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Long-term penile morphometric alterations in patients treated with robot-assisted versus open radical prostatectomy

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SUMMARY

Neglected side effects after radical prostatectomy have been previously reported. In this context, the prevalence of penile morphometric alterations has never been assessed in robot-assisted radical prostatectomy series. We aimed to assess prevalence of and predictors of penile morphometric alterations (i.e. penile shortening or penile morphometric deformation) at long-term follow-up in patients submitted to either robot-assisted (robot-assisted radical prostatectomy) or open radical prostatectomy. Sexually active patients after either robot-assisted radical prostatectomy or open radical prostatectomy prospectively completed a 28-item questionnaire, with sensitive issues regarding sexual function, namely orgasmic functioning, climacturia and changes in morphometric characteristics of the penis. Only patients with a post-operative follow-up ≥ 24 months were included. Patients submitted to either adjuvant or salvage therapies or those who refused to comprehensively complete the questionnaire were excluded from the analyses. A propensity-score matching analysis was implemented to control for baseline differences between groups. Logistic regression models tested potential predictors of penile morphometric alterations at long-term post-operative follow-up. Overall, 67 (50%) and 67 (50%) patients were included after open radical prostatectomy or robot-assisted radical prostatectomy, respectively. Self-rated post-operative penile shortening and penile morphometric deformation were reported by 75 (56%) and 29 (22.8%) patients, respectively. Rates of penile shortening and penile morphometric deformation were not different after open radical prostatectomy and robot-assisted radical prostatectomy [all $p > 0.5$]. At univariable analysis, self-reported penile morphometric alterations (either penile shortening or penile morphometric deformation) were significantly associated with baseline international index of erectile function–erectile function scores, body mass index, post-operative erectile function recovery, year of surgery and type of surgery (all $p < 0.05$). At multivariable analysis, robot-assisted radical prostatectomy was independently associated with a lower risk of post-operative penile morphometric alterations (OR: 0.38; 95% CI: 0.16–0.93). Self-perceived penile morphometric alterations were reported in one of two patients after radical prostatectomy at long-term follow-up, with open surgery associated with a potential higher risk of this self-perception.

INTRODUCTION

Besides a demonstrated benefit on overall and cancer-specific survival, radical prostatectomy (RP) has been invariably associated with a well-known risk of post-operative functional sequelae, including urinary incontinence (UI) and erectile dysfunction (ED) (Nguyen *et al.*, 2017).

However, there are several surgery-related functional impairments known as 'neglected side effects'(Frey *et al.*, 2014a,b); among them, there are many post-operative sexual dysfunctions, thus including the impairment of sexual desire, orgasmic function (i.e. anejaculation, orgasm intensity, painful orgasm and climacturia) and a number of penile cosmetic alterations (Frey *et al.*, 2014a,b; Salonia *et al.*, 2017b). Of those, some modifications of penile morphology after surgery for prostate cancer (PCa) have been described (Frey *et al.*, 2014a,b; Salonia *et al.*, 2017b); of them, a significant reduction in penile shaft length has been variably reported in post-RP series, with data showing a range of 15–68% of patients complaining of post-operative penile shortening (PS) (Frey *et al.*, 2014a,b; Salonia *et al.*, 2017b). Likewise, the previous literature showed that significant

post-operative modifications in terms of penile shape (e.g. penile morphometric deformity [PMD]) also occur in up to 16% of patients (Tal *et al.*, 2010). Robot-assisted RP (RARP) currently represents the surgical technique of choice for PCa patients (Chang *et al.*, 2015; Salonia *et al.*, 2017a,b). Of note, available data on penile alterations after surgery only refer to open RP (ORP) series; contemporary series data on penile morphometric alterations (PMA) after RARP completely lack.

We sought to assess rates of and predictors of PMA in patients who underwent either ORP or RARP; moreover, given the proven correlation between the elapsed time from surgery and the reported rates of PMA, as a consequence of the link between post-RP erectile function (EF) recovery and the recovery of a subjectively normal penile morphology (Vasconcelos *et al.*, 2012), we analysed the prevalence of PMA at a post-operative long-term follow-up in a cohort of sexually active patients submitted to RP for clinically localized PCa in a tertiary referral academic centre.

