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***Retrospective Study***

**Colostomy is a simple and effective procedure for severe chronic radiation proctitis**

Yuan ZX *et al.* Diverting colostomy for radiation proctitis

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**Abstract**

**AIM:** To assess the efficacy and safety of diverting colostomy in treating severe hemorrhagic chronic radiation proctitis (CRP).

**METHODS:** Patients with severe hemorrhagic CRP who were admitted from 2008 to 2014 were enrolled into this study. All of CRP patients were diagnosed by a combination of pelvic radiation history, clinical rectal bleeding, and endoscopic findings. Inclusion criteria were CRP patients with refractory bleeding along with moderate to severe anemia at a hemoglobin level < 90 g/L. The study group included patients who were treated by diverting colostomy, while the control group included these cases who received medical conservative measures.The remission of bleeding was defined as complete cessation or only occasional bleeding that need no further treatment. The primary outcome was bleeding remission at six-month after treatments. The quality of life before treatments and at follow-up was evaluated according to EORTC QLQ C30. Severe CRP complications were recorded during follow-up.

**RESULTS:** Forty-seven consecutive patients were enrolled, including 22 in colostomy group and 27 in the conservative group. When compared to conservative treatments, colostomy obtained a higher rate of bleeding remission (94% *vs* 12%), especially in control of transfusion-dependent bleeding (100% *vs* 0%), and offered a better control of refractory perianal pain (100% *vs* 0%), and a lower score of bleeding (*P* < 0.001) at six months after treatment. At one-year after treatment, colostomy achieved better remission of both moderate bleeding (100% *vs* 21.5%, *P* = 0.002) and severe bleeding (100% *vs* 0%, *P* < 0.001), obtained a lower score of bleeding (0.8 *vs* 2.0, *P* < 0.001), and achieved obvious elevated Hb levels (*P* = 0.003), when compared to conservative group. The quality of life dramatically improved after colostomy which included global health, functions, and symptoms, but it was not improved in the control group. Pathological evaluation after colostomy found diffused chronic inflammation cells, and massive fibrosis collagen depositions under rectal wall, which revealed potential fibrosis formation.

**CONCLUSION:** Diverting colostomy is a simple, effective and safe procedure for severe hemorrhagic CRP. Colostomy can improve quality of life and reduce serious complications secondary to radiotherapy.

**Key words:** Chronic radiation proctitis; Rectal bleeding; Diverting colostomy; Quality of life; Serious complication.

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**Core tip:** The study describes the efficacy and safety of diverting colostomy in treating severe hemorrhagic chronic radiation proctitis. The procedure focuses on improving the severe refractory bleeding and reducing severe complications. The advantages of diverting colostomy are as follows: it acts very effectively and rapidly in controlling severe bleeding that did not respond to medical conservative treatments anymore; it is a very simple procedure that can be conducted in many medical centers; it can improve the quality of life dramatically and reduce serious complications that occur secondary to radiotherapy.

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**INTRODUCTION**

Chronic radiation proctitis (CRP) is a common complication after radiotherapy of pelvic malignancies, accounting for 5%-20% of cases[1].  The onset of radiation proctitis can be delayed months to years after the radiotherapy. In mechanism, CRP develops as a result of ischemia lesions due to obliterative endarteritis and progressive fibrosis[2,3]. Rectal bleeding is the most common symptom, which accounts for more than 80% of CRP patients[4]. Acute and mild CRP are usually self-limiting and easy to manage, but moderate to severe CRP are difficult to treat, especially those cases requiring blood transfusions and threatening life[1,5].

Various treatment modalities have been tried. Medical agents include topical sucralfate, steroids[6], sulfasalazine[7], metronidazole[8], rebampide[9] and short-chain fatty acid[10]. Other treatment options include topical formalin[11,12], endoscopic argon plasma coagulation (APC)[13], laser therapy[14], and hyperbaric oxygen therapy[15]. However, most of these treatments are only useful for mild to moderate bleeding, severe and refractory bleeding is still problematic[16]. Furthermore, endoscopic treatments can bring severe side-effects and multiple treatments sessions are needed for severe CRP[17]. In addition, accompanying symptoms such as intractable perianal pain, urgency and tenesmus in CRP are usually hard to manage.

