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Endoscopic Findings during the Early Induction Phase of Infliximab Therapy may Predict its Efficacy for Refractory Ulcerative Colitis

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Abstract

Background and Aims: Infliximab (IFX) is one of the most potent and effective treatments for steroid- or immunomodulator-refractory ulcerative colitis (UC). We evaluated the early efficacy of IFX, based on endoscopic findings, and also attempted to define endoscopic findings predictive of IFX efficacy.

Methods: Nine patients were treated with IFX induction therapy at weeks 0, 2, and 6. Early efficacy was evaluated, using endoscopic and clinical findings, at week 1 (n=9) and again at weeks 3 (n=3) or 7 (n=4). Efficacy was evaluated using the Mayo, Schroeder, and Rachmilewitz endoscopic (RES) scores.

Results: At week 1, 8 of 9 (89%) patients showed a clinical response, and 11% (1 of 9) experienced clinical remission. The mean Mayo score was significantly decreased at week 1 (10 ± 1.2 at baseline vs. 5.6 ± 1.9 at week 1, $p<0.001$). By week 7, 63% of patients (5 of 8) achieved clinical remission and mucosal healing. We used the RESs at week 1 to evaluate the endoscopic findings and to detect marker(s) predictive of remission. We found that week 1 endoscopic findings of "vascular pattern," "vulnerability of mucosa," and "mucosal damage" were predictive. Additionally, C-reactive protein levels at weeks 1 and 6 were positive (>0.3 mg/dl) in the non-remission group, but were negative in the remission group.

Conclusions: Week 1 endoscopic findings for "vascular pattern," "vulnerability of mucosa," and "mucosal damage" are very important for predicting IFX efficacy.

Keywords: Ulcerative colitis; Infliximab; Mayo score; Rachmilewitz endoscopic score; Schroeder score

Introduction

Crohn's disease (CD) and ulcerative colitis (UC), collectively termed inflammatory bowel disease (IBD), are chronic relapsing intestinal inflammatory disorders. UC is characterized by the infiltration of the colonic mucosa with activated T-lymphocytes, neutrophils, and plasma cells [1]. Current evidence suggests that apoptosis-resistant activated T-lymphocytes in the intestinal mucosa are central to the pathogenesis of CD [2–4]. In addition, local mononuclear cell production of proinflammatory cytokines, such as interleukin (IL)-1, IL-6, and tumor necrosis factor (TNF)-α, are significantly increased in IBD patients [5–7]. Several IBD treatments, including azathioprine and 6-mercaptopurine; methotrexate; anti-TNF antibodies, such as infliximab (IFX) and adalimumab; and even sulfasalazine have been associated with induction of T-lymphocyte apoptosis in the lamina propria [8–11]. Medical management of UC that is refractory to corticosteroid therapy is limited to cyclosporine [12], IFX [13], and tacrolimus [14]; however, surgery, including total colectomy, is often required.

Two randomized, double-blind, placebo-controlled studies, the Active Ulcerative Colitis Trials 1 and 2 (ACT 1 and ACT 2, respectively), recently evaluated the efficacy of IFX induction and maintenance therapy in adults with UC [13]. In each study, patients with moderate-to-severe active UC, refractory to current medications, received intravenous IFX (5 mg or 10 mg/kg body weight) at weeks 0, 2, and 6, and then every 8 weeks. Patients receiving either 5 mg or 10 mg of IFX demonstrated more significant clinical responses at week 8 than did the placebo group patients ($p<0.001$ for both comparisons with placebo). In both studies, patients receiving IFX were also more likely to have a clinical response at week 30 ($p<0.002$ for all comparisons) [13]. In ACT 1, more patients receiving IFX had clinical responses at week 54 than did those receiving placebo ($p<0.001$ for both comparisons) [13]. IFX therapy also substantially improved the patients' health-related quality of life (HRQL); maintenance IFX therapy sustained this benefit for 1 year [15]. In both the ACT 1 and ACT 2 studies, endoscopic findings showed improvements at week 8. Further, a recent report indicated that the IFX use prevents colectomy in two-thirds of corticosteroid-refractory UC patients in whom cyclosporine treatment fails [16]. Another study showed that cyclosporine was not more effective than IFX in patients with severe, acute UC refractory to intravenous steroids [17]. Therefore, IFX is considered one of the most potent and effective treatments for refractory UC.

