



前列腺癌根治术中前列腺尖部及膀胱颈精准解剖与重建对尿控改善的影响

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【摘要】 目的 探讨前列腺癌根治术中行前列腺尖部及膀胱颈尿道精准解剖与重建对术后尿控改善的影响。方法 回顾性选取2023年1月1日-2023年12月31日在本中心行机器人辅助前列腺癌根治术的随访资料完善的前列腺癌患者131例,其中64例研究组使用改良手术方式,67例对照组为传统手术方式。采用倾向性评分匹配法,按照1:1的比例匹配两组的年龄、体质量指数(body mass index, BMI)、术前前列腺特异抗原(prostate specific antigen, PSA)、前列腺体积、前列腺影像报告和数据系统(Prostate Imaging Reporting and Data System, PI-RADS)评分、穿刺Gleason评分、术前尿控情况等资料。匹配后比较两组患者的术前基线资料、手术切缘阳性率、术后3个月时的尿控情况等资料。手术前后尿控情况的评估均采用术前国际尿失禁咨询问卷简表(International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form, ICIQ-UI SF)量表。结果 通过1:1倾向性评分匹配,研究组和对照组共成功匹配56对患者。术后3个月时,研究组ICIQ-UI SF量表得分中位数为7.0分,对照组ICIQ-UI SF量表得分中位数为9.5分,差异有统计学意义($P<0.05$);研究组和对照组切缘阳性率差异无统计学意义。多重线性回归分析发现,研究组中前列腺体积和Gleason评分均与术后3个月时ICIQ-UI SF评分呈正相关($P<0.05$),对照组中患者年龄与术后3个月时ICIQ-UI SF评分呈正相关($P<0.05$)。结论 前列腺癌根治术中对前列腺尖部及膀胱颈尿道精准解剖与重建可明显改善术后3个月时患者尿控功能。

【关键词】 前列腺癌根治术 精准解剖 重建 尿控

Effect of Precise Dissection and Reconstruction of the Prostate Apex and Bladder Neck in Radical Prostatectomy on Urinary Control Improvement WANG Yufan¹, TAI Sheng¹, ZHOU Jun¹, YANG Cheng¹, SHI Haoqiang¹, CHEN Jinhui¹, LIANG Chaozhao^{1,2,3,Δ}. 1. Department of Urology, The First Affiliated Hospital of Anhui Medical University, Hefei 230022, China; 2. Institute of Urology, Anhui Medical University, Hefei 230022, China; 3. Anhui Provincial Key Laboratory of Urological and Andrological Diseases Research and Translational Medicine, Hefei 230022, China

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【Abstract】 **Objective** To investigate the impact of the precise dissection and reconstruction of the prostate apex and bladder neck urethra during radical prostatectomy on the improvement in postoperative urinary control in patients with prostate cancer. **Methods** A retrospective study was conducted. A total of 131 prostate cancer patients who underwent robot-assisted radical prostatectomy at our institution between January 1, 2023 and December 31, 2023 were enrolled. The subjects were divided into two groups, with 64 in the experimental group and 67 in the control group. Patients in the experimental group underwent radical prostatectomy in a modified approach, while those in the control group underwent conventional radical prostatectomy. Propensity score matching was employed to match the two groups at a 1-to-1 ratio based on age, body mass index (BMI), preoperative prostate specific antigen (PSA), prostate volume, Prostate Imaging Reporting and Data System (PI-RADS) scores, biopsy Gleason score, and preoperative urinary control status. After matching, we compared the preoperative baseline data, surgical margin positivity rates, and urinary control status at 3 months post operation between the two groups. Urinary control was assessed before and after surgery using the International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UI SF) scale. **Results** A total of 56 pairs of patients were successfully matched between the experimental group and the control group through 1-to-1 propensity score matching. At 3 months after surgery, the median score for ICIQ-SF scale of the experimental group was 7.0 points, while that of the control group was 9.5 points, with the difference being statistical significant ($P<0.05$). There was no significant difference in the positive rate of incision margins between the experimental group and the control group. Multiple linear regression analysis showed that both the prostate volume and the Gleason score in the experimental group were positively correlated with the ICIQ-UI SF scores 3 months after surgery ($P<0.05$), while the age of patients in the control group was positively correlated with ICIQ-UI SF score 3 months after surgery ($P<0.05$). **Conclusion** Precise dissection and reconstruction of the prostate apex and bladder neck urethra during

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radical prostatectomy significantly improve the postoperative urinary control of patients at 3 months after surgery.