Diverting colostomy has been reported previously, mainly for severe CRP complications[18,19]. Colostomy can reduce the irritation injury of fecal stream to the irradiated tissues and thus decrease rectal bleeding. However, unlike formalin or APC, colostomy is now not widely used. And the issue of colostomy is not well studied as far. To our knowledge, no study has ever before made any comparison of diverting colostomy to these conservative measures. The aim of this study was to assess the efficacy and safety of diverting colostomy in severe CRP patients. The indications, the quality of life, severe CRP complications, and stoma reversals after colostomy were also investigated, when compared to conservative treatments.

**MATERIALS AND METHODS**

***Patients and ethical statements***

Hemorrhagic CRP patients who were treated at the Sixth Affiliated Hospital of Sun Yat-Sen University (SYSU) from March 2008 to October 2014 were retrospectively enrolled in this study. Electronic files and medical records were both carefully collected to extract clinic-pathologic data. This study was approved by the ethical committee of the Sixth Affiliated Hospital of SYSU and the study was corresponding to the provisions of the World Medical Association’s Declaration of Helsinki in 1995 (revised later in Tokyo 2004). Due to the nature of the retrospective study, informed consent was waived.

***Inclusion and exclusion criteria***

Inclusion criteria were CRP patients with refractory bleeding along with moderate to severe anemia at a hemoglobin level < 90 g/L. Refractory bleeding was defined as no response to conservative measures. Patients who were treated with diverting stomas were enrolled in the study group, while those continued to non-surgical treatment were enrolled in the control group. Patients with tumor relapses, lost to follow-up, or performed a rectal resection with a preventive colostomy were excluded.

***Diagnosis, scores and definitions***

All of patients were diagnosed by the combination of pelvic radiation history, clinical rectal bleeding, and endoscopic findings of injured rectum mucosa. Flexible colonoscopies were performed in all patients to rule out other causes of bleeding, such as recurrent tumors, inflammatory bowel disease and anal benign hemorrhagic diseases. Vienna Rectoscopy Score[20] system was used to assess endoscopic severity.

Current scores to evaluate the severity of bleeding included Common Terminology Criteria for Adverse Events (CTCAE)[21], Radiation Therapy Oncology Group (RTOG) / European Organization for Research and Treatment of Cancer (EORTC) score[22]. However, most of them are based on subjective complains of patients, instead of accurate laboratory tests. Because the severity of bleeding was mainly reflected by the drop of hemoglobin level, we designed a modified Subjective Objective Management Analysis (SOMA) system reported in previous study[23], to assess the severity of bleeding, included both subjective complains of bleeding and objective hemoglobin level. All patients were scored by the system (Table 1). The remission of bleeding was defined as complete cessation of bleeding or only occasional bleeding that need no further treatment. Failure in conservative group was defined as no improvement or even worse of bleeding and decreased hemoglobin level six months after the treatment.

***Indications of diverting colostomy***

All patients, except those cases with fistulas, were initially treated with medical agent enemas including almagate (one mucosa-protector like sucralfate), corticosteroids, and metronidazole. Topical formalin (details listed in our previous study)[24] or endoscopic APC were suggested when they experienced recurrent bleeding. As for refractory and transfusion-dependent CRP after these conservative measures, physicians suggested they chosen a diverting stoma. If patients refused a colostomy and demanded to continue conservative treatments, they were enrolled in the control group. Other indications of diverting colostomy were as follow: (1) fistula, perforation or stricture; and (2) deep ulcer with refractory perianal pain.

Diverting loop colostomies were conducted under general anesthesia in the operation room. Briefly, transverse colon was pulled out through a small incision, then a soft catheter of a stent was inserted to prevent stoma retraction, and a double-cavity stoma of transverse colon was then created. The catheter was removed postoperatively. Classical images of a double-cavity colostomy and a “gunsight” of stoma closure were shown (Figure 1). This technique of stoma closure can simplify wound care, decrease surgical site infection, and give a neat cosmetic result[25,26].

