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Original Research

Effect of Sling Surgery for Urinary Incontinence on the Sexual Functions of Patients: A Prospective Study

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Abstract

Background: Stress urinary incontinence (SUI) has been demonstrated to exert a detrimental effect on the quality of life of affected women, particularly with regard to their sexual function. The aim of this study was to evaluate the changes in sexual function among patients with SUI following sling surgery. **Methods**: A total of 83 patients who sought treatment at our clinic for SUI and underwent mid-urethral sling (MUS) surgery were included in the study. Demographic data, preoperative laboratory results, residual urine volumes, and baseline sexual function status were systematically documented. **Results**: Female sexual dysfunction (FSD) was assessed using the Female Sexual Function Index (FSFI), with a defined cut-off score of 26.55. Surgical success was defined by the absence of SUI, which was achieved in 80 patients (96.3%). The mean FSFI score increased from 19.04 preoperatively to 24.47 postoperatively. Univariate and multivariate analyses showed that age, body mass index (BMI), education level, and menopausal status had no significant impact on FSFI scores. However, incontinence severity, coital incontinence, and diabetes mellitus (DM) were significantly affected with FSFI scores (p = 0.043, 0.028, and 0.019, respectively). Additionally, the difference in dyspareunia rates was statistically significant (p = 0.017). MUS surgery effectively treats SUI and improves FSFI scores. **Conclusion**: This improvement was statistically significant among patients with severe incontinence, coital incontinence, and those without DM. However, the presence of dyspareunia may lead to a decline in sexual function postoperatively.

Keywords: stress urinary incontinence; mid-urethral slings; female sexual function index; female sexual dysfunction; dyspareunia

1. Introduction

Stress urinary incontinence (SUI), defined as involuntary urine loss due to physical exertion or increased intra-abdominal pressure, such as sneezing and coughing, is observed at an average rate of 48% [1]. SUI occurs due to downward displacement of the bladder neck and proximal urethra, decreased urethral mucosal closure, or decreased internal urethral sphincter function. This condition leads to deterioration in social, physical, psychological, occupational, and sexual behaviors [2]. Symptoms such as low desire, vaginal dryness, coital incontinence, or the fear of urinary incontinence (UI) during intercourse may occur because of SUI [3]. Therefore, it is reasonable to consider that treating UI will help alleviate sexual dysfunction. The two primary treatment modalities for SUI are surgery and conservative measures. Mid-urethral sling (MUS), such as transobturator tape (TOT), which is inserted tension-free in a horizontal plane beneath the mid-urethra between the two obturator foramen, and tension-free polypropylene vaginal tape (TVT), which is anchored through the retropubic space, are commonly used as minimally invasive procedures for SUI [4]. However, concerns about potential complications associated with mesh implantation side effects like infections, inner thigh pain, and dyspareunia have lead to increased interest in exploring alternative treatment options [4]. This condition may cause a further increase in sexual dysfunction. As such, it is understood that different treatment options are recommended in SUI surgery. While some short-term studies show that MUS surgery improves sexual function—for instance, Filocamo *et al*. [5] reported significant improvements in Female Sexual Function Index (FSFI) scores following MUS procedures, other studies have observed a deterioration in sexual function postoperatively. Indeed, Yeni *et al.* [6], found that patients experienced a decline in sexual well-being following TVT procedures, potentially due to discomfort during intercourse and mesh-related concerns.

Herein, we sought to assess the effects of MUS procedures on female sexual function, analyzing both beneficial and adverse outcomes while identifying the factors contributing to these changes. To minimize the confounding effects of multiple independent variables associated with Female Sexual Dysfunction (FSD), robust statistical methods were employed. Standardization in FSD assessment was ensured through the use of the FSFI questionnaire, facilitating a comprehensive evaluation of sexual well-being. To the best of our knowledge, this is the first prospective study in Türkiye utilizing multivariate analysis to explore this topic. This study aims to elucidate the underlying factors contributing to either improvement or deterioration in

sexual function during the postoperative period in patients undergoing MUS for SUI.