【Key words】 Radical prostatectomy Precise dissection Reconstruction Urinary control

在全球范围内,前列腺癌是严重危害中老年男性人群健康的实体肿瘤之一^[1]。对于早期前列腺癌患者,根治手术是首选的治疗方法^[2]。但尿失禁为术后常见的并发症之一,严重影响患者的生活质量^[3]。多年来,许多泌尿外科专家通过解剖研究^[4-6]、结构重建^[7-8]等多种技术使得前列腺癌术后尿控状况有了明显改善;为进一步提高患者术后尿控效果,本中心近年来对前列腺尖部、膀胱颈尿道精准解剖并进行重建,取得明显效果,现报道如下。

1 资料与方法

1.1 队列资料

回顾性选取2023年1月1日-2023年12月31日在本中心行手术治疗随访资料完善的前列腺癌患者131例,按照手术方式不同分为研究组64例及对照组67例,两组所有患者均在手术2周后拔除导尿管。手术治疗3个月后对患者进行一次随访,随访收集的数据包括:①术前基线数据:年龄、术前前列腺特异抗原(prostate specific antigen, PSA)、体质量指数(body mass index, BMI)、穿刺Gleason评分、前列腺体积、前列腺影像报告和数据系统(Prostate Imaging Reporting and Data System, PI-RADS)评分、术前国际尿失禁咨询问卷简表(International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form, ICIQ-UI SF)评分等;②术后资料:切缘情况、术后3个月时的ICIQ-UI SF尿控量表评分等;③除尿失禁以外的其他围手术期和远期并发症发生情况。本研究经安徽医科大学第一附属医院医学伦理委员会审批通过(伦理批号:快-安医一附院伦审-PJ 2024-06-32)。

1.2 纳入与排除标准

纳入标准:①术前穿刺病理资料完善,诊断为前列腺癌;②手术指征明确,术前无手术相对或绝对禁忌;③患者及家属充分知情同意。

排除标准:①合并其他肿瘤的患者;②存在神经系统疾病的患者;③手术前半年至随访日有脑血管疾病发作史的患者;④存在其他可能影响尿控疾病的患者;⑤对手术和麻醉出现预料外不良反应的患者;⑥术前行内分泌治疗者;⑦术前存在前列腺手术史的患者;⑧术前存在尿道狭窄病史的患者。

1.3 手术方法

1.3.1 研究组

常规消毒铺巾,保留导尿,建立气腹,置入穿刺器及

达芬奇机器人手术器械。

探查腹腔后沿左、右脐动脉与左、右侧腹壁之间无血管平面之间依次钝、锐结合切开双侧膀胱侧间隙上至脐血管起始。沿前列腺、膀胱外侧脂肪囊与盆壁之间无血管平面逐渐松解;沿前列腺表面脂肪囊与其包膜之间无血管平面逐步将脂肪清理至膀胱前壁,后充分游离前列腺侧壁及尖部,缝扎前列腺尖部静脉复合体。

显露出膀胱前列腺交界处,准确识别交界处“倒三角”形后分离脂肪组织,自膀胱肌肉纤维和前列腺交界处进行分离;确保瘤控基础上分离和保留膀胱颈部括约肌及部分尿道,后予以切开逐步显露膀胱颈部尿道前壁后壁(图1A);尽可能保留膀胱颈与尿道交界处漏斗状结构。将导尿管自膀胱腔内抽出再次插入体内,充分显露出膀胱颈后唇与前列腺后壁交界处疏松组织,沿无血管平面锐性切开打开膀胱前列腺肌;游离、显露双侧输精管、精囊。

