

# Evaluation of factors associated with formation of intra-abdominal collections in single-port appendectomy for complicated acute appendicitis

## *Evaluación de factores asociados a formación de colecciones intraabdominales en apendicectomía monopuerto para apendicitis aguda complicada*

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### Abstract

**Objective:** To compare the decreases between the appendectomy by single port vs. multiport laparoscopy and to establish if there is a difference in the risk of postoperative intra-abdominal collection. **Method:** Retrospective study was carried out using 116 medical records of patients undergoing laparoscopic appendectomy through a single port and multiport in two medical centers. **Results:** 12 (10.3%) patients developed an abdominal collection. No differences were found between the two techniques in terms of intra-abdominal collection development ( $p = 0.242$ ), there was no difference between the two techniques in terms of intraoperative bleeding ( $p = 0.012$ ), the surgical time was greater in the single-port group (17.4 min on average). 62.5% of patients with bleeding > 50 mL developed intra-abdominal collection. **Conclusions:** There was no evidence of the superiority of either of the two interventions in complicated appendicitis, but it does confirm that single-port laparoscopic appendectomy is a safe, feasible, noninferior procedure and with similar complication rates compared to the conventional laparoscopic appendectomy technique.

**Keywords:** Surgery. Single port. Laparoscopic. Appendectomy.

### Resumen

**Objetivo:** Comparar los desenlaces entre la apendicectomía por laparoscopia por puerto único y multipuerto, y establecer si existe diferencia en el riesgo de colección intraabdominal posoperatoria. **Método:** Se realizó un estudio retrospectivo, observacional, mediante 116 historias clínicas de pacientes llevados a apendicectomía laparoscópica por único puerto y multipuerto en dos centros médicos. **Resultados:** Desarrollaron colección intraabdominal 12 (10.3%) pacientes. No se encontraron diferencias entre ambas técnicas en cuanto al desarrollo de colección intraabdominal ( $p = 0.242$ ), no hubo diferencia entre ambas técnicas en cuanto a sangrado intraoperatorio ( $p = 0.012$ ) y el tiempo quirúrgico fue mayor en el grupo de puerto único (17.4 minutos en promedio). El 62.5% de los pacientes con sangrado > 50 ml desarrollaron colección intraabdominal. **Conclusiones:** No se evidenció superioridad de ninguna de las dos intervenciones en apendicitis complicada, pero sí se confirma que la apendicectomía laparoscópica por puerto único es un procedimiento seguro, factible, no inferior y con tasas similares de complicaciones en comparación con la técnica convencional de apendicectomía laparoscópica.

**Palabras clave:** Cirugía. Monopuerto. Laparoscopia. Apendicectomía.

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## Introduction

Current incidence of appendicitis in Europe and America is around 100 per 100,000 people per year<sup>1</sup>. Appendectomy is one of the most common surgical procedures<sup>2</sup>. This procedure has been performed for more than 100 years, after McBurney first described it<sup>3</sup>. Currently, when reviewing the literature, we find that the reference method for the treatment of acute appendicitis is multiport or conventional (three-port) laparoscopic appendectomy. Conventional laparoscopic appendectomy is a safe and feasible procedure. Its proposed benefits include a reduced postoperative hospital stay, better postoperative pain control and a faster return to daily activity, as well as better cosmetic outcomes, in comparison with open appendectomy<sup>4</sup>.

With technological advances, surgeons have developed minimally-invasive procedures that provide safety and benefits for the patient. The use of natural orifices (NOTES – Natural Orifice Transluminal Endoscopic Surgery) has been described, as well as single-port appendectomy, also called transumbilical embryonic natural orifice transluminal endoscopic surgery (E-NOTES), in which the embryonic scar is used to introduce a single port through this anatomical landmark, using conventional laparoscopy equipment, and thereby carry out the surgical procedure<sup>5-7</sup>. A recent development in appendectomy has been the introduction of less invasive single-incision laparoscopic surgery, which uses a single multi-luminal port or multiple mono-luminal ports through the same skin incision<sup>8,9</sup>.