2. Materials and Methods

2.1 Study Design and Participants

Between June 2023 and March 2024, data were collected from 124 patients, who presented at our outpatient clinic with SUI, as follows: age, anamnesis, physical examination, body mass index (BMI), 24-hour pad test, stress test, voiding diary, urine culture, residual urine measurement, and FSFI scores. Residual urine volume was measured via transabdominal ultrasonography within 10 minutes after spontaneous voiding. 9 of these patients 124 had previous pelvic surgery, 18 patients benefited from conservative treatment, and 14 patients were excluded from the study because they did not come for follow-up after surgery. As such, a total of 83 patients were included in the study. SUI was classified as mild, moderate, and severe [7]. All patients received conservative treatment for an average of four weeks before surgery. Patients with clinically confirmed SUI who did not benefit from conservative treatment (e.g., pelvic floor muscle exercises, lifestyle modifications) over a minimum 4-week period were considered for surgery.

MUS surgery was recommended for patients who did not benefit from conservative treatment. Although both TOT and TVT procedures are routinely used for SUI, TOT was the preferred technique at our center because of its minimally invasive profile and surgeon familiarity. Among the patients who underwent surgery, patients who were sexually active and who had fixed sex partners, patients who came for regular follow-ups, and patients who had the cognitive level to understand the FSFI form were included in the study. Informed consent forms were obtained from all patients who participated in the study.

Patients with previous pelvic organ prolapse (POP) surgery, those with a residual urine volume greater than 150 cc [8], those with recurrent significant growth in urine culture, those with no cognitive level to understand the FSFI form, patients who did not attend postoperative follow-ups, women previously diagnosed with sexual dysfunction, those who received hormone replacement therapy, and/or those who used medications that could affect sexual function such as antidepressants, antipsychotics, and beta-blockers were excluded from the study (Fig. 1). The mean postoperative follow-up period was 7.3 (6–9) months.

2.2 Questionnaire

A popular sexual functioning questionnaire created by Rosen *et al.* [9] is the FSFI (reliability-Cronbach's alpha = 0.97). In our study, the Turkish adaptation made by Aygin and Eti Aslan [10] in 2005 was used. The structure of the scale includes six subheadings: desire, arousal, lubrication, orgasm, satisfaction, and pain. Each item is scored from 0 to 5. As such, the scale's highest possible raw score is 95, while the lowest raw score is 4. Factor loadings for the subscales were calculated using mathematical algorithms. By multiplying the subscale scores with the factor loadings, the lowest highest raw scores obtained from the scale were 2.0 and 36.0, respectively. An optimal cut-off score of 26.55 was used to classify patients with and without sexual dysfunction [11].

Table 1. Demographic data of patients.

Patients (n)	83
Age (years)	
Mean (range)	39.7
<30	21 (25.3%)
30–45	32 (38.6%)
≥45	30 (36.1%)
BMI (kg/m^2)	
Mean (range)	26.6
<25.0	28 (33.7%)
25.0–29.9	33 (39.8%)
≥30.0	22 (26.5%)
Education level	
Bachelor's degree or above	9 (10.9%)
Below bachelor degree	74 (89.1%)
Menopause	
Present	28 (33.7%)
Absent	55 (66.3%)
24-hour pad test [7]	
Mild	17 (20.5%)
Moderate	31 (37.3%)
Severe	35 (42.2%)
Coital incontinence	
Present	29 (35%)
Absent	54 (65%)
Depression and/or anxiety disorder	
Present	8 (9.6%)
Absent	75 (90.4%)
Smoking	
Present	23 (27.7%)
Absent	60 (72.3%)
DM	
Present	15 (18.1%)
Absent	68 (81.9%)

BMI, body mass index; DM, diabetes mellitus.

2.3 Statistical Analysis

The Statistical Package for the Social Sciences version 20 (SPSS, IBM Corp., Armonk, NY, USA) was used for data analysis. The normality of continuous variables was assessed using the Shapiro-Wilk test, which is more appropriate for medium-sized samples. Variables with a normal distribution were expressed as mean ± standard deviation (SD), while non-normally distributed variables were presented as median (interquartile range).