***Follow-up***

Follow-up were scheduled through outpatient visits or telephonic questionnaires at six months and one year after treatment. The quality of life before treatments and at follow-up was evaluated according to EORTC QLQ C30, respectively[27]. The primary outcome was the remission rate of bleeding at six-month after treatment. The second outcomes included hemoglobin level, remission rate of bleeding at one-year after treatment, quality of life, stoma related complications, severe CRP complications, and stoma reversal rate.

***Statistical analysis***

Comparisons of characteristics were made by student *t-*test analysis for continuous variables. For categorical variables, χ2 test was used. Fisher exact test was adopted when appropriate. For non-parameter variable, the Wilcoxon rank-sum test was used. All statistical analyses were performed by SPSS software version 17.0 (Chicago, IL). *P* value less than 0.05 (two-tails) was considered to be statistically significant.

**RESULTS**

***Demographics and characteristics***

A total of 47 patients were analyzed. Of them, 22 (46.8%) were treated by diverting colostomy, other 27 (53.2%) patients were managed by conservative treatments (Figure 2). Among them, 43 (91.5%) were females, and 40 (85.1%) of primary malignancies were cervical cancers. Cumulative radiation dosage of one patient was about 80 Gy, which included the radiation for both sites of primary malignancy and invasive lymph nodes. The detailed radiotherapy for those patients with gynecological cancers, especially cervical cancer, was 25 rounds (2 Gy/round) of external beam radiation and 5-6 episodes (6 Gy/episode) of intra-cavity brachytherapy. Patients with prostate or rectal cancers received only external beam radiation. When compared demographics prior to treatment between two groups, there were no significant differences in age, gender, type of primary malignancy, cumulative radiation dosage, latency period, duration from treatment to end of radiotherapy, duration of bleeding, albumin level, Body Mass Index (BMI), concomitant radiation uropathy, radiation enteritis, and associated risk factors of CRP such as previous history of abdominal surgery, diabetes mellitus and hypertension (Table 2). Thus, these above characteristics were comparable between the two groups. However, colostomy group had a higher score of bleeding (2.7 *vs* 2.0, *P* < 0.001) and a lower hemoglobin level (60.8 *vs* 88.2, *P* < 0.001), when compared to conservative group, respectively. These results indicated that colostomy group had more serious bleeding before treatment (Table 2).

***Treatments***

In colostomy group, the indications of colostomy were as follows: (1) severe bleeding in eight (36.4%) cases; (2) fistulas in 11 (50%) cases, including nine (40.9%) rectovaginal fistulas and two (9.1%) sigmoid-vesical-vaginal fistulas; (3) deep ulcer + refractory perianal pain in two (9.1%) cases; and (4) severe bleeding + deep ulcer + anal stricture in one (4.5%) case. Among these 11 patients with fistulas, five also had concomitant severe bleeding. Among these nine recto-vaginal fistulas, one had concomitant recto-urethral fistula, and another one had concomitant recto-vesical fistula and small bowel fistula.

In the conservative group, seven received topical formalin irrigation and one received APC treatment after the enrollment date. All eight (32%) cases transiently obtained bleeding remission, but only two (25%) obtained long-term remission of bleeding. The other six patients experienced recurrent bleeding and developed to severe anemia. Repeat topical formalin obtained only limited efficacy in these patients with severe anemia (average 2 sessions of formalin at 2-4 wk intervals). The remaining 17 patients refused formalin treatments, and thus continued retention enemas and transfusions when needed.

***Outcomes***

During a mean 22 (range: 6-77) mo of follow-up, eight (17%) patients died. The cause of death was recurrent malignancy in seven cases. The other one died of bladder perforation and sepsis which occurred secondary to radiation recto-vesical-vaginal perforation. At six months after treatment, colostomy offered higher remission of bleeding (94% *vs* 12%, *P* < 0.001), higher remission of refractory perianal pain (100% *vs* 0%, *P* < 0.001), decreased scores of bleeding (1.1 *vs* 2.2, *P* < 0.001), and obvious increased Hb levels (34.1 *vs* -12.3, *P* < 0.001), comparing to conservative group, respectively. At one-year after treatment, colostomy achieved still higher remission of both moderate bleeding (100% *vs* 21.5%, *P* = 0.002) and severe bleeding (100% *vs* 0%, *P* < 0.001), acquired lower score of bleeding (0.8 *vs* 2.0, *P* < 0.001), and still obvious elevated Hb levels (40.3 *vs* -1.9, *P* = 0.003), than those cases in conservative group, respectively. In addition, three recto-vaginal fistulas were found in conservative group during follow-up, but no new fistula occurred after the operation in colostomy group. Patients who did not have bleeding remission continued conservative treatments at home in conservative group (Table 3).