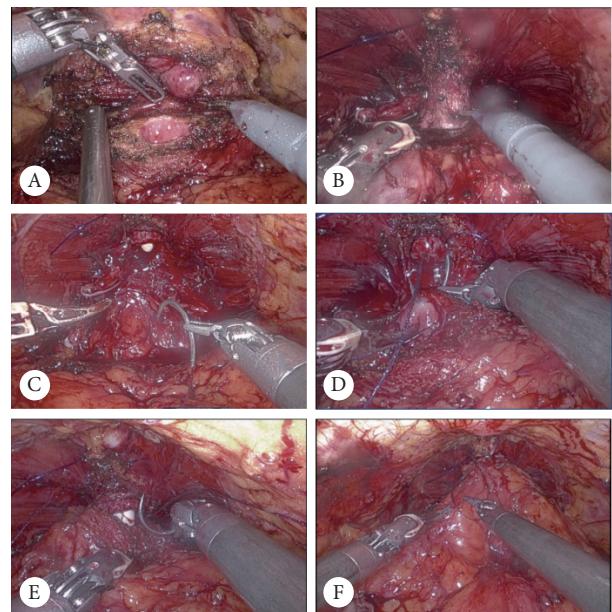


图1 精准解剖的机器人辅助前列腺根治术

Fig 1 Robot-assisted radical prostatectomy with precise dissection

A, Dissection of the urethra at the bladder neck; B, dissection of the prostatic apex urethra; C, complete resection of prostatic tumor; D, anastomosis of bladder neck and prostatic apex urethra; E, anterior wall anastomosis; F, anastomosis completed.

切开Denonvilliers筋膜后沿直肠前间隙与前列腺后壁筋膜之间无血管平面钝性游离至前列腺尖部及双侧底部血管束;离断双侧侧韧带侧血管束;后离断前列腺前基质组织,逐步显露出尖部尿道前壁(图1B)。旋转游离

前列腺腺体,尽可能保留完整的尖部结构。在确保切缘阴性及功能尿道基础上保留足够长度尖部尿道后离断,完整切除前列腺(图1C),而后吻合膀胱颈口与后尿道(图1D~图1F)。

1.3.2 对照组

采用常规机器人辅助腹腔镜前列腺癌根治术方法。

同法游离组织及缝扎前列腺尖部静脉复合体;显露出膀胱前列腺交界处,自交界处直接切开逐步显露膀胱颈部尿道前后壁;再次置入尿管,充分显露出膀胱颈后唇与前列腺后壁交界处疏松组织(图2A),沿疏松无血管平面锐性切开膀胱前列腺肌;游离、显露双侧输精管、

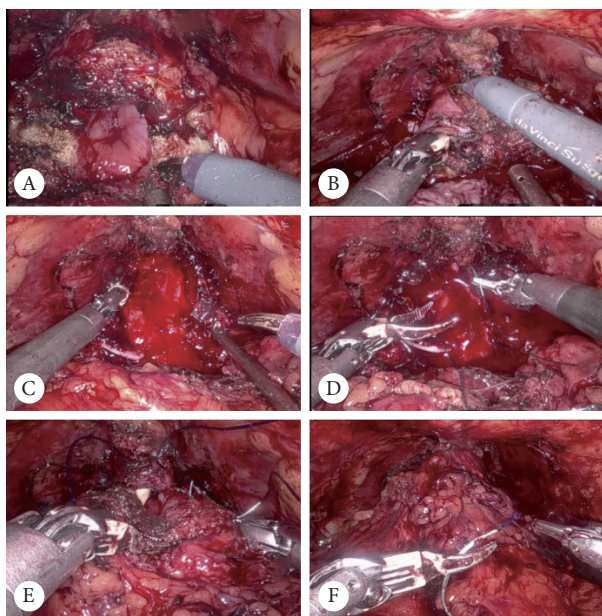


图 2 常规机器人辅助前列腺根治术

Fig 2 Conventional robotic-assisted radical prostatectomy

A, Incision in the bladder neck urethra; B, incision of the prostatic apex urethra; C, complete resection of prostatic tumor; D, anastomosis of bladder neck and prostatic apex urethra; E, anterior wall anastomosis; F, anastomosis completed.

精囊。

充分游离、显露前列腺尖部尿道(图2B),完整切除前列腺组织(图2C);而后吻合膀胱颈、尖部尿道(图2D~图2F)。

1.4 资料收集与分析方法

依次统计患者术前相关基线数据及围手术期相关数据。术前术后尿控情况采用ICIQ-UI SF量表评分。ICIQ-UI SF量表总分21分,得分高表示尿控较差。

计量资料、计数资料及等级资料均采用IBM SPSS Statistics 29.0.1.0处理。对符合正态分布的计量资料以 $\bar{x} \pm s$ 表示,采用 t 检验进行两两比较,非正态计量资料和等级资料均采用Mann-Whitney U 检验比较;计数资料以率(%)表示,使用 χ^2 检验在组间进行比较;使用倾向性评分匹配法降低研究组和对照组的基线差异,纳入年龄、BMI、术前PSA、前列腺体积、PI-RADS评分、穿刺Gleason评分、术前尿控情况等7项资料进行两组的1:1匹配,卡钳值设为0.1。利用斯皮尔曼等级相关系数(Spearman's rank correlation coefficient)对倾向性评分匹配后的两组基线数据进行筛选,将 $P < 0.1$ 的数据纳入多重线性回归。 $\alpha = 0.05$ 为检验水准。