In clinical practice, IFX demonstrates dramatic effects in some patients with UC after only 1 infusion. However, no reports have

focused on the early efficacy of IFX infusion during the induction phase, especially efficacy results obtained using endoscopy. Therefore, we evaluated the early efficacy of IFX induction treatment in patients with UC, based on endoscopic findings, and also attempted to determine whether endoscopic findings predicted IFX efficacy.

Materials and Methods

Patients

Patients with moderate-to-severe active UC, refractory to their current medications, were selected for the study. All eligible patients had active disease, with Mayo scores of 6–12 points (range, 0–12, with high scores indicating increased disease severity) (Table 1) and moderate-to-severe active disease on colonoscopy (a Mayo endoscopic subscore [Schroeder score] of at least 2), despite treatment with corticosteroids alone or in combination with immunomodulators (azathioprine or tacrolimus) and medications containing 5-aminosalicylates.

Stool frequency*
0 = Normal number of stools for this patient
1 = 1 to 2 stools more than normal
2 = 3 to 4 stools more than normal
3 = 5 or more stools more than normal
Subscore, 0 to 3
Rectal bleeding+
0 = No blood seen
1 = Streaks of blood with stool less than half the time
2 = Obvious blood with stool most of the time
3 = Blood alone passes
Subscore, 0 to 3
Findings on endoscopy
0 = Normal or inactive disease
1 = Mild disease (erythema, decreased vascular pattern, and mild friability)
2 = Moderate disease (marked erythema, lack of vascular pattern, friability, and erosions)
3 = Severe disease (spontaneous bleeding and ulceration)
Subscore, 0 to 3
Physician's global assessment¶
0 = Normal
1 = Mild disease
2 = Moderate disease
3 = Severe disease
Subscore, 0 to 3

Table 1: Mayo score (17). The Mayo score ranges from 0 to 12, with high scores indicating increased disease severity. These data are presented from Schroeder et al. (18). * Each patient serves as his or her own control to establish the degree of abnormality of stool frequency. + Daily bleeding score represents the most severe bleeding experienced in the day. ¶The physician's global assessment includes the above 3 criteria, patient's daily recollection of abdominal discomfort, and general sense of well-being and other observations, e.g. physical findings and patient's performance status.

Patients were treated with intravenous IFX (5 mg/kg body weight) at weeks 0, 2, and 6. Prior to IFX therapy, all patients were screened using tuberculin skin tests involving a purified protein derivative, chest radiographs, computed tomography (CT), whole blood tuberculosis infection diagnostic tests (QuantiFERON-TB Gold® [Qiagen, Venlo, Netherlands], based on the quantitative measurement of gamma-interferon), and hepatitis B core antibody assays.

Follow-up and safety and efficacy evaluations

Colonoscopy was performed, during the induction phase, on 9 patients with moderate-to-severe UC. We obtained informed consent from each patient prior to each colonoscopy evaluation. Colonoscopy was not performed in the absence of consent or if the patient demonstrated severe, active disease. IFX administration continued every 8 weeks following the induction at weeks 0, 2, and 6. To determine the early IFX efficacy, endoscopic and clinical findings were evaluated at week 1, (1 week after the first infusion), and at weeks 3 (1 week after the second infusion) or 7 (1 week after the third infusion). Overall clinical responses were evaluated using the Mayo score [18]; a clinical response was defined as a total Mayo score decrease of at least 30% (3 points) from baseline, with an accompanying decrease in the subscore for rectal bleeding of at least 1 point or an absolute subscore of 0 or 1. Clinical remission was defined as a total Mayo score of ≤2 points, with no individual subscore exceeding 1 point [18]. Endoscopic findings were evaluated using the Schroeder endoscopic index (Table 2) [19], which is part of the Mayo score. Mucosal healing was defined as an absolute endoscopic subscore of 0 or 1. In addition, detailed endoscopic findings were evaluated using the Rachmilewitz endoscopic score (RES; scale, 0–12, with higher scores indicating increased disease severity) (Table 3) [19] to focus on mucosal changes in greater detail. Mucosal healing was defined as a total RES of ≤4 points.

