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The Impact of Infliximab Trough Level and Anti-Drug Antibody on Clinical Outcomes in Crohn's Disease Patients: A Cross-Sectional Study in Iraq

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Abstract

Primary and secondary response loss , often mediated by the development of anti-drug antibodies (ADAs), limit treatment efficacy. Therapeutic drug monitoring (TDM) is important in optimizing infliximab therapy by correlating drug level with clinical outcomes. This study aimed to find the relationship between infliximab level, ADA presence, and clinical activity in Iraqi Crohn's disease (CD) patients. This cross-sectional study included adult Crohn's disease patients receiving maintenance infliximab (IFX) treatment. Data on demographics and clinical characteristics were collected. Infliximab level and ADA were measured using ELISA. Forty-three patients were included. Patients in remission had significantly higher infliximab levels and lower ADA levels compared to those with active disease. The CD Activity Index (CDAI) correlated negatively with infliximab levels and positively with ADA levels . Infliximab levels correlated negatively with treatment duration and ESR , while positively correlating with the infliximab dose. ADA levels correlated positively with treatment duration. This study, which investigated IFX and ADA levels in CD patients during maintenance therapy, observed a remission rate of approximately 50% in patients. The mean IFX plasma level was 3.28±5.19, with significantly higher levels in remission group compared to active disease (4.91±6.65 vs. 1.73±2.56). This study found no significant difference in response between patients using these medications and those who weren't. Notably, active disease patients showed high ADA and low IFX levels, with a negative correlation between CDAI and IFX levels and a positive correlation between CDAI and ADA levels. These findings, consistent with other research, underscore the critical need for therapeutic drug monitoring (TDM) to personalize IFX dosing, aiming to improve patient response rates, reduce overall treatment costs, and minimize adverse events from concomitant medications, particularly in regions like Iraq where TDM implementation is currently limited. This study concluded that infliximab level was significantly linked to Crohn's disease clinical activity. Patients in remission had higher infliximab level and lower anti-drug antibody level, indicating the importance of TDM in personalize IFX treatment for better results.

Keywords: Autoantibody, Crohn's Disease, Inflammatory Bowel Disease, Infliximab, Therapeutic Drug Monitoring.

Introduction

Crohn's disease (CD) is a complex chronic inflammatory condition which involve different parts of the gastrointestinal tract. The prevalence is increasing globally, showing a significant clinical challenge, particularly as the disease often demonstrates in young ages. This progressive condition necessitates sustained therapeutic interventions to prevent exacerbations and complications[(1,2)]. The annual incidence rate of 1.46 per 100,000 individuals for CD was recorded through a recent meta-analyses that also highlighting a rising prevalence of inflammatory bowel disease (IBD) across the Arab world[(3)]. The etiology of CD involves multifactorial mechanisms, including genetic factors, alteration of immune response, altered microbiota of bowel, and as well as environmental influences. However, the precise underlying mechanisms remain unknown. (ˠInfliximab (IFX), a chimeric human-mouse monoclonal antibody, act through inhibition of tumor necrosis factor-alpha (TNF-α) , via having high affinity and specificity for TNF-α. This mechanism of action make infliximab effective in treating several inflammatory diseases, including

psoriasis, which is frequently associated with elevated TNF-α level. Infliximab not only bound to soluble TNF-α but also bound to transmembrane TNF-α, leading to complement activation and antibody mediated cytolysis. The formation of these stable complexes with TNF-α contributes to the rapid therapeutic effect [4]. The IFX is used in moderate-severe IBD that do not respond to the conventional treatment, and the standard treatment protocol involve an induction phase consisting of doses of 5 mg/kg administered at weeks 0, two, and six, followed by a maintenance phase at 5 mg/kg every eight weeks. In cases of inadequate response in adults, the dose may be escalated to 10 mg/kg at eight week intervals or reduce the interval to every four weeks, though this increase carries a increase risk of infection[5]. Despite its efficacy[6], a notable percentage of patients do not adequately respond to anti-TNF induction therapy, recognized as primary non-responders. Furthermore, up to 50% of patients who initially respond may show secondary loss of response over time, which might necessitating switching to other treatment. A crucial contributor to the secondary loss of response is the development of anti-drug antibodies (ADA). This phenomenon, known as "immunogenicity," can lead to increase the clearance of the drug, resulting in reduced serum level and the following loss of therapeutic efficacy [٧].

Current literature suggests that therapeutic trough level of 3 to 5 µg/ml is generally satisfactory for patients with IBD to achieve clinical remission. This range is believed to sustain therapeutic effects while prevent potential side effects[7,8]. Moreover, the presence of ADAs is significantly correlated with an increased risk of diminished clinical responses to IFX, as well as lowered serum drug levels in IBD patients. In this context, reactive therapeutic drug monitoring (TDM) is gaining prominence as the emerging standard of care, facilitating the optimization of biologic therapies in the management of IBD. This approach aims to tailor treatment regimens to individual patient needs, enhancing clinical outcomes and minimizing adverse effects [٩].

