoms including decreased pain and improved bowel function. Three (43%) patients were assessed to have minor prolapse remaining at the end of treatment but all of these patients reported an improvement in their prolapse symptoms, which included decreased pain, improved bowel function, and reduced sensation of the prolapse in the vagina.

Table 2. Cohort 1: Summary of patients' clinical assessments, treatments, and outcomes

	Baseline Assessments					Treatment Summary		Final Assessments		
Pt ID	**Posture Assessment**	**Independent Prolapse Assessment**	**Patient Reported Symptoms**	**Therapist Assessed Prolapse**	**Pelvic Floor Grade**	**Areas of Pelvic Tension and focus for Treatment**	**Sessions N (months)**	**Patient Reported Symptoms**	**Therapist Assessed Prolapse**	**Pelvic Floor Grade**
1.1	Restricted medial hip rotation R Tight R quad Tight L&R hips Tight L&R gluteal Tight L&R iliotibial band Tight L&R quadriceps Tight L&R adductors	Diagnosed with 'prolapse' by GP at 6 week post-natal check	Pain on episiotomy scar R deep hip pain Pain and heaviness in saddle area.	Moderate rectocele Mild cervical descent to R Mild urethrocele	1	**External release** abdominal mobilization gluteals piriformis hip rotators adductor tendons **Internal Release** anterior wall posterior wall R sided birth scar R iliococcygeus	**8(8)**	No sensation of prolapse No pain in buttock	No rectocele No Cervical descent No urethrocele	3
1.2	Tight R hip Zero R hip medial rotation 2 finger diastasis.	**None**	Sensation of pressure in vagina	Moderate cervical descent Mild cystocele to L	**NA**	**External release** Posterior hip Buttock **Internal Release** scar on R posterior wall R pubococcygeus Posterior wall Palpation of pubococcygeus replicated back pain	**5(7)**	Mild sensation of prolapse Decreased back pain Decreased scar pain	No cervical descent No cystocele	4
1.3	Pubic symphysis malalignment Tight R adductor Tight R lower abdomen L pelvis posteriorly rotated Tight L iliacus Stork +ve L&R	**None**	Incomplete emptying of stool Digitally assisting defecation Stress and urge urinary incontinence Pelvic pain	Moderate cystocele to L Mild rectocele	NA	**External Release** R side bladder ligaments L psoas L iliacus **Internal release** L Anterior wall	**3(1)**	Mild sensation of prolapse Reduced pain over pubis	Mild cystocele Mild rectocele	NA

1.4	Diastasis 2 fingers	None	Post micturition dribble Feeling of heaviness on perineum Bulging sensation in vagina	Mild cystocele to R	0	**Internal Release** R anterior wall L anterior wall L&R posterior wall Birth scar perineal body	**5(8)**	No sensation of prolapse No bladder pain No leaking	No cystocele	4
1.5		None	Bulging sensation in vagina Digitally assisting defecation	Mild rectocele	3	**Internal Release** Perineal body birth scar L&R posterior walls	**3(2)**	Mild sensation of prolapse Easier to defecate	No rectocele	4
1.6	Diastasis 1 finger.	Diagnosed with cystocele by NHS physiotherapist at 6 weeks post-natal check,	Bulging sensation in vagina	Mild urethrocele Mild cervical descent to L	3	**External release** L lower Abdomen **Internal Release** L anterolateral wall L taut band cervix L iliococcygeus L superior aspect of pubic bone	**4(1)**	Mild sensation of bladder prolapse No sensation of cervical prolapse	Mild urethrocele No cervical descent	4
1.7	Upper back tension Diastasis 2 fingers	Diagnosed with rectocele by GP at 6 week post-natal check	Constipation Digitally assisting defecation	Mild cervical descent Mild rectocele	3	**Internal Release** L posterior wall L iliococcygeus L pubococcygeus	**3(1)**	Mild sensation of prolapse No pelvic pain Reduced constipation easier to pass stools	Mild cervical descent Mild rectocele	4