Score	Findings of Endoscopy
0	Normal or inactive disease
1	Mild disease (erythema, decreased vascular pattern, mild friability)
2	Moderate disease (marked erythema, lack of vascular pattern, friability, erosions)
3	Severe disease (spontaneous bleeding, ulceration)

Table 2: Schroeder endoscopic index (18). Subscore, 0 to 3.

Granulation scattering reflected light	No	0
	Yes	2
Vascular pattern	Normal	0
	Faded/disturbed	1
	Absent	2
Vulnerability of mucosa	None	0
	Contact bleeding	2
	Spontaneous bleeding	4

Mucosal damage (mucus, fibrin, erosion, ulcer)	None	0
	Slight	2
	Pronounced	4

Table 3: Rachmilewitz Endoscopic Score (19). Rachmilewitz endoscopic score (RES) can range from 0 to 12, with higher scores indicating increased disease severity. Mucosal healing is defined as a total RES of ≤4 points.

All patients received 200 mg of hydrocortisone, by drip infusion, immediately before IFX to prevent infusion reactions. Adverse events and concomitant medications were recorded at each visit, in all cases.

Statistical Analysis

The primary endpoint was mucosal healing and a clinical response or remission at week 1. Secondary endpoints were clinical responses or clinical remission at week 7, and mucosal healing at weeks 3 and 7.

Differences between the mean values for groups were analyzed using Student's t-test; a p-value < 0.05 was considered significant.

Results

We evaluated 9 patients with moderate-to-severe, active UC that was resistant to prednisolone and/or immunosuppressants. All patients treated with IFX underwent colonoscopy at week 1.

Variable	Results
Male, n (%)	7 (78%)
Median age at entry, years (range)	49 (19–65)
Median duration of UC, years (range)	11 (0–40)
Disease site: Left-sided	1 (11%)
Pan-colonic	8 (89%)
Mayo score, median (range)	10 (7–11)
Median C-reactive protein concentration (mg/dl)	3.0 (0.2–8.4)
Concomitant medications, n (%)	
Corticosteroids (Oral or Enema(1)	6 (67%)
Azathioprine (2)	2 (22%)
Tacrolimus (3)	2 (22%)
Oral 5-aminosalicylates a	8 (89%)
LCAP	1 (11%)
1 and 2	2 (22%)
1 and 3	2 (22%)

Table 4: Baseline characteristics of the 9 ulcerative colitis patients treated with IFX. a Mesalamine and sulfasalazine.

Colonoscopy was again performed on 2 of these patients at week 3, on 1 at week 4 (the colonoscopy was scheduled for week 3, but the patient elected to receive it at week 4), on 3 at week 7, and on 1 patient at both weeks 3 and 7. The patients' baseline characteristics (Table 4) show a mean baseline Mayo score of 10 points (range, 7–11). One patient (Case 9) discontinued IFX treatment after the first dose because of a persistent high fever.

