Original Article - Urological Oncology

Investig Clin Urol 2021;62:159-165.
https://doi.org/10.4111/icu.20200236
pISSN 2466-0493 • eISSN 2466-054X

INVESTIGATIVE AND CLINICAL UROLOGY
ICUROLOGY

Predictors of erectile dysfunction after transperineal template prostate biopsy

Jo-Lynn Tan[1], Nathan Papa[2], Uri Hanegbi[3], Ross Snow[3], Jeremy Grummet[3,4], Sarah Mann[4], Adam Cuthbertson[3], Mark Frydenberg[2,3,4], Daniel Moon[3,4,5]

[1]Department of Urology, St. Vincent's Hospital Melbourne, Victoria, [2]School of Public Health and Preventive Medicine, Monash University, Victoria, [3]Australian Urology Associates, Malvern, Victoria, [4]Department of Urology, Epworth Healthcare, Melbourne, Victoria, [5]Department of Surgery, University of Melbourne, Victoria, Australia

Purpose: To investigate the incidence and possible contributing factors of erectile dysfunction (ED) after transperineal template prostate biopsy (TTPB).

Materials and Methods: Males undergoing TTPB were prospectively administered a Sexual Health Inventory for Men (SHIM) questionnaire before biopsy and one month after. SHIM questionnaires were repeated at 3- and 9-months for males not receiving interventional treatment. Sexually inactive males were excluded. Interval change in SHIM categories based upon baseline characteristics were evaluated. Multivariable logistic regression models were used to evaluate predictors of change in SHIM score category.

Results: A total of 576 males were included in our sample. Of these, 450 (78%) males underwent their first biopsy. A decline in SHIM category within the immediate 4-weeks post-biopsy was reported by 167 males (31% of total eligible sample). Age was the strongest predictor of decline in SHIM category, the predicted probability of a decline in SHIM at age 50 was 10% (95% confidence interval [CI], 1%–19%), 32% at age 60 (95% CI, 25%–40%) and 36% at age 70 (95% CI, 29%–44%). For new onset ED, the predicted probability of ED within 4-weeks post-TTPB were 6.7% at age 50 (95% CI, 0%–15%), 26% at age 60 (95% CI, 17%–34%) and 31% at age 70 (95% CI, 21%–40%).

Conclusions: Older age at biopsy is an independent predictor of immediate ED after TTPB in sexually active males. This association was observed in the subgroup with no pre-existing ED. These findings provide useful information when counselling males undergoing TTPB.

Keywords: Erectile dysfunction; Prostate biopsy; Prostatic neoplasms

INTRODUCTION

Prostate biopsy is the gold standard investigation for proving a diagnosis of prostate cancer. In the last decade, transperineal template prostate biopsy (TTPB) has replaced transrectal prostate biopsy in many centres, due to higher cancer detection rates [1-3] and lower rates of complications, in particular infection and post-biopsy sepsis [4,5]. More significantly, TTPB demonstrates superior sampling of anterior and apical regions of the prostate, and is less likely to underestimate disease volume and grade [3,6], making it an important tool for accurate risk stratification and subsequent active surveillance.

Up to 25% of males undergoing TTPB have been repor-

Received: 29 May, 2020 • **Revised:** 19 August, 2020 • **Accepted:** 6 October, 2020 • **Published online:** 31 December, 2020
Corresponding Author: Jo-Lynn Tan https://orcid.org/0000-0002-4622-1031
Department of Urology, St. Vincent's Hospital Melbourne, 41 Victoria Parade, Fitzroy VIC 3065, Australia
TEL: +61-3-9231-2211, FAX: +61-3-9231-3399, E-mail: jolynnstan@gmail.com

