Novel Technique in Crohn's Surgery; End to End Single Sero-Muscular Manual Suture Excluding Mucosa

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Abstract
Background: An optimal method performing intestinal anastomosis in patients with Crohn’s disease has not been widely accepted yet. The current research is proposing a novel hand-sew technique applied on end to end ileo-colic resection anastomosis cases.

Methods: Between January 2012 and December 2017, 63 cases previously diagnosed as Crohn’s disease presented to the emergency department as fecal peritonitis secondary to ileo-caecal perforation or gangrene with or without abscess formation.

Results: Crohn’s patients presented to emergency department with picture of acute abdomen secondary to perforated bowel were included in the study. All patients had pre-operative abdominal computerized tomography for diagnosis and post-operatively for follow up. Post-operatively seven patients had minor submucosal anastomotic dissection of dye that is contained within the subserosal layer. None of the patients needed additional surgery during their primary hospitalization nor needed surgical hospitalization during the long follow up stay.

Discussion: There was no leakage from the anastomotic line in any of the study cases. Moreover the extended follow up has revealed no needed re-operation as any recurrent disease at the region of surgical anastomosis. Comparing the current research result to that from literature proves the proposed technique superior. Surgical anastomotic technique in Crohn’s disease is an important factor as patients with permanent end ileostomy seldom suffer from recurrence.

Conclusion: Application of the proposed anastomotic technique upon Crohn’s cases is an extreme challenge that suggests the technique as potentially competent one in any intestinal anastomotic situation. The proposed surgical technique needs to be verified on larger sample.

Keywords: Crohn’s disease; Single layer sero-muscular anastomosis; Ileo-ascending colon primary anastomosis; TPN

Abbreviations
CD: Crohn’s Disease; IBD: Inflammatory Bowel Disease; ACT: Abdominal Computerized Tomography; TPN: Total Parenteral Nutrition; CDAI: The Crohn’s Disease Activity Index

Introduction
Surgery plays a crucial role in the treatment of Crohn’s Disease (CD) complications, with the majority of patients undergoing surgical intestinal resections within the first 10 years of diagnosis [1]. In literature, studies on surgical outcomes in this cohort have shown high rates of post-operative complications. Though the literature is heterogeneous, post-operative intra-abdominal abscess rates range from 2.6% to 14% and anastomotic leak rates from 1.2% to 16.7% [2-4]. Usage of the linear stapler for gastrointestinal anastomoses was first introduced in the 1980s. A recent Cochrane review confirmed the superiority of the stapler in preventing anastomotic leaks in ileo-caecal resections for cancer, but failed to show this benefit in Inflammatory Bowel Disease (IBD) patients [5-7]. Though smaller studies support side to side stapler anastomosis over the traditional hand-sewn end to end anastomosis in CD, the magnitude of the benefit in this population has not been established [8-11]. Over sewing of staple lines is a method with the potential to further reduce anastomotic complications. Its main application to date has been in foregut surgery where a large meta-analysis indicated that over sewing significantly reduces anastomotic leaks and overall complications in bariatric surgery [12]. The optimal method of performing an intestinal anastomosis in patients with CD has not been established yet. The obstacle to study surgical outcomes in patients with CD is the many factors that may predispose to complications such as usage of steroids, pre-operative...
Two abdominal drains are positioned in the left para-colic and pelvic
No omental or any tissue flapping over the anastomosis site is done.
mucosal layer from the suture line. A second raw of interrupted sero-
sero-muscular continuous layer, hand sew suturing, excluding the
as an end to end anastomosis of the ileo-ascending colon, single
load on the anastomotic site. The technique of anastomosis is defined
fecal volume outcome and in the same time decreasing the tension
lumen axis being vertical and anti-gravity to increase the transient
segments are fixed to the peritoneal cavity to maintain the intestinal
either side that might affect the proper opposition and approximation
each other to avoid the crowding effect of the thickened mesentery on
Proper surgical technique in CD includes segmental resection