MATERIALS AND METHODS

The analyses were based on prospectively collected data of a cohort of patients submitted to RP (either ORP or RARP) for clinically localized PCa at a single tertiary referral academic centre and consecutively included in the study, between January 2003 and October 2013.

Patients were included if they reported to be pre-operatively sexually active, with a normal EF and a full urinary continence (defined as no pad use at baseline). Likewise, patients were included if they had comprehensive clinical data, thus including age at surgery, body mass index (BMI), health-significant comorbidities (as scored with the Charlson comorbidity index [CCI]) (Charlson *et al.*, 1987), clinical stage, biopsy Gleason score, nodal invasion (patients were categorized in risk groups according to the National Comprehensive Cancer Network guidelines (Mohler, 2010)) and a detailed description of the surgical technique defined as non-nerve-sparing (NNS), unilateral nerve-sparing (UNS) and bilateral nerve-sparing (BNS) (Patel *et al.*, 2012). In this context, the indication for a NS procedure was based on the clinical judgement of every surgeon according to both clinical and pathological pre-operative characteristics.

Throughout the follow-up period, all patients were invited to complete the International Index of Erectile Function (Rosen *et al.*, 1997), with specific attention paid to the EF domain (IIEF-EF) together with a non-validated 28-item questionnaire with closed questions about sensitive issues regarding sexual function, including specific items on (i) orgasmic function; (ii) climacturia; (iii) orgasm-related pain; and (iv) morphometric characteristics of the penis. Results of this survey have been previously published (Capogrosso *et al.*, 2016). Post-operative EF recovery was defined as an IIEF-EF ≥ 22 (Briganti *et al.*, 2011). Moreover, patients were asked to report a subjectively perceived significant reduction in penile length in erection as compared to baseline (arbitrarily defined as a shortening ≥1 cm); similarly, every patient was also requested to report any subjective feeling of a deformation of the penile shaft at the maximum achieved erection as compared to the pre-operative condition. Both outcomes were assessed at a 6-mo and 12-mo post-RP follow-up and yearly thereafter.

As a main inclusion criterion, patients with a post-operative follow-up ≥24 months were considered (No. = 678). Moreover, those submitted to either salvage or adjuvant therapies throughout the follow-up period (No. = 272) or those with partially incomplete questionnaires (No. = 234) were excluded from the study. A total of 171 patients were included in the final analysis.

Data collection followed the principles outlined in the Declaration of Helsinki; all patients provided their informed consent agreeing to supply their own anonymous information for this and future studies.

Main outcome measures

Primary end point of this study was to rate post-operative PS and PMD reported at a long-term (≥ 24 months) follow-up after RARP. Rates of reported changes at different time points from surgery (i.e. 6, 12 and 24 months) were also reported.

Moreover, potential differences between RARP and ORP patients for every outcome were also assessed. Secondary outcome was to identify potential factors associated with the occurrence of either PS and/or PMD after surgery.

Statistical analyses

To control for measurable baseline differences among patients in the two treatment groups, adjustment was performed using 1:1 propensity-score matching (D'Agostino, 1998). Propensity scores were computed using a logistic regression model with the dependent variable defined as the odds of receiving ORP vs. RARP and the independent variables as age, PCa risk category, pre-operative EF and length of follow-up. Subsequently, covariate balance between the matched groups was examined. Overall, 134 patients were considered subdivided into the following 67 ORP patients and 67 RARP patients, namely four and 34 men were excluded during pair-matching analysis from the ORP and RARP groups, respectively. Descriptive statistics of both patients with and without PMA was detailed using Chi-squared test and one-way analysis of variance (ANOVA). Univariable (UVA) and multivariable (MVA) logistic regression analyses tested potential predictors of reporting post-operative PMA after 24 months from surgery (i.e. either PS or PMD). Statistical analyses were performed using R statistical software, v 3.3.0 (Vienna, Austria). All tests were two-sided, with a significance level set at 0.05.

