Original article

doi:10.1111/codi.12333

Live anatomy of the perineal body in patients with third-degree rectocele

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Received 27 January 2013; accepted 14 March 2013; Accepted Article online 2 July 2013

Abstract

Aim In many pelvic floor disorders, the perineal body is damaged or destroyed. There is still a considerable variation in anatomical descriptions of the perineal body and even more debate with regard to its attachments and relationships. Cadaveric dissections do not always reflect the functional behaviour of structures in the pelvis and description of live anatomy on imaging studies is not always reliable. This study aimed to define the anatomy of the perineal body in patients with rectocele during the live dissection required for minimally invasive surgical repair.

Method From January 2007 to December 2009 consecutive patients requiring surgery for third-degree rectocele and symptoms of obstructed defaecation were recruited. Participants underwent dissection of the perineal body, rectum and vagina preliminary to a tissue fixation system, an operation which inserts a tensioned tape to repair the perineal body.

Results Thirty Caucasian female patients, mean age 61 (range 47–87) years, mean parity 2.6 (range 1–5), were included. Live dissection demonstrated that the perineal body was divided into two parts, joined by a stretched central part, anchored laterally by the deep transverse perineii muscle to the descending ramus of the pubic bone. The mean longitudinal length of the perineal body was 4.5 (3.5–5.5) cm, accounting for 50% of the posterior vaginal support.

Conclusion In women with low rectocele, the perineal body appears to be divided into two parts, severely displaced behind the ischial tuberosities.

Keywords Endovaginal ultrasonography, obstructed defaecation, perineal body, rectocele, transperineal ultrasonography

What does this paper add to the literature?

In the existing literature, there is still a considerable variation in anatomical descriptions of the perineal body and even more debate regarding its attachments and relationships. Cadaveric dissections do not always reflect the functional behaviour of structures in the pelvis and description of live anatomy on imaging studies is not always reliable. To the best of our knowledge, this is the first paper to describe the complex anatomy of the perineal body in patients with third-degree rectocele during the live dissection required for surgical repair.

Introduction

The supportive role of the perineal body (PB) is well documented. Using X-ray and evacuating proctogram studies, Abendstein *et al.* [1] demonstrated that the PB structures support at least 50% of the posterior vaginal wall. Using an ultrasound technique limited to the axial plane, Zetterström *et al.* [2] found that the PB measured only 12 ± 3 mm in asymptomatic subjects. Soga *et al.* [3] described a centrally located PB which measured 10–20 mm in the antero-posterior diameter, with bilateral extensions (LEX) which have a higher proportion of smooth muscle than the PB.

Considerable controversy exists on the anatomical composition and relationships of the PB, the real existence of the 'urogenital diaphragm' and the deep transversus perineii (DTP) muscles [4–7]. Despite extensive histological studies, Oelrich [8] could not identify the urogenital diaphragm. DeLancey [9] quoted the PB as linking the two halves of the perineal membrane. In a histological and gross cadaveric anatomical dissection, Stein *et al.* [10] stated that the perineal membrane has two distinct parts, a dorsal and a ventral portion, inti-

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mately connected to the levator ani muscle. The ventral portion consists of bilateral ‘fibrous bands’ of connective tissue; the dorsal portion is related to the support of the PB and lateral vaginal wall through its attachment to the ischiopubic rami, and is devoid of striated muscle. In a cadaveric study, Shafik *et al.* [11] described the PB as a ‘digastric pattern’ composed of three layers of perineal muscles: (i) a superficial layer – fleshy fibres of the external anal sphincter extending across the PB to become the bulbospongiosus muscle; (ii) the middle layer – tendinous extension of the superficial transverse perineii (STP) muscle crossing the PB to the contralateral muscle, with which it forms a criss-cross pattern; and (iii) a deep layer – tendinous fibres of the DTP muscle, decussating in criss-cross pattern with the contralateral muscle. A significant problem is that almost all anatomical studies to date have been performed on cadavers. Whereas skeletal limb anatomy is reasonably analogous with live anatomy, the pelvic floor anatomy differs considerably. The pelvic floor behaves much like a trampoline: the organs are stretched by directional muscle forces. On death, the pelvic muscles and organs collapse downwards, so that cadaveric pelvic anatomy may not be analogous to that in the living patient.

