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ORIGINAL ARTICLE

Analysis of a practical surgical skills laboratory for nerve sparing radical prostatectomy

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Abstract

Purpose With the rapidly expanding anatomical and technical knowledge surrounding nervesparing radical prostatectomy (NSRP), anatomical and operative textbooks have failed to keep pace with the literature. A surgical skill laboratory (SSL) was designed to educate urology trainees on surgical anatomy and techniques for NSRP. The objective was to assess the validity of a SSL program.

Methods A low-fidelity, anatomically accurate prostate model with its appropriate fascial coverings and location of the neurovascular bundle was created. Participants were surveyed prior to a SSL workshop for their knowledge of NSRP focusing on clinical and anatomical considerations. An interactive 2-h tutorial and workshop was then undertaken outlining the clinical and anatomical nuances for NSRP, with participants then practising an intra and inter-fascial NSRP on the model. Participants were resurveyed immediately after the workshop and at 6 months.

Results Thirty participants completed the NSRP workshop. Significant differences ($p < 0.0001$) in anatomical and clinical knowledge were noted after the workshop with improvements for both junior and senior trainees. The knowledge was retained at 6 months following the workshop.

Conclusions A low-fidelity bench-top model is a feasible and reproducible technique for improving the understanding of periprostatic anatomy and the different surgical approaches for NSRP. The SSL is useful and knowledge gained appears to be retained by workshop participants. SSL workshops are a valid hands-on approach to teaching surgical skills and should remain an integral part of urology training.

Keywords Prostate cancer · Neurovascular bundle · Anatomical models · Surgical skills laboratory · Nerve-sparing prostatectomy

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Introduction

Radical prostatectomy has evolved rapidly in the past decade due to a new appreciation of neural anatomy and evolution in surgical techniques and technologies. The trifecta of negative surgical margins whilst maintaining urinary continence and erectile function remains the goal when managing organ-confined disease surgically. This has driven extensive investigation into the complex peri-prostatic neural and fascial anatomy. We have subsequently seen an expansion in the uro-oncological lexicon with an array of new terms and surgical techniques being described. Since Walsh and Donker's [1] landmark paper defining the neurovascular bundles (NVBs), nerve-sparing radical prostatectomy (NSRP) has become the standard of care when possible. Traditionally described as coursing postero-laterally to the prostate, the

NVBs occupy the avascular spaces bounded by the prostatic fascia medially, the lateral pelvic fascia and Denonvillier's fascia posteriorly [2–4]. The location and course of the cavernous nerves containing the parasympathetic fibres responsible for erectile function has been revised multiple times within the literature. In their course from the inferior hypogastric plexus towards the apex of the prostate they have been demonstrated in the pelvic plexus, around the bladder, posterolateral to the prostate and also fanning out to reach antero-laterally [2, 5, 6]. A tri-zonal distribution was proposed by Tewari et al in which a neural "hammock" was described [7]. Redefining the fasciae and "capsule" of the prostate in relation to the neural anatomy [8–10] has been crucial in the adoption of particular techniques and approaches in order to spare these important nerves [2–9].

The majority of anatomical and operative textbooks have not kept pace with advances in the literature regarding our understanding of the surgical anatomy relevant to prostatectomy [11, 12]. As such, it is difficult for residents learning the craft of urology to understand the anatomical principles and terminology for NSRP. We are now confronted with many new acronyms for NSRP (e.g. nsEERP = nerve-sparing endoscopic extra-peritoneal radical prostatectomy) [13] and associated pseudo-anatomical descriptions (e.g. the "Veil of Aphrodite" or "Curtain dissection") [14–16]. Also, the names of the fascial layers of the prostate remain in dispute (e.g. parietal fascia or levator ani fascia laterally) [4, 9, 17].

Completion of structured operative steps and a comprehensive understanding of surgical anatomy govern the success of NSRP. With these factors needing to be mastered, subtleties such as intra-fascial versus inter-fascial NSRP remain elusive to many. Whilst exposure in the operating room or review of articles and recorded surgical footage may assist in appreciation of surgical technique, surgical skills laboratories (SSL) or workshops may be desirable to allow hands on learning. A variety of materials can be used for these purposes ranging from simple models, 3D printed reconstructions, or cadaveric tissue. Our group has previously described an anatomically correct model ideal for a SSL that simulates the anatomy and the surgical approach to intrafascial and interfascial NSRP as well as wide excision at RP [18]. The importance if SSL based learning may be further emphasised in the current training climate in which more trainees are faced with reduced working hours and subsequently fewer case numbers and exposure to the operating theatre.

