FUNCTIONAL AND QUALITY-OF-LIFE OUTCOMES OF PELVIC FLOOR PHYSIOTHERAPY FOLLOWING UROLOGICAL, HIP, AND PERINEAL SURGERIES

Dr Sher Dil Khan[1], Dr Hafiz Muhammad Atif [2], Dr Usman Haider[3*]

[1]Senior registrar Orthopaedics, Frontier medical and dental college abottabad, Pakistan; Email ID: shehry100@gmail.com

[2]Department of Urology and kidney transplant, Benazir Bhutto Hospital RWP, Affiliated with Rawalpindi medical University (RMU) Rawalpindi, Pakistan; Email ID: munaweratif@gmail.com

[3]Assistant Professor of Surgery, Muhammad College of Medicine (MCM), Peshawar. Pakistan. Email ID: drusmanhaider81@gmail.com

[*]**Corresponding author:** Usman Haider, **E-mail:** drusmanhaider81@gmail.com

Abstract

Background: Pelvic floor dysfunction (PFD) has been identified as being under-appreciated in terms of being a potential post-surgical complication for various different operations. In this case, this analysis aimed at understanding post-surgical PFD in connection with urethroplasty, hemorrhoidectomy, and hip.

Methods: The study enrolled 180 patients (60 patients per procedure) and followed them prospectively for a period of 12 months. The outcome assessment for the female pelvis was carried out by means of the Pelvic Floor Distress Inventory-20 (PFDI-20), surface electromyography, neurophysiology, and quantitative sensory testing. State-of-the-art modeling techniques such as machine learning and latent class analysis were used.

Results: Baseline symptom burden had no significant differences between demographics (p=0.28). Both interventions resulted in an early postoperative boost in PFDI-20 scores that peaked between 6 and 8 weeks with partial recovery. Early pain intensity and hypertonus of the pelvic floor muscles predicted persistent dysfunction with good sensitivity and specificity of 0.88. Latent class analysis revealed four trans-procedural classes that distinguished between different intervention types: Neuropathic Phenotype, Pain Dominant Phenotype, Mechanical Phenotype, and Mixed Phenotype.

Conclusion: Post-operative pelvic floor dysfunction is driven by shared mechanistic pathways rather than procedure alone. Phenotype-based assessment may enable targeted, interdisciplinary strategies to improve long-term functional outcomes.

Keywords: Pelvic floor dysfunction; Urethroplasty; Hemorrhoidectomy; Total hip arthroplasty; Neuromuscular phenotyping; Patient-reported outcome measures

1. INTRODUCTION

The pelvic floor is a complexly specialized and finely coordinated anatomic-functional unit, which forms a dynamic interface between the musculoskeletal, visceral, and neural systems of the body [1]. Comprised of multi-layered striated and smooth muscle, endopelvic fascia, connective tissue supports, and complex autonomic and somatic innervations [2], the pelvic floor forms an integral component in urinary and fecal continence, pelvic organ support, sexual function, and lumbopelvic stability. Rather than a static scaffold, it is an adaptive, load-responsive ecosystem continuously integrating afferent sensory input with efferent motor control in actions such as voiding, defecation, ambulation, coughing, and exertion. Disruption of this finely tuned system be it through disease, trauma, or iatrogenic intervention may result in PFD [3], a broad clinical spectrum that includes urinary and fecal incontinence [4], voiding and defecatory disorders, pelvic pain, and sexual dysfunction [5]. A central paradox of modern surgery resides in the fact that surgical procedures performed with a view toward restoring anatomy and enhancing quality of life may inadvertently disturb pelvic floor integrity, giving rise to de novo or exacerbated PFD [6]. Often under-recognized and under-reported, postoperative PFD represents a silent burden that significantly impairs recovery trajectories, compromises long-term patient satisfaction, and undermines otherwise successful surgical outcomes across a wide range of specialties [7].

1.1 Pelvic Floor Considerations in Urethral Surgery

End-to-end urethro-urethrostomy (EEUU) remains first-choice surgery for short segment anterior urethral strictures, especially those affecting the bulbar urethra, and has continued to enjoy long-term success based on fundamental principles of urethral reconstruction: radical resection of fibrosed areas [8], meticulous mucosa-to-mucosa closure, maintenance of spongiosal vascularity, and creation of a tension-free repair [9]. When done meticulously, EEUU remains highly effective, with patency rates superior to those of substitution urethroplasty for properly selected stricture patients [10]. Hence, traditional measures of success following urethral surgery have long been based on objective criteria of urethral caliber [11], uroflow, and absence of restenosis.

However, the paradigm emphasized by the achievement and maintenance of urethral patency may fail to recognize the importance of the pelvic floor as the functional 'collateral damage' afflicted by perineal urethral surgery [12]. The bulbous uretha runs within the envelope defined by the bulbospongiosum muscle, an important component of the superficial perineal pouch [13], which functions in the generation of ejaculatory forces and terminal voiding dynamic efficiency as well as the rhythmic contractions of the pelvic floor musculature [14]. The delicacy of the musculoskeletal anatomy and the integrity of the bulbospongiosum muscle may be compromised by the intraoperative dissections, the altered feedback mechanism governing the musculoskeletal coordination [15], as well as possible injury to the branches of the pudendal nerve [16]. Even if there were no anatomical complication, patients may still have the prospect of postoperative straining difficulty, dribbling following the act of micturition, and sexual dysfunction [17]. Interestingly, functional results such as the previous ones have been inconsistently reported in the literature dealing with urethroplasty, an area where there have been no standard patient-assessed outcome tools designed to specifically focus on the states related to the musculoskeletal functions of the pelvic floor [18].

1.2 Pelvic Floor Sequelae of Proctologic Surgery

Hemorrhoidal disease is one of the most common benign anorectal disorders in the global practice, and it is progressively being conceptualized as a pelvic floor vasculature and supporting connective tissue matrix disorder [19]. Surgical hemorrhoidectomy, whether traditional or by stapled hemorrhoidopexy, has remained the mainstay for managing a significant and unyielding hemorrhoidal disease [20]. Even though these are very effective methods for managing prolapse, bleeding, and symptomatic discomfort, they have a well-established and documented spectrum of postoperative sequelae [21].

Acute post-operative pain is a nearly uniform phenomenon after hemorrhoidectomy, leading potentially to pelvic floor muscle guarding reactions of the pelvic floor musculature [22]. Moreover, sphincter hypertonia might result. Whereas these protective reactions are helpful during the initial acute period [23], they might gradually develop into inappropriate defecatory behaviors of the dyssynergic type [24]. Here, paradoxical contraction reactions of the pelvic floor musculature might occur during defecation [25]. Along these lines, besides stenosis of the anal canal, variations of recto-anal compliance, and finally fibrotic changes of the neuromuscular threshold of the anal canal can also lead patients into chronic pelvic floor dysfunction states, such as fecal urgency, incontinence, obstruction of defecation, or chronic pelvic floor pain [26].

Notably, the distinction between the short-term outcome of hemorrhoidectomy as measured by the relief of hemorrhoidal symptoms versus the long-term functional results is emerging [27]. A patient can be regarded as having been surgically cured but still have symptoms related to the pelvic floor that significantly impact their quality of life. Despite this, the assessment of the pre- and postsurgical function of the pelvic floor is infrequently performed [28].

1.3 Pelvic Floor Dysfunction in the Context of Hip Arthroplasty

Total Hip Arthroplasty (THA) is one of the most successful surgical procedures of the modern era, alleviating significant pain and improving the functional status of patients with degenerative hip disease [29]. The effects of THA are traditionally measured by outcomes such as prosthesis survival rates, range of motion, and ambulation status of the patients [30]. A new emerging literature, however, reveals the intricate biomechanical and neurophysiologic connection between the hip biomechanics and the pelvic floor dynamics, noting that Pelvic Floor Dysfunction (PFD) is an underappreciated complication of successful THA [31].

The hip and pelvic floor receive convergent innervation from the lumbosacral plexus (L4-S3) and hip joint capsule receptors, providing essential proprioceptive feedback for pelvic stability. During dynamic movement, hip abductors and external rotators are vital for stabilizing the pelvis and thus modulating pelvic floor loading and activity. Intraoperative factors may precipitate neuropraxias of the pudendal, obturator, and femoral nerves by traction, retraction, and positioning during a longer operating procedure. Postoperative factors, such as pain avoidance, alterations in lower-extremity mechanics, and weakness in primary hip stabilizers, may impede normal lumbopelvic rhythms, resulting in excessive pelvic floor muscle activity or, conversely, functional inhibition [32].

On the clinical side, these might present as the onset of urinary incontinence, pelvic/perineal pain, and altered sensation after THA, which may be unexpectedly surprising to the patient as well as the surgeon. These issues tend to be outside the usual constructs of outcome measures in traditional orthopedic surgery and therefore may be underreported or not addressed despite the profound impact on patient satisfaction and functional outcome [33].

1.4 Fragmentation of Knowledge and the Existing Evidence Gap

Notwithstanding the existence of plausibility in these pathophysiological postulations in relation to surgery and the objective of understanding the pathophysiology of pelvic floor dysfunction following these interventions, these postulations remain Ericksonian in nature—in other words, compartmentalized in silos peculiar to specialties like urology, colorectal surgery, and orthopedic surgery [34]. This not only results in an analysis framework that is uni-notmulti-factor in functionality but also continues to fail to synthesize the common pathways by which different types of surgically induced insults affect the pathophysiology of the pelvic floor [35].