Imaging techniques have provided relevant information on PB anatomy [12–24]. Using MRI, Larson *et al.* [25] also described the PB as having three layers, albeit drawn from different muscle origins: (i) a superficial region at the level of the vestibular bulb, (ii) a mid-region at the proximal end of the STP muscle, and (iii) a deep region at the level of the mid-urethra and puborectalis muscle. Using three-dimensional (3D) ultrasound methodology, Santoro *et al.* [26] visualized the connection of the STP muscle to the PB; however, they could not find evidence of the DTP muscle, a consequence perhaps of the limitations of ultrasound.

The aim of this study was to examine the live PB anatomy in women with low rectocele entirely from a structural perspective during the dissection required for tissue fixation system (TFS), an operation which inserts a tensioned tape to repair the PB.

Method

Between January 2007 and December 2009, patients eligible to participate in the study were consecutively recruited in tertiary referral units in Germany, Spain and Australia. All patients were interviewed regarding their medical history and underwent a gynaecological and proctological examination including an assessment of the genital hiatus, the levator ani muscle and the pelvic organs based on the Pelvic Organ Prolapse Quantification (POP-Q) staging system [27]. Inclusion criteria were everting rectocele with bulging of 2 cm or more beyond the hymenal remnant on straining at clinical examination, (POP-Q Stage III), ‘outlet’ obstruction requiring manual assistance during defaecation and pressure in the vagina or perineum. Exclusion criteria were absence of symptoms of obstructed defaecation or any other symptoms related to the rectocele conditioning the quality of life, presence of multicompartimental prolapse requiring operation through the abdominal route or a history of genitourinary or proctological surgery in the perineal area.

Pelvic floor ultrasonography (US) was performed preoperatively in all patients by an ‘integrated’ multimodalities approach (transperineal, TPUS; endovaginal, EVUS; endoanal, EAUS) as previously reported [18]. On TPUS, rectocele was measured, during Valsalva manoeuvre, as the maximal depth of the protrusion beyond the expected margin of the normal anterior rectal wall [16,28]. A herniation of a depth of over 2 cm was considered diagnostic (Fig. 1). On EVUS, the PB and perineal muscles were assessed at level IV [26,29]. In normal nulliparous women, in the midsagittal plane, the PB appears as an oval hypoechoic structure between the anal canal and the vaginal wall. The STP muscles are visualized in the axial plane as two hypoechoic bands lying transversally between the ischial tuberosity and the PB (Fig. 2). As previously reported [26,29], the DTP muscle cannot be identified by using this modality.

The institutional ethical committees approved this protocol. All subjects gave written informed consent.

Surgical dissection technique

All participants meeting the inclusion criteria underwent anatomical dissection for perineal body repair by TFS. This technique is based on the anatomical concept that in women with rectocele the DTP muscle, which we consider as the principal support of the PB and lower half of the posterior vaginal wall, is angulated downwards and outwards (Fig. 3a,b). This creates a hernial gap which allows prolapse inwards of the rectum. In such cases, the rectum almost invariably spreads laterally onto the DTP and requires dissection off it. In order to obliterate the rectocele herniation, the separated and inferiorly displaced PBs are elevated and approximated closer to the midline by insertion of nonstretch 7-mm polypropylene TFS tape (Fig. 4a). In the surgical operation, anchors attached to the sling penetrate the DTP muscles, passing beyond their insertion point behind the descending pubic ramus. Over the long-term, the central band linking the two PBs, becomes totally incorporated by collagenous tissue to form a neo ‘central tendon perineii’.