Abbreviations: GP, general practitioner; pt, patient; R, right; L, Left; TrP, trigger point; +ve, positive; NA, not assessed

Cohort 2

Cohort 2 (Table 3) included seven women. With the exception of patient 2.6 who received treatment to the right Sartorius for knee pain, patients in this cohort received internal treatments without additional external treatment. The most common areas to be treated were birth scars, pubococcygeus, iliococcygeus, and anterior and posterior walls. In this cohort, patients continued to present with complex symptoms with multiple areas of tension. For some patients, however, there were clearer indications of an association between pelvic tissue tension and the nature of prolapse. For example, assessment of patient 2.1 identified a taut band of tissue with trigger points to the right of the cervix alongside right-sided cervical descent. Patient 2.2 was found to have trigger points to the right side of the urethra alongside a right-sided urethrocele. Assessment of patient 2.3 showed a relationship between a left-sided taut band with trigger points along the pelvic floor, left sided deep hip pain, and left-sided cystocele and rectocele. The final prolapse assessment, undertaken by the treating therapist, indicated that four (57%) patients had no detectable prolapse. Of these patients three confirmed they had no sensation of prolapse and reported improved symptoms. The fourth patient reported a reduced sensation of prolapse and improved symptoms. Three patients were assessed to have mild prolapse remaining and of these one patient reported no prolapse sensation or symptoms and two patients reported reduced sensation of prolapse and improved symptoms, including reduced pain and improved bladder control.

Table 3. Cohort 2: Summary of clients' clinical assessments, treatments, and outcomes

	Baseline Assessment					Treatment Summary		Final Assessment		
Pt ID	**Posture Assessment**	**Independent Prolapse Assessment**	**Patient Reported Symptoms**	**Therapist Assessed Prolapse**	**Pelvic Floor Grade**	**Areas of Pelvic Tension and focus for Treatment**	**Sessions N (months)**	**Patient Reported Symptoms**	**Therapist Assessed Prolapse**	**Pelvic Floor Grade**
2.1	L piriformis syndrome	Consultant gynecologist diagnosed moderate cystocele ++, moderate recto enterocele ++, uterine descent Recommended anterior and posterior repair, optional Culpo suspension and hysterectomy	Difficulty defecating Dragging sensation L Deep buttock ache	Moderate cystocele Moderate cervical descent to R Moderate rectocele	3	R cervix taut band R pubococcygeus L pubococcygeus L iliococcygeus L posterior wall taut band TrPs in L and R compressor urethra Deep birth scar through L iliococcygeus & L pubococcygeus L transverse perineal release	7(5)	No sensation of prolapse Occasional urinary leakage	No cystocele No cervical descent No rectocele	3
2.2	1 finger diastasis	GP diagnosed cystocele during 6 week postnatal check	Post-micturition dribble Sensation of bulge in vagina Incomplete emptying of bowel R Hip pain Abdominal ache	Moderate cystocele Moderate urethrocele to R	3	TrPs R anterior wall L&R posterior wall	3(1)	Reduced sensation of prolapse Occasional urinary leakage	No cystocele No urethrocele	4
2.3	Positive L stork test	GP diagnosed cystocele Gynecology consultant	Sensation of bulge in vagina L Hip pain	Moderate cystocele to L Mild rectocele to L	3	R iliococcygeus L posterior wall taut band with TrPs L iliococcygeus	5(3)	No sensation of prolapse	No cystocele	4