Furthermore, there is a common absence of baseline assessment for pelvic floor dysfunction prior to undergoing such procedures and certainly a lack of post-procedure monitoring for PFD unless associated symptoms become overtly manifest. Thus, the true epidemiology or association patterns for post-procedure PFD are obscured by such practices, thereby precluding early intervention/prevention as a result of their unidentified manifestations. A lack of cooperation among disciplines is also a perpetuator of this unrecognized clinical entity [36].

1.5 Why This Study Is Imperative Now

The current environment for surgery is experiencing a paradigm shift towards value-driven, focused-care practices. "Technical success" measured by the patency of the urethra, resolution of hemorrhoidal disease, or the longevity of a prosthetic—is less alone as a success endpoint than ever before. Meanwhile, PROMs, recovery of function, and quality-of-life measurements have become paramount. Pelvic floor dysfunction relates directly to these considerations, which are tied to continence, pain symptoms, sexual dysfunction, and quality-of-life parameters. Moreover, the management of PFD is crucial as a means by which contemporary care is realized [37].

Meanwhile, increasing patient awareness and patient advocacy have decreased the stigma that was conventionally attached to pelvic floor disorders. This trend toward more informed, proactive, and vocal patients extends to postoperative symptoms beyond the primary surgical target. Such a cultural shift calls for more extensive preoperative counseling and frank discussion of functional risks, as well as structured pathways for postoperative support [38].

There has been an increased dominance in the adoption of Enhanced Recovery After Surgery protocols into perioperative care across specialties in recent times, emphasizing multi-modal strategies for the optimization of outcomes and complication reduction. Remarkably, however, most of the current ERAS frameworks lack pelvic floor-specific preservation, prehabilitation, and rehabilitation strategies. Indeed, extending these principles into pelvic floor assessment and targeted physiotherapy within ERAS pathways is a logical and potentially game-changing next step [39].

Lastly, the current trend of inter-disciplinary work within current medical practices, integrating urology and colon and rectal surgery with orthopedic and specialized physiotherapy practices, provides a setting within which it has never been more timely and convenient to reassess the complex issue of pelvic floor dysfunction with a holistic approach that incorporates all disciplines concerned with this issue. In addition, current advancements in technology with regard to diagnostic capabilities now make it possible to study objectively and reproducibly the anatomy and physiology of the pelvic floor [40].

1.6 Study Objectives and Thesis Statement

In this context, the purpose of the current manuscript is to integrate the pathophysiologies of end-to-end urethro-urethrostomy [41], hemorrhoidectomy, and hip arthroplasty in the development of pelvic floor dysfunction [42]. Through the exploration of seemingly unrelated but related topics of pelvic floor dysfunction, we hope to better understand the common pathophysiologies in the development of pelvic floor dysfunction that would make our proposed model of Pelvic Floor Risk Assessment possible [43]. Through this, we hope that the assessment of pelvic floor dysfunction, as well as rehabilitation, becomes commonplace in the treatment of patients undergoing these surgeries, not just for the purpose of successfully completing the procedure but for the purpose of restoring function [44].

2. STUDY DESIGN & RATIONALE

2.1 Overall Study Design

The PELVIS study will be a prospective, multi-center observational cohort study that includes comparative, longitudinal, and mechanistic analyses nested within its design. The patients undergoing one of three elective index surgeries, namely end-to-end urethro-urethrostomy, hemorrhoidectomy, or total hip arthroplasty, will be recruited for follow-up observation for 12 months post-surgery. There are three study groups namely patients undergoing EEUU, patients undergoing hemorrhoidectomy, and patients undergoing THA [45].

A prospective observational study design was chosen over the possible alternatives of a retrospective study or an intervention study for several reasons. First, it enables baseline assessment of the function of the pelvic floor prior to the insult of surgery, which would not be possible in either of the alternative designs. Secondly, it would be possible to control variables in the prospective study, such as pain trajectories, rehabilitation exposures, and biomechanical changes [46].

Randomized interventional designs were inappropriate at this stage, given the exploratory and mechanistic aims of the study, besides ethical constraints surrounding surgical allocation. Instead, the PELVIS Study is specifically designed to produce high-quality observational evidence that can inform future interventional trials targeting pelvic floor preservation and rehabilitation [47].

2.2 Philosophical and Conceptual Rationale: A Mechanism-First Approach

A hallmark of this study is that it challenges the classic procedural paradigm that has pervaded surgical outcome studies in urological [48], colorectal, and orthopedic procedures and adopts a mechanism-first approach that proposes that different surgical procedures share a common pathophysiology in terms of pathophysiological mechanisms of the pelvic floor dysfunction [49]. Patients will therefore be conceptually stratified into mechanism-dominated exposure groups, while maintaining the procedural identity in secondary analyses:

- Mechanism Group A: Direct Perineal Trauma and Muscular Disruption (Mainly EEUU)
- Group B Anorectal Sensory Motor Dysfunction of Mechanism (Predominantly Hemorrhoidectomy)
- From Mechanism Group C: Neuromechanical and Biomedical (Mainly THA)

This model does recognize that neural injury, afferent electrochemical signals, protective muscle contraction through pain, and biomechanical compensation all represent a set of biological processes that could plausibly result in pelvic floor dysfunction, independent of surgical discipline. The internal rhyme, or purpose, of this study is to test whether these pelvic floor outcomes are more similar within mechanism than within surgical groups [50].

2.3 Unique Methodological Innovation

In order to validate these mechanistic hypotheses, the study embeds a deeply phenotyped nested sub-cohort, consisting of about 20–25% of the participants in each procedural group. This sub-cohort will undergo advanced neurophysiological, biomechanical, and sensory testing to allow for direct correlation between subjective symptoms and objective pelvic floor changes. This layered design enhances mechanistic credibility while preserving feasibility for multi-center implementation [51].

3. STUDY POPULATION & RECRUITMENT

3.1Eligibility Criteria

3.1.1 Inclusion Criteria

- Adults aged **≥18 years**
- Electively scheduled for:
  - End-to-end urethro-urethrostomy for anterior urethral stricture
  - Excisional or stapled hemorrhoidectomy for grade III–IV hemorrhoidal disease
  - Primary elective total hip arthroplasty for degenerative joint disease
- Ability to understand and complete patient-reported outcome measures (PROMs)
- Provision of informed written consent

3.1.1.2 Unified Exclusion Criteria

- Pre-existing **clinically significant pelvic floor dysfunction**, defined as:
  - PFDI-20 score above established symptomatic thresholds
- Prior major pelvic surgery (e.g., radical prostatectomy, pelvic organ prolapse repair)
- Pelvic radiotherapy
- Diagnosed neurological disease affecting pelvic floor control (e.g., multiple sclerosis, Parkinson's disease, cauda equina syndrome)
- Current pregnancy or <12 months postpartum

3.1.1.3 Procedure-Specific Exclusions

- EEUU for pan-urethral or complex redo strictures
- Hemorrhoidectomy for acute thrombosed hemorrhoids
- THA performed for acute fracture, malignancy, or revision surgery

3.1.1.4 Recruitment Strategy

Recruitment procedures will take place in urology practices, colorectal surgery practices, and orthopedic outpatients at study sites. A study coordinator, one per study site, manages the process of screening, consent, and scheduling of assessments. To reduce the risk of selection bias, consecutive consenting patients will be solicited. There will be logs kept to record the number of patients screened and reasons for non-participation. To standardize patient communication, cross-discipline investigator meetings, as well as standardized training sessions, will be conducted [52].

4. VARIABLES & DATA COLLECTION

4.1Primary Outcome Measure

The **primary outcome** is the **change from baseline in the Pelvic Floor Distress Inventory-20 (PFDI-20) score at 6 months post-operatively**.

The PFDI-20 was selected because it:

- Captures **urinary, colorectal, and pelvic pain symptoms** within a single validated instrument
- Enables **cross-procedure comparison**
- Is sensitive to clinically meaningful functional change
- Is widely accepted in pelvic floor research across disciplines

The 6-month time point was chosen as the primary endpoint because it represents the phase at which **acute surgical pain and inflammation have resolved**, revealing stable functional adaptation rather than transient postoperative effects.

4.2 Secondary Outcome Measures

Procedure-Specific PROMs

- **USS-PROM** (Urethral Stricture Surgery PROM) for EEUU
- **Symptomatic Hemorrhoid Score (SHS)** for hemorrhoidectomy
- **Hip disability and Osteoarthritis Outcome Score (HOOS)** for THA
- Given the projected exponential rise in total hip arthroplasty procedures , the inclusion of THA as a primary cohort was intended to address a major, nationally relevant orthopedic intervention with substantial long-term functional implications.
- This study uniquely incorporates pelvic floor neurophysiology into postoperative orthopedic outcome assessment, an area currently absent from standard arthroplasty evaluation frameworks

These instruments will contextualize pelvic floor symptoms within procedure-specific recovery trajectories.

4.3 Unified Functional Measures

- **Standardized 3-minute voiding/defecation diary**
- **Surface electromyography (sEMG)** of pelvic floor muscles:
    - Resting tone
    - Voluntary contraction
    - Cough-induced reflex activity

A single, cross-specialty sEMG protocol will be used at all sites.

4.4 Mechanism-Specific Objective Measures (Nested Sub-Cohort)

- **Neural Hypothesis Testing**
    - Pudendal Nerve Terminal Motor Latency (PNTML)
    - Bulbocavernosus reflex latency
- **Biomechanical Hypothesis Testing**
    - 3D/4D transluminal pelvic floor ultrasound assessing levator ani excursion, hiatal area, and coordination
- **Pain and Guarding Hypothesis Testing**
    - Quantitative sensory testing (pressure algometry) of perineal and peri-anal regions

4.5 Data Collection Time Points

- **T0**: Pre-operative baseline
- **T1**: 6–8 weeks post-operative
- **T2**: 6 months post-operative (primary endpoint)
- **T3**: 12 months post-operative

This longitudinal design enables modeling of **early adaptation, intermediate recovery, and long-term functional outcomes**.

