

Comparison of Postoperative Pain Following Open, Laparoscopic and Single-Port Colon Surgery

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Abstract

Introduction: The potential benefits of single-port laparoscopic surgery include improved aesthetic outcomes, reduced postoperative pain, less surgical trauma and faster recovery. The aim of this study is to compare the results obtained (especially pain) by different approaches to colectomy. We state the hypothesis that postoperative pain is lower in the single port group.

Material and Method: Perioperative outcomes and pain were compared prospectively for patients who underwent colon surgery, according to the approach adopted (Group 1, open approach (n = 30); Group 2, laparoscopic approach (n = 31); Group 3, single-port approach (n = 30)). The perioperative parameters analysed were anaesthetic risk (ASA), sex, age, procedure, morbidity, complications, reintervention, mortality, length of hospital stay and postoperative pain in the first 24 hours (according to the American Pain Society questionnaire).

Results: Patients undergoing single-port surgery obtained perioperative results similar to those for open and laparoscopic surgery, with less postoperative pain.

Conclusion: The single-port approach to colon surgery is safe and can improve postoperative pain outcomes.

Keywords: Single-Incision Laparoscopic Surgery (SILS); Colorectal Surgery; Postoperative Pain

Introduction

The laparoscopic approach to surgery for colon cancer emerged in the 1990s, revolutionising the treatment of this disease. However, in recent years, new approaches have been introduced, such as natural orifice transluminal endoscopic surgery (NOTES) and the single-port approach, although these have not yet been shown to provide clear advantages over laparoscopic surgery.

Conventional laparoscopic surgery (CLS) is less traumatic than open surgery but may still provoke tissue trauma to the tissues and multiple scars [1]. The extent of trauma is determined by the size and number of ports [2,3] and therefore it is assumed that single port laparoscopic surgery can minimize surgical trauma. Accordingly, this concept is gaining acceptance; moreover, it can offer excellent aesthetic results [4] and also reduce postoperative pain.

In view of these considerations, a study was undertaken to compare perioperative outcomes and immediate postoperative pain in patients undergoing colon surgery with either the open approach, the laparoscopic approach or the single-port approach.

Material and Methods

This prospective study considered all the patients who underwent colon surgery (who accepted to participate) at our hospital from November 2014 to December 2017, regardless of the indication of colectomy. This study was approved by the Research and Ethics Committee (11-6-11). Three study groups were distinguished according to the surgical approach taken: Group 1, open approach; Group 2, laparoscopic approach; Group 3, single-port approach. Pain management approach was the same in all 3 groups. The parameters assessed included perioperative outcomes and postoperative pain during the first 24 hours.

The single-port approach was conducted using the Octoport™ apparatus (Dalim, Seoul, Korea) (Figure 1). This is a recently-developed laparoscopic multichannel access device that allows multiple instruments to pass through one incision. The inlets in the device allow the passage of two large-calibre instruments (up to 12 mm) in addition to another two of smaller diameter (up to 5 mm).



Figure 1: Single-port approach using the Octoport™ apparatus.

Postoperative pain was measured (24 hours postoperative) using the American Pain Society questionnaire [5], with some modifications [6] (Table 1). This questionnaire includes 10 questions (X1 - X10) with a numerical scale as an instrument for measuring pain intensity, although in the present study we considered it more appropriate to use a visual analogue scale (VAS) with respect to three different moments: at the time of the interview, during the last 24 hours and at the moment of minimum pain following the administration of analgesics. In addition, we assessed the patients' degree of satisfaction with the medical staff (doctors and nurses) and the time elapsed from when a request for analgesia was made until it was administered. The questionnaire distinguished, moreover, between the first request made for analgesia and subsequent ones (rescue analgesia). Finally, as suggested by Ward, *et al.* [6], a question was added to this questionnaire to ascertain the patient's opinion about the degree of postoperative pain relief obtained by analgesics. Moderate pain was defined as VAS > 3 and severe pain as VAS > 6.

Table 1

We are interested in how well your pain was managed during your stay here at University Hospital and Clinics. Please complete the following questions. We really want to know. Any comments you have will be greatly appreciated. This is confidential. All identifying information will be destroyed at the end of the study.