Study Design

This is a case series pilot study introducing a new surgical
techique for intestinal resection and anastomosis in CD based on a
genuine concept that is never described before.
Study inclusion criteria

Patient sample has been restricted to perforated or gangrenous
ileo-caecal segment with fecal peritonitis complicating CD. Such
selection assures the most difficult circumstances that could face the
surgeon challenging the proposed technique for primary anastomosis
without doing a protective stoma.
Study exclusion criteria

These were pregnancy; age less than 18 years, and Crohn’s disease
manifestation at a gastro-intestinal site other than the terminal ileum
with the exception of Perianal fistulae.
Technique of intestinal resection

The resection has been designed to be segmental but not right
hemicolectomy; resecting at least 5 cm from either side of the lesion
area reaching apparently normal looking bowel segment.
Technique of intestinal anastomosis

Spatial rotation of the mesenteric edges 15 to 20 degrees apart from
each other to avoid the crowding effect of the thickened mesentery on
either side that might affect the proper opposition and approximation
of the intestinal loops on the mesenteric border. The anastomosed
segments are fixed to the peritoneal cavity to maintain the intestinal
lumen axis being vertical and anti-gravity to increase the transient
time of contents, encouraging more fluid absorption and reduce the
fecal volume outcome and in the same time decreasing the tension
load on the anastomotic site. The technique of anastomosis is defined
as an end to end anastomosis of the ileo-ascending colon, single
sero-muscular continuous layer, hand sew suturing, excluding the
mucosal layer from the suture line. A second raw of interrupted sero-
muscular suture to release tension on the first raw suture is achieved.
No omental or any tissue flapping over the anastomosis site is done.
Two abdominal drains are positioned in the left para-colic and pelvic

infections, and the poor nutrition and have been extracted mostly
from retrospective studies [2-4,8,13-16]. Review of literature reveals
shy studies on small scale working on surgical complications of CD.
Up to author’s best knowledge, there is no study on modifying the
end to end manual anastomosis technique that has been practiced
as a tradition applied with variable skill levels and resulted in
unsatisfactory results. This research is proposing a novel hand-sew
technique applied on end to end ileo-caecal anastomosis in cases of
complicated CD with potential improved results based on proved
literature theoretical basis.

Rationale behind the surgical technique of excluding the
mucosal layer from the suture line is summarized in the following
points:
1. The high mucosal cell turn over and the supreme healing
power of the mucosal layer that could heal fast and spontaneously
upon approximation without even suturing.
2. Mucosal layer suturing might jeopardize its blood supply and
so delays the tissue healing potential.
3. In addition; taking the mucosal layer in the suture line
might encourage “creeping out-line growth of the mucosal cells”
and progression to fistula formation, especially at the thickened
mesenteric circumference side.
4. More over; even if an early minor leakage through the
mucosal opposition line took place, it might be contained by the
serosal layer; the effectively creeping mesothelium.

Pre- and post-operative radiological assessment: Abdominal
Computerized Tomography (ACT) is achieved for diagnosis pre-
operatively as well as on fifth, fifteenth and thirtieth post-operative
days as routine in all study cases. Ultra-sonography was used to assess
peritoneal free fluids in addition to possible further intervention.

Nutritional management and medications

Total Parenteral Nutrition (TPN) as balanced formula is started
from the early time of inclusion in the study for seven days. Special
CD treatments including immune suppressive drugs and steroids
are given without restriction. Oral feeding starts early in the form of
clear fluids from the first post-operative day for five days until the
first ACT is achieved assuring no leakage, then soft diet is allowed for
the following three days then special diet for CD is allowed as patient
tolerance.

Follow up duration is divided into

1. Short follow up period that is the first thirty days (period
related to operative complications).
2. Long follow up period extended for at least further six
months (period related to post-operative complications).