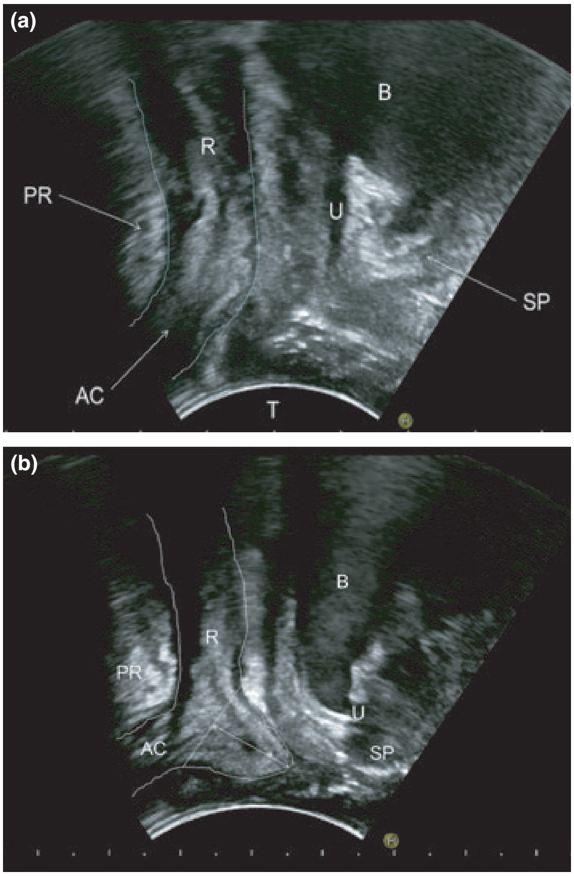

Figure 1 Mid-sagittal image of the pelvic floor on transperineal ultrasonography. (a) At rest. (b) During Valsalva manoeuvre. Rectocele is measured as the maximal depth of the protrusion beyond the expected margin of the normal anterior rectal wall. AC, anal canal; B, bladder; PR, puborectalis muscle; R, rectum; SP, symphysis pubis; T, convex transducer; U, urethra.

Our standard protocol requires precise identification and dissection of vagina, rectum, PB, STP and DTP muscles. A transverse full-thickness 4 cm incision is performed 1 cm inside the hymenal ring. Under tension, with a finger in the rectum to identify structures properly, the rectum is dissected off the PB to reveal the DTP and STP muscles (Fig. 3b). The deeper parts of the PB displaced behind the ischial tuberosity are brought to the surface using a strong curved needle attached to a No. 1 Vicryl thread. The DTP muscle is identified as follows: the threads are pulled distally; an index finger in the rectum identifies the junction of the upper two-thirds and lower third of the descending pubic ramus; a firm muscular body is identified extending from the PB to behind the descending ramus. The PB/DTP complex is grasped with an Allis forceps; fine Metzenbaum scissors penetrate the DTP to beyond its insertion into the posterior surface of the descending ramus; a TFS applicator loaded with an anchor is pushed into the tunnel until it penetrates the insertion point of the DTP behind the bone; this procedure is repeated contralaterally (Fig. 4b). The tape, which has a one-way mechanism at the anchor base, is then tightened; the PB/DTP complex is elevated like two downwardly displaced trapdoors hinged at the bone being lifted upwards toward the centre. At the end of this procedure we estimated the length of the PB.

Statistical analysis

Descriptive statistics (SPSS 14.0 PL for Windows) for continuous data was performed and the results are given as mean values with standard deviation (SD). Statistical significance was assigned to $P < 0.05$.

Results

The cohort comprised 30 female Caucasian patients, mean age 61 (range 47–87) years, mean parity 2.6 (range 1–5). Three women were menopausal. All patients had an everting rectocele with bulging of 2 cm or more beyond the hymenal remnant on straining at clinical examination (POP-Q Stage III) and complained of 'outlet' obstruction requiring manual assistance during defaecation.

