# Erectile Function Following Prostate Cancer Treatment: Factors Predicting Recovery

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**ABSTRACT**

Prostate cancer represents the most common nonskin malignancy encountered in men, and the excellent long-term survival achieved in the majority of patients has allowed more attention to be given to the side effects associated with its treatment. Erectile function is one of the main concerns of patients when considering treatment options for prostate cancer. Not surprisingly, post-treatment sexual function is closely related to outcome satisfaction and has long-lasting effects on quality of life. Radical prostatectomy is currently the most commonly employed therapy for prostate cancer. Conflicting rates of erectile dysfunction have been reported after surgery, owing not only to different surgical techniques but also because of dissimilar patient populations and definitions. Providing accurate information to individual patients in regards to their chances of recuperating the ability to have intercourse after treatment is important not only because it allows patients to make informed decisions but also because it has the potential to reduce treatment dissatisfaction. This article mainly focuses on discussing predictors of erectile function after radical prostatectomy. Patient factors, surgical aspects, including comparisons between open, laparoscopic, and robotic approaches, and postoperative management issues that impact sexual outcomes are evaluated. Prediction models combining multiple factors are described. The definition and chronology of erectile function recovery and impact of sexual function on quality of life after surgery are also discussed. **Teloken PE and Mulhall JP. Erectile function following prostate cancer treatment: Factors predicting recovery. Sex Med Rev 2013;1:91–103.**

***Key Words.*** Quality of Life; Sexual Function; Prostate Cancer

## Impact of Sexual Function on Quality of Life

Erectile function (EF) after treatment for prostate cancer, whether radical prostatectomy (RP) or radiation therapy, has significant and long-lasting effects. Sexual function has been identified as the quality-of-life domain most strongly associated with outcome satisfaction after treatment for prostate cancer [1]. Amidst multiple physical and psychosocial factors, EF has been shown to be an independent predictor of both bother and depression in men after RP [2].

A prospective study of 453 men showed that sexual bother increased from 18% in the month preceding surgery to 66% 1 year after surgery [3]. Eighty-three percent of patients who were sexually active in the preceding 4 weeks indicated that bother was related to sexual function impairment. A study with longer follow-up showed that sexual bother failed to change between 1 and 2 years after surgery [4]. Preoperative sexual bother, sexual activity, and nervousness have also been shown to be independent predictors of sexual bother in the postoperative period [3].

Fifteen percent of patients with localized disease report regretting their treatment choice, and regret was associated with worse sexual function and increased sexual bother post-treatment [5–7]. The dissatisfaction with treatment seems to arise from a perceived difference between expectations and experience.

Sexual function is inversely associated with depressive symptoms in patients treated for prostate cancer [8], and this association persists at least 4 years after the diagnosis of prostate cancer even after correction for possible confounders [9]. Results from the Scandinavian Prostate Cancer Group-4 randomized trial showed that 12 years after surgery, the inability to achieve an erection was the physical symptom associated with the highest relative risk of a low-to-moderate quality of life [10]. Moreover, about half of the patients reported moderate-to-great distress because of loss of erection.

It is important to recognize that erections are necessary but not sufficient to guarantee satisfactory sexual function. Nelson et al. reported that sexual bother scores increase after RP even in patients with normal erectile [4]. In summary, EF impairment after treatment for prostate cancer leads to significant and long-lasting detrimental psychological effects, and the ability to predict its occurrence might reduce treatment dissatisfaction.

## Defining EF Recovery

Rates of erectile dysfunction (ED) between 3% and 95% after treatment for prostate cancer have been reported. The discrepancies are a result of many factors, which include differences in patient population, timing of EF assessment, method of data acquisition, and definition of ED [11]. Results from institutional series have been particularly discordant with population-based data with single-center series having the highest rate of functional erections after RP. The literature records at least 22 different definitions of favorable EF outcome, and more than one-third of studies do not clearly state the definition used [12].

Measurements of EF at baseline (prior to treatment) might not be accurate given the psychological stress that the diagnosis of prostate cancer is associated with, and as of yet, the optimal timing for such remains to be defined. In the pretreatment period, many patients who report functional erections are found to have ED when validated questionnaires such as the International Index of Erectile Function (IIEF) are used [13].

The definition of ED has been distorted in the post-treatment period. Most studies consider patients that attain erections sufficient for intercourse using phosphodiesterase type-5 inhibitors (PDE-5i) as having recovered EF after surgery, while such patients are considered to have ED based on the National Institutes of Health (NIH) consensus conference definition [14,15]. Because the most commonly used inventories do not specifically distinguish between EF with and without the use of erectile aids, it can be difficult to ascertain if patients' answers pertain to their spontaneous or medication-assisted erections.

Finally, there does not yet exist a consensus as to which score cutoff on the IIEF or sexual health inventory for men (SHIM) (IIEF-5) represents adequate EF recovery. While 26 on the IIEF and 21 on the SHIM have been deemed to define normal EF or at least the absence of ED, others have suggested scores of between 22 and 25 [4,16]. Teloken et al. demonstrated that for men with IIEF scores between 22 and 25, 70% agreed somewhat or completely with the statement that they could have sexual intercourse whenever they wished [17].

## Chronology of EF Recovery

RP can lead to structural changes in the corpora cavernosa. Iacono et al. performed corpus cavernosum biopsies in 19 men at the time of RP and at 2 and 12 months postoperatively [18]. Postoperatively, all patients had an increase in collagen and decreased smooth muscle and elastic fibers. Such findings were already present at 2 months and progressed further at 12 months postoperatively. In an animal model, User et al. demonstrated that unilateral or bilateral neurotomy of the cavernous nerve(s) produces apoptosis in the corpora cavernosa, mostly of smooth muscle cells, starting on the first day after injury [19].

A prospective study measuring EF postoperatively at regular intervals after RP in 482 patients found that 3 months after surgery, 16% of patients had functional erections. Of these, 20% deteriorated between months 3 and 6 [20]. This study suggests that for some patients, the nadir of EF might not be the immediate postoperative period.

While there are data that suggest that the majority of the patients who will recover EF do so in the first year after surgery [21–23], and the median time to recovery seems to be progressively decreasing with refinements in nerve-sparing technique [24], EF improvements can occur beyond 2 years after surgery. A study following 136 men who had not recovered consistent erections sufficient for intercourse 2 years after bilateral nerve-sparing RP found that more than 20% of these men reported an improvement in erection between 2 and 5 years after surgery [25]. Glickman et al. published data on 248 men followed for 48 months after open RP. A moderate or marked improvement in EF between 24 and 48 months after surgery was reported by 19.8% and any improvement by 42.3% of patients [26]. Finally, a meta-analysis found that follow-up time is associated with EF recovery rates, with studies that fol-

**Table 1** Potential predictors of postoperative erectile function recovery

| Preoperative | Intraoperative | Postoperative |
|---|---|---|
| Erectile function | Procedure<br>• Approach<br>• Nerve-sparing status<br>• Nerve-sparing technique<br>o Completeness<br>o Traction<br>o Thermal injury | Penile rehabilitation |
| Patient age | Surgeon | Pathological stage |
| Patient-partner age difference | Surgeon volume/experience | Abnormal erectile hemodynamics |
| Charlson Comorbidity Index | Response to cavernous nerve stimulator | Response to PDE-5i/ICI |
| Vascular risk factors | | |
| PSA | | |

ICI = intracavernosal injection; PDE-5i = phosphodiesterase type-5 inhibitor; PSA = prostate-specific antigen

lowed patients for ≥18 months reporting greater rates of EF recovery [12].

## Predictors of EF Recovery

An overview of factors potentially impacting EF recovery after surgery is presented in Table 1.

