

Nerve Bundle Hydrodissection and Sexual Function after Robot Prostatectomy

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ABSTRACT

Background and Objectives: Loss of erectile function is common after prostatectomy, and surgeons have long sought techniques that reduce this adverse outcome. This study was conducted to assess erectile function after robot-assisted laparoscopic prostatectomy, with and without hydrodissection (HD) of the neurovascular bundles (NVBs).

Methods: Using a database of 335 consecutive RALP procedures conducted by 2 surgeons, we identified all nerve-sparing surgeries performed by HD or standard dissection (SD). The primary and secondary endpoints were Sexual Health Inventory for Men (SHIM) scores and surgical margin positivity, respectively. Subset analyses were performed on men with preoperative SHIM scores ≥ 17 . Determinants of the postoperative SHIM score were evaluated by multivariate linear regression.

Results: Among men with preoperative SHIM scores ≥ 17 who underwent bilateral complete nerve sparing ($n = 73$), mean preoperative SHIM scores were similar in the HD and SD groups, but were significantly higher in the HD group at 6 months (16.1 ± 8.6 vs 8.3 ± 8.1 ; $P = .024$) and >1 year after surgery (16.9 ± 7.1 vs 9.1 ± 6.4 ; $P = .004$). According to multivariate linear regression analysis including all patients, HD at RALP (odds ratio [OR] 6.9; 95% confidence interval (CI) 2.8–11.0; $P = .001$) and preoperative SHIM score were independent predictors of erectile function at >1 year after surgery. There was no significant difference in surgical margin positivity between groups ($P = .36$).

Conclusion: HD of the NVB appears to improve erectile function after RALP.

Key Words: Hydrodissection, Prostate cancer, Robotic surgery, Sexual function.

INTRODUCTION

Erectile dysfunction is common after radical prostatectomy (RP) for localized prostate cancer. Recovery of potency after RP is strongly related to the patient's age, baseline erectile function, and degree of neurovascular bundle (NVB) preservation.^{1–3} Surgeons have explored various nerve-sparing techniques to enhance recovery of sexual potency, with cautery-free techniques leading to improved postoperative erectile function. There are many surgical methods for NVB preservation during RP, but the optimal technique has not been universally established.^{4–6}

HD is an athermal nerve-sparing technique in which a solution of lidocaine and epinephrine is injected into the lateral prostatic fascia to separate it from the prostatic capsule. Similar techniques are used in neurosurgery and in ophthalmic, plastic, and general surgeries to minimize tissue damage, limit manipulation of the tissue, and enhance visualization of correct tissue planes. Patel et al⁷ found that HD of the NVB during open RP improves postoperative erectile function compared with standard dissection (SD) of the NVB, but this result has not been externally validated. Use of the HD technique for NVB preservation has been described in robot-assisted laparoscopic prostatectomy (RALP),⁸ although erectile function outcomes were not reported.

Our objective was to assess sexual function after RALP, with and without HD of the NVB.

METHODS

We reviewed the clinical records of 335 consecutive men with prostate cancer who underwent RALP conducted by two surgeons (SE and JDR) at the University of Chicago and Penn State Health Milton S. Hershey Medical Center.

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This study was approved by the institutional review boards of both centers and adhered to the Declaration of Helsinki. All persons gave their informed consent for review of records before inclusion in the study. Patients eligible for inclusion underwent complete or partial nerve sparing bilaterally or unilaterally, as decided by the surgeon before or at the time of surgery based on pathologic biopsy and imaging characteristics. Beginning in October 2010, the surgeons used HD during select RALP cases, specifically in patients with intact sexual function before surgery.

We identified all cases that included nerve-sparing HD, as described by Patel et al,⁷ or athermal SD. For HD cases, a 22-gauge spinal needle with a beveled tip was inserted immediately superior to the pubic symphysis and placed directly under the lateral prostatic fascia, after which 5 mL 1% lidocaine with epinephrine was slowly injected. Adequacy of the technique was visually confirmed by distension of the space between the prostatic capsule and the lateral prostatic fascia. Anesthesia monitoring failed to note any adverse sequelae of the injection, as measured by change in heart rate or blood pressure change. The lateral prostatic fascia was then incised at the midportion of the anterolateral prostate and extended cranially and caudally. The NVBs were then bluntly and sharply dissected off the prostatic capsule, with partial nerve resection performed based on preoperative decision or intraoperative visual evidence of extraprostatic extension.

