Evaluation of the Predictive Value of Serum C-Reactive protein and Procalcitonin Levels in Early Detection of Anastomotic Leakage after Gastrointestinal Surgery

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Abstract

Background: Anastomotic leak (AL) after gastrointestinal surgery is a serious postoperative complication that leads to significant morbidity and mortality. Objective: To evaluate the role of sequential postoperative serum determinations of C-reactive protein (CRP) and Procalcitonin (PCT) in the identification and prediction of anastomotic leakage after gastrointestinal surgery and to describe the kinetics of PCT and CRP after surgery and their relative usefulness for the early detection of anastomotic leaks after gastrointestinal surgery. Patients and Methods: This study is a clinical prospective randomized observational analytical cross sectional study conducted in the elective and emergency surgery theaters of the department of general surgery at Suez Canal university hospital from Jan 2015 to Jan 2016 on 45 patients who underwent small bowel, colonic and rectal surgery with resection and primary anastomosis. The data was collected by using a questionnaire and lab results. Results: In our study, 22.2% of study patients developed anastomotic leakage, 48.9% of the studied population was between the ages of (46–60) (range 18-72 years), and 62.2% of the study populations were female. Both biochemical markers were elevated in patients with anastomotic leakage at day2, 3 and 4 and showed slightly similar curves, percentages but the upper hand was for PCT than CRP in the point of early detection and in the much more sensitive and more specific. The Pearson correlation with fistula was more powerful for CRP than for PCT. Conclusion: Patients with PCT greater than 0.65mg/dL and CRP greater than 21 mg/dL on Day4, even in the absence of clinical signs, are not permitted to leave the hospital and a diagnostic work-up for sepsis (lung, urinary tract, intra-abdominal, or wound) is actively pursued.

Key words: anastomotic leakage, Procalcitonin, C - reactive protein, gastrointestinal surgery

Introduction

Anastomotic leak (AL) after gastrointestinal surgery is a serious postoperative complication that leads to significant morbidity and mortality. The frequency and consequences of anastomotic failure vary according to the site of anastomosis within the gastrointestinal tract. It is a serious complication after pancreatic surgery because dehiscence of anastomosis with autodigestion and destruction of surrounding tissue from leaking pancreatic juice is associated with a high mortality rate\(^1\).

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Dehiscence after colorectal anastomosis increases the perioperative mortality rate due to peritonitis and septicemia, and adversely affects the late outcome in survivors because of increased local recurrence of carcinoma. Anastomotic leak may be used as an indicator of the quality of surgical care\(^1-2\). Anastomotic leakage is also responsible for delayed resumption of GI transit, pain, prolonged hospital stay and increased costs. On the long term, it worsens functional prognosis after rectal surgery, promotes local recurrence and is a prognostic factor for poor one-year survival in patients undergoing cancer surgery\(^2-4\). According to the report of the French Association of Surgery, elective colorectal surgery in France has a mortality rate of about 4% and an overall morbidity of 35\%\(^5-8\). Anastomotic leakage is responsible for many of these complications, and accounts for one third of deaths\(^9-10\). The anastomotic leak rate varies from 1 to 40% in various reports depending on the definition chosen\(^7,8,11\). Despite the increased understanding about risk factors for anastomotic leakage and improvement in surgical technique, anastomotic leakage remains an important complication and occurs without obvious cause in some patients\(^11\). According to Alves et al, the delayed diagnosis after Post-Operative Day 5 (POD 5) of anastomotic leakage is associated with a mortality rate of 18%, but minimal morbidity if diagnosed and treated before POD 5. Early detection of this complication is essential for timely institution of treatment, making early distinctive markers useful\(^5\). Early detection allows appropriate treatment and less morbidity with a decreased need for ostomy, and less deterioration in the patients’ quality of life. Clinical examination is often nonspecific, and symptoms of anastomotic leakage often develop late\(^12-13\). Since routine postoperative imaging is not efficient, the use of serum markers of inflammation has been proposed to aid in early detection of postoperative septic complications\(^14,16\). Thus, it has been shown that a serum C-reactive protein (CRP) greater than 12.5 mg/dL on the fourth postoperative day is predictive of septic complications. Moreover, fast track surgery and early rehabilitation have become standard in colorectal surgery with hospital discharge by the fifth postoperative day\(^17\). Anastomotic leaks and their consequences can occur well beyond that time, so it is necessary to find a marker of intra-abdominal infection with a high negative predictive value that allows safe hospital discharge with a low risk of re-admission\(^18\). Procalcitonin (PCT) is an inflammatory marker with a short half-life. It is frequently used in the ICU as a prognostic marker for serious infections and has been used to evaluate the response to antibiotic treatment. However, PCT has not been adequately evaluated in the postoperative period\(^19-23\). It is possible that the rise in PCT occurs earlier than that of CRP in bacterial infections\(^24-28\).