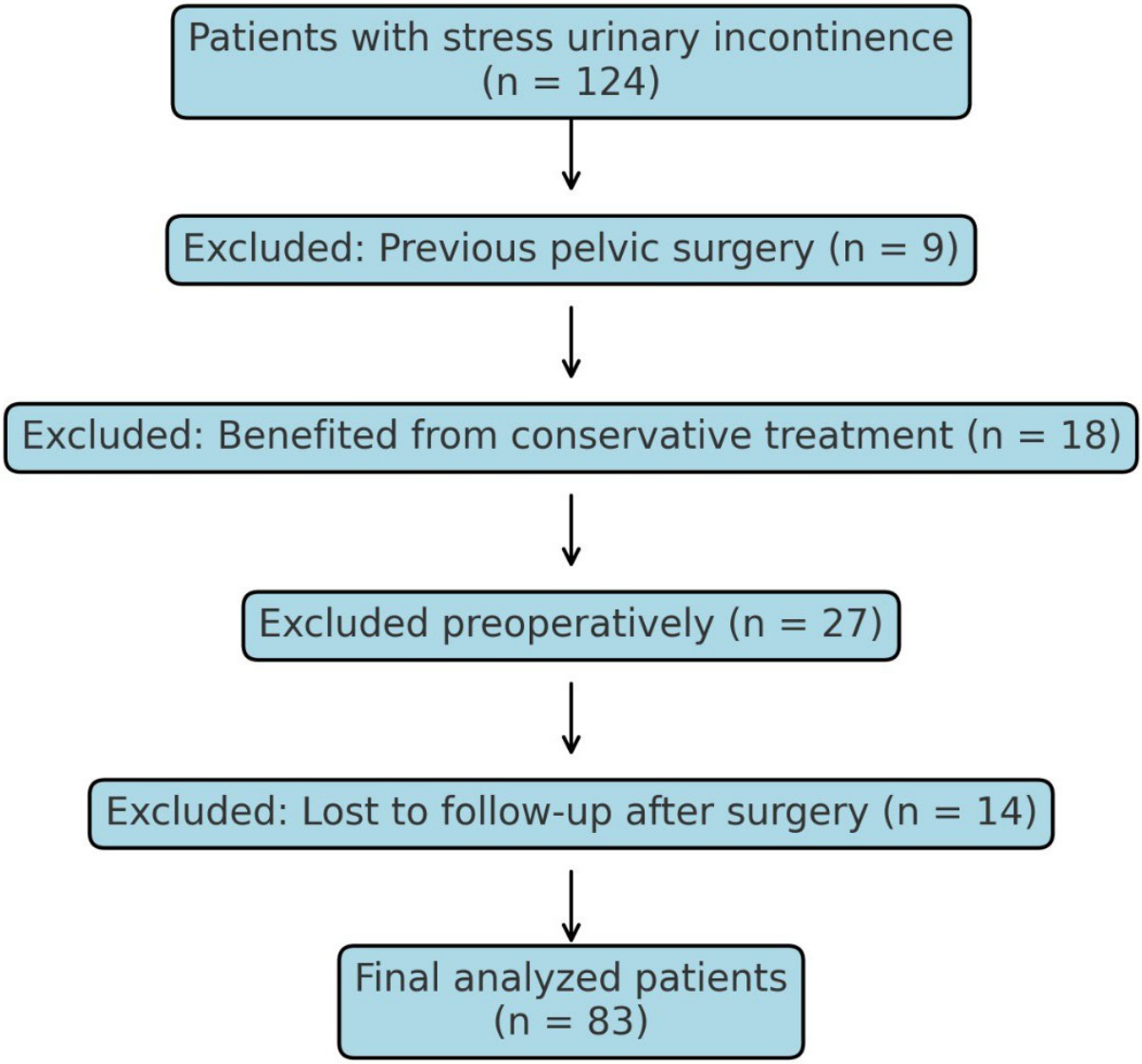

Fig. 1. Flowchart of study design.