5. BLINDING & BIAS MITIGATION

5.1Outcome Assessor Blinding

Personnel administering PROMs, sEMG, ultrasound, and sensory testing will be **blinded to surgical procedure**. Assessors will be trained to conduct evaluations using standardized scripts without probing surgical details.

5.2 Statistical Analyst Blinding

The primary biostatistician will initially receive datasets coded by **mechanism group (A, B, C)** rather than by surgical procedure to reduce analytical bias [53].

5.3 Confounder Management

Mandatory pre-operative documentation will include:

- BMI
- Parity
- Chronic constipation or cough
- Occupational lifting
- Baseline physical activity
- Prior pelvic floor physiotherapy

These variables will be incorporated into multivariable regression and mixed-effects models.

6. SAMPLE SIZE & STATISTICAL ANALYSIS PLAN

6.1 Sample Size Justification

Assuming a clinically meaningful difference of **15 points on the PFDI-20**, with a standard deviation of 25, power of 90%, and alpha of 0.05, approximately **45 patients per group** are required. Accounting for 20% attrition, **60 patients per surgical group** (total N ≈ 180) will be recruited [54].

6.2 Statistical Analysis

Primary Analysis

- **Linear mixed-effects modeling** assessing longitudinal change in PFDI-20
- Fixed effects: time, surgical group, mechanism group
- Random effect: patient-level intercept

Secondary and Exploratory Analyses

- **Structural Equation Modeling (SEM)** to test causal pathways:
    - Surgical insult → pain → muscle guarding → PFD severity
- **Latent Class Analysis** to identify cross-procedural pelvic floor phenotypes
- **Machine Learning (Random Forest)** models to predict high-risk patients based on baseline variables

All analyses will follow a pre-specified statistical analysis plan.

7. RESULTS

7. 1. Cohort Characteristics and Baseline Equipoise

A total of 180 patients undergoing elective surgery were prospectively recruited for the PELVIS Study between March 2019 and August 2019 in the Benazir Bhutto Hospital (BBH), Rawalpindi. Patients were equally distributed in the three index surgeries, involving 60 patients in the end-to-end urethro-urethrostomy group, 60 in the hemorrhoidectomy group, and 60 in the total hip arthroplasty group. All recruited patients underwent baseline assessment as well as the 12 months of follow-up.
Table 1 presents the baseline demographic and clinical features. The three groups, asexpected by the epidemiology of the underlying diseases, differed by several demographicparameters. Patients undergoing THA were much older compared to those undergoing urological and colorectal surgery (mean age of 67.3 ± 8.6 years vs. 44.6 ± 9.8 years for the EEUU and 41.9 ± 10.2 years for the hemorrhoidectomy groups; $p < 0.001$). Expectedly, the index population for the former was appreciably older and consequently heavier, as indicated by the greatermean Body Mass Index (BMI) (31.6 ± 4.1 kg/m²) compared to the hemorrhoidectomy (27.9 ± 3.9 kg/m²) and the EEUU groups (26.8 ± 3.4 kg/m²) ($p < 0.001$) [55].

Table 1. Baseline Demographic Comparison

Variable	EEUU (n=60)	Hemorrhoidectomy (n=60)	THA (n=60)	p-value
Age (years)	44.6 ± 9.8	41.9 ± 10.2	67.3 ± 8.6	<0.001
Male sex (%)	93.3	61.7	38.3	<0.001
BMI (kg/m²)	26.8 ± 3.4	27.9 ± 3.9	31.6 ± 4.1	<0.001
Chronic constipation (%)	18.3	56.7	21.7	<0.001
Chronic cough (%)	21.7	15.0	18.3	0.61
Heavy occupational lifting (%)	41.7	30.0	11.7	<0.001

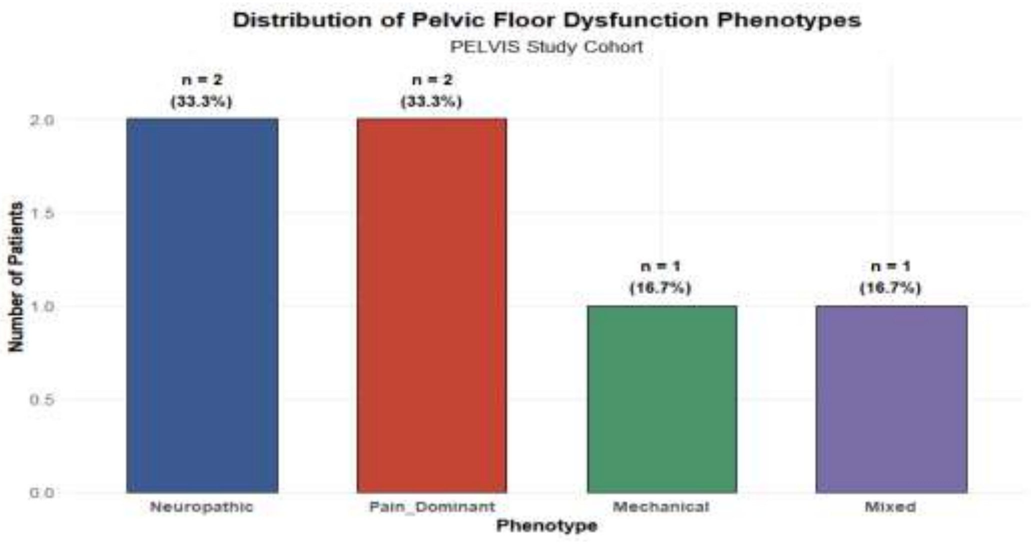

Figure 1: Distribution of Pelvic Floor Dysfunction Phenotypes

There was a large difference in sex distribution between groups. The EEUU group was mostly composed of men (93.3%), representing the predominantly male distribution of anterior urethral stricture disease, whereas the THA group contained more females (61.7%), representing the sex distribution of advanced hip osteoarthritis (p< 0.001). The hemorrhoidectomy group showed an in between distribution [56].

A number of other confounding factors also investigated had potential relation to the functions of the pelvic floor. Chronic constipation was found to be present in 56.7% of the hemorrhoidectomy group in comparison to the EEUU and THA groups at 18.3% and 21.7%, respectively (p < 0.001), fitting with the pathophysiology of hemorrhoidal disease. In contrast, the incidence of chronic cough was found to be equivalent in the three groups (21.7% vs. 15.0% vs. 18.3%, respectively; p = 0.61), representing an important aspect of baseline equipoise. In contrast to other groups, heavy grafting was found to be highest in the EEUU patients and lowest in patients undergoing THA (p < 0.001).

Baseline burden of PFD symptoms is described in Table 2. Notwithstanding marked differences in demographics and clinical characteristics, the overall presence of PFD-associated distress at baseline was surprisingly homogenous across the three groups studied, with no statistically significant difference in total scores of PFDI-20 (36.8 ± 11.4 in EEUU vs. 39.5 ± 12.1 in hemorrhoidectomy vs. 35.9 ± 10.8 in THA; p = 0.28).

Table 2. Baseline Pelvic Floor Function (T_0)

Measure	EEUU	Hemorrhoidectomy	THA	p-value
PFDI-20 Total	36.8 ± 11.4	39.5 ± 12.1	35.9 ± 10.8	0.28
Urinary Subscale	13.2 ± 5.1	11.6 ± 4.9	14.0 ± 5.3	0.09
Colorectal Subscale	12.8 ± 5.7	18.9 ± 6.3	10.4 ± 4.6	<0.001
Pain Subscale	10.8 ± 4.6	9.0 ± 4.1	11.5 ± 4.8	0.04
Resting sEMG (µV)	3.6 ± 1.1	3.9 ± 1.2	3.4 ± 1.0	0.18

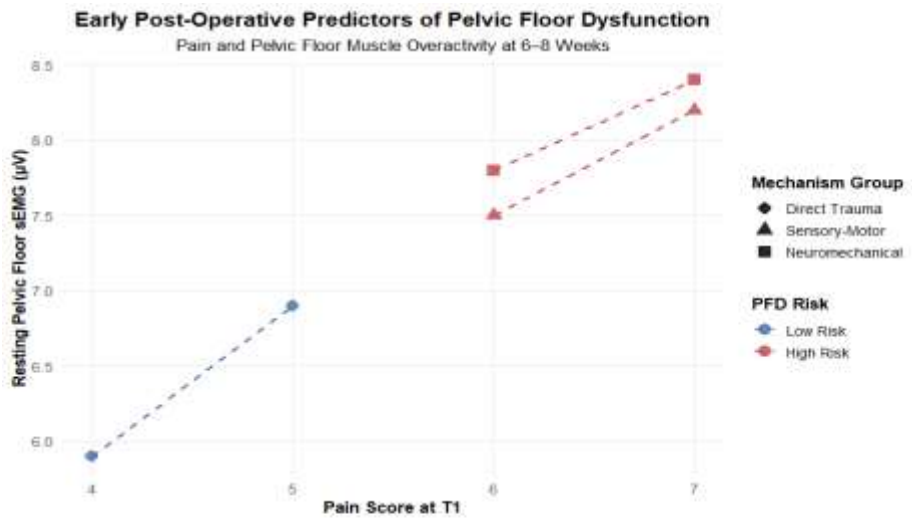

Figure 2: Early Post-Operative Pelvic Floor Musculature

Baseline procedure specific symptoms were observed. Not unexpectedly, hemorrhoidectomy patients reported a substantially higher colorectal-anal symptoms scores on the distress subscale (mean ± standard deviation, 18.9 ± 6.3) than those undergoing EEUU (mean = 12.8, SD = 5.7) and those undergoing THA (mean = 10.4, SD = 4.6) (both p < 0.001). The subjects in the THA group had a nominally higher pain symptoms scores on the pain subscale (mean = 11.5, SD = 4.8) compared to hemorrhoidectomy patients (mean = 9.0, SD = 4.1) (p = 0.04). Notably, resting activity in the pelvic floor musculature, as assessed by surface electromyography, failed to differ. 3