**Patients and Methods**

**Study design**

After approval of Ethics Committee of the Faculty of Medicine, Suez Canal University, this clinical prospective randomized study conducted in the elective and emergency surgery theaters of the department of general surgery at Suez Canal university hospital from Jan 2015 to Jan 2016 on 45 patients who underwent small bowel, colonic and rectal surgery with resection and primary anastomosis.

**Patients and Methods**

All patients were subjected to thorough medical history and physical examination, laboratory investigations to evaluate the patients general condition including; complete blood count, bleeding profile, electrolytes, arterial blood gases, serum albumin random blood sugar, liver and kidney
function tests, Serum CRP and PCT. Pelvic-abdominal ultrasonography, Pelvic-abdominal computerized tomography with double contrast, Other studies as barium meal, enema, upper gastrointestinal endoscopy and colonoscopy if needed.

Pre-operative preparation
This included keeping the patient Nothing Per Oral (NPO), Intravenous fluids, Intravenous antibiotics, Mechanical preparation either polyethylene glycol electrolyte solution, laxatives (mineral oil, agar and phenolphthalein), mannitol, enemas (water, 900 ml; glycerin, 100 ml), sodium picosulphate 10 mg, Bisacodyl (10 mg) + enemas, and diets low and non-residue. For each patient, the following data was recorded: surgical indication, For each intervention data was recorded concerning the surgical approach (laparotomy or laparoscopy), underlying pathology, type of resection (subtotal gastrectomy with gastro-jejunostomy, Roux en Y anastomosis, partial small bowel resection with entero-enteric anastomosis, right hemicolectomy, left hemicolectomy, total colectomy, anterior resection with colorectal anastomosis, proctocolectomy with ileoanal anastomosis, and hepaticojejunostomy anastomosis), characteristics of the anastomosis (mechanical or manual), presence or absence of drain. Patients were examined daily to assess the clinical condition (pain, fever, hemodynamic status, abdominal examination, return of bowel function, and any wound discharge, hemoglobin level). Serum CRP and PCT was measured on the day prior to surgery (Day 0) and on the first, second, third and fourth postoperative days (Day 1, Day 2, Day 3 and Day 4). Anastomotic leakage was diagnosed on the clinical signs of peritonitis and/or clinical evidence of free faecal fluid within the abdomen or emerging from the drain site. On clinical suspicion, the diagnosis was confirmed by abdominal and pelvic CT scan, using intravenous and anorectal contrast. The patients were allocated into two groups according to the presence or absence of anastomotic leakage: with anastomotic leakage, without anastomotic leakage. The two groups were compared according to the following characteristics: gender and average age of patients, underlying pathology, planning of intervention (electives, urgent), surgical approach (laparotomy vs. laparoscopy), type of resection, mean hospital stay, postoperative morbidity and mortality, and mean values of serum CRP and Procalcitonin in the pre- and postoperative period. Serum CRP <12 mg/L and serum Procalcitonin <0.05 µg/L were considered normal values. Inclusion criteria: adults ranging from 18–60 years old, both sexes included, Patients underwent elective or emergency gastrointestinal surgery with resection and primary anastomosis at the same setting while. Exclusion criteria: Patients with active infection (respiratory and urinary tract infection) before surgery or an acquired infection in the postoperative period other than leakage (respiratory, urinary tract and surgical wound infection), Patients those received chemotherapy and radiotherapy, Patients on long term corticosteroid therapy, Presence of a defunctioning stoma. After taking the blood samples, chemical analysis for all samples were done at once and value for each sample was recorded. The blood samples (5 cc of venous blood from peripheral vein) were collected and the process of serum separation were done by the researcher in the hospital laboratory then coded in the serum form and preserved in the freezer of the blood bank (of the hospital at -80ºc temperature) till the time of analysis by the specific kits using ELISA analysis in the hospital laboratory by a fixed laboratory technician. The disposable laboratory materials (e.g. blood sample tubes) used in the research will be brought by the researcher. CRP was determined
by immunonephelometry automated dimension Vista analyzer (Siemens, Erlangen, Germany). PCT was determined by homogeneous phase sandwich ELISA analysis (Brahms, Hennigsdorf, Germany)\(^{(26)}\).

