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# Comparing the da Vinci Si Single Console and Dual Console in Teaching Novice Surgeons Suturing Techniques

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# Comparing the da Vinci Si Single Console and Dual Console in Teaching Novice Surgeons Suturing Techniques

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## ABSTRACT

**Background and Objectives:** Robot-assisted laparoscopic surgery is often taught with the surgical mentor at the surgeon console and the trainee at the patient's bedside. The da Vinci dual console (Intuitive Surgical, Sunnyvale, California) allows a surgical mentor to teach with both the mentor and the trainee working at a surgeon console simultaneously. The purpose of this study is to evaluate the effectiveness of the dual console versus the single console for teaching medical students robotic tasks.

**Methods:** Forty novice medical students were randomized to either the da Vinci single-console or dual-console group and were taught 4 knot-tying techniques by a surgical mentor. The students were timed while performing the tasks.

**Results:** No statistically significant differences in mean task times were observed between the single- and dual-console groups: interrupted stitch with a 2-handed knot (300 seconds for single vs 294 seconds for dual, $P = .59$), interrupted stitch with a 1-handed knot (198 seconds for single vs 212 seconds for dual, $P = .88$), figure-of-8 stitch with a 2-handed knot (261 seconds for single vs 219 seconds for dual, $P = .20$), and figure-of-8 stitch with a 1-handed knot (200 seconds for single vs 199 seconds for dual, $P = .53$).

**Conclusion:** No significant difference was observed in performance time when teaching knot-tying techniques to medical students using the da Vinci dual console compared with the single console. More research needs to be performed on the utility of the da Vinci dual console in surgical training.

**Key Words:** da Vinci Si, Robotics, Robot-assisted laparoscopic surgery, Teaching, Simulation training.

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## INTRODUCTION

The da Vinci surgical system (Intuitive Surgical, Sunnyvale, California) has been approved by the US Food and Drug Administration for use in gynecologic surgery since April 2005.[1] The da Vinci Si Surgical System was approved by the US Food and Drug Administration for surgical use in February 2009, which also includes dual-console capability to support training and collaboration during minimally invasive surgery. The advantages of robot-assisted laparoscopic procedures include decreased hospitalization time, blood loss, and complications compared with open procedures while showing a lower rate of conversion to open procedures when compared with laparoscopic procedures.[2,3] The robotic platform features 3-dimensional vision, tremor elimination, and wristed instrumentation, which may improve surgeon performance on laparoscopic tasks.[4,5] Despite the many benefits, robotic surgical procedures are generally more expensive, with a robotic hysterectomy costing approximately $8868 and a laparoscopic hysterectomy costing approximately $6679.[6]

The teaching method for robot-assisted laparoscopic surgery has classically consisted of the mentor teaching from the bedside or standing next to the console while the student completes the task at hand. Intuitive Surgical introduced the da Vinci Si dual-console interface in April 2009, allowing 2 surgeons to sit at 2 different surgical consoles and control the same robot simultaneously (**Figure 1**). This technology was introduced to enhance surgical teaching for robotic surgery. Other robotic mentoring platforms have been described and have shown improved performance of surgical tasks and resident participation in surgery.[7] Although there are reports of using the dual console for gynecologic surgery, there is a paucity of literature evaluating the effectiveness of the da Vinci Si dual console for teaching purposes.[8]

In a study comparing the outcomes of laparoscopic surgery with robotic surgery using the dual console in a gynecologic oncology fellowship training program, dual-console robotic surgery resulted in overall decreased surgical time and estimated blood loss and did not adversely affect outcomes.[9] Another study conducted in a training facility compared operative times and surgical outcomes while operating with the dual-console model in the first 50 cases of gynecological surgery. The results were compa-

**Figure 1.** da Vinci Si dual console in use. The surgeon consoles on the left and right both control the robotic arms in the center of the picture.

rable with historically reported outcomes of single-console gynecologic procedures.[10]