RESULTS

Overall, 67 (50%) and 67 (50%) patients were included in the analyses after ORP or RARP, respectively (Table 1). Groups did not differ in terms of baseline clinical, pathological and functional characteristics. Overall, a subjective significant PS was reported by 75 (56%) patients at ≥24 months after surgery; similarly, 29 (21.6%) patients complained of PMD at same follow-up assessment. The rates of reported PMA were higher at 12-month assessment compared to a later assessment (Table 1). Of note, patients treated with ORP reported an overall higher rate of PMA compared to RARP (67.2% vs. 49.3%; $p = 0.02$).

Table 2 shows clinical characteristics of patients with PMA at follow-up. Patients reporting PS had significantly higher BMI values compared to those without PS; moreover, the same group had lower baseline IIEF-EF scores and a lower rate of IIEF-EF recovery at ≥24-month follow-up (all $p \leq 0.02$). Conversely, patients reporting PMD showed worse pre-operative disease characteristics (X^2 8.6; $p = 0.01$; Table 2).

At UVA, baseline IIEF-EF scores, BMI, post-operative EF recovery, year of surgery and the type of surgery (i.e. ORP vs. RARP)

Table 1 Clinical characteristics and morphometric alterations of the overall cohort of patients [No. 134]

	Overall	ORP	RARP	X^2; *p*-value*
No. of patients (%)	134	67 (50)	67 (50)	–
Follow-up [months]				
Mean (median)	45.3 (46)	47.2 (51)	43.3 (42)	–; 0.08
IQR	33–57	31–61	35–50	
Age [years]				
Mean (median)	60.6 (61)	60.8 (61)	60.5 (61)	–; 0.8
IQR	56–66	55–66	56–65	
BMI [kg/m^2]				
Mean (median)	25.7 (25.2)	25.7 (25.5)	25.2 (24.9)	–; 0.27
IQR	23.5–26.8	24.2–26.9	23.5–26.8	
CCI				
0	116 (86.6)	59 (88.1)	57 (85.1)	0.25; 0.80
≥1	18 (13.4)	8 (11.9)	10 (14.9)	
Baseline IIEF-EF				
Mean (median)	21.8 (26)	22.1 (28)	21.4 (25)	–; 0.66
IQR	17–29	16–29	18–28	
PCa risk group [No. (%)]				
Low	70 (52.2)	34 (50.7)	36 (53.7)	0.60; 0.73
Intermediate	47 (35.1)	23 (34.3)	23 (35.8)	
High	17 (12.7)	10 (14.9)	7 (10.4)	
Nerve-sparing status [No. (%)]				
None or unilateral	14 (10.4)	5 (7.5)	9 (13.4)	1.27; 0.39
Bilateral	120 (89.6)	62 (92.5)	58 (86.6)	
EF recovery [No. (%)]				
Yes	90 (67.2)	41 (61.2)	49 (73.1)	2.1; 0.19
No	44 (32.8)	26 (38.8)	18 (26.9)	
PS at ≥ 24 months	75 (56.0)	43 (64.2)	32 (47.8)	3.66; 0.08
PS at 12 months	27 (67.5)	11 (61.1)	16 (72.7)	0.1; 0.4
PS at 6 months	14 (36.8)	5 (35.7)	9 (37.5)	0.08; 0.5
PMD at ≥ 24 months	29 (21.6)	14 (20.9)	15 (22.4)	0.04; 1.0
PMD at 12 months	20 (50)	8 (44.4)	12 (54.5)	0.2; 0.5
PMD at 6 months	10 (26.3)	3 (21.4)	7 (29.1)	0.06; 0.5
PMA at ≥ 24 months	78 (58.2)	45 (67.2)	33 (49.3)	4.4; 0.02
PMA at 12 months$^+$	31 (76.9)	14 (77.7)	17 (75)	0.3; 0.3
PMA at 6 months$^+$	15 (40)	6 (42.8)	9 (33.3)	0.3; 0.4

ORP, open radical prostatectomy; RARP, robot-assisted radical prostatectomy; BMI, body mass index; EF, erectile function; PS, penile shortening; PMD, penile morphometric deformity; PMA, penile morphometric alterations (either PS or PMD). **p*-value according to ANOVA or Chi-squared test, as indicated. + Data at 6 and 12 month assessment were available for 38 and 40 patients, respectively.