	Restricted let- go in L pelvis on squatting	recommended surgery	Decreased sexual function			Taut Band around cervix Posterior wall		No prolapse symptoms	No Rectocele	
2.4	No concerns	GP diagnosed rectocele	Digitally assisting defecation R Deep buttock ache	Moderate rectocele	1	R Transverse perineal R pubococcygeus R iliococcygeus L pubococcygeus L iliococcygeus	4(3)	No sensation of prolapse No prolapse symptoms	Mild rectocele	3
2.5	2 finger diastasis	GP diagnosed cystocele and rectocele at 6 week postnatal check	Sensation of bulge in vagina Occasional urine leaking Constipation	Moderate rectocele Mild cystocele to L Mild urethrocele to L	1	R posterior wall R iliococcygeus L iliococcygeus L pubococcygeus L anterior wall L posterior labia L posterior wall	5(3)	Prolapse feels smaller	Mild rectocele No cystocele No urethrocele	2
2.6	R medial hip rotation reduced	None	Urinary leakage R Hip pain R Knee pain	Mild cystocele Mild urethrocele	3	**External release** L sartorius (knee pain) **Internal release** R posterior wall R deep hip R iliococcygeus R pubococcygeus R episiotomy scar L anterior wall	4(5)	No sensation of prolapse Improved bladder control	No cystocele No urethrocele	3
2.7	Reduced ROM bilateral hip General hypermobility	GP diagnosed hip pain as 'wear and tear' and prescribed codeine for pain	Bilateral deep hip pain Constipation Incomplete bowel emptying Digitally assisting defecation	Mild rectocele	NA	Bilateral posterior walls. Taut bands L and R posterior walls Palpation of taut bands replicated sensation of rectocele	3(5)	Minimal sensation of prolapse Hip pain reduced	Mild rectocele	3

Abbreviations: GP, general practitioner; L, left; R, Right; pt, patient; ROM, range of movement; TrP, trigger point; NA, not assessed

Cohort 3

Cohort 3 (Table 4) included nine patients. Two patients in this cohort (3.6 and 3.8) received external treatment to the abdomen to release scarring from previous abdominal surgery. The most common areas for internal treatment in this cohort were birth scars, pubococcygeus, iliococcygeus, and anterior and posterior walls, as per previous cohorts. In addition, the puborectalis muscle was identified to be an important area of focus and was often found to be taut in patients with rectocele (e.g., patients 3.2, 3.4, 3.6, and 3.7). As per previous cohorts, the relationship between musculoskeletal issues, pelvic tissue tension, birth scars, and the nature of prolapse continued to be explored. Patient 3.3 presented with complex scarring to the right posterior wall alongside quadruple prolapses that were all right-sided. For patient 3.8 a relationship was observed between a right-sided episiotomy scar, right-sided tethers from a caesarian-section scar, right sided internal pelvic tension, with right-sided bladder and urethra position.

The final prolapse assessment, undertaken by the treating therapist, indicated that four (44%) patients had no detectable prolapse following treatment. Of these, two patients confirmed they had no sensation of prolapse and reported improved symptoms. The other two patients reported a reduced sensation of prolapse with improved symptoms. Five patients were assessed to have mild prolapse remaining at the end of treatment and most of these patients reported that the sensation of prolapse was mild and their symptoms, such as bowel and urinary function, had improved.

Table 4. Cohort 3: Summary of clients' clinical assessments, treatments, and outcomes