In recent studies, resident surgeons have shown a greater ability to interact with new robotic technology and instruments and have shown a higher capacity to learn surgical skills when compared with senior surgeons who have performed >200 procedures as the main surgeon.[11] Despite the learning difference between the two groups, by using robotic simulators, both novice and expert surgeons were able to practice complex surgical maneuvers and learn new techniques that may not be considered routine. For newly trained robotic surgeons, acquiring the skills necessary to perform robot-assisted surgery is only part of the process in becoming expert robotic surgeons. Maintenance of the learned robotic skill is equally as important since robotic surgical skills have been found to degrade significantly within 4 weeks of inactivity in recently trained surgeons.[12] As robotic surgery is increasingly adopted into practice, more studies need to be performed to evaluate how to effectively instruct trainees in the technology.

The objective of this study is to assess the effectiveness of the dual console compared with the single console in teaching novice surgeons suturing techniques. We hypothesize that the dual console will teach novice surgeons more effectively than the single console because the dual console allows for more interaction between the surgical mentor and the trainee.

## MATERIALS AND METHODS

Volunteers participating in this study were required to be medical students at the University of Central Florida College of Medicine. Any subjects who were unable to travel to the Nicholson Center at Florida Hospital Celebration Health were not eligible to participate in the study. This project was approved by the institutional review boards at Florida Hospital and the University of Central Florida.

Forty students were enrolled and completed the study, and participants received a $25 stipend for study participation. The study was completed on 5 intermittent Sundays between July 2012 and September 2012. A randomized block design was used to split the 40 students into 2 equal groups, one for the single console and one for the dual console. Each student was assigned a participant number from 1 to 40 based

on the order in which they enrolled in the study, and a random number generator within Microsoft Excel 2011 (Microsoft, Redmond, Washington) calculated the first 20 numbers that would be assigned to the single-console group. The remaining 20 students were placed into the dual-console group. All randomization was performed by the statistician on our research team.

Students completed a survey questionnaire that included questions about the student's age, sex, hand preference, and year in medical school, as well as questions investigating whether the student played video games, played a musical instrument, had previous surgical experience, or had an interest in surgery.

For the single-console group, the student observed the mentor performing the suturing task on the external monitor. Subsequently, the student sat at the console and completed the same task while the mentor observed the external monitor and provided verbal instruction. This sequence was repeated for a total of 4 surgical tasks: interrupted stitch with a 2-handed knot, interrupted stitch with a 1-handed knot, figure-of-8 stitch with a 2-handed knot, and figure-of-8 stitch with a 1-handed knot. Outcomes measured included the student performance time per task, as well as whether the suture was frayed or whether the knot was floating.

For the dual-console group, both the student and the surgical mentor sat at their respective consoles. The student observed the mentor performing the suturing task while sitting at a console, and then the control of the instrument arms was swapped to the student and the student then completed the suturing task with the mentor observing and instructing also from a surgical console. The mentor instruction included verbal instruction with the internal microphone and use of what we referred to as "virtual hands," the blue arrows that appear on the screen corresponding to the hand movements made at the console that does not have control of the robotic arms. A maximum performance time was set at 600 seconds for each task, at which point the student was not allowed to continue performing the task. The tasks were performed with the Mega SutureCut Needle Driver and the Long Tip Forceps robotic instruments (Intuitive Surgical), and the knots were tied with 6-inch No. 0 Vicryl (Ethicon, Somerville, New Jersey). The same surgical mentor instructed all of the students.

Statistical analysis was performed with SPSS software, version 20.0 (IBM, Armonk, New York). A Mann-Whitney *U* test was used to compare performance times for the surgical tasks. $P < .05$ was considered statistically significant, and the study was powered at 79.1% to detect large differences between groups. All tests performed were 2 tailed. Median and means with ranges and 95% confidence intervals were calculated for all operative tasks. Logistic regression analysis was performed to further evaluate outcomes when warranted. All box and whisker graphs (Figs 2–4) were plotted with the whiskers extending to the 2.5 and 97.5 percentiles. Points below and above the whiskers are drawn as individual dots.