***Stoma closure and complications***

Of the eight patients who received colostomy to control severe bleeding, three (37.5%) underwent stoma closure (two cases at nine months and one case at ten months after colostomy). All three had no bleeding and remained well after stoma reversal. Of the remaining five, all obtained bleeding remissions and improved hemoglobin levels dramatically. However, among these five, one had an IV grade (New York Heart Failure classification) of heart failure and can’t bear the risks of stoma closure. Four were unsuitable for closure because of erythema and telangiectasia at six months after colostomy, and two of these four had not yet reached one year of follow-up to assess the lesion by a colonoscopy.

Stoma complications were found in seven (31.8%) cases, which contained six stoma prolapses and one stoma stricture. Of these six stoma prolapses, four were managed with conservative measures by manual repositions (grade II by Clavien–Dindo classification[28]), and two required stoma rebuilt (grade III). One stoma stricture was occurred in a stoma of descending colon, instead of transverse colon, and stoma stricture was managed by finger dilatation (grade II).

***Quality of Life***

The quality of life was evaluated in 41 (87.2%) patients by the EORTC QLQ-C30 questionnaires successfully. Because there were no similar reported files of Chinese population, the values were referred to normal German population. Osoba *et al*[29] suggested that a difference of ≥ 20 points in global health was considered to be clinically relevant. In this study, when compared to pre-treatment, diverting colostomy had greatly improved quality of life, including improved global health (difference = 42, *P* < 0.001), improved functions like physical function (*P* < 0.001), role function (*P* < 0.001), emotional function (*P* < 0.001), social function (*P* < 0.001), and improved symptoms like fatigue (*P* < 0.001), pain (*P* = 0.001), dyspnea (*P* = 0.003), insomnia (*P* = 0.026), and diarrhea (*P* = 0.018). However, conservative treatment did not significantly raised the level of quality of life at follow-up than that before treatment (Table 4).

***Endoscopic and pathological features***

Classical endoscopic images prior to colostomy and at stoma closure from three patients with stoma closures were collected (Figure 3). After a mean 9.3 (range: 9-10) months after colostomy, endoscopic lesions of active bleeding, multiple confluent telangiectasia, congested mucosa, or even ulcer were greatly improved and reach the criteria of stoma closure.

Pathological evaluation of endoscopic biopsy from rectal lesion was conducted at 31 months after colostomy in case 3. This patient has obtained complete remission of bleeding and the biopsy sites were fully healed according to endoscopic observation at follow-up. Pathologically, diffused chronic inflammation cells were observed in the mucosa and sub-mucosa layers. In addition, massive fibrotic collagen depositions were found in the sub-mucosa layer, which revealed fibrosis formation (Figure 4).

**DISSCUSSION**

Endoscopic treatments, such as topical formalin, and APC, are extensively used for mild to moderate hemorrhagic CRP across the worldwide[14,16]. However, these treatments show only limited long-term efficacy for severe CRP[17]. It is also unclear how many of patients have received these treatments for serious transfusion-dependent bleeding in previous studies[17]. Meanwhile, serious complications can be caused by these endoscopic treatments[5,17]. Our previous study also suggested that topical formalin should not be applied in CRP with ulcer because of risk of fistula[24]. In the present study, patients in conservative group had received more topical formalin or APC treatments and developed more fistulas later, than these in colostomy group. Therefore, we suggest topical formalin or APC should be selected very cautiously for these severe CRP patients. Recently, new radiofrequency ablation (RFA) in treating CRP has been introduced and improvement in hemoglobin level and decrease in clinical symptoms are observed[30,31]. But most of RFA studies are based on retrospective case series without controls and current data are scare, prospective trials of RFA should be conducted in the future to validate its efficacy and application in severe CRP patients.

