RESEARCH ARTICLE

Is laparoscopic experience helpful in simulator based robotic training in general surgery?

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Abstract

Objective: To evaluate whether or not prior laparoscopic training improves performance during robotic surgery utilising DaVinci robotic skills simulator.

Methods: The cross-sectional study was conducted at the Civil Hospital, Karachi, from May 4 to November 11, 2018, and comprised first year residents in Group A with no laparoscopic skills and fourth year residents doing laparoscopic cholecystectomy independently and surgical faculty members in Group B who had laparoscopic skills. Both the groups had no previous exposure to robotic surgery and skills simulator. There were 4 exercises which were repeated three times by each participant. Scoring was done using the DaVinci robotic skills simulator software. Data was analysed using SPSS 22.

Results: Of the 30 surgeons, there were 15(50%) in Group A with a mean age of 26±0.56 years, and 15(50%) in Group B with a mean age of 32 ± 9.16 Years ($p<0.001$). The overall mean age was 32±9.16 years (range: 25-52 years). There were 19(63.3) females in the sample compared to 11(36.6%) males. Mean scores of Ring walk 2, Peg board 2, and Suture sponge 3 were better in Group A, while mean score of Matchboard 2 was better in Group although B ($p>0.05$). Group B fared better in the individual scoring of Suture sponge 2 ($p>0.05$).

Conclusion: Laparoscopic skills apparently did not confer any benefit while performing exercises on the DaVinci skills simulator.

Keywords: DaVinci Si, DaVinci skills simulator, dVSSS, Robotic surgery curriculum, Robotic surgery simulation.

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Introduction

Today the world has gone beyond technology and resources are now being spent on preparing people for success in the era of artificial intelligence (AI) that is becoming pervasive with more than two-thirds of smartphone users already using AI or machine learning, and, in the eyes of experts, this is just the beginning. This has impacted the healthcare industry as well. Robotics has taken this industry by storm, with more and more surgeons opting for robotic surgery since the learning curve is smoother than laparoscopic training.[1]

Teaching and training is the essence of medical profession. Simulator-based learning has been proven to be the best training modality. Improvement in technology has led to more innovation in simulators, creating more life-like and real scenarios-based learning opportunities. To facilitate the new generation of surgeons in stepping into the AI era, we need to teach and train them on simulators.

Due to the rampant increase in the use of robotic surgery, there is an interest in developing a curriculum for this surgical modality.[2-4] There has been a lot of debate on whether laparoscopic skills can be utilised in robotic surgery, and, if so, then the surgeons should be first trained in laparoscopic surgery to achieve mastery before moving on to robotic surgery.[5,6] This has led to conventional laparoscopic training being incorporated into robotic training programmes. There are many aspects of robotic surgery where laparoscopy training helps, like in ports placement, adhesiolysis, multi-quadrant surgery and in case of technical failure or difficulty when surgeons can perform the task laparoscopically.[7] Resolution of this dilemma will have an important impact on the development of robotic surgery training methods and curriculum.[8,9]

In 2011, Pakistan acquired its first DaVinci robot. This was the DaVinci S system, which was installed at the Sindh Government Qatar Hospital in Karachi. The second robotic platform was DaVinci Si and along with the DaVinci skills simulator (dVSSS) it was installed in the operation theatre (OT) complex of Civil Hospital, Karachi (CHK), in 2013. While the first robot became non-functional, the second one at the CHK is still in use. There has been no robotic simulator-based studies in Pakistan so far. The current study was planned to fill the gap by evaluating whether or not prior laparoscopic training

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improves performance during robotic surgery utilising dVSSS.

Subjects and Methods

The cross-sectional study was conducted in Operation Room 1 (OR1) of the OT Complex at the CHK, from May 4 to November 11, 2018. After approval from the ethics review board of the Dow University of Health Sciences (DUHS), Karachi, the sample size was worked out in the light of literature.[10] The sample was raised using non-probability, convenience sampling from among first year residents in Group A with no laparoscopic skills and fourth year residents doing laparoscopic cholecystectomy independently and surgical faculty members in Group B who had laparoscopic skills. None of the participants in any of the two groups had ever used robotic virtual reality (VR) simulators and had no robot-assisted surgical experience. Informed consent was obtained from all the subjects.

