FOLIA MEDICA CRACOVIENSIA
Vol. LXVI, 1, 2026: 145–153
PL ISSN 0015-5616 eISSN 2957-0557
DOI: 10.24425/ fmc.2026.158993

Preliminary clinical association between the Nerve-Sparing Quality (NSQ) Score and early functional outcomes after robot-assisted radical prostatectomy

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Abstract: Introduction: Nerve-sparing during robot-assisted radical prostatectomy (RARP) plays a critical role in postoperative functional recovery, particularly urinary continence and erectile function. Although several tools exist for assessing surgical performance in robotic surgery, objective intraoperative evaluation of nerve-sparing quality remains limited. The Nerve-Sparing Quality (NSQ) Score was recently introduced as a structured intraoperative scoring system designed to evaluate the technical quality of neurovascular bundle preservation. The aim of the present study was to explore the preliminary clinical correlation between NSQ Score and early functional outcomes following RARP.

Methods: This retrospective observational study included 20 patients who underwent RARP and had available intraoperative NSQ Score assessment together with 6-month postoperative functional follow-up. The NSQ Score is a 10-point intraoperative scoring system based on five domains: dissection plane, bleeding control, bundle manipulation, continuity of dissection, and symmetry. Functional outcomes were assessed at 6 months using data obtained from routine postoperative follow-up records, using pad use (pads per day) and the International Index of Erectile Function-5 (IIEF-5). Associations between NSQ Score and functional outcomes were evaluated using Spearman correlation analysis. Exploratory subgroup comparisons were performed using an NSQ Score threshold of ≥8.

Results: The mean NSQ Score was 7.95 ± 1.61. Mean pad use at 6 months was 0.75 ± 0.91 pads/day, and mean IIEF-5 score was 18.05 ± 6.60. Higher NSQ Score correlated with lower pad use (Spearman $\rho = -0.56$, $p = 0.011$) and higher IIEF-5 ($\rho = 0.87$, $p < 0.001$). Patients with NSQ Score ≥8 demonstrated significantly better erectile function compared with those with lower scores (21.38 ± 4.46 vs 11.86 ± 5.40, $p = 0.001$) and lower pad use (0.38 ± 0.51 vs 1.43 ± 1.13 pads/day, $p = 0.035$).

Conclusions: Higher NSQ Score was associated with improved early functional outcomes after RARP, particularly regarding erectile function and postoperative pad use. These findings provide preliminary clinical support for the construct validity of the NSQ Score as a structured intraoperative measure of nerve-sparing quality. Larger prospective studies incorporating baseline functional parameters are required to determine the independent predictive value of the NSQ Score.

Keywords: robot-assisted radical prostatectomy, Nerve-Sparing Quality Score, nerve-sparing technique, functional outcomes, erectile function, urinary continence, surgical quality assessment.

Submitted: 18-Feb-2026; **Accepted in the final form:** 20-Mar-2026; **Published:** 31-Mar-2026.

Introduction

Nerve-sparing during radical prostatectomy is one of the most important determinants of postoperative functional recovery, particularly urinary continence and erectile function, which are key contributors to patient quality of life following prostate cancer treatment. [1, 2, 3] Since the original anatomical description of nerve-sparing prostatectomy by Walsh and Donker, numerous refinements in surgical technique have aimed to preserve the neurovascular bundles responsible for erectile function while maintaining oncologic efficacy. [4]

The introduction of robotic surgical platforms has significantly improved visualization and dexterity during prostatectomy, allowing more precise dissection in proximity to the neurovascular bundles. [5] As a result, robot-assisted radical prostatectomy (RARP) has become the predominant surgical approach for localized prostate cancer in many countries. [6] Despite these technological advances, substantial variability in postoperative functional outcomes persists. Large prospective studies have demonstrated significant heterogeneity in continence and potency recovery following RARP, suggesting that surgical technique remains a key determinant of postoperative results. [7, 8]

Several tools have been developed to assess surgical performance in robotic surgery. The Global Evaluative Assessment of Robotic Skills (GEARS) evaluates general robotic surgical competence, including depth perception, dexterity, and efficiency. [9] The Objective Structured Assessment of Technical Skills (OSATS) provides a broader framework for structured surgical skill evaluation across multiple surgical disciplines. [10] Procedure-specific assessment tools such as the Prostatectomy Assessment and Competency Evaluation (PACE) score have also been proposed for evaluating robotic prostatectomy performance. [11] However, these instruments primarily focus on overall surgical performance and do not specifically evaluate the quality of nerve-sparing dissection.