Surgical intervention is often reserved to be the last resort for severe CRP[3,19]. Rectal resection is controversial, because it is difficult to perform a safe anastomosis in the radiation-injured tissue, and high risks of anastomotic leak and deaths of postoperative peritonitis are reported[19]. Therefore, a simple and safe procedure to save life and relive symptoms is mandatory. Theoretically, diverting colostomy can reduce bacterial contamination and decrease irritation injury by fecal stream, and colostomy can win time to subside any radiation reaction to protect injured tissue[32]. Thus, severe bleeding and refractory perianal pain can be controlled. Colostomy can also accelerate the course of fibrosis and relieve severe proctitis rapidly, which may prevent deep ulcers to progress to fistulas. In our recent study[33], we reported typical histo-pathological features of CRP: telangiectasia, abnormal hyaline-like wall vessels and sporadic radiation fibrocytes in the submucosa layer. In this study, consistently, massive fibrotic collagen depositions were observed in irradiated tissue after colostomy. Collectively, the nature of CRP is a progressive fibrosis course[7]. The efficacy and safety of colostomy have been reported in previous studies[18,19,34]. However, most previous studies did not contain controls, which could not discriminate the efficacy of interventions from the self-remission course. To our knowledge, no previous study has reported quality of life after colostomy. It is also not clear whether colostomy can reduce serious CRP complications.

In this study, diverting colostomy had resolved most of severe bleeding. No recurrent bleeding and no colostomy-related death were observed. Colostomy can also decrease serious complications, including remission of long-term perianal pain, transfusion-dependent bleeding and fistula. Deep ulcer with severe bleeding is a contraindication of endoscopic treatments, because it is very easy to progress to fistula, for the poor-healing capacity and impaired blood supply of friable intestinal wall[17,19]. Actually, we have tried topical revision and skin flap transplantation for some CRP fistulas previously. But the efficacy is very limited and new fistula can occur quickly, due to poor healing capacity of irradiated mucosa and bacterial infection from fecal stream, which leads to failure of these treatments. In this study, two patients with deep ulcer and severe bleeding were successfully controlled by colostomy, and no fistula was found at follow-up.

As for type of colostomy, transverse colostomy is preferred, because it provides more blood supply by preserving superior rectal and left marginal vessels, and provides more options for later possible recto-sigmoid resection than sigmoid colostomy, and transverse colostomy is easier to be closed and is more effective[32,34]. In addition, the recto-sigmoid colon is expected to receive a higher radiation dosage of radiotherapy for pelvic malignancy, while transverse colon receives the least radiation and damage, because it is most away from pelvic tumors, and thus causes the least complications[19,32,35]. Loop ileostomy is not widely used for risks of high-volume fluid discharge. Colostomy related complications were reported ranging from 21.8% to 40%[19,35]. Consistent with previous studies, colostomy related complications in this study was 31.8%, including six (85%) cases of grade II and one (15%) case of grade III complications. Among them, stoma prolapse was a common complication.

Colostomy for recto-vaginal fistula and rectal stricture will be permanent. However, colostomy, for patients unresponsive to medical measures, can be closed when severe proctitis improves enough. Paul *et al*[19] reported six (43%) colostomy reversals in 14 CRP patients, who were unresponsive to medical measures. Similar result was observed in the present study. Three (38%) of eight patients with severe bleeding were closed successfully in a mean 9 mo after colostomy. Because the duration of follow-up after fecal diversion was relatively short to assess, many patients who obtained long-term remission of bleeding after colostomy actually had great potential to reverse the stoma.

 In this study, we used a modified SOMA system, which coordinates subjective bleeding symptom and objective accurate hemoglobin level. According to the system, we suggest mild to moderate hemorrhagic CRP can be managed by medical or endoscopic treatments. However, severe refractory bleeding should consider colostomy promptly to prevent to develop serious complications. The score system will guide physicians in primary care to evaluate patient condition easily according to hemoglobin level, and then choose the proper treatment. Having a routine and easy protocol can reduce treatment related delays and avoid unnecessary morbidity[7].

In this study, 44 (94%) of CRP patients enrolled were gynecological cancers, so most of fistulas were documented in females. While in the western countries, prostate cancers in males are the dominant population receiving pelvic radiation and CRP is mainly reported in prostate cancers[4,12]. However, prostate cancers receive only external beam radiation such as 3-dimensional conformal radiotherapy (3D-CRT) or intensity-modulated radiotherapy (IMRT), and they don’t receive intra-cavity brachytherapy, thus less fistulas are observed. According to our clinical practice, intra-cavity radiation can bring much more fistulas and other severe adverse radiation-related symptoms than external beam radiation.

