Exploring the Optimal Erectile Function Domain Score Cutoff That Defines Sexual Satisfaction After Radical Prostatectomy

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ABSTRACT

Introduction: The International Index of Erectile Function (IIEF) is the gold standard validated instrument for defining erectile function (EF) and its response to treatment. The EF domain (EFD) contains six questions and is a sensitive and specific measurement of treatment-related changes in EF. The EFD score has been widely used as a primary assessment end point for clinical trials of EF recovery after radical prostatectomy (RP). Various EFD scores have been used to define functional erections. Recently, an EFD score of at least 22 has been used as a threshold in major post-RP penile rehabilitation studies.

Aim: To define the EFD score that optimally defines “functional” erections after RP.

Methods: We assessed men 24 months after RP using the IIEF and specifically analyzed the scores of the EFD and intercourse satisfaction domain (ISD).

Main Outcome Measures: We used two questions on satisfaction (score = 0–5) and enjoyment (score = 0–5) from the ISD to classify IS (score = 0–10). We tested the following intercourse satisfaction classifications: ISD score equal to 10, ISD score of at least 8, and a score of at least 4 for the ISD questions on satisfaction and enjoyment. We used the classification that produced the largest area under the curve (AUC) using a receiver operating characteristic (ROC) curve. Then, we used a three-step process to determine the optimal EFD score cutoff using sensitivity and specificity analysis.

Results: One hundred seventy-eight men had an average age at RP of 58 ± 7 years and a 24-month EFD score of 20 ± 9. Sixty-four percent had complete nerve-sparing surgery, 35% had partial nerve-sparing surgery, and 1% had the nerves fully resected. Thirty-three percent had laparoscopic RP and 67% had open RP. The ROC curves produced AUCs of 0.80 (ISD score = 10), 0.85 (ISD score ≥ 8), and 0.86 (ISD scores for satisfaction and enjoyment ≥ 4; P < .001 for all comparisons). Using the IS criterion of ISD scores for satisfaction and enjoyment of at least 4 (largest AUC), the sensitivity and specificity values were 0.89 and 0.66 for an ESD score equal to 22, 0.78 and 0.71 for a score equal to 23, 0.78 and 0.80 for a score equal to 24, 0.77 and 0.82 for a score equal to 25, and 0.73 and 0.85 for a score equal to 26. The scores of 24 and 25 met the criteria outlined in the first two steps of analysis. The score of 24 was selected as the cutoff using face valid judgment and the previous literature.

Conclusion: These data support an EFD score of 24 as a valid cutoff defining “functional” erection in men with erectile dysfunction after RP. These data are important for clinicians in counseling patients and to researchers to define inclusion criteria and treatment end points for trials of erectile dysfunction after RP. Terrier JE, Muhall JP, Nelson CJ. Exploring the Optimal Erectile Function Domain Score Cutoff That Defines Sexual Satisfaction After Radical Prostatectomy. J Sex Med 2017;14:804–809.

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Key Words: Erectile Dysfunction; Prostatectomy; Prostate Cancer; Erectile Function; International Index of Erectile Function; Score Interpretation

INTRODUCTION

Prostate cancer is the most frequently diagnosed solid tumor and the second most common cause of death from malignancy in men in the United States.1 Radical prostatectomy (RP) is a gold standard curative treatment for early and localized prostate cancer. RP has been found to decrease the risk of prostate cancer death vs watchful waiting in men younger than 65 years at...
10 years of follow-up. Erectile dysfunction (ED) is a common side effect of RP. Despite the development of nerve-sparing RP, only 16% of men undergoing RP will regain their presurgery level of erectile functioning. This is important because ED can have a negative effect on quality of life and can cause significant distress in men and their partners. The burden of sexual bother after RP persists at significantly high levels for at least 2 years after surgery and the link between ED and depressive symptoms is well established.