ted to experience deficits in sexual function, with symptoms lasting up to 3 months post-TTPB [7,8]. Number of biopsy cores taken and presence of previous biopsies have been investigated as possible contributors for reduced sexual function after prostate biopsy [9-11]. Anatomical explanations postulated include neuropraxia caused by laterally directed biopsy needles resulting in injury to the prostatic neurovascular bed, as well as compression on the neurovascular bundle by oedema or haematoma. Additionally, we postulate that TTPB may induce erectile dysfunction (ED) through neuropraxia at a higher rate than the transrectal approach given passage of multiple needles through the apex of the prostate where the neurovascular bundles are converging. The proximity to the neurovascular bundles during this approach is evident through observation of needle passage in real time ultrasound at time of biopsy, and also through the consistent apical scarring seen at radical prostatectomy in these patients.

There is no published long-term data available on sexual function after TTPB. In an era of increasing management of low-volume and localised disease, more males are undergoing active surveillance for low-volume cancers. This may lead to males having several prostate biopsies over the years whilst undergoing active surveillance protocols.

Data examining the impact of TTPB on sexual function is key during counselling of patients for TTPB. More information may also alleviate anxiety related to the diagnosis and procedure, which may have a psychological benefit and impact on sexual function outcomes.

Our study aimed to investigate the incidence of ED after TTPB and possible contributing factors.

MATERIALS AND METHODS

We reviewed the results of pre-biopsy Sexual Health Inventory for Men (SHIM) questionnaires prospectively administered to all males undergoing TTPB at a multi-surgeon high-volume centre between October 2013 and February 2019. Only patients who consented to having their data prospectively collected were included in this study. All males who reported not being sexually active were excluded. Males were not instructed to avoid sexual activity after biopsy. SHIM questionnaires were repeated within four weeks of biopsy and at 3- and 9-months for males not receiving interventional treatment. ED was defined by any total SHIM score of less than 22. For scores below 22, severity of ED was categorised as validated by the SHIM scoring tool [12,13]. These score categories are 22–25 (no ED), 17–21 (mild ED), 12–16 (mild to moderate ED), 8–11 (moderate ED) and 5–7 (severe ED). Baseline data collected included age at biopsy, pre-biopsy prostate-specific antigen (PSA), number of biopsy cores taken and whether the patient had a previous prostate biopsy.

All TTPB were performed by one of five experienced urologists (JG, DM, MF, RS, UH). Biopsies were performed using standardised TTPB protocols and sampling patterns of sectors as described by the Ginsburg Study Group [14]. Biopsies were performed under general anaesthesia, and between 18 to 36 biopsy cores were sampled depending on surgeon clinical judgement, and based on previous investigation such as prostate magnetic resonance imaging and prostate volume. 18–24 cores were taken if the prostate volume was <30 mL, where three cores were taken from each of the anterior, mid and posterior sectors. If the prostate volume was between 30–50 mL, about four cores were taken from each of the anterior, mid and posterior sectors with additional cores taken from the base of the prostate. Similarly, for prostate volumes >50 mL, five cores were taken from each sector with additional cores taken from the basal sector.

The two outcome measures of interest were a change in one or more SHIM score categories immediately post-biopsy (within 4-weeks of biopsy) and development of post-biopsy ED (SHIM score 21 or below) for the subgroup of males with no pre-existing ED (SHIM score 22 or above). Males with the worst category of ED prior to biopsy were thus excluded from the analysis leaving a total eligible sample.

Predictors of the outcomes, including age, PSA, number of cores and repeat biopsy were evaluated as categorical variables with Wilcoxon rank-sum tests. These were then entered simultaneously into a multivariable logistic regression model with age and log transformed PSA as continuous variables. To further explore the effect of age, it was entered in the above models as a restricted cubic spline with knots at the tertiles and the results expressed graphically. Exploratory descriptive analysis of the 3- and 9- month follow-up SHIM data was also performed. A p-value <0.05 was considered statistically significant, and all p-values presented are two-sided. All statistical analyses were performed using Stata version 14.0 (StataCorp., College Station, TX, USA).