 Although the colostomy group had more severe bleeding than the conservative group, which would bring selection bias, but on contrary, colostomy group had achieved dramatically better control of bleeding, higher increased hemoglobin level, and improved quality of life than conservative group. These results have shown the advantages of diverting colostomy in treating severe CRP bleeding. Topical formalin or APC was not used in all patients of conservative group, because some patients in China have not enough knowledge of CRP, poor compliance of physician’s advices, poor economic status. Thus, they choose to continue self-enemas at home, when recurrent bleeding occurred. In addition, this study was limited by nonrandomized, retrospective design and small sample size. Additional randomized prospective study of diverting colostomy is needed to confirm these findings.

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**COMMENTS**

***Background***

Chronic radiation proctitis (CRP) occurs in 5%–20% of patients receiving radiotherapy for pelvic malignant tumors. Mild to moderate CRP are usually self-limiting and easy to manage, but severe and refractory bleeding is still problematic, especially those cases requiring blood transfusions and threatening life. Furthermore, endoscopic treatments can bring severe side-effects and only limited efficacy can be obtained for severe CRP. Thus, a simple and safe treatment with less complications to save life and relive symptoms is mandatory.

***Research frontiers***

Diverting colostomy has been reported previously, mainly for severe CRP complications. However, unlike formalin or APC, colostomy is now not widely used for severe bleeding in CRP patients. And the issue of colostomy is not well studied as far. To our knowledge, no study has ever before made any comparison of diverting colostomy to the conservative measures in treating severe hemorrhagic CRP.

***Innovations and breakthroughs***

In this series, we reported our experience that diverting colostomy was a simple, effective and safe procedure for severe hemorrhagic CRP. Furthermore, we found colostomy can improve quality of life and reduce serious complications secondary to radiotherapy, while conservative medical and endoscopic treatments didn’t show the efficacy in severe CRP patients.

***Applications***

Diverting colostomy is a very simple and safe procedure which can be performed in most of medical centers. We also developed a modified Subjective Objective Management Analysis system, which coordinates subjective bleeding symptom and objective accurate hemoglobin level, to guide physicians in primary care to evaluate patient condition easily according to hemoglobin level, and then choose the proper treatment. Having a routine and easy protocol can reduce treatment related delays and avoid unnecessary morbidity.

***Terminology***

The underlying causes of CRP are endarteritis obliterans and progressive submucosal fibrosis due to radiotherapy. Diverting colostomy can reduce bacterial contamination and decrease irritation injury by fecal stream, and can win time to subside any radiation reaction to protect injured tissue. Colostomy can also accelerate the course of fibrosis and relieve severe proctitis rapidly, which may prevent deep ulcers to progress to fistulas.

***Peer-review***

This is a single center, controlled, and retrospective case series of severe CRP patients who received diverting colostomy. Colostomy can relieve most of severe bleeding rapidly and unexpected, colostomy can also reduce serious CRP complications, including remission of long-term perianal pain, transfusion-dependent bleeding and fistula.

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**Figure 1 Classic representative images of a double-cavity colostomy.** A: A double-cavity colostomy with a soft catheter as a stent; B: A colostomy after during follow-up; C: A “gunsight” skin incision and closure for stoma reversal.



**Figure 2 Flow chart of patient selection.**



**Figure 3 Classical endoscopic images before colostomy and at stoma reversal.** Severe active bleeding (A and C), or confluent telangiectasia, edema and ulcer (E) were observed in case 1-3 before colostomy, while these lesions was greatly improved at stoma reversal (B, D, F).



**Figure 4 Histo-pathological features after colostomy in case 3.** Complete remission of confluent telangiectasia, edema and ulcer were observed 31 months after colostomy (A-B). Diffused chronic inflammation cells and rebuilt of mucosa integrity were found by HE slides (C: × 100; D: × 400). Massive fibrotic collagen depositions were observed in sub-mucosa layer with green color by Masson staining (E: × 100; F: × 400).