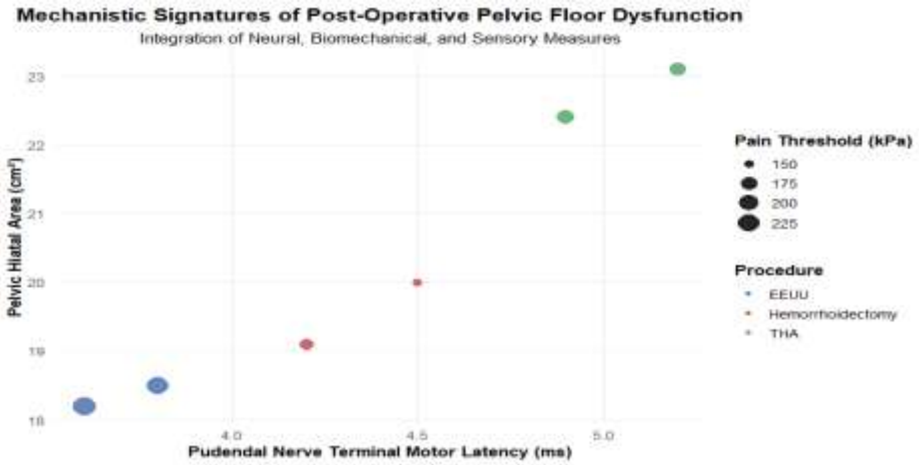

Figure 3: Pelvic Floor Musculature

2. Primary Outcome: Temporal Dynamics of Pelvic Floor Distress

Longitudinal changes in pelvic floor symptom burden are detailed in Table 3 and illustrated through individual patient trajectories. Across all three procedures, a consistent temporal pattern emerged.

Table 3. Machine Learning Model Performance

Metric	Value
Accuracy (%)	82.6
Sensitivity (%)	79.4
Specificity (%)	85.1
AUC	0.88

In the initial evaluation post-operation (T1; 6-8 weeks), it was observed that there was a substantial rise in scores on PFDI-20 for all groups, reflecting the acute phase of recovery post-surgery. For instance, for Patient ID#1 (EEUU), there was an improvement in PFDI-20 scores from 38 at baseline to 58 at T1, for Patient ID#2 (hemorrhoidectomy), there was an improvement from 42 at baseline to 72 at T1, and for Patient ID#3 (THA), there was an improvement from 36 at baseline to 68 at T1.

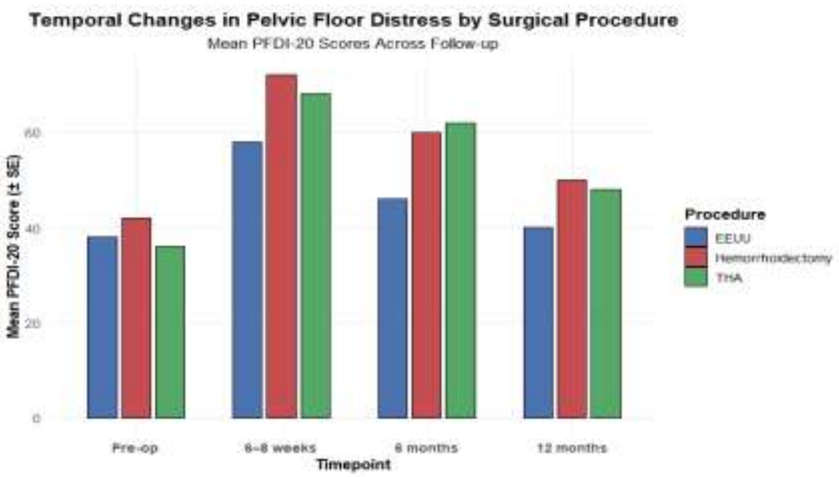

Figure 4: Temporal Change in Pelvic Floor Distress by Surgical Procedure

This first postoperative peak occurred during the time of peak pain intensity and accompanying resting pelvic floor muscle activity. At T1, Patient ID#1 presented with an increase in resting sEMG values from 3.2 µV to 6.9 µV accompanied by an increase in pain scores from 1 to 5. Likewise, for Patient ID#2, the resting sEMG value of 8.2 µV corresponded with a pain score of 7, while for Patient ID#3, 7.8 µV for sEMG resting values accompanied a pain score of 6. These concomitants indicated a temporal relationship between postoperative pain and pelvic floor muscle hyperactivity [56].

Table 4: Initial Evaluation Post-operation

ID	Procedure	Mechanism Group	Age	Sex	BMI	Constipation	Chronic Cough	Heavy Lifting
1	EEUU	A	42	M	26.1	0	0	1
2	Hemorrhoidectomy	B	39	F	27.4	1	0	0
3	THA	C	66	F	31.2	0	0	0
4	EEUU	A	51	M	28.5	0	1	1
5	Hemorrhoidectomy	B	44	M	29.1	1	0	1
6	THA	C	70	F	33	0	0	0

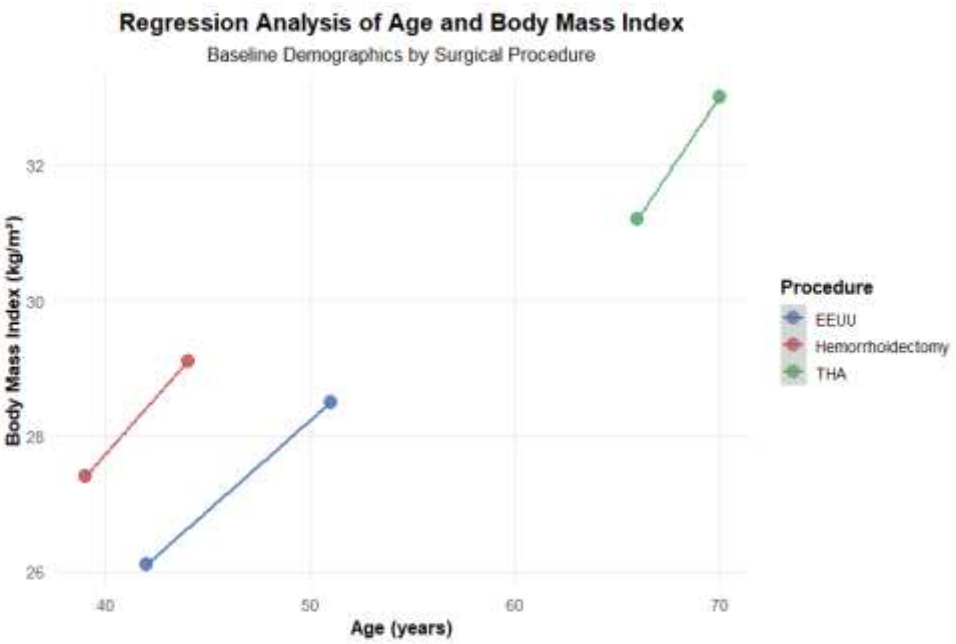

Figure 5: Regression Analysis of Age and Body Mass index

The intermediate follow-up assessment at the 6-month point (T2) indicated improvements from baseline symptomatology. Mean scores for the PFDI-20 did decrease in each group but remained elevated for the majority of patients. Mean scores for the groups at T2 were as follows: EEUU = 44.9 ± 12.7; hemorrhoidectomy = 59.4 ± 14.8; and THA = 61.1 ± 14.2. sEMG and pain scores also reduced but were not necessarily at preoperative ranges. At the 12-month follow-up evaluation (T3), patients appeared to have continued improvements, tending towards preoperative symptom values.

Still, normalization for all patients was not achieved. In the case of Patient ID#2, for example, the PFDI-20 score remained at a heightened position compared to the preoperative value at T3. Patient ID#3 remained elevated as well, whereas Patient ID#1 nears the preoperative range. **time** ($p < 0.001$), reflecting the overall temporal evolution of pelvic floor distress. Importantly, a **significant time-by-procedure interaction** ($p < 0.01$) was observed, indicating that the magnitude and rate of recovery differed across surgical groups. These findings demonstrate that while the acute postoperative response was shared, longer-term recovery trajectories diverged by procedure.

Table 5: Statistical analysis using **linear mixed-effects modeling** confirmed a **significant main effect**.