Clinical and endoscopic effectiveness

At week 1, 89% of the patients (8 of 9) showed a clinical response, and 11% (1 of 9) experienced clinical remission, based on the Mayo score (Table 5a); the mean Mayo score had markedly decreased by week 1 (10 ± 1.2 at baseline vs. 5.6 ± 1.9 at week 1, $p < 0.001$). Three of the 9 patients (33%) demonstrated mucosal healing, based on the Schroeder score, at week 1; these 3 patients had endoscopic subscores of 1 (Tables 5b and 5c). Using the RES criteria, one patient (11%) experienced mucosal healing at week 1, with the scores in the remaining 8 (89%) patients having decreased more than 30% from the baseline (range, 30–63%). The "vascular pattern," "mucosal vulnerability," and "mucosal damage," based on the RES, were markedly improved in this group of 8 patients, but "granulation scattering" persisted at week 1 (Figures 1–3). The endoscopic findings of "vascular pattern," "vulnerability of mucosa," and "mucosal damage" were significantly improved ($p = 0.004$, $p = 0.008$, and $p = 0.004$, respectively) (Table 6). Figure 1 illustrates the marked improvements in mucosal edema and erythema observed at week 1; erosions and mucosal bleeding were also absent.

Case	Age, Sex	Concomitant medications	Disease extension	Mayo score	Mayo score	Mayo score	Mayo score Week 7
				Baseline	Week 1	Week 3 (or 4)	
1	63y.o., M	5-ASA, AZA, PSL	total	10	4	-	1
2	62y.o., F	5-ASA	total	7	2	-	1
3	30y.o., M	5-ASA, TAC, CsA	total	11	5	-	2
4	32y.o., M	5-ASA, AZA, LCAP	left-sided	11	7	2	-
5	66y.o., F	PSL	total	10	6	2 (Week 4)	-
6	21y.o., M	5-ASA, PSL	total	9	6	-	-
7	62y.o., M	5-ASA	total	11	7	4	3
8	62y.o., M	5-ASA, PSL	total	10	4	-	-
9	54y.o., M	5-ASA, TAC	total	11	9	canceled	canceled
Mean ± SD				10 ± 1.2	5.6 ± 1.9	2.7 ± 0.9	1.8 ± 0.8
						n=3	n=4

Table 5a: Mayo Score. PSL: Prednisolone; CsA: Cyclosporine; TAC: Tacrolimus; LCAP: Leukocytapheresis.

Although large, deep ulcerations were detected before the initial IFX treatment, almost all lesions showed improvement at week 1 (Figure 2). The deep, extensive ulcerations and diffuse mucosal edema were markedly improved 1 week after the first IFX infusion (Figure 3). Regenerating epithelium was also broadly detected at week 1 (Figures 3c and 3d).

Case	Age, Sex	Concomitant medications	Disease extension	Schroeder Baseline	Schroeder Week 1	Schroeder Week 3 (or 4)	Schroeder Week 7
1	63y.o., M	5-ASA, AZA, PSL	total	2	1	-	0
2	62y.o., F	5-ASA	total	2	1	-	0
3	30y.o., M	5-ASA, TAC, CsA	total	3	2	-	0
4	32y.o., M	5-ASA, AZA, LCAP	total	3	2	1	-
5	66y.o., F	PSL	total	3	2	1 (Week 4)	-
6	21y.o., M	5-ASA, PSL	left-sided	2	1	-	-
7	62y.o., M	5-ASA	total	3	2	2	2
8	62y.o., M	5-ASA, PSL	total	3	2	-	-
9	54y.o., M	5-ASA, TAC	total	3	3	canceled	canceled
Mean ± SD				2.7 ± 0.5	1.9 ± 0.7	1.3 ± 0.5 n=3	0.5 ± 0.9 n=4

Table 5b: The Schroeder score. PSL: Prednisolone; CsA: Cyclosporine; TAC: Tacrolimus; LCAP: Leukocytapheresis.

Case	Age, Sex	Concomitant medications	Disease extension	RES* Baseline	RES Week 1	RES Week 3 (or 4)	RES Week 7
1	63y.o., M	5-ASA, AZA, PSL	total	10	5	-	0
2	62y.o., F	5-ASA	total	8	5	-	1
3	30y.o., M	5-ASA, TAC, CsA	total	12	7	-	0
4	32y.o., M	5-ASA, AZA, LCAP	total	10	7	3	-
5	66y.o., F	PSL	total	12	8	3 (Week 4)	-
6	21y.o., M	5-ASA, PSL	left-sided	8	3	-	-
7	62y.o., M	5-ASA	total	12	10	7	7
8	62y.o., M	5-ASA, PSL	total	12	7	-	-
9	54y.o., M	5-ASA, TAC	total	10	8	canceled	canceled
Mean ± SD				10.4 ± 1.6	6.7 ± 1.9	4.3 ± 1.9 n=3	2.0 ± 2.9 n=4

Table 5c: The Rachmilewitz endoscopic score. * RES: Rachmilewitz endoscopic score; PSL: Prednisolone; CsA: Cyclosporine; TAC: Tacrolimus; LCAP: Leukocytapheresis.