### *Treatment Modality*

Prospective series using validated questionnaires have compared the impact of different treatment modalities for prostate cancer on quality of life. Litwin et al. followed 580 men for 24 months after RP, external beam radiation therapy, or brachytherapy [27]. Considering the 187 patients who had functional erections prior to treatment, patients who had external beam radiation were more likely to recover EF, and there was no difference between patients treated with brachytherapy or bilateral nerve sparing RP.

The Prostate Cancer Outcomes and Satisfaction with Treatment Quality Assessment (PROSTQA) was a prospective multicenter study that followed 1,201 patients treated for prostate cancer with RP, external beam radiation, or brachytherapy for 24 months [1]. A decrease in sexual quality of life occurred across all groups and was associated with older age, large prostate size, and high prostate-specific antigen (PSA). Non-nerve-sparing procedures and androgen deprivation were associated with worse recovery of sexual quality of life in those having surgery or radiotherapy, respectively. Distress related to sexual dysfunction was reported by 44%, 22%, and 13% of patients in the RP, external beam, and brachytherapy groups, respectively.

Pardo et al. presented data on 435 patients who underwent RP, external beam radiation, or brachytherapy for prostate cancer and were followed for 36 months [28]. Importantly, patients who received androgen ablation were excluded from this study. RP was associated with the greatest deterioration in sexual function. Three years after treatment, patients submitted to surgery still had lower scores on the sexual domain of the Expanded Prostate Cancer Index Composite (EPIC) questionnaire.

These results need to be interpreted with caution as it is known that sexual function after radiation therapy can continue to decline beyond 3 years after treatment [29]. Moreover, the percentage of patients in the radiotherapy groups receiving androgen deprivation may have been smaller in these series than what it observed in contemporary practice.

### *Surgical Approach*

No randomized study has compared open RP with either the laparoscopic or robotic approaches. Three case series comparing EF outcomes in patients after open or laparoscopic RP found similar outcomes at 3 [30], 12 [31], and 24 [32] months postoperatively. Three prospective nonrandomized studies of consecutive patients have compared open with robotic RP. Ficarra et al. reported results on 208 patients who underwent open or robotic RP. Apart from the fact the patients in the robotic group were younger, both groups had similar characteristics. Twelve months after RP, EF recovery had been achieved by 81% and 49% of patients in the robotic and open arms, respectively [33]. Di Pierro et al. performed a study of 150 consecutive patients after open or robotic RP who had similar baseline characteristics [34]. Considering those with preserved baseline EF, recovery of erections, with or without PDE-5i use, occurred in 55% in the robotic and 26% in the open arm 12 months after surgery. Kim et al. performed a prospective analysis of 763 consecutive patients after open or robotic RP by a single surgeon [35]. Patients submitted to robotic surgery were younger, had lower PSA levels, lower body mass index (BMI), received neoadjuvant therapy less frequently, more frequently underwent nerve sparing surgery, and had lower pathological stage and grade. Patients in the robotic group were more likely to attain erections sufficient for intercourse with or without PDE-5i at 6, 12, and 24 months after surgery, and this difference remained statistically significant even after correction for multiple covariates. Other factors independently associated with recovery of functional erections were younger age and higher preoperative total serum testosterone levels.

Conversely, a case-control study comparing patients matched for baseline characteristics after open or robotic surgery found no difference in EF recovery between the two groups [36]. Two randomized, controlled trials comparing laparoscopic with robotic prostatectomy found that the latter was associated with improved recovery of EF [37,38]. In both studies, all procedures were performed by a single surgeon who had more experience in laparoscopic surgery.

While individual series favor robotic surgery in regard to EF recovery, the absence of a randomized trial undermines the ability to definitely prove differences between open and laparoscopic/robotic procedures in terms of this quality-of-life end point.

### *Nerve-Sparing Status*

There is ongoing debate in regards to the anatomy of the neurovascular bundles and their relationship to the fasciae surrounding the prostate [39]. Moreover, anatomical studies have shown significant variation in the neural anatomy [40,41], and fascial planes are not always well defined [42]. Nonetheless, different approaches to nerve sparing can be characterized by the fascial plane of dissection. An intrafascial dissection consists of separating the prostatic capsule from the prostatic fascia and remaining anterior to the posterior prostatic fascia/seminal vesicle fascia. In interfascial dissection, the neurovascular bundle is separated from the prostate leaving the prostatic fascia and the posterior prostatic fascia/seminal vesicle fascia on the prostate. Lastly, an extrafascial dissection entails removing the levator ani fascia, prostatic fascia, and posterior prostatic fascia/seminal vesicle fascia with the prostate, excising the neurovascular bundles [39].

Current guidelines from the European Association of Urology recommend that nerve-sparing technique should be used for men with both preserved preoperative EF and organ-confined disease [43]. Stember et al. analyzed a total of 2,323 men who underwent RP for factors predicting nerve resection (Stember et al. [44]). On multivariable analysis, factors independently predicting for non-nerve-sparing surgery included biopsy Gleason sum, clinical T stage ≥ T2, patient age, and percentage of biopsy cores positive and most importantly baseline EF, with men with baseline ED being five times more likely to undergo nerve resection during RP.

Numerous studies have shown that EF recovery rates improved significantly after the introduction and refinements to nerve-sparing technique [45]. It has also been demonstrated that bilateral nerve-sparing surgery is associated with better outcomes than unilateral preservation. Ayyathurai et al. reported on 797 men submitted to nerve-sparing RP [46]. After a mean follow-up of 45.7 months, erections sufficient for intercourse were being attained by 72% submitted to bilateral and 53% of those submitted to unilateral nerve sparing. Bilateral nerve sparing was independently associated with EF even after adjustment for age and surgeon experience.

Kundu et al. published results from a series of 1,834 preoperatively potent patients submitted to nerve-sparing RP by a single surgeon [47]. EF was assessed by patient response to a nonvalidated questionnaire. After at least 18 months of follow-up, return of erection occurred in 75% of patients submitted to bilateral nerve sparing and 53% of those submitted to unilateral/partial nerve-sparing surgery. Younger age, bilateral nerve sparing, and surgery after 1992 were the only factors independently associated with return of EF on multivariable analysis.

Poorer results seen with non-nerve-sparing RP might be due to the development of venous leak. Tal et al. reported data on 142 patients who developed ED after RP and underwent penile hemodynamic evaluation [48]. Only patients who had been submitted to non-nerve-sparing surgery developed venous leak within 3 months of surgery. Six months after surgery, the prevalence of venous leak in bilateral nerve sparing, unilateral nerve sparing, and non-nerve-sparing patients was 7%, 11%, and 75%, respectively.

Recognizing that nerve sparing is not an all-or-none phenomenon and that it is incremental, grading systems for the amount of neurovascular bundle preserved have been developed. Intraoperative estimation of the completeness of neurovascular bundle preservation independently predicts recovery of erections.

Levinson et al. used a subjective intraoperative grading system from 0 (no preservation) to 5 (excellent preservation) on each side, created a nerve-sparing score by summing both figures [49]. Using data from 313 men with SHIM scores >21 preoperatively who were submitted to laparoscopic RP, the authors showed that the nerve-sparing score was independently associated with sexual function scores on the EPIC questionnaires even after adjustment for age, time since surgery, and preoperative SHIM score. Importantly, the nerve-sparing score explained more of the variation in sexual function postoperatively than the simple classification of bilateral, unilateral, or non-nerve-sparing surgery.

Moskovic et al. used a cumulative neurovascular bundle damage grading system where each side was graded from 1 (complete preservation) to 4 (complete resection) [50]. Grades were summed, devising a nerve damage score between 2 and 8. Using data from 173 men, these authors showed that at 24 months, those higher nerve damage scores had greater reduction in the IIEF-EF domain. Recovery of EF was independently associated with lower nerve damage score, younger age, and higher preoperative IIEF-EF score.

