Risk Factors and Prognostic Assessments: Incontinence Prediction via Logistic Regression

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ABSTRACT

Risk factors and prognostic assessments were examined, none exhibited as significant a correlation with incontinence as hysterectomy did. This finding underlines the complexity of incontinence as a multifactorial condition. Our study advocates for preoperative counseling on the potential risk of incontinence, especially for women considering hysterectomy. The development of comprehensive risk assessment tools incorporating surgical history is recommended to aid clinicians in predicting postoperative incontinence. This study investigated the outcomes of Transobturator Tape (TOT) surgery for incontinence. Researchers looked back at medical records (retrospective) and divided patients into two groups: those who only had TOT (73 patients) and those who had TOT with additional pelvic floor repair (178 patients). They carefully documented various patient details like age, weight, and medical history to understand if these factors influence the surgery's effectiveness affect incontinence. More women received combined TOT and pelvic reconstruction surgery, suggesting a preference for treating complex cases. The procedures had a low complication rate. Combined surgery resulted in slightly better perceived improvement. Patients with complications reported lower satisfaction. Other factors like childbirth history or marital status had minimal impact. The study identified a significant association between prior hysterectomy and increased risk of incontinence after TOT surgery. This study underscores the need for a nuanced understanding of urinary incontinence, emphasizing the significant role of surgical history, especially hysterectomy, in its development. It also calls for targeted rehabilitation programs and updated clinical practice guidelines to better manage and mitigate the risk of incontinence.

Keywords: Urinary incontinence, hysterectomy, logistic regression analysis

Risk Faktörleri ve Prognostik Değerlendirmeler: Lojistik Regresyon ile İnkontinans Tahmini

ÖZET

Risk faktörleri ve prognostik değerlendirmeler incelenmiş olup, hiçbirinin histerektomi kadar inkontinans ile anlamlı bir korelasyon göstermediği görülmüştür. Bu bulgu, inkontinansın çok faktörlü bir durum olarak karmaşıklığını vurgulamaktadır. Çalışmamız, özellikle histerektomi düşünen kadınlar için preoperatif dönemde inkontinans riskine yönelik danışmanlık verilmesini önermektedir. Ameliyat geçmişini içeren kapsamlı risk değerlendirme araçlarının geliştirilmesi, klinisyenlerin postoperatif inkontinansı tahmin etmelerine yardımcı olması amacıyla tavsiye edilmektedir. Bu çalışma, inkontinans tedavisinde Transobturator Bant (TOT) ameliyatının sonuçlarını incelemiştir. Araştırmacılar, tıbbi kayıtları geriye dönük olarak inceleyip hastaları iki gruba ayırmıştır: yalnızca TOT yapılan hastalar (73 hasta) ve TOT ile ek pelvik taban onarımı yapılan hastalar (178 hasta). Yaş, kilo ve tıbbi geçmiş gibi çeşitli hasta bilgilerini dikkatle belgeleyerek bu faktörlerin cerrahi etkinlik ve inkontinans üzerindeki etkisini anlamaya çalışmışlardır. Daha fazla kadının karmaşık vakaların tedavisinde tercih edilen bir yöntem olarak TOT ve pelvik rekonstrüksiyon kombinasyonunu aldığı görülmüştür. Prosedürlerde düşük bir komplikasyon oranı kaydedilmiştir. Kombine ameliyat, algılanan iyileşme oranını biraz daha yüksek seviyede tutmuştur. Komplikasyon yaşayan hastalar, memnuniyet oranının daha düşük olduğunu bildirmiştir. Doğum geçmişi veya medeni durum gibi diğer faktörlerin minimal etkisi gözlemlenmiştir. Çalışma, önceden histerektomi geçirmiş olmanın, TOT ameliyatı sonrası artan inkontinans riski ile önemli bir ilişki taşıdığını tespit etmiştir. Bu araştırma, cerrahi geçmişin, özellikle de histerektominin, üriner inkontinansın gelişimindeki önemli rolünü vurgulayarak, bu durumu daha iyi yönetmek ve riskini azaltmak için hedefe yönelik rehabilitasyon programları ve güncellenmiş klinik uygulama rehberlerinin gerekliliğine işaret etmektedir.

Anahtar Kelimeler: Üriner inkontinans, histerektomi, lojistik regresyon analizi

1   Introduction

Urinary incontinence (UI) is a prevalent and often distressing condition that substantially impacts individuals' quality of life and psychological well-being across various age groups. Defined by the involuntary loss of urine, UI varies in severity and manifestation, affecting day-to-day activities and social interactions (Athanasopoulos et al., 2011). The complexity of UI arises from its multifactorial etiology, which encompasses physiological, pathological, and lifestyle factors (Barnoiu et al., 2013). These contributing factors underline the importance of a comprehensive approach to both understanding and managing this condition.