1. At any time during your care, have you needed treatment for pain? Yes - No

THE REMAINING QUESTIONS REFER TO PAIN YOU HAVE HAD IN THE PAST 24 H

2. Have you experienced any pain in the past 24 h? Yes - No

3. On this scale, how much discomfort or pain are you having right now?

no pain 0 1 2 3 4 5 6 7 8 9 10 worst pain possible

4. On this scale please indicate the worst pain you have had in the last 24 h.

no pain 0 1 2 3 4 5 6 7 8 9 10 worst pain possible

5. On this scale, what was your lowest level of pain after receiving medication or other treatment for pain.

no pain 0 1 2 3 4 5 6 7 8 9 10 worst pain possible

6. Circle the phrase that indicates how satisfied you are with the way your nurses treated your pain.

Very dissatisfied, dissatisfied, slightly dissatisfied, slightly satisfied, satisfied, very satisfied
 (1) (2) (3) (4) (5) (6)

7. Circle the phrase that indicates how satisfied you are with the way your doctors treated your pain.

Very dissatisfied, dissatisfied, slightly dissatisfied, slightly satisfied, satisfied, very satisfied
 (1) (2) (3) (4) (5) (6)

8. When you asked for pain medication, what was the longest time you had to wait to get it?

15 min or less, 15-30 min, 30-60 min, more than 1 h, never asked for pain medication
 (1) (2) (3) (4) (5)

9. Was there a time that the medication you were given for pain didn't help and you asked for something more or different to relieve the pain? - Yes - No

10. If you answered "yes", how long did it take before your doctors or nurses changed your treatment to a stronger or different medication and gave it to you?

1 h or less, 1-2 h, 2-4 h, 4-8 h, 8-24 h, more than 24 h
 (1) (2) (3) (4) (5) (6)

Do you have any suggestions for how your pain management could be improved'?

THANK YOU FOR DOING THIS SURVEY. Please place your completed survey in the envelope provided, seal it, and return it to your nurse.

Table 1: Modified American Pain Society questionnaire.

Our analysis of the perioperative results included the following variables: degree of anaesthetic risk (ASA), sex, age, procedure (right hemicolectomy, transverse colectomy, left hemicolectomy, sigmoidectomy, anterior resection, total colectomy), morbidity, complications (mild or severe; extra-abdominal complications), reintervention, mortality (abdominal or extra-abdominal aetiology) and length of hospital stay.

The association between the qualitative variables was determined by the chi-square test, or by Fisher’s exact test when over 20% of the values were expected to be less than 5.

To analyse the differences between the continuous quantitative variables in three independent groups, we first examined whether the conditions of homoscedasticity and normality were satisfied (using Levene’s test and the Shapiro-Wilk test, respectively). If normality was absent, the non-parametric Kruskal-Wallis test was performed, and if the hypothesis of equality was rejected, a 2 x 2 comparison was conducted using the Bonferroni-corrected Mann-Whitney U test to see how the groups differed.

Results

The three groups (1n = 30, 2 n = 31, 3n = 30) were found to be homogeneous in terms of degree of anaesthetic risk, sex, age and procedure performed. There were no significant differences among the three groups regarding morbidity, reintervention, mortality or length of hospital stay (Table 2). However, the pain test revealed significant differences between Groups 1 and 3 (in favour of Group 3) in all variables except No. 1, for which the results were similar, and variable number 9, which was not analysed because in most cases its value was zero. The differences between Groups 2 and 3 were quite significant (in favour of Group 3) for all the variables, although they only reached statistical significance for variables 8 and 10 (Table 3).