	Baseline Assessment					Treatment Summary		Final Assessment		
Pt ID	**Posture Assessment**	**Independent Prolapse Assessment**	**Patient Reported Symptoms**	**Therapist Assessed Prolapse**	**Pelvic Floor Grade**	**Areas of Pelvic Tension and focus for Treatment**	**Sessions N (months)**	**Patient Reported Symptoms**	**Therapist Assessed Prolapse**	**Pelvic Floor Grade**
3.1	Restricted medial hip rotation L	GP diagnosed cystocele at 6 week check	Stress urinary leakage Abdominal pain Reduced sexual function	Mild cystocele to L Mild rectocele to L Mild urethrocele to L	L3R2	R birth side scar R pubococcygeus R transverse perineal L birth scar L anterolateral wall L anterior wall L pubococcygeus	5(3)	Mild occasional sensation of prolapse Mild occasional urinary leakage	No cystocele No rectocele No urethrocele	L4R4
3.2	Restricted medial hip rotation R 2 finger diastasis	Gynecologist diagnosed cystocele and rectocele	Coccyx pain Tugging sensation in vagina Occasional pain on defecation	Moderate cystocele to R Moderate rectocele to R	L2R1	R birth scar R pubococcygeus R puborectalis R transverse perineal L pubococcygeus L ischiocavernosus	5(5)	Mild sensation of bladder prolapse No tugging sensation	No cystocele No rectocele	L3R3
3.3	Restricted medial hip rotation R	Gynecologist diagnosed cystocele grade 2-3 rectocele grade 2 cervical descent grade 1-2	Post-micturition dribble Pain during intercourse Incomplete bowel emptying Urge incontinence Lower abdominal pain	Moderate cystocele to R Mild urethrocele to R Mild rectocele to R Moderate cervical descent to R	L0R0	Complex scaring on R posterior wall L pubococcygeus	3(1) Treatment postponed due to pregnancy	Reduced sensation of prolapse Improved bowel movements Reduced urinary leakage No pain during intercourse	No cystocele No urethrocele Mild rectocele Mild cervical descent	L3R3

3.4	Restricted medial hip rotation L	None	Sensation of bulge in vagina Urge urinary incontinence Incomplete bowel emptying Occasional R hip ache	Moderate cystocele to L Moderate urethrocele to L Moderate cervical descent to L Mild rectocele	L2R3	R anterior wall R puborectalis L deep hip L anterolateral wall L pubococcygeus L iliococcygeus L puborectalis L labia L adductor tendon	3(2)	No sensation of prolapse Reduced urinary urgency	No cystocele No urethrocele No cervical descent No rectocele	L3R3
3.5	Restricted medial hip rotation R 2 finger diastasis	Gynecologist diagnosed grade 3 rectocele Surgery booked for posterior repair	Sensation of bulge in vagina Digitally assisting defecation Repeated thrush infections	Moderate rectocele	L2R2	Widespread tethering of R birth scar R posterior wall R pubococcygeus R iliococcygeus L posterior wall L transverse perineal L adductor tendon	5(3)	Reduced sensation of bulge in vagina Occasional digitally assisting defecation Surgery cancelled	Mild rectocele	L3R3
3.6	Restricted medial hip rotation R Large scar from previous abdominal surgery	Gynecologist diagnosed grade 4 rectocele Prescribed estrogen pessaries Surgery booked for posterior repair	Sensation of bulge in vagina Digitally assisting defecation Poor sensation of need to defecate	Severe rectocele	L2R2	**External release** Abdominal viscera **Internal release** R abdomen R iliococcygeus R pubococcygeus R ischiocavernosus L iliococcygeus L puborectalis L ischiocavernosus	7(4)	Reduced sensation of prolapse Improved bowel function Cancelled posterior repair surgery	Mild rectocele	L3R3
3.7	Restricted medial hip rotation L & R	Gynecologist diagnosed enterocele, cystocele, rectocele, and rectal	Incomplete emptying of stool Occasional episiotomy scar pain	Moderate cystocele Moderate urethrocele	L1R1	R episiotomy scar R posterior wall R pubococcygeus R puborectalis R iliococcygeus L posterior wall	5(3)	Decreased constipation Defecation easier	No cystocele No urethrocele	L3R3