2 结果

2.1 倾向性评分匹配及匹配前后基线资料比较

倾向性评分匹配成功56对患者,将匹配前后患者的基线资料在两组间进行比较(表1)。年龄、BMI采用 t 检验比较,认为匹配前后组间差异均无统计学意义($P > 0.05$)。术前PSA、前列腺体积、PI-RADS评分、穿刺Gleason评分、术前尿控ICIQ-UI SF评分使用Mann-Whitney U 检验进行比较,认为匹配前后组间差异均无统计学意义($P > 0.05$)。以平行假设检验来检测倾向性评分匹配的效果,各项基线资料的标准化偏差绝对值均小

表 1 术前基线资料

Table 1 Preoperative baseline data

Item	Before matching				After matching			
	Experimental group ($n=64$, $\bar{x} \pm s$ or median [P_{25} , P_{75}])	Control group ($n=67$, $\bar{x} \pm s$ or median [P_{25} , P_{75}])	t/Z	P	Experimental group ($n=56$, $\bar{x} \pm s$ or median [P_{25} , P_{75}])	Control group ($n=56$, $\bar{x} \pm s$ or median [P_{25} , P_{75}])	t/Z	P
Age/yr.	68.45±7.79	69.37±7.37	-0.694	0.489	67.79±7.85	68.32±7.15	0.377	0.707
BMI/(kg/m ²)	23.70±3.66	23.79±3.08	-0.165	0.869	23.54±3.83	23.49±2.96	-0.086	0.931
Preoperative PSA/(ng/mL)	15.67 (8.19, 29.57)	13.13 (8.92, 21.04)	-0.541	0.588	13.44 (7.98, 30.44)	13.26 (8.66, 22.83)	-0.201	0.841
Prostate volume/cm ³	37.87 (29.11, 46.96)	34.40 (23.34, 52.80)	-1.137	0.255	36.99 (29.10, 44.70)	35.73 (23.55, 53.18)	-0.576	0.565
PI-RADS	4.0 (4.0, 4.0)	4.0 (4.0, 5.0)	-0.583	0.561	4.0 (4.0, 4.0)	4.0 (4.0, 5.0)	-0.197	0.843
Gleason score	7.0 (7.0, 8.0)	7.0 (7.0, 7.0)	-1.464	0.143	7.0 (7.0, 8.0)	7.0 (7.0, 7.0)	-0.050	0.960
Preoperative ICIQ-UI SF	0 (0.0, 0.0)	0.0 (0.0, 0.0)	-1.542	0.123	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	-0.593	0.553

于0.2, 且匹配后各基线资料的差异均无统计学意义 ($P > 0.05$), 说明匹配效果较好。

2.2 手术后组间尿控功能比较

采用Mann-Whitney *U* 检验对匹配前后两组患者术后3个月时的尿控进行比较, ICIQ-UI SF量表评分结果的中位数匹配前后均为研究组较低而对照组较高, 研究组得分中位数为7.0分, 对照组得分中位数为9.5分, 证实有

统计学意义 ($P < 0.05$)。该结果提示采用改良手术方法的患者术后3个月时尿控功能恢复更好(表2)。

2.3 手术切缘阳性率比较

为确定改良手术方法是否对手术的切缘阳性率有不良影响, 对匹配后两组患者的切缘阳性率进行卡方检验, 连续性校正卡方检验认为研究组和对照组切缘阳性率的差异无统计学意义 ($P > 0.05$) (表3)。

表 2 术后3个月两组患者尿控功能比较

Table 2 Comparison of postoperative urinary continence function

Item	Before matching		Z	P	After matching		Z	P
	Experimental group (n=64, median [P ₂₅ , P ₇₅])	Control group (n=67, median [P ₂₅ , P ₇₅])			Experimental group (n=56, median [P ₂₅ , P ₇₅])	Control group (n=56, median [P ₂₅ , P ₇₅])		
Postoperative ICIQ-UI SF	7.00 (7.00, 9.00)	10.00 (8.00, 12.00)	-4.619	<0.001	7.00 (6.25, 9.00)	9.50 (8.00, 12.00)	-4.154	<0.001