The HD technique, including solution type and volume, was adapted from Patel et al⁷ for RALP procedures and has been demonstrated in a video.⁹ **Figures 1** and **2** show

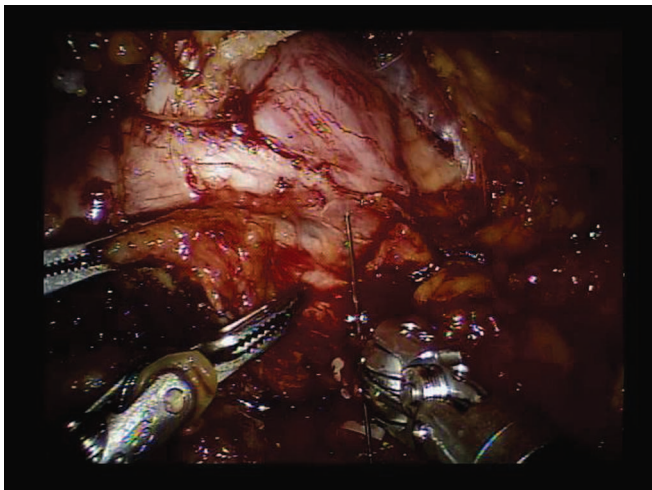


Figure 1. 22 gauge needle inserted into the lateral prostatic fascia to hydrodissect the right neurovascular bundle.

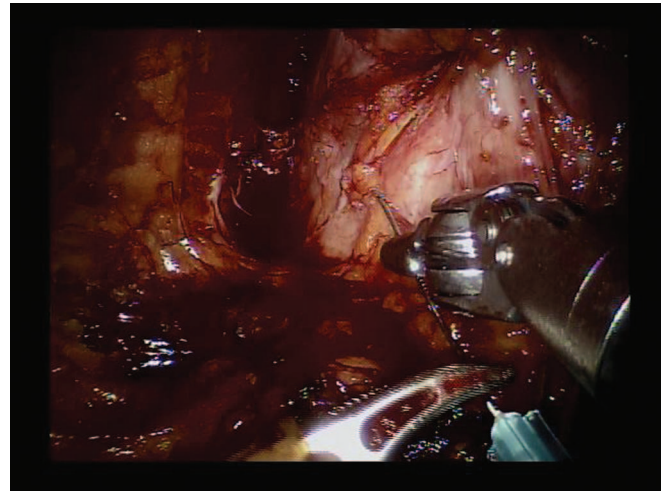


Figure 2. Hydrodissection of the left neurovascular bundle following division of the bladder neck.

intraoperative images of the injection technique. In SD cases, a similar technique was used, but no lidocaine-epinephrine solution was injected.

As part of routine perioperative care, Sexual Health Inventory for Men (SHIM) scores were obtained before surgery and at 6 weeks, 6 months, and 1 or more years after surgery. The primary and secondary endpoints were SHIM scores and rate of positive surgical margins, respectively. Statistical analyses were conducted with Stata software (Stata Statistical Software: Version 14, StataCorp, LLC, College Station, Texas, USA). Pre- and postoperative SHIM scores were examined by independent *t* test analyses for men with preoperative SHIM scores ≥ 17 who underwent RALP with nerve sparing. Subanalyses of the cohort of patients with preoperative SHIM scores ≥ 17 were performed based on degree of nerve sparing and date of surgery.

Rates of positive surgical margins were assessed for the entire cohort. Determinants of postoperative SHIM score were evaluated by multivariate linear regression analyses of all patients, regardless of nerve-sparing status and preoperative SHIM score.

RESULTS

Of 335 patients, 156 (47%) underwent SD, 94 (28%) underwent HD, and 85 (25%) underwent bilateral wide resection. Among the 250 who underwent SD or HD, 37% of patients had normal erectile function (SHIM score, 22–25), 15% had mild ED (SHIM score, 17–21), and 48% had

moderate or severe ED (SHIM \leq 16) or were not sexually active (**Table 1**).

Analyses focused on men with preoperative SHIM scores \geq 17 who underwent SD or nerve-sparing HD. Among this cohort, 114 patients (67%) underwent SD, and 56 patients (33%) underwent HD. Preoperative, intraoperative, and pathological characteristics are detailed in **Table 1**. No significant difference was observed between SD and HD groups in age ($P = .40$), race ($P = .35$), mean preoperative prostate-specific antigen (PSA; $P = .50$), pathological stage ($P = .43$), or pathological Gleason score ($P = .60$). There was, however, a higher rate of bilateral complete nerve sparing in the HD group than in the SD group (68% vs 46%, respectively; $P = .007$).