**Table 1 Modified subjective objective management analysis system to assess the severity of bleeding in radiation proctitis**

|  |  |  |  |
| --- | --- | --- | --- |
| **Grade** | **Bleeding** | **Severity** | **Anemia (Hb, g/L)** |
| 1 | Mild bleeding | Occasionally or Occult | Mild anemia (Hb: ≥ 90 g/L) |
| 2 | Moderate bleeding | Persistent | Moderate anemia (Hb: 70-90 g/L) |
| 3 | Severe bleeding | Gross  | Severe anemia, transfusion needed (Hb: < 70 g/L) |

**Table 2 Comparisons of patient demographics between the colostomy group and conservative group before treatment**

|  |  |  |  |
| --- | --- | --- | --- |
| **Characteristics** | **Diverting Colostomy (*n* = 22)** | **Conservative treatment (*n* = 25)** | ***P* value** |
| Age (mean ± SD) | 60.1 ± 2.2 | 60.2 ± 2.4 | 0.964 |
| Gender (female/male) | 20/2 | 23/2 | 1.0001 |
| Primary malignancy, *n* (%)Cervical cancerEndometrial cancerRectal cancerProstate cancer | 19 (86.4)2 (9.1)1 (4.5)0 (0) | 21(84)2 (8)1 (4)1 (4) | 0.8222 |
| Cumulative radiation dosage (Gy), mean ± SD | 80.5 ± 17.3 | 83.6 ± 20.5 | 0.8423 |
| Latency period (mo), mean ± SD | 8.3 ± 0.8 | 7.2 ± 1.1 | 0.2523 |
| Duration from treatment to end of radiotherapy (month), mean ± SD | 16.3 ±1.3 | 14.8 ±1.6 | 0.2773 |
| Duration of bleeding (month), mean ± SD | 7.9 ±1.0 | 8.0 ± 1.8 | 0.466\* |
| Score of bleeding, mean ± SD | 2.7 ± 0.5 | 2.0±0.5 | **< 0.001**3 |
| Mean hemoglobin (g/L), mean ± SD | 60.8 ± 18.1 | 88.2±19.3 | **< 0.001** |
| Alb (g/L), (≤ 35/> 35) | 6/16 | 3/22 | 0.3391 |
| BMI (kg/m2), (≤ 17.5/> 17.5) | 3/19 | 2/23 | 0.8801 |
| Concomitant radiation uropathy, *n* (%) | 8 (36.4%) | 6 (24%) | 0.355 |
| Radiation enteritis, *n* (%) | 5 (22.7) | 2 (8) | 0.3151 |
| Previous abdominal surgery, *n* (%) | 6 (27.3) | 11 (44) | 0.234 |
| Diabetes mellitus, *n* (%) | 2 (9.1) | 3 (12) | 1.0001 |
| Hypertension, *n* (%) | 6 (27.3) | 7 (28) | 0.956 |

1χ2 test; 2 The Fisher exact test; 3The Wilcoxon rank-sum test. BMI: Body mass index; Alb: Albumin; SD: Standard deviation.

**Table 3 Bleeding remissions in severe radiation proctitis after treatment**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Diverting Colostomy (*n* = 22)** | **Conservative treatment (*n* = 25)** | ***P* value** |
| Six months after treatment |  |  |  |
|  | Remission of bleeding, *n* (%) | 17/18 (94%) | 3/25 (12%) | < 0.0011 |
|  | Remission of refractory perianal pain | 8/8 (100%) | 0/6 (0%) | < 0.0012 |
|  | Score of bleeding, mean ± SD | 1.1 ± 0.5 | 2.2 ± 0.7 | < 0.0013 |
|  | Elevated Hb, mean ± SD | 34.1 ± 18.2 | -12.3 ± 9.14 | < 0.001 |
| One year after treatment |  |  |  |
|  | Remission of moderate bleeding, *n* (%) | 8/8 (100%) | 6/19 (21.5%) | 0.0022 |
|  | Remission of severe bleeding, *n* (%) | 11/11 (100%) | 0/5 (0) | < 0.0012 |
|  | Score of bleeding, mean ± SD | 0.8 ± 0.5 | 2.0 ± 0.9 | < 0.0013 |
|  | Post-treatment recto-vaginal fistula, *n* (%) | 0/22 | 3/25 (12%) | 0.2372 |
|  | Elevated Hb, mean ± SD | 40.3 ± 19.3 | -1.9 ± 32.54 | 0.003 |

1χ2 test; 2 The Fisher exact test; 3The Wilcoxon rank-sum test; 4Represents decreased level.