Materials and Methods

The protocol for this research project has been approved by the
institution’s Scientific and Ethics Committees and it conforms to the
provisions of the Declaration of Helsinki and holding Committee
Approval No (34/10/2011). All informed consent was obtained
from patients included in the study. The author is responsible to
submit all documents upon publisher’s request. International
research registration is not necessary as the research is applying
only a suturing technique modification. Between January 2012 and
December 2017, 63 cases previously diagnosed as CD (according to
the international parameters of histology and serology) presented to
the emergency department as fecal peritonitis secondary to ileo-colic
perforation or gangrene with or without abscess formation. Patients
were all stabilized clinically and operated as soon as possible applying
the same surgical technique designed and proposed for the study.
All aspects of the study including the pre-operative management,
surgical technique, post-operative oral feeding and TPN and clinical
and radiological follow up are all fixed to all patients.
Data collection

Pre-operative information involved demographic and clinical data including "The Crohn’s Disease Activity Index" (CDAI). Crohn-specific pre-operative treatment is documented. Surgical details were recorded in addition to postoperative complications and duration of hospital stay.

Data analysis

All results are presented in a descriptive manner. Base-line characteristics and intraoperative and postoperative data are given as mean and standard deviation for continuous variables and percentages for categorical and ordinal data.

Results and Discussion

All study patients presented to emergency department with picture of acute abdomen but only 4 (6.1%) presented with septic shock. Forty seven patients (74.6%) had no previous laparotomy. Most of study patients were males (88.9%) with median of middle age category. Medication type or no medication is recorded in detail. Pre-operative evaluation and assessment was achieved to all patients as described in Table 1. All patients had had pre-operative ACT for diagnosis. All signs of ileo-caecal granulation and perforation in addition to fecal peritonitis were demonstrated in all the study patients (Figure 1 and 2). Intra-operatively study patients presented with ileal perforation and ileo-caecal gangrene frequency was 29 & 34 respectively. All patients showed diffuse mesenteric thickening and 57 patients showed gross mesenteric lymphadenopathy. Intra-operative details are shown in Table 2. Post-operatively, the anastomotic line was assessed by ACT using both oral and intravenous contrast. Seven patients showed linear anastomotic submucosal dye dissection that was contained below the serosal layer (Figure 3). Intra-abdominal fluid collection noticed in 4 patients as detected by ultrasonography and guided aspiration revealed reactionary serous fluid volume ranging between 15 ml and 30 ml. In all the four cases fluid aspirated was analyzed biochemically for bilirubin and was negative. Contained sub-serosal dye dissection within the intestinal wall was detected by ACT in 7 patients without showing free peritoneal fluid or prolonged ileus. Minor complications of delayed wound healing and wound site superficial infection were experienced. No anastomotic leakage (bilirubin negative extra-luminal intra-abdominal fluid) occurred in any of the patients. None of the patients needed additional surgery during their primary hospitalization stay nor needed surgical hospitalization during the long follow up for anastomotic site stricture or obstruction. The mean hospital stay duration was below fourteen days. Detailed results of post-operative follow up are shown in Table 3. Post-operative complications and re-operation in CD can occur due to the recurrent nature of the disease. Several factors may influence the outcomes after surgical treatment for CD, including the surgical technique [17,18]. Regarding the surgical anastomotic technique, a crucial research conclusion states that "surgical anastomosis is considered to be an important factor because patients