### Patient Age

Age strongly impacts the recovery of EF after RP, being independently associated with erectile outcome in virtually every study. Using data from the Prostate Cancer Outcomes Study, Penson et al. reported that after 5 years after bilateral nerve-sparing RP, 61% of patients <55 years of age and 18% of those >65 years of age had functional erections [51]. A systematic review found that after open RP, potency rates for men below 50 and over 70 years of age range between 61% and 100%, and 0% and 51%, respectively [52]. The importance of age has been demonstrated in open [46], laparoscopic [53], and robotic surgery [54].

A study of 189 sexually active patients who underwent RP found that not only patient age but also partner age was predictive of erectile outcome [55]. Younger patients and those with a greater age difference between patient and partner were significantly more likely to recover functional erections, and the effect of age difference was independent from patient age.

### Preoperative EF

Along with age, preoperative EF has been identified as one of the main predictors of postoperative EF in numerous studies [21,56,57]. The optimal method to assess preoperative (also called *baseline*) EF is yet to be defined. Subjective patient self-report, partner-corroborated reports, single assessment questions, and validated instruments have been used; however, no consensus exists [58]. Of note, a previously literature review found that one-third of studies did not report preoperative EF assessment [11].

The importance of using validated questionnaire in the assessment of preoperative EF was emphasized by Salonia et al., who observed that out of 234 patients who had self-reported as fully potent and highly motivated to maintain EF after RP, 56% had abnormal IIEF-EF scores [13]. The same authors showed that it is important to prospectively acquire EF data, having shown in a study of 333 patients undergoing RP that remembered IIEF scores do not have good statistical agreement with scores obtained in “real time” [59].

Timing of preoperative EF assessment in regards to the diagnosis of cancer and treatment planning also seems to be important. The diagnosis of prostate can potentially masquerade one’s true EF. Some patients might overestimate their true functional status, while in others, the anxiety brought on by the diagnosis could impair sexual function [58].

The assessment of EF can be compromised because of the prostate cancer diagnosis even when validated questionnaires are used. Salonia et al. previously noted that the IIEF-EF might not be adequate in the preoperative setting [13], as patients not reporting sexual activity in the previous 4 weeks would be classified as having severe ED, when in fact they could have completely normal EF and not have engaged in intercourse because of psychological reasons. Kim et al. recently showed that mean SHIM scores before prostate biopsy were significantly lower than those on the day preceding surgery [60].

### Comorbid Conditions

Karakiewicz et al. reported on 2,415 men who had an RP in Canada between 1988 and 1996, and found that diabetes mellitus and peripheral vascular disease were associated with worse sexual outcomes [61]. Conversely, a Dutch population-based study failed to identify a difference in sexual outcomes in patients with or without diabetes mellitus [62]. An analysis of data from the Cancer of the

Prostate Strategic Urologic Research Endeavor (CaPSURE) registry showed that severe cardiovascular disease is independently associated with slower recovery of sexual function after RP or radiotherapy within the first 24 months after treatment [63]. In a secondary analysis of patients followed for 48 months, cardiovascular disease was strongly associated with worse sexual function outcomes after correction for baseline EF [64].

Marien et al. reported data on 634 men with preserved EF at baseline who underwent open RP and were followed for 24 months [65]. Self-reported ability to engage in sexual intercourse without the use of erectile aids was used to define EF recovery. Upon univariate analysis, age, coronary artery disease, hypertension, diabetes, baseline EF, frequency of intercourse, nerve-sparing surgery, and prior use of PDE-5i were predictive of recovery of functional erections, while dyslipidemia, smoking history, and BMI were not. On multivariate analysis, only diabetes, age, and neurovascular bundle preservation remained associated with the outcome.

We previously performed an analysis of 984 patients after RP who had preoperative data on vascular risk factors and EF, were followed for at least 24 months, and did not participate in penile rehabilitation [66]. EF at 24 months, measured by a physician assessment on a 5-point scale, was independently associated with age, baseline EF, visual nerve-sparing score, and the number of vascular risk factors.

Most authors have found that the recovery of EF after RP is not different across BMI groups. Two studies used the University of California, Los Angeles, Prostate Cancer Index to evaluate the impact of BMI on health-related quality of life after open RP [67,68]. Both reported that impact of surgery on sexual function and bother was the same for normal weight, overweight, and obese patients. Montgomery et al. reported on 376 patients undergoing open RP who completed the EPIC questionnaire before and after surgery [69]. Postoperative sexual function and bother were similar across all BMI groups. Similarly, Boorjian et al. found that BMI had no impact on the return of functional erections on 400 consecutive patients after robotic RP [70]. Uffort and Jensen reported data on 123 patients after robotic RP who answered the IIEF at baseline and every 3 months for 1 year after surgery. Functional erections were defined as an IIEF-EF domain score $\geq 16$. At 12 months, 27% of patients had recovered functional erections, and there was no difference in scores between patients with BMI $<30$ or $>30$ [71]. Unfortunately, an EF domain of $\geq 16$ is extremely low and does not represent functional erections. In contrast, upon analyzing 765 patients with normal EF preoperatively who had laparoscopic RP, Campeggi et al. found that those with BMI $>30$ were less likely to report erections sufficient for intercourse 1 year after surgery [72]. Of note, no adjustment for possible confounding factors such as age, nerve sparing, and preoperative EF were done.

Ko et al. looked for predictors of EF on 89 men submitted to robotic RP. Within the first year after surgery 62.9% of patients reported erections sufficient for satisfactory sexual intercourse [73]. These authors found that hyperlipidemia was independently associated with erectile outcome even after adjustment for nerve-sparing status and preoperative IIEF-5 score.

One of the great challenges with comorbidity assessment is the failure to grade the severity of the comorbidity. For example, diabetes and hypertension are not homogenous condition with different levels of glycemic control and end-organ failure in the former and different levels of endothelial dysfunction and medication requirement for the latter. Medicine is in dire need of a weighted grading system to define not just the presence but also the severity of comorbidities and their impact upon outcomes such as EF.

### *Surgeon*

The surgeon seems to play an important role in EF recovery. Vickers et al. compared the functional outcomes 1 year after surgery across 11 surgeons in a large-volume cancer center [74]. A total of 1,910 patients with preserved preoperative EF were included in the analysis, and the surgeon assessed EF using a single 5-point scale, which has been shown to compare well with the IIEF-EF domain score [75]. Significant heterogeneity was found between surgeons, with rates of EF recovery ranging from 8% to 49%. Surgeon caseload was also associated with recovery of erections. Interestingly, surgeons achieving better functional outcomes also had higher rates of freedom from biochemical recurrence. While the use of surgeon-reported outcomes created the concern that the results might have been skewed by each surgeon's assessment, similar results were obtained using newer data, where patient-reported outcomes were available.

Ayyathurai et al. presented data on 1,620 patients after open RP who had preserved baseline EF [46]. On multivariable analysis age, bilateral nerve sparing and surgeon experience were associated with the ability to attain erections sufficient for intercourse with or without PDE-5i. In robotic surgery, it has been suggested that until 250–300 cases have been performed, greater experience is associated with earlier erectile recovery [76].

### *Postoperative Hemodynamics*

Hemodynamic studies early after RP are predictive of functional outcomes. Mulhall et al. reported on 96 preoperatively potent patients who underwent bilateral nerve sparing and had hemodynamic evaluation at a mean of 6 months after surgery. Subjects were evaluated with duplex penile Doppler ultrasonography or dynamic infusion cavernosometry and cavernosography. At a mean follow-up of 18 months, erections sufficient for vaginal intercourse were possible in 47% of patients with normal hemodynamics, 31% with arterial insufficiency, and 9% of those with venous leak [77]. A further study following 111 patients who had a duplex penile Doppler ultrasonography within 6 months after surgery found that 18 months after the procedure, response to sildenafil citrate was 72% in those with normal hemodynamics and 43% in those with an abnormal penile Doppler [78].