			Granulation scattering		Vascular Pattern		Vulnerability of mucosa		Mucosal damage	
	Case	Age, Sex	Pre	Week 1	Pre	Week 1	Pre	Week 1	Pre	Week 1
Remission group	1	63y.o., M	2	0	2	1	2	2	4	2
	2	62y.o., F	2	2	2	1	2	0	2	2
	3	30y.o., M	2	2	2	1	4	2	4	2
	4	32y.o., M	2	2	2	1	2	2	4	2
	5	66y.o., F	2	2	2	2	4	0	4	4
		Mean SD	2.0 ± 0	1.6 ± 0.8	2.0 ± 0	1.2 ± 0.4	2.8 ± 1.0	1.2 ± 1.0	3.6 ± 0.8	2.4 ± 0.8

Non-Remission group	6	62y.o., M	2	2	2	2	4	2	4	4
	7	62y.o., M	2	2	2	1	4	2	4	2
	8	54y.o., M	2	2	2	2	2	2	4	2
		Mean SD	2.0 ± 0	2.0 ± 0	2 ± 0	1.7 ± 0.5	3.3 ± 0.9	2.0 ± 0	4.0 ± 0	2.7 ± 0.9
		Mean ± SD (n=8)	2 ± 0	1.8 ± 0.6	2 ± 0	1.4 ± 0.5	3.0 ± 1.0	1.5 ± 0.9	3.8 ± 0.7	2.5 ± 0.9
t-TEST (n=8)			p=0.35		p=0.01		p=0.02		p=0.01	

Table 6: Endoscopic findings in RES* at week 1. * RES: Rachmilewitz endoscopic score.

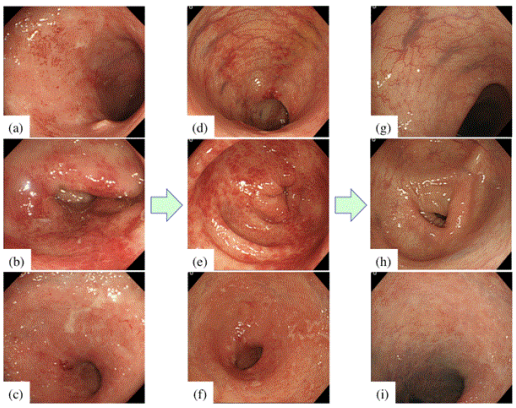

Figure 1: Endoscopic findings in Case 1. (a–c), Before infliximab (IFX) treatment; (d–f), week 1 (1 week after the first IFX infusion; and (g–i), week 7 (1 week after the third IFX infusion). (a), (d), (g): The descending colon. (b), (e), (h): The sigmoid colon. (c), (f), (i): The rectum.

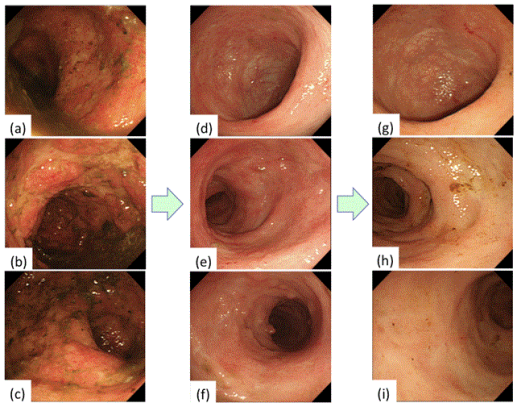

Figure 2: Endoscopic findings in Case 3. (a–c), Before infliximab (IFX) treatment; (d)–(f), week 1 (1 week after the first IFX infusion; (g)– (i), week 7 (1 week after the third IFX infusion). (a), (d), (g): The descending colon. (b), (e), (h): The sigmoid colon. (c), (f), (i): The rectum.