Predictive modeling has gained prominence in urology, particularly for conditions like UI, where accurate prediction of onset and progression is essential for effective management (Campbell et al., 1985). Such models allow clinicians to personalize treatment strategies, anticipate patient-specific needs, and ultimately enhance patient outcomes. The significance of identifying preoperative prognostic factors and understanding their correlation with postoperative outcomes has been well-documented (Athanasopoulos et al., 2011; Barnoiu et al., 2013). In this context, identifying preoperative prognostic factors and assessing their relationship with postoperative outcomes is considered essential in supporting the development of individualized treatment approaches (Smith et al., 2017; Patel & Lee, 2019).

Logistic regression analysis, a robust statistical method, is widely used in medical research to examine binary outcomes and evaluate relationships between multiple predictor variables and specific clinical outcomes (Jelovsek et al., 2014). In the context of urology, logistic regression is particularly suited for analyzing risk factors linked to UI, as it enables a deeper understanding of how these factors interact to shape patient prognoses.

This study leverages logistic regression analysis to dissect the complex array of risk factors associated with UI. By evaluating diverse patient characteristics, Patient Global Impression of Improvement (PGI-I) scores, and other critical variables, the research aims to enhance prognostic assessment frameworks for UI. This approach aligns with predictive modeling objectives in urology, which seek to elevate patient care through targeted, personalized interventions. It is hypothesized that specific preoperative patient characteristics, including age, BMI, comorbidities, and baseline UI severity, significantly influence postoperative improvement as measured by PGI-I scores. Additionally, it is expected that the integration of these factors into predictive models will enhance the accuracy of UI prognosis and aid in tailoring individualized treatment plans.

2   Methodology

2.1. Study Design

This retrospective study was conducted at Sağlık Bilimleri Üniversitesi İstanbul Bağcılar Eğitim ve Araştırma Hastanesi and Bakırköy Dr. Sadi Konuk Eğitim ve Araştırma Hastanesi. The study employed logistic regression analysis to investigate various factors impacting the development of urinary incontinence (UI) among women treated for stress urinary incontinence (SUI) between April 2020 and April 2022.

Patients were retrospectively divided into two groups based on the surgical intervention received: those who underwent only the Transobturator Tape (TOT) surgery and those who had TOT in combination with pelvic floor reconstruction surgery. Detailed demographic and clinical data were collected for each participant, including age, weight, body mass index (BMI), parity, smoking status, and menopausal status. This data was meticulously recorded to allow a comprehensive assessment of potential risk factors for UI development.

2.2. Data Collection and Analysis

The study included a total of 251 patients, of whom 73 received only the TOT procedure, and 178 underwent combined TOT and pelvic reconstruction surgery. Patient history was thoroughly evaluated, with exclusions applied for those with neuromuscular diseases, connective tissue disorders, a history of radiation therapy, prolonged steroid use, non-stress incontinence, or previous pelvic surgery. This ensured a well-defined cohort focused specifically on SUI.

2.3. Application of Logistic Regression Model

The primary statistical analysis utilized logistic regression to identify significant risk factors associated with UI development. A key focus of this analysis was to determine whether a prior hysterectomy significantly influenced UI risk. Univariate logistic regression revealed that hysterectomy was a significant risk factor for UI, with an odds ratio of 2.160 (95% CI: 1.018-4.582, $p=0.045$). This association emphasizes the relevance of hysterectomy history in predicting UI outcomes.

2.4. Objective and Analytical Rigor

The study's methodology, grounded in robust data collection and statistical rigor, provides valuable insights into the risk factors contributing to UI. By isolating and analyzing specific factors such as hysterectomy using logistic regression, this study aims to advance the understanding of UI's multifactorial nature and support the development of more effective prevention and treatment strategies.

2.5. Ethical Considerations

This study was conducted in accordance with the principles outlined in the Declaration of Helsinki and approved by the Institutional Review Board (IRB) of Sağlık Bilimleri Üniversitesi İstanbul Bağcılar Eğitim ve Araştırma Hastanesi and Bakırköy Dr. Sadi Konuk Eğitim ve Araştırma Hastanesi (Approval

Number: [2023-170]). Informed consent was not required due to the retrospective nature of the study; however, patient confidentiality and data privacy were strictly maintained. All patient data were anonymized before analysis to ensure compliance with ethical and legal standards

3 Results

The analysis of patient demographics and clinical characteristics offers important insights into the profile of women undergoing Transobturator Tape (TOT) surgery for urinary incontinence (UI), either as a standalone procedure or in combination with pelvic reconstruction. Table 1 summarizes these characteristics, highlighting trends in factors such as age, BMI, and parity that have been associated with increased UI risk in the literature. This demographic overview provides context for understanding the outcomes of surgical interventions in a population predisposed to UI.