## RESULTS

All 40 medical students who applied to participate in our study were enrolled and completed the study in its entirety. 23 of the participants were first-year medical students, 16 were second-year medical students, and 1 was a third-year medical student. The participants in the single-console group and the dual-console group had similar demographic characteristics (**Table 1**). There was no statistically significant difference between the dual-console and single-console groups when performing the surgical tasks. For the interrupted stitch with a 2-handed knot, the mean knot time was 300 seconds for the single console versus 294 seconds for the dual console ($P = .59$). For the

**Table 1.**
Participant Demographic Characteristics

| | Single Console (n = 20) | Dual Console (n = 20) |
|---|---|---|
| Mean age (y) | 24.4 | 24.6 |
| Male | 70% | 65% |
| Female | 30% | 35% |
| Right handed | 85% | 85% |
| Left handed | 15% | 15% |
| Mean No. of years of medical school completed | 0.3 | 0.5 |
| No. of first-year medical students | 13 | 10 |
| No. of second-year medical students | 7 | 9 |
| No. of third-year medical students | 0 | 1 |
| Previous surgical experience | 20% | 15% |
| Interest in surgery | 25% | 25% |
| Plays video games | 70% | 50% |
| Mean hours played monthly | 6.6 | 6 |
| Plays instrument | 35% | 40% |
| Keys | 42.9% | 62.5% |
| String | 42.9% | 25% |
| Wind | 0% | 12.5% |
| Percussion | 14.2% | 0% |

**Table 2.**
Comparison of Mean Suturing Times for All 4 Tasks in Single- and Dual-Console Groups

| | Single-Console Group (n = 20) (Mean ± SD) (s) | Dual-Console Group (n = 20) (Mean ± SD) (s) | *P* Value |
|---|---|---|---|
| Interrupted stitch with 2-handed knot | 300 ± 96 | 294 ± 130 | .59 |
| Interrupted stitch with 1-handed knot | 198 ± 93 | 212 ± 129 | .88 |
| Figure of 8 with 2-handed knot | 261 ± 102 | 219 ± 76 | .20 |
| Figure of 8 with 1-handed knot | 200 ± 65 | 199 ± 91 | .53 |

$P < .05$ was considered statistically significant.

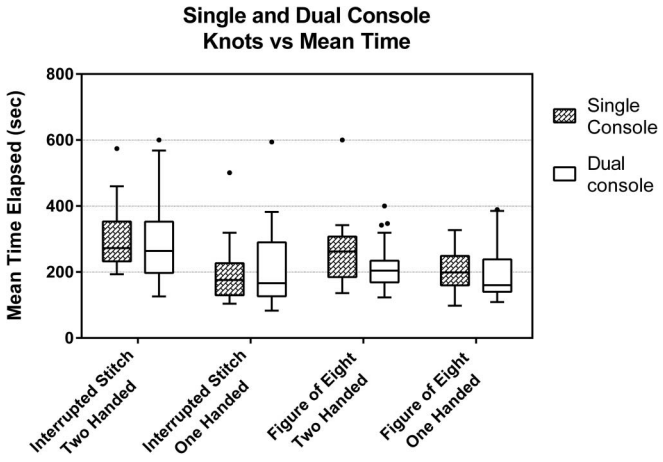


**Figure 2.** Comparison of suturing times for each knot in single- and dual-console groups.

interrupted stitch with a 1-handed knot, the mean knot time was 198 seconds for the single console versus 212 seconds for the dual console ($P = .88$). For the figure-of-8 stitch with a 2-handed knot, the mean knot time was 261 seconds for the single console versus 219 seconds for the dual console ($P = .20$). For the figure-of-8 stitch with a 1-handed knot, the mean knot time was 200 seconds for the single console versus 199 seconds for the dual console ($P = .53$) (**Table 2**, **Figure 2**). There was no significant difference in the numbers of frayed sutures or floating knots produced by the single- or dual-console group during any of the tasks (**Tables 3 and 4**). The few students who created frayed sutures or floating knots also repeated the mistakes and were responsible for most of the data points in **Tables 3 and 4**. The students who were interested in surgery performed suturing tasks faster than the