Among men with preoperative SHIM scores \geq 17, mean preoperative scores were similar between HD and SD groups (22.9 ± 2.0 and 22.7 ± 2.3 , respectively; $P = .80$). At 6 months after surgery, the mean SHIM score in the HD group was 7.4 points higher than in the SD group (16.1 ± 8.6 vs 8.3 ± 8.1 ; $P = .024$). At >1 year after surgery, the score remained 7.8 points higher in the HD group (16.9 ± 7.1 vs 9.1 ± 6.4 ; $P = .004$). To minimize the confounding impact of the surgeon's experience, we further divided our cohort of men with preoperative SHIM scores \geq 17 undergoing bilateral nerve-sparing operations by time period of surgery. We specifically split each HD and SD cohort into early and late time points based on time of procedure. We observed no differences in HD (16.3 ± 7.3 early cohort vs 17.2 ± 7.6 later cohort; $P = .18$) or SD SHIM scores (9.0 ± 6.5 early cohort vs 9.1 ± 6.4 later cohort; $P = .87$) at 1 year, respectively.

On multivariate linear regression analysis controlling for age and degree of nerve sparing, preoperative SHIM score and HD were independent predictors of erectile function at 6 months and >1 year after surgery (**Table 2**; $R^2 = 0.32$ and 0.29 ; $P = .0001$ and $.0003$, respectively), whereas increasing age was predictive of decreased sexual potency at 6 months only. In particular, HD at RALP was an independent predictors of erectile function at 6 months (odds ratio [OR] 4.5; 95% confidence interval [CI] 1.1–7.9; $P = .01$ and >1 year (OR 6.9, 95% CI 2.8–11.0; $P = .001$) after surgery.

Positive surgical margins were present in 20% of all nerve-sparing cases, occurring in 19% of SD cases and 21% of HD cases ($P = .30$). Among patients with pT2 cancers, positive margins were present in 12% of SD and 9% of HD ($P = .80$) cases. Positive margins were present in 37% of SD cases and 39% of HD cases in patients with pT3 cancers ($P = .47$).

DISCUSSION

The neuroanatomy of the pelvic plexus in relation to erectile function was first delineated in 1982 by Walsh and Donker.¹⁰ Since then, sexual potency after RP has markedly improved, with \sim 70–90% of patients who undergo RALP with bilateral nerve sparing at high-volume centers regaining erectile function by 1 year after surgery.⁶ The ideal technique for NVB preservation allows for dissection of the correct plane between the NVB and the prostate while also preventing capsular incision and NVB injury or resection. The surgical approach to NVB dissection should maintain hemostasis and minimize thermal injury, tension, and countertraction to the NVB to optimize recovery of sexual function.^{6,8}

With this in mind, several technical modifications of the standard nerve-sparing approach during RALP have been developed and studied, including “veil of Aphrodite” nerve sparing,^{11,12} athermal dissection,⁴ and tension-free nerve sparing.^{13,14} HD is an athermal nerve-sparing technique that enhances visualization of the proper dissection plane after injection of a lidocaine–epinephrine solution into the lateral prostatic fascia. This method allows for easier separation of the fascia from the prostatic capsule via an athermal, tension-free approach. In publications of HD in noneurological procedures, saline alone is injected into the desired dissection planes.^{15,16} Our surgeons followed the protocol published by Patel et al.⁷ Epinephrine was used to enhance hemostasis and therefore visualization of anatomical planes; it was commercially available in a prepared solution with lidocaine, although lidocaine was not necessary for the procedure.

Our findings are among the first to suggest that HD of the NVB during RALP is associated with improved erectile function. This observation was identified among all patients in our study, particularly in those with minimal preoperative ED who underwent bilateral nerve sparing. Guru et al⁸ described HD of the NVB during RALP in a 10-patient cohort. Although they outlined the HD technique in detail, sexual function outcomes were not assessed. Patel et al⁷ later described HD during open RP and evaluated erectile function at 6 weeks and 6 months after surgery.⁷ This study found that, in men who underwent bilateral NVB dissection or unilateral partial NVB dissection, mean SHIM scores were significantly higher in the HD group at 6 weeks and 6 months. Furthermore, men who underwent bilateral nerve sparing by HD required significantly less time to achieve successful intercourse (median of 3 months) than did those in the SD group (median of 6 months).