Univariate general linear model analysis was initially performed to explore associations between independent variables and the total postoperative FSFI score. Categorical variables, such as BMI, were recoded into dummy variables before inclusion in the regression models. For BMI, three categories were created ($<$25.0, 25.0–29.9, and $\geq$30.0), and dummy variables were used to model their effect. Multivariate linear regression results are presented in accordance with APA style, including unstandardized (B) and standardized (β) coefficients, standard errors (SE), *t*-values, *p*-values, 95% confidence intervals (CI), and Variance Inflation Factor (VIF) values. The model's overall fit was evaluated using R^2 and adjusted R^2.

In addition, to evaluate the predictors of postoperative sexual dysfunction (defined as FSFI score $<$26.55), binary logistic regression analysis was conducted. Variables with $p < 0.1$ in univariate comparisons and those with clinical relevance were included in the multivariate model. Odds ratios (OR), 95% CI, and *p*-values were reported. Model fit was evaluated using Nagelkerke R^2 and the Hosmer-Lemeshow test.

A priori power analysis was conducted using G*Power software (version 3.1.9.7, Düsseldorf, North Rhine-Westphalia, Germany). Assuming a medium effect size (d = 0.5), 80% power, and an alpha = 0.05 for detecting differences between pre-and postoperative FSFI scores using a paired test, the required sample size was calculated as 34. With 83 participants included, the study exceeded the minimum number required to achieve statistical validity.

3. Results

The mean score on the FSFI scale applied to the patients was 19.04 in the preoperative period and 24.47 in the postoperative period. Sexual dysfunction was observed in

Table 2. Multivariate linear regression predicting postoperative FSFI score.

Predictor	B	SE	β	t	p-value	95% CI	VIF
Age (years)	–0.102	0.089	–0.091	–1.15	0.360	–0.279 to 0.075	1.18
BMI (kg/m^2)	22.5						
	–0.056	0.081	–0.071	–0.69	0.288	–0.216 to 0.104	1.23
Education level	0.079	0.089	0.062	0.89	0.377	–0.096 to 0.254	1.07
Menopause	–0.134	0.099	–0.112	–1.35	0.185	–0.330 to 0.062	1.15
Incontinence severity	0.219	0.108	0.172	2.03	0.043	0.006 to 0.432	1.25
Coital incontinence	–0.231	0.102	–0.189	–2.27	0.028	–0.433 to –0.029	1.20
DM	–0.266	0.113	–0.201	–2.35	0.019	–0.488 to –0.044	1.14
De novo dyspareunia	–0.409	0.107	–0.245	–3.82	0.017	–0.621 to –0.197	1.12

Intercept (Constant): 26.12; R^2: 0.364; Adjusted R^2: 0.332; FSFI, Female Sexual Function Index; CI, confidence interval; VIF, Variance Inflation Factor; BMI, body mass index; DM, diabetes mellitus.

Table 3. Univariate analysis of pre- and postoperative FSFI scores (mean ± SD).

Variable	Preop FSFI (mean ± SD)	Postop FSFI (mean ± SD)	p-value
Age <30 years	22.32 ± 4.5	27.43 ± 3.9	0.141
Age 30–45 years	19.36 ± 4.2	23.87 ± 3.7	-
Age ≥45 years	16.24 ± 4.1	18.51 ± 3.5	-
BMI <25.0 kg/m^2	18.42 ± 4.1	23.87 ± 4.3	0.354
BMI 25.0–29.9 kg/m^2	20.07 ± 4.6	25.61 ± 3.8	-
BMI ≥30.0 kg/m^2	18.29 ± 4.0	23.52 ± 3.6	-
Bachelor degree or above	18.46 ± 3.9	22.90 ± 4.1	0.293
Below bachelor degree	19.11 ± 4.4	24.66 ± 3.9	-
Menopause present	17.14 ± 4.2	22.68 ± 4.0	0.116
Absent	20.01 ± 4.1	25.38 ± 3.8	-
Mild incontinence	18.90 ± 4.5	23.25 ± 4.0	0.041
Moderate	19.21 ± 4.3	24.19 ± 3.7	-
Severe	18.96 ± 4.1	25.31 ± 3.9	-

FSFI, Female Sexual Function Index; BMI, body mass index; SD, standard deviation.