**Statistical analysis**

The process of data analysis was processed and encoded, these codes were entered into the computer through using statistical package for social science SPSS version 16 (SPSS Inc., Chicago, IL, USA). Quantitative data were expressed as means and standard deviation while qualitative data were expressed as numbers and percentages. Student t test were used to test significance of difference for quantitative variables and Chi square were used to test significance of difference for qualitative variables. \(p\)-value > 0.05 was considered statistically significant.

**Results**

In our study, 48.9% of the studied population was between the ages of (46–60) (range 18-72 years), 62.2% were female, 46.7% of the patients had single co morbidity (table 1). 15.6% of our patients were mechanically prepared, 80% of patients were operated laparotomy and 20% of them were operated laparoscopically, 80% of study patients were manually hand sewn. While 17.7% of the study patients were stapled, 2.2% were mixed, drains were used in whole study patients, 20% of them were re explored, the mean of hospital stay days was 9.2 and the median was 7 days and it was between 3 to 35 days. The mean and the median value of serum albumin level of study patients were 2.9 and it ranged from 2.1 to 3.9, the mean and the median value of serum hemoglobin level of study patients were 11.4 and it ranged from 9 to 14.8 patients were died which represents 17.8% (table 2 and 3), more sensitive and specific, the area under the ROC curve were slightly similar as at day 2, 3 it was more higher for PCT than CRP 0.820, 0.959 for 0.819, 0.954 and at day 4, it was higher for CRP than PCT 0.979 for 0.959. Also, serum PCT level at day 2 of 0.65 had sensitivity of 80% and specificity of 66%. But serum CRP level at day 2 of 27 had the same sensitivity but more specific 80%. At day 3, 4 and serum PCT levels of 0.7, 0.65 had 100% sensitivity and 95% specificity while that of serum CRP levels 24, 21 had lower sensitivity and specificity than PCT at day 3 as 90%, 89% and equal sensitivity at day 4 as 100% and more specific 98% (Figures 1, 2) In comparison between PCT and CRP in the point of early detection, both markers were elevated in patients with anastomotic leakage at day2, 3 and 4 and showed slightly similar curves, percentages but the upper hand was for PCT than CRP in the point of early detection, higher sensitivity and specificity. The Pearson correlation with fistula was more powerful for CRP than for PCT (Figures 3-6).

