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Predictors of trainees' proficiency during the learning curve of robot-assisted radical prostatectomy at high--volume institutions: results from a multicentric series

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Introduction The aim of this series was to evaluate predictors of Proficiency score (PS) achievement on a multicentric series of robot-assisted radical prostatectomies (RARP) performed by trainee surgeons with two different surgical techniques at four tertiary-care centers.

Material and methods Four institutional datasets were merged and queried for RARPs performed by surgeons during their learning curve (LC) between 2010 and 2020 using two different approaches (Group A, Retzius-sparing RARP, n = 164; Group B, standard anterograde RARP, n = 79). Logistic regression analysis was performed to identify predictors of PS achievement for the overall trainee cohort. For all analyses, a two-sided p <0.05 was considered significant.

Results Group B showed significantly increased median operative time, positive surgical margins (PSM) status, increased number of nerve-sparing procedures, shorter LC time (each p <0.04). PS, continence status, potency, biochemical recurrence and 1-year trifecta rates were comparable between groups (each p >0.3). On multivariable analysis, time from LC starting ≥12 months (OR = 2.79; 95%IC [1.15–6.76]; p = 0.02) and a nerve-sparing intent (OR = 3.18; 95%IC [1.15–8.77]; p = 0.02) were independent predictors of PS score achievement (Table 3).

Conclusions Higher PS rates for RARP trainees may be expected after 12 months from LC beginning. Short-term training courses are unlikely to confer proper surgical training, while long-term structured training programs seem to be beneficial on perioperative outcomes.

Key Words: retzius-sparing ‹› trifecta ‹› learning curve ‹› proficiency score ‹› robot-assisted radical prostatectomy

INTRODUCTION

Robot-assisted radical prostatectomy (RARP) represents one of the most performed, as well as the first major robotic procedure learned by urologists [1]. Nonetheless, RARP training programs remain suboptimal in transferring surgical expertise to trainees during their learning curve (LC) [2]. The latter consists in the timeframe necessary for a trainee surgeon to accomplish the entire procedure in a proficient way, while achieving satisfactory functional and cancer-control outcomes [3]. To date, different approaches to RARP-LC evaluation have been proposed with conflicting results due to the rapid spread of multiple approaches and continuous technical refinements [4]. Consequently, there is no evidence-based definition or standardized platform to measure RARP-LC. In this context, we recently introduced an innovative tool, namely 'Proficiency score' (PS) to provide an early assessment of surgical quality among trainee surgeons performing RARP [5]. Notably, PS was independently associated with one-year trifecta achievement. However, no previous studies investigated whether patient and tumor characteristics, as well as surgical approaches may influence PS achievement. Consequently, we conducted a multi-institutional case-control study with the primary objective to investigate those factors. In more detail, we focused our attention on the 'Retzius-sparing' (RS) approach [6, 7]. Despite evidence suggesting improved early continence recovery in RS relative to standard RARP, several authors still consider RS-RARP a complex procedure that requires a prolonged LC [8, 9]. Conversely, we hypothesized that no differences in proficiency score achievement were recorded between RS vs standard (STD)-RARP performed by trainee surgeons.

MATERIAL AND METHODS

Study design and study population

We relied on a retrospective multi-institutional cohort spanning from 2010 to 2020. We included patients with low and intermediate risk prostate cancer (PCa), according to European Association of Urology (EAU) guidelines [10], treated with RARP at any of the participating institutions. We excluded patients who underwent pelvic lymph node dissection (PLND) in addition to RARP. Moreover, cases operated by mentors were necessary only to calculate the PS and subsequently excluded. Additionally, only the first 50 consecutive RARP performed by a trainee surgeon were considered part of the LC. Thus, the final cohort relied exclusively on RARP performed by trainee surgeons during their LC.

Notably, RS-RARP were performed only at one of the participating institutions (Niguarda Hospital, Milan, Italy), where this represents the preferred apporach. Conversely, STD-RARP were performed at all other participating institutions. All trainee procedures were performed under direct supervision of their mentors.

Finally, neither double console nor a standardized training protocol were implemented at any participating institution.