The participants were given an introductory lecture and 10 minutes of practice on camera targeting exercise to be able to understand the basic handling of the robot. Each participant was then asked to do 4 simulated skills, which included 3 basic skills PEG board 2, Ring walk 2 and Match board 2, and one advanced skill Suture sponge 3. Peg board 2 assesses the candidates' ability of EndoWrist and camera manipulation. It includes rings which are grasped by one hand, transferred to the other hand and then placed on the peg. Match board 2 involves picking objects and putting them into their defined places. This evaluates the EndoWrist manipulation and clutching. Ring walk 2 involves running a ring along a thin tube with multiple bends. This requires EndoWrist manipulation, camera and clutching. Suture sponge is an advanced exercise in which a needle is driven along the specified targets on a sponge. This exercise involves camera control, clutching, needle control and needle driving skills. Each participant repeated each task 3 times and mean scores were taken for comparison. After every task, the simulator programme calculated different variables of the participants and an overall score was generated which was recorded on a proforma that was filled at the same time.

Data was analysed using SPSS 22. Mean scores were calculated for each exercise. Chi-square was used for cross-tabulation among qualitative variables. Independent t test was applied for quantitative data when comparing between the groups. $P<0.05$ was considered statistically significant.

Results

Of the 30 surgeons, there were 15(50%) in Group A with a

Table-1: Mean scores of exercises in the two groups.

Exercise	Operator	N	Mean	Standard Deviation	Standard Error Mean	p
Ring walk 2	Non laparoscopic	15	45.8889	17.89372	4.62014	0.619
	Laparoscopic	15	40.4444	17.66292	4.56055	
Peg board 2	Non laparoscopic	15	72.9111	11.18493	2.88794	0.306
	Laparoscopic	15	69.0667	10.2052	2.63497	
Match board 2	Non laparoscopic	15	59.3778	9.50761	2.45486	0.618
	Laparoscopic	15	59.9111	8.42941	2.17647	
Suture Sponge 3	Non laparoscopic	15	59.7556	10.29984	2.65941	0.599
	Laparoscopic	15	58.7333	9.2832	2.39691	

Table-2: Individual scores for the Ring walk 2 in the two groups.

Variables	Operator	N	Mean	Standard Deviation	p
Time taken	Non laparoscopic	15	307.7333	63.34401	0.325
	Laparoscopic	15	314.1111	118.35598	
Economy of motions	Non laparoscopic	15	385.7778	136.68761	0.989
	Laparoscopic	15	491.0889	139.48457	
Collisions	Non laparoscopic	15	5.0667	2.90648	0.093
	Laparoscopic	15	7.4222	4.61101	
Excessive instrument force	Non laparoscopic	15	12.3778	13.99312	0.341
	Laparoscopic	15	11.1333	10.65163	
Out of view	Non laparoscopic	15	1.7111	2.36666	0.228
	Laparoscopic	15	4.7333	7.7901	
Master workspace range	Non laparoscopic	15	11.5778	1.84506	0.127
	Laparoscopic	15	11.0444	1.43021	

Table-3: Individual scores for the Peg board 2 in the two groups.

	Operator	N	Mean	Standard Deviation	p
Time taken	Non laparoscopic	15	168.2667	30.6048	0.013
	Laparoscopic	15	192.0889	65.32574	
Economy of motions	Non laparoscopic	15	346.8444	84.62812	0.331
	Laparoscopic	15	371.7111	140.23138	
Collisions	Non laparoscopic	15	1.8444	2.12643	0.051
	Laparoscopic	15	3.0444	2.82805	
Excessive instrument force	Non laparoscopic	15	0	0	0
	Laparoscopic	15	0.1111	0.24125	
Out of view	Non laparoscopic	15	0	0	0
	Laparoscopic	15	0.1778	0.35337	
Master workspace range	Non laparoscopic	15	10.7333	1.14226	0
	Laparoscopic	15	11.1778	2.40656	
Drops	Non laparoscopic	15	0.0889	0.23458	0.007
	Laparoscopic	15	0.5333	0.53154	

Table-4: Individual scores for the Match board 2 in the two groups.