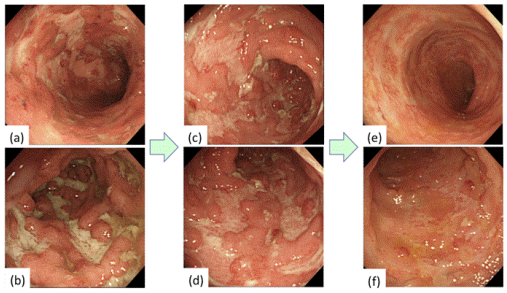

Figure 3: Endoscopic findings in Case 5. (a), (b), Before infliximab (IFX) treatment; (c), (d), week 1 (1 week after the first IFX infusion); (e), (f), week 4 (2 weeks after the second IFX infusion). (a), (c), (e): The descending colon. (b), (d), (f): The sigmoid colon.

Two additional patients demonstrated clinical remission and mucosal healing, based on their Mayo and Schroeder scores, after the second IFX infusion (weeks 3 and 4). Thus, 5 patients demonstrated mucosal healing (Schroeder score) by week 3/4. Two additional patients (a total of 3 patients) experienced mucosal healing by week 3/4, based on their RES. In the patient examined at week 4, almost all of the extensive ulcerations had improved and the vascular patterns were reconstructed (Figure 3e and 3f).

An additional 2 patients showed clinical remission (based on their Mayo scores) at week 7. Based on the Schroeder index, 63% of the patients (5 of 8 patients; one patient did not undergo endoscopy at week 7) demonstrated mucosal healing by week 7.

Based on the RES, 67% of the patients (6 of 9) showed mucosal healing by week 7. In contrast, 2 (22%) of the 9 patients, with week 1 endoscopy scores of 3, failed to show clinical responses or mucosal healing by week 7.

At week 7, the endoscopic findings (RES) were compared between patients in the remission (Cases 1–5) and non-remission (Cases 7–9; Case 6 did not undergo endoscopy at week 7) groups.

The "vascular pattern", "mucosal vulnerability", and "mucosal damage" scores tended to be improved at week 1 in the remission group but not in the non-remission group (Table 6).

The C-reactive protein (CRP) levels were positive (>0.3mg/dl)in the non-remission group (Case 7–9) at weeks 1 (2.3 ± 1.7 mg/dL) and 6 (3.8 ± 1.8 mg/dL), and negative in the remission group (Cases 1–5) at weeks 1 (0.1 ± 0.12 mg/dL) and 6 (0.27 ± 0.38 mg/dL) (Table 7).

	Case	Age, Sex	Pre	Week 1	Week 6
Remission group	1	63y.o., M	0.31	0.34	0.04
	2	62y.o., F	0.23	0.04	0.04
	3	30y.o., M	0.98	0.04	0.04
	4	32y.o., M	0.29	0.06	1.02
	5	66y.o., F	1.32	0.07	0.22
		Mean ± SD	0.63 ± 0.44	0.1 ± 0.12	0.27 ± 0.38
Non-Remission group	6	62y.o., M	5.02	2.66	5.41
	7	62y.o., M	1.27	0.09	1.35
	8	54y.o., M	5.21	4.18	4.62
		Mean ± SD	3.8 ± 1.8	2.3 ± 1.7	3.8 ± 1.8

Table 7: CRP during clinical course.

Safety

One patient had a persistent fever (>39°C), without any symptoms of infection, for 10 days following the first IFX infusion. Since a delayed infusion reaction to IFX could not be excluded, this patient did not receive a second IFX infusion. The other patients received IFX without any specific adverse effects during the induction and maintenance phases.