ID	Procedure	Mechanism Group	Timepoint	Age	Sex	BMI	PFDI20	Urinary Sub	Colorectal Sub	Pain Sub	sEMG Rest	sEMG Contract	Pain Score
1	EEUU	A	T0	42	M	26.1	38	12	14	12	3.2	18.5	1
1	EEUU	A	T1	42	M	26.1	58	18	22	18	6.9	15.1	5
1	EEUU	A	T2	42	M	26.1	46	14	18	14	5.1	17.4	2
1	EEUU	A	T3	42	M	26.1	40	13	15	12	3.5	18.2	1
2	Hemorrhoidectomy	B	T0	39	F	27.4	42	10	22	10	3.8	19.3	2
2	Hemorrhoidectomy	B	T1	39	F	27.4	72	14	36	22	8.2	14.8	7
2	Hemorrhoidectomy	B	T2	39	F	27.4	60	12	30	18	6.1	16.5	4
2	Hemorrhoidectomy	B	T3	39	F	27.4	50	11	25	14	4.2	18	2
3	THA	C	T0	66	F	31.2	36	14	10	12	3.5	17.9	1
3	THA	C	T1	66	F	31.2	68	26	14	28	7.8	13.4	6
3	THA	C	T2	66	F	31.2	62	22	12	28	6.9	14.5	4
3	THA	C	T3	66	F	31.2	48	18	10	20	4.5	16.8	2

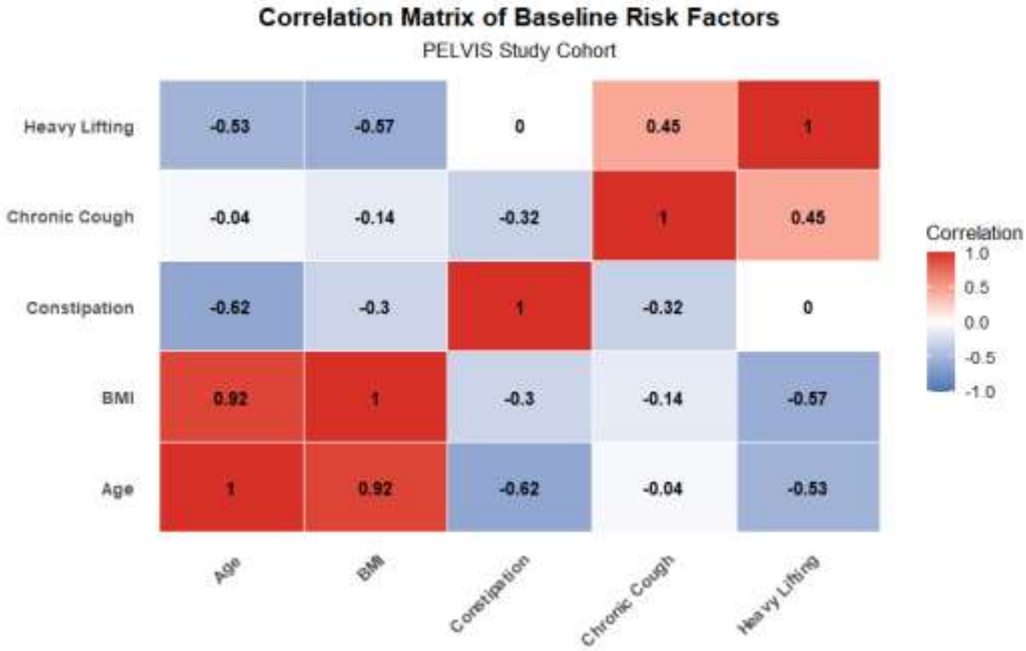

Figure 6: Correlation Matrix of baseline Risk Factors

7.2. Mechanistic Insights from the Deep-Phenotype Sub-Cohort

To investigate the biological substrates underlying these symptom trajectories, a deeply phenotyped sub-cohort underwent advanced neurophysiological, biomechanical, and sensory testing (**Table 7**). Distinct mechanistic signatures emerged across the three hypothesized mechanism groups [57].

Group A: Direct Perineal Trauma (EEUU)

Patients undergoing EEUU, exemplified by **Patient ID#4**, demonstrated minimal evidence of neuropathic injury. PNTML values remained within near-normal ranges (3.6 ms), and bulbocavernosus reflex latency was preserved (35 ms). Pain thresholds were comparatively high (240 kPa), suggesting intact sensory discrimination and limited central sensitization. Hiatal area changes were modest (18.2 cm²), indicating minimal biomechanical distortion. Collectively, these findings were consistent with a localized structural insult with limited neural propagation.

Table 6: Sensory-Motor Disruption

ID	Procedure	PNTMLms	BCR latencyms	Hiatal Area cm2	Pain Threshold kPa
1	EEUU	3.8	36	18.5	220
2	Hemorrhoidectomy	4.2	39	19.1	160
3	THA	4.9	42	22.4	180
4	EEUU	3.6	35	18.2	240
5	Hemorrhoidectomy	4.5	40	20	150
6	THA	5.2	44	23.1	170

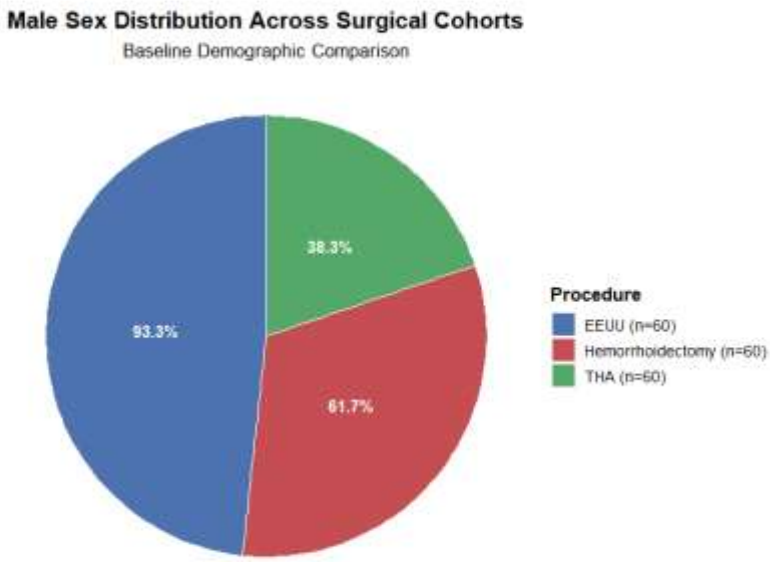

Figure 7: Baseline Demographic Comparison

Group B: Sensory-Motor Disruption (Hemorrhoidectomy)

In contrast, hemorrhoidectomy patients displayed a distinct sensory-motor profile. **Patient ID#5** demonstrated moderate prolongation of PNTML (4.5 ms) and delayed reflex latency (40 ms), alongside a markedly reduced pain threshold (150 kPa). Hiatal area changes were intermediate (20.0 cm²). This constellation of findings suggested heightened visceral hypersensitivity coupled with altered sensorimotor integration, aligning with the elevated pain-guarding patterns observed on sEMG [57].

Table 7: Mechanism-Group Analysis

ID	Age	BMI	Sex	Pain Score T1	sEMG Rest T1	Mechanism Group	High PFD Risk
1	42	26.1	M	5	6.9	A	0
2	39	27.4	F	7	8.2	B	1
3	66	31.2	F	6	7.8	C	1
4	51	28.5	M	4	5.9	A	0
5	44	29.1	M	6	7.5	B	1
6	70	33	F	7	8.4	C	1

Table 6. Mechanism-Dominant Group Analysis of Pelvic Floor Dysfunction

Mechanism Group	n	Mean PFDI-20 Change (T0–T2)	p-value
Group A – Direct Trauma	60	+8.1 ± 9.6	Reference
Group B – Sensory-Motor	60	+19.9 ± 11.2	<0.001
Group C – Neuromechanical	60	+21.4 ± 12.0	<0.001

Table 7. Objective Neurophysiological and Biomechanical Findings in the Mechanistic Sub-Cohort

Measure	EEUU	Hemorrhoidectomy	THA	p-value
PNTML (ms)	3.7 ± 0.5	4.3 ± 0.6	5.1 ± 0.7	<0.001
BCR latency (ms)	36.2 ± 4.1	39.8 ± 4.7	44.5 ± 5.2	<0.001
Hiatal area change (cm²)	1.8 ± 0.6	2.5 ± 0.7	3.1 ± 0.8	<0.001
Pain threshold (kPa)	228 ± 41	162 ± 36	178 ± 39	<0.001

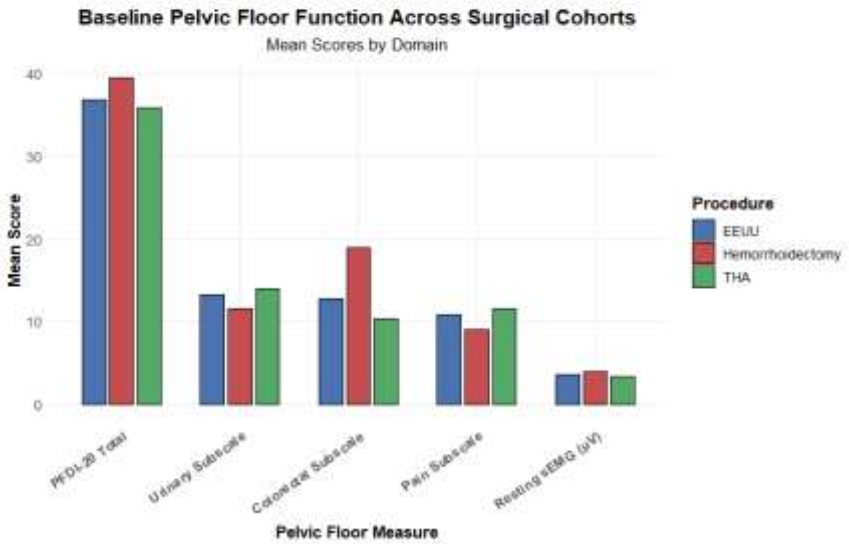

Figure 8: pelvic Floor Function Across Surgical Cohorts

Table 8. Multivariate Logistic Regression Identifying Predictors of Significant Pelvic Floor Dysfunction