The prevalence of accessory pudendal arteries, defined as supralevator arteries that pass alongside the prostate and travel toward the penis underneath the pubic bone, has varied from 4% in open RP series to 70% in cadaveric studies [79]. Laparoscopic series suggest that they are present in 25–30% of patients [80–82]. The impact of accessory pudendal artery preservation on EF is contentious. In a series of 52 undergoing open bilateral nerve-sparing RP, preservation of accessory pudendal arteries was associated with an increased likelihood of and shorter time to recovery of EF [83]. In contrast, a case series of 58 patients <65 years of age with normal preoperative IIEF scores found that ligation of accessory pudendal artery had no impact on EF [84].

### *Post-Treatment Rehabilitation*

Most studies looking at predictors of EF recovery after treatment for prostate cancer have not taken into account whether patients were participating in a penile rehabilitation program. Müller et al. performed an analysis of patients who had commenced penile rehabilitation within 12 months of surgery and had at least 18 months of follow-up after surgery looking for factors associated with EF outcomes [85]. Age >60 years, nonbilateral nerve-sparing surgery, >1 vascular comorbidity, commencement of rehabilitation >6 months after surgery, no response to sildenafil at 12 months, and requiring >50 units of trimix were independently predictive of failure to recover spontaneous erections.

Two randomized, placebo-controlled trials have assessed the role of PDE-5i in post-RP penile rehabilitation. A multicenter study randomized 123 men with normal EF who underwent bilateral nerve-sparing RP to sildenafil or placebo nightly, starting 4 weeks after surgery, for 36 weeks [86]. The primary outcome was return of spontaneous erections, defined as a combined score of ≥8 for questions 3 and 4 of the IIEF and a positive response to "Were erections good enough for satisfactory sexual activity?" Assessment occurred after an 8-week washout period. Of note, only 76/123 randomized patients completed the study and were included in the analysis. Return of spontaneous erections similar in rigidity to preoperative level was achieved by 27% of patients in the sildenafil group and 4% in the placebo group. The mean (±standard deviation) unassisted postoperative IIEF scores were 13.1 (±9.5) and 8.8 (±7.0) in the sildenafil and placebo groups, respectively.

The second study randomized 628 patients with normal EF undergoing nerve-sparing RP to nightly vardenafil, on-demand vardenafil, or placebo, starting within 14 days of surgery, for 9 months [87]. The primary outcome was the percentage of patients with and IIEF-EF ≥22 measured after a 2-month washout period. Of 628 randomized patients, 423 completed the study. No differences in the primary outcome was found with IIEF-EF ≥22 being achieved by 24%, 29%, and 29% of patients in the nightly vardenafil, on-demand vardenafil, and placebo groups, respectively, 11 months after surgery. The study designs of both of these randomized controlled trials (RCTs) were quite different, and thus, the results are not comparable. Unfortunately, we still do not have the definitive rehabilitation trial to define the role of post-RP rehabilitation in EF recovery.

### *Other Factors*

Hollenbeck et al. published results of an analysis of 671 patients who underwent open RP [88]. Novel factors independently associated with higher EPIC sexual summary scores included smaller prostate size, higher education level, and higher household income. While most studies have concentrated on EF treatment for prostate cancer, Steinsvik et al. concentrated on sexual bother after

RP using data from 453 men who had completed the EPIC before and 1 year after surgery [3]. Sexual bother was present in 18% at baseline and 66% 1 year after surgery. The factors that independently predicted postoperative sexual bother were preoperative sexual bother, frequency of sexual activity in the month preceding surgery, and nervousness (neuroticism).

Because larger prostate gland can be more challenging to excise, it has been hypothesized that prostate weight might influence EF outcomes. Conflicting results have been reported. Separate studies evaluating patients submitted to open [46,89], laparoscopic [90], and robotic [91] found no independent association between prostate weight and postoperative EF. Frota et al. reported that patients with prostate weight ≤ 30 g submitted to laparoscopic RP had worse EF 1 year after surgery [92]. Conversely, Ahlering et al. reported that patients with larger prostates submitted to robotic RP have worse EF 3 months after surgery and speculated that such phenomenon is related to traction injury [93].

The effect of tumor staging and PSA on EF recovery is contentious. Tumor staging might impact decisions regarding the performance and choice plane of dissection for nerve sparing. Most studies have found no independent association between tumor stage or PSA, and EF outcome once adjustment for nerve-sparing status is made [21,47]. However, Abdollah et al. found an independent association between pathological stage and PSA, and recovery of EF, with patients who had pT3 disease or PSA >10 having worse outcomes [94]. However, all patients underwent nerve-sparing surgery, unilateral or bilateral nerve sparing, and unfortunately, no grading of nerve-sparing completeness was used in this study. It is possible that in patients with less advanced disease, a plane of dissection closer to the prostatic capsule was used, resulting in improved neurovascular bundler preservation and outcomes.

Intraoperative cavernous nerve stimulation has been suggested as a method to predictive EF recovery. Rabbani et al. analyzed 183 patients and found that increases in penile girth with cavernous nerve stimulation at the end of RP independently predicted EF recovery [95]. However, 35% of patients with minimal response to cavernous nerve stimulation still achieved IIEF-EF domain scores ≥22, signaling the high *false-negative* rate associated with this method.

## Prediction Models

An overview of the prediction models evaluating factors associated with postoperative EF recovery is presented in Table 2. Müller et al. published

**Table 2** Prediction models

| Author | Patient population | Included variables | Outcome | Accuracy |
|---|---|---|---|---|
| Müller et al. [85] | N = 92<br>RP<br>Functional erections preoperatively<br>Commenced rehabilitation within 1 year | Age<br>Vascular comorbidities<br>Nerve-sparing surgery<br>Rehabilitation commencement<br>Response to sildenafil at 12 months<br>Required Trimix dose | Partner-corroborated functional erections without PDE-5 inhibitors | Not reported |
| Briganti et al. [96] | N = 435<br>Open bilateral nerve-sparing RP | Age<br>Preoperative IIEF-EFD<br>Charlson Index | IIEF-EFD ≥22<br>3 years after RP | AUC 69% |
| Alemozaffar et al. [97] | N = 511<br>RP | Age<br>Preoperative EPIC score<br>PSA<br>Nerve sparing | Patient reported erection “firm enough for intercourse” during last 4 weeks (EPIC-26) 2 years after surgery | AUC 77% |
| Abdollah et al. [94] | N = 1,135<br>Open or robotic RP<br>Unilateral or bilateral nerve sparing | Age<br>Preoperative IIEF<br>Charlson Index<br>Pathological stage<br>Surgical approach<br>Nerve sparing<br>Postoperative use of PDE-5 inhibitor | IIEF-EFD score ≥ 22<br>6, 12 and 24 months after surgery | Harrell’s C discrimination index of 76% |
| Kilminster et al. [98] | N = 12,449 from 33 studies<br>“Potent” preoperatively<br>RP | Age<br>Surgical approach | Patient-reported erections sufficient for intercourse or validated questionnaire<br>Up to 48 months | $r^2$<br>Open = 0.812<br>Lap = 0.777<br>RALP = 0.855 |

AUC = area under the curve; EFD = Erectile function Domain; EPIC = Expanded Prostate Cancer Index Composite; IIEF = International Index of Erectile Function; PDE-5 = phosphodiesterase type-5; PSA = prostate-specific antigen; RALP = robotic-assisted laparoscopic radical prostatectomy; RP = radical prostatectomy data on 92 patients submitted to RP who had erections sufficient for intercourse before surgery and within 12 months of surgery were commenced on a penile rehabilitation aiming at obtaining at least three erections rigid enough for vaginal penetration per week [85]. Fifty-seven percent of patients had erections sufficient for intercourse without PDE-5i 18 months after surgery. Factors independently associated with failure of return of spontaneous erections were age >60, nonbilateral nerve-sparing surgery, >1 vascular comorbidity, commencement of rehabilitation >6 months after surgery, no response to sildenafil 12 months after surgery, and requiring >50 units of trimix to achieve penetration rigidity erection.