The erectile function domain (EFD) of the International Index of Erectile Function (IIEF) has been widely used as a primary assessment end point for clinical trials of EF recovery after RP. Various EFD scores have been used to define functional erections. Normally, absence of ED is defined by an EFD score of at least 26; however, this cutoff was developed in men with erections. Normally, absence of ED is defined by an EFD score after RP. Various EFD scores have been used to define functional erections. Normally, absence of ED is defined by an EFD score of at least 26; however, this cutoff was developed in men with general ED as opposed to men with ED after prostate cancer treatment. Briganti et al presented data on an EFD cutoff score in men after RP and demonstrated that patient sexual satisfaction after RP was equivalent for patients with mild ED (EFD score = 22–25) and those men with no ED (EFD score ≥ 26). They concluded that an EFD score cutoff of 22 could be used to define postoperative EF recovery. Subsequently, this cutoff has been used as the threshold in a major erectile rehabilitation study (REINVENT and REACT) after RP.

Although the study by Briganti et al helped provide the first data quantitatively defining EF recovery with the EFD score after RP, this has never been replicated. There is concern that a score of 22 might be too low to represent “true” EF recovery and this low score might overestimate the percentage of men with “recovered” EF. Also, the method of dividing EFD scores into specific severity groups and comparing those groups raises some methodologic questions. For example, if different group ranges were selected (eg, mild ED score = 20–25), then the investigators might have easily defined a different cutoff score.

The aim of this study was to define an optimal EFD cutoff score after RP to define “functional” erections.

METHODS

Patient Population

This study is part of a larger prospective quality-of-life (QOL) study conducted in patients with early-stage prostate cancer at our institution. The study was approved by the institutional review board and complied with the International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use Good Clinical Practice Guidelines founded on the Declaration of Helsinki. The subjects eligible for this study were men diagnosed with localized prostate cancer who were undergoing an RP and could speak English. Patients were recruited consecutively in our clinics before RP and, after consent, completed the Prostate-Health Related Quality-of-Life Questionnaire. The subjects completed this questionnaire before surgery and then every 3 months for 2 years after surgery. Because nerve healing and recovery are considered complete by 24 months after RP, the analysis in this article uses data from the men who completed the 24-month assessments.

Outcome Measurements

The Prostate-Health Related Quality-of-Life Questionnaire is a psychometrically validated, patient self-report questionnaire that contains 63 disease-specific items that measure 8 domains: urinary, sexual, and bowel function; associated bother and role limitations domains; and cancer worry, treatment satisfaction, and regret. This study used the sexual function subscale from this QOL instrument, which is represented by the IIEF. The IIEF contains five domains, and this study analyzed the six questions that compose the EFD (maximum score = 30) and two of the three questions of the intercourse satisfaction domain (ISD; maximum score = 10). The EFD is considered the gold standard assessment of EF and is a sensitive and specific measurement of treatment-related changes in EF. We included only those men who were sexually active (EFD score ≥ 6) at 24 months after RP. The ISD asks about frequency, satisfaction, and enjoyment of sexual intercourse. We used only the satisfaction and enjoyment questions of the ISD. We removed the intercourse frequency question from the ISD for this analysis because physical and psychological factors related to sexual functioning after RP can affect sexual frequency and confound ISD results. Higher scores indicated better functioning in these domains.