**Discussion**

According to age distribution of the study population, 48.9% of the studied population was between the ages of (46–60) (range 18-72 years),The mean age of our patients was 47.3 with standard deviation 11.02, while 50% of patients developed leakage was between the same age group and it’s considered 11.1% of the whole patients. While in a pilot study conducted in France at the Digestive Surgery and Oncology Service, CHU de Dijon by Lagouttea, there were 100 patients with a mean age of 64 and a median age of 63 (range 20—87 years)(\(^{(26)}\) where the median age for the patients in a study in Belgradeat Zvezdara University Clinical Centre by Scepanovic was 65(\(^{(28-30)}\). While in a prospective study done in department of surgical oncology and colorectal surgery in poland and UK by Zawadzki, on 55 patients, the mean age
was 66.1±11.2\(^{30}\). The mean age of non-leakage group in the study of Almeida, department of general surgery of Centrohospitalar de sao joao, Portugal, was 65.5 years, while in the leakage group was 69.5 years\(^{22}\). In this study, 62.2\% of the study populations were female, and 80\% of patients who developed leakage were also female (17.7\% of the total population).

### Table 1: Demographic data and its relation to the anastomotic leakage

<table>
<thead>
<tr>
<th>Variables</th>
<th>LEAK</th>
<th>Total</th>
<th>Percent</th>
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</thead>
<tbody>
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<td><strong>Age groups (Yrs.)</strong></td>
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<tr>
<td>18-30</td>
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<td>31-45</td>
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<tr>
<td>46-60</td>
<td>17</td>
<td>5</td>
<td>48.9</td>
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<tr>
<td>&gt; 60</td>
<td>3</td>
<td>1</td>
<td>8.9</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
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<td></td>
</tr>
<tr>
<td>Male</td>
<td>15</td>
<td>2</td>
<td>37.8</td>
</tr>
<tr>
<td>Female</td>
<td>20</td>
<td>8</td>
<td>62.2</td>
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<tr>
<td>Total</td>
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<td>10</td>
<td>100</td>
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</tbody>
</table>

### Table 2: Surgical data characteristics and its relation to the anastomotic leakage

<table>
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<th>Variables</th>
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<tbody>
<tr>
<td><strong>Approach</strong></td>
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<td>80</td>
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<tr>
<td>Total</td>
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<td>100</td>
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<tr>
<td>Manual</td>
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<td>80</td>
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<tr>
<td>Both</td>
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<td>0</td>
<td>2.2</td>
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<tr>
<td>Total</td>
<td>35</td>
<td>10</td>
<td>100</td>
</tr>
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</table>

### Table 4: Distribution of hemoglobin and albumin serum level characteristics

<table>
<thead>
<tr>
<th></th>
<th>Albumin</th>
<th>Hemoglobin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>2.913333E0</td>
<td>11.49</td>
</tr>
<tr>
<td>Median</td>
<td>2.900000E0</td>
<td>11.00</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>.4424108</td>
<td>1.308</td>
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<tr>
<td>Minimum</td>
<td>2.1000</td>
<td>9</td>
</tr>
<tr>
<td>Maximum</td>
<td>3.9000</td>
<td>14</td>
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</table>

