A novel technique for enterotomy closure in stapled laparoscopic intracorporeal anastomosis

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Abstract

Aim The proximal edge of the enterotomy in a side-to-side anastomosis has been shown to be the site at highest risk of leakage. Several methods have been described to overcome this vulnerability. The technical challenge of intra-corporeal anastomosis (ICA) is to re-create angles between tissues and instruments, similar to those in an open anastomosis. The axis between the suture line and the needle driver is paramount and this angle should be $< 45^\circ$.

Method The crotch stitch of the enterotomy is difficult because of the narrow space between the loops and the depth of the anastomosis. The usual technique is suturing right-handed, ‘out–in and in–out’, colonic edge first to small bowel. The risk of suture misplacement (e.g. ‘out–in/out–in’ or ‘out–out’) is similar to open procedures but laparoscopically the second bite is challenging, due to the straight needle-driver. This may lead to asymmetrical closure of the corner resulting in a slightly larger angle on the bowel side and a potential postoperative leak/fistula. Rotating the small bowel loop to counterbalance this issue, risks tearing of the staple line. The rationale is that starting with a back-handed stitch and taking the small bowel edge first would allow the necessary acute angled bite to be achieved. Subsequently, mounting the needle right-handed for taking the colonic edge also allows achievement of an acute angled bite.

Results Our novel technique, named the ‘back-handed, left-to-right stitch’ technique, is intended to achieve symmetrical approximation of the ileal and colonic edges during laparoscopy, with an optimal closure of the deepest extremity of the enterotomy. Such a stitch, used in a series of 10 patients, may be useful to avoid leaving an opening within this angle and/or to avoid potential technical pitfalls when closing the deepest apex of the enterotomy.

Conclusion This ‘back-handed, left-to-right’ stitch described here allows a properly angled closure of the proximal edge of the enterotomy and a safe approximation of the corner of the enterotomy in a side-to-side ICA.

Keywords Laparoscopic colorectal surgery, intracorporeal anastomosis, laparoscopic suturing, right colectomy, ileo-colic anastomosis, surgical technique education

Introduction

Most laparoscopic side-to-side anastomoses are performed extracorporeally for technical reasons.[1] However, laparoscopic intracorporeal anastomosis (ICA) has many potential advantages compared with extracorporeal anastomosis: it allows smaller and more flexible incisions for specimen extraction (extraction is usually possible from a mini-Pfannenstiel) with a lower risk of incisional hernia and wound infection, it is less invasive, it facilitates surgery in obese patients and it is associated with a faster recovery and decreased analgesic requirements.[2–4] Nonetheless we recognize the technical difficulties associated with fashioning an ICA, which necessitates advanced laparoscopic techniques.

Evidence suggests that it is the angle of an anastomosis which is the site of greatest risk for developing a leak.[5] Experimental studies have shown that the ‘crotch’ of a stapled anastomosis is the site of greatest
weakness.[6,7] Several methods have been described that attempt to overcome the vulnerability of this part of the anastomosis in open surgery,[8,9] with some authors recommending a ‘crotch stitch’ to reinforce the staple line at the site of the crotch of the anastomosis[10].

**Technical challenges and pitfalls in the enterotomy closure of an intracorporeal laparoscopic side-to-side anastomosis**

The proximal edge of the enterotomy of a side-to-side ICA falls exactly on the crotch of the anastomosis. For this reason, the closure of the apex of the enterotomy of an ICA is a particularly critical step, and perhaps an inaccurate and incomplete closure of the common enterotomy can result in early leaks.

The important principles of the closure of the enterotomy of a laparoscopic ICA are the same as those of open surgery.[11] In order to achieve a proper angle-stitch, the axis between the suture line and the needle driver is of paramount relevance and this angle should be between $0^\circ$ (i.e. parallel) and $\pm 45^\circ$ on both sides. The technical challenge of laparoscopy is to create the same angles between the instruments and the tissues as in open surgery. However, in contrast to open surgery, laparoscopic ports do not allow the surgeon to approach the bowel from multiple different angles. These limitations are reduced in robotic surgery.