**Table 3.**
Total Number of Frayed Sutures for All 4 Tasks in Single- and Dual-Console Groups

| | Single-Console Group (n = 20) | Dual-Console Group (n = 20) | *P* Value |
|---|---|---|---|
| Interrupted stitch with 2-handed knot | 6 | 3 | .262 |
| Interrupted stitch with 1-handed knot | 1 | 3 | .298 |
| Figure of 8 with 2-handed knot | 2 | 7 | .062 |
| Figure of 8 with 1-handed knot | 5 | 4 | .708 |

$P < .05$ was considered statistically significant.

**Table 4.**
Total Number of Floating Knots for All 4 Tasks in Single- and Dual-Console Groups

| | Single-Console Group (n = 20) | Dual-Console Group (n = 20) | *P* Value |
|---|---|---|---|
| Interrupted stitch with 2-handed knot | 1 | 1 | >.999 |
| Interrupted stitch with 1-handed knot | 0 | 0 | >.999 |
| Figure of 8 with 2-handed knot | 1 | 1 | >.999 |
| Figure of 8 with 1-handed knot | 1 | 0 | .317 |

$P < .05$ was considered statistically significant.

students without an interest in surgery (**Table 5**, **Figure 3**). Comparison of the participants in the first 2 days of the study with the participants in the last 2 days of the study showed faster performance times for participants in the latter half of the study, regardless of whether the single or dual console was used (**Table 6**, **Figure 4**).

There were 2 instances when participants reached the 600-second cap set for the knot-tying procedures. One of those occurrences was a single-console participant while tying a figure-of-8 stitch with a 2-handed knot. The other occurrence was a dual-console participant while tying an interrupted stitch with a 2-handed knot.

## DISCUSSION

This study does not show a statistically significant difference in performance time for tasks with use of the da Vinci Si

**Table 5.**
Comparison of Mean Suturing Times for All 4 Tasks in Group of Students With Unknown Specialty Preference and Group of Students Interested in Surgery

| | Unknown Specialty Preference (n = 30) (Mean ± SD) (s) | Interest in Surgery (n = 10) (Mean ± SD) (s) | *P* Value |
|---|---|---|---|
| Interrupted stitch with 2-handed knot | 319 ± 120 | 234 ± 55 | .005 |
| Interrupted stitch with 1-handed knot | 222 ± 121 | 155 ± 52 | .02 |
| Figure of 8 with 2-handed knot | 252 ± 98 | 206 ± 57 | .08 |
| Figure of 8 with 1-handed knot | 209 ± 85 | 173 ± 46 | .09 |

$P < .05$ was considered statistically significant.

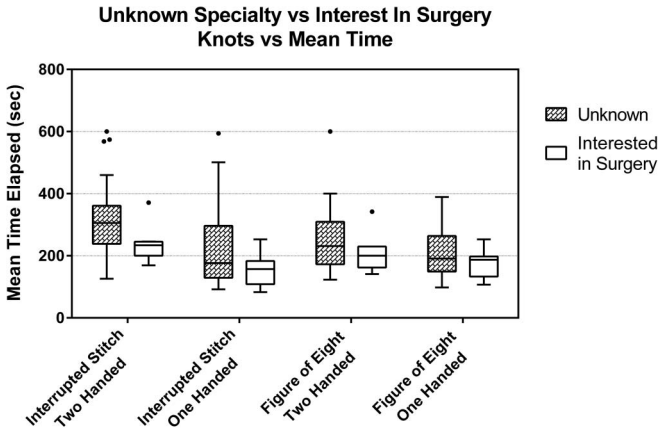


**Figure 3.** Comparison of mean task time in students with unknown specialty preference and students who are interested in surgery.