Table 2 Clinical and pathological characteristics of patients reporting PMA ≥ 24 months after surgery

	Penile shortening		X^2; *p*-value*	Penile deformation		X^2; *p*-value*
	Yes	No		Yes	No	
Age [years]						
Mean (median)	61.45 (62)	59.68 (60)	–; 0.10	60.2 (62)	60.8 (61)	–; 0.65
IQR	58–66	54–65		55–75	56–66	
BMI [kg/m^2]						
Mean (median)	26.04 (25.6)	24.76 (24.7)	–; <0.01	25.8 (25.4)	25.3 (25.1)	–; 0.34
IQR	24.5–27.3	22.9–26.1		23.7–27.9	23.5–26.7	
CCI						
0	61 (81.3)	55 (93.2)	4.01; 0.07	26 (89.7)	90 (85.7)	0.30; 0.76
≥1	14 (18.7)	4 (6.8)		3 (10.3)	15 (14.3)	
Baseline IIEF-EF						
Mean (median)	20.2 (24)	23.9 (27)	–; 0.02	20.2 (24)	22.2 (27)	–; 0.34
IQR	24–29	24–29		15–29	20–29	
PCa risk group [No. (%)]						
Low	33 (44)	37 (62.7)	5.73; 0.05	15 (51.7)	55 (52.4)	8.66; 0.01
Intermediate	29 (38.7)	18 (30.5)		6 (20.7)	41 (39)	
High	13 (17.3)	4 (23.5)		8 (27.6)	9 (8.6)	
Nerve-sparing status [No. (%)]						
None or unilateral	9 (12)	5 (8.5)	0.43; 0.57	2 (6.9)	12 (11.4)	0.49; 0.73
Bilateral	66 (88)	54 (91.5)		27 (93.1)	93 (88.6)	
EF recovery [No. (%)]						
Yes	44 (58.7)	46 (78)	5.5; 0.02	18 (62.1)	72 (68.6)	0.43; 0.51
No	31 (41.3)	13 (22)		11 (37.9)	33 (31.4)	

PMA, penile morphometric alterations; BMI, body mass index; CCI, Charlson comorbidity index; IIEF-EF, International Index of Erectile Function–erectile function domain; ORP, open radical prostatectomy; RARP, robot-assisted radical prostatectomy. **p*-value according to ANOVA or Chi-squared test, as indicated.

were significantly associated with a subjectively reported post-operative PMA (any type) (Table 3). Conversely, open surgery emerged as the only independent predictor of PMA post-RP, after accounting for age, CCI, BMI, baseline EF, PCa risk category, NS status, post-operative EF recovery and year of surgery (Table 3).

DISCUSSION

We assessed rate of and the potential predictors of self-reported alterations in terms of penile morphology in a cohort of pre-operatively sexually active patients treated with RP for clinically localized PCa; of clinical relevance, our data showed that 56% and 21.6% of patients complained of self-perceived PS and PMD after more than 24 months from surgery, respectively. Moreover, patients after open surgery were more likely to report PMA (either PS or PMD) compared to those treated with RARP.