The conventional method for suturing the enterotomy following creation of a stapled ICA after a lap colectomy (e.g. ileocolic anastomosis after a right colectomy, or intracorporeal colo-colic anastomosis after splenic flexure resection) is performed with a continuous running suture starting from the angle on the proximal apex, closest to the camera, passing a right-handed intracorporeal stitch, through the right edge first (‘out–in’) and then taking the second bite on the left wall (‘in–out’), fashioning a ‘right-to-left’ direction (Connell sutures) (Fig. 1a). Despite ensuring adequate bites, the limited range allowed by standard laparoscopic equipment (which is straight and rigid) and the sharp and acute angles to be sutured, lead to the risk of passing the suture asymmetrically. This may lead to an uneven approximation of colonic and ileal edges with the possibility of leaving a larger open angle on the left ileal side (Fig. 1b). This open angle is often wide and eventually at risk of becoming a partially open area (highlighted in red in Video S1 in the Supporting Information) at higher risk of leak or fistula.

The crotch of a side-to-side ICA is the most difficult apex to suture laparoscopically because it lies at an acutely angled corner and it is located deep between the walls of the two anastomosed loops of bowel (Fig. 2). The conventional technique for suturing the proximal edge of the enterotomy, whether open or laparoscopic, is right-handed and proceeds right to left (e.g. the colonic edge is taken first as in Fig. 1(a), then the small bowel). However, in a laparoscopic ICA the second bite

**Figure 1** (a) The usual suturing technique, both open and laparoscopically, is right-handed and proceeds right to left (colonic edge is taken first, then the small bowel), however in an ICA the second bite is harder and often challenging to take, due to the limited range of the straight and rigid laparoscopic needle-driver. (b) The standard technique of suturing “right to left” may result in asymmetrical closure of this corner of the enterotomy, leaving a slightly larger angle on the left side (small bowel - see red highlighted area), that is possibly at higher risk for postoperative leak/fistula.
is more difficult due to the limited range of the straight and rigid laparoscopic needle-driver. This may result in asymmetrical closure of this corner of the enterotomy, leaving a slightly larger angle on the left side (e.g. small bowel) which may predispose to anastomotic leak (Fig. 1b). Alternatively, the operating surgeon may attempt to rotate and pull the side of the left bowel loop (e.g. small bowel) with a series of awkward movements in order to pass the needle more proximally and take a properly narrowed angled bite (see ‘Pitfalls’ in Video S1). However, this risks excessive traction on the crotch of the anastomosis and possible tearing of the staple line at this level. Technical mistakes can also still be easily made when attempting to take bites in the correct ‘out-in’ and ‘in-out’ pattern, when suturing is carried out in a traditional right-handed fashion (see ‘Pitfalls’ in Video S1).

Figure 2 The novel technique achieves an easier closure of the proximal extremity of the enterotomy and a symmetrical approximation of the corner of the enterotomy made during a side-to-side ICA.

The novel ‘back-handed, left-to-right’ technique

Our new technique (named the ‘back-handed, left-to-right’ technique), demonstrates a simple way to take a correctly angled stitch when closing the proximal apex of the enterotomy during laparoscopy which avoids the pitfalls in closing this crotch angle. Mounting the needle back-handed on the laparoscopic needle-driver and taking the left bowel edge first, allows taking an acutely angled bite of tissue and avoids taking the bite on the small bowel side, too far from the extreme apex of the enterotomy. (b) Then the needle can be mounted right-handed and the colonic edge taken with an appropriately acute angle, coming out at the correct distance from the edge of the staple line.