	Operator	N	Mean	Standard Deviation	p
Time taken	Non laparoscopic	15	223.1556	34.65038	0.153
	Laparoscopic	15	281.1333	49.35743	
Economy of motions	Non laparoscopic	15	390.2889	49.94662	0.004
	Laparoscopic	15	448.0667	87.02884	
Collision	Non laparoscopic	15	2.0667	2.02837	0.628
	Laparoscopic	15	1.7333	2.14624	
Excessive instrument force	Non laparoscopic	15	7.2667	4.62601	0.083
	Laparoscopic	15	7.6667	6.7153	
Out of view	Non laparoscopic	15	1.0444	0.98292	0.247
	Laparoscopic	15	0.5111	0.86251	
Master workspace range	Non laparoscopic	15	9.8	3.1718	0.002
	Laparoscopic	15	9.8667	0.85263	
Drops	Non laparoscopic	15	0.1333	0.16903	0.698
	Laparoscopic	15	0.3333	0.25198	

Table-5: Individual scores for the Suture sponge 2 in the two groups.

	Operator	N	Mean	Standard Deviation	Standard Error Mean	p
Time taken	Non laparoscopic	15	622.7778	122.63222	31.6635	0.681
	Laparoscopic	15	550.1333	110.53849	28.54092	
Economy of motions	Non laparoscopic	15	596.9778	61.5357	15.88845	0.33
	Laparoscopic	15	551.6	118.80538	30.67542	
Collisions	Non laparoscopic	15	5.5333	4.72044	1.21881	0.28
	Laparoscopic	15	8.0889	7.57551	1.95599	
Excessive instrument force	Non laparoscopic	15	0.4222	0.19787	0.05109	0.054
	Laparoscopic	15	1.0889	1.81032	0.46742	
Out of view	Non laparoscopic	15	0.5556	0.41148	0.10624	0.95
	Laparoscopic	15	0.4667	0.43278	0.11174	
Master workspace range	Non laparoscopic	15	4.1778	1.5164	0.39153	0.438
	Laparoscopic	15	4.3778	1.60291	0.41387	
Drops	Non laparoscopic	15	0.2667	0.2873	0.07418	0.589
	Laparoscopic	15	0.2222	0.43033	0.11111	
Missed targets	Non laparoscopic	15	17.4889	5.97331	1.5423	0.255
	Laparoscopic	15	17.7111	10.46526	2.70212	

mean age of 26±0.56 years, and 15(50%) in Group B with a mean age of 32±9.16 years (p<0.001). The overall mean age was 32±9.16 years (range: 25-52 years). There were 19(63.3) females in the sample compared to 11(36.6%) males. Mean scores of Ring walk 2, PEG board 2, and Suture sponge 3 were better in Group A, while, for Match board 2, the score was better in Group B. However, the differences were not significant (Table-1). In Ring walk 2 the individual components of scoring was better in Group A except for excessive instrument force and master workspace range, but the differences were not significant (Table-2). In Peg board 2, Group A performed better in all individual components and the difference was significant except for economy of motion (Table-3). In Match board 2, all individual components were better in Group A, but the differences were significant only in the economy of motions and master workspace range (Table-4). In Suture sponge 3, Group B did better in time taken to complete, economy of motions, out of view, drops and missed targets, but the differences were not significant (p>0.05). The remaining components of collision, excessive instrument force and master workspace range was better in Group A, but the difference was only significant in excessive instrument force (Table-5).

