



## Assessment of the daVinci Single Port (SP) Robotic Platform on Indirect Inguinal Hernia Repair in Adolescents

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### Abstract

**Background:** The da Vinci Single Port (SP) robotic platform has great appeal for pediatric surgery. To assess the feasibility, efficacy and identify potential challenges, 11 adolescents underwent SP robotic inguinal herniorrhaphy, and their results were evaluated.

**Methods:** Patients > 13 years old who presented with an inguinal hernia were offered robotic inguinal hernia repair. We report on the first 11 participants. Through a single 2.5 cm cannula the surgeon controls three fully-wristed, elbowed instruments, and the first fully-wristed da Vinci endoscope. The SP system was used for unilateral and bilateral repair. 2-0 Ethibond sutures were placed extraperitoneally and circumferentially to complete a high ligation of the sac.

**Results:** All patients were ASA class I or II, outpatients, mean age was 16 years old, mean weight was 77 kg, and 10/11 patients were male. In two cases an unsuspected contralateral hernia was also repaired. There were no fatalities or returns to the operating room. The mean estimated blood loss was 3 ml, and mean case duration was 82 minutes. No patients used immediate postoperative narcotics. One adolescent reported mild constipation and intermittent groin pain, but did not return for repeat follow-up. One patient presented a year later with a direct hernia on the side of the previous repair, and one patient reported a nodule in the incision scar.

**Conclusions:** SP robotic herniorrhaphy in adolescents appears to be safe and effective. The wristed robotic instruments improve surgeon dexterity. The single incision hidden in the umbilicus improves cosmesis. Patients reported limited pain with prompt return to full activity. Finally, the camera allows identification and repair of bilateral inguinal hernias through a single incision. The cost, procedure duration and long term complications should be further considered, but this series provides an exciting glimpse of what is possible in pediatric robotic surgery.

**Keywords:** Indirect hernia; Pediatrics; Robotic surgery; Single-port

### Introduction

Laparoscopic surgical techniques have proven benefits in children. Bilateral inguinal hernia repairs are shorter in length when done laparoscopically versus open because both groins can be explored and repaired through the same laparoscopic incisions [1]. Furthermore, the extremely delicate cord structures in neonates are also less susceptible to injury in a laparoscopic approach

compared to an open approach [2]. The widespread adaptation of robotic surgery in children, however, has proved challenging. Although the first robotic surgery on a child was reported in April 2001 [3], robotic surgery within spatially-constrained workspaces in children makes traditional platforms less suitable. The Single Port (SP) da Vinci surgical system, however, appears to make robotic surgery more feasible in pediatric populations. The SP is a 4<sup>th</sup> generation da Vinci surgical system. It uses the same surgeon console as the da Vinci X and Xi systems. Through a single 2.5 cm cannula the surgeon controls three fully-wristed, elbowed

instruments, and the first fully-wristed da Vinci endoscope. SP instruments can reach up to 24 cm deep and triangulate at the distal tip. Instruments can also reach anatomy anywhere within 360° of port placement. The SP consists of a flexible 3-D camera and three, flexible, interchangeable instruments, all of which pass through a 2.5 cm cannula. The instruments have mid-instrument flexion and can be manipulated immediately beyond the end of the cannula. Once deployed the telescope and instruments are functional within a 7 cm diameter space. This technology provides narrow, deep access<sup>4</sup> making it highly applicable for pediatric surgery.

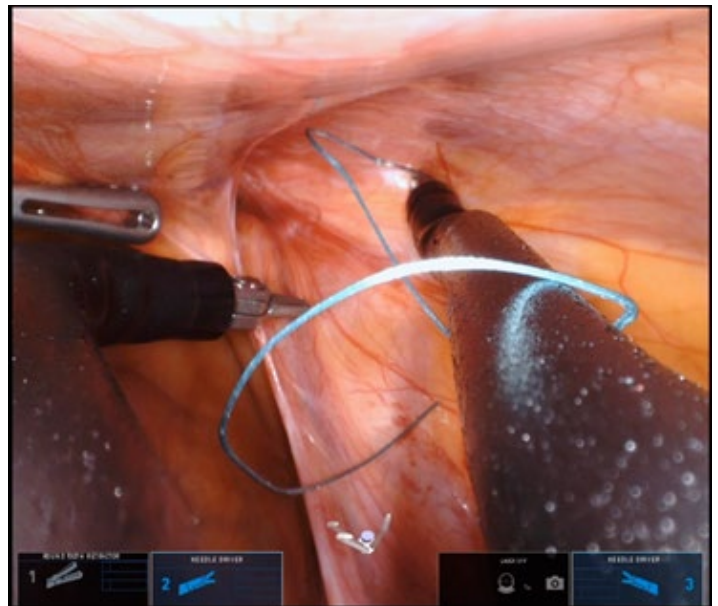
Eleven adolescents underwent SP robotic-assisted inguinal herniorrhaphy at the University of Illinois at Chicago (UIC). Their results were evaluated to assess feasibility, efficacy and identify potential challenges.