Variables definition

The following data were available: age (years), body mass index (BMI, kg/m^2), hypertension, diabetes, American Society of Anesthesiology (ASA) score (1–2 vs 3–4), prostate volume (ml), overall RARP duration (min), technique (RS vs STD), number of consecutive procedures, time from LC starting (months), nerve-sparing intent (yes vs no), perioperative transfusion, perioperative complication (highest Clavien-Dindo [11]), pathologic T stage (pT2 vs pT ≥3), surgical margin status, one-year continence status (no/safety vs multiple pads), one-year sexual function [spontaneous erection sufficient for intercourse ± phosphodiesterase type 5 inhibitors (PDE5i)], one-year biochemical recurrence (BCR) and one-year trifecta. Trifecta was defined as follows: (1) prostate-specific antigen (PSA) ≤0.2 ng/mL with confirmatory value; (2) attainment of erections sufficient for intercourse with or without oral pharmacological agents; (3) wearing zero/safety pads [12]. The outcome of interest, 'Proficiency score', was defined as coexistence of all following criteria: a comparable operation time to the interquartile range (IQR) of mentor surgeon at each center (Table 1); absence of any significant perioperative complications Clavien-Dindo Grade 3–5; no perioperative blood transfusions; negative surgical margins [1].

Statistical analysis

First, the study population was stratified according to surgical approach between RS vs STD-RARP. Frequencies and proportions were reported for categorical variables, while means and standard deviations were reported for continuously coded variables. Descriptive analyses were used. Second, to identify independent predictors of 'Proficiency score' achievement, we fitted univariable and multivariable logistic regression models. All available covariates were tested in a stepwise fashion, according to previous methodology [13]. All tests were two-sided with a level of significance set at $p < 0.05$. Statistical analysis was carried out using the Statistical Package for Social

Sciences (SPSS) software v.27.0 (IBM Corp, Armonk, NY, USA).

RESULTS

Baseline characteristics

We identified 243 patients operated by 16 trainee surgeons during their LC (Table 1). Of those patients, 164 vs 79 were treated with RS (Group A) vs STD-RARP (Group B), respectively. Group A exhibited longer median time from LC starting (22.0 vs 7.2 months, p = 0.02), shorter RARP duration (120 vs 161 min, p = 0.02) and lower rate of positive surgical margin (9.7 vs 29.1%, p = 0.015) than Group B. Moreover, Group A patients were treated less frequently with nerve-sparing intent (35.3 vs 73.4%, p = 0.038). No statistically significant differences were observed for other baseline and perioperative features between the two groups (each p ≥0.05). Additionally, no difference in BCR rate as well as one-year continence, sexual function and trifecta achievement were recorded between RS vs STD-RARP (each p ≥0.05, Table 2).

Predictors of 'Proficiency score' achievement

Overall, Proficiency score was achieved in 113 patients (46.5%). No differences, in Proficiency score achievement rate was observed between Group A vs Group B (43.2 vs 53.1%, p = 0.087). At univariable logistic regression analysis, only time from LC starting ≥12 months (OR 2.48; 95%IC 1.06–5.81, p = 0.035) and use of nerve-sparing approach (OR 2.71; 95%IC 1.02–7.16, p = 0.04) were associated with Proficiency score achievement. After multivariable adjustments, time from LC starting ≥12 months (OR 2.79; 95%IC 1.15–6.76; p = 0.02) and use of nerve-sparing intent (OR 3.18; 95%IC 1.15–8.77; p = 0.02) remained independently predictors of Proficiency score achievement (Table 3).

Table 1. *Distribution of trainers involved, median operative times of experienced surgeons, serving as surrogate for calculating proficiency score*

Center	LC period	Median operative time	IQR	Number of trainers on LC
Niguarda-Milan	2014–2021	130	110-150	7
Bruxelles	2017–2019	210	170-240	1
Trento	2015–2021	190	134-257	4
Regina Elena-Rome	2019–2021	130	109-142	4

LC – learning curve; IQR – interquartile range

Table 2. *Baseline, perioperative, pathologic and functional outcomes of LC surgeons cohorts according to surgical approach*