Discussion

It is imperative to learn the efficient and safe robot-assisted techniques before using it on patients. Recent years have seen a remarkable evolution of VR simulation or training systems for laparoscopic and robot-assisted surgery techniques. Surgical simulators have proven to enhance skilled performance in surgical procedures, decrease the operating time, diminish the error rate, and improve outcomes.[11-13] The current study compared two groups, taking into account different skills in different exercises. Each exercise had different difficulty and dexterity index.

When comparing the combined mean of all 4 exercises, it was clear that the non-laparoscopic group was better, although not significantly. Since the mean age of the laparoscopic group was significantly more than the non-laparoscopic group, therefore we eliminated the age bias by restricting the groups to ≤35 years and calculating the means again. In this setup, we had 15 participants in the non-laparoscopic group and 7 in the laparoscopic group. Even then the combined mean scores were better in the non-laparoscopic group. This implies that age was not a factor that affected the results in the current study.

Prior laparoscopic training may have had an effect since laparoscopic movements are opposite to the intended movements, while in robotic surgery the movements are similar and natural. The other factor could be the increased dexterity and familiarity of the younger generation of surgeons to the gaming consoles and technology, helping them to perform better. The data was also evaluated by isolating the element of gender and doing the mean scores in males only and then in females only. When comparing the males only in both the groups, the mean was again similar, with non-laparoscopic group performing better and significantly so in Peg board 2 and Match board 2. When only females in both the groups were compared, the mean was only better in Match board 2 in the laparoscopic group, but this was not significant. Studies[10,14] have not reported any difference in the performance of robotic tasks when comparing age, gender and prior laparoscopic experience.

When evaluating suture sponge, which is an advanced exercise requiring passing of a needle through designated points on a sponge, it was evident that the laparoscopic surgeons performed better in terms of individual scores in time taken to complete THE exercise, economy of motion, out of view and drops. However, these results were not significant. This also enforces the notion that prior experience can also help in the completion of robotic task effectively and more advanced exercises may be better handled by the experts than the novices. Since we only did one advanced exercise, we cannot make a generalisation in this regard. One study[15] did not find laparoscopic experience beneficial in the simulator tests. However, that study only tested basic skills which could be the reason for that conclusion. Another study[14] concluded that laparoscopic experience does play a role in the advanced robotic simulator exercises which is similar to the finding of the current study. A study in 2009 claimed that prior laparoscopic skills had significant effect on performance on dVSSS. Three tasks were assessed in their study, which included tyinga, double knot and needle driving. Their results might have been biased since these tasks require the knowledge and principles of knot-tying, and handling of round needles, which the novice group was not familiar with. So planning the tasks/exercises for comparison should address all these confounders to reduce the bias.[16]

In the current study, dVSSS was used, which has a good construct validity, meaning that this device can discriminate between experienced and inexperienced surgeons. However, the non-laparoscopic group performed better in all exercises. In terms of individual scores in each exercise, the laparoscopic group performed better in Suture sponge which has already been labelled as an exercise with the highest statistical differences between skilled and less-skilled surgeons in robotics.[1,17,18] There are many factors that influence the scoring i.e. the number of times the task is performed, the fatigue of doing the same exercise many times and the previous experience of skills, like suturing. The current study asked the participants to perform each exercise 3 times and took the mean score. Laparoscopic skills undoubtedly are necessary for certain aspects of robotic surgery, which include port placement, adhesiolysis and multi-quadrant abdominal access,[7] but these can be taught and incorporated into the robotic training programmes.

The limitations of the study are its single-centre nature and a small sample size.

Conclusion

The non-laparoscopic group performed slightly better in the overall scores, confirming the impression that laparoscopic skills are not necessary in starting robotic surgery programmes and can be taught during the programme itself.

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Conflict of Interest: None.