Figure 3 (a) Mounting the needle back-handed on the laparoscopic needle-driver and taking the small bowel edge first, allows taking an acutely angled bite of tissue and avoids taking the bite on the small bowel side, too far from the extreme apex of the enterotomy (Fig. 3a). Then the needle can be mounted right-handed and the colonic edge taken with an appropriately acute angle, coming out at the correct distance from the edge of the staple line.
Table 1: Results of experience in 10 cases of sutured enterotomy closure with the variation of ‘back-handed, left-to-right’ stitching.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (years), gender</th>
<th>Diagnosis</th>
<th>Setting</th>
<th>Intervention</th>
<th>Type of side-to-side ICA</th>
<th>Major morbidity: bleeding, leakage, AAI</th>
<th>Minor morbidity: incisional hernia, SSI</th>
<th>In-hospital mortality</th>
<th>Length of stay (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17, M</td>
<td>Perforated appendicitis with gangrenous caecum and diffuse peritonitis</td>
<td>Emergency</td>
<td>Lap. right hemicolectomy</td>
<td>Ileo-colic</td>
<td>None</td>
<td>None</td>
<td>No</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>86, M</td>
<td>Right colon adenocarcinoma T4 + gastric GIST</td>
<td>Elective</td>
<td>Lap. right hemicolectomy</td>
<td>Ileo-colic</td>
<td>None</td>
<td>None</td>
<td>No</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>79, F</td>
<td>Ascending colon adenocarcinoma</td>
<td>Elective</td>
<td>Lap. right hemicolectomy</td>
<td>Ileo-colic</td>
<td>None</td>
<td>None</td>
<td>No</td>
<td>76</td>
</tr>
<tr>
<td>4</td>
<td>54, F</td>
<td>Ascending colon adenocarcinoma</td>
<td>Elective</td>
<td>Lap. right hemicolectomy</td>
<td>Ileo-colic</td>
<td>None</td>
<td>None</td>
<td>No</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>75, M</td>
<td>Splenic flexure colon adenocarcinoma</td>
<td>Elective</td>
<td>Lap. left hemicolectomy</td>
<td>Ileo-colic</td>
<td>None</td>
<td>None</td>
<td>No</td>
<td>2</td>
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<tr>
<td>6</td>
<td>73, M</td>
<td>Transverse colon adenocarcinoma with subacute LBO</td>
<td>Emergency</td>
<td>Lap. subtotal colectomy</td>
<td>Ileo-colic</td>
<td>None</td>
<td>None</td>
<td>No</td>
<td>6</td>
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<td>7</td>
<td>42, F</td>
<td>Inflammatory caecal mass with perforation and diffuse peritonitis</td>
<td>Emergency</td>
<td>Lap. right hemicolectomy</td>
<td>Ileo-colic</td>
<td>None</td>
<td>None</td>
<td>No</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>66, M</td>
<td>Perforated acute Crohn’s ileitis</td>
<td>Emergency</td>
<td>Lap. distal ileum resection and right hemicolectomy</td>
<td>Ileo-colic</td>
<td>None</td>
<td>None</td>
<td>No</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>29, M</td>
<td>Perforated caecal diverticulitis with peritonitis</td>
<td>Emergency</td>
<td>Lap. right hemicolectomy</td>
<td>Ileo-colic</td>
<td>None</td>
<td>None</td>
<td>No</td>
<td>6</td>
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<tr>
<td>10</td>
<td>25, M</td>
<td>Perforated appendiceal carcinoid tumour and diffuse peritonitis</td>
<td>Emergency</td>
<td>Lap. right hemicolectomy</td>
<td>Ileo-colic</td>
<td>None</td>
<td>None</td>
<td>No</td>
<td>6</td>
</tr>
</tbody>
</table>

M, male; F, female; GIST, gastrointestinal stromal tumour; LBO, large bowel obstruction; CD, Crohn’s disease; SSI, surgical site infection; IAA, intra-Abdominal Abscesses.
closure of the proximal/lower extremity of the enterotomy and a symmetrical approximation of the edges in the corner of the ICA (Fig. 2), therefore permitting optimal closure of the deepest extremity of the enterotomy (green circle and green arrow at the end of Video S1).

This technique has been used in 10 cases to date (April 2017) by the consultant surgeon (SdS); the details are shown in Table 1. Four cases were elective and six cases were performed in an acute care setting [11] and the technique proved to be safe and effective in the closure of the enterotomy with no leaks or fistulas occurring from this site of the anastomosis angle. Our preliminary results suggest that such technique may allow a technically easier closure of the apex of the enterotomy and may be useful in avoiding mistakes and incomplete closure and leaving an open orifice within the proximal angle of the enterotomy, thereby reducing the risk of anastomotic leakage after a stapled ICA.

Author contributions

Conception and design: SdS, ABir, ES, ST, RAB. Acquisition of data: SdS, ABir, ES, ST, RAB. Analysis and interpretation of data: SdS, ABir, ES, ST, RAB, MN, SK, ABio. Drafting the article or revising it critically for important intellectual content: SdS, ABir, ES, ST, RAB, MN, SK, ABio. Final approval of the version to be published: SdS, ABir, ES, ST, RAB, MN, SK, ABio. SdS suggested and developed the novel technique. SdS is the operating attending surgeon in the online videos.

References


Supporting Information

Additional Supporting Information may be found in the online version of this article:

Video S1. Video Showing the potential pitfalls and technical challenges of closure of an enterotomy after a stapled intracorporeal anastomosis.