**Table 6.**
Comparison of Trainer Experience and Mean Task Times

| | Study Days 1 and 2 (*n* = 18) (Mean ± SD) (s) | Study Days 4 and 5 (*n* = 15) (Mean ± SD) (s) | *P* Value |
|---|---|---|---|
| Interrupted stitch with 2-handed knot | 365 ± 117 | 243 ± 62 | .001 |
| Interrupted stitch with 1-handed knot | 276 ± 125 | 131 ± 27 | .001 |
| Figure of 8 with 2-handed knot | 280 ± 107 | 202 ± 64 | .015 |
| Figure of 8 with 1-handed knot | 251 ± 82 | 151 ± 37 | .001 |

$P < .05$ was considered statistically significant.

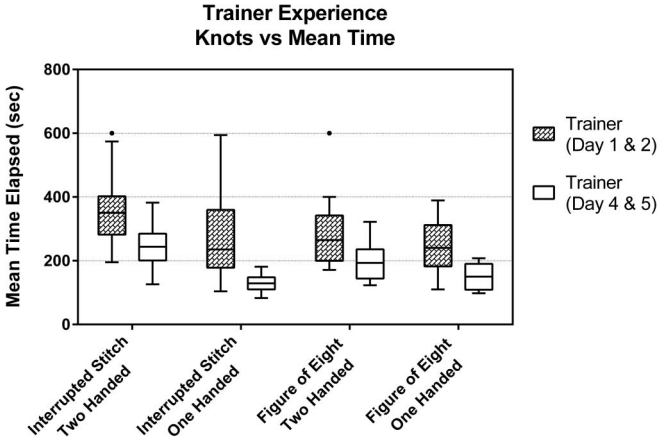


**Figure 4.** Comparison of mean task completion time and trainer's experience.

dual-console surgical system. This is the first study to compare the efficacy of the da Vinci Si dual console with that of the single console in teaching novice surgeons surgical techniques. We hypothesized that the dual-console group would perform the 4 surgical tasks significantly more quickly than the single-console group because the trainees at the dual console would have a more interactive learning experience through the ability to swap control of instruments, to observe tasks being performed with 3-dimensional vision through the console versus 2-dimensional vision on an external monitor, and to receive visual cues with arrows in addition to verbal instruction. Although there was not a statistically significant difference between the single- and dual-console groups' performance times, the dual-console group's performance times were generally faster than those of the single-console group.

Limitations to this study include the small sample size; a larger study population may be needed to detect a significant difference. The primary outcome of this study was performance time for knot-tying tasks; however, this study did not test other benefits that may be achieved from use of the dual console over the single console. For example, in a clinical setting, although operative time is very important, ultimately clinical outcome and morbidity experienced by the patient are most significant. This study evaluated knot tying, a basic skill traditionally requiring the use of only 2 hands, whereas actual surgery involves many complex tasks. Use of a mentoring console in which trainees could feel the movement of the surgical mentor's

hands at the adjacent console has been shown to decrease the time to complete complex 3-handed surgical tasks.[6] The da Vinci Si dual console could potentially be useful in teaching more complex surgical tasks. In addition, the presence of a dual console may provide the surgical mentor with additional comfort when instructing a trainee by allowing the mentor to more rapidly take control of the robotic arms in case of difficulty or emergency. It is difficult to measure the value of such an intangible benefit.

This study compared single- and dual-console learning curves only among first-, second-, and third-year medical students. We chose to include medical students because they have had minimal, if any, exposure to surgical techniques, especially knot tying. We were able to assess the learning curve for a student who had no surgical experience and had never tied surgical knots before. Although it would be interesting to perform this test among surgical residents and look for a similar trend between the single console and dual console, it would be very difficult to compare each participant's pre-existing skill level.