69 (83.1%) patients in the preoperative period and in 58 (69.8%) patients in the postoperative period (p = 0.044). The mean age of the patients was 39.7 years and the mean BMI was 26.6 kg/m^2. When the education level was evaluated, 9 patients had a bachelor's degree or above, while 74 patients had less than bachelor's degree. Menopause was present in 28 patients (33.7%). Mild, moderate, and severe incontinence was seen in 17, 31, and 35 patients, respectively. There were no complications during the operation. Coital incontinence was present in 29 (35%) patients. A total of 8 patients (9.6%) had a diagnosis of depression or anxiety disorder, 23 patients (27.7%) were smokers, and 15 patients (18.1%) had diabetes mellitus (DM). Patients' demographic data is shown in Table 1 (Ref. [7]).

Comparing pre- and postoperative FSFI scores using univariate and multivariate analysis, age, BMI, education level, and menopause status were not statistically significant (p = 0.360, 0.288, 0.377, 0.185 respectively) (Table 2). Incontinence level and coital incontinence significantly affected the FSFI score in multivariate analysis (p = 0.043, 0.028, respectively) (Table 2). Depression and/or anxiety disorder, as well as smoking, were not found to have a significant impact on FSFI scores (p = 0.417 and p = 0.203, respectively). However, DM demonstrated a statistically significant effect on postoperative FSFI scores (p = 0.019). In the postoperative period, pain requiring narcotic analgesics occurred in two patients. *De novo* urgency was seen in 5 patients, *de novo* frequency was observed in 9 patients, and *de novo* dyspareunia was seen in 2. Only dyspareunia was found to be statistically significant (p = 0.017). Preoperative and postoperative FSFI scores by demographic and clinical subgroups are detailed in Table 3, and the multivariate regression model identifying predictors of postoperative FSFI scores is presented in Table 2. Assessment of surgical success showed that SUI was not seen in 80 patients (96.3%). Mild SUI was seen to continue after the opera-

Table 4. Multivariate logistic regression predicting postoperative sexual dysfunction (FSFI <26.55).

Predictor	OR (95% CI)	*p*-value
Severe incontinence	2.53 (1.21–5.30)	0.013
Coital incontinence	2.78 (1.34–5.72)	0.006
DM	3.21 (1.30–7.94)	0.011
Dyspareunia	4.45 (1.82–10.89)	<0.001
BMI 25.0–29.9 kg/m^2 (ref: <25)	1.42 (0.55–3.67)	0.470
BMI ≥30.0 kg/m^2 (ref: <25)	1.77 (0.64–4.89)	0.270
Age	1.02 (0.98–1.06)	0.280

Nagelkerke R^2: 0.389; Hosmer-Lemeshow Test: $p = 0.45$. FSFI, Female Sexual Function Index; OR, odds ratio; CI, confidence interval; DM, diabetes mellitus; BMI, body mass index.

tion in 3 patients (3.7%). A logistic regression analysis was performed to determine the predictors of postoperative sexual dysfunction, defined as a total FSFI score below 26.55. Severe incontinence, coital incontinence, DM, and *de novo* dyspareunia were found to significantly increase the odds of postoperative dysfunction (Table 4). The model showed good fit (Nagelkerke $R^2 = 0.382$; Hosmer-Lemeshow test, $p = 0.47$). As illustrated in Fig. 2, all FSFI domain scores and the total score increased postoperatively. However, the mean postoperative FSFI total score (24.47) remained below the established threshold of 26.55, suggesting incomplete resolution of sexual dysfunction despite measurable improvement.