		intersessection via pelvic scan	Mild buttock ache	Moderate Rectocele		L pubococcygeus L puborectalis		Feels tight along L side	Mild rectocele to L	
3.8	Restricted medial hip rotation R Fall on coccyx Abdominal scar from caesarian sections	Consultant gynecologist diagnosed cystocele	Urinary leakage, with full void of bladder under pressure. Wears incontinence pads Pain during intercourse Tender abdomen	Moderate cystocele to R Moderate urethrocele to R	L1R1	**External release** Uterus and bladder mobilization Cesarean section scar **Internal release** R sided episiotomy scar R ischiocavernosus R pubococcygeus R anterior wall L ischiocavernosus L pubococcygeus L puborectalis L anterior wall	5(2)	No urinary leakage Improved control of abdominal muscles with reduced pain	No cystocele No urethrocele	L3R2
3.9	Restricted medial hip rotation R Previous R leg injury	Gynecologist diagnosed grade 3 rectocele	Incomplete emptying of stool Decreased control of wind Reduced sexual function Sensation of bulge in vagina	Severe rectocele	L3R3	R birth scars tethered to adductor tendon R ischiocavernosus R puborectalis L ischiocavernosus L posterior wall Perineal body	5(2)	Mild sensation of bulge in vagina Improved bowel function	Mild rectocele	L3R3

Abbreviations: GP, general practitioner; L, left; R, Right; pt, patient; ROM, range of movement; TrP, trigger point; NA, not assessed

Cohort 3 also completed PDFI-20 questionnaires at baseline and after final treatment and the summary scores for the group are presented in Table 5. As can be seen from baseline data there was variability across patients regarding the severity of self-reported symptoms at the start of treatment. Five patients reported PFDI-20 total scores below 100 at baseline, with the remaining four patients reporting scores over 100, indicating more severe symptoms. At follow-up all patients reported reduced symptom severity, with only one patient reporting a total score over 100. The reported reduction in symptoms for all patients met the criteria for a clinically meaningful improvement (i.e., 15% or greater decrease in total score compared to baseline) with a mean reduction of 56.54%.

Table 5. Summary of patient self-reported PFDI20 Questionnaire Subscale and Total scores at baseline and after final treatment

	Baseline assessment				Final assessment				Change in total score from baseline to final assessment
ID	POPDI-6	CRADI-8	UDI-6	PFDI20 TOTAL	POPDI-6	CRAD-8	UDI-6	PFDI20 TOTAL	Number (%)
3.1	16.67	12.50	41.67	70.83	0.00	0.00	20.83	20.83	-50.00* (-70.59*)
3.2	25.00	6.25	8.33	39.58	8.33	6.25	0.00	14.58	-25.00 (-63.16*)
3.3	66.67	34.38	45.83	146.88	41.67	28.13	33.33	103.13	-43.75 (-29.79*)
3.4	16.67	25.00	41.67	83.33	12.50	15.63	8.33	36.46	-46.88* (-56.26*)
3.5	25.00	21.88	4.17	51.04	16.67	15.63	0.00	32.29	-18.75 (-36.74*)
3.6	62.50	37.50	25.00	125.00	41.67	31.25	12.50	85.42	-39.58 (-31.67*)
3.7	37.50	28.13	20.83	86.46	8.33	6.25	4.17	18.75	-67.71* (-78.31*)
3.8	58.33	87.50	91.67	237.50	4.17	28.13	41.67	73.96	-163.54* (-68.86*)
3.9	45.83	46.88	29.17	121.88	12.50	15.63	4.17	32.29	-89.58* (-73.50*)
Mean	39.35	33.33	34.26	106.94	16.20	16.32	13.89	46.41	-60.53* (-56.54*)

ID, identifier. POP, Pelvic Organ Prolapse. DI, distress inventory. CRADI, colorectal-anal distress inventory. UDI, urinary distress inventory. *=clinically significant change in score (or percentage) between baseline and final assessment.

Across the whole sample of 23 patients, 12 (52%) patients were assessed by the treating therapist to have no detectable prolapse by the last treatment session. Of these seven confirmed that they had no sensation of prolapse and five reported some or occasional sensation of prolapse alongside mild symptoms. It was observed that urethroceles were more often assessed to have resolved fully compared to cervical descent and rectoceles. The number of prolapses fully resolved by the last treatment were: 9/10 (90%) urethrocele; 12/14 (86%) cystocele; 5/7 (71%) cervical descent; and 6/17 (35%) rectocele. Pelvic floor grade was also observed to increase during treatment. Across the sample at baseline median pelvic floor

grade was 2 (range 0-3) increasing to 3 (range 2-4) by the last treatment session. The median number of treatments received across the sample was 5 (range 3-8) over a median period of 3 (range 1-8) months.