Briganti et al. developed a risk stratification model to predict EF recovery after bilateral nerve-sparing RP using data from 435 patients [96]. Age, baseline IIEF-EF domain, and the Charlson Comorbidity Index (CCI) were associated with EF recovery, which was defined as IIEF-EFD score ≥22. These factors were used to stratify patients as low risk (age ≤65 years, IIEF-EF ≥26, CCI ≤1), intermediate risk (age 66–69 years or IIEF-EF 11–25, CCI ≤1), or high risk (age ≥70 years or IIEF-EF ≤10, CCI ≥2) for the development of postoperative ED. The AUC for this stratification was 69.1%.

Novara et al. reported data on 208 patients submitted to bilateral nerve-sparing robotic RP [99]. One year after surgery, 62% of patients had IIEF-EFD scores ≥18, the chosen definition for EF recovery. Stratifying patients according to Briganti's risk model, recovery was achieved by 81.9%, 56.7%, and 28.6% of patients in low-, intermediate-, and high-risk groups, respectively. On multivariable analysis age, CCI score and baseline IIEF-EFD scores were independent predictors of EF recovery.

To investigate predictors of recovery spontaneous erections, Gallina et al. evaluated 293 patients submitted to open bilateral nerve-sparing RP who did not use PDE-5i postoperatively [100]. At a mean follow-up of 26 months, 35.8% of patients had IIEF-EFD scores ≥22, and such outcome was independently associated with age, preoperative IIEF-EFD, and CCI score.

Using data from the PROSTQA, a cohort of men treated for prostate cancer across nine university-affiliated hospitals, Alemozaffar et al. created a model to predict functional erections, defined as having usually attained erections firm enough for intercourse in the preceding 4 weeks [97]. At 2 years after surgery, 35% of 511 patients had functional erections, and factors independently associated with such an outcome were younger age, lower PSA, better baseline EF (assessed by EPIC score), and nerve-sparing surgery. Using these four variables, a prediction model was created and externally validated using data from the CaPSURE registry, achieving an AUC of 0.77.

Using data from 1,135 men who underwent nerve-sparing RP over a 10-year period, Abdollah et al. developed a nomogram to predict recovery of EF after surgery, defined as an IIEF-EFD score ≥22, with or without PDE-5i use [94]. Factors independently associated with an increased chance of erectile recovery were Briganti EF risk group (based on age, preoperative IIEF, and CCI), pathological stage, robotic surgery, bilateral nerve sparing, and use of PDE-5i in the postoperative period. A nomogram predicting the probability of erections at 6, 12, and 24 months was constructed, and it achieved a Harrell's C discrimination index of 76%.

Kilminster et al. performed a meta-analysis of 33 studies reporting data on 12,449 patients after RP who had preserved EF preoperatively and created nomograms predicting the likelihood of EF recovery using age and surgical approach (open, laparoscopic, or robotic) [98]. Nerve-sparing status was excluded from the model because it accounted for less than 1% of the variance. The definition of EF was not uniform; some studies used patient-reported erections sufficient for intercourse, while others employed validated questionnaires. Younger age and robotic approach were associated with better outcomes. Separate models for open, laparoscopic, and robotic surgery were constructed and using age as the only variable coefficients of determination ($r^2$) of 0.812, 0.777, and 0.855 were found, respectively.

### Summary

Post-treatment EF is one of the main determinants of outcome satisfaction in patients with prostate cancer. Providing realistic expectations in regards to the impact that the treatment of prostate cancer will have on EF, and the chances of recovery is fundamental so that patients can make informed decisions. While many factors that impact post-treatment erectile have been described, it is difficult to provide accurate information to individual patients. While prediction models have been developed at high-volume institutions, the applicability of these to patients being treated elsewhere is yet to be determined. It is probably necessary that each clinician validates models in their own practice, as outcomes obtained by different surgeons vary. Moreover, differences in the utilization of rehabilitation protocols might impact results.

The three factors that have consistently been shown to impact the chances of EF recovery are age, pretreatment EF, and nerve-sparing surgery. While not as consolidated, there is increasing evidence showing that comorbidities also play a role. Also, the completeness of neurovascular bundle preservation subjectively assessed by the surgeon seems to improve the predictive of models.

Similarly to what occurs in the prediction of cancer-free survival, prediction models can be used at different stages of a patient's journey. Before treatment, an estimate of the chances of EF recovery can be provided. Such figure can be revised as more information becomes available. For example, immediately after surgery, data on the completeness of nerve sparing can be added.

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## References

1 Sanda MG, Dunn RL, Michalski J, Sandler HM, Northouse L, Hembroff L, Lin X, Greenfield TK, Litwin MS, Saigal CS, Mahadevan A, Klein E, Kibel A, Pisters LL, Kuban D, Kaplan I, Wood D, Ciezki J, Shah N, Wei JT. Quality of life and satisfaction with outcome among prostate-cancer survivors. N Engl J Med 2008;358:1250–61.

2 Nelson CJ, Choi JM, Mulhall JP, Roth AJ. Determinants of sexual satisfaction in men with prostate cancer. J Sex Med 2007;4:1422–7.

3 Steinsvik EAS, Axcrona K, Dahl AA, Eri LM, Stensvold A, Fosså SD. Can sexual bother after radical prostatectomy be predicted preoperatively? Findings from a prospective national study of the relation between sexual function, activity and bother. BJU Int 2012;109:1366–74.

4 Nelson CJ, Deveci S, Stasi J, Scardino PT, Mulhall JP. Sexual bother following radical prostatectomyjsm. J Sex Med 2010;7(1 Pt 1):129–35.

5 Diefenbach MA, Mohamed NE. Regret of treatment decision and its association with disease-specific quality of life following prostate cancer treatment. Cancer Invest 2007;25:449–57.

6 Hu JC, Kwan L, Saigal CS, Litwin MS. Regret in men treated for localized prostate cancer. J Urol 2003;169:2279–83.

7 Schroeck FR, Krupski TL, Sun L, Albala DM, Price MM, Polascik TJ, Robertson CN, Tewari AK, Moul JW. Satisfaction and regret after open retropubic or robot-assisted laparoscopic radical prostatectomy. Eur Urol 2008;54:785–93.

8 Roberts KJ, Lepore SJ, Hanlon AL, Helgeson V. Genitourinary functioning and depressive symptoms over time in younger versus older men treated for prostate cancer. Ann Behav Med 2010;40:275–83.

9 Nelson CJ, Mulhall JP, Roth AJ. The association between erectile dysfunction and depressive symptoms in men treated for prostate cancer. J Sex Med 2011;8:560–6.

10 Johansson E, Steineck G, Holmberg L, Johansson J-E, Nyberg T, Ruutu M, Bill-Axelson A. Long-term quality-of-life outcomes after radical prostatectomy or watchful waiting: The Scandinavian Prostate Cancer Group-4 randomised trial. Lancet Oncol 2011;12:891–9.

11 Mulhall JP. Defining and reporting erectile function outcomes after radical prostatectomy: Challenges and misconceptions. J Urol 2009;181:462–71.