Furthermore, there is a learning curve to teaching suturing techniques. Although the participant schedule alternated between the single- and dual-console groups, the surgical mentor likely became better at providing instruction because the participants' performance times in the latter part of the study were significantly faster than those of the initial participants (**Table 5**). The students tied all 4 knots in the same order regardless of console group. Implementing a balanced Latin square design or assigning students to subgroups randomizing the order of task completion will help eliminate a learning curve. The learning curve was mostly likely influenced by the use of vocal instruction for the single-console group and the use of the virtual hands for the dual-console group.

This study does not address the cost of the additional surgeon console that is required for use of the dual-console platform. The current cost of the da Vinci Si surgical system is just under $2 million, and the annual maintenance is estimated to be around $150 000 per year. Robotic surgery has generated controversy regarding the high costs associated with it, and purchasing an additional console could prove to be difficult for some facilities, especially if it is not necessary to achieve the same results at a training facility. Hence it is beneficial to investigate the advantages of such a capital purchase for both educational and surgical goals.

## CONCLUSION

This study did not show a significant difference between the da Vinci Si dual console and single console for teaching novice medical students suturing techniques. However, additional studies should be performed evaluating the effectiveness of the dual console, particularly in the clinical setting, in teaching trainees and allowing a more interactive surgical experience. Although this study focused on the benefit of the dual console for training purposes, further research into the advantages of using the dual console for performing more complex surgical tasks should be performed.

**References:**

1. ACOG Technology Assessment in Obstetrics and Gynecology No. 6: robot-assisted surgery. *Obstet Gynecol.* 2009;114(5):1153–1155.

2. Lim P, Kang E, Park DH. A comparative detail analysis of the learning curve and surgical outcome for robotic hysterectomy with lymphadenectomy versus laparoscopic hysterectomy with lymphadenectomy in treatment of endometrial cancer: a case-matched controlled study of the first one hundred twenty two patients. *Gynecol Oncol.* 2011;120:413–418.

3. Holloway RW, Patel SD, Ahmad S. Robotic surgery in gynecology. *Scand J Surg.* 2009;98(2):96–109.

4. Lanfranco AR, Castellanos AE, Desai JP, Meyers WC. Robotic surgery: a current perspective. *Ann Surg.* 2004;239:14–21.

5. Advincula A, Wang K. Evolving role and current state of robotics in minimally invasive gynecologic surgery. *J Minim Invasive Gynecol.* 2009;16:291–301.

6. Wright JD, Ananth CV, Lewin SN, et al. Robotically assisted vs laparoscopic hysterectomy among women with benign gynecologic disease. *JAMA.* 2013;309(7):689–698.

7. Hanly EJ, Miller BE, Kumar R, et al. Mentoring console improves collaboration and teaching in surgical robotics. *J Laparoendosc Adv Surg Tech A.* 2006;16(5):445–451.

8. Marengo F, Larrain D, Babilonti L, Spinillo A. Learning experience using the double-console da Vinci surgical system in gynecology: a prospective cohort study in a University hospital. *Arch Gynecol Obstet.* 2012;285:441–445.

9. Smith AL, Krivak TC, Scott EM, et al. Dual-console robotic surgery compared to laparoscopic surgery with respect to surgical outcomes in a gynecologic oncology fellowship program. *Gynecol Oncol.* 2012;126(3):432–436.

10. Smith AL, Scott EM, Krivak TC, et al. Dual-console robotic surgery: a new teaching paradigm. *J Robot Surg.* 2013;7(2):113–118.

11. Di Lorenzo N, Coscarella G, Faraci L, et al. Robotic systems and surgical education. *JSLS.* 2005;9(1):3–12.

12. Jenison EL, Gil KM, Lendvay TS, et al. Robotic surgical skills: acquisition, maintenance, and degradation. *JSLS.* 2012;16(2):218–228.