In some studies, single port approach has been shown to be just as safe as multiport appendectomy, and even with better cosmetic results, better pain control, lower infection rate and higher patient satisfaction, without costs, surgical times or the risk of complications being increased<sup>9,10</sup>. There is still great controversy among some surgeons, who do not see this management option as a good alternative, since it implies less ergonomics, greater dexterity, and longer time to reach the learning curve. However, when reviewing the literature, there are few controlled observational trials that compare both these approaches in patients with complicated appendectomy, and even with the performance of more complex procedures, such as single-port cecectomy.

A retrospective study was carried out with the purpose to compare, with conventional laparoscopic management, the efficacy and safety of the single-port technique, without affecting costs or surgical times, in

complicated appendicitis, and even when more complex interventions, such as cecectomy, are required, with the risk of intra-abdominal collection being evaluated.

## Method

### *Population and sample*

The prevalence of intra-abdominal collection was established in patients with complicated acute appendicitis undergoing single-port and multiport laparoscopy, which was 10.3%. Subsequently, the sample size was determined, which was defined with the use of the Epidat software and which yielded a sample of 114 patients with a margin of error of 3%.

A total of 116 patients with similar demographic characteristics underwent surgery. The procedures were performed by three surgeons with the same academic background. Data were collected retrospectively from all 116 patients; out of them, 54 (46.5%) corresponded to laparoscopic multiport approach, and 62 (53.5%), to laparoscopic single port approach. Single-port approach interventions were carried out transumbilically with an unconventional port with a latex glove (glove port); three trocars were used through the port, which was previously attached to a laparoscopic surgery device (Alexis). All patients received intravenous antibiotics for at least 3 days, and more if clinical response was not satisfactory after this time.

### *Inclusion criteria*

- Patients older than 15 years.
- Patients with complicated acute appendicitis.
- Single port laparoscopic surgery.
- Three-ports conventional laparoscopic surgery.
- Intra-abdominal collection.

### *Exclusion criteria*

- Single-port laparoscopic appendectomy for peri-appendicitis due to pelvic inflammatory disease.
- Patients undergoing single-port appendectomy using a trademarked device (such as single-incision laparoscopic surgery [SILS] or Gelport).
- Patients diagnosed with complicated appendicitis managed with open surgery.
- Patients who underwent single or conventional port laparoscopic interval appendectomy.
- Patients with intraoperative findings such as appendicular neoplasms or peritoneal carcinomatosis.

**Table 1. Demographic characteristics, type of procedure and outcomes in both groups**

| Variable               | Multiport (n = 54) | Single port (n = 62) |
|------------------------|--------------------|----------------------|
| Age, years             | 31.3 (18-65)       | 30.5 (18-56)         |
| Body mass index        | 33.7 (24.1-39.2)   | 32.9 (23.5-36.8)     |
| Bleeding, mL           | 35 (25-90)         | 29 (27-80)           |
| Surgical time, minutes | 59.6 (30-75)       | 42.2 (25-60)         |
| Hospital stay, days    | 5.5 (3-7)          | 5 (3-6)              |
| Cecectomy              | 9                  | 5                    |

### Data collection technique

Data collection was carried out based on medical records direct review by the researchers, after approval of the institutions involved in the study, and were recorded in an organized way on a data collection form and then digitized in an Excel table for tabulation and statistical analysis.

### Data analysis plan

The Statistical Package for the Social Sciences (SPSS) program was used. Qualitative variables were expressed in terms of relative proportions and percentages. Quantitative variables had the average and range calculated. The continuity correction test and Fisher's exact statistical likelihood ratio test were performed.

In all cases, a p-value < 0.005 was regarded as a criterion for statistical significance to be established.

### Ethical considerations

The researchers declare that they are familiar with the standards for research on human subjects based on the Nuremberg Code, the Belmont Report and the Declaration of Helsinki. This study is classified as risk-free research according to resolution 8430 of 1993, since consultation of a database is used and no intervention or modification of physiological, biological, psychological and social variables of study participants is carried out. In addition, exemption of any participant will not negatively affect his/her well-being or his/her rights. The study protocol was submitted to the medical institutions for approval. All surgically intervened patients have knowledge of the surgical procedure via the informed consent, previously explained by the surgeon and signed by the patient.