DISCUSSION

The aim of this study was to describe the development of the BFT method and the rationale for the authors' hypothesis that tension within pelvic tissues may be associated with POP. We have summarized the retrospective clinical notes from the first twenty-three women who received BFT during the period of September 2015 to May 2018. The number of treatments received was determined by patients following discussion with the therapist about their functional goals and priorities, therefore the number of treatments received varied across the sample. The median number of treatments received was five (range 3-8) over a median period of three (range 1-8) months. This is substantially fewer treatments than the 12-16 weekly sessions that are typically prescribed in pelvic floor muscle training studies (Li et al 2016).

By the last treatment session an improvement in prolapse was observed for all women in the current study. Improvement was defined as the treating therapist observing a reduction in prolapse grade by the last treatment session alongside an improvement in patients' self-reported symptoms (e.g., reduced pain; decreased sensation of prolapse including a bulge in the vagina, sensation of dragging, heaviness, or pressure in the pelvis; improved bowel function; or improved urinary function). Twelve women were assessed by the treating therapist to have fully resolved prolapse by the final treatment session. This was corroborated by patients in seven (58%) cases but the remaining five patients reported ongoing mild or occasional sensation of prolapse or urinary or bowel function symptoms. Some discrepancy between therapist assessment of prolapse grade and patient-reported symptoms is a common finding in POP research studies (Ellerkmann et al 2001; Srikrishna et al 2008; Volløyhaug et al 2016).

It was observed in the current sample that cystoceles and urethroceles were more often seen to fully resolve than rectoceles. Whilst partial recovery and an improvement in symptoms and bowel function was seen for all women, it is possible additional taut pelvic tissues not identified in the current study prevented the rectum from returning fully to its optimal shape, and this is an area for future investigation.

The most common pelvic areas to be treated in this study included pubococcygeus, iliococcygeus, anterior and posterior walls, and puborectalis. Across the sample we observed that these tissues were often tight and inflexible and it was possible in many patients to trace lines of tension between the prolapsed organ, the location of birth scars, and taut pelvic tissue. Applying myofascial release to taut tissue was observed to improve tissue elasticity and reduce the caudal/downward pull on pelvic tissue. Organs were observed to move towards their natural positions during the course of treatment.

Previous research has demonstrated that injury to the pelvic floor muscles is common following birth and this can lead to weakness in vaginal closure force during voluntary muscle contraction, which is thought to contribute to pelvic organ prolapse (Ashton-Miller & Delancey 2009). The pelvic floor is a dynamic structure which has to change shape to accommodate childbirth so flexibility within the tissues is a key feature of healthy pelvic floor function (Hallock & Handa 2016). Many women in the current study presented with poor pelvic floor power at baseline that had improved by final assessment (e.g., patients 1.1, 1.4, 2.4, 3.2, 3.3, 3.8, and 3.8). Whether patients carried out PFMT during the course of BFT treatment was not systematically recorded, however, women who reported that PFMT resulted in pain or exacerbated symptoms of bulging or dragging were advised to discontinue and focus instead on relaxing and letting go of the pelvic floor. Observations during BFT suggested that tight internal pelvic tissue may have reduced the efficiency, power, and speed of pelvic floor contractions and prevented full hiatus closure and release. This aligns with previous research showing the importance of lengthening pelvic floor tissues before strengthening (FitzGerald & Kotarinos 2003; Stein & Hughes 2016). The role of PFMT alongside or after BFT is not currently understood and needs investigation in future research.