Variable	Retzius-sparing (n = 164)	Standard anterograde technique (n = 79)	p
Age at surgery (n, median, IQR)	65 (60–70)	68 (64–72)	0.758
Number of consecutive procedures (n, median, IQR)	27 (11–40)	10 (4–25)	0.095
Time from LC starting (n, median, IQR)	22 (9–41)	7.2 (2–12)	0.001
Operative time (median, IQR)	120 (120–150)	161 (128–223)	0.02
ASA score: 1–2 3–4	 132 (80.4%) 32 (19.6%)	 73 (92.4%) 6 (7.6%)	0.158
Diabetes (n,%)	3 (1.8%)	7 (8.8%)	0.197
Hypertension (n, %)	25 (15.2%)	20 (25.3%)	0.467
Nerve-sparing intent (n,%)*	58 (35.3%)	58 (73.4%)	0.038
pT (n, %): pT1–pT2 pT3	 155 (94.5%) 9 (5.4%)	 59 (74.6%) 20 (25.4%)	0.084
PSM (n, %)	16 (9.7%)	23 (29.1%)	0.015
Perioperative Clavien-Dindo (n, %): 1–2 3–5	 5 (3%) 0	 6 (7.5%) 3 (3.7%)	0.053
Perioperative transfusions (n,%)	2 (1.2%)	2 (2.5%)	0.078
Prostate volume (ml)	42 (35-60)	51 (36.7-66.2)	0.402
BCR (n, %)	4 (2.43%)	2 (2.53%)	0.306
Continence (0–1 safety/pad)	87%	96%	0.483
Sexual functions (spontaneous and/or with PDE5-I use)	54 (32.9%)	25 (31.6%)	0.515
Trifecta (1-year)	57 (34.7%)	27 (34.1%)	0.796
Proficiency score (n, %)	71 (43.2%)	42 (53.1%)	0.087

*(Including unilateral and bilateral nerve-sparing procedures)
n – number of patients; LC – learning curve; IQR – interquartile range;
ASA – American Society of Anesthesiologists; PSM – positive surgical margin;
BCR – biochemical recurrence; PDE5-I – phosphodiesterase type 5 inhibitor

DISCUSSION

To date, several studies have investigated the role of host and surgical factors affecting RARP-LC according to different metrics (eg. surgical margin, operative time, intraoperative complications, estimated blood loss, etc.) with conflicting results [4]. To overcome these limitations, we recently proposed a composite endpoint (PS) which independently predicts one-year trifecta among trainee surgeons performing RARP [5]. Nevertheless, determinants of PS achievement are yet to be identified in this setting. Herein, we focused on the role of host and surgical factors, which may significantly impact or predict

Table 3. *Univariable and multivariable logistic regression analysis evaluating predicting factors of proficiency score achievement during the LC*

Variable	Univariable analysis				Multivariable analysis			
	OR	95.0% CI			OR	95.0% CI		
		Lower	Higher	P		Lower	Higher	p
Age ≥70 years	0.54	0.25	1.14	0.109	–	–	–	–
ASA score	0.87	0.35	2.15	0.776	–	–	–	–
Diabetes	0.36	0.09	1.38	0.140	–	–	–	–
Hypertension	1.06	0.47	2.35	0.882	–	–	–	–
BMI	1.01	0.83	1.23	0.900	–	–	–	–
Monthly caseload (at least 1 procedure/month)	1.08	0.60	1.95		–	–	–	–
Number of progressive procedures (1–50)	1	0.99	1.02	0.823	–	–	–	–
Surgical technique	0.54	0.26	1.09	0.089	–	–	–	–
Time from LC starting (<12 months vs ≥12 months)	2.48	1.06	5.81	0.035	2.79	1.15	6.76	0.02
Nerve-sparing intent technique (intra/inter vs extrafascial)	2.71	1.02	7.16	0.04	3.18	1.15	8.77	0.02
Prostate volume (ml)	1.01	0.99	1.02	0.162	–	–	–	–

LC – learning curve; BMI – body mass index; ASA – American Society of Anasthesiologists; OR – odds ratio; CI- confidence interval

the Proficiency score achievement in a multi-institutional cohort of trainee surgeons performing RARP. Additionally, we investigated whether different surgical approaches (RS vs STS-RARP) may influence LC among trainee surgeons when Proficiency score achievement is considered the metric of interest. We made several noteworthy observations.

