

# Intracorporeal hybrid single port vs conventional laparoscopic appendectomy in children

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## Abstract

Transumbilical laparoscopic assisted appendectomy combines laparoscopic single port dissection with open appendectomy after exteriorization of the appendix through the port site. Compared to the conventional three-port approach, this technique provides an alternative with excellent cosmetic outcome. We developed a safe and effective technique to perform an intracorporeal single port appendectomy, using the same laparoscope employed in the extracorporeal procedure. Retrospective review of 71 consecutively performed intracorporeal single port appendectomies and 30 conventional three-port appendectomies in children 6 to 17 years of age. A straight 10-mm Storz telescope with inbuilt 6 mm working channel is used to dissect the appendix, combined with one port-less 2.3 mm percutaneous grasper. Polymer WECK® hem-o-lock® clips are applied to seal the base of the appendix and the appendiceal vessels. No intraoperative complications were reported with the hybrid intracorporeal single port appendectomy or three-port appendectomy. There were two post-operative complications in the group treated with the single port hybrid technique: one intra-abdominal abscess and one surgical site infection. Groups did not differ in age, weight, and types of appendicitis. Operative times were shorter for the hybrid technique (70 vs 79 minutes) but did not differ significantly ( $P=0.19$ ). This modified technique to a previously described single port extracorporeal appendectomy is easy to master and implement. It provides exposure similar to a three-port laparoscopic appendectomy, while maintaining virtually scarless results and potentially reduces the risk for surgical site infections compared to the extracorporeal technique.

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## Introduction

Appendectomy is one of the most common surgeries performed in children. Innovations in laparoscopic surgery are continuously evolving in efforts to minimize scars, improve operative outcomes and maintain cost effectiveness. In pediatric patients the transumbilical laparoscopic assisted appendectomy is widely conducted. This technique combines the use of a straight telescope with inbuilt working channel, with an open appendectomy after externalizing the appendix through the umbilical port site.<sup>1-3</sup> The natural umbilical scar provides an ideal location to gain access to the abdomen.<sup>4</sup> In this transumbilical laparoscopic assisted technique, blunt mobilization of the cecum to provide leverage to extracorporealize the appendix is often necessary.<sup>5,6</sup> Cecal mobilization is not typically required during a standard single port appendectomy in an adult. The described technique allows for a completely intracorporeal appendectomy via one single 10 mm umbilical port without the need for cecal mobilization or placement of a spacious multi-access system and it omits the need for exteriorization of the appendix through the umbilicus. Exteriorization can be challenging in overweight patients and potentially poses an increased risk for surgical site infections.<sup>7</sup>

## Materials and Methods

### Patients

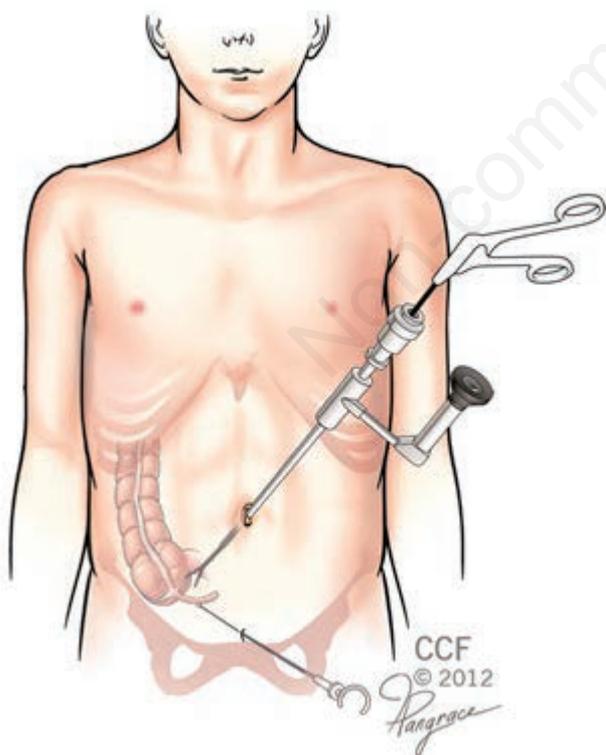
This is a retrospective study of patients who underwent the hybrid appendectomy technique by a single surgeon from October 2010 through November 2015. After institutional review board approval, 101 charts of patients with appendicitis as the exclusive diagnosis were included in the study. 30 of 101 patients underwent conventional three port laparoscopic appendectomy and 71 underwent the single port hybrid technique. All surgeries were performed at a single pediatric quaternary care center. Procedures were performed by the same surgeon. Data were extracted from operative reports, surgical progress notes, and 6 week follow up clinic visits with pediatric surgery, nutrition, and pediatric gastroenterology. Our summary includes operative time and any postoperative complications through a 6-week follow up period.