**Table 2. Grade III surgical site infection**

|           |             | No | Yes | p     | LR    |
|-----------|-------------|----|-----|-------|-------|
| Technique | Single port | 58 | 4   | 0.242 | 0.138 |
|           | Multiport   | 46 | 8   |       |       |

LR: likelihood ratio.

**Table 3. Association between the use of Hook device or laparoscopic surface sealant and the development of grade III SSI**

| Hook use                     |     |    |     |       |       |
|------------------------------|-----|----|-----|-------|-------|
|                              |     | No | Yes | Total | p     |
| SSI III                      | No  | 88 | 16  | 104   | 1.000 |
|                              | Yes | 10 | 2   | 12    |       |
| Total                        |     | 98 | 18  | 116   |       |
| Laparoscopic surface sealant |     |    |     |       |       |
|                              |     | No | Yes | Total | p     |
| SSI III                      | No  | 16 | 88  | 104   | 0.591 |
|                              | Yes | 3  | 9   | 12    |       |
| Total                        |     | 18 | 98  | 116   |       |

LR: likelihood ratio.

## Results

The medical records of 116 patients who underwent laparoscopy in two hospital centers during the period from January 2018 to March 2019 were reviewed, out of which 54 (46.5%) correspond to approaches with multiport laparoscopic technique and 62 (53.5%) to single-port laparoscopic approaches. Average age of the group that underwent multiport approach was 31.3 years, while that of the group that underwent single-port approach was 30.5 years. Average body mass index was 33.7 in the multiport group and 32.9 in the single port group. Average bleeding was 31.31 mL in the multiport group and 29.2 mL in the single-port group. Average surgical time was 35.2 minutes in the multiport group and 38.3 minutes in the single-port group. In 14 cases (25%), cecectomy was practiced (average hospital stay 5.5 days in the multiport group and 5 days in the single-port group). There was no need for conversion to open surgery in either group and 100% of patients in both groups had complicated acute appendicitis (Table 1).

Intra-abdominal collection (grade III surgical site infection [SSI]) was identified in patients 12 (10.3%), out

**Table 4. Association between bleeding and technique**

|          |           | Type of technique |           | Total | p     | LR    |
|----------|-----------|-------------------|-----------|-------|-------|-------|
|          |           | Single port       | Multiport |       |       |       |
| Bleeding | 0-50 mL   | 61                | 52        | 113   | 0.012 | 0.017 |
|          | 50-100 mL | 1                 | 2         | 3     |       |       |
|          | > 100 mL  | 0                 | 0         | 0     |       |       |
| Total    |           | 62                | 54        | 116   |       |       |

LR: likelihood ratio.

**Table 5. Association of bleeding and grade III SSI**

|          |           | SSI III |     | Total | p     | LR    |
|----------|-----------|---------|-----|-------|-------|-------|
|          |           | No      | Yes |       |       |       |
| Bleeding | 0-50 cc   | 101     | 7   | 108   | 0.001 | 0.001 |
|          | 50-100 cc | 3       | 5   | 8     |       |       |
|          | > 100 cc  | 0       | 0   | 0     |       |       |
| Total    |           | 104     | 12  | 116   |       |       |

LR: likelihood ratio.

of whom 4 patients (33.3%) underwent single-port approach, and 8 (66.7%), multiport approach (Table 2).

In 18 patients (15.5%), monopolar electroscalpel (Hook) was used (Table 3), out of whom 2 (11.1%) developed grade III SSI. In 98 patients (84.5%), laparoscopic surface sealant was used (Table 3), among whom 9 (9.1%) developed surgical site infection.