| | | Group | | | |
|----------------|------------------------------|------------|------------|------------|---------------------|
| | | 1 | 2 | 3 | p-value |
| ASA | 1 | 3 (10%) | 3 (9.7%) | 2 (6.7%) | 0.68 ^(b) |
| | 2 | 7 (23.3%) | 5 (16.1%) | 7 (23.3%) | |
| | 3 | 13 (43.3%) | 9 (29.0%) | 10 (33.3%) | |
| | 4 | 7 (23.3%) | 14 (45.2%) | 11 (36.7%) | |
| Sex | 0 | 22 (73.3%) | 20 (64.5%) | 22 (73.3%) | 0.68 ^(a) |
| | 1 | 8 (26.7%) | 11 (35.5%) | 8 (26.7%) | |
| Procedure | Right colectomy | 10 (33.3%) | 7 (22.6%) | 15 (50.0%) | 0.15 ^(b) |
| | Transverse colectomy | 2 (6.7%) | 1 (3.2%) | 1 (3.3%) | |
| | Left colectomy | 2 (6.7%) | 1 (3.2%) | 2 (6.7%) | |
| | Sigmoidectomy | 10 (33.3%) | 8 (25.8%) | 9 (30%) | |
| | Anterior resection | 6 (20%) | 13 (41.9%) | 3 (10%) | |
| | Total colectomy | 0 (0%) | 1 (3.2%) | 0 (0%) | |
| Morbidity | 0 | 19 (63.3%) | 20 (64.5%) | 18 (60.0%) | 0.74 ^(b) |
| | Minor abdominal complication | 4 (13.3%) | 8 (25.8%) | 7 (23.3%) | |
| | Major abdominal complication | 4 (13.3%) | 1 (3.2%) | 3 (10.0%) | |
| | Extraabdominal complication | 3 (10.0%) | 2 (6.5%) | 2 (6.7%) | |
| Reintervention | 0 | 28 (93.3%) | 30 (96.8%) | 27 (90%) | 0.52 ^(b) |
| | 1 | 2 (6.7%) | 1 (3.2%) | 3 (10%) | |
| Mortality | No | 26 (86.7%) | 30 (96.8%) | 28 (93.3%) | 0.37 ^(a) |
| | Abdominal etiology | 2 (6.7%) | 1 (3.2%) | 0 (0%) | |
| | Extraabdominal etiology | 2 (6.7%) | 0 (0%) | 2 (6.7%) | |

Table 2: Analysis of association of qualitative variables.

(a) Chi-cuadrado test

(b) Fisher’s exact test

| | Group | | | |
|---------------|--------------|--------------|--------------|---------------------|
| | 1 | 2 | 3 | p-value |
| Age | 72.5 (±11.5) | 68.7 (±12.2) | 69.8 (±12.9) | 0.53 ^(b) |
| Hospital_stay | 9.96 (±3.8) | 8.35 (±2.0) | 8.36 (±2.7) | 0.18 ^(b) |

Table 2: Analysis of continuous variables in three independent groups.

(a) ANOVA test.

(b) Kruskal-Wallis test

| | Group 1 | | Group 2 | | Group 3 | | p value | Test |
|-----|---------|---------|---------|---------------------|---------|--------|---------|------|
| X1 | 0.9 | (±0.3) | 0.9 | (±0.3) | 0.7 | (±0.4) | 0.1232 | (a) |
| X2 | 0.8 | (±0.4)* | 0.5 | (±0.5) | 0.4 | (±0.5) | 0.0266 | (a) |
| X3 | 4.2 | (±2.3)* | 3.9 | (±2.3) | 2.5 | (±2.6) | 0.0194 | (a) |
| X4 | 5.8 | (±2.6)* | 5.0 | (±3.0) | 3.6 | (±3.5) | 0.0242 | (a) |
| X5 | 2.7 | (±2.4)* | 1.3 | (±1.4) | 1.2 | (±1.8) | 0.0041 | (a) |
| X6 | 5.4 | (±1.0)* | 5.5 | (±1.0) | 5.9 | (±0.3) | 0.0407 | (a) |
| X7 | 5.1 | (±0.9)* | 5.5 | (±1.0) | 5.9 | (±0.3) | < 0.001 | (a) |
| X8 | 1.9 | (±1.7)* | 1.2 | (±1.3) [□] | 4.3 | (±1.5) | < 0.001 | (a) |
| X10 | 2.5 | (±1.0)* | 2.0 | (±0.7) [□] | 1.3 | (±0.4) | < 0.001 | (a) |

(a): One factor ANOVA test.

*p < 0.05 group 1 versus group 3.

□p < 0.05 group 2 versus group 3.

Note: variable n° 9 was not analysed because in most cases its value was zero.

| | Group | | |
|----|-------|----|----|
| X9 | 1 | 2 | 3 |
| 0 | 28 | 30 | 27 |
| 1 | 2 | 0 | 3 |

Table 3: Analysis of pain test results.

Discussion

Laparoscopic surgery is associated with reduced postoperative complications, decreased length of hospital stay, faster recovery of bowel function and reduced surgical site infection, in comparison with open-approach colorectal surgery. Notwithstanding these advantages, surgeons have tried to decrease the number of ports used during conventional laparoscopy in order to achieve better cosmetic results, less pain and a lower risk of hernia developing.