This study was reviewed and approved by the Institutional Review Board of Cabrini Hospital for low-risk research ethics (approval number: HREC Study Approval LR191-14).

RESULTS

We identified 576 males who underwent TTPB and had provided pre- and post- biopsy SHIM scores. The median age

https://doi.org/10.4111/icu.20200236

of our study cohort was 65 years (interquartile range [IQR], 59–69 years) and median PSA was 6.2 ng/mL (IQR, 4.3–8.7 ng/mL). 450 males (78%) underwent first-time biopsy, 483 (84%) had 24 or more cores taken. Median SHIM scores were 23 (IQR, 18–25) at pre-biopsy and 21 (IQR, 14–24) at post-biopsy (Table 1).

Table 2 describes pre- and post- SHIM categories for the sample. Normal sexual function (SHIM score 22–25) was reported by 329 (57%) males prior to biopsy, of which 79 (24%) reported an immediate new onset ED within 4-weeks post-biopsy (i.e. score of 21 or less). Of the eligible sample, 167 males (31%) reported a drop in SHIM category in the immediate 4-weeks after undergoing biopsy. In 31 out of 247 (13%) males, an increase in SHIM category after biopsy was seen, with 19 of these (8%) resolving to no ED.

Age as a categorical variable was a strong predictor of drop in SHIM category with 22% of males aged under 60 versus 39% of males older than 70 experiencing a drop (p=0.004) (Table 3). These results were similarly significant in the subgroup of males with no prior ED (18% aged under 60 versus 36% males aged over 70). In the multivariable model, a five-year increase in age was significantly associated with decline in SHIM category in the total eligible sample (odds ratio [OR], 1.25; 95% confidence interval [CI], 1.09–1.44) and no prior ED subgroup (OR, 1.33; 95% CI, 1.10–1.60). Having a biopsy with less than the 24 cores was weakly associated with preservation of baseline erectile function i.e. SHIM category prior to biopsy (Table 4). There was no evidence of an effect of the other examined predictors.

In the spline model, the predicted probability of a decline in SHIM category at age 50 was 10% (95% CI, 1%–19%) rising to 32% at age 60 (95% CI, 25%–40%) and then flattening with increasing age to 36% at age 70 (95% CI, 29%–44%) (Fig. 1). The corresponding predicted probabilities of new onset ED immediately post biopsy were 6.7% at age 50 (95% CI, 0%–15%), 26% at age 60 (95% CI, 17%–34%), and 31% at age 70 (95% CI, 21%–40%) (Fig. 2).

Recovery of normal erectile function at either 3- or 9-months for untreated males without prior ED was also associated with younger age, with 9 of 12 males (75%) aged under 60 versus 10 of 25 males (40%) older than 60 regaining a normal SHIM score (p=0.046). Only one of six males older than 68 recovered normal function.

Table 1. Characteristics of the sample

Variable	Value
No. of patients	576
Age (y)	65 (59–69)
PSA (ng/mL)	6.2 (4.3–8.7)
Number of cores	
<24	93 (16)
24	381 (66)
>24	102 (18)
Clinical setting	
Initial biopsy	450 (78)
Repeat biopsy	126 (22)
SHIM scores	
Pre-biopsy	23 (18–25)
Post-biopsy	21 (14–24)
Subsequent treatment[a]	
RP	217 (38)
XRT	23 (4)
ADT	17 (3)
Other	10 (2)
None[b]	320 (56)

Values are presented as number only or median (interquartile range) or number (%).
PSA, prostate-specific antigen; SHIM, Sexual Health Inventory for Men; RP, radical prostatectomy; XRT, radiotherapy; ADT, androgen deprivation therapy.
[a]:Sum>100% as patients may have had multiple modality therapy.
[b]:Patients who underwent active surveillance or had benign pathology.