As for intraoperative bleeding, 61 patients (98%) in the single-port group had a usual bleeding of less than 50 mL, and only one had 50-100-mL bleeding, while in the multiport group, 52 patients (96.3%) had a bleeding of less than 50 mL and only two patients experienced bleeding of 50-100 mL; in neither of the two groups was bleeding higher than 100 mL recorded (Table 4). Of the 12 patients who developed grade III SSI, 100% were associated with some type of intraoperative bleeding (Table 5), and 62.5% of patients in whom bleeding higher than 50 mL was documented and 6.4% of patients with bleeding lower than 50 mL developed intra-abdominal collection.

## Discussion

Currently, laparoscopic appendectomy is the treatment of choice for acute appendicitis. According to the latest Jerusalem guidelines, published by Di Saverio et al.<sup>11</sup>, for the diagnosis and management of acute

appendicitis, it is the recommended approach in uncomplicated and complicated appendectomy in children and adults<sup>12</sup>, and also make special mention of single-port laparoscopic appendectomy as a technique that has been shown to be safe, feasible and basically as effective as conventional multiport laparoscopic appendectomy. Estimated intra-abdominal collection risks associated with laparoscopic appendectomy range from 1.8% to 3.4%<sup>3,10,12</sup>. In our study, 10.3% of patients developed grade III surgical site infection, 3.4% in the single-port group and 6.8% in the conventional laparoscopic appendectomy group, without a statistically significant difference between both groups ( $p = 0.242$ ) or predisposition to develop intra-abdominal collections being observed with one technique or the other (Table 2), as reported by Zhou et al.<sup>13</sup> in their study.

As for the use of devices for mesoappendix section, such as monopolar electroscalpel (Hook) or laparoscopic surface sealant, they were not shown to be related to the development of grade III SSI, as shown in table 3. In a study carried out by Di Saverio et al.<sup>12</sup> there is no difference recorded in the development of intra-abdominal collection associated with the use of different electrical dissection devices, which is consistent with our findings, since we were also unable to identify differences or association between both devices in terms of intraoperative bleeding with the use of different types of energy. On average, calculated intraoperative bleeding was 35 mL with the single port laparoscopic approach and 29 mL with the multiport laparoscopic approach. Carter et al.<sup>14</sup> also compared both surgical techniques and found no difference with regard to intraoperative bleeding or other complications; there only seemed to be slightly more postoperative pain in the single-port surgery group. It should be noted that, in our study, 62.5% of patients whose intraoperative bleeding was higher than 50 mL were observed to

develop intra-abdominal collection, in comparison with 6.4% of patients in whom bleeding was quantified in a smaller amount ( $p = 0.001$ ; CI 95% LR 0.001), with no association being documented between the type of surgical technique and the occurrence of intraoperative bleeding (Table 4).

The result was an increase of 17.4 minutes in average surgical time with the single-port approach in comparison with the conventional multiport technique (59.6 vs. 42.2 minutes), in accordance with what was published in recent Jerusalem guidelines<sup>11</sup>. There were no differences between both groups with regard to hospital stay, which was 5.5 days on average.

Minimally-invasive techniques have revolutionized surgery; however, the superiority of laparoscopic access for complicated appendicitis continues to be controversial for some<sup>15</sup>. When the occurrence of intra-abdominal collection was compared, 12 out of 116 patients surgically intervened for complicated acute appendicitis developed intra-abdominal collections, out of whom 4 (33.3%) underwent the single-port laparoscopic approach, and 8 (66.7%) underwent a conventional multiport approach. Given the results, it can be concluded that there is no superiority of neither surgical procedure in the approach to complicated appendectomy. Fischer et al.<sup>15</sup> reported intra-abdominal collection as similar complications in both groups (1.4 vs. 1.8%). Similarly, several comparative studies, systematic reviews and meta-analyses have not found significant differences in the development of postoperative intra-abdominal collection, which is consistent with our study<sup>9,10,16,17</sup>.

## Conclusions

There was no evidence of superiority of either intervention in complicated appendicitis, but it is confirmed that single-port laparoscopic appendectomy is a safe, feasible, non-inferior procedure with similar rates of complications in comparison with the conventional laparoscopic appendectomy technique.