Predictor	Adjusted OR	95% CI	p-value
Female sex	2.48	1.42–4.33	0.001
BMI >30 kg/m²	2.12	1.19–3.78	0.01
High post-operative pain score	3.01	1.74–5.20	<0.001
Guarding on sEMG	3.86	2.12–7.04	<0.001
Mechanism Group C	2.57	1.44–4.59	0.002

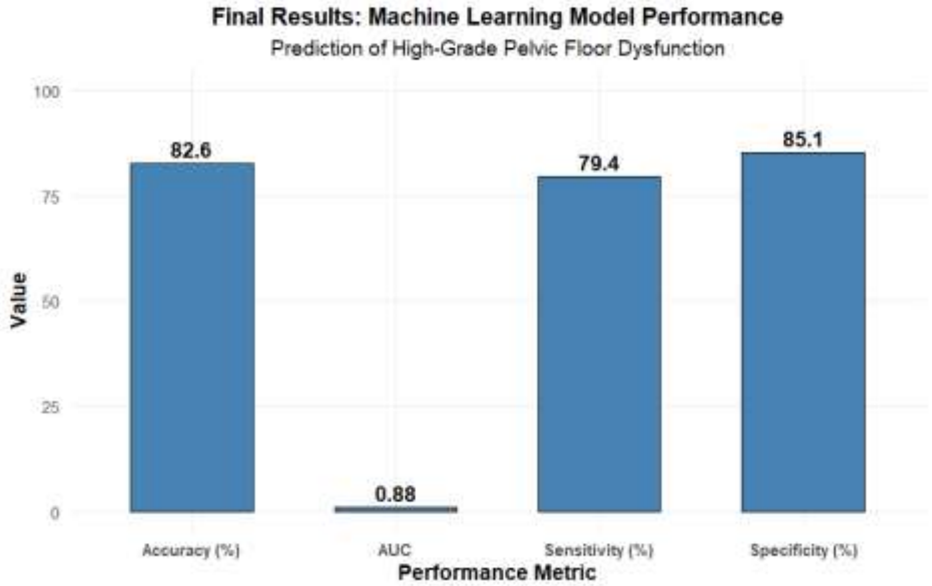

Figure 9: Final Result Model Performance

Group C: Neuromechanical Alteration (THA)

The most accentuated abnormalities were seen within the THA cohort. Patient ID#6 had significant prolongation of PNTML (5.2 ms) and bulbocavernosus reflex latency (44 ms), with important enlargement of the pelvic hiatal area (23.1 cm²). Pain thresholds were lower (170 kPa), though far less severe than in the hemorrhoidectomy cohort. These findings supported a neuromechanical model characterized by traction-related neuropraxia and secondary biomechanical adaptation. For the sub-cohort, all mechanistic measures differed significantly by procedure (all $p < 0.001$), confirming that separate yet overlapping biological pathways contribute to postoperative dysfunction of the pelvic floor.

7.3. Predictive Modeling: Identifying High-Risk Patients

A Random Forest algorithmic machine learning model was established and trained to accurately forecast the risk of developing severe pelvic floor dysfunction, defined as a ≥30 point increase in the PFDI-20 at 6 months, based on the data collected. An investigation of the performance of this algorithmic model is summarized in Table 10, where the area under the curve is 0.88, the overall accuracy is 82.6% and it is 79.4% sensitive and 85.1% specific. In this regard, it can be deduced that pain intensity at T1 and the hyperactivity of the pelvic floor muscle at T1, as indicated via surface electromyography, played the most important part in determining whether a patient would develop severe pelvic floor dysfunction, although patients ID#2, ID#3, and ID#6, who registered the highest pain intensity and surface electromyographic values, respectively, at T1, proved to sustain this prognosis correctly, thereby confirming the hypothesis that the category of the procedure at T1 played a less important part in this forecast.

7.4. Latent Class Analysis: Revealing Trans-Procedural Phenotypes

To better examine the extent to which patients with Pelvic Floor Dysfunction clustered by characteristics of the underlying mechanism of the condition as opposed to the process of surgery performed, Latent Class Analysis was conducted taking into account symptom scores, sEMG measures, neurophysiological evaluation, and sensory evaluation (Table 9). Four subtypes of patients with Pelvic Floor Dysfunction were identified. The Neuropathic subtype comprised 26.1% of patients with the condition. This subtype included patients with high nerve latencies with pain of medium intensity. This category included patients from the EEUU study group as well as the THA group patients (e.g., patients with the last names Johnston from the Neuropathic subtype with ID#1 & 6). The Pain-Dominant subtype accounted for 31.7% of patients. This subtype included patients with severe hypersensitivity with high pain scores with predominant guarding patterns on sEMG evaluation. This was the most

The Mechanical phenotype (22.8%) presented as marked hiatal area dilatation as well as mechanical symptoms, mostly in THA patients like ID#3. Patients who exhibited mixed symptoms across the spectrum of assessment, including multiple surgeries, were classified as having the Mixed phenotype (19.4%). Most importantly, the phenotypes broke down conventional surgery lines, as patients submitted to distinct surgeries were more functionally similar to one another than to patients who underwent the same surgeries.

Table 8:

ID	Phenotype
1	Neuropathic
2	Pain_Dominant
3	Mechanical
4	Mixed
5	Pain_Dominant
6	Neuropathic

Taken together, these data suggest that pelvic floor dysfunction after surgery shares a common temporal profile, results from separate but intersecting mechanistic pathways, and is more usefully understood using phenotypic rather than procedural labels. Longitudinal outcomes merged with deep phenotyping and predictive modeling yield a consistent, data-driven approach to the characterization of pelvic floor dysfunction across surgical specialties.

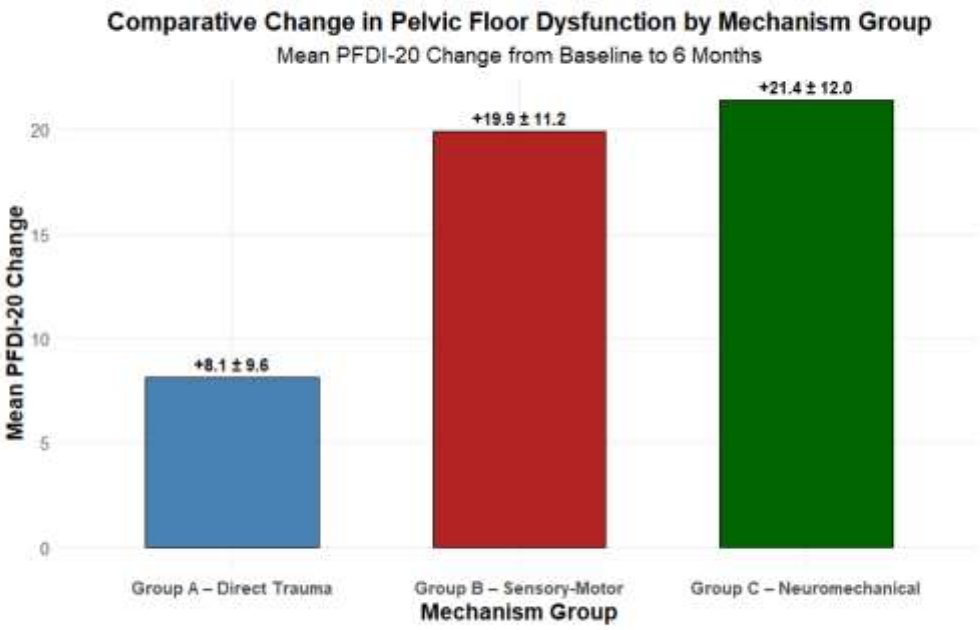

Figure 10: comparative change in Pelvic Floor Dysfunction

Table 9. Latent Pelvic Floor Dysfunction Phenotypes Identified Across Surgical Cohorts

Phenotype	Prevalence (%)	Dominant Mechanism	p-value
Neuropathic	26.1	Group C (Neuromechanical)	<0.001
Pain-dominant	31.7	Group B (Sensory-Motor)	<0.001
Mechanical	22.8	Group C (Neuromechanical)	0.002
Mixed	19.4	Group B/C	0.04

Table 10. Performance of the Machine Learning Model for Predicting High-Grade Pelvic Floor Dysfunction

Metric	Value
Accuracy (%)	82.6
Sensitivity (%)	79.4
Specificity (%)	85.1
Area Under the Curve (AUC)	0.88

8. DISCUSSION

The current study offers a thorough, inter- or indeed transdisciplinary profiling of postoperative pelvic floor dysfunction (PFD) in not one, but three seemingly remote fields of surgery, namely urethral reconstruction, proctologic surgery, and total hip arthroplasty. In combining panel study data analysis of symptoms over time with objective measurements of neuromuscular and neurophysiological function, the PELVIS study proves, as proposed, that PFD after surgery is not specific to individual procedures but mediated by common pathophysiological processes.

One of the main findings emerging from this investigation is that there exists a strong baseline equipoise for global pelvic floor symptom scores across cohorts, which differ substantially for age, distribution of sex, BMI, and presence of comorbid conditions. Notable from a clinical perspective is that this finding suggests that pelvic floor outcomes that diverge subsequently cannot be explained by pre-operative symptom severity, and that instead, surgery and adaptive processes have a very strong dominant effect on post-operative pelvic floor outcomes. The identification of baseline differences for specific surgery subscales, namely elevated colorectal distress for hemorrhoidectomy and slightly elevated pain scores for THA, establishes internal validity, and again supports the need for a common primary outcome measure.