### Materials and Methods

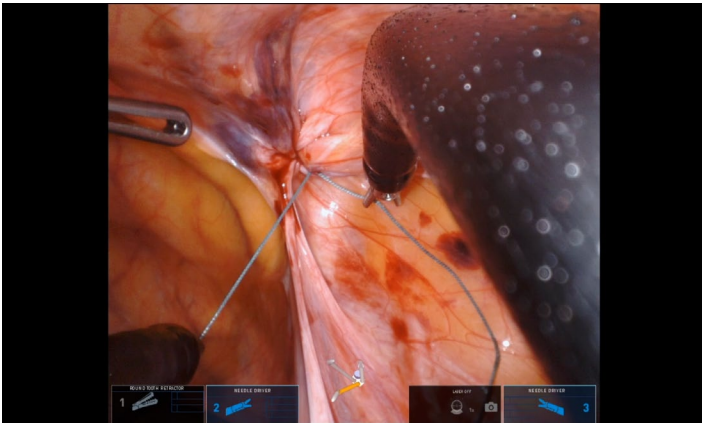
The University of Illinois at Chicago Institutional Review Board gave approval for this study. The research protocol number is 2014-0396. Patients 13-18 years of age who presented to the UIC pediatric surgery service with a clinically apparent indirect inguinal hernia on physical examination were offered a robotic inguinal hernia repair versus a more traditional open or laparoscopic inguinal hernia repair. The UIC IRB approved the study and the parents of all patients provided consent for participation in the study. We report our experience with the first 11 participants. The SP approach was used for both unilateral and bilateral hernia repair. Patients were placed supine and a small incision was made through the midline of the umbilicus, through all layers of the abdominal wall, into the peritoneal cavity. The robotic single port was introduced and the abdomen was insufflated. Both groins were examined for inguinal hernias and other pathology. A 2-0 Ethibond suture was introduced into the peritoneal cavity through one of the instrument ports of the SP cannula. The suture was then placed circumferentially to perform an extraperitoneal high ligation of the hernia sac at the level of the internal ring. The vas deferens and vessels were carefully avoided during the passage of the needle. No additional instrumentation was required (Figures 1-3).



**Figure 1:** Patient prepped and draped with single port through the midline of the umbilicus.



**Figure 2:** Indirect inguinal hernia and 2-0 Ethibond suture in the peritoneal cavity.



**Figure 3:** Circumferential extraperitoneal high ligation of the hernia sac.

In one case a hydrocele of the cord was noted that sat at the internal inguinal ring, dilating it to greater than 4 cm diameter. The size of the hernia neck prompted the decision to place mesh for the hernia repair. A transverse incision was made in the peritoneum of the anterior abdominal wall approximately 2 cm cephalad and superior to the upper rim of the internal inguinal ring. The peritoneal incision extended sufficiently lateral from the umbilical ligament to approximate the width of the proposed mesh implant. The flap was extended distally and inferiorly in order to expose the hydrocele and dissect the hernia sac from the cord structures which were left intact. The hydrocele was then removed. It did not extend distally through the inguinal canal. Mesh was then inserted through the telescopic port of the SP cannula and was placed over the hernia defect in the pouch that was just created. Once in place, the peritoneum was reapproximated using a running 3-0 Vicryl suture, completing the repair.

The robotic single port was then removed. The fascia was closed using 0 PDS. The incision was closed in layers, and skin glue was applied over the incision (Figure 4).



**Figure 4:** Single port insertion site immediately post-operatively.

Finally, key demographic information and patient outcomes were collected in a retrospective chart review, and results were analyzed.

### Results

All patients were ASA class I or II, outpatients, mean age was 16 years old ranging from 13 to 18 years old, mean weight was 77 kg ranging from 52 to 91 kg, and 10/11 patients were male. In two cases an initially unsuspected, contralateral hernia was identified intraoperatively and repaired. There were no fatalities, no return trips to the operating room for recurrence or complications. The mean estimated blood loss was 3 ml per operation, and the mean case duration was 83 minutes. All patients were treated as outpatients and no patients used immediate postoperative narcotics. Nine out of 11 patients attended their follow-up appointment for a mean follow-up period of 20 days. Of these nine patients one reported some mild constipation and intermittent groin pain, but he did not return for repeat follow up. One patient presented a year later with a new direct right inguinal hernia on the side of the previous repair, and one patient reported a nodule in the incision scar.

## Discussion

Robotic herniorrhaphy is a new and exciting alternative to open and laparoscopic inguinal hernia repair. The robotic approach has the same relative and absolute contraindications as laparoscopic surgery: inability to tolerate pneumoperitoneum, uncorrectable coagulopathy, abdominal compartment syndrome, abdominal wall infection, and previous extensive abdominal surgery [5]. The camera system on the SP system, however, allows identification of contralateral hernias, and the 360-degree rotation makes repair of bilateral inguinal hernias through a single incision possible.

## Conclusion

In our case series, SP robotic herniorrhaphy was safe and effective. Although robotic surgery can be more costly than traditional approaches, the increased functionality gives the experienced robotic surgeon far more tools to safely perform an operation. The robotic approach adds increased flexibility and range of motion for the surgeon over the use of laparoscopic instruments. The elbowed instruments allow for improved ease of use for multiple instruments passing through the same, single port. In addition, the single incision provided cosmetic improvement

over multiple abdominal trocar sites, and patients reported limited pain with a prompt return to full activity. The cost, length of procedure and long-term complications must all be considered, but this case series sets an exciting precedent for SP robotic surgery and pushes the needle forward for what is possible in children's robotic surgery.

## Funding Information

University of Illinois at Chicago Department of Surgery.

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