This study is designed to conduct a comprehensive comparison of serum levels of infliximab (IFX) and free anti-drug antibodies (ADA) in patients diagnosed with CD. In this context, the research aims to elucidate the relationships between IFX concentrations, the presence of ATIs, and the Crohn's Disease Activity Index (CDAI), while also assessing their correlation with other clinical and demographic variables .

Materials and Methods

Study design and population

This cross-sectional study performed from March 2024 to September 2024 in a specialized hospital for gastroenterology and liver diseases in Najaf, Iraq. Adult patients who visited the hospital taking IFX (Remicade) in the maintenance phase were included in the study after providing verbal consent.

Exclusion criteria

The exclusion criteria included obesity, concomitant autoimmune diseases, patients in the induction phase, smoking, diabetes, hypertension, pregnancy, children, patients on steroids, and patients who refused to participate.

Sample collection and biomarker testing

Patient characteristics and demographic information were collected, along with blood samples for laboratory tests, including C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR). Additional blood samples were collected, and plasma was used to measure IFX levels and free ADA. IFX trough level (TL) and free ADA levels were measured using enzyme-linked immunosorbent assay (ELISA) kits provided by Shikari QS-INFLIXI and Q-ATI W/confirmation (Matriks Biotech, Turkey).

Study groups

Patients were categorized to remission and active group based on their CDAI score (≤150 remission,> 150 score Active disease)[10].

Statistical Analysis

All the data were recorded in Microsoft Excel, and analysis (Chi-square, ANOVA, Spearman's Rank Correlation, and Kruskal-Wallis) tests were performed using SPSS 26.

Results

As detailed in Table 1, 43 patients participated in the study, and the demographic data and patient characteristics were outlined. In the cohort of Crohn's disease patients, 58.1% were male. The mean age (years) of the participants was 33.37 ± 12.5 , and the average body mass index (BMI) was 23.98 ± 5.52. The sample group had an average disease duration of 55.2 ± 47.3 months. Concerning the administration of infliximab (Remicade), the mean duration of treatment was 78.1 ± 57.18 weeks, with a median duration of 41 weeks. The mean IFX level recorded was 378.6 ± 127.06 µg/ml, while the concentration of free ADA averaged 86.52 ± 203.58 ng/ml. It was observed that only four patients received the intensified dosing of either 10 mg/kg every 8 weeks or 5 mg/kg every 4 weeks. Additionally, the majority of patients were on concomitant immunomodulators, with 88.4% receiving azathioprine, while 23.3% were treated with mesalazine.

Regarding the CDAI score, nearly half of the patients (48.8%) were in remission, and no cases of severe active disease were reported among the study sample. Most patients (83.9%) showed to have negative C-reactive protein (CRP). The mean

erythrocyte sedimentation rate (ESR) was seen to be 20.1 ± 14.9. Other parameters, including white blood cells count (CBC), hemoglobin (Hb), hematocrit (Hct), mean corpuscular volume (MCV), and platelets, were within normal ranges.

Table 1. Patients demography and characteristics

Items (N=43)	**Mean**	**SD**	**Median**
Age (years)	37.37	12.5	29
Weight (Kg)	67.72	16.12	68
BMI Kg/m^2	23.98	5.52	22.86
Disease duration (Month)	55.2	47.3	41
ESR mm/hr (N=41)	20.1	14.9	15
Hb (g/dL)	13.06	2.05	13.2
WBC (cell 10^9/L)	7.41	1.86	7.3
Platelet (cell 10^9/L)	299.67	112.95	278
MCV (fL)	81.49	7.19	83.45
Hct %	39.68	4.99	40
CDAI Score	170.56	95.54	152
Duration of IFX (weeks)	78.1	57.18	66.71
Total IFX dose (q8week)	378.6	127.06	350
IFX TL (ug/ml)	3.28	5.19	1.26
Free ATI (ng/ml)	86.52	203.58	28.8
IFX dose escalation	Yes n(%)	4 (9.3%)	-
	No n(%)	39 (90.7%)	-
Gender	Male n(%)	25 (58.1%)	-
	Female n(%)	18 (41.9%)	-
History of Azathioprine	Positive n(%)	38 (88.4%)	-
	Negative(%)	5 (11.6%)	-
History of Mesalazine	Positive n(%)	10 (23.3%)	-
	Negative(%)	33 (76.7%)	-
CRP (n=31)	Positive n(%)	5 (16.1%)	-
	Negative(%)	26 (83.9%)	-
CDAI category	Remission n(%)	21 (48.8%)	-
	Active (n(%) 22 (51.2%)	Mild-Moderate	12 (27.9%)
		Moderate-Severe	10 (23.3%)
		Severe	0(0%)

Comparing different variables related to disease activity (as presented in Table 2), it was seen that hemoglobin levels were significantly differ between the remission and active groups (p=0.01). The median hemoglobin level in the remission group was slightly higher with median of 13.7, compared to 12.8 in the active group. Similarly, hematocrit levels also showed a significant difference (p=0.024), with median of 41.3 for the remission group and 39 for the patients in the active group.