Table 1: *Patient demographic and clinical characteristics (n = 251)*

Characteristic	Mean ± SD	Median (Min-Max)	Frequency (%)
Age (years)	52.06 ± 9.91	50 (28-75)	-
Weight (kg)	76.60 ± 12.57	75 (41-118)	-
Height (cm)	159.51 ± 6.32	160 (145-180)	-
BMI	30.15 ± 5.00	29.66 (16.22-49.12)	-
Parity	3.33 ± 1.79	3 (0-16)	-
Type of Operation	-	-	TOT: 73 (29.0%)
			TOT + Pelvic Reconstruction: 178 (71.0%)
Hysterectomy Status	-	-	Hysterectomized: 49 (19.5%)
			Not Hysterectomized: 202 (80.5%)
Complications	-	-	None: 246 (98.0%)
			Present: 5 (2.0%)
Cesarean Section (C/S) Delivery	-	-	No: 207 (82.5%)
			Yes: 44 (17.5%)
Normal Spontaneous Delivery (NSD)	-	-	No: 8 (3.2%)
			Yes: 243 (96.8%)
Menstrual Status	-	-	Premenopausal: 104 (41.4%)
			Menopausal: 147 (58.6%)
Marital Status	-	-	Married: 218 (86.9%)
			Single: 33 (13.1%)
Smoking Status	-	-	Non-smoker: 202 (80.5%)
			Smoker: 49 (19.5%)
Education Level	-	-	None: 36 (14.3%)
			Primary: 195 (77.7%)
			Secondary: 13 (5.2%)
			Higher: 4 (1.6%)
			Postgraduate: 3 (1.2%)
Literacy	-	-	Illiterate: 29 (11.6%)
			Literate: 222 (88.4%)

The data indicate that the study cohort primarily consists of middle-aged women, with a mean BMI in the overweight range, which has been previously associated with an increased risk of UI. The high percentage of patients who had natural childbirth and those in the menopausal age range align with known risk factors for UI. Additionally, the preference for combined TOT and pelvic reconstruction procedures (71%) suggests that more complex cases were managed within this cohort.

Table 2: *Patient Global impression of improvement (PGI-I) scores by condition*

Condition	Group	PGI-I Score	Statistical Test	p-value
Operation Type	TOT	1.88 ± 1.37 (1-6)	KW = 2.365	0.306
	TOT + Pelvic Reconstruction	2.03 ± 1.24 (1-7)	U = 4269.5	0.167
Hysterectomy Status	Hysterectomized	1.83 ± 1.31 (1-6)	U = 528.5	0.572
	Not Hysterectomized	2.01 ± 1.26 (1-7)		
Complications	Absent	1.98 ± 1.27 (1-7)		
	Present	1.60 ± 0.89 (1-3)		
Childbirth History	C/S Birth	1.93 ± 1.16 (1-6)		
	NSD Birth	2.20 ± 1.66 (1-7)		
Menstrual Status	Premenopausal	1.97 ± 1.25 (1-7)	U = 7293.5	0.569
	Menopausal	1.97 ± 1.19 (1-6)	U = 3218.5	0.314
Marital Status	Married	2.00 ± 1.28 (2-7)		
	Single	1.84 ± 1.23 (1-5)	U = 4473.5	0.285
Smoking Status	Non-Smoker	2.01 ± 1.28 (1-7)		
	Smoker	1.84 ± 1.23 (1-5)		

Table 2 provides a comparison of the Patient Global Impression of Improvement (PGI-I) scores across various patient characteristics, such as type of operation, hysterectomy status, and presence of complications. This table highlights patient-perceived improvement following the surgical interventions and allows for a nuanced understanding of factors that may influence postoperative satisfaction. Patients undergoing combined TOT and pelvic reconstruction reported slightly higher PGI-I scores, indicating better perceived improvement compared to TOT-only patients, though the difference was not statistically significant. Patients with a history of hysterectomy reported marginally lower PGI-I scores, suggesting a slightly reduced satisfaction level. As anticipated, patients with complications reported significantly lower PGI-I scores, highlighting the impact of surgical complications on patient-perceived outcomes. Other factors, such as menstrual status, marital status, and smoking, showed minimal influence on the PGI-I scores.

Table 3: *Logistic Regression Analysis for Risk Factors Influencing Incontinence*

Variable	B (SE)	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
With Hysterectomy	0.770 (0.354)	2.160	1.018 - 4.582	0.045*
(Reference: Without Hysterectomy)				

SE: Standard Error; **OR**: Odds Ratio; **CI**: Confidence Interval
The sections highlighted in bold are statistically significant (p<0.05).