In the current study, the therapist's observations of improved organ position following digital pelvic examination was supported by patients reporting a reduced sensation of a bulge in their vagina alongside other symptoms such as a reduction in the feeling of pelvic heaviness, improved bowel and urinary function, and reduced pain. Patient-reported symptom experiences were important throughout this study in terms of guiding the nature and focus of therapy and also for deciding when treatment should finish. Previous research has shown that patients reporting a sensation of a bulge in the vagina is an important screening tool for POP (Tan et al 2005) with 81% positive predictive validity. To enhance the documentation of patient-reported experiences, patients in Cohort 3 were also asked to

complete the PFDI-20 questionnaire at baseline and after final treatment. Examining data between first and last treatment showed that this small sample of nine patients all reported a clinically important improvement in symptoms (i.e., 15% or greater reduction in total score from baseline) with a mean reduction in total score of 56% from baseline. This information alongside patient narratives captured in clinical records suggests that the BFT approach offered benefit to patients across the sample.

The findings from this case series align with other recent studies demonstrating positive outcomes of using women's health physiotherapy approaches that consider pelvic tension, alignment, and biotensegrity. These include abdomino-visceral release (Horton 2015), treating internal trigger points for pain, ensuring pelvic floor tissues have full length as well as strength (Herrerra 2014; Stein & Hughes 2016), and postural optimization to improve pelvic and abdominal function (Lee et al 2008). The findings of the current study also corroborate previous findings by Whelan (2013), who presented a case series of 12 women with pelvic organ prolapse who responded positively to manual therapy to the pelvic floor, as well as standard pelvic floor muscle training.

Limitations

The data presented in this study were obtained from a retrospective review of clinical records. Therefore, there are several limitations and likely sources of bias that should be considered when interpreting the findings from this study. For example, as this study presents the early development of the BFT, the methods of treatment, assessment, and monitoring adapted over time as clinical practice developed, in a way that is not seen in pre-planned clinical trials.

Patients in this study did not always present with a clear prolapse diagnosis from an independent health professional. The assessment of prolapse at baseline and after completion of treatment was undertaken by the treating therapist, who is also the lead author of the current study, and independent clinical verification of prolapse grade after the last treatment was not obtained. Therefore, the assessment and grading of prolapse in this study is subjective and may be at risk of bias. Future work investigating the BFT approach should include independent clinical assessment of prolapse in addition to the treating therapists' assessment.

Whilst we include patient-reported experiences for all patients at baseline and after final treatment, these were only captured as brief narratives in patient records for the first two cohorts. Only a small sample of nine patients in Cohort 3 completed the validated PFDI-

20 questionnaire. As such, statistical inferences about the magnitude of change in patient-reported data cannot be made at this stage. The preliminary findings from this current study need further exploration to better understand the relationship between pelvic tissue tension and pelvic organ prolapse. The efficacy of the BFT method can only be determined following a fully powered randomized controlled trial.

Conclusions

In this small sample of women, we have demonstrated that the symptoms of pelvic organ prolapse were reduced and in some cases resolved whilst receiving biotensegrity-focused therapy. Considering pelvic tension, restrictions, and tensional pulls within the vagina and pelvic floor is likely to be important in advancing current treatments for pelvic organ prolapse. Further research is needed to fully understand the mechanisms, efficacy, and longer-term outcomes for women receiving this treatment approach.

CLINICAL RELEVANCE

- The findings from this study suggest that there may be an association between tension in pelvic tissues and pelvic organ prolapse.
- The BFT method described in this study includes the assessment of pelvic tension and restrictions through observing global movements, examining pelvic floor tension as well as strength, determining the presence and location of any scar tissue within the vagina, and the myofascial release of all identified areas of pelvic tension.
- It was observed that treatment focused on reducing tension and restrictions in pelvic tissue, particularly pubococcygeus, iliococcygeus, anterior and posterior walls, and puborectalis, may have improved pelvic organ position and patients' experience of prolapse symptoms.

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