While in the pilot study conducted at the Digestive Surgery and Oncology Service, CHU de Dijon by Lagouttea, 58 were men and 42 werewomen\(^{26}\). And it was 57.1\% males and 42.9\% women in Scepanovic study\(^{29}\). While in Zawadzki study, 37 patients were males (67.3\%) and 18 patients were females (32.7\%)\(^{30}\). In the study of Almeida, 88 (50.8\%) of patients were males and 30 (49.2\%) were females\(^{27}\). Only 15.6\% of our patients were mechanically prepared, 90\% of patients developed leakage were not prepared. All patients in Lagouttea study, Scepanovic and Zawadzki study were mechanically prepared as these studies were on elective cases\(^{26,29,30}\). Regarding the surgical technique of the operation, 80\% of our patients were operated with laparotomy and 20\% were operated laparoscopically, and 80\% of patients developed leakages were operated laparotomy. While in the pilot study at Dijon by Lagouttea, there were 65\% of patients operated laparotomy and 35\% operated laparoscopically\(^{26}\). All patients in the study of Scepanovic were operated with laparotomy\(^{29}\). But at Zawadzki study, 29 patients (52.7\%) underwent a robotic surgery while the others (26 patients, 47.3\%) underwent open surgery\(^{30}\). In the study of Almeida, there were 31 (17.9\%) patients were operated laparoscopically, one of them had developed leakage, while the others (142 (82.1%) patients) were operated laparotomy, 23 patients of them had developed leakage\(^{27}\). In our study, 17.8\% of patients suffered from perforated peptic, 15.6\% of patients suffered from morbid obesity, 2.2\% with esophageal cancer, 6.7\% with cancer stomach, 4.4\% with perianampullary cancer, 6.7\% cancer head of pancreas, 2.2\%
with cholangiocarcinoma, 8.9% with MVO, 4.4% with strangulated small bowel in hernia, 4.4% with cancer caecum, 2.2% with splenic flexure mass, 2.2% with recto sigmoid mass, 4.4% with cancer rectum, 4.4% with closure of colostomy, 2.2% with sigmoid volvulus 8.9% with ligated CBD post cholecystectomy, 2.2% with hepatic flexure mass. While 20% of patients developed leakage accounted for cancer head of pancreas, mesenteric vascular occlusion, morbid obesity and 10% of them accounted for stomach cancer, strangulated small bowel in Pera umbilical hernia, cancer caecum, closure of Hartman’s colostomy post recto sigmoid mass. While in the pilot study of Lagouttea, there was Cancer (52 patients): 2 rectum, 14 left colon, 16 right colon, 1 transverse colon. Diverticulitis (17 patients). Benign colon tumor (3 patients). Re-anastomosis (8 patients). Others: polyps unresectable by endoscopy (7 patients), solitary ulcer (1 patient), rectal villous adenoma (1 patient), ileo-cecal stricture (2 patients), familial adenomatous polyposis (2 patients), anastomotic stricture (3 patients), migration of prosthetic material into the rectum (2 patients), ischemic stricture (1 patient), colonic metastasis from melanoma (1 patient)\(^{(26)}\). While it was 96.8% carcinoma in the study of Belgrade and was 3.2% IBD\(^{(29)}\).

All patients in Zawadzki study were cancer colon\(^{(30)}\). In the study of Almeida, there were 129 (74.5%) patients had cancer colon, 17 patients of them developed leakage, 8 (4.6%) patients had IBD, 2 patients of them developed leakage, 4 (2.3%) patients had diverticular disease, 32 (18.4%) patients had other pathologies, 5 patients of them
developed leakage\(^{(27)}\). In our study, 80% of our patients were manually hand sewn, 10% developed leakage. While 17.7% of our patients were stapled, 25% of them developed leakage and one patient with esophageal cancer was repaired mechanically for construction of gastric tube and manually for esophagogastric anastomosis. While Lagouttea and Belgrade there were 16% protective ileostomy (in our study there were on protective stoma), 57% stapled anastomoses, and 43% hand-sewn anastomoses\(^{(26)}\). And it was 75% hand sewn versus 25% mechanical in the study of Scepanovic\(^{(29)}\). While in Zawadzki study, 29 patients (52.7%) were stapled and 26 patients (47.3%) were hand sewn\(^{(30)}\). Drains were used in whole study patients while it was 62% in the pilot study of Lagouttea\(^{(26)}\). We found that 22.2% of our patients developed anastomotic leakage, 20% of them were re-explored. While it was 13% of patients included in pilot study done at Dijon by Lagouttea\(^{(26)}\).