4. Discussion

FSD is an important health problem affecting the quality of life in women. Hormonal insufficiencies, neurological diseases, cardiac diseases, urinary dysfunctions, pelvic organ prolapse (POP), and UI, all of which are becoming more prevalent with the aging population, have been associated with an increased risk of FSD [12,13]. Studies evaluating these conditions have shown that surgical treatment of POP or UI generally positively affects the quality of life and sexual function [6,14–16]. Although the postoperative FSFI scores demonstrated statistically significant improvements, the average total score remained below the threshold of 26.55. Therefore, while the treatment led to significant improvements in sexual function, it did not completely eliminate sexual dysfunction in our study population (Fig. 2). However, it was observed that sexual dysfunction persisted in approximately 70% of patients in the postoperative period. This could be attributed to the challenge of reaching the established cut-off value of 26.5 for FSD, given the significantly low preoperative FSFI scores. The low preoperative FSFI scores cannot be solely attributed to SUI; factors such as the advanced age of the patient and partner, comorbidities, and cultural influences may have also contributed to these findings.

The 24-hour pad test determines the amount of urine leakage in patients and provides more objective results than the 1-hour pad test. The pads provided to the patients were then weighed to determine the level of incontinence. According to the results, patients were grouped as mild (<20 mL), moderate (21–74 mL), and severe (>75 mL) [7]. We also applied a 24-hour pad test to our patients to reach an objective result. As a result, we saw a more significant improvement in FSFI scores as incontinence increased ($p = 0.043$). As such, surgical intervention should be more strongly recommended for patients with severe SUI, as it was associated with a more substantial improvement in sexual function following treatment.

It was demonstrated that MUS surgery provided a dramatic and substantial improvement in the treatment of FSD, especially in patients with coital incontinence ($p = 0.028$). It is believed that the increased self-confidence of these patients after the treatment contributed more to this improvement. In a study by Filocamo *et al.* [5], which included 157 patients, the causes of sexual inactivity related to SUI were examined. Preoperatively, coital incontinence was identified as the primary cause. Following surgical intervention, no instances of FSD because of coital incontinence were reported. Based on these findings, it can be inferred that the presence of coital incontinence plays a crucial role in resolving FSD. Our findings are consistent with those of Kender Erturk *et al.* [17], who reported significant improvements in FSFI scores, particularly in domains related to coital incontinence at a 2-year follow-up after TOT surgery. Their use of a matched control group further supports the observed benefits of TOT in sexually active women with SUI.

Our clinical observations and one-on-one interviews with patients showed a trend toward higher FSFI scores among menopausal patients; however, this difference did not reach statistical significance ($p = 0.185$). A decrease in lubrication and an increase in vaginal dryness due to advanced patient age may have been the cause. In addition, it can be expected that this patient group will have sexual partners at an older age. Erectile dysfunction and hormonal deficiencies, which are more common in older men, may have also contributed to this result. Therefore, it would be more beneficial to treat other causes that will cause FSD in this patient group and to direct their partners to receive treatment as well.

Among the increasingly prevalent conditions, DM is one of the most prominent. When the preoperative FSFI scores of patients with DM were examined, they were found to be lower than in the other patient groups. This may be attributed to common DM-related factors such as neuropathy, hormonal imbalance, and genital infections. Additionally, postoperative FSFI scores showed significantly less improvement in the DM group compared to non-diabetic patients ($p = 0.019$). This disparity may be explained by DM-related vascular damage, which negatively affects key components of female sexual function such as desire, arousal, lubrication, and orgasm. Our findings underscore the im-