Statistical Analysis

All analyses were conducted using IBM SPSS 24 (IBM Corp, Armonk, NY, USA). Descriptive statistics are provided to characterize the sample. We used a receiver operating characteristic (ROC) curve to determine the optimal EFD score cutoff that would identify intercourse satisfaction (IS). The ISD as used in the analysis has two questions that have response options that range from 1 to 5 on a Likert scale. Because there is no standard or defined cutoff for the ISD score, we defined a priori three “face valid” classifications of IS based on subjects’ scores on the ISD. The three classifications were an ISD score equal to 10 (very highly satisfying, highest score possible), an ISD score of at least 8 (fairly to very highly satisfying), and an ISD score of at least 4 for the ISD questions on satisfaction and enjoyment (highly to very highly satisfying). We ran a separate ROC curve for each of these three definitions of IS and used the one that produced the largest area under the curve (AUC) as primary definition for the analysis. An AUC equal to 1 represents perfect classification, and an AUC equal to 0.5 indicates no better than chance. Once we determined the ISD criterion that produced the largest AUC, we analyzed the sensitivity and specificity for each EFD score based on this criterion. Sensitivity is the measurement of the proportion of “positives” who are correctly identified by the cutoff score (ie, the proportion of men correctly identified who met the ISD criterion of sexual satisfaction). Specificity measures the proportion of...
“negatives” who are correctly identified by the cutoff scores (ie, the proportion of men correctly identified who did not meet the ISD criterion of sexual satisfaction). Because there is no standard definition of IS, we repeated this analysis for the other two definitions of IS to determine whether there were any discrepancies among definitions. We include this as supplemental analyses to support the primary analysis.

There is a lack of established empirical guidelines to determine optimal sensitivity and specificity; therefore, we used a three-step process to define which EFD cutoff score produced the optimal sensitivity and specificity in this study. First, we outlined acceptable levels of sensitivity and specificity for determining the best cutoff score for the EFD. Second, we set the acceptable level of sensitivity and specificity at 75% because we judged this was the minimum level acceptable for this type of cutoff score. If these levels were met by more than one score, then we used the Youden index (J = maximum [sensitivity + specificity − 1]) to determine the highest combination of sensitivity and specificity for the remaining scores. The Youden index is recognized as one of the most reliable ways of determining an optimal cutoff score compared with visual inspection of ROC curves.

Third, if the criteria of sensitivity and specificity were met and the Youden index was within 0.10 of the remaining possible cutoff scores, then we used a “face valid” assessment and/or previous research to determine the most reasonable cutoff.

RESULTS

Four hundred thirty-three men completed the baseline assessment of the larger QOL study and 232 men completed the 24-month assessment. Of these 232, 178 men were sexually active at the 24-month follow-up. This analysis focuses on these 178 men. Eighty-four percent of men at baseline had penetration hardness erections (EFD score ≥ 24) and 16% had EFD scores no higher than 23. We included men with non-penetration hardness erections before surgery because we wanted these analyses to apply to all men after RP. Table 1 presents patient characteristics of the sample. All degrees of nerve-sparing surgery were included: 64% had complete nerve-sparing surgery, 35% had partial nerve-sparing surgery, and 1% had the nerves fully resected. Thirty-three percent had laparoscopic RP and 67% had open RP. Before surgery, 83% “never” used a phosphodiesterase type 5 inhibitor (PDE5i), 12% “sometimes” used a PDE5i, and 5% “always” used a PDE5i. At 24 months, 47% “never” used a PDE5i, 38% “sometimes” used a PDE5i, and 15% “always” used a PDE5i.

Defining the IS Criterion

The three a priori defined criteria for IS produced a percentage of “satisfied” that ranged from 14% to 46% (Table 2). These produced a relatively large AUC that ranged from 0.80 to 0.86 and all were significant (P < .001; Table 2). The IS criterion that produced the largest ROC AUC of 0.86 was the ISD score of at least 4 for the two ISD questions (Figure 1). This criterion was used to determine the sensitivity and specificity of EFD scores.

Selecting EFD Cutoff Score

Step 1
Two potential cutoff scores met the criterion of sensitivity and specificity higher than 75%. These cutoff scores were 24 and 25 (Table 3).

Step 2
The Youden index values for these two scores were within 0.10 of each other. The Youden index for score 24 was equal to 1.58 and that for score 25 was equal to 1.60.