Table 2. Distribution of pre- and post-biopsy SHIM scores by category

Pre-biopsy SHIM	Post-biopsy SHIM					Total
	None	Mild	Mild to moderate	Moderate	Severe	
None	250 (76)	55 (17)	7 (2)	6 (2)	11 (3)	329
Mild	18 (13)	67 (49)	27 (20)	9 (7)	16 (12)	137
Mild to moderate	1 (2)	4 (9)	16 (37)	9 (21)	13 (30)	43
Moderate	0 (0)	2 (7)	2 (7)	11 (38)	14 (48)	29
Severe	0 (0)	1 (3)	0 (0)	3 (8)	34 (89)	38
Total	269	129	52	38	88	576

Values are presented as number (%) or number only.
SHIM, Sexual Health Inventory for Men.

Table 3. Univariable categorical predictors of drop in SHIM category

Variable	Total eligible sample (n=538)			No pre-existing ED (n=329)		
	Drop in category (n=167)	No drop in category (n=371)	p-value	New onset ED (n=79)	Remain no ED (n=250)	p-value
Age (y)			0.004			0.030
<60	32 (22)	112 (78)		21 (18)	93 (82)	
60–70	97 (33)	199 (67)		43 (25)	130 (75)	
>70	38 (39)	60 (61)		15 (36)	27 (64)	
PSA (ng/mL)			0.34			0.73
<5	52 (28)	133 (72)		27 (23)	90 (77)	
5–10	86 (33)	178 (67)		38 (24)	119 (76)	
>10	29 (33)	60 (67)		14 (25)	41 (75)	
Number of cores			0.075			0.69
<24	19 (22)	68 (78)		10 (20)	41 (80)	
24	115 (32)	240 (68)		57 (25)	169 (75)	
>24	33 (34)	63 (66)		12 (23)	40 (77)	
Repeat biopsy			0.081			0.15
Yes	28 (24)	87 (76)		12 (17)	57 (83)	
No	139 (33)	284 (67)		67 (26)	193 (74)	

Values are presented as number (%).
SHIM, Sexual Health Inventory for Men; ED, erectile dysfunction.

Table 4. Multivariable predictors of drop in SHIM category

Variable	Total eligible sample	No pre-existing ED
Age (per 5-year increase)	1.25 (1.09–1.44)	1.33 (1.10–1.60)
Log PSA	1.09 (0.82–1.44)	1.09 (0.73–1.61)
Cores		
<24	0.57 (0.33–1.01)	0.75 (0.35–1.62)
24	1.0	1.0
>24	1.01 (0.62–1.64)	0.80 (0.38–1.65)
Repeat biopsy (yes vs. no)	0.64 (0.40–1.04)	0.60 (0.30–1.19)

Values are presented as odds ratio (95% confidence interval).
SHIM, Sexual Health Inventory for Men; ED, erectile dysfunction; PSA, prostate-specific antigen.

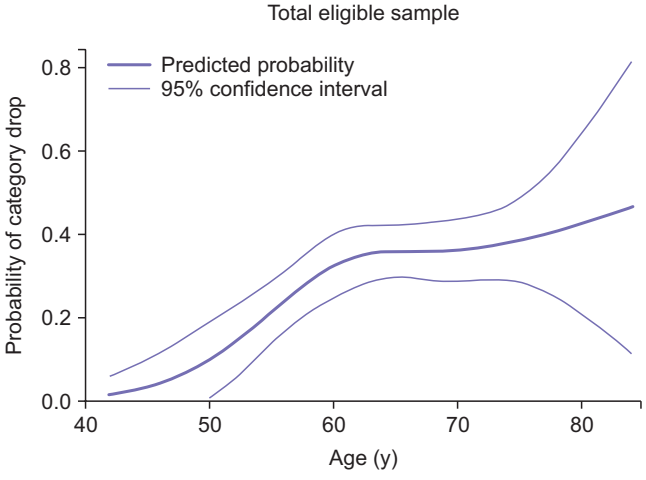

Fig. 1. Age as predictor of drop in Sexual Health Inventory for Men (SHIM) category.