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References

1. Stefanidis D, Hope WW, Scott DJ. Robotic suturing on the FLS model possesses construct validity, isless physically demanding, and is favored by more surgeons compared with laparoscopy. Surg Endosc.2011; 25:2141-6.
2. Tillou X, Collon S, Martin-Francois S, Doerfler A. Robotic surgery simulator: elements to build a training program. J Surg Educ. 2016; 73:870-8.
3. Lovegrove C, Novara G, Mottrie A, Guru KA, Brown M, Challacombe B, et al. Structured and modular training pathway for robot-assisted radical prostatectomy (RARP): validation of the RARP assessment score and learning curve assessment. Eur Urol. 2016; 69:526-35.
4. Hogg ME, Tam V, Zenati M, Novak S, Miller J, Zureikat AH, et al. Mastery-based virtual reality robotic simulation curriculum: the first step toward operative robotic proficiency. J Surg Educ. 2017; 74:477-85.
5. Vurgun N, Vongsurbchart T, Myszka A, Richter P, Rogula T. Medical student experience with robot-assisted surgery after limited laparoscopy exposure. J Robot Surg. 2021; 15:443-50.
6. Kim IK, Kang J, Park YA, Kim NK, Sohn SK, Lee KY. Is prior laparoscopy experience required for adaptation to robotic rectal surgery? feasibility of one-step transition from open to robotic surgery. Int J Colorectal Dis. 2014; 29:693-9.
7. Abaza R. The robotic surgery era and the role of laparoscopy training. Ther Adv Urol. 2009; 1:161-5.
8. Tobias-Machado M, Mitre AI, Rubinstein M, Costa EF, Hidaka AK. Robotic-assisted radical prostatectomy learning curve for experienced laparoscopic surgeons: does it really exist? Int Braz J Urol. 2016; 42:83-9.
9. Nacul MP, Melani AGF, Zilberstein B, Benevenuto DS, Cavazzola LT, Araujo RLC, et al . Educational note: teaching and training in robotic surgery. An opinion of the Minimally Invasive and Robotic Surgery Committee of the Brazilian College of Surgeons. Rev Col Bras Cir. 2020; 47:e20202681.
10. Pimentel M, Cabral RD, Costa MM, Neto BS, CavazzolaLT. Does Previous Laparoscopic Experience Influence Basic Robotic Surgical Skills? Surg Educ. 2018; 75:1075-81.
11. Zevin B, Aggarwal R, Grantcharov TP. Surgical simulation in 2013: why is it still not the standard in surgical training? J Am Coll Surg. 2014; 218:294-301.
12. Nagendran M, Gurusamy KS, Aggarwal R, Loizidou M, Davidson BR. Virtual reality training for surgical trainees in laparoscopic surgery. Cochrane Database Syst Rev. 2013; 2013:CD006575.
13. Leijte E, de Blaauw I, Van Workum F, Rosman C, Botden S. Robot assisted versus laparoscopic suturing learning curve in a simulated setting. Surg Endosc. 2020; 34:3679-89.
14. Finnerty BM, Afaneh C, Aronova A, Fahey TJ 3rd, Zarnegar R. General surgery training and robotics: Are residents improving their skills? Surg Endosc. 2016; 30:567-73.
15. Yoo BE, Kim J, Cho JS, Shin JW, Lee DW, Kwak JM, et al. Impact of laparoscopic experience on virtual robotic simulator dexterity. J Minim Access Surg. 2015; 11:68-71.
16. Hagen ME, Wagner OJ, Inan I, Morel P. Impact of IQ, computer-gaming skills, general dexterity, and laparoscopic experience on performance with the da Vinci surgical system. Int J Med Robot. 2009; 5:327-31.
17. Lyons C, Goldfarb D, Jones SL, Badhiwala N, Miles B, Link R, et al. Which skills really matter? Proving face, content, and construct validity for a commercial robotic simulator. Surg Endosc. 2013; 27:2020-30.
18. Hung AJ, Zehnder P, Patil MB, Cai J, Ng CK, Aron M, et al. Face, content and construct validity of a novel robotic surgery simulator. J Urol.2011; 186:1019-24.