Over the last decade, minimally invasive RP has overcome any open technique for RP, and the robot-assisted approach is now widely considered as the treatment of choice for PCa (Mottet *et al.*, 2016). In this regard, although not yet unequivocal, some published data reported a number of advantages of RARP in terms of peri- and post-operative functional outcomes, thus including UC and EF recovery (Ficarra *et al.*, 2012a,b; Salonia *et al.*, 2017a,b). However, the occurrence of surgical sequelae other than UI and ED has been scantly analysed in contemporary robotic series (Capogrosso *et al.*, 2016, 2017). More precisely, data suggested that the impairment of several so-called neglected aspects of sexual function after ORP is anything but uncommon. For instance, orgasmic dysfunction has been shown to affect between 20% and 93% of patients after surgery in terms of climacturia (Dubbelman *et al.*, 2010; Salonia *et al.*, 2017b); similarly, episodes of orgasm-associated pain seemed to occur in up to 16% of cases after RP (Matsushita *et al.*, 2012; Salonia *et al.*, 2017b). Likewise between 14% and 45% of patients had been reported to complain of post-operative low sexual desire in published series (Salonia *et al.*, 2017b). Nonetheless, PMA could eventually occur after RP. In a series of 126 patients treated with ORP, Gontero *et al.* reported a significant mean reduction of 1.34 cm and of 2.3 cm for the flaccid and stretched penile length, respectively, one year after surgery (Gontero *et al.*, 2007). In a large, cross-sectional study including 1288 patients, a significant reduction in penile length was self-reported by 55% of them after surgery (Carlsson *et al.*, 2012). Similarly, in a cohort of 256 sexually active men after RP, Frey *et al.* (Frey *et al.*, 2014a, b) reported a 47% of subjective penile shortening greater than 1 cm. Overall, we observed a 56% rate of patients self-reporting a significant PS (≥1 cm) after surgery, which at least confirms previous findings.

Moreover, when specifically requested to report any subjective significant post-operative modification in terms of penile shape and morphometric characteristics as compared to the baseline condition, a group as large as 21.6% of patients reported PMD occurring after RP.

Penile curvatures after surgery for PCa have been related to the development of fibrotic plaques occurring at the level of the tunica albuginea, mostly resulting in a disorder termed post-RP Peyronie's disease (Bjekic *et al.*, 2006; Tal *et al.*, 2010). Tal *et al.* reported data on the occurrence of Peyronie's disease after RP as assessed with a physical examination aimed to identify every penile plaque or nodule responsible for a significant curvature compared to the baseline condition (Tal *et al.*, 2010); of 1011 men submitted to RP, 77 developed the condition within one year post-operatively, 139 within 2 years and 161 within 3 years, respectively, thus yielding an overall Peyronie's disease incidence of 15.9%. Conversely, in a cohort of 110 men, Ciancio *et al.* reported the occurrence of either penile curvatures or waistband deformities in 11% of the operated patients (Ciancio & Kim, 2000); of clinical interest, palpable plaques were identified only in a proportion of patients reporting penile curvatures, leading the authors to classify the phenomenon as a 'penile fibrotic change' rather than a formal Peyronie's disease (Ciancio & Kim, 2000).

In this context, the surgical removal of the prostate is almost invariably associated with a more or less limited period of dormancy of the nerves underlying EF control, thus leading to a potential impairment of erectile tissue oxygenation and the consequent production of fibrogenic factors (e.g. TGF-β1, ET-1, NGF and HIF-1α) responsible for several structural changes in the erectile tissue, eventually resulting in both PS and PMD (Hatzimouratidis *et al.*, 2009). Therefore, we considered both PS and PMD as an expression of the same pathophysiological epiphenomenon. Moreover, Vasconcelos *et al.* assessed the natural history of PS through the study of every change in penile length over time after RP (Vasconcelos *et al.*, 2012); they found an initial mean loss of 1 cm in length ($p < 0.001$), which remained significant until 24 months after surgery. Indeed, the possible recovery of the baseline penile morphology has been strictly linked to the achievement of post-RP EF recovery over time (Briganti *et al.*, 2007; Vasconcelos *et al.*, 2012; Frey *et al.*, 2014a,b). For these reasons, we only focused our attention on a cohort of patients with a follow-up not inferior to 24 months in order to identify those individuals with a more probable EF recovery

Table 3 Logistic regression analysis assessing predictors of PMA (every type) at ≥ 24 months follow-up after surgery