Table 3 presents the findings from the logistic regression analysis, identifying hysterectomy as a significant predictor of urinary incontinence. The odds ratio and confidence interval illustrate the increased likelihood of developing UI among patients with a history of hysterectomy. The logistic regression analysis reveals that a history of hysterectomy is associated with significantly increased odds of developing UI, with an odds ratio of 2.160 (p = 0.045). This finding underscores the need for preoperative counseling on the potential risks of incontinence, particularly for patients considering hysterectomy. The statistically significant result emphasizes the importance of hysterectomy as a predictor of UI, suggesting that surgical history should be carefully considered in risk assessment and management plans for patients at risk of incontinence.

4 Discussion

The findings of this study emphasize the importance of differentiating surgical outcomes based on patient characteristics. For example, while complications were rare (2%), their presence significantly impacted Patient Global Impression of Improvement (PGI-I) scores. This observation aligns with Maher et al. (2013), who highlighted that postoperative complications are a primary determinant of patient satisfaction following urogynecological surgeries. The reduced satisfaction observed in hysterectomized patients further supports findings by Altman et al. (2007), who reported that hysterectomy might disrupt pelvic innervation and anatomical support, potentially compromising surgical outcomes.

Interestingly, factors such as marital status, smoking habits, and menstrual status had minimal impact on perceived improvement, as reflected in PGI-I scores. This observation is consistent with Collins et al. (2016), who suggested that these demographic variables do not significantly influence the success rates or patient satisfaction in UI interventions. However, BMI and parity remain prominent factors influencing UI outcomes, as corroborated by Pang et al. (2018), who identified a direct correlation between higher BMI, parity, and increased UI severity.

The multifactorial nature of UI necessitates a holistic approach to its management, as highlighted by Barber et al. (2011). This study adds to the growing evidence that surgical history, particularly hysterectomy, should be a cornerstone of preoperative risk assessments. Moreover, the slight but consistent improvement in PGI-I scores for combined TOT and pelvic reconstruction surgery underscores the efficacy of a comprehensive surgical approach in addressing multiple facets of pelvic floor dysfunction. This finding is consistent with Lo et al. (2015), who demonstrated that combined surgeries yield better patient outcomes compared to isolated procedures.

The results of this study have significant clinical implications. The association between hysterectomy and increased UI risk suggests the necessity for preoperative counseling, especially for patients with benign indications for hysterectomy. Rodríguez-Mias et al. (2018) emphasized that educating patients about the potential consequences of hysterectomy can help manage expectations and improve satisfaction levels. Additionally, tailored rehabilitation programs focusing on pelvic floor muscle strengthening, as proposed by Bø et al. (2007), could mitigate the risk of postoperative incontinence, particularly in high-risk groups.

This study also supports the findings of Wang et al. (2020), who noted that combined surgical interventions not only improve functional outcomes but also enhance patient satisfaction in cases of coexisting pelvic organ prolapse and UI. Furthermore, the low complication rate reported in this study mirrors the outcomes from systematic reviews by Schulten et al. (2021), which advocate for minimally invasive techniques in urogynecology.

While this study provides valuable insights, further research is warranted to explore the long-term outcomes of combined TOT and pelvic reconstruction surgeries, particularly in patients with a history of hysterectomy. Prospective studies incorporating advanced imaging and biomechanical analyses, as suggested by Mori da Cunha et al. (2019), could elucidate the underlying mechanisms linking hysterectomy to increased UI risk. Additionally, investigating the role of emerging technologies such as AI-based predictive models, as proposed by Patel et al. (2021), could revolutionize risk assessment and management strategies for UI.

5   Conclusions

In summary, the findings of this study highlight the intricate interplay between surgical history, patient characteristics, and postoperative outcomes in urinary incontinence. The significant association between hysterectomy and increased UI risk underscores the need for comprehensive preoperative evaluations, targeted rehabilitation programs, and patient education. By aligning with and expanding upon existing literature, this study contributes to the ongoing effort to refine clinical practices and enhance the quality of care for women undergoing UI surgery.

6   Declarations

The author(s) declared none of the limitations faced in this study that might significantly affect the research outcome.

6.1   Acknowledgement

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6.2   Funding Source

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6.3   Competing Interests

The author(s) declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

6.4   Authors' Contributions

All authors contributed to the study conception and design. Bahtiyar ÇİFTÇİ performed the material preparation and data collection. Teymur BORNAUN carried out the analysis and interpretation of the results. Bahtiyar ÇİFTÇİ and Teymur BORNAUN drafted the manuscript, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

7   Human and Animal Related Study

For this type of study, formal consent is not required.

7.1   Ethical Approval

Since this study involved a desk review, the author(s) assert that all procedures contributing to this study comply with the ethical standards of the relevant institutional committees. For this type of study, formal consent is not required.

7.2   Informed Consent

Informed consent was obtained from all individual participants included in the study.

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