Compared to STD-RARP, RS-RARP yielded shorter operative time and lower rate of positive surgical margins (each p <0.03). However, no differences in other perioperative, functional and cancer control outcomes were recorded between groups (each p >0.1). Specifically, 'Proficiency score' was achieved in 43% of RS-RARP vs 53% of STD-RARP patients (p = 0.087). Taken together, these findings questioned the shared opinion that RS-RARP represents a complex procedure that requires a prolonged LC [6]. Nonetheless, it must be underlined that trainee surgeons performing RS-RARP experienced longer time from LC starting in the current study cohort (22 vs 7 months, p = 0.001). It's possible that an increasing time from LC starting may have influenced surgical experience in performing RS-RARP, relative to STD-RARP. Unfortunately, limited sample size, retrospective design, and lack of data granularity on training modalities prevented us from further investigations.

Subsequently, we customized univariable and multivariable logistic regression models to investigate predictors of Proficiency score achievement. At multivariable analysis, only nerve-sparing intent (OR 3.18, p = 0.02) and time from LC starting (OR 2.79, p = 0.02) reached an independent predictor status. More interestingly, time from LC starting greater than 12 months was associated with two-fold increase in the probability of Proficiency score achievement among trainees during their LC. In consequence, training duration appears to play a major role in enhancing quality of RARP [14]. It can be postulated that an ideal RARP training should not only rely on a modular step-by-step approach, as previously reported [15, 16, 17], but also on an adequate surgical exposure.

To the best of our knowledge, we are the first to report perioperative results between RS vs STD-RARP performed by trainee surgeons during their LC. Indeed, previous studies compared the two approaches among experienced surgeons only [18]. Moreover, we introduced an innovative tool to provide a standardized comparison between different RARP techniques. We observed no differences in Proficiency score achievement between RS-RARP vs STD-RARP. Conversely, nerve-sparing intent and duration of LC were both independently associated with higher probability to achieve Proficiency score. It's of note that neuro-vascular bundle dissection is a challenging step of RARP and accomplishment of nerve-sparing approach relies on multiple host and intraoperative factors [15]. Moreover, we analyzed data from centers of excellence (average yearly caseload >200 procedures), where nerve-sparing is routinely performed whenever possible [19]. Consequently, it is possible that intraoperative decision of not fulfilling nerve-sparing approach indirectly

reflects an unexpected complexity of the specific surgical case [20], thus affecting Proficiency score achievement after RARP [21, 22]. Unfortunately, the retrospective design of the current study prevented us from investigating reasons for not pursuing a nerve-sparing intent. Secondly, we wonder whether an optimal timeframe for LC might be identified. According to our data, 12-months appears to be a reasonable interval to achieve adequate experience on RARP at high-volume centers. However, we set this value based on the median duration of LC within our study cohort. In consequence, further studies should be conceptualized to specifically address this issue. This concept of optimal duration has important consequences in planning training programs that should ideally rely not only on a modular step-by-step approach and optimal number of cases, but also on optimal surgical time exposure. Finally, our study encourages the introduction of PS as a standardized tool for early evaluation of surgical expertise among trainees. The advantage of this tool is two-fold. Firstly, it provides an internal quality control by comparing trainee with mentor operative time. Secondly, it allows for the comparison of RARP performed during the LC across different surgeons, techniques and training programs, by relying on a standardized reporting system.

Our study is not devoid of limitations. The first and foremost limitation is the retrospective study design. In consequence, standardized training protocols were not adopted in the current study. Moreover, we had neither data on previous surgical experience of trainees nor information on how and to what extent mentors support trainees during RARP. However, these data might be available exclusively when a prospective study is conducted. Second, we relied on limited sample size and low event rate. Ideally, similar analyses should be reiterated on a larger sample. These results are not generalizable out of a tertiary referral high-volume robotic center, where trainees are routinely exposed to multiple robotic surgical procedures as an observer or assistant. In consequence, LC at this center is extended well beyond the first RARP performed as the main operator.

CONCLUSIONS

Irrespectively of the surgical technique considered, higher Proficiency score rates for RARP trainees may be expected after 12 months from LC beginning at high-volume institutions. Short-term training courses are unlikely to confer proper surgical training, while long-term institutional structured training programs seem to be beneficial on perioperative outcomes. These aspects should be considered for implementation of RARP training.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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