	UVA OR; *p*-value (95% CI)	MVA OR; *p*-value (95% CI)
Age at surgery	1.04; 0.09 (0.99–1.10)	1.02; 0.53 (0.95–1.09)
BMI	1.19; 0.02 (1.02–1.40)	1.18; 0.05 (0.99–1.40)
CCI	2.82; 0.08	2.43; 0.17
0 vs. ≥1	(0.88–9.16)	(0.67–8.78)
Pre-operative IIEF-EF	0.95; 0.02 (0.91–0.99)	0.96; 0.19 (0.92–1.01)
PCa risk group		
Low	Ref; 0.57	Ref; 0.16
Intermediate	1.61; 0.21 (0.76–3.4)	1.42; 0.41 (0.61–3.30)
High	4.6; 0.02 (1.23–17.6)	4.14; 0.06 (0.92–18.5)
Year of surgery	1.36; 0.04 (1.01–1.86)	1.43; 0.07 (0.97–2.10)
EF recovery	0.33; <0.01	0.79; 0.66
No vs. Yes	(0.15–0.74)	(0.28–2.21)
Type of surgery	0.47; 0.03	0.38; 0.03
ORP vs. RARP	(0.23–0.95)	(0.16–0.93)
Nerve-sparing	0.75; 0.62	0.51;0.63
None or unilateral vs. bilateral	(0.23–2.37)	(0.16–2.46)

PMA, penile morphometric alterations; UVA, univariable analysis; MVA, multivariable analysis; OR, odds ratio; CI, confidence interval; BMI, body mass index; CCI, Charlson comorbidity index; IIEF-EF, International Index of Erectile Function–erectile function domain; ORP, open radical prostatectomy; RARP, robot-assisted radical prostatectomy.

already occurred along with potentially irreversible PMA. According to this theory, we observed higher rates of reported penile alterations after 12 months than after a longer follow-up.

Besides post-operative EF recovery (Briganti *et al.*, 2007; Iacono *et al.*, 2008), pre-operative penile length and NS procedure have been also reported as predictors of PMA after surgery (Gontero *et al.*, 2007; Tal *et al.*, 2010; Carlsson *et al.*, 2012). As a major strength of the study, we first reported novel data about the prevalence of PMA in a series of RARP patients; in this context, even almost 48% and 22% of patients complained of PS and PMD, respectively. Moreover, for the first time, we looked at potential differences between RARP and pair-matched ORP patients. Our interest was fuelled by previous data demonstrating a significant advantage of the robotic approach in terms of incidence and recovery from the so-called neglected post-operative sexual side effects (Capogrosso *et al.*, 2016); for instance, Capogrosso *et al.* previously showed that patients treated with RARP reported a faster recovery from climacturia after surgery and a lower overall incidence of painful orgasm as compared to the open approach (Capogrosso *et al.*, 2016). Of clinical relevance, our data suggested that patients treated with ORP could be at major risk of perceiving a subjective modification in terms of penile morphology after surgery as compared to those treated with RARP. In this context, we can speculate that the precision provided by a robotic approach may allow for a more careful preservation of neural tissue, eventually leading to a faster EF recovery along with a consequent reduced risk of fibrotic changes in the penile shaft. However, we cannot rule out the possibility that confounding factors such as depressive symptoms and/or treatment regrets (Christie *et al.*, 2015) could have play a role in the subjective perception of the alteration of penile morphology. These findings further underline the importance of a comprehensive discussion with every patient about all potential sexual side effects associated also with a robot-assisted surgical approach having clear that the way of dealing with sexual functioning after RP has deeply changed, going well beyond a 'simple' evaluation of the presence of functional erections (either spontaneous or pharma-assisted) and successful coital intercourses (Capogrosso *et al.*, 2017; Salonia *et al.*, 2017a,b).

Our study is not devoid of limitations. First, while post-operative functional outcome data were prospectively collected, patients had been not prospectively randomized to a surgical approach (e.g. ORP vs. RARP), thus leading to a potential selection bias partially undermining the value of these findings; however, we performed a propensity-score matching analysis to ensure the equivalence of both groups at the baseline. Second, our analyses did not take into account data regarding post-operative medications, such as pro-erectile compounds, which could have modified the study outcomes. However, EF recovery was not independently associated with PMA. Finally, although we are aware of the potential major bias related to the subjective estimation of PMA, it establishes a range of expected disease severity and outcomes that the patients are likely to experience in the real-life setting; this emerges to be even more important as it has been largely discussed that patients deserve to be comprehensively counselled about real expectations after RP even and mainly in terms of overall sexual function recovery (Salonia *et al.*, 2017a,b).