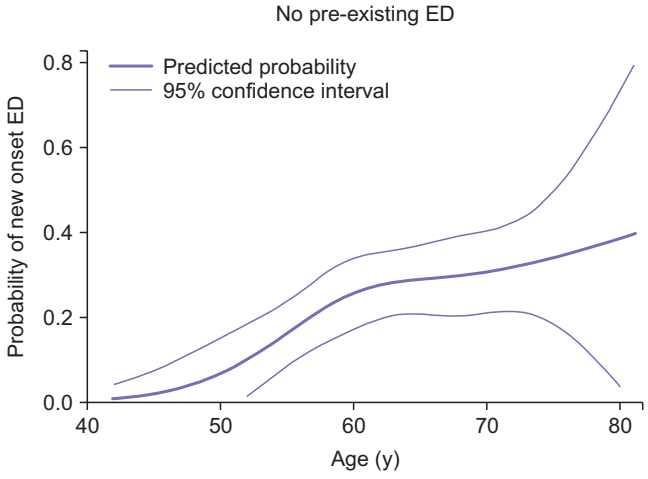

Fig. 2. Age as predictor of new onset erectile dysfunction (ED).

DISCUSSION

Availability of data on the impact of serial prostate biopsies on sexual function is becoming more pertinent as more males undergo active surveillance for low-risk prostate cancer [15]. This is particularly relevant in younger males who experience early detection of disease and seek management options which balance quality of life with disease prognostic factors. Appropriate counselling of patients with regards to disease management options relies on availability of data on predictors of sexual function, as well as short and long-term impact on sexual function.

Age is a well-documented predictor of erectile function

https://doi.org/10.4111/icu.20200236

recovery from baseline in both radical prostatectomy [16] and active surveillance cohorts [11]. In a study of 64 males undergoing active surveillance after initial transrectal ultrasound (TRUS) guided biopsy, Chong et al. (2016) [17] demonstrated that serial TTPB was associated with adverse effects on erection function but did not examine the impact of age-related change. One study on TRUS prostate biopsies investigated age as a contributor to ED [15]. In their subset analysis, Soloway et al. (2010) [15] found significant increases in ED when comparing initial to last SHIM scores over a mean 35-month active surveillance period and in 3 out of 4 of their age groups, suggesting that age may not be the significant factor that affects ED in TRUS prostate biopsies. Interestingly, they report at least moderate ED (SHIM scores ≤16) in their active surveillance cohort at baseline; this is in contrast to our cohort which had a median SHIM score of 23 (IQR, 18–25), suggesting normal sexual function to borderline ED at baseline. To our knowledge, this is the largest published single cohort study investigating the impact of age on sexual function after TTPB.

A unique finding from our study is the demonstration of age as an independent predictor for post-TTPB erectile function independent of the number of biopsy cores taken and previous biopsy. It allows us to inform males of their predicted probability of a decline in SHIM in the immediate 4-weeks post-TTPB, based on their age. Older age is significantly associated with a decline in sexual function post-TTPB. For those with no ED at baseline, the predicted probability of experiencing a decline in SHIM category is 6.7%, 26% and 31% for ages 50, 60, and 70, respectively. Our study further adds that younger age predicts recovery in the medium-term, mirroring the findings from radical prostatectomy cohorts [18]. It is possible that younger males have greater physiological reserve that buffers loss of function and aids recovery after injury to the neurovascular bundle. This is reflected in the higher rates of reduced function in older males, as well as greater degree of recovery of erectile function in younger males after TTPB. These results provide important information when counselling males about active surveillance for low-risk, low-volume disease, offering some reassurance to younger males where preservation of erectile function is a key concern in the decision-making process.