To address this limitation, the Nerve-Sparing Quality (NSQ) Score was recently introduced as a structured intraoperative scoring system designed to evaluate the technical quality of neurovascular bundle preservation during RARP. The NSQ Score has been developed as a structured intraoperative scoring system for evaluating nerve-sparing quality during robot-assisted radical prostatectomy. A detailed description and methodological validation of the score are presented in a separate methodological study. The score incorporates five domains - dissection plane, bleeding control, bundle manipulation, continuity of dissection, and symmetry, and provides a standardized framework for assessing nerve-sparing technique. [12]

While the feasibility and reproducibility of the NSQ Score have been previously demonstrated, its clinical relevance in relation to postoperative functional outcomes has not yet been explored. Establishing such a relationship would provide important support for the clinical utility of the score. Therefore, the aim of this study was to perform a preliminary exploratory analysis of the association between NSQ Score and early functional outcomes after RARP, including urinary continence and erectile function at 6 months.

Materials and Methods

Study design

This retrospective observational study evaluated the relationship between intraoperative nerve-sparing quality and postoperative functional outcomes following robot-assisted radical prostatectomy.

The study was conducted at a high-volume tertiary referral center with an established robotic surgery program performing more than 600 robotic procedures annually, including a substantial number of robot-assisted radical prostatectomies. Robot-assisted radical prostatectomy has been routinely performed at our institution for several years and represents a standardized component of the surgical treatment of localized prostate cancer.

Intraoperative assessment

The assessment was performed through retrospective review of anonymised, recorded operative videos focusing on the nerve-sparing dissection phase and applying the predefined NSQ Score criteria.

Nerve-sparing quality was evaluated using the Nerve-Sparing Quality (NSQ) Score, a structured 10-point intraoperative scoring system based on five domains.

- continuity of dissection
- bleeding control
- dissection plane
- bundle manipulation
- symmetry

Each domain is scored from 0 to 2 points, resulting in a total score ranging from 0 to 10.

In bilateral NS, both sides were rated separately and averaged to obtain a composite score. In unilateral NS procedures, symmetry was always scored as 0, ensuring that the total score more accurately reflected the actual quality and extent of nerve preservation.

The scoring definitions for each parameter were standardized and are presented in Table 1.

Table 1. Nerve-Sparing Technique Scoring System.

Parameter	0 points	1 point	2 points
Continuity of dissection	Interrupted, chaotic	Moderate continuity	Smooth, uninterrupted
Intraoperative bleeding	Massive, obscuring field	Moderate, controlled	Minimal or none
Dissection plane	Outside anatomical layer	Partially correct	Fully anatomical
Bundle manipulation	Grasping, stretching and/or extensive monopolar or bipolar cauterization close to the bundle	Light touching/tension and/or limited or indirect cautery near the neurovascular bundle	None or very delicate manipulation, only pinpoint coagulation
Symmetry	Significant difference/unilateral	Minor differences	Both sides comparable

Functional outcome assessment

Functional outcomes were assessed at 6 months after surgery using data obtained from routine postoperative follow-up visits documented in the outpatient clinic medical records.

Two outcome measures were collected:

Urinary continence

Continence was evaluated using pad use per day, which represents a commonly used clinical measure of urinary continence following radical prostatectomy. [2]

Erectile function

Erectile function was evaluated using the International Index of Erectile Function-5 (IIEF-5) questionnaire, a validated instrument widely used for assessing erectile function in clinical studies. [13]

Statistical analysis

Statistical analysis was performed using standard exploratory methods appropriate for small sample size studies. Continuous variables were summarized as mean ± standard deviation (SD) as well as median with interquartile range (IQR), to provide a comprehensive description of data distribution.

Given the limited sample size and potential non-normal distribution of variables, non-parametric statistical methods were used throughout the analysis. Associations between the Nerve-Sparing Quality (NSQ) Score and functional outcomes were assessed using Spearman rank correlation coefficients. Correlation strength was interpreted as weak ($\rho < 0.3$), moderate ($\rho = 0.3–0.6$), or strong ($\rho > 0.6$).

Exploratory subgroup analyses were performed using a predefined NSQ Score threshold of ≥8. Between-group comparisons were conducted using the Mann–Whitney U test for continuous variables. Categorical variables were analyzed using Fisher's exact test, as appropriate.

In addition to correlation analysis, descriptive distribution analyses were performed, including frequency distribution of NSQ scores and continence status (0 vs ≥1 pad/day), to better characterize clinical outcomes.

All statistical tests were two-sided, and a p-value < 0.05 was considered statistically significant. Due to the exploratory nature of the study and the limited sample size, no adjustment for multiple comparisons was applied, and no multivariable analysis was performed.

Statistical analyses were conducted using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) and verified using R software (R Foundation for Statistical Computing, Vienna, Austria).

Results

Twenty patients with available intraoperative NSQ Score assessment and complete 6-month functional follow-up were included in the analysis.