表 3 匹配后切缘阳性率比较

Table 3 Comparison of positive margin rates after matching

Group	n	Positive margin rate/case (%)	Negative margin rate/case (%)	Chi-square value	P
Experimental	56	2 (3.571)	54 (96.429)	0.176	0.675
Control	56	4 (7.143)	52 (92.857)		

2.4 基线资料与术后尿控关系

为探究改良术式适用于何种类型的患者, 基于基线数据资料进行线性回归分析。先利用斯皮尔曼等级相关系数对倾向性评分匹配后的两组基线数据进行筛选, 将 $P < 0.1$ 的数据纳入多重线性回归(表4), 分析后得出, 在匹配后的研究组中, 前列腺体积和Gleason评分均与术后

表 4 两组患者术后3个月 ICIQ-UI SF 评分与各基线资料相关性分析

Table 4 Correlation analysis of ICIQ-UI SF scores and the baseline data 3 month after surgery in the the two groups

Item	3 months postoperation ICIQ-UI SF	
	Experimental group (n=56)	Control group (n=56)
Age	r	-0.014
	P	<0.001
BMI	r	0.088
	P	0.519
Preoperative PSA	r	0.106
	P	0.435
PI-RADS	r	-0.088
	P	0.519
Prostate volume	r	0.339
	P	0.011
Gleason score	r	0.353
	P	0.008
Preoperative ICIQ-UI SF	r	0.158
	P	0.245

3个月时 ICIQ-UI SF 评分呈正相关 ($P < 0.05$), 提示研究组中前列腺体积较大、Gleason 评分较高的患者尿控较差(表5)。在对照组中患者年龄与术后3个月时 ICIQ-UI SF 评分呈正相关 ($P < 0.05$), 提示对照组中年龄较高的患者预后较差(表6)。

表 5 研究组术后3个月 ICIQ-UI SF 评分的多重线性回归分析

Table 5 Multiple linear regression analysis of ICIQ-UI SF scores 3 month after surgery in the experimental group

Item	B	β	SE	t	P	VIF	95% CI
Prostate volume	0.064	0.368	0.021	3.079	0.003	1	0.023-0.105
Gleason score	1.225	0.328	0.446	2.749	0.008	1	0.352-2.099

B: partial regression coefficient; SE: standard error; VIF: variance inflation factor; CI: confidence interval.

表 6 对照组术后3个月 ICIQ-UI SF 评分的多重线性回归分析

Table 6 Multiple linear regression analysis of ICIQ-UI SF scores 3 month after surgery in the control group

Item	B	β	SE	t	P	VIF	95% CI
Age	0.229	0.442	0.068	3.377	0.001	1.18	0.096-0.362
Preoperative ICIQ-UI SF	0.273	0.084	0.426	0.641	0.524	1.18	-0.562-1.108

B: partial regression coefficient; SE: standard error; VIF: variance inflation factor; CI: confidence interval.

2.5 两组术后并发症情况

统计围手术期并发症情况, 包括严重出血、感染、直肠损伤、尿瘘、深部静脉血栓、肺栓塞, 结果为两组均无患者发生围手术期并发症。对于远期并发症, 除尿失禁情况外, 还随访两组患者是否发生膀胱颈挛缩及腹股沟疝, 结果为两组均无患者发生以上两种远期并发症。

3 讨论

随着我国前列腺癌发病率的逐年升高^[9], 早期前列腺癌患者越来越多, 前列腺癌根治手术的患者也越来越

多。然而术后尿失禁的问题一直是前列腺癌根治术的一大难题^[10-12]。在术后早期,较多患者可能存在尿控不佳的困扰;少数患者可存在术后长期尿失禁,对患者的生活质量造成较大影响^[13]。多年来,泌尿外科医师在尿控方面做了大量研究,提升了术后尿控质量。本中心也对前列腺癌根治术进行了相关研究,并提出了一些改良的技术和方法^[14]。本研究对膀胱颈及前列腺尖部进行精准解剖与重建,并与传统手术方案进行研究比较,取得了明显效果。