And it was 9.6% at the study done in Belgrade at Zvezdara University Clinical Centre by Scepanovic\(^{(29)}\). Also, it was 9.1% (5 patients) at the study of Zawadzki and all of them were reexplored\(^{(30)}\). In the study of Almeida, there were 24 (13.8) patients developed leakage, 21 of them had been reexplored\(^{(27)}\). The mean of hospital stay days was 9.2 and the median was 7 days and it was between 3 to 35 days. At Lagouttea study, the average length of stay was 12.5±9.8 days (range: 4-55 days)\(^{(26)}\). While at Zawadzki study, the mean hospital stays in non AL was 5.9 ±1.6, but in AL patients were 6.7 ±3.2 days \(^{(30)}\). In the study of Almeida, the mean hospital stay in non AL was 11.7 days, but in AL patients was 29.5 days\(^{(27)}\). The mean and the median value of serum albumin level of study patients were 2.9 and it ranged from

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**Figure 3**: Median serum PCT levels at D0, D1, D2, D3, and D4 characteristics in non-anastomotic leak

**Figure 4**: Median serum PCT levels at D0, D1, D2, D3, and D4 characteristics in anastomotic leak

**Figure 5**: Median serum CRP levels at D0, D1, D2, D3, and D4 characteristics in non-anastomotic leak

**Figure 6**: Median serum CRP levels at D0, D1, D2, D3, and D4 characteristics in anastomotic leak
The mean and the median value of serum hemoglobin level of study patients were 11.4 and it ranged from 9 to 14. In this study 8 patients were died which represents 17.8%, 50% of them had developed anastomotic leakage. At Lagouttea study, 2 patients died which represents 2% (26). While 3 patients died in the study of Scepanovic Belgrade which represents 1.9% (29). And no one died in Zawadzki study (30).