### Technique

#### Hybrid single port appendectomy

A weight-appropriate dose of Ampicillin/Sulbactam (50 mg/kg) or Piperacillin/Tazobactam (100 mg/12.5 mg/kg) is given intravenously within the hour prior to incision. The patient is placed in supine position on the operative table and undergoes standard general anesthesia. Bladder and stomach are both decompressed. A longitudinal 11mm

incision is made directly through the umbilicus and entrance into the abdominal cavity is obtained under direct visualization through the central umbilical defect. An 11 mm Step™ bladeless trocar (Covidien, Mansfield, MA, USA) is inserted and the abdomen is insufflated with CO<sub>2</sub> to 12 mmHg. The 10 mm Storz Hopkins telescope with a 6mm working channel is used to identify the inflamed appendix. All instruments used through working channel are a minimum of 43 cm long. Through a suprapubic stab incision, a 2.3 mm Clutch Grasper (Stryker, MiniLap, Kalamazoo, MI, USA) is introduced under direct visualization (Figure 1). The appendix is bluntly released from its peritoneal attachments. With the appendix retracted using the clutch grasper, dissection of the appendiceal base and vasculature is further carried out with a blunt grasper, introduced through the working channel of the telescope. A polymer WECK® hem-o-lock clip® is placed around the mesoappendix, 2 clips proximally and 1 clip distally. The mesoappendix is then sharply transected between clips. A laparoscopic bowel clamp is used to compress the base of the appendix in similar fashion to an open appendectomy. Two laparoscopic-polymer WECK® hem-o-lock clips® are then applied proximally and one distally to the appendiceal base. The appendix is sharply divided between the clips. The appendix is released by the clutch grasper and handed to the blunt telescope instrument. The mini grasper is extracted and under direct vision, the appendix is subsequently pulled into the trocar. Trocar and telescope are removed from the abdominal cavity, avoiding direct contact of the protected appendix to the tissues of the abdominal wall at the umbilicus. The umbilical ring and skin are closed with absorbable sutures and dressed with a Tegaderm® vacuum dressing.<sup>8</sup> The suprapubic stab incision is closed with Dermabond® skin glue.



**Figure 1.** Introducing a 2.3 mm Clutch Grasper through a suprapubic stab incision. Reproduced with permission, Cleveland Clinic Center for Medical Art & Photography ©2015. All Rights Reserved.

## Instruments

Instruments used were as follows. A straight 10 mm 0 degree Storz telescope with inbuilt 6 mm working channel (Figure 2); an 11mm Step™ bladeless trocar (Covidien); medium sized Polymer WECK® Hem-o-Lock Clip® (Teleflex, Research Triangle Park, NC, USA) (Figure 3); 2.3 mm Clutch Grasper (Stryker) (Figure 4).