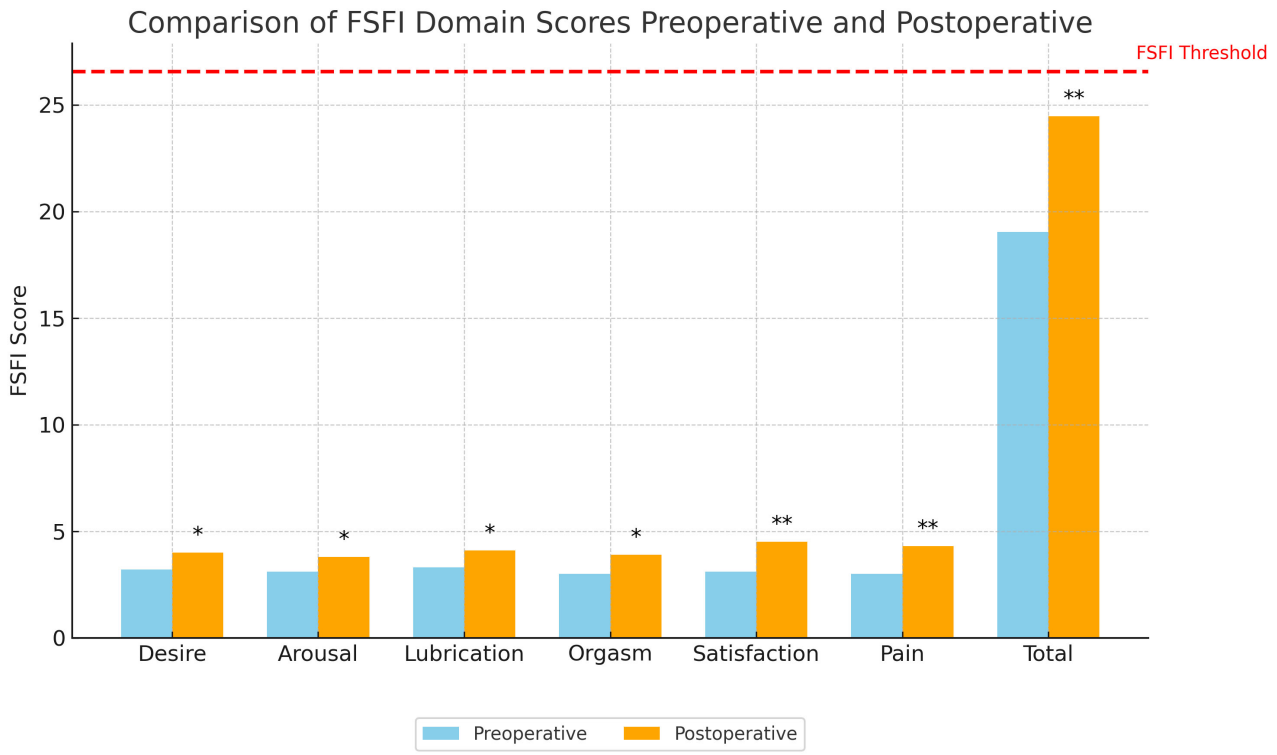

Fig. 2. Comparison of FSFI domain scores pre- and postoperation. The figure displays the mean scores of FSFI domains before and after MUS surgery. Statistical significance is indicated using asterisk notations (*$p < 0.05$, **$p < 0.01$). A red dashed line represents the FSFI threshold (26.55) for sexual dysfunction. Domain scores for desire, arousal, lubrication, orgasm, satisfaction, and pain show improvements postoperatively. FSFI, Female Sexual Function Index; MUS, mid-urethral sling.

portance of considering the presence of DM in SUI surgery candidates and its role in predicting FSD outcomes.

Among the commonly encountered diseases with increasing prevalence, DM stands out [18]. In our study, the pre-operative FSFI scores of patients with DM revealed lower scores than other patient groups. This may be attributable to factors such as neuropathy, hormonal imbalances, and genital infections, which are more frequently observed in individuals with DM [19]. Furthermore, when evaluating post-operative FSFI scores, a more pronounced improvement was noted in the group without DM, reaching statistical significance ($p = 0.019$). This disparity may be attributed to the vascular damage associated with DM, which affects multiple aspects of sexual function. Desire, arousal, lubrication, and orgasm—key components of women's sexual function—may be adversely affected by the consequences of DM [20]. Our study underscores the importance of considering the presence of DM in the context of SUI surgical treatment and highlights its role in predicting outcomes related to FSD for clinicians.