Step 3
We decided on the final cutoff score of 24. Because the Youden index values for the two remaining scores were within 0.10 of each other, we used two criteria to select the score of 24. First, a score of 24 equals an average of four points (of five points) of each of the six questions. A score of 4 represents an average response of “most of the time” for each question and would indicate very good EF. This is a “face valid” determination. Second, previous research has suggested a cutoff score of 22

Table 1. Sample Characteristics (N = 178)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value (N = 178)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y), mean (SD)</td>
<td>58 (7)</td>
</tr>
<tr>
<td>Married or partnered, %</td>
<td>86</td>
</tr>
<tr>
<td>Caucasian, %</td>
<td>94</td>
</tr>
<tr>
<td>EFD before RP, mean (SD)</td>
<td>27 (6)</td>
</tr>
<tr>
<td>EFD 24 mo after RP, mean (SD)</td>
<td>20 (9)</td>
</tr>
<tr>
<td>Hypercholesterolemia, %</td>
<td>36</td>
</tr>
<tr>
<td>Hypertension, %</td>
<td>33</td>
</tr>
<tr>
<td>Diabetes, %</td>
<td>2</td>
</tr>
<tr>
<td>Smoking status, %</td>
<td></td>
</tr>
<tr>
<td>Current smoker</td>
<td>4</td>
</tr>
<tr>
<td>Former smoker</td>
<td>14</td>
</tr>
<tr>
<td>Never smoker</td>
<td>27</td>
</tr>
<tr>
<td>Unknown</td>
<td>55</td>
</tr>
</tbody>
</table>

EFD = erectile function domain score of the International Index of Erectile Function; RP = radical prostatectomy.

Table 2. AUC for each receiver operating characteristic curve by IS classification

<table>
<thead>
<tr>
<th>IS classification</th>
<th>AUC (% reporting sexual satisfaction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISD score = 10</td>
<td>0.80 (15)</td>
</tr>
<tr>
<td>ISD score ≥ 8</td>
<td>0.85 (46)</td>
</tr>
<tr>
<td>ISD scores for satisfaction and enjoyment ≥ 4</td>
<td>0.86 (44)</td>
</tr>
</tbody>
</table>

AUC = area under the curve; IS = intercourse satisfaction; ISD = intercourse satisfaction domain.
for men after RP, suggesting that the lower score of 24 might be the most appropriate cutoff score.

**Supplementary Analysis**

In determining the IS criterion, we selected the definition of IS that produced the largest AUC. Because all three potential criteria produced significant AUCs with values very close one another (Table 2), we ran the same three-step process to select a cutoff for the other two potential criteria for IS. The criterion of an ISD score of at least 8 produced an AUC of 0.85. The cutoff scores of 24 and 25 met the criteria of sensitivity and specificity higher than 75%, and the cutoff score of 24 produced the highest Youden index value. The criterion of an ISD score of at least 10 produced the smallest AUC of 0.80. For this criterion, there were no cutoff scores that met the criterion of sensitivity and specificity higher than 75%. Because this was the “strictest” criterion, it produced the smallest percentage of sexually “satisfied” subjects (14% vs 44% and 46% from the other two criteria). The lower sensitivity and specificity combined with the low level of satisfaction indicates this might not be an appropriate criterion. This supplemental analysis for ISD scores of at least 8 and at least 10 supports 24 as an appropriate cutoff.

**DISCUSSION**

In the present analysis, we found that the EFD score of 24 produced the most reasonable EFD cutoff to indicate “functional” erections after RP. We used IS as the criterion, defined as men indicating a score of at least 4 on the two questions of the ISD, and ROC curve analysis identified an EFD score of 24 as the optimal cutoff score. Therefore, we suggest that an EFD score of 24 should be used to indicate men who have “functional” erections after RP in future clinical studies and outcomes studies when surgeons are defining the percentage of patients who recover EF after surgery.