The baseline characteristics of the study cohort are presented in Table 2. The mean NSQ Score was 7.95 ± 1.61, with a median of 8 (IQR 7–9), indicating generally high-quality nerve-sparing dissection within the cohort.

At 6 months after surgery, the mean pad use was 0.75 ± 0.91 pads/day (median 0.5, IQR 0–1), while the mean IIEF-5 score was 18.05 ± 6.60 (median 21.5, IQR 13.5–23), reflecting variability in functional recovery.

Table 2. Baseline characteristics of the study cohort.

Variable	Mean ± SD	Median (IQR)	Range
NSQ Score	7.95 ± 1.61	8 (7–9)	5–10
Pad use (pads/day)	0.75 ± 0.91	0.5 (0–1)	0–3
IIEF-5 score	18.05 ± 6.60	21.5 (13.5–23)	6–25

Correlation analysis

Higher NSQ Score was significantly associated with improved functional outcomes. A moderate negative correlation was observed between NSQ Score and pad use (Spearman $\rho = -0.56$, $p = 0.011$), indicating that better nerve-sparing quality was associated with improved urinary continence. The correlation analysis is summarized in Table 3.

A strong positive correlation was found between NSQ Score and erectile function (Spearman $\rho = 0.87$, $p < 0.001$), suggesting a substantial relationship between intraoperative nerve preservation and postoperative erectile recovery.

Table 3. Correlation between NSQ Score and functional outcomes.

Variable	Spearman ρ	p-value
NSQ Score vs Pad use	−0.56	0.011
NSQ Score vs IIEF-5 score	0.87	<0.001

Subgroup analysis

Patients were stratified using an NSQ Score threshold of ≥8.

Patients with higher NSQ Scores demonstrated significantly better functional outcomes. Mean pad use was 0.38 ± 0.51 pads/day in the NSQ ≥8 group compared with 1.43 ± 1.13 pads/day in the NSQ <8 group ($p = 0.035$). Mean IIEF-5 score was 21.38 ± 4.46 in the NSQ ≥8 group versus 11.86 ± 5.40 in the NSQ <8 group ($p = 0.001$). Functional outcomes according to NSQ score threshold are presented in Table 4.

At 6 months, 10 patients (50%) achieved complete continence (0 pads/day), while 10 patients (50%) required at least one pad per day.

Table 4. Functional outcomes according to NSQ score threshold.

Outcome	NSQ <8 (n = 7)	NSQ ≥8 (n = 13)	p-value
Pad use (pads/day)	1.43 ± 1.13	0.38 ± 0.51	0.035
IIEF-5 score	11.86 ± 5.40	21.38 ± 4.46	0.001

Distribution analysis

The distribution of NSQ Scores demonstrated that procedures were generally performed with moderate-to-high technical quality, with 16 of 20 patients (80%) achieving an NSQ Score of 7 or higher. This reflects the overall distribution of technical performance, while a threshold of ≥8 was used for subgroup analysis.

Discussion

This study provides the first preliminary clinical evidence linking the Nerve-Sparing Quality (NSQ) Score with early functional outcomes following robot-assisted radical prostatectomy. The main finding is that higher NSQ Scores were associated with both lower pad use and improved erectile function at 6 months after surgery.

The observed relationship between NSQ Score and postoperative erectile function is biologically plausible. The score specifically evaluates technical aspects of nerve-sparing dissection that are directly related to preservation of the neurovascular bundles, including accurate identification of the dissection plane, minimal traction on the bundles, and continuity of dissection. These factors have previously been shown to influence postoperative erectile recovery. [14]

In recent years, increasing attention has been directed toward identifying objective metrics that can link surgical performance with patient outcomes in robotic surgery. Although global assessment tools such as GEARS or OSATS provide valuable information regarding overall surgical skill, they do not specifically capture the technical nuances of nerve-sparing dissection during prostatectomy. Procedure-specific tools such as the PACE score partially address this limitation; however, they still evaluate the overall performance of the procedure rather than focusing specifically on neurovascular bundle preservation. The NSQ Score was therefore designed to fill this gap by focusing exclusively on the key technical components of nerve-sparing dissection.

From a biological perspective, the strong correlation observed between NSQ Score and postoperative erectile function is consistent with the current understanding of neurovascular bundle preservation during radical prostatectomy. Damage to the cavernous nerves may occur through several mechanisms including traction injury, thermal injury from electrocautery, and disruption of the anatomical dissection plane. Each of these mechanisms is indirectly captured within the NSQ Score domains, including bundle manipulation, bleeding control, and dissection plane accuracy. Consequently, higher NSQ Scores may reflect a surgical technique that minimizes mechanical and thermal trauma to the neurovascular structures responsible for erectile function.