<p>| Table 1: Patients’ epidemiology &amp; pre-operative data. |</p>
<table>
<thead>
<tr>
<th>Variant</th>
<th>Value/Mean (± SD)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender : Male : Female</td>
<td>56:07:00</td>
<td>-</td>
</tr>
<tr>
<td>Age (years)</td>
<td>27.4 ± 8.5</td>
<td>-</td>
</tr>
<tr>
<td>BMI</td>
<td>22.1 ± 2.4</td>
<td>-</td>
</tr>
<tr>
<td>CDAI</td>
<td>199 ± 64.7</td>
<td>-</td>
</tr>
<tr>
<td>Smoker</td>
<td>16</td>
<td>25.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Medication Type</th>
<th>Value/Mean (± SD)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not committed on medication</td>
<td>16</td>
<td>25.4</td>
</tr>
<tr>
<td>Immunosuppressive therapy</td>
<td>13</td>
<td>20.6</td>
</tr>
<tr>
<td>Mesalazine</td>
<td>21</td>
<td>33.3</td>
</tr>
<tr>
<td>Prednisolone+ Immunosuppressive therapy</td>
<td>4</td>
<td>6.1</td>
</tr>
<tr>
<td>Prednisolone+ Mesalazine</td>
<td>6</td>
<td>9.5</td>
</tr>
<tr>
<td>Prednisolone+ Mesalazine + Immunosuppressive therapy</td>
<td>3</td>
<td>4.8</td>
</tr>
<tr>
<td>Patients presented with septic shock</td>
<td>4</td>
<td>6.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ASA Class</th>
<th>Value/Mean (± SD)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class II</td>
<td>20</td>
<td>31.8</td>
</tr>
<tr>
<td>Class III</td>
<td>37</td>
<td>58.7</td>
</tr>
<tr>
<td>Class IV</td>
<td>6</td>
<td>9.5</td>
</tr>
<tr>
<td>Number operated upon as first laparotomy</td>
<td>47</td>
<td>74.6</td>
</tr>
<tr>
<td>Number of patients previously laparotomized</td>
<td>16</td>
<td>25.4</td>
</tr>
</tbody>
</table>

<p>| Table 2: Patients’ intra-operative data. |</p>
<table>
<thead>
<tr>
<th>Variant</th>
<th>Value/Mean (± SD)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients with fecal peritonitis</td>
<td>63</td>
<td>100</td>
</tr>
<tr>
<td>Patients presented with ileal perforation</td>
<td>29</td>
<td>46</td>
</tr>
<tr>
<td>Patients with gangrenous ileo-caecal junction</td>
<td>34</td>
<td>54</td>
</tr>
<tr>
<td>Patients with gross mesenteric lymphadenitis</td>
<td>57</td>
<td>90.5</td>
</tr>
<tr>
<td>Patients operated as designed in the study</td>
<td>63</td>
<td>100</td>
</tr>
<tr>
<td>Patients had ileostomy, colostomy, or no bowel anastomosis for a second stage procedure</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Patients had resection limited to ileo-caecal region</td>
<td>63</td>
<td>100</td>
</tr>
<tr>
<td>Patients had resection beyond the ileo-caecal region</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Duration of surgery (minutes)</td>
<td>121.6 (± 37.2)</td>
<td>-</td>
</tr>
</tbody>
</table>

![Figure 2: Pre-operative ACT views showing thickened ileo-caecal junction, thickened mesentery and Pneumo-peritoneum.](image)