## Conventional three port laparoscopic appendectomy

An infraumbilical incision is made and a Verress needle is used to create a capnoperitoneum. A 12-mm umbilical trocar is introduced into the peritoneal cavity followed by a 5-mm trocar in the suprapubic position and a 5-mm trocar in the left lower quadrant. The appendix and the mesoappendix are divided with a 10mm EndoGIA™ stapler (Covidien). The appendix is extracted from the umbilical trocar in an Endocatch™ pouch (Covidien). Trocars are removed under direct vision. The umbilical fascial defect is closed with a figure-of-eight polyglactin suture. The 5mm port sites are closed with polyglactin and poliglecaprone in two layers. A vacuum dressing with dry gauze and Tegaderm® is applied on the umbilicus.<sup>8</sup>

## Results

The results for all appendectomies were stratified by operative procedure: 71 patients underwent the hybrid technique while 30 were operated by conventional laparoscopic three-port appendectomy.

The median age in the hybrid technique is 12.3, and 13.1 in the triple port (P=0.59).

The hybrid technique was used to treat 63% male patients and 37% female patients whereas the three-port procedure was used on 93% male and 7% female (P=0.002).

Median weight in the hybrid technique was 45.2 and 51.4 kg in the three-port technique (P=0.16).

In the hybrid technique, 63% of patients were categorized as underweight/normal weight, 12% were overweight and 28% were obese. In the group treated with the three-port technique, 53% were underweight/normal weight, 10% were overweight, and 37% were obese (P=0.26).

The median operative time was 70 minutes in the hybrid group and 79 minutes in the group treated with conventional laparoscopy (P=0.19). The relatively high operating time is reflective of involvement of surgical trainees who were often first-time laparoscopic users. Based on histo-pathology, in patients treated with the hybrid technique 82% had acute appendicitis, 6% had gangrenous appendicitis and 13% had perforated appendicitis, against 80% acute, 3% gangrenous and 17% perforated in the three port technique (P=0.91).

One patient in the hybrid technique group had a surgical site infection (1.4%), which was treated with oral antibiotics. Another patient (1.4%) developed a peritoneal abscess associated with perforated appendicitis, necessitating drainage by interventional radiology and a course of intravenous antibiotics. No patient in the three-port group had any postoperative complication. There were no intraoperative complications in the conventional or hybrid technique.

## Discussion

In recent years the laparoscopic appendectomy has evolved modifying the number of ports and location of port sites. Furthermore, several single access techniques have been described to perform laparoscopic surgeries. These involve transumbilical incisions to accommodate a

multi- instrument port or enough space to position multiple ports through one skin incision simultaneously. Compared to the infraumbilical access, the transumbilical incisions provide excellent cosmetic outcome and omit the use of a Verress needle. Therefore, the transumbilical access was applied in the more recent patients undergoing the hybrid technique in this single surgeon series. The need for a relatively large umbilical incision makes many single access techniques less attractive for its use in the pediatric population. To obviate disproportionate incisions, several surgical alternatives have been described. A widely used technique is the extracorporeal transumbilical laparoscopic assisted appendectomy, which requires mobilization of the cecum in order to gain enough mobility to exteriorize the appendix through the umbilicus. This technique has been shown to be cost efficient, safe, quick and with excellent cosmetic outcome.<sup>2,6</sup> The latter can be very challenging in obese patients. As described by Knott *et al.* the single site approach is not recommended in obese patients due to a longer operative time, longer length of stay, more doses of postop analgesics and greater costs.<sup>9</sup> We propose a hybrid technique - combining a single port laparoscopic instrument with a port-less grasper to provide traction and exposure of the appendix. A similar approach has been described by Schier in 1998 without the use of a disposable port-less grasper and non-absorbable polymer locking clips.<sup>10</sup> We did not study the cost of this hybrid technique but hypothesize that the charges are comparable or less costly than for conventional laparoscopic appendectomy, considering the addition of one inexpensive port-less grasper and 6 polymer clips and the lack of endoscopic staplers.