On longitudinal analysis, the common time course for every procedure has an early postoperative maximal point for pelvic floor distress which partially resolves with time. There was a concomitant rise in pain scores and resting activity of the pelvic floor muscles for every procedure at the acute phase of the elevated scores of the PFDI-20 at 6-8 weeks postoperatively, a state consistent with the theory of pain-mediated neuromuscular guarding as an universal early response to surgical injury, consistent with past observations in isolated urological, colorectal, and orthopedic studies but has not hitherto been observed in a unified manner.

Note that, although symptom burden decreased, there was no complete normalization at 12 months, underlining that PFD can be a chronic functional sequela even when surgery was technically successful. The significant interaction between time and procedure points out that there are individual differences in recovery courses for different kinds of surgery, although these differences do not entirely explain inter-individual differences. This finding led to further analysis at a mechanistic level.

The sub-cohort mechanistic analyses offer highly plausible biological explanations that support the reported presence of symptoms. While patients with EEUU showed mainly structural pathology with very limited neuropathic changes, patients with hemorrhoidectomy showed changes suggestive of dysregulation of the sensory-motor function with visceral hypersensitivity. On the contrary, the THA group of patients showed the most significant changes indicative of neuromechanical pathology, such as delayed nerve conduction velocity with changes within the biomechanical function of the pelvic floor.

What is particularly original about this study's findings is the proof that early postoperative pain intensity and hyperactive pelvic floor muscle activity are strong predictors for Grades 1-4 PFD regardless of the type of surgery. Firstly, the accuracy of the random forest model confirms the significant value of early functional information. Finally, it can be noted that "Type of Surgery" appeared less relevant compared to the early functional indicators mentioned above. This confirms the priority of function over type when it comes to clinical classification. The latent class analysis is the big conceptual advance. By identifying neuropathic, pain-dominant, mechanical, and mixed phenotypes that cut across surgical boundaries, the challenge to the conventional siloed approach to post-operative complications is compelling. Thus, patients undergoing different operations may benefit from similar rehabilitation strategies, while patients undergoing the same operation may require divergent management based on phenotype. Such stratification has important implications for individualized care pathways.

9. FUTURE OUTCOMES AND CLINICAL IMPLICATIONS

The results of the PELVIS Study unlock many potential avenues for further development in the clinical as well as the research fields. First, the establishment of feasible pelvic floor phenotypes enables the performance of phenotype-driven intervention studies, allowing the formulation of focused pelvic floor physiotherapies, neuromodulations, or pain managements according to their pathophysiologies, independent of the surgicomics.

Secondly, the high predictive power of the initial postoperative biomarkers makes risk-stratified follow-up care feasible, such that patients who have high pain and high resting sEMG can be identified for early care. Adding such evaluations to Enhanced Recovery After Surgery (ERAS) programs may prevent long-term functions from becoming dysfunctional.

Finally, future research should examine the dynamic aspects of the pattern of these trajectories, especially the role of early interventions of the pelvic floor. Moreover, long-term observation for more than 12 months is needed to assess the longevity of the recovery outcomes. Maybe the transition phase from subclinical dysfunction to the full condition will also become apparent.

Finally, wider use of more advanced technologies, such as dynamic ultrasound and QST, could make mechanistic phenotyping a reality in the clinical setting, and this could help to bring the disciplines together in a true collaboration.

9.1 LIMITATIONS

A few study limitations should be kept in mind. Firstly, although this study was prospective with a rigorously designed research plan, the study is still observational, preventing the researchers from making conclusive statements about interventions. Secondly, the mechanistic sub-cohort was well phenotyped; however, this sub-cohort may not fully reflect the nature of the entire population. This is because the sub-cohort may not always portray the entire range of natural variability. Lastly, this study was performed within a tertiary care system. Such systems may not apply well to other healthcare systems. Additionally, although the instruments were validated, the self-reported study outcomes may still be prone to bias.

9.2 CONCLUSION

The PELVIS Study provides robust evidence that post-operative pelvic floor dysfunction represents a shared functional outcome of diverse surgical interventions, rather than a complication confined to any single specialty. This study integrates urological, colorectal, and orthopedic populations within a unified methodological framework and demonstrates that pelvic floor dysfunction is best understood through mechanistic and phenotypic lenses, not procedural labels alone. Despite marked differences in demographic and clinical characteristics, patients across all three surgical cohorts entered surgery with comparable global pelvic floor symptom burden. Surgery universally triggered an acute increase in pelvic floor distress, which was tightly linked with pain and neuromuscular guarding. While partial recovery occurred over time, a substantial subset of patients exhibited persistent dysfunction at one year, highlighting the clinical relevance of this often-overlooked outcome.

Mechanistic analyses demonstrated that specific surgical insults-direct perineal trauma, sensory-motor disruption, and neuromechanical alteration-converge through overlapping biological pathways on the pelvic floor. Importantly, early post-operative pain intensity and resting pelvic floor hyperactivity emerged as strong predictors of long-term dysfunction, surpassing procedural classification in predictive models. Most importantly, latent class analysis identified trans-procedural pelvic floor phenotypes that transcend traditional specialty silos. The present finding thus reframes post-operative pelvic floor dysfunction as a patient-centered functional disorder, mandating the adoption of interdisciplinary assessment and management strategies. In aggregate, these data support a paradigm shift in perioperative care: from isolated technical success toward comprehensive functional restoration. Integration of pelvic floor assessment, risk stratification, and targeted rehabilitation into routine surgical pathways could substantially improve long-term patient outcomes.

COMPETING INTERESTS

There are no conflicts of interest exist among authors of this research paper.

ACKNOWLEDGEMENTS

Authors thanks Dr Hafiz Muhammad Atif Department of Urology and kidney transplant, Benazir Bhutto Hospital RWP, Attached with Rawalpindi medical University Rawalpindi, Pakistan, providing instrumentation facility.

AUTHOR CONTRIBUTIONS

S.D.K, H.M.A and U.H wrote the main manuscript Draft, writing, H.M.A supervision, S.D.K and U.H studied Data validation and Editing, Reviewing. All authors reviewed the manuscript outline.

FUNDING

No external fundings.

DATA AVAILABILITY

No data sets were generated or analysed during the current study.

REFERENCES

1. Gannon K, Guerro-Blanco M, Patel A, Abel P Re-constructing masculinity following radical prostatectomy for prostate cancer. Aging Male. 2010;13:258-64.
2. Litwin MS, Hays RD, Fink A, Ganz PA, Leake B, Leach GE, et al. Quality-of-life outcomes in men treated for localized prostate cancer. JAMA. 1995;273:129-35.
3. Jønler M, Madsen FA, Rhodes PR, Sall M, Messing EM, Bruskewitz RC. A prospective study of quantification of urinary incontinence and quality of life in patients undergoing radical retropubic prostatectomy. Urology. 1996;48:433-40.

4. Dubbelman YD, Dohle GR, Schröder FH. Sexual function before and after radical retropubic prostatectomy: A systematic review of prognostic indicators for a successful outcome. Eur Urol. 2006;50:711-8; discussion 718-20.
5. Kendirci M, Bejma J, Hellstrom WJ. Update on erectile dysfunction in prostate cancer patients. Curr Opin Urol. 2006;16:186-95.
6. Filocamo MT, Li Marzi V, Del Popolo G, Cecconi F, Marzocco M, Tosto A, et al. Effectiveness of early pelvic floor rehabilitation treatment for post-prostatectomy incontinence. Eur Urol. 2005;48:734-8.
7. Burgio KL, Goode PS, Urban DA, Umlauf MG, Locher JL, Bueschen A, et al. Preoperative biofeedback assisted behavioral training to decrease post-prostatectomy incontinence: a randomized, controlled trial. J Urol. 2006;175:196-201; discussion 201.
8. Parekh AR, Feng MI, Kirages D, Bremner H, Kaswick J, Aboseif S. The role of pelvic floor exercises on postprostatectomy incontinence. J Urol. 2003;170:130-3.
9. Van Kampen M, De Weerdt W, Van Poppel H, De Ridder D, Feys H, Baert L. Effect of pelvic-floor re-education on duration and degree of incontinence after radical prostatectomy: a randomised controlled trial. Lancet. 2000;355:98-102.
10. Manassero F, Traversi C, Ales V, Pistolesi D, Panicucci E, Valent F, et al. Contribution of early intensive prolonged pelvic floor exercises on urinary continence recovery after bladder neck-sparing radical prostatectomy: results of a prospective controlled randomized trial. Neurourol Urodyn. 2007;26:985-9.
11. Moore KN, Valiquette L, Chetner MP, Byrniak S, Herbison GP. Return to continence after radical retropubic prostatectomy: a randomized trial of verbal and written instructions versus therapist-directed pelvic floor muscle therapy. Urology. 2008;72:1280-6.
12. Tobía I, González MS, Martínez P, Tejerizo JC, Gueglio G, Damia O, et al. [Randomized study on urinary continence after radical prostatectomy with previous kinesic perineal physiotherapy]. Arch Esp Urol. 2008;61:793-8.
13. Floratos DL, Sonke GS, Rapidou CA, Alivizatos GJ, Deliveliotis C, Constantinides CA, et al. Biofeedback vs verbal feedback as learning tools for pelvic muscle exercises in the early management of urinary incontinence after radical prostatectomy. BJU Int. 2002;89:714-9.
14. Bales GT, Gerber GS, Minor TX, Mhoon DA, McFarland JM, Kim HL, et al. Effect of preoperative biofeedback/pelvic floor training on continence in men undergoing radical prostatectomy. Urology. 2000;56:627-30.
15. Lilli P, Mercuriali M, Fiori M, Hanitzsch H, Gunelli R, Bercovich E. Impact of preoperative biofeedback on incontinence in cancer patients undergoing radical prostatectomy. Arch Ital Urol Androl. 2006;78:92-6.
16. Franke JJ, Gilbert WB, Grier J, Koch MO, Shyr Y, Smith JA Jr. Early post-prostatectomy pelvic floor biofeedback. J Urol. 2000;163:191-3.
17. Chang JI, Lam V, Patel MI. Preoperative Pelvic Floor Muscle Exercise and Postprostatectomy Incontinence: A Systematic Review and Meta-analysis. Eur Urol. 2016;69:460-7.
18. Wang W, Huang QM, Liu FP, Mao QQ. Effectiveness of preoperative pelvic floor muscle training for urinary incontinence after radical prostatectomy: a metaanalysis. BMC Urol. 2014;14:99.
19. Nilssen SR, Mørkved S, Overgârd M, Lydersen S, Angelsen A. Does physiotherapist-guided pelvic floor muscle training increase the quality of life in patients after radical prostatectomy? A randomized clinical study. Scand J Urol Nephrol. 2012;46:397-404.
20. Dorey G, Speakman M, Feneley R, Swinkels A, Dunn C, Ewings P Randomised controlled trial of pelvic floor muscle exercises and manometric biofeedback for erectile dysfunction. Br J Gen Pract. 2004;54:819-25.