Table 1.
Characteristics of Patients who Underwent RALP with Nerve Sparing

	Standard Dissection (n = 156)	Hydrodissection (n = 94)
Median age (IQR)	61 (55–66)	62 (55–65)
Race		
Caucasian	109 (70)	82 (87)
African American	39 (25)	10 (11)
Asian	7 (4)	1 (1)
Hispanic	1 (1)	1 (1)
Preop SHIM score		
22–25	79 (50)	44 (47)
17–21	35 (22)	14 (15)
12–16	9 (6)	17 (18)
8–11	9 (6)	6 (6)
1–7	20 (13)	13 (14)
Unknown	4 (3)	—
Mean preop PSA ± SD	8.11 ± 7.99	7.64 ± 6.01
Pathological stage		
pT2a	5 (3)	1 (1)
pT2b	19 (12)	1 (1)
pT2c	89 (57)	54 (57)
pT3a	34 (22)	33 (35)
pT3b	8 (5)	5 (5)
pT0	1 (1)	0 (0)
Pathological Gleason score		
6	22 (14)	18 (19)
7	116 (74)	68 (72)
8	9 (6)	7 (7)
9	8 (5)	1 (1)
0	1 (1)	0 (0)
NVB preservation		
Bilateral complete	71 (46)	64 (68)
Bilateral partial	6 (4)	4 (4)
Unilateral complete	24 (15)	8 (8)
Unilateral partial	11 (7)	2 (2)
Unilateral complete with contralateral partial	44 (28)	16 (17)
Positive surgical margins		
pT2a	0/5 (0)	0/1 (0)
pT2b	2/19 (11)	0/1 (0)
pT2c	12/89 (13)	5/54 (9)
pT3a	15/34 (44)	14/33 (42)
pT3b	1/8 (13)	1/5 (20)
p0	0/1 (0)	0/0/ (0)

Data are number of patients (percentage of the group), unless otherwise indicated. IQR, interquartile range.

Table 2. Multivariate Linear Regression Analysis of SHIM Score at 6 Months and >1 Year after Surgery

	6 Months*			>1 Year**		
	Coefficient (95% CI)	Beta Coefficient	P-value	Coefficient (95% CI)	Beta Coefficient	P-value
Age	-0.24 (-0.48 to -0.0081)	-0.21	.0043	-0.031 (-0.29 to -0.23)	-0.023	0.8
Preoperative SHIM score	0.28 (0.097 to 0.47)	0.29	.003	0.30 (0.056 to 0.55)	0.25	0.016
Degree of nerve sparing						
Bilateral complete	0.12 (-8.4 to -8.6)	0.0075	.9	0.25 (-9.0 to -9.5)	0.015	0.9
Bilateral partial	—	—	—	—	—	—
Unilateral complete	-2.1 (-11 to -6.8)	-0.090	.6	2.3 (-8.3 to 13)	0.074	0.7
Unilateral partial	-2.9 (-13 to -6.7)	-0.095	.5	-2.7 (-14 to 8.2)	-0.076	0.6
Unilateral complete with contralateral partial	-3.2 (-12 to -5.3)	-0.18	.5	-2.5 (-12 to -6.8)	-0.14	0.6
Hydrodissection	4.5 (1.1 to 7.9)	0.26	.010	6.9 (2.8 to 11)	0.35	0.001

*P = .0001, R² = 0.32, adjusted R² = 0.25. **P = .0003, R² = 0.29, adjusted R² = 0.2.

Although greater technical precision leading to improved sexual function outcomes may be achieved with HD of the NVBs, a concern is increased rates of positive surgical margins resulting from closer dissection to the prostatic capsule. As Guru et al⁸ explain, the anatomy of the prostate may be distorted and thus the surgical margin status compromised if the lidocaine–epinephrine solution is injected too close to the base of the gland. In our study, as well as that by Patel et al, this concern was not observed.

Our study demonstrates that postoperative erectile function was significantly improved in men who underwent NVB preservation by HD, without compromising surgical margin rates. Several limitations must be considered, including the modest size of the cohort. Because only 2 surgeons used the HD technique, the volume of patients accrued for this study was limited. However, statistical significance was observed in postoperative erectile function outcomes, suggesting that the HD technique is superior. Second, the cohort was not prospectively randomized; however, baseline characteristics of SD and HD cohorts (including preoperative SHIM score) were equivalent, indicating well-matched groups. Nevertheless, it is possible that unmeasured confounders accounted for the observed difference in erectile function outcomes. We are in the planning stages of a prospective randomized comparison of SD versus HD to further evaluate our findings. Last, enhanced recovery of the sexual potency seen in HD patients could be attributable to improved surgical experience over time, as opposed to the HD technique itself. Our subset analysis did not appear to suggest that learning curve impacted SHIM score in either the HD or SD populations. Nonetheless, several studies of the learning curve for RALP procedures indicate that surgical, oncological, and functional outcomes comparable to open RP are achieved after 80–150 RALP cases, with overall positive margin status ranging from ~15–25% and improving with the number of cases performed.^{17–19}

CONCLUSIONS

Compared to SD, HD of the NVBs during RALP improved erectile function at 6 months and >1 year after surgery.

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