12 Tal R, Alphs HH, Krebs P, Nelson CJ, Mulhall JP. Erectile function recovery rate after radical prostatectomy: A meta-analysis. J Sex Med 2009;6:2538–46.

13 Salonia A, Zanni G, Gallina A, Saccà A, Sangalli M, Naspro R, Briganti A, Farina E, Roscigno M, Dapozzo LF, Rigatti P, Montorsi F. Baseline potency in candidates for bilateral nerve-sparing radical retropubic prostatectomy. Eur Urol 2006;50:360–5.

14 NIH Consensus Development Panel on Impotence. NIH Consensus Conference. Impotence. JAMA 1993;270:83–90.

15 Salonia A, Burnett AL, Graefen M, Hatzimouratidis K, Montorsi F, Mulhall JP, Stief C. Prevention and management of postprostatectomy sexual dysfunctions part 2: Recovery and preservation of erectile function, sexual desire, and orgasmic function. Eur Urol 2012;62:273–86.

16 Briganti A, Gallina A, Suardi N, Capitanio U, Tutolo M, Bianchi M, Salonia A, Colombo R, Di Girolamo V, Martinez-Salamanca JI, Guazzoni G, Rigatti P, Montorsi F. What is the definition of a satisfactory erectile function after bilateral nerve sparing radical prostatectomy? J Sex Med 2011;8:1210–7.

17 Teloken P, Valenzuela R, Parker M, Mulhall J. The correlation between erectile function and patient satisfaction. J Sex Med 2007;4:472–6.

18 Iacono F, Giannella R, Somma P, Manno G, Fusco F, Mirone V. Histological alterations in cavernous tissue after radical prostatectomy. J Urol 2005;173:1673–6.

19 User HM, Hairston JH, Zelner DJ, McKenna KE, McVary KT. Penile weight and cell subtype specific changes in a post-radical prostatectomy model of erectile dysfunction. J Urol 2003;169:1175–9.

20 Katz D, Bennett NE, Stasi J, Eastham JA, Guillonneau BD, Scardino PT, Mulhall JP. Chronology of erectile function in patients with early functional erections following radical prostatectomy. J Sex Med 2010;7(2 Pt 1):803–9.
21 Rabbani F, Stapleton AM, Kattan MW, Wheeler TM, Scardino PT. Factors predicting recovery of erections after radical prostatectomy. J Urol 2000;164:1929–34.
22 Geary ES, Dendinger TE, Freiha FS, Stamey TA. Nerve sparing radical prostatectomy: A different view. J Urol 1995;154:145–9.
23 Quinlan DM, Epstein JI, Carter BS, Walsh PC. Sexual function following radical prostatectomy: Influence of preservation of neurovascular bundles. J Urol 1991;145:998–1002.
24 Masterson TA, Serio AM, Mulhall JP, Vickers AJ, Eastham JA. Modified technique for neurovascular bundle preservation during radical prostatectomy: Association between technique and recovery of erectile function. BJU Int 2008;101: 1217–22.
25 Rabbani F, Schiff J, Piecuch M, Yunis LH, Eastham JA, Scardino PT, Mulhall JP. Time course of recovery of erectile function after radical retropubic prostatectomy: Does anyone recover after 2 years? J Sex Med 2010;7:3984–90.
26 Glickman L, Godoy G, Lepor H. Changes in continence and erectile function between 2 and 4 years after radical prostatectomy. J Urol 2009;181:731–5.
27 Litwin MS, Gore JL, Kwan L, Brandeis JM, Lee SP, Withers HR, Reiter RE. Quality of life after surgery, external beam irradiation, or brachytherapy for early-stage prostate cancer. Cancer 2007;109:2239–47.
28 Pardo Y, Guedea F, Aguiló F, Fernández P, Macías V, Mariño A, Hervás A, Herruzo I, Ortiz MJ, Ponce de León J, Craven-Bratle J, Suárez JF, Boladeras A, Pont À, Ayala A, Sancho G, Martínez E, Alonso J, Ferrer M. Quality-of-life impact of primary treatments for localized prostate cancer in patients without hormonal treatment. J Clin Oncol 2010;28:4687–96.
29 Zelefsky MJ, McKee AB, Lee H, Leibel SA. Efficacy of oral sildenafil in patients with erectile dysfunction after radiotherapy for carcinoma of the prostate. Urology 1999;53: 775–8.
30 Roumeguere T, Bollens R, Vanden Bossche M, Rochet D, Bialek D, Hoffman P, Quackels T, Damoun A, Wespes E, Schulman CC, Zlotta AR. Radical prostatectomy: A prospective comparison of oncological and functional results between open and laparoscopic approaches. World J Urol 2003; 20:360–6.
31 Anastasiadis AG, Salomon L, Katz R, Hoznek A, Chopin D, Abbou C-C. Radical retropubic versus laparoscopic prostatectomy: A prospective comparison of functional outcome. Urology 2003;62:292–7.
32 Touijer K, Eastham JA, Secin FP, Romero Otero J, Serio A, Stasi J, Sanchez-Salas R, Vickers A, Reuter VE, Scardino PT, Guillonneau B. Comprehensive prospective comparative analysis of outcomes between open and laparoscopic radical prostatectomy conducted in 2003 to 2005. J Urol 2008;179: 1811–7; discussion 1817.
33 Ficarra V, Novara G, Fracalanza S, D'Elia C, Secco S, Iafrate M, Cavalleri S, Artibani W. A prospective, non-randomized trial comparing robot-assisted laparoscopic and retropubic radical prostatectomy in one European institution. BJU Int 2009;104:534–9.
34 Di Pierro GB, Baumeister P, Stucki P, Beatrice J, Danuser H, Mattei A. A prospective trial comparing consecutive series of open retropubic and robot-assisted laparoscopic radical prostatectomy in a centre with a limited caseload. Eur Urol 2011;59:1–6.
35 Kim SC, Song C, Kim W, Kang T, Park J, Jeong IG, Lee S, Cho YM, Ahn H. Factors determining functional outcomes after radical prostatectomy: Robot-assisted versus retropubic. Eur Urol 2011;60:413–9.
36 Krambeck AE, DiMarco DS, Rangel LJ, Bergstralh EJ, Myers RP, Blute ML, Gettman MT. Radical prostatectomy for prostatic adenocarcinoma: A matched comparison of open retropubic and robot-assisted techniques. BJU Int 2009;103:448–53.
37 Asimakopoulos AD, Pereira Fraga CT, Annino F, Pasqualetti P, Calado AA, Mugnier C. Randomized comparison between laparoscopic and robot-assisted nerve-sparing radical prostatectomy. J Sex Med 2011;8:1503–12.
38 Porpiglia F, Morra I, Lucci Chiarissi M, Manfredi M, Mele F, Grande S, Ragni F, Poggio M, Fiori C. Randomised controlled trial comparing laparoscopic and robot-assisted radical prostatectomy. Eur Urol 2013;63:606–14.
39 Walz J, Burnett AL, Costello AJ, Eastham JA, Graefen M, Guillonneau B, Menon M, Montorsi F, Myers RP, Rocco B, Villers A. A critical analysis of the current knowledge of surgical anatomy related to optimization of cancer control and preservation of continence and erection in candidates for radical prostatectomy. Eur Urol 2010;57:179–92.
40 Takenaka A, Tewari AK. Anatomical basis for carrying out a state-of-the-art radical prostatectomy. Int J Urol 2012;19:7–19.
41 Lunacek A, Schwentner C, Fritsch H, Bartsch G, Strasser H. Anatomical radical retropubic prostatectomy: "Curtain dissection" of the neurovascular bundle. BJU Int 2005;95:1226–31.
42 Costello AJ, Brooks M, Cole OJ. Anatomical studies of the neurovascular bundle and cavernosal nerves. BJU Int 2004;94:1071–6.
43 Heidenreich A, Bellmunt J, Bolla M, Joniau S, Mason M, Matveev V, Mottet N, Schmid H-P, van der Kwast T, Wiegel T, Zattoni F. EAU guidelines on prostate cancer. Part 1: Screening, diagnosis, and treatment of clinically localised disease. Eur Urol 2011;59:61–71.
44 Stember DS, Nelson CJ, Mulhall JP. Preoperative erectile function is an independent predictor for decision to spare cavernous nerves during radical prostatectomy. J Sex Med 2013 May 16. doi:10.1111/jsm.12195. [Epub ahead of print] PMID: 23679104
45 Carter S, Le JD, Hu JC. Anatomic and technical considerations for optimizing recovery of sexual function during robotic-assisted radical prostatectomy. Curr Opin Urol 2013;23:88–94.
46 Ayyathurai R, Manoharan M, Nieder AM, Kava B, Soloway MS. Factors affecting erectile function after radical retropubic prostatectomy: Results from 1,620 consecutive patients. BJU Int 2008;101:833–6.
47 Kundu SD, Roehl KA, Eggener SE, Antenor JA V, Han M, Catalona WJ. Potency, continence and complications in 3,477 consecutive radical retropubic prostatectomies. J Urol 2004;172(6 Pt 1):2227–31.
48 Tal R, Valenzuela R, Aviv N, Parker M, Waters WB, Flanigan RC, Mulhall JP. Persistent erectile dysfunction following radical prostatectomy: The association between nerve-sparing status and the prevalence and chronology of venous leak. J Sex Med 2009;6:2813–9.
49 Levinson AW, Pavlovich CP, Ward NT, Link RE, Mettee LZ, Su L-M. Association of surgeon subjective characterization of nerve sparing quality with potency following laparoscopic radical prostatectomy. J Urol 2008;179:1510–4.
50 Moskovic DJ, Alphs H, Nelson CJ, Rabbani F, Eastham J, Touijer K, et al. Subjective characterization of nerve sparing predicts recovery of erectile function after radical prostatectomy: Defining the utility of a nerve sparing grading system. J Sex Med 2011;8:255–60.