According to the values of serum PCT levels, the median of D0, D1, D2, D3, and D4 were 0.3, 0.6, 0.6, 0.3 and 0.2 accordingly in the patients whom didn’t develop anastomotic leakage. While those who develop anastomotic leakage were 10 (22.2%) patients as follow 0.2, 0.75, 0.8, 1 and 1.45. At Lagouttea study, the values of serum PCT levels, the median of D0, D1, D2, D3, and D4 were 0.007, 0.062, 0.081, 0.063 and 0.045 in the patients whom didn’t develop anastomotic leakage. While those who develop anastomotic leakage were 13 (13%) patients as follow 0.013, 0.163, 0.134, 0.111 and 0.026 (26). At Zawadzki study, serum PCT were measured prior to surgery, 8 h after the incision, on the first and third postoperative day (0, +8 h, POD 1, POD 3) and the values of median serum PCT levels were 0.05, 0.07, 0.72 and 0.22 in the patients whom didn’t develop anastomotic leakage. While those who develop anastomotic leakage were 5 (9.1%) patients as follow 0.05, 0.05, 3.3 and 4.88 (30). This study showed that serum PCT level of 0.02 at day 0 has no much significance in prediction of anastomotic leakage, sensitivity 40% and specificity 49% as well the serum PCT level of 0.65 at day 1 has no much significance, sensitivity 60% and specificity 60%. This differs from day 2 as the sensitivity increased up to 80% with specificity 66% at the serum PCT level value of 0.65, also at value of 0.75 sensitivity was 60% and specificity was 31% as the area under ROC curve increased 0.820 which showed a high significance for prediction of anastomotic leakage. While at day 3 and day 4 at the serum PCT level values of 0.7, 0.65, the sensitivity was 100% with specificity 95% and the area under ROC curve increased up to 0.959 which showed a very high significance for prediction of anastomotic leakage. The mean values of serum PCT levels increased on POD 1 and 3 in all patients, but the rise of PCT was significantly higher among the patients with AL only on POD 3. The mean PCT on POD 1 was 2.0 ng/ml in non-AL and 3.8 ng/ml in AL patients, whereas on POD 3 it was 0.56 ng/ml and 10.4 ng/ml, respectively (30). Analysis of ROC curves showed that PCT on POD 3 had AUC of 0.30. A cutoff value for PCT on POD 3 was calculated at the level of 3.26 ng/ml with 75% sensitivity and 100% specificity for AL (30). According to the values of serum CRP levels, the median of D0, D1, D2, D3, and D4 were 0.47, 12.4, 15.2, 11.30 and 8.5 in the patients whom didn’t develop anastomotic leakage. While those who develop anastomotic leakage were 13 (13%) patients as follow 2.33, 15.5, 22.1, 15.2, 11.30 and 8.5 in the patients whom didn’t develop anastomotic leakage. While those who develop anastomotic leakage were 10 (22.2%) patients as follow 6, 27, 51, 81 and 162. At Lagouttea study, the values of serum CRP levels, the median of D0, D1, D2, D3, and D4 were 0.47, 12.4, 15.2, 11.30 and 8.5 in the patients whom didn’t develop anastomotic leakage. While those who develop anastomotic leakage were 13 (13%) patients as follow 2.33, 15.5, 22.1, 15.2, 11.30 and 8.5 in the patients whom didn’t develop anastomotic leakage. While those who develop anastomotic leakage were 10 (22.2%) patients as follow 6, 27, 51, 81 and 162.
develop anastomotic leakage were 24 (13.8%) patients as follow 22, 116, 187, 201, 129, 162, 178, 201, 209 and 174 respectively. This study showed that serum CRP level of 3 at day 0 has no much significance in prediction of anastomotic leakage, sensitivity 60% and specificity 40% as well the serum CRP level of 21 at day 1 has no much significance, sensitivity 60% and specificity 55%. This differs from day 2 as the sensitivity increased up to 80% with specificity 80% at the serum CRP level value of 27 as the area under ROC curve increased 0.819 which showed a high significance for prediction of anastomotic leakage. While at day 3 and day 4 at the serum CRP level values of 24, 21 the sensitivity was 90%, 100% with specificity 89%, 98% and the area under ROC curve increased up to 0.954, 0.979 which showed a very high significance for prediction of anastomotic leakage. In the study of Belgrade by Scepanovic, POD 2, mean serum CRP was 187 mg/L in leak group and 132 mg/L in non leak group. On POD 3, those values were 201 mg/L in leak group and 105 mg/L in non leakage group. Based on the evaluation of the ROC curves, a cut-off value of 140 mg/L on POD 3 maximized the sensitivity (78%) and specificity (66%). But serum CRP level at day 2 of 27 had the same sensitivity but more specific 80%. At day 3, 4 and serum PCT levels of 0.7, 0.65 had 100% sensitivity and 95% specificity while that of serum CRP levels 24, 21 had lower sensitivity and specificity than PCT at day 3 as 90%, 89% and equal sensitivity at day 4 as 100% and more specific 98%. Indeed, both of the biochemical markers were elevated in patients with anastomotic leakage at day 2, 3 and 4 and showed slightly similar curves, percentages but the upper hand is for PCT than CRP in the point of early detection and in the much more sensitive and specific.
the PCT\(^{(26)}\). Comparison of ROC curves for Belgrade patients was Day 3, Day 5, and Day 7 with respective area under the curve values of 0.738, 0.756 and 0.827\(^{(29)}\). The Pearson correlation with fistula was more powerful for CRP than for PCT in our study and in the study of Dijon. Thus, a patient with a PCT greater than 0.65 mg/dL and CRP greater than 21 mg/dL on Day 4, even in the absence of clinical signs, is not permitted to leave the service and a diagnostic work-up for sepsis (lung, urinary tract, intraabdominal, or wound) is actively pursued. While in Lagoutte a study it was PCT greater than 0.1 mg/dL and CRP greater than 12.5 mg/dL. And it was on day 3, a cutoff value of CRP 135 mg/l was associated with the development of AL, providing a sensitivity of 73\% and specificity of 73 \%. on Day 7, a cutoff value of CRP 30 mg/l was associated with the development of AL, providing a sensitivity of 80\% and specificity of 90\%, and a high diagnostic accuracy\(^{(26)}\).

**Conclusion**

Patients with PCT greater than 0.65 mg/dL and CRP greater than 21 mg/dL on day 4, even in the absence of clinical signs, should not leave the hospital and a diagnostic work-up for sepsis (lung, urinary tract, intra-abdominal, or wound) should be actively pursued.

**References**

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