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## Ethical disclosures

**Protection of human and animal subjects.** The authors declare that no experiments have been performed on humans or animals for this research.

**Confidentiality of Data.** The authors declare that they have followed the protocols of their work center on the publication of patient data.

**Right to privacy and informed consent.** The authors have obtained informed consent from the patients and/or subjects referred to in the article. This document is in the possession of the corresponding author.

## Conflicts of interest

The authors declare that they have no conflicts of interest.

## References

- Ohmann C, Franke C, Kraemer M, Yang Q. Neues zur Epidemiologie der Akuten Appendizitis. *Der Chir.* 2002;73:769-76.
- Addiss DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and appendectomy in the United States. *Am J Epidemiol.* 1990;132:910-25.
- Xue C, Lin B, Huang Z, Chen Z. Single-incision laparoscopic appendectomy versus conventional 3-port laparoscopic appendectomy for appendicitis: an updated meta-analysis of randomized controlled trials. *Surg Today.* 2015;45:1179-86.
- Direkze NC, Hill ADK, Darzi A. The current status of laparoscopic appendectomy. *Minim Invasive Ther Allied Technol.* 2008;5:41-5.
- Moris DN, Bramis KJ, Mantonakis EI, Papalampros EL, Petrou AS, Papalampros AE. Surgery via natural orifices in human beings: yesterday, today, tomorrow. *Am J Surg.* 2012;204:93-102.
- Schaefer M. Natural orifice transluminal endoscopic surgery (NOTES): implications for anesthesia. *F1000 Med Rep.* 2009;4:2-5.
- Graur F, Elisei R, Al-Hajjar N. E-NOTES transumbilical laparoscopic appendectomy. *Chirurgia (Bucur).* 2013;108:571-5.
- Rehman H, Rao AM, Ahmed I. Single incision versus conventional multi-incision appendectomy for suspected appendicitis. *Cochrane Database Syst Rev.* 2011;(7):CD009022.
- Aly OE, Black DH, Rehman H, Ahmed I. Single incision laparoscopic appendectomy versus conventional three-port laparoscopic appendectomy: a systematic review and meta-analysis. *Int J Surg.* 2016;35:120-8.
- Markar SR, Karthikesalingam A, Di Franco F, Harris AM. Systematic review and meta-analysis of single-incision versus conventional multiport appendectomy. *Br J Surg.* 2013;100:1709-18.
- Di Saverio, Podda M, De Simone B, Ceresoli M, Augustin G, Gori A, et al. Diagnosis and treatment of acute appendicitis: 2020 update of the WSES Jerusalem guidelines. *World J Emerg Surg.* 2020;15:27.
- Di Saverio, Birindelli A, Kelly MD, Catena F, Weber DG, Sartelli M, et al. WSES Jerusalem guidelines for diagnosis and treatment of acute appendicitis. *World J Emerg Surg.* 2016;11:1-25.
- Zhou H, Jin K, Zhang J, Wang W, Sun Y, Ruan C, et al. Single incision versus conventional multiport laparoscopic appendectomy: a systematic review and meta-analysis of randomized controlled trials. *Dig Surg.* 2014;31:384-91.
- Carter JT, Kaplan JA, Nguyen JN, Lin MY, Rogers SJ, Harris HW. A prospective, randomized controlled trial single-incision laparoscopic vs conventional 3-port laparoscopic appendectomy for treatment of acute appendicitis. *J Am Coll Surg.* 2014;218:950-9.
- Fischer CP, Castaneda A, Moore F. Laparoscopic appendectomy: indications and controversies. *Semin Laparosc Surg.* 2002;9:32-9.
- Deng L, Xiong J, Xia Q. Single-incision versus conventional three-incision laparoscopic appendectomy: a meta-analysis of randomized controlled trials. *J Evid Based Med.* 2017;10:196-206.
- Sateesh S, Subraj H, Mahesh G, Rao P. Comparative analysis between single incision and conventional laparoscopic appendectomy for acute appendicitis. *Int J Res Med Sci.* 2014;2:1626.