51 Penson DF, McLerran D, Feng Z, Li L, Albertsen PC, Gilliland FD, Hamilton A, Hoffman RM, Stephenson RA, Potosky AL, Stanford JL. 5-year urinary and sexual outcomes after radical prostatectomy: Results from the Prostate Cancer Outcomes Study. J Urol 2005;173:1701–5.
52 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.
53 Stolzenburg J-U, Kallidonis P, Minh D, Dietel A, Häfner T, Dimitriou D, Al-Aown A, Kyriazis I, Liatsikos EN. Endoscopic extraperitoneal radical prostatectomy: Evolution of the technique and experience with 2,400 cases. J Endourol 2009;23:1467–72.
54 Ko YH, Coelho RF, Sivaraman A, Schatloff O, Chauhan S, Abdul-Muhsin HM, Carrion RJV, Palmer KJ, Cheon J, Patel VR. Retrograde versus antegrade nerve sparing during robot-assisted radical prostatectomy: Which is better for achieving early functional recovery? Eur Urol 2013;63:169–77.
55 Descazeaud A, Debré B, Flam TA. Age difference between patient and partner is a predictive factor of potency rate following radical prostatectomy. J Urol 2006;176(6 Pt 1):2594–8; discussion 2598.
56 Stanford JL, Feng Z, Hamilton AS, Gilliland FD, Stephenson RA, Eley JW, Albertsen PC, Harlan LC, Potosky AL. Urinary and sexual function after radical prostatectomy for clinically localized prostate cancer: The Prostate Cancer Outcomes Study. JAMA 2000;283:354–60.
57 Talcott JA, Manola J, Clark JA, Kaplan I, Beard CJ, Mitchell SP, Chen RC, O'Leary MP, Kantoff PW, D'Amico AV. Time course and predictors of symptoms after primary prostate cancer therapy. J Clin Oncol 2003;21:3979–86.
58 Salonia A, Burnett AL, Graefen M, Hatzimouratidis K, Montorsi F, Mulhall JP, Stief C. Prevention and management of postprostatectomy sexual dysfunctions. Part 1: Choosing the right patient at the right time for the right surgery. Eur Urol 2012;62:261–72.
59 Salonia A, Gallina A, Briganti A, Zanni G, Saccà A, Dehò F, Karakiewicz P, Guazzoni G, Rigatti P, Montorsi F. Remembered International Index of Erectile Function domain scores are not accurate in assessing preoperative potency in candidates for bilateral nerve-sparing radical retropubic prostatectomy. J Sex Med 2008;5:677–83.
60 Kim DS, Chung YG, Kim DJ, Park KK, Chung MS, Lee DH, Lee SH, Mah SY, Chung BH. Optimal timing to evaluate prediagnostic baseline erectile function in patients undergoing robot-assisted radical prostatectomy. J Sex Med 2012;9:602–7.
61 Karakiewicz PI, Bhojani N, Neugut A, Shariat SF, Jeldres C, Graefen M, Perrotte P, Peloquin F, Kattan MW. The effect of comorbidity and socioeconomic status on sexual and urinary function and on general health-related quality of life in men treated with radical prostatectomy for localized prostate cancer. J Sex Med 2008;5:919–27.
62 Mols F, Aquarius AE, Essink-Bot M-L, Aaronson NK, Kil PJM, Van de Poll-Franse LV. Does diabetes mellitus as a comorbid condition affect the health-related quality of life in prostate cancer survivors? Results of a population-based observational study. BJU Int 2008;102:1594–600.
63 Van de Poll-Franse LV, Sadetsky N, Kwan L, Litwin MS. Severity of cardiovascular disease and health-related quality of life in men with prostate cancer: A longitudinal analysis from CaPSURE. Qual Life Res 2008;17:845–55.
64 Van de Poll-Franse LV, Kwan L, Reiter RE, Lee SP, Litwin MS. The influence of cardiovascular disease on health related quality of life in men with prostate cancer: A 4-year followup study. J Urol 2008;179:1362–7; discussion 1367.
65 Marien T, Sankin A, Lepor H. Factors predicting preservation of erectile function in men undergoing open radical retropubic prostatectomy. J Urol 2009;181:1817–22.
66 Teloken PE, Nelson CJ, Karellas M, Stasi J, Eastham J, Scardino PT, et al. Defining the impact of vascular risk factors on erectile function recovery after radical prostatectomy. BJU Int 2013;111:653–7.
67 Freedland SJ, Haffner MC, Landis PK, Saigal CS, Carter HB. Obesity does not adversely affect health-related quality-of-life outcomes after anatomic retropubic radical prostatectomy. Urology 2005;65:1131–6.
68 Anast JW, Sadetsky N, Pasta DJ, Bassett WW, Latini D, DuChane J, et al. The impact of obesity on health related quality of life before and after radical prostatectomy (data from CaPSURE). J Urol 2005;173:1132–8.
69 Montgomery JS, Gayed BA, Hollenbeck BK, Daignault S, Sanda MG, Montie JE, Wei JT. Obesity adversely affects health related quality of life before and after radical retropubic prostatectomy. J Urol 2006;176:257–61; discussion 261–2.
70 Boorjian SA, Crispen PL, Carlson RE, Rangel LJ, Karnes RJ, Frank I, Gettman MT. Impact of obesity on clinicopathologic outcomes after robot-assisted laparoscopic prostatectomy. J Endourol 2008;22:1471–6.
71 Uffort EE, Jensen JC. Impact of obesity on early erectile function recovery after robotic radical prostatectomy. JSLS 2011;15:32–7.
72 Campeggi A, Xylinas E, Ploussard G, Ouzaid I, Fabre A, Allory Y, Vordos D, Abbou CC, Salomon L, de la Taille A. Impact of body mass index on perioperative morbidity, oncological, and functional outcomes after extraperitoneal laparoscopic radical prostatectomy. Urology 2012;80:576–84.
73 Ko WJ, Truesdale MD, Hruby GW, Landman J, Badani KK. Impacting factors for recovery of erectile function within 1 year following robotic-assisted laparoscopic radical prostatectomy. J Sex Med 2011;8:1805–12.
74 Vickers A, Savage C, Bianco F, Mulhall J, Sandhu J, Guillonneau B, Cronin A, Scardino P. Cancer control and functional outcomes after radical prostatectomy as markers of surgical quality: Analysis of heterogeneity between surgeons at a single cancer center. Eur Urol 2011;59:317–22.
75 Tal R, Rabbani F, Scardino PT, Mulhall JP. Measuring erectile function after radical prostatectomy: Comparing a single question with the International Index of Erectile Function. BJU Int 2012;109:414–7.
76 Alemozaffar M, Duclos A, Hevelone ND, Lipsitz SR, Borza T, Yu H-Y, Kowalczyk KJ, Hu JC. Technical refinement and learning curve for attenuating neurapraxia during robotic-assisted radical prostatectomy to improve sexual function. Eur Urol 2012;61:1222–8.
77 Mulhall JP, Slovick R, Hotaling J, Aviv N, Valenzuela R, Waters WB, Flanigan RC. Erectile dysfunction after radical prostatectomy: Hemodynamic profiles and their correlation with the recovery of erectile function. J Urol 2002;167:1371–5.
78 Ohebshalom M, Parker M, Waters B, Flanagan R, Mulhall JP. Erectile haemodynamic status after radical prostatectomy correlates with erectile functional outcome. BJU Int 2008;102:592–6.
79 Mulhall JP, Secin FP, Guillonneau B. Artery sparing radical prostatectomy—Myth or reality? J Urol 2008;179:827–31.
80 Secin FP, Touijer K, Mulhall J, Guillonneau B. Anatomy and preservation of accessory pudendal arteries in laparoscopic radical prostatectomy. Eur Urol 2007;51:1229–35.
81 Matin SF. Recognition and preservation of accessory pudendal arteries during laparoscopic radical prostatectomy. Urology 2006;67:1012–5.