Transperineal ultrasonography confirmed the clinical diagnosis of rectocele. During Valsalva manoeuvre, the mean protrusion of the anterior rectal wall was 2.4 (range 2–4.5) cm (Fig. 1). No significant prolapse of the anterior or middle compartments or anal sphincter lesions that could change the indication to TFS were found. On EVUS, in all patients, the oval hypoechoic structure of PB could not be identified in the midsagittal plane and was replaced by an area of scar of mixed echogenicity (Fig. 2). The STP muscles appeared damaged on the left side in 12 (40%) patients, on the right side in eight (26.6%) and bilaterally in 10 (33.4%) (Fig. 2).

During surgical dissection, in all 30 patients the rectum had ballooned and was densely attached to the vagina. The RVF could be identified as a very loose and very thin structure adhering to the fibromuscular rectal layer. We found two PBs bound together by a very thin stretched out central part where the rectum was directly adherent to the vaginal wall. The PB was whitish in appearance with a supero-inferior length estimated at 2.5 cm. The laterally displaced PBs were hidden behind the ischial tuberosity and had to be brought out using a large needle attached to a No.1 Vicryl suture. When the PB was stretched with Allis forceps, the origin of the STP muscle could be palpated at the lower third of the

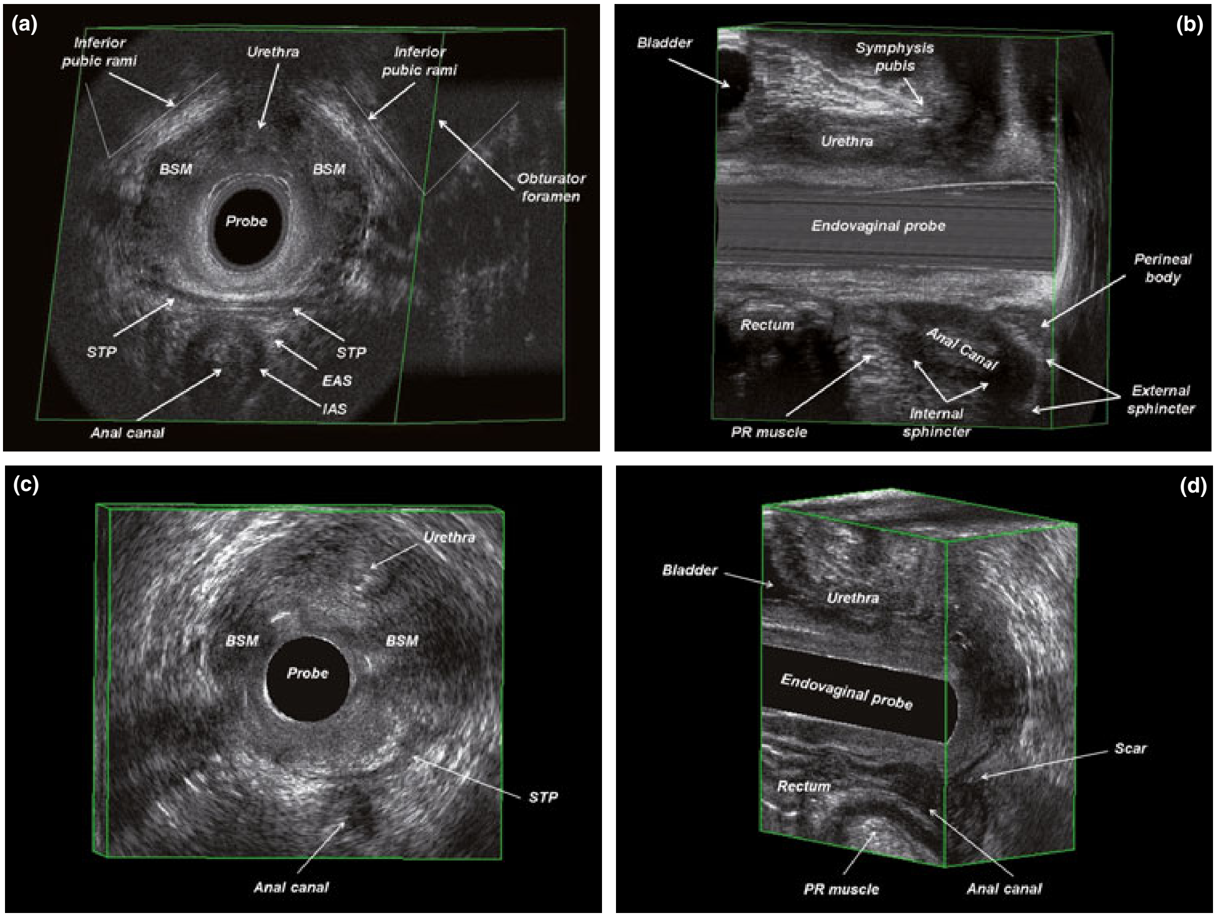