Thus, laparoscopic colon surgery performed through a single port is a concept that is gaining rapid acceptance, presenting an interesting challenge for surgeons to develop and implement this approach [7-10]. The potential benefits of this new procedure include better cosmetic results [11,1] faster recovery and less postoperative pain [12,13].

Theoretically, the single-port approach in colorectal surgery could reduce the degree of surgical trauma and tissue damage, since the surgical incisions made are shorter than in CLS. However, the single port increases the difficulty of the surgical procedure and can increase operating time and, consequently, complication rates. This complexity arises from the need to operate with little possibility of triangulation and with off-axis vision [14-16], which poses a significant technical difficulty in obtaining sufficient traction and contraction through the single port, especially in patients with rectal lesions and/or a narrow pelvis, and in patients with transverse colon lesions.

Recently, surveys have shown that patients would largely favour NOTES compared to standard laparoscopy, except if the risk of NOTES drastically out passed those of the laparoscopic approach [17,18].

On the other hand, a major advantage of single-port colon surgery is that it allows samples to be extracted with good insulation from the abdominal wall, which can be very important in cancer patients [19,20].

Several clinical series have demonstrated the feasibility and safety of single-port surgery in diverse surgical procedures [22,23]. According to a recent systematic review and meta-analysis, colorectal surgery performed with a single port technique is both feasible and safe [18], although this technique is still in its infancy. To date, only two randomised controlled trials of single-port colectomy have been published [24,25]. Possible limitations of these studies include a small and highly selected study population and a short follow up period.

Papaconstantinou., *et al.* [25] reported that peak pain scores on postoperative days 1 and 2 were significantly lower after single-port hemicolectomy than after CLS and manually assisted laparoscopic surgery. Poon., *et al.* [26] conducted a randomised clinical trial into opioid use and pain and reported a lower median postoperative pain score following single-port hemicolectomy than after CLS but observed no difference in total postoperative morphine use.

The results obtained in the present study highlight the subjective impression of reduced pain with laparoscopy, compared to open surgery, and even more so with single-port procedures, compared to laparoscopy. Thus, the results for item 3 in the questionnaire, on pain at 24 hours after surgery, reflected 'mild pain' in the patients who underwent single-port surgery but 'moderate pain' among patients subjected to the laparoscopic or the open surgery approach.

One of the main benefits of the single-port technique is that a better cosmetic result seems to be achieved (Figure 2). Furthermore, reducing the number of port sites can decrease the risk of accidental vascular or bowel injuries resulting from trocar insertion. In addition, the risk of hernia at the trocar site, calculated at 5%, may be reduced with the single-port approach [27]. However, in our series, ventral hernia was a major problem encountered; thus, a significant number of laparotomic hernias occurred, possibly due to the poor vascularity of the wall edges, which may be provoked by sustained single-port pressure, for one or more hours. This problem was, however, overcome by placing a supra-aponeurotic prolene mesh at the closure of the mini-laparotomy, in all cases.



Figure 2: Single-port cosmetic result.

Complication rates were similar in all three groups of patients, and there were no statistically significant differences in morbidity or mortality.

It may be difficult to demonstrate any economic benefit from using the single-port technique rather than CLS. In the cases analysed in this study, the material used (Octoport™) is 136 euros more expensive than that used in CLS (two 5 mm trocars, one of 10 - 11 mm and one of 10 - 12 mm, plus the Alexis wound retractor). Nevertheless, this relatively slight economic difference is offset by the postoperative improvements obtained (less pain, less need for analgesia, earlier hospital discharge). We conclude, therefore, that the cost- benefit relation is clearly favourable to the single-port approach, using the Octoport™ apparatus.

Finally, we believe that in the near future, robotics may contribute to overcoming the limitations inherent to single-port surgery, such as limited space and the possible collision of instruments.

Conclusion

The present study shows that single-port colon surgery can reduce postoperative pain and is an acceptable and safe alternative to CLS for suitable patients. However, largescale randomised controlled trials should be conducted to determine the precise benefit of this new

technique prior to its possible introduction into routine clinical settings. At present, single-port colon surgery should only be offered with caution, to be performed by highly experienced laparoscopic surgeons on carefully-selected patients.

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