Overall, for the first time, we reported novel data about the prevalence of PMA in a series of patients treated with RARP as compared to ORP, suggesting that up to one of two patients could be bothered by a significant modification of penile morphology at long-term follow-up after surgery, with a potential higher risk for those treated with an open approach. Thereof, it is absolutely clear that patients should be carefully counselled regarding the possible occurrence of a number of less commonly discussed side effects after RP, thus including PMA.

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CONFLICT OF INTEREST

The authors have nothing to disclose.

AUTHORS' CONTRIBUTION

PC and AS performed the research and wrote the manuscript. PC and EV analysed the data. WC, AS, FP and LB collected the data. GG and FD contributed to the interpretation of the data and analyses. AB, FM and AS revised it critically.

REFERENCES

Bjekic MD, Vlajinac HD, Sipetic SB & Marinkovic JM. (2006) Risk factors for Peyronie's disease: a case-control study. *BJU Int* 97, 570–574.

Briganti A, Fabbri F, Salonia A, Gallina A, Chun FK, Deho F, Zanni G, Suardi N, Karakiewicz PI, Rigatti P & Montorsi F. (2007) Preserved postoperative penile size correlates well with maintained erectile function after bilateral nerve-sparing radical retropubic prostatectomy. *Eur Urol* 52, 702–707.

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. (2011) What is the definition of a satisfactory erectile function after bilateral nerve sparing radical prostatectomy? *J Sex Med* 8, 1210–1217.

Capogrosso P, Ventimiglia E, Serino A, Stabile A, Boeri L, Gandaglia G, Deho F, Briganti A, Montorsi F & Salonia A. (2016) Orgasmic dysfunction after robot-assisted versus open radical prostatectomy. *Eur Urol* 70, 223–226.

Capogrosso P, Ventimiglia E & Salonia A. (2017) Assessing robot-assisted laparoscopic prostatectomy. *Lancet* 389, 800.

Carlsson S, Nilsson AE, Johansson E, Nyberg T, Akre O & Steineck G. (2012) Self-perceived penile shortening after radical prostatectomy. *Int J Impot Res* 24, 179–184.

Chang SL, Kibel AS, Brooks JD & Chung BI. (2015) The impact of robotic surgery on the surgical management of prostate cancer in the USA. *BJU Int* 115, 929–936.

Charlson ME, Pompei P, Ales KL & MacKenzie CR. (1987) A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 40, 373–383.

Christie DR, Sharpley CF & Bitsika V. (2015) Why do patients regret their prostate cancer treatment? A systematic review of regret after treatment for localized prostate cancer. *Psychooncology* 24, 1002–1011.

Ciancio SJ & Kim ED. (2000) Penile fibrotic changes after radical retropubic prostatectomy. *BJU Int* 85, 101–106.

D'Agostino RB Jr. (1998) Propensity score methods for bias reduction in the comparison of a treatment to a non-randomized control group. *Stat Med* 17, 2265–2281.

Dubbelman Y, Wildhagen M, Schroder F, Bangma C & Dohle G. (2010) Orgasmic dysfunction after open radical prostatectomy: clinical correlates and prognostic factors. *J Sex Med* 7, 1216–1223.

Ficarra V, Novara G, Ahlering TE, Costello A, Eastham JA, Graefen M, Guazzoni G, Menon M, Mottrie A, Patel VR, Van der Poel H, Rosen RC, Tewari AK, Wilson TG, Zattoni F & Montorsi F. (2012a) Systematic

review and meta-analysis of studies reporting potency rates after robot-assisted radical prostatectomy. *Eur Urol* 62, 418–430.

Ficarra V, Novara G, Rosen RC, Artibani W, Carroll PR, Costello A, Menon M, Montorsi F, Patel VR, Stolzenburg JU, Van der Poel H, Wilson TG, Zattoni F & Mottrie A. (2012b) Systematic review and meta-analysis of studies reporting urinary continence recovery after robot-assisted radical prostatectomy. *Eur Urol* 62, 405–417.