**Table 4 Quality of life between diversion group and conservative group in CRP patients by EORTC QLQ-C30 scale**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Ref.** | **Diverting colostomy group (*n* = 18), mean(SD)** |  | Conservative treatment group **(n = 23),mean(SD)** |
| **QLQ-C30 Scale**  | **(Normal German population)** | **Pre-treatment** | **Follow-up** | **Δ(FU)-Pre1** | **Significance2** | **Pre-treatment** | **Follow-up** | **Δ(FU)-Pre** | **Significance**\* |
| Global health | 63.2 | 23.1 (15.1) | 64.8 (13.8) | 41.7 | ＜0.001 |  | 47.1 (21.5) | 62.3 (25.0) | 15.2 | 0.033 |
| Physical function | 82.6 | 50.7 (17.8) | 77.8 (16.6) | 27.1 | ＜0.001 |  | 78.0 (22.7) | 78.6 (26.1) | 0.6 | 0.856 |
| Role function | 75 | 34.3 (23.9) | 75.9 (27.3) | 41.6 | ＜0.001 |  | 77.5 (24.9) | 77.5 (29.1) | 0 | 0.775 |
| Emotional function | 62.2 | 46.3 (27.4) | 73.6 (27.0) | 27.3 | 0.001 |  | 75.7 (17.6) | 80.8 (23.8) | 5.1 | 0.384 |
| Cognition function | 81.3 | 92.6 (12.7) | 93.5 (9.8) | 0.9 | 0.581 |  | 94.2 (15.6) | 95.7 (9.0) | 1.5 | 0.798 |
| Social function | 78.4 | 43.5 (28.9) | 65.7 (31.7) | 22.2 | 0.004 |  | 91.3 (20.6) | 89.1 (21.1) | -2.2 | 0.916 |
| Fatigue | 34.1 | 72.8 (12.9) | 36.4 (25.9) | -36.4 | ＜0.001 |  | 26.6 (24.1) | 23.2 (27.2) | -3.4 | 0.695 |
| Nausea/vomiting | 5.7 | 4.6 (15.5) | 1.9 (7.6) | -2.7 | 0.109 |  | 5.1 (15.4) | 6.5 (16.5) | 1.4 | 0.655 |
| Pain | 33.1 | 44.4 (28.3) | 14.8 (22.8) | -29.6 | 0.001 |  | 14.5 (21.5) | 11.6 (18.4) | -2.9 | 0.481 |
| Dyspnea | 18.8 | 42.6 (31.0) | 18.5 (22.8) | -24.1 | 0.003 |  | 14.5 (19.7) | 8.7 (18.0) | -5.8 | 0.210 |
| Insomnia | 38.5 | 48.1 (35.5) | 29.6 (31.2) | -18.5 | 0.026 |  | 21.7 (21.6) | 26.1 (31.7) | 4.4 | 0.287 |
| Appetite loss | 9.4 | 22.2 (27.2) | 13.0 (19.7) | -9.2 | 0.125 |  | 10.1 (25.5) | 8.7 (18.0) | -1.4 | 0.785 |
| Constipation | 9.1 | 9.3 (14.9) | 3.7 (10.5) | -5.6 | 0.066 |  | 8.7 (20.6) | 7.2 (22.4) | -1.5 | 0.414 |
| Diarrhea | 9.2 | 33.3 (33.3) | 22.2 (24.8) | -11.1 | 0.018 |  | 11.6 (23.8) | 2.9 (9.6) | -8.7 | 0.078 |
| Financial difficulties | 17.1 | 59.3 (26.2) | 50.0 (31.9) | -9.3 | 0.211 |  | 26.1 (31.7) | 24.6 (30.5) | -1.5 | 0.595 |

1 The Wilcoxon rank-sum test; 2Point (Follow-up) – point (pre-treatment).