Discussion

In this study, patients with moderate-to-severe, active UC that was refractory to initial treatment showed clinical responses or remission, based on their Mayo scores, within 1 week of starting IFX induction therapy. Endoscopic remission rates indicated that IFX efficacy was prompt and required only 1 IFX infusion for most patients. Similar to the ACT 1 and 2 studies (13), our data also showed that clinical remission was evident in 56% of the patients by week 7.

Our previous experience indicated that a single IFX infusion worked extremely well for UC patients; therefore, this study focused on the endoscopic findings during the early phase of treatment. Specifically, the first post-treatment colonoscopy, 1 week after the first IFX infusion, was performed to evaluate the detailed endoscopic changes that had occurred, i.e., the extent of damaged colonic mucosal recovery. The endoscopic findings describing the RESs for "vascular pattern", "mucosal vulnerability", and "mucosal damage" demonstrated significant improvement within the first week. Because a single IFX infusion resulted in these dramatic endoscopic findings, IFX is considered one of the most potent induction therapies for UC, as it is for CD. A single infusion, however, appeared to be insufficient to result in "granulation scattering" improvement, which did not show recovery until after the second or third infusion. Laharie et al. showed that the initial IFX infusion works as well as intravenous cyclosporine therapy within the first week [17]. Our data also showed that IFX efficacy can be evaluated, using colonoscopy, 1 week after the first IFX infusion.

However, 22% of the treated patients, with a week 1 Schroeder endoscopy score of 3, did not exhibit clinical responses or mucosal healing at week 7. Although some of the patients had a clinical response at week 1, they had not achieved clinical remission by week 7. In the remission group, 5 of the 6 patients achieved "vascular pattern" improvements at week 1, but only 1 of 3 patients achieved this finding in the non-remission group. Therefore, we believe that if "vascular pattern", "mucosal vulnerability", and "mucosal damage" improvements can be determined using the RES (with a particular focus on "vascular pattern") at week 1, the patients may have a greater likelihood of achieving clinical remission during the induction phase.

Identifying a predictive marker for patients who experience a significant positive response to IFX remains difficult. Our results suggest that endoscopic findings at week 1 may be reliable predictors of an IFX response in patients with UC. CRP levels are generally recognized as useful predictive markers of CD and UC activity [20–22]. In this study, CRP was positive at weeks 1 and 6 in the non-remission group and negative (CRP ≤ 0.3) at weeks 1 and 6 in the remission group. Since CRP was negative when IFX infusion resulted in remission, CRP levels at weeks 1 and 6 may also be reliable predictive markers of IFX efficacy. Recently, Brandse et al. reported that IFX can be detected in the feces of patients with severe IBD and that the highest concentrations were measured on the day after initiation of therapy (Brandse JF et al., Digestive Disease Week, May 18–21, 2013, Orlando, FL, USA). Three of our patients did not respond to IFX during the induction phase. Cases 7 and 9 had high CRP (Table 7) and low albumin concentrations at week 6 (3.0 g/dL and 2.6 g/dL, respectively); therefore, these patients might have lost too much IFX and albumin in their feces. Measuring serum IFX concentrations at weeks 1 and 6 may become a useful predictive marker of IFX efficacy, but further study will be required to confirm its utility.

Limitation of Study and Recommendations for Future Research

A limitation of the current study is the small number of the patients. This was the first trial to evaluate the early endoscopic improvements resulting from IFX infusion in patients with steroid- or immunomodulator-resistant UC. The small number of patients reflects the few who were willing to undergo frequent colonoscopies. The endoscopic improvements observed during the early phase of IFX treatment may predict overall IFX efficacy; however, additional multicenter studies are required to clearly determine the significance of the present observations.

Conclusions

We demonstrated dramatic endoscopic improvements following IFX infusion in steroid- or immunomodulator-resistant UC patients. Specifically, we demonstrated endoscopic improvements in "vascular pattern", "mucosal vulnerability", and "mucosal damage" within 1 week after the first IFX infusion. We believe that these observations may be important for predicting IFX treatment efficacy.

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