82 Park BJ, Sung DJ, Kim MJ, Cho SB, Kim YH, Chung KB, Kang SH, Cheon J. The incidence and anatomy of accessory pudendal arteries as depicted on multidetector-row CT angiography: Clinical implications of preoperative evaluation for laparoscopic and robot-assisted radical prostatectomy. Korean J Radiol 2009;10:587–95.
83 Rogers CG, Trock BP, Walsh PC. Preservation of accessory pudendal arteries during radical retropubic prostatectomy: Surgical technique and results. Urology 2004;64:148–51.
84 Box GN, Kaplan AG, Rodriguez E, Skarecky DW, Osann KE, Finley DS, Ahlering TE. Sacrifice of accessory pudendal arteries in normally potent men during robot-assisted radical prostatectomy does not impact potency. J Sex Med 2010;7(1 Pt 1):298–303.
85 Müller A, Parker M, Waters BW, Flanigan RC, Mulhall JP. Penile rehabilitation following radical prostatectomy: Predicting success. J Sex Med 2009;6:2806–12.
86 Padma-Nathan H, McCullough AR, Levine LA, Lipshultz LI, Siegel R, Montorsi F, Giuliano F, Brock G. Randomized, double-blind, placebo-controlled study of postoperative nightly sildenafil citrate for the prevention of erectile dysfunction after bilateral nerve-sparing radical prostatectomy. Int J Impot Res 2008;20:479–86.
87 Montorsi F, Brock G, Lee J, Shapiro J, Van Poppel H, Graefen M, Stief C. Effect of nightly versus on-demand vardenafil on recovery of erectile function in men following bilateral nerve-sparing radical prostatectomy. Eur Urol 2008;54:924–31.
88 Hollenbeck BK, Dunn RL, Wei JT, Montie JE, Sanda MG. Determinants of long-term sexual health outcome after radical prostatectomy measured by a validated instrument. J Urol 2003;169:1453–7.
89 Pettus JA, Masterson T, Sokol A, Cronin AM, Savage C, Sandhu JS, Mulhall JP, Scardino PT, Rabbani F. Prostate size is associated with surgical difficulty but not functional outcome at 1 year after radical prostatectomy. J Urol 2009;182:949–55.
90 Ward NT, Parsons JK, Levinson AW, Bagga HS, Mettee LZ, Su L-M, Pavlovich CP. Prostate size is not associated with recovery of sexual function after minimally invasive radical prostatectomy. Urology 2011;77:952–6.
91 Zorn KC, Orvieto MA, Mikhail AA, Gofrit ON, Lin S, Schaeffer AJ, Shalhav AL, Zagaja GP. Effect of prostate weight on operative and postoperative outcomes of robotic-assisted laparoscopic prostatectomy. Urology 2007;69:300–5.
92 Frota R, Turna B, Santos BMR, Lin Y-C, Gill IS, Aron M. The effect of prostate weight on the outcomes of laparoscopic radical prostatectomy. BJU Int 2008;101:589–93.
93 Ahlering TE, Kaplan AG, Yee DS, Skarecky DW. Prostate weight and early potency in robot-assisted radical prostatectomy. Urology 2008;72:1263–8.
94 Abdollah F, Sun M, Suardi N, Gallina A, Bianchi M, Tutolo M, Passoni N, Tian Z, Salonia A, Colombo R, Rigatti P, Karakiewicz PI, Montorsi F, Briganti A. Prediction of functional outcomes after nerve-sparing radical prostatectomy: Results of conditional survival analyses. Eur Urol 2012;62:42–52.
95 Rabbani F, Patel M, Cozzi P, Mulhall JP, Scardino PT. Recovery of erectile function after radical prostatectomy is quantitatively related to the response to intraoperative cavernous nerve stimulation. BJU Int 2009;104:1252–7.
96 Briganti A, Gallina A, Suardi N, Capitanio U, Tutolo M, Bianchi M, Passoni N, Salonia A, Colombo R, Di Girolamo V, Guazzoni G, Rigatti P, Montorsi F. Predicting erectile function recovery after bilateral nerve sparing radical prostatectomy: A proposal of a novel preoperative risk stratification. J Sex Med 2010;7:2521–31.
97 Alemozaffar M, Regan MM, Cooperberg MR, Wei JT, Michalski JM, Sandler HM, Hembroff L, Sadetsky N, Saigal CS, Litwin MS, Klein E, Kibel AS, Hamstra DA, Pisters LL, Kuban DA, Kaplan ID, Wood DP, Ciezki J, Dunn RL, Carroll PR, Sanda MG. Prediction of erectile function following treatment for prostate cancer. JAMA 2011;306:1205–14.
98 Kilminster S, Müller S, Menon M, Joseph JV, Ralph DJ, Patel HRH. Predicting erectile function outcome in men after radical prostatectomy for prostate cancer. BJU Int 2012;110:422–6.
99 Novara G, Ficarra V, D'Elia C, Secco S, De Gobbi A, Cavalleri S, Artibani W. Preoperative criteria to select patients for bilateral nerve-sparing robotic-assisted radical prostatectomy. J Sex Med 2010;7(2 Pt 1):839–45.
100 Gallina A, Ferrari M, Suardi N, Capitanio U, Abdollah F, Tutolo M, Bianchi M, Saccà A, Salonia A, Rigatti P, Montorsi F, Briganti A. Erectile function outcome after bilateral nerve sparing radical prostatectomy: Which patients may be left untreated? J Sex Med 2012;9:903–8.