The objective of this study was to assess the validity of a SSL based program in deciphering the clinical context and surgical anatomy of NSRP, particularly intra and interfascial techniques. In this study we examine participants' performance in answering anatomical and clinical questions correctly, before and after an active workshop dedicated to NSRP to validate such a workshop as an educational tool for urology trainees.

Materials and methods

Population

The workshop was conducted within the University of Toronto as part of the compulsory educational sessions for urological residents and fellows. The facilitators were staff and senior fellows with training in urologic oncology.

Surveys

The workshop surveys were carefully designed to capture demographics as well as specific aspects of anatomical and clinical implications regarding NSRP. Questions were taken from key papers regarding NSRP [19–26]. Uro-oncologists completed the questionnaire to refine wording, check accuracy and to ensure that the questions were set an appropriate level. The questionnaire comprised of 20 questions covering participant demographics, anatomical knowledge, clinical questions as well as subjective opinions regarding the usefulness of the workshop. The answers were in multiple-choice format with four options for each question. Finally, a separate qualitative survey was administered at the end of the session to assess participant's workshop experience in terms of structure, model appropriateness and course facilitation. Assessments were undertaken pre and immediately post workshop to assess knowledge levels as part of the educational process. No identifying data were collected and answers remained anonymous apart from year of training. Responses were entered into an online database for later analysis.

Model

The model used in this NSRP has been previously described in detail [18] and shown in Fig. 1. In brief, the model is simple to re-create, requiring a 22Fr Foley Catheter that has its balloon filled with ballistics gelatine (50 cc). Thus the gel represents the prostate substance and the balloon, its capsule. Simulation of NVBs and prostatic fascial layers is achieved by pulling a party balloon over the catheter balloon with glue between, to act as the first layer of prostatic fascia. A mesh fabric is then placed in a similar fashion over the first balloon to act as the NVB. Finally, a second party balloon (preferably a different colour for later identification) has glue inserted into its neck and is stretched over the fabric to represent the outer fascial layer. The balloons with mesh between are stretched and secured with silk ligatures. The model sets and is fixed to a piece of wood by simple hooks.

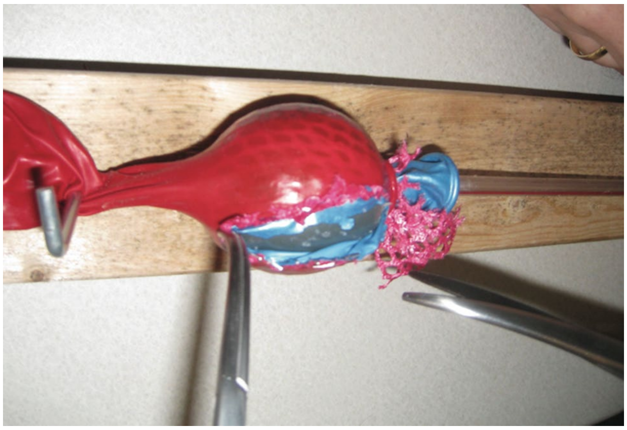

Fig. 1 Ballistics model of prostate with fascial coverings used for the NSRP. Described by and used with permission of Lawrentschuck et al. [18]

A NSRP may then be conducted with standard, laparoscopic or robotic instruments and may be utilized to dissect the fascial layers in an inter- or intrafascial manner using surgical clips if desired. The NVB is easily identified (the mesh) and the principles of high (veil) and low release may be explored. Incisions into the prostate are noted by perforations in the Foley catheter balloon. Models take approximately 5 min to construct and 2 h to set once the gel has been made.

Workshop structure

The workshop duration was 2 h and involved an introduction as well as a pre-workshop assessment (15 min). Answers were not supplied to participants following this assessment. A brief tutorial covering anatomical and clinical aspects of NSRP was followed by an interactive demonstration on our anatomical prostate model (30 min). This was followed by practising of NSRP in pairs with facilitators moving around qualifying and assisting with understanding of anatomy and subtleties of surgical technique (1 h). Finally, the participants repeated the questions from the pre-workshop assessment (15 min). No handouts were given during the workshop and no prior warning of the second assessment was given.

Statistical analysis

The results of the pre and post NSRP workshop surveys resulted in matched-pairs of data due to the repeated measurement of the same subjects. For matched pairs with a categorical response, a two-way contingency table with the same row and column categories summarizes the data. As such, tests of marginal homogeneity were utilised. McNemar's Test, Signed Rank Test and Wilcoxon Rank Sum Tests were utilised. All statistics analysed using SAS version 9.1 (SAS Institute, Cary, NV, USA).