Figure 2 Endovaginal ultrasonography. (a) Axial image of the pelvic floor at level IV in a normal nulliparous woman. The superficial transverse perineii (STP) muscles are visualized as two hypoechoic bands lying transversally between the vagina and the anal canal. (b) Midsagittal image of the pelvic floor in a normal nulliparous woman. The perineal body appears as an oval hypoechoic structure. (c) Axial image of the pelvic floor at level IV in a patient with third-degree rectocele. The STP is visualized only on the left lateral side and is damaged on the contralateral side. (d) Mid-sagittal image of the pelvic floor in a patient with third-degree rectocele. The oval hypoechoic structure of the perineal body cannot be identified and is replaced by a mixed echogenicity area of scar. BSM, bulbospongiosus muscle; EAS, external anal sphincter; IAS, internal anal sphincter.

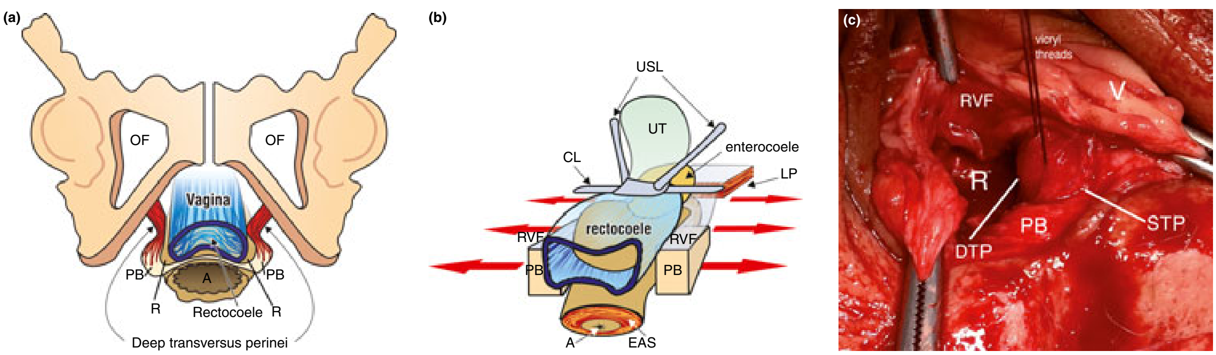

Figure 3 (a, b) Schematic three-dimensional view of the separation of the perineal body (PB) and rectovaginal fascia (RVF) to create potential defect for rectocele. The rectum (R) everts forward and spreads laterally to attach densely to the laterally displaced PB. The deep transversus perineii (DTP) is attached to the posterior surface of the descending ramus of the pubic bone. (c) Live anatomical dissection of the PB looking into the introitus. The vagina (V) has been dissected off the rectum which has also been dissected off the PB and superficial transversus perineii (STP) muscle to reveal the DTP muscle. The Vicryl threads are shown elevating the PB/DTP complex upwards from behind the ischial tuberosities. A, anal canal; CL, cardinal ligament; EAS, external anal sphincter; OF, obturator foramen; LP, levator plate; USL, uterosacral ligament; UT, uterus.