Heterogeneity of results from previously published studies looking at the impact of serial prostate biopsies on ED highlight the challenges in accounting for numerous confounders and biases when examining erectile function in this population [9,19,20]. Fujita et al. (2009) [9] looked at TRUS biopsies and found that annual serial prostate biopsy for active surveillance had negative effect on ED, and that ED was more pronounced in patients with a normal baseline SHIM, and 3 or more previous biopsies. Conversely, Hilton et al. (2012) [19] found that the association between erectile function and number of serial biopsies was negligible, after adjusting for age, sexual activity status and disease prognosis factors. Furthermore, day-to-day reporting of erectile function in itself can be influenced by a multitude of factors. Interestingly, a small number of males in our cohort reported no ED (SHIM scores 22–25) post-biopsy despite having mild ED (SHIM score 17–21) prior to biopsy. This perhaps reflects subjectivity and variability in day-to-day reporting of sexual function. Additionally, it suggests that the difference between a SHIM score of 21 (mild ED) and 22 (no ED) may not be functionally significant and having an additional questionnaire such as the International Index of Erectile Function would have possibly added robustness to our data.

We observed that a numerically greater proportion of males having a first-time biopsy had a decline in erectile function compared to males having a repeat biopsy. This is despite similar pre-biopsy baseline SHIM scores in those undergoing first-time biopsy compared to repeat biopsy (data not shown). Admittedly, the number of males who underwent repeat prostate biopsies were under-represented in this cohort, with 78% having first-time biopsies, and 22% having had previous prostate biopsies (either TRUS guided or TTPB). Further limitations were the lack of detailed data on the number of previous biopsies, number of cores taken at previous biopsies, and whether they were TRUS guided or TTPB. For those undergoing first-time biopsy, having a comparison group of males undergoing first-time TRUS biopsies may have yielded interesting findings, however this was not possible as TRUS biopsies are no longer routinely performed at our centre due to higher risk of sepsis and improved anterior sampling afforded by the transperineal approach.

Robust short and long-term data on sexual function outcomes after TTPB are lacking [8,21]. We explored medium-term recovery of sexual function in those males with normal pre-biopsy SHIM scores but experienced a decline in SHIM category immediately post-biopsy. Loss of numbers to treatment intervention and high rates of dropout at 3- and 9-months, limited our analysis of this. Seventeen patients showed a return to normal sexual function at 3 or 9 months, with age being a strong predictor of this. However, due to low numbers, this conclusion is only exploratory in nature and further studies are warranted.

The aetiology of ED after TRUS or TTPB remains unclear and is likely multifactorial. Both direct and indirect physical and psychogenic factors are likely to play a role, and at different time-points from initial work-up and di-

agnosis. Anatomical theories would argue that the more biopsy cores taken the greater potential for neurovascular bundle injury, yet previous findings from TRUS biopsies do not support that [10,22,23]. Akbal et al. (2008) [22] and Klein et al. (2010) [10] found no correlation between the number of TRUS biopsy cores taken and transient ED, although saturation biopsy itself resulted in transient ED. We observed a smaller proportion of new or worsening ED in the small number of males who had fewer than 24 cores taken. However, further exploration of this as a continuous variable was precluded as the majority of males had exactly 24 cores taken. Furthermore, the presence of comorbidities such as diabetes and metabolic syndrome likely play a role in baseline erectile function and may impact recovery after TTPB, and other post-biopsy complications such as haematospermia or haematuria may impact time taken to return to sexual activity, however this data was not specifically captured in this cohort.

Prostate cancer diagnosis has been shown to be an independent factor negatively impacting erectile function [24]. This may be related to anxiety levels associated with a new cancer diagnosis, and individual patient factors may contribute to the degree and extent of impact on quality of life. A limitation to our study was the lack of psychometric measures pre- and post-biopsy, and biopsy outcome, that is, whether it was a benign result versus low grade (active surveillance) versus malignancy. Current available data on the predictive association between sexual dysfunction and anxiety, number of biopsies, or total cores taken in TTPB thus remains inconclusive. More robust long-term data is needed looking at functional outcomes after serial TTPB in males undergoing active surveillance protocols. There is value in examining the time between serial biopsies and degree of recovery of sexual function between each biopsy as this may provide useful information on timing of serial biopsies with respect to optimal recovery of sexual function.