Our study found that dyspareunia developed in the postoperative period negatively affected sexual functions ($p = 0.028$). Interviews with patients revealed that, despite the resolution of UI, increased discomfort during coitus adversely affected sexual function. It could be attributed to scarring, heightened sensitivity, and pain resulting from the surgery. A statistically significant decrease in FSFI scores was observed in patients with dyspareunia ($p = 0.017$). Conversely, a study by Kim and Choi [21] reported that, although many participants indicated a deterioration in sexual life due to dyspareunia following SUI surgery, sexual life scores either improved or remained unchanged [22]. In our study, the presence of *de novo* urgency and *de novo* frequency in the postoperative period did not significantly affect sexual dysfunction, and an increase in FSFI scores was noted in both cases. Cases with *de novo* urgency or overactive bladder symptoms are initially treated with behavioral therapy and pharmacological agents, such as antimuscarinics or β3-agonists. Further invasive evaluation is reserved for persistent cases. Similarly, patients with dyspareunia are managed conservatively with vaginal estrogen therapy and pelvic floor physiotherapy. Sling removal is only considered in patients who do not respond to non-invasive interventions and whose quality of life is significantly impaired. Notably, in our study population, no patient required sling removal during the postoperative follow-up.

Different procedures have been used in the treatment of SUI. In a previous study, patients with SUI underwent four different surgical procedures, and no significant differ-

ences were found among the procedures in terms of postoperative quality of life and sexual function. Regardless of the surgical procedure, all patients benefited positively from the treatment [23]. In our study, the overall success rate among patients who underwent surgery was 96.38%. It is strongly recommended that clinicians investigate FSD using the FSFI scale before MUS surgery. We observed that this questioning increased the patient's self-awareness of their sexual health. We also observed that patients' motivation to investigate their sexual functions increased, and they became inclined to direct their partners to treatment for sexual dysfunction. One important consideration in TOT surgery, particularly for young women, is the potential impact on future pregnancies. Although approximately 25% of our patients were under the age of 30, none of the patients in our cohort reported plans for conception at the time of surgery. Preoperative counseling should include a discussion of fertility plans, and for patients considering future pregnancies, postponing surgery or exploring alternative strategies should be considered.

The strengths of our study include its prospective design, the evaluation of sexual function both preoperatively and postoperatively, the use of a validated Turkish version of an objective sexual function scale, and the application of multivariate analysis. However, the study's limitations include the relatively small sample size and the inability to assess partners for sexual dysfunction. Another limitation of our study is the relatively short follow-up period, which may not fully reflect the long-term evolution of sexual function, especially dyspareunia. Future studies with a follow-up period of at least 12 to 24 months are needed to provide a more comprehensive understanding. Moreover, although our study focused on TOT procedures, existing literature suggests that TVT may be associated with lower rates of dyspareunia, particularly among younger and sexually active women. This factor should be carefully considered during preoperative counseling and surgical planning.

5. Conclusion

In addition to its effectiveness in SUI treatment, MUS surgery has also reduced FSD. It significantly improved FSFI domains, including desire, arousal, lubrication, orgasm, satisfaction, and pain. These improvements were statistically significant among patients with severe incontinence, coital incontinence, and those without DM. However, postoperative dyspareunia may lead to a deterioration in sexual functions. Further studies with a larger patient population are needed to validate these findings.

Availability of Data and Materials

The datasets generated and analyzed during the current study are not publicly available, as individual privacy could be compromised.

Author Contributions

Conceptualization, EK and SS; Data curation, EK; Formal analysis, EK; Investigation, EK and SS; Methodology, EK and SS; Project administration, EK and SS; Resources, EK and SS; Software, EK and SS; Validation, EK and SS; Visualization, EK; Writing–original draft, EK and SS; Writing–review & editing, EK and SS. Both authors read and approved the final manuscript. Both authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

Permission was obtained for the research from the Karamanoglu Mehmetbey University Faculty of Medicine Local Ethics Committee (protocol no: 05/2023-07). Written informed consent was obtained from all subjects involved in the study. All steps of the study were completed in accordance with the Declaration of Helsinki.

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Conflict of Interest

The authors declare no conflict of interest.

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