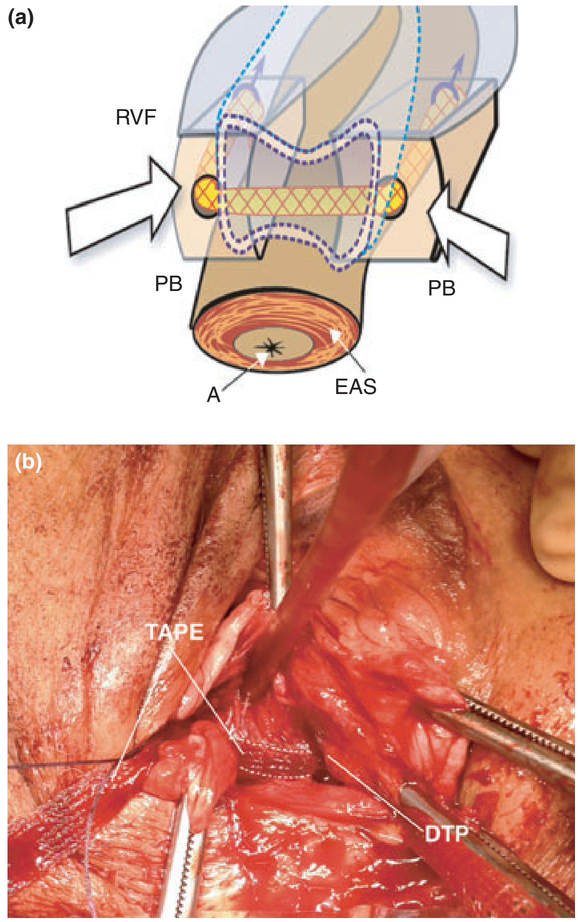

Figure 4 (a) Schematic 3D view of the tissue fixation system (TFS) operation. The tape (arrows) approximates the laterally displaced perineal body (PB), and with it the rectovaginal fascia (RVF). (b) Surgical image. The TFS is embedded through the prolapsed deep transverse perineii muscles (DTP) and is attached immediately behind the insertion of DTP into the posterior surface of the descending ramus of the pubis between the upper two-thirds and lower third. The tape remains bare for a distance of 1.5–2 cm between the two PBs and it fibroses with time to form a 'central tendon neoligament'. A, anal canal; EAS, external anal sphincter.

descending ramus of the pubic bone (Fig. 3c). The dissection then continued in the direction of the DTP muscle, a thick cylindrical band up to 1 cm diameter, attaching the PB to the posterior surface of the descending ramus exactly at the junction of the upper two-thirds and lower third. This structure was contiguous with and inseparable from the 'PB' (Fig. 3c). We were not able to confirm a perineal membrane as such by palpation. In two patients (6.6%), the right DTP muscle had been severed. At the end of the dissection, the TFS was brought into the canal on both sides and tightended in the midline, which brought the STP and DTP muscles into the normal horizontal position (Fig. 4). The median longitudinal length of the reconstituted PB was 4.5 (range 3.5–5.5) cm. Of this, half constituted the portion posterior to the descending ramus and half anterior to the ramus.

Histological study of biopsies of the medial part of PB in three patients demonstrated the presence of smooth muscle fibres, collagen, elastic tissue, nerves and blood vessels with also some striated muscle fibres.