CONCLUSIONS

This study quantifies older age at biopsy as a significant predictor of immediate ED after TTPB in males who are sexually active, independent of baseline PSA, number of cores taken and if it was a repeat biopsy. This association was also observed in the subgroup of males with no pre-existing ED. Our findings provide useful information when counselling males undergoing TTPB.

CONFLICTS OF INTEREST

The authors have nothing to disclose.

AUTHORS' CONTRIBUTIONS

Research conception and design: Jo-Lynn Tan, Jeremy Grummet, Uri Hanegbi, Ross Snow, Mark Frydenberg, and Daniel Moon. Data acquisition: Jo-Lynn Tan, Jeremy Grummet, Sarah Mann, Adam Cuthbertson, and Daniel Moon. Data analysis and interpretation: Jo-Lynn Tan and Nathan Papa. Drafting of the manuscript: Jo-Lynn Tan, Nathan Papa, and Daniel Moon. Critical revision of the manuscript: Jo-Lynn Tan, Nathan Papa, Jeremy Grummet, Uri Hanegbi, Ross Snow, Mark Frydenberg, and Daniel Moon. Statistical analysis: Jo-Lynn Tan and Nathan Papa. Obtaining funding: Jeremy Grummet, Uri Hanegbi, Ross Snow, Mark Frydenberg, and Daniel Moon. Administrative, technical, or material support: Sarah Mann and Adam Cuthbertson. Supervision: Jeremy Grummet, Uri Hanegbi, Mark Frydenberg, and Daniel Moon. Approval of the final manuscript: Jeremy Grummet, Uri Hanegbi, Mark Frydenberg, and Daniel Moon.

REFERENCES

1. Ayres BE, Montgomery BS, Barber NJ, Pereira N, Langley SE, Denham P, et al. The role of transperineal template prostate biopsies in restaging men with prostate cancer managed by active surveillance. BJU Int 2012;109:1170-6.
2. Mabjeesh NJ, Lidawi G, Chen J, German L, Matzkin H. High detection rate of significant prostate tumours in anterior zones using transperineal ultrasound-guided template saturation biopsy. BJU Int 2012;110:993-7.
3. Hansen NL, Kesch C, Barrett T, Koo B, Radtke JP, Bonekamp D, et al. Multicentre evaluation of targeted and systematic biopsies using magnetic resonance and ultrasound image-fusion guided transperineal prostate biopsy in patients with a previous negative biopsy. BJU Int 2017;120:631-8.
4. Ehdaie B, Vertosick E, Spaliviero M, Giallo-Uvino A, Taur Y, O'Sullivan M, et al. The impact of repeat biopsies on infectious complications in men with prostate cancer on active surveillance. J Urol 2014;191:660-4.
5. Grummet JP, Weerakoon M, Huang S, Lawrentschuk N, Frydenberg M, Moon DA, et al. Sepsis and 'superbugs': should we favour the transperineal over the transrectal approach for prostate biopsy? BJU Int 2014;114:384-8.
6. Ong WL, Weerakoon M, Huang S, Paul E, Lawrentschuk N, Frydenberg M, et al. Transperineal biopsy prostate cancer detection in first biopsy and repeat biopsy after negative tran-