An alternative method to the single port appendectomy with extracorporealization, is the SWING suture technique described by Akgur,

Ates *et al.*<sup>11,12</sup> This method involves insertion of a polypropylene suture through an angiocath to sling the appendix into the suture for traction. This method provides a similar approach to our proposed single port technique with regards to the use of traction on the appendix. Compared to the angiocath, the clutch grasper is stiffer and longer which allows higher range of motion and changes of retraction.<sup>11</sup>

One potential benefit to conducting a completely intracorporeal appendectomy is the presumed decreased risk of surgical site infections. The *all in one* appendectomy, which requires extracorporealization of an infected appendix that inevitably comes into contact with the skin, does pose concerns for surgical site infections. The rate of surgical site infections of the transumbilical laparoscopic assisted appendectomy with extracorporeal amputation of the appendix ranges from 7.4% to 11.1%.<sup>2,6,13</sup> Wound infections after conventional three port laparoscopic appendectomies are less frequent ranging from 0.09 to 3.1%.<sup>14,15</sup> In our study only 1 patient operated by the hybrid technique developed a wound infection (1.4%). Of the 30 patients treated with conventional three-port laparoscopy, no surgical site infection was recorded. We speculate that the low wound infection rate of patients operated with the hybrid technique compared to the extracorporeal transumbilical technique is influenced by the lack of contact of the appendix with the tissues of the abdominal wall. Further investigation is required to substantiate this reduced risk for surgical site infection with a completely intracorporeal appendectomy compared to transumbilical laparoscopic assisted appendectomy in a prospective randomized study.

The use of polymer clips in appendectomies has been reported in the literature. Akkoyun *et al.* demonstrated the use of polymer clip in a tra-



Figure 2. A straight 10 mm 0 degree Storz telescope with inbuilt 6 mm working channel.



Figure 3. Medium sized Polymer WECK® Hem-o-Lock Clip®.

ditional 3 port laparoscopic appendectomy was feasible and safe in closing the appendiceal stump.<sup>16</sup> The polymer clips are non-absorbable and range in size between 7 and 13 mm. The clips have small serrated teeth which allow it to firmly attach to tissue and limit shifting or migration.<sup>16</sup> We apply the clips to the base of the appendix to seal the mesoappendix. Alternatively, the mesoappendix can be divided by the use of electrocautery. Polymer clips are reported to induce minimal soft tissue inflammation.<sup>17</sup> In our cohort we did not encounter any symptomatic foreign body reaction.

The polymer clips are applied with long appliers through the 6mm working channel of the straight 10 mm 0 degree Storz telescope. Conventional staplers do not fit the channel and commercially available Endoloop® ligatures (Ethicon part of the Johnson & Johnson family of companies; Johnson & Johnson, New Brunswick, NJ, USA) are too short. A potentially limiting step in our proposed method is the size of the clips. Only the medium sized clips fit the instrument channel, which allow ligation of up to 10 mm thick tissue. Larger appendices are not amenable to this technique. This method of single port appendectomy provides a safe ligation of the appendiceal base and vasculature with a more traditional approach to limited cecal mobilization.

Compared to the conventional three port laparoscopic appendectomy, average operative time was shorter using the hybrid technique. This did not reach statistical significance possibly due to small sample size. The cohorts presented in this study had a similar sex, age, type of appendicitis, and weight distribution although patients treated by the three-port technique were more likely to be male.



Figure 4. A 2.3 mm Clutch Grasper (Stryker).

## Conclusions

The hybrid single port laparoscopic appendectomy using the 10 mm Storz telescope with inbuilt working channel, Polymer WECK® Hem-o-Lock Clip® and 2.3 mm Clutch Grasper has been shown to be safe, effective, replicable, with a virtually scar-less results and was successfully applied in normal weight and overweight pediatric patients. We have found that the surgical site infection rate is similar to the conventional three-port laparoscopic appendectomy with a lower incidence compared to the transumbilical laparoscopic assisted extracorporeal appendectomy. We speculate that wider application of the hybrid technique results in reduced cost compared to the conventional three-port technique but a prospective randomized study is necessary to enforce this suggested benefit.

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