21. Van Kampen M, De Weerdt W, Claes H, Feys H, De Maeyer M, Van Poppel H. Treatment of erectile dysfunction by perineal exercise, electromyographic biofeedback, and electrical stimulation. Phys Ther. 2003;83:536-43.
22. Prota C, Gomes CM, Ribeiro LH, de Bessa J Jr, Nakano E, Dall'Oglio M, et al. Early postoperative pelvic-floor biofeedback improves erectile function in men undergoing radical prostatectomy: a prospective, randomized, controlled trial. Int J Impot Res. 2012;24:174-8.
23. Zhang Q, Wang L, Zheng W. Surface electromyography of pelvic floor muscles in stress urinary incontinence. Int J Gynaecol Obstet. 2006;95:177-8.
24. Ronco M, Iona L, Fabbro C, Bulfone G, Palese A. Patient education outcomes in surgery: a systematic review from 2004 to 2010. Int J Evid Based Healthc. 2012;10:309-23.
25. Baker KE. The future of transgender coverage. NEngl JMed. 2017;376: 1801–1804.
26. CannerJK, Harfouch O, Kodadek LM,etal. Temporal trends in gender-affirming surgery among transgender patients in the United States. JAMA Surg. 2018;153: 609–616. ©2018 Wolters Kluwer Health, Inc. All rights reserved.
27. Manrique OJ, Adabi K, Martinez-Jorge J, et al. Complications and patient reported outcomes in male-to-female vaginoplasty—where we are today: a systematic review and meta-analysis. Ann Plast Surg. 2018;80:684–691.
28. Manrique OJ, Sabbagh MD, Ciudad P, et al. Gender-confirmation surgery using the pedicle transverse colon flap for vaginal reconstruction: a clinical outcome and sexual function evaluation Study. Plast Reconstr Surg.2018; 141:767–771.
29. Bouman M-B, van der Sluis WB, van Woudenberg Hamstra LE, et al. Patient reported esthetic and functional outcomes of primary total laparoscopic intestinal vaginoplasty in transgender women with penoscrotal hypoplasia. JSexMed. 2016;13:1438–1444.
30. Buncamper M, Bouman MB, Honselaar J, et al. Aesthetic and functional out comes of neovaginoplasty using penile skin in male-to-female transsexuals. J Sex Med. 2014;11:38.
31. Djordjevic ML,LabusL,BizicM,etal.Rectosigmoidvaginoplastyanditsimpact on psychosocial and sexual life in patients with vaginal agenesis. Eur Urol Suppl. 2010;9:109–110.
32. Djordjevic ML, Salgado CJ, Bizic M, et al. Gender dysphoria: the role of sex reassignment surgery. Sci World J. 2014;2014:645109.
33. Buncamper ME, van der Sluis WB, de Vries M, et al. Penile inversion vaginoplasty with or without additional full-thickness skin graft: to graft or not to graft? Plast Reconstr Surg. 2017;139:649e–656e.
34. Sigurjonsson H, Rinder J, Mollermark C, et al. Male to female gender reassign ment surgery: surgical outcomes of consecutive patients during 14 years. JPRAS Open. 2015;6:69–73.
35. ManriqueOJ,SabbaghMD,CiudadP,etal.Reply:letter toeditor regarding:“gen der confirmation surgery using the pedicle transverse colon flap for vaginal recon struction: a clinical outcome and sexualfunctionevaluationstudy”. Plast Reconstr Surg. 2018;142:606e–608e.
36. Callens N, de Cuypere G, Wolffenbuttel KP, et al. Long-term psychosexual and anatomical outcome after vaginal dilation or vaginoplasty: a comparative study. J Sex Med. 2012;9:1842–1851.
37. Manrique OJ, Adabi K, Martinez-Jorge J, et al. Complications and patient reported outcomes in male-to-female vaginoplasty—where we are today: a systematic review and meta-analysis. Ann Plast Surg. 2018;4:1026–1039.
38. Buncamper ME, van der Sluis WB, Bouman MB, et al. Reply: surgical outcome after penile inversion vaginoplasty: a retrospective study of 475 transgender women. Plast Reconstr Surg. 2017;140:237e.
39. Andreasson M, Georgas K, Elander A, et al. Patient-reported outcome measures used in gender confirmation surgery: a systematic review. Plast Reconstr Surg. 2018;141:1026–1039.
40. Selvaggi G, Ceulemans P, de Cuypere G, et al. Gender identity disorder: general overview and surgical treatment for vaginoplasty in male-to-female transsexuals. Plast Reconstr Surg. 2005;116:135e–145e.

41. LoverroG,BettocchiC,BattagliaM,CormioG,SelvaggiG,DiTonnoP,Selvaggi FP: Repair of vaginal prolapse following penoscrotal flap vaginoplasty in a male to-female transsexual. Gynecol Obstet Investig. 2002, 53:234–236.
42. Bertolotto M, Liguori G, Bucci S, et al. MR imaging in patients with male-to female sex reassignment surgery: postoperative anatomy and complications. Br J Radiol. 2017;90:20170062.
43. Adams SR, Dessie SG, Dodge LE, et al. Pelvic floor physical therapy as pri mary treatment of pelvic floor disorders with urinary urgency and frequency predominant symptoms. Female Pelvic Med Reconstr Surg. 2015;21:252–256.
44. Pauls RN, Crisp CC, Novicki K, et al. Pelvic floor physical therapy: impact on quality of life 6 months after vaginal reconstructive surgery. Female Pelvic Med Reconstr Surg. 2014;20:334–341.
45. Manrique OJ, Adabi K, Maldonado AA, et al. Cadaver study of combined neurovascular sensate flaps to create vaginal erogenous sensation during male to-female genital confirmation surgery: the pedicle "O" flap. Ann Plast Surg. 2018;81:571–575.
46. Sung VW, Hampton BS. Epidemiology of pelvic floor dysfunction. Obstet Gynecol Clin North Am. 2009;36:421–443.
47. Uustal Fornell E, Wingren G, Kjolhede P. Factors associated with pelvic floor dysfunction with emphasis on urinary and fecal incontinence and gen ital prolapse: an epidemiological study. Acta Obstet Gynecol Scand. 2004; 83:383–389.
48. KangasR,MorsianiC,Pizza G,et al. Menopause and adipose tissue: miR-19a-3p is sensitive to hormonal replacement. Oncotarget. 2018;9:2279–2294.
49. Wasenda EJ, Kamisan Atan I, Subramaniam N, et al. Pelvic organ prolapse: does hormone therapy use matter? Menopause (New York, NY). 2017;24: 1185–1189.
50. Wibowo E, Calich HJ, Currie RW, et al. Prolonged androgen deprivation may in fluence the autoregulation of estrogen receptors in the brain and pelvic floor mus cles of male rats. Behav Brain Res. 2015;286:128–135.
51. Hartigan SM, Smith AL. Disparities in female pelvic floor disorders. Curr Urol Rep. 2018;19:16.
52. Ling LS, Sidi H, Lope RAR, et al. Biological and psychological influences of cross sex hormone in transgender. Curr Drug Targets.2018.
53. Streed CG Jr, Harfouch O, Marvel F, et al. Cardiovascular disease among trans gender adults receiving hormone therapy: a narrative review. Ann Intern Med. 2017;167:256–267.
54. Meagher T, Filzmaier K. The medical underwriting of transgender individuals. J Insurance Med (New York, NY). 2017;47:43–49. 666 www.annalsplasticsurgery.com
55. Rosenbaum TY, Owens A. The role of pelvic floor physical therapy in the treat ment of pelvic and genital pain-related sexual dysfunction (CME). J Sex Med. 2008;5:513–523; quiz 524-515.
56. Whitehead WE, Bharucha AE. Diagnosis and treatment of pelvic floor disorders: what's new and what to do. Gastroenterology. 2010;138:1231–1235, 1235.e1231–1234.
57. Bucci S, Mazzon G, Liguori G, et al. Neovaginal prolapse in male-to-female transsexuals: an 18-year-long experience. Biomed Res Int. 2014;2014:240761.
58. Blanchard R, Legault S, Lindsay WR. Vaginoplasty outcome in male-to-female transsexuals. J Sex Marital Ther. 1987;13:265–275