![Figure 3: Post-operative ACT views showing anastomotic sub-mucosal dye dissection sign without free leakage.](image)
with permanent end ileostomy seldom suffer from recurrence, and nearly 90% of recurrences of disease occur in the peri-anastomotic segment '[19,20]. This conclusion should direct surgeons’ interest to find a technical anastomatic procedure for the resected diseased segment that might reduce the complications of leakage and disease recurrence. Post-operative early and frequent recurrence of Crohn’s disease is common in patients who underwent resection surgery with nearly 90% of recurrences of disease occur in the peri-anastomotic segment. Early postoperative complication rate 20% with hand sewn end-to-end anastomosis compared to 7% in the side-to-side anastomosis. Anastomotic leakage was described in 4.5% in the former vs. 2.8% in the later group. Recurrent disease activity was reported in 57% in the former and in 24% in the later group [25]. They concluded that unexpected technical factor in the hand sewn procedure is reason causing such higher incidence of complications. Simillis et al. compared conventional hand sewn end-to-end anastomosis vs. other anastomotic configurations after resection in CD. The anastomotic leakage was significantly higher in the end-to-end anastomosis group (6.7% of 382 patients) compared to the other anastomotic configurations group (2.3% of 259 patients received a side-to-side anastomosis). In addition, they showed a significant difference regarding the overall postoperative complications [7]. In literature, only one of the included surveys comparing end-to-end anastomoses versus side-to-side anastomoses was a prospective randomized controlled trial; the others represented non-randomized, retrospective studies [7,24,29]. The overall postoperative complications other than anastomotic leak were decreased in the side-to-side group. These literature contradictive and inconclusive results; all offer a potential proof that there is a still missing standard technique to rely on whether staple- or hand-based in resection and anastomosis in CD patients. Such contemporary situation of the ileo-colic anastomosis in CD complicated cases demands further research considering trial of new anastomotic techniques. From the previous review of literature, it is concluded that side to side ilio-colic anastomosis using either stapler or hand sew technique are both superior to end to end anastomosis regarding operative complications and in addition have less local recurrence disease with no difference regarding systemic disease. The author proposes an explanation for such results as follows: CD as an immune derived disease and lymphatics play a major role in the pathogenesis. By applying the side to side anastomosis using hand sew technique or stapler the circumferential lymphatics in the intestinal wall are interrupted isolating the anastomotic site from the immune lymphatic drive and local recurrence of the disease is decreased. In addition the traditional end to end multi-layer anastomosis using either hand sew or stapler techniques preserve the circumferential lymphatic connection and so local recurrence of the disease at the anastomotic site is high. In addition the later technique might jeopardize the blood supply to the healing anastomosed layers and more over might create a mucosal tissue intervening through the wall thickness initiating an intestinal fistula. These explanations are just theoretical suggestions that remain with no proofs but have leaded the author to think seriously to save the end to end hand sew anastomosis from the ambiguous incriminations without any explanation.

**Conclusion**

The surgical technique described in this study is thought genuine and based on a strong theory basis. Intestinal fistula formation always starts with mucosal healing defect or mucosal transposition in an abnormal tissue plane through the anastomotic plane is both avoided by mucosal exclusion from the suture line as in the proposed technique. The intestinal mucosa is proved to hold the highest cellular turnover among all the body cell types; leaving no doubt concerning its capacity to growth and healing without suturing assistance. Approximation of the submucosal floor that is, the sero-muscular

**Table 3:** Patients’ postoperative & follow up data.

<table>
<thead>
<tr>
<th>Complication Type</th>
<th>NO. of patients/ Median ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postoperative bleeding</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Contained sub-serosal dye dissection within the intestinal wall (ACT detected)</td>
<td>7 (12.3%)</td>
</tr>
<tr>
<td>Anastomotic leak or anastomotic line breakage</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Ultrasound guided serous abdominal collection aspiration (aspiration volume ≤ 30 ml)</td>
<td>4 (6.4%)</td>
</tr>
<tr>
<td>Mean abdominal collection aspirated volume (ml)</td>
<td>19.7 (± 3.1)</td>
</tr>
<tr>
<td>Number of patients whom aspirated abdominal fluid (bilirubin assay came negative for all)</td>
<td>4 (100%)</td>
</tr>
<tr>
<td>Intrabdominal abscess collection</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Deep venous thrombosis (lower limb)</td>
<td>1 (1.3%)</td>
</tr>
<tr>
<td>Atelecstasis</td>
<td>3 (5.5%)</td>
</tr>
<tr>
<td>Patients had delayed wound healing without infection (≤ 21 days)</td>
<td>5 (8.3%)</td>
</tr>
<tr>
<td>Mean duration of prolonged wound healing in 5 patients (days)</td>
<td>11.5 (± 1.2)</td>
</tr>
<tr>
<td>Patients had wound infection</td>
<td>4 (6.3%)</td>
</tr>
<tr>
<td>Mean duration of infected wound recovery in 4 patients (days)</td>
<td>14.3 (± 2.5)</td>
</tr>
<tr>
<td>First postoperative bowel motion timing (days)</td>
<td>2.3 (± 0.3)</td>
</tr>
<tr>
<td>Patients needed re-operation during hospital stay</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Duration of hospital stay (days)</td>
<td>13.8 (± 3.2)</td>
</tr>
<tr>
<td>Mortality</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Patients needed surgical re-hospitalization for surgical reason</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Patients commenced on medical treatment post-operatively</td>
<td>63 (10.6%)</td>
</tr>
<tr>
<td>Re-operation for recurrence during follow up duration</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Patients showed intestinal obstruction/stricture during the follow up duration</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Follow up duration (months)</td>
<td>32.3 (± 6.4)</td>
</tr>
</tbody>
</table>