Another important implication of the present findings relates to the potential role of the NSQ Score in surgical training and quality assessment. Modern surgical education increasingly emphasizes objective assessment of procedural performance. In robotic surgery, structured assessment tools have been shown to facilitate skill acquisition and improve the standardization of surgical training. A focused intraoperative metric specifically evaluating nerve-sparing quality could therefore provide a useful educational tool, particularly during the learning phase of robotic prostatectomy.

In addition to its potential educational value, the NSQ Score may also contribute to quality monitoring in robotic prostatectomy programs. Variability in functional outcomes after RARP remains substantial even among experienced surgeons. Objective intraoperative metrics capable of capturing technical quality may therefore provide an additional layer of quality control and allow more precise investigation of the relationship between surgical technique and postoperative outcomes.

Finally, the concept of structured intraoperative assessment may have broader implications for surgical research. Many outcome studies in prostatectomy rely primarily on postoperative functional results without direct evaluation of intraoperative technique. Incorporating standardized technical metrics such as the NSQ Score could help bridge this gap and improve our understanding of how specific surgical maneuvers translate into patient outcomes.

The correlation with urinary continence was less pronounced but remained consistent in direction. Continence recovery after prostatectomy is multifactorial and may depend on additional surgical factors such as urethral length preservation, bladder neck reconstruction, and pelvic floor function. [15] Therefore, although nerve-sparing contributes to continence recovery, it represents only one component of the overall functional outcome.

Interestingly, several cases were observed in which patients achieved excellent continence outcomes despite poor postoperative erectile function, even in the presence of high NSQ Scores. Further follow-up revealed that some of these patients had impaired erectile function prior to surgery. This observation highlights the importance of baseline erectile status when interpreting postoperative outcomes and emphasizes that intraoperative technical quality alone cannot fully explain postoperative erectile recovery.

The present study should therefore be interpreted as an exploratory clinical correlation rather than a definitive validation of the NSQ Score. Nonetheless, the results provide an early signal suggesting that structured intraoperative evaluation of nerve-sparing quality may have clinical relevance. If confirmed in larger cohorts, the NSQ Score may represent a useful tool for surgical training, quality monitoring, and research on the relationship between surgical technique and patient outcomes.

Future studies should incorporate prospective data collection including preoperative erectile function, patient age, comorbidities, and oncological variables, enabling multivariable analyses and more robust validation of the NSQ Score as a surgical quality metric.

Study limitations

This study has several limitations that should be acknowledged. First, the sample size was relatively small and the analysis was conducted at a single institution, which limits the generalizability of the findings. The present study should therefore be considered exploratory and hypothesis-generating.

Second, important baseline patient characteristics were not available for analysis. In particular, preoperative erectile function assessed by IIEF-5 and patient age were not systematically collected. Both factors are well-established determinants of postoperative erectile recovery after radical prostatectomy and may confound the observed relationship between intraoperative nerve-sparing quality and postoperative functional outcomes.

Furthermore, pad use, although widely used as a clinical indicator of continence recovery, may not fully capture the complexity of postoperative urinary function.

Fourth, no multivariable analysis was performed due to the limited sample size and the absence of key baseline covariates. Consequently, the observed associations between NSQ Score and functional outcomes should be interpreted as preliminary correlations rather than evidence of an independent predictive relationship.

Finally, the present analysis focused on early functional outcomes at six months after surgery. Longer follow-up will be required to determine whether the observed associations persist over time.

Conclusions

Higher Nerve-Sparing Quality (NSQ) Score was significantly associated with improved early functional outcomes following robot-assisted radical prostatectomy, particularly in relation to erectile function and urinary continence at 6 months.

The strong correlation observed between NSQ Score and postoperative erectile function supports the clinical relevance of structured intraoperative assessment of nerve-sparing quality. These findings suggest that technical precision during neurovascular bundle dissection may play a critical role in functional recovery.

The NSQ Score may represent a promising tool for objective intraoperative evaluation, with potential applications in surgical training, quality assurance, and outcome prediction. By providing a standardized framework for assessing nerve-sparing technique, it may facilitate better understanding of the relationship between surgical performance and patient outcomes.

However, given the exploratory design and limited sample size, these results should be interpreted as hypothesis-generating. Further prospective studies incorporating baseline functional parameters and multivariable analyses are required to validate the independent predictive value of the NSQ Score.

Acknowledgments

The authors thank all staff involved in the robotic surgery program and postoperative follow-up.

Funding

No external funding was received for this study.

Author contributions

J.K. conceived the study, analyzed data, and drafted the manuscript. K.Ba., O.D., and K.Bu. contributed to data interpretation, manuscript revision, and final approval.

Conflict of interest

None declared.

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