既往行前列腺根治术后患者尿控情况较差的原因可能在于,手术中通常在膀胱颈和前列腺尖部远端直接切断尿道,这种方式所带来的周围组织损伤,包括尿控相关肌肉和神经的损伤相对较重,且残留尿道较短,膀胱颈和远端尿道吻合后张力较大^[15]。因此既往有术者对手术方式进行改进,比如在不影响瘤控的前提下尽可能保留正常组织,以及切除后对结构进行重建。保留组织的改良包括膀胱颈的保留^[16-18]、神经血管束的保留^[19-20]、前列腺尖部尿道的保留等^[21-22];结构的重建包括盆底筋膜重建等^[23]。这一思路整体得到学界认可,然而受限于手术器材、术者能力以及患者自身情况,以往这类改良手术并非主流选择,多数术者仍以传统手术方式为主。

机器人辅助腹腔镜手术在世界范围内已广泛开展,在泌尿微创领域也为患者的手术治疗带来了新的可能性^[24]。机器人手术具有视野清晰、暴露彻底、操作精准的特点,在减少术中创伤、缩短手术时间、改善患者术后恢复的方面具有传统腹腔镜手术难以媲美的优势。术中损伤的减轻对于改善患者术后尿控具有积极影响^[25]。既往有研究表明,使用辅助机器人行前列腺根治手术相较一般腹腔镜手术在术后尿控恢复中更有优势^[26]。

得益于机器人手术系统的推广,其精准微创的特性也可被用于上述手术内容的改良。本研究回顾选取了本中心曾行的改良手术病例,这些病例包含研究组和对照组在内,均利用手术机器人完成。其中研究组在术中通过精准解剖,同时予以最大程度保留膀胱颈和前列腺尖部尿道及其周围组织,再予以行膀胱颈-尿道吻合,重建尿道结构;对照组则行常规机器人辅助腹腔镜前列腺根治术。研究组术式的优势在于:①膀胱颈结构完整,无需重建膀胱颈,且具有括约肌功能的环形纤维也得到保留;②保留了前列腺尖部周围组织复合体;③膀胱颈和前列腺尖部部分尿道的保留降低了吻合后张力。这些因素均有利于术后尿控恢复。本研究分析结果显示,经倾向性评分匹配后,研究组术后3个月时ICIQ-UI SF评分中位数7.0分,对照组为9.5分($P < 0.01$)。结果表示研究组术后3个月时尿控恢复较好。

对匹配后切缘阳性率进行分析,研究组切缘阳性仅有2例,占研究组的3.571%;对照组切缘阳性4例,占比7.413%,切缘阳性率差异无统计学意义。研究组保留组织更多但并未影响瘤控,这可能是由于研究组术中将前列腺与周围组织分离更加清晰彻底,在手术过程中更易发现肿瘤与周围组织是否关系密切,利于完整切除肿瘤。

此外,为明确何种基线特征的患者更适合选择改良术式,对匹配后的两组数据分别进行相关性分析筛选,利用剩余自变量进行多重线性回归分析,结果提示研究组中前列腺体积较大、Gleason评分较高的患者尿控较差,对照组中年龄较高的患者尿控较差。两组分析结果的差异可能提示,年龄较高的患者更适合行改良术式,而前列腺体积较大、Gleason评分较高的患者接受改良术式可能作用不显著。然而,这一结论还需以更大的样本量及更多样化的统计方式进一步验证。

综上所述,该改良术式通过行膀胱颈和前列腺尖部尿道的精准解剖并行膀胱颈-尿道重建,最大程度保留膀胱颈、前列腺尖部尿道和周围组织,可以显著改善患者在术后3个月时的尿控功能,并且在切缘阳性率方面相较传统手术也无差异。该研究的不足之处在于:①样本量较小,且为单中心研究,可能存在数据偏倚;②研究只局限于一种改良手术方式,既往还存在其他的改良手术方式,其中一部分已被指出可使患者受益^[27-30],根据患者自身情况的不同,或许存在效果优于本研究中改良术式的方案。将来也可进一步探究个体化手术方案的选择,即在一般的机器人辅助前列腺癌根治手术基础上,结合患者身体一般情况、穿刺病理、PSA水平和术前影像学检查提供的解剖信息等因素,为患者定制最适合的组织保留和结构重建方案。可考虑进行多中心、大样本的研究,建立相关的尿控预后预测模型以用于患者手术方案的选择。

* * *

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