Discussion

The main finding of our study was to demonstrate that in women with a low rectocele, the PB appeared to be divided into two parts, severely displaced behind the ischial tuberosities. The two PBs were bound together by a very thin stretched out central part, where the rectum was directly adherent to the vagina. Furthermore, we could identify that the PB was attached to the junction of the upper two-thirds and lower third of the descending ramus of the pubic bone by a firm structure which we considered to be the DTP muscle (Fig. 3). As an anatomical structure, what we termed DTP muscle was consistent with the descriptions of Stein *et al.* [10] who reported that fibrous bands attached the two parts of the perineal membrane to the pubic rami. However, they stated that there was no striated muscle, even if no histological assessment was performed. The DTP structure found in our dissections seemed to form a seamless continuum with the PB. It appears to correspond to the lateral extension (LEX) of the PB described by Soga *et al.* [3]. They found a higher smooth muscle content in 'LEX'. No attachment of 'LEX' to the descending ramus of the pubis could be demonstrated, though they qualified their statement with reference to the extreme age of the cadavers [3]. Our study was consistent with the 'digastric pattern' of the PB reported by Shafik *et al.* [11] who also described a DTP muscle. The finding of striated muscle fibres in our three biopsies also supported Shafik's 'crossover' thesis, though the preponderance of smooth muscle and collagen fibres indicated that the PB was also a structure in its own right, as suggested by Soga *et al.* [3]. Whether DTP is totally collagenous, or whether, as we found in our study, it has smooth muscle components which qualify it as a muscle, it is an important supporting structure for the PB. Our findings were also consistent with Zacharin's descriptions [30] of the lower 2–3 cm of vagina being densely adherent to the urethra, PB and rectum, a direct consequence of the embryology of this area, the cloacal membrane and urogenital sinus. We believe that, in our study population, the abnormal anatomy of two PBs stretched laterally and bound together by a very thin stretched out central part is the mechanism for the development of the low rectocele (perineocele), and does not discount the descriptions of PB as reported by Soga *et al.* [3] and DeLancey [9].

The results of our study are clinically relevant for the reconstructive surgery of the PB. The one-way TFS tensioning apparatus approximates and elevates the laterally displaced PB structures, re-creating an artificial neo 'centrum tendineum perineii' formed by the tape (Fig. 4). From a bioengineering perspective, the polypropylene tape joins together the two PBs, like a central lock holding together two hinged doors. The median longitudinal length of this reconstituted PB was 4.5 cm in our study. The massive discrepancy between our findings and those of Zetterstrom *et al.* [2] (1.2 cm) may perhaps be attributed to the difference in methodology. Our surgical measurement included the STP and DTP muscles, whereas Zetterstrom *et al.* [2] measured the PB by ultrasonography as the distance between the inner surface of the internal anal sphincter and the reflection of a finger held gently against the posterior vaginal wall. Using radiological methods, Abendstein *et al.* [1] reported that the PB formed more than 50% of the support of the posterior vaginal wall; however, they did not specify the actual length of the PB.

In the current report, the small sample size limited the analysis of correlations between age or parity and the degree of damage to the PB. We are currently conducting a further investigation in a larger cohort to confirm our preliminary findings and to determine the range of PB measurements. A second limitation is that this study was conducted in multiparous women with POP-Q Stage III rectocele and the abnormal anatomy of the PB does not correspond to normal anatomy in nulliparous women. Nevertheless, as previously reported, our finding of a digastric pattern of the PB anchored by DTP structure to the pubic bone is consistent with most published studies in the literature.

In conclusion, in women with a third-degree rectocele, the PB appears as two separated structures angulated downwards and laterally, attached like a hinge to the posterior surface of the descending pubic ramus by the DTP muscle. When elevated and approximated by a tensioned tape, the support of the posterior vaginal wall is restored. The rectum is displaced backwards into its correct anatomical position, and the rectocele disappears.

Author contributions

Each author has participated sufficiently in the work to take responsibility for it and approved the final submitted version. W.F.M.E. and P.P.: were responsible in the project conception and design; W.F.M.E., D.A.E. and P.P.: performed all surgical operations according to the protocol; W.F.M.E. and GAS: were responsible of the acquisition, analysis and interpretation of data and in writing the manuscript.

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