The symptomatic disease recurrence was (22.7% in the end-to-end vs. 21.9% in the side-to-side anastomosis group) and the study concluded that the rate of disease recurrence is independent of the configuration of the anastomosis [29]. Munoz-Juarez et al. reported early postoperative complication rate 20% with hand sewn end-to-end anastomosis compared to 7% in the side-to-side anastomosis. Anastomotic leakage was described in 4.5% in the former vs. 2.8% in the later group. Recurrent disease activity was reported in 57% in the former and in 24% in the later group [25]. They concluded that unnoticed technical factor in the hand sewn procedure is reason causing such higher incidence of complications. Simillis et al. compared conventional hand sewn end-to-end anastomosis vs. other anastomotic configurations after resection in CD. The anastomotic leakage was significantly higher in the end-to-end anastomosis group (6.7% of 382 patients) compared to the other anastomotic configurations group (2.3% of 259 patients received a side-to-side anastomosis). In addition, they showed no significant difference regarding the overall postoperative complications [7]. In literature, only one of the included surveys comparing end-to-end anastomoses versus side-to-side anastomoses was a prospective randomized controlled trial; the others represented non-randomized, retrospective studies [7,24,29]. The overall postoperative complications other than anastomotic leak were decreased in the side-to-side group. These literature contradictive and inconclusive results; all offer a potential proof that there is a still missing standard technique to rely on whether staple- or hand-based in resection and anastomosis in CD patients. Such contemporary situation of the ileo-colic anastomosis in CD complicated cases demands further research considering trial of new anastomotic techniques. From the previous review of literature, it is concluded that side to side ilio-colic anastomosis using either stapler or hand sew technique are both superior to end to end anastomosis regarding operative complications and in addition have less local recurrence disease with no difference regarding systemic disease. The author proposes an explanation for such results as follows: CD as an immune derived disease and lymphatics play a major role in the pathogenesis. By applying the side to side anastomosis using hand sew technique or stapler the circumferential lymphatics in the intestinal wall are interrupted isolating the anastomotic site from the immune lymphatic drive and local recurrence of the disease is decreased. In addition the traditional end to end multi-layer anastomosis using either hand sew or stapler techniques preserve the circumferential lymphatic connection and so local recurrence of the disease at the anastomotic site is high. In addition the later technique might jeopardize the blood supply to the healing anastomosed layers and more over might create a mucosal tissue intervening through the wall thickness initiating an intestinal fistula. These explanations are just theoretical suggestions that remain with no proofs but have leaded the author to think seriously to save the end to end hand sew anastomosis from the ambiguous incriminations without any explanation.

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layer, offers the basis for mucosal healing and anastomotic plane closure with no hindrance of its blood supply. The sero-muscular layer is considered the anchor holding the opposite mucosa layers together to heal and in the same time acts as a guarding flap to contain any minimal possible leakage as proved radiologically in minority cases. It is of great worth to mention that the seven patients who got sub-serosal dye dissection showed the highest CDAI scores in the patients’ sample. Such correlation indicates a prognostic value of the CDAI in predicting CD patients prone to post-anastomotic leakage. In addition it proves the efficacy of the proposed anastomotic technique. Upon review of literature the study is unique proposing an end to end hand sewn technique in CD patients as a primary anastomosis without doing a protective stoma. The study case sample is relatively small and the proposed surgical technique need verification on a larger study sample. Critic is invited.

References