https://doi.org/10.4111/icu.20200236

srectal ultrasound-guided biopsy: the Victorian Transperineal Biopsy Collaboration experience. BJU Int 2015;116:568-76.
7. Bhatt NR, Breen K, Haroon UM, Akram M, Flood HD, Giri SK. Patient experience after transperineal template prostate biopsy compared to prior transrectal ultrasound guided prostate biopsy. Cent European J Urol 2018;71:43-7.
8. Dowrick AS, Wootten AC, Howard N, Peters JS, Murphy DG. A prospective study of the short-term quality-of-life outcomes of patients undergoing transperineal prostate biopsy. BJU Int 2016;118:60-7.
9. Fujita K, Landis P, McNeil BK, Pavlovich CP. Serial prostate biopsies are associated with an increased risk of erectile dysfunction in men with prostate cancer on active surveillance. J Urol 2009;182:2664-9.
10. Klein T, Palisaar RJ, Holz A, Brock M, Noldus J, Hinkel A. The impact of prostate biopsy and periprostatic nerve block on erectile and voiding function: a prospective study. J Urol 2010;184:1447-52.
11. Braun K, Ahallal Y, Sjoberg DD, Ghoneim T, Dominguez Esteban M, Mulhall J, et al. Effect of repeated prostate biopsies on erectile function in men on active surveillance for prostate cancer. J Urol 2014;191:744-9.
12. Cappelleri JC, Siegel RL, Glasser DB, Osterloh IH, Rosen RC. Relationship between patient self-assessment of erectile dysfunction and the sexual health inventory for men. Clin Ther 2001;23:1707-19.
13. Day D, Ambegaonkar A, Harriot K, McDaniel A. A new tool for predicting erectile dysfunction. Adv Ther 2001;18:131-9.
14. Kuru TH, Wadhwa K, Chang RT, Echeverria LM, Roethke M, Polson A, et al. Definitions of terms, processes and a minimum dataset for transperineal prostate biopsies: a standardization approach of the Ginsburg Study Group for Enhanced Prostate Diagnostics. BJU Int 2013;112:568-77.
15. Soloway MS, Soloway CT, Eldefrawy A, Acosta K, Kava B, Manoharan M. Careful selection and close monitoring of low-risk prostate cancer patients on active surveillance minimizes the need for treatment. Eur Urol 2010;58:831-5.
16. Alemozaffar M, Regan MM, Cooperberg MR, Wei JT, Michalski JM, Sandler HM, et al. Prediction of erectile function following treatment for prostate cancer. JAMA 2011;306:1205-14.
17. Chong JJ, Van Hemelrijck M, Cahill D, Kinsella J. Serial transperineal sector prostate biopsies: impact on long-term erectile dysfunction. Ecancermedicalscience 2016;10:643.
18. Brajtbord JS, Punnen S, Cowan JE, Welty CJ, Carroll PR. Age and baseline quality of life at radical prostatectomy--who has the most to lose? J Urol 2014;192:396-401.
19. Hilton JF, Blaschko SD, Whitson JM, Cowan JE, Carroll PR. The impact of serial prostate biopsies on sexual function in men on active surveillance for prostate cancer. J Urol 2012;188:1252-8.
20. Pearce SM, Wang CH, Victorson DE, Helfand BT, Novakovic KR, Brendler CB, et al. A longitudinal study of predictors of sexual dysfunction in men on active surveillance for Prostate Cancer. Sex Med 2015;3:156-64.
21. Loeb S, Vellekoop A, Ahmed HU, Catto J, Emberton M, Nam R, et al. Systematic review of complications of prostate biopsy. Eur Urol 2013;64:876-92.
22. Akbal C, Türker P, Tavukçu HH, Simşek F, Türkeri L. Erectile function in prostate cancer-free patients who underwent prostate saturation biopsy. Eur Urol 2008;53:540-4.
23. Merrick GS, Taubenslag W, Andreini H, Brammer S, Butler WM, Adamovich E, et al. The morbidity of transperineal template-guided prostate mapping biopsy. BJU Int 2008;101:1524-9.
24. Helfand BT, Glaser AP, Rimar K, Zargaroff S, Hedges J, McGuire BB, et al. Prostate cancer diagnosis is associated with an increased risk of erectile dysfunction after prostate biopsy. BJU Int 2013;111:38-43.