Frey A, Sonksen J, Jakobsen H & Fode M. (2014a) Prevalence and predicting factors for commonly neglected sexual side effects to radical prostatectomies: results from a cross-sectional questionnaire-based study. *J Sex Med* 11, 2318–2326.

Frey AU, Sonksen J & Fode M. (2014b) Neglected side effects after radical prostatectomy: a systematic review. *J Sex Med* 11, 374–385.

Gontero P, Galzerano M, Bartoletti R, Magnani C, Tizzani A, Frea B & Mondaini N. (2007) New insights into the pathogenesis of penile shortening after radical prostatectomy and the role of postoperative sexual function. *J Urol* 178, 602–607.

Hatzimouratidis K, Burnett AL, Hatzichristou D, McCullough AR, Montorsi F & Mulhall JP. (2009) Phosphodiesterase type 5 inhibitors in postprostatectomy erectile dysfunction: a critical analysis of the basic science rationale and clinical application. *Eur Urol* 55, 334–347.

Iacono F, Prezioso D, Somma P, Chierchia S, Galasso R & Micheli P. (2008) Histopathologically proven prevention of post-prostatectomy cavernosal fibrosis with sildenafil. *Urol Int* 80, 249–252.

Matsushita K, Tal R & Mulhall JP. (2012) The evolution of orgasmic pain (dysorgasmia) following radical prostatectomy. *J Sex Med* 9, 1454–1458.

Mohler JL. (2010) The 2010 NCCN clinical practice guidelines in oncology on prostate cancer. *J Natl Compr Canc Netw* 8, 145.

Mottet N, Bellmunt J, Bolla M, Briers E, Cumberbatch MG, De Santis M, Fossati N, Gross T, Henry AM, Joniau S, Lam TB (2016) EAU-ESTRO-SIOG guidelines on prostate cancer. Part 1: screening, diagnosis, and local treatment with curative intent. *Eur Urol* 71, 618–629.

Nguyen LN, Head L, Witiuk K, Punjani N, Mallick R, Cnossen S, Fergusson DA, Cagiannos I, Lavallee LT, Morash C & Breau RH (2017) The risks and benefits of cavernosal neurovascular bundle sparing during radical prostatectomy: a systematic review and meta-analysis. *J Urol* 198, 760–769.

Patel VR, Schatloff O, Chauhan S, Sivaraman A, Valero R, Coelho RF, Rocco B, Palmer KJ & Kameh D. (2012) The role of the prostatic vasculature as a landmark for nerve sparing during robot-assisted radical prostatectomy. *Eur Urol* 61, 571–576.

Rosen RC, Riley A, Wagner G, Osterloh IH, Kirkpatrick J & Mishra A. (1997) The international index of erectile function (IIEF): a multidimensional scale for assessment of erectile dysfunction. *Urology* 49, 822–830.

Salonia A, Adaikan G, Buvat J, Carrier S, El-Meliegy A, Hatzimouratidis K, McCullough A, Morgentaler A, Torres LO & Khera M (2017a) Sexual rehabilitation after treatment for prostate cancer-part 1: recommendations from the fourth international consultation for sexual medicine (ICSM 2015). *J Sex Med* 14, 285–296.

Salonia A, Adaikan G, Buvat J, Carrier S, El-Meliegy A, Hatzimouratidis K, McCullough A, Morgentaler A, Torres LO & Khera M (2017b) Sexual rehabilitation after treatment for prostate cancer – part 2: recommendations from the 4th International Consultation For Sexual Medicine (ICSM 2015). *J Sex Med* 14, 297–315.

Tal R, Heck M, Teloken P, Siegrist T, Nelson CJ & Mulhall JP. (2010) Peyronie's disease following radical prostatectomy: incidence and predictors. *J Sex Med* 7, 1254–1261.

Vasconcelos JS, Figueiredo RT, Nascimento FL, Damiao R & da Silva EA. (2012) The natural history of penile length after radical prostatectomy: a long-term prospective study. *Urology* 80, 1293–1296.