We used two questions from the ISD of the IIEF (items 7 and 8 related to satisfaction and enjoyment of intercourse) to define IS. We selected the ISD because it has been used in analyses in previous studies to help clarify the meaning of EFD scores. The ISD has been used to supplement ROC analyses in the development of cut points in the EFD in men with general ED, for the estimation of minimal clinically important differences in the EFD, and for determining an EFD cutoff in men after prostate cancer surgery. The National Institutes of Health also considers these questions relevant to the definition of ED. As stated in the Methods section, we removed the intercourse frequency question from the ISD for this analysis because physical and psychological factors related to sexual functioning after RP can affect sexual frequency and confound the IS results. Because there is no standard or defined cutoff for the ISD, we defined three “face valid” definitions of “satisfied” on the ISD. Although we selected one of these three definitions as the primary definition for the analysis, we ultimately ran the analysis for all three definitions. All three indicated that a score of 24 was the more appropriate cutoff score and the consistency among these three definitions supports the results of this study.

Our suggested cutoff score of 24 is between the cutoff of 26 outlined in the original IIEF validation study and the cutoff of 22 suggested by Briganti et al for men after RP. The differences between the methods and analyses presented in this article and those of the original validation study are clear. The studies that suggested a cutoff of 26 were conducted in men who had general ED as opposed to ED associated with prostate cancer treatment and used the criterion of men with ED vs men without ED to anchor the ROC curve analysis.

Our article and the article by Briganti et al investigated the cutoff score in men after RP and used IS as the criterion variable (Briganti et al also used the overall satisfaction domain of the IIEF). This IS criterion is used because it is difficult to define a group of men without ED after prostate cancer surgery. The vast majority of men (85%) reported at least some difficulty with erections after prostate cancer treatment, and only 16% of men will regain pre-RP EF. The primary difference between our study and the study by Briganti et al is the analytic methodology. They divided men into three ED severity groups as outlined in
the initial validation studies of the IIEF (moderate to mild ED, EFD score = 17–21; mild ED, EFD score = 22–25; no ED, EFD score = 26–30). There was no difference in IS between the mild ED and no ED groups, and the moderate to mild ED group reported lower ISD scores. They concluded that men with a score of 22 reached a threshold of IS that was similar to men with a score higher than 22. The method of dividing EFD scores into specific severity groups and comparing those groups raises some methodologic questions. For example, if different group ranges were selected (eg, mild ED, score = 20–25), then Briganti et al might have easily defined a different cutoff score. Also, the group ranges that Briganti et al used were the defined ranges of the EFD in men without prostate cancer and these ranges might not be appropriate to apply to men after RP. In fact, if they were appropriate, then there would be no need to develop a different cutoff score. The study samples also differ. The sample in the study by Briganti et al excluded men who had ED before surgery and included only those who had bilateral nerve-sparing surgery. Our study did not have inclusion and exclusion criteria related to erectile quality before surgery or type of nerve-sparing surgery.

We believe the methodology used in our study is appropriate for selecting a cutoff score. First, we considered three different criteria for IS. Second, we used ROC curve analysis, which is standard methodology used to develop cutoff scores. Third, we used multiple criteria to weigh the sensitivity and specificity of the potential cutoff scores and used the results presented by Briganti et al as part the decision-making process. Thus, we argue that a score of 24 is the most appropriate cutoff score. At 24 months, the nerves are considered fully healed and any recovery that will take place is judged to be complete. Therefore, we judged this was the most appropriate time point to use. The goal was to develop a cutoff that indicated “functional” erections after surgery. If a patient has an EFD score of 24 at 1 year, we believe these data would still apply and they would be considered “functional” erections.

Our report suggests that IDS scores decrease after RP even in men with a good EFD score. Rossi et al reported significant decreases in overall satisfaction after RP even in men who reported back-to-baseline erections after surgery. Of 383 patients who achieved back-to-baseline erections, only 26.9% were sexually active at the 24-month follow-up. The fact that our cutoff differs from that of Briganti et al suggests that future research is needed on the validity of our EFD cutoff score after RP. Results from multiple centers with potentially different methodologies could help clarify which score is most appropriate.

CONCLUSIONS

An EFD score of 24 represents the optimal cutoff for the prediction of IS in men with ED after RP. These data might be important when defining an EFD score that defines “functional” erection after treatments such as RP and for defining inclusion criteria and treatment end points for trials of ED after RP.

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