Results

Results include a total of 30 workshop participants all from the medical team. Of the 30 clinicians, 14 (47%) were junior and 16 (53%) senior (4th and 5th year trainees and fellows). There were no staff urologists as participants. Most participants (93%), both before and after the workshop, believed that the terminology surrounding NSRP should be standardized to represent anatomical terms only. Participant's opinions regarding this did not change significantly after the workshop (p value = 1.00).

Comparing participants' performance pre- and post-NSRP workshop

The median pre-workshop score was 56% (IQR 44–68%), and the overall post-workshop score was 75% (69–81%). The median increase in participants' scores from before and after the workshop was 19% (IQR 6–31%); this was a statistically significant increase (p value < 0.0001). As a group, participants experienced a significant increase in scores for both the anatomical and clinical questions (median increase of 13 and 25%, respectively, p value < 0.0001). Junior participants experienced a higher increase in the overall survey scores as compared to senior participants (median increase of 22% versus 19%, respectively), but there was no statistically significant difference in this increase between these two groups. The data are summarised in Table 1.

Participants' performance at 6 months

The overall score at 6 months post workshop was 78% (median, range 56–100) when compared to 56% pre-workshop (median, range 44–69) which was statistically significant ($p = 0.0001$). These scores overall, for anatomy specific and clinical specific were equal to or better than participant's Post Score. Distribution of test scores for pre-, post-, and post-6 is illustrated in Fig. 2.

Participants' opinions of the language used in clinical and anatomy questions

When comparing responses prior to the workshop, a larger number of people found the language used mostly clear and precise following the workshop (27% pre-workshop versus 47% post-workshop). This was statistically significant ($p < 0.0001$), indicating that participants, for the most part, found the language mostly clear and precise after

Table 1 Distribution of students overall scores for the clinical and anatomical survey questions

		Pre scores	Post scores	Post-6 scores	Difference in scores (post score − pre score)		Difference in scores (post 6 score − pre score)	
		Median (IQR) Range Mean (SD)			Median (IQR) Range Mean (SD)	*p* value	Median (IQR) Range, % Mean, SD %	*p* value
Overall		56 (44 to 69) 31 to 81 54 (0.13)	75 (69 to 81) 56 to 88 74 (0.09)	78 (69 to 81) 56 to 100 78 (0.09)	19 (6 to 31) 0 to 50 20 (13.47)	< 0.0001	25 (13 to 31) 0 to 50 23 (14)	< 0.0001
Question type	Anatomy	63 (38 to 75) 13 to 88 55 (20.1)	75 (63 to 88) 50 to 88 73 (11.7)	75 (75 to 88) 50 to 100 78 (10.7)	13 (0 to 38) − 25 to 63 18 (21.9)	< 0.0001	25 (0 to 38) − 25 to 75) 23 (23.3)	< 0.0001
	Clinical	56 (50 to 63) 13 to 75 53 (16.1)	75 (63 to 88) 63 to 88 75 (10.1)	75 (63 to 88) 63 to 100 77.5 (12.0)	25 (13 to 25) − 13 to 50 22 (14.6)	< 0.0001	25 (13 to 38) − 13 to 50 24 (16.1)	< 0.0001
Current status	Junior	50 (38 to 63) 31 to 69 51 (13.2)	75 (69 to 81) 56 to 88 75 (9.6)	78 (68 to 81) 56 to 100 77 (11.1)	22 (13 to 31) 6 to 50 24 (13.2)	0.18	28 (13 to 44) 0 to 50 26 (15.9)	0.41
	Senior	56 (50 to 69) 38 to 81 57 (13)	75 (68 to 81) 56 to 88 74 (9.1)	81 (75 to 81) 69 to 88 79 (0.1)	19 (6 to 28) 0 to 44 17 (13.3)		81 (75 to 81) 69 to 88 79 (6.2)	

Hypotheses were tested using the Signed Rank Test or the Wilcoxon Rank-Sum test as appropriate $N = 30$

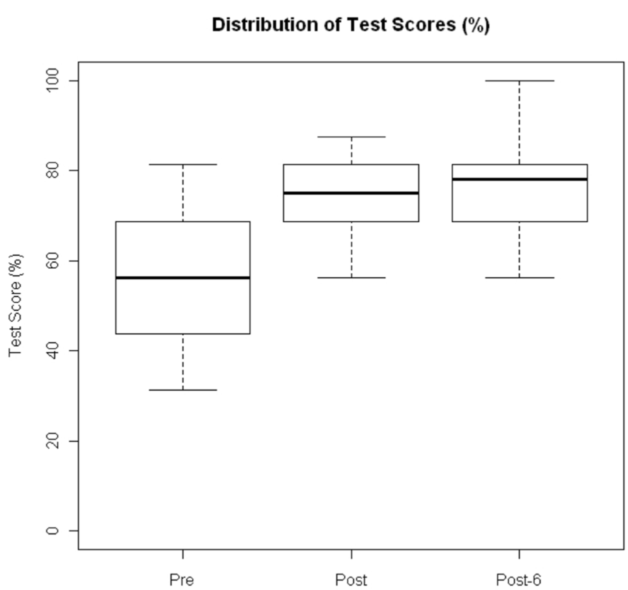

Fig. 2 Distribution of Students' overall test scores, before and after the workshop and post-6 workshop ($N = 30$)

attending the workshop, versus only sometimes clear and precise before attending the workshop.

Overall assessment of the workshop quality

95% of participants either agreed or strongly agreed that the workshop was useful and achieved its desired aims regarding NSRP. The model was universally praised and there were no negative responses regarding the format, instructors or ability to problem solve in the workshop.

Discussion

The teaching and training of surgeons is evolving slowly from the "master–apprentice" clinical teaching model to a more structured learning process that incorporates workshops, simulators and multimedia presentations [27]. Urology is no exception to this, particularly due to the rapid change in our understanding of surgical anatomy related to prostatectomy and the introduction of robotic surgery to the field [11, 28]. Despite the allure of virtual reality surgical simulation, it has yet to declare definitive improvement in translation of skills to surgical practice [29]. This underpins the need for realistic models to use in bench top surgical simulation to allow practice of technique and to reinforce anatomical principles. Ultimately not every workshop conducted will achieve "perfect" status in the sense that they are close enough to reality to act as a surrogate.

In summary, the participants' understanding of NSRP improved as a result of the NSRP workshop. Responses to almost all questions showed improvement after gaining knowledge through the workshop. Significant improvements occurred in anatomical and clinical knowledge aspects of NSRP whilst there appeared to be no difference whether the participant was at a junior or senior level. This is important as the workshop has broad appeal and avoids skills and knowledge gaps that many programs suffer from. A low fidelity but anatomically accurate model is indispensable for SSL. Previous groups have reported on the use of 3D printed models for use in surgical workshops to allow for hands-on learning [30]. The main difficulty with these models is the time taken to create them and associated costs. Our model uses only supermarket items, surgical instruments and a Foley catheter making it simple, inexpensive and reproducible. Furthermore, there are no ethical concerns regarding our model. Both of these factors are important as we should aim to have accessible and universal teaching materials.

Limitations of this study are that these results only reflect participants' comprehension as measured directly after finishing the workshop and at the 6-month time point and no assessment of intra-operative surgical skill was measured. Future studies will aim to follow residents/trainees after completion of the workshop to assess if any difference in learning is displayed when actually performing NSRP.

In an ideal world, every SSL would conclude with monitoring of performance in the operating room with flattening of the participant learning curve as the ultimate definition of success. Evidence is starting to arrive supporting the use of virtual reality and simulated surgical tasks in improving performance. However, the use of a SSL to understand anatomy remains valuable as an early step in training. In any case, our model may be utilised in laparoscopic or robot assisted workshops to further delineate an understanding of the operative techniques and surgical anatomy. A multicentre analysis of SSL, their aims, translation to surgical practice as well as types of models used would help to define the utility of this style of education. When designing surgical workshops, particularly regarding prostate surgery, educators need to be cognisant of the variability in current textbook descriptions of prostate anatomy. Further to this, residents and trainees must ensure a variety of approaches to their education of modern descriptions of prostate anatomy, as the translations from urological literature to the textbooks slowly occurs [28].

Conclusion

A low-fidelity bench top model is a feasible and reproducible technique for improving understanding of the anatomy of the neurovascular bundles and the different surgical approaches for NSRP. SSL-based learning is a valid teaching method to complement trainee's surgical education and should remain and integral part of the curriculum as operative hours and exposure remains a challenge facing today's trainees.

Author contribution EC: Manuscript writing/editing. DC: Manuscript writing/editing. UL: Project/protocol development, Data collection/management. KF: Data analysis, Data collection/management. EJ: Data collection/management. AF: Data collection/management. NF: Project/protocol development, Data collection/management. NL: Project/protocol development, Manuscript writing/editing

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Compliance with ethical standards

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

Conflict of interest The authors have no conflict of interest to declare.

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