The CRP did not show a significant difference between the two groups. However, the ESR demonstrated a significant difference (p=0.025), with a higher median in the active group compared to the remission group (20 vs 10 mm/hr). The CDAI revealed a very significant difference between the two groups (P<0.001), with medians of 95 in the remission group and 213 in the active disease group. In addition, the IFX level and the free antibodies against IFX (ADA), both showed significant differences between remission and active disease (p=0.037 and p=0.049, respectively). The IFX median level was 1.59 ug/ml in remission group compared to 0.78 ug/ml in the active group and median ADA of 21.36 ng/ml in remission group compared to 32.77 ng/ml in the active group, indicating that the remission group had higher IFX TL and lower ADA levels.

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Table 2. Distribution of variables according to Crohn's disease activity index CDAI

Variables		**Remission**	**Active**	**P value**
Age (year)	Mean ±SD	33.9 ± 13.46	32.87 ± 11.8	0.808
	median	30	28	
Weight (Kg)	Mean ±SD	70.7 ± 16.02	64.9 ± 16.02	0.197
	Median	70	58	
Gender N (%)	Male	14 (66.67%)	11 (50%)	0.268
	Female	7 (33.33%)	11 (50%)	
BMI	Mean ±SD	24.98 ± 5.99	23.02 ± 4.99	0.319
	Median	24.98	22.35	
Disease duration (Month)	Mean ±SD	51.16 ± 34.68	59.06 ± 57.41	0.827
	Median	42.63	31.1	
Duration of IFX (weeks)	Mean ±SD	80.5 ± 67.34	75.79 ± 46.99	0.875
	Median	66.71	66.79	
Total IFX dose (q8week)	Mean ±SD	393.81 ± 149.46	364.09 ± 102.76	0.777
	Median	350	332.5	
Dose escalation	Yes	2 (9.5%)	2 (10%)	0.961
	No	19 (90.5%)	20 (90%)	
History of Azathioprine	(positive) n(%)	19 (90.5%)	19 (86.4%)	0.674
History of Mesalazine	(positive) n(%)	7 (33.3%)	3 (13.6%)	0.126
CRP	(positive) n(%)	2 (18.2%)	3 (16.7%)	0.924
WBC	Mean ±SD	7.63±1.8	7.2±1.92	0.46
	Median	7.1	7.45	
Hb	Mean ±SD	13.86±1.76	12.29±2.04	**0.01** *
	Median	13.7	12.8	
MCV	Mean ±SD	82.58±6.21	80.4±8.05	0.334
	Median	83.5	83	
Hct	Mean ±SD	41.4±4.46	38.03±4.99	**0.024** *
	Median	41.3	39	
PLT	Mean ±SD	305.95±107.58	293.68±120.07	0.466
	Median	295	256	
ESR	Mean ±SD	15.19 ± 11.81	25.25 ± 16.5	**0.025** *
	Median	10	20	
CDAI Score	Mean ±SD	97.48 ± 31.79	240.32 ± 82.79	<**0.001** *
	Median	95	213	
IFX TL (ug/ml)	Mean ±SD	4.91 ± 6.65	1.73 ± 2.56	**0.037** *
	Median	1.59	0.78	
Free ATI (ng/ml)	Mean ±SD	73.17±151.37	99.27±246.407	**0.049** *
	Median	21.36	32.77	

Table 2. Correlation of variables

Variables		CDAI	IFX level	Free ATI	age	Wt	BMI	Disease Duration(M)	IFX Duration (W)	IFX dose	ESR
CDAI	correlation	—									
	p-value	—									
IFX TL	correlation	-0.34	—								
	p-value	0.025	—								
Free ADA	correlation	0.36	-0.32	—							
	p-value	0.019	0.037	—							
Age	correlation	NS	NS	NS	—						
	p-value				—						
Wt	correlation	NS	NS	NS	0.43	—					
	p-value				<0.01	—					
BMI	correlation	NS	NS	NS	0.42	0.94	—				
	p-value				<0.01	<0.001	—				
Disease Duration(M)	correlation	NS	NS	NS	NS	NS	NS	—			
	p-value							—			
IFX duration (week)	correlation	NS	-0.34	0.34	NS	NS	NS	NS	—		
	p-value		0.03	0.03					—		
IFX dose	correlation	NS	0.38	NS	NS	0.628	0.62	NS	NS	—	
	p-value		0.011			<0.001	<0.001			—	
ESR	correlation	NS	-0.36	NS	NS	NS	NS	NS	NS	NS	—
			0.020								

The correlations among various variables are summarized in Table 3. The Clinical Disease Activity Index (CDAI) demonstrated a negative correlation with IFX levels, indicated by a correlation coefficient of -0.34 (p=0.025), and a positive correlation with free ADA, with a coefficient of 0.36 (p=0.019). Interestingly, IFX levels also displayed a negative correlation with the duration of IFX treatment (-0.34, p=0.03) and with the ESR (-0.36, p=0.02). In opposition, a positive correlation was seen between the dose of IFX and the serum level of IFX (0.38, p=0.011).

Furthermore, the correlation showed a positive association between ADA and the duration of IFX treatment (0.34, p=0.03). Notably, disease duration did not show any significant correlation with other variables. The present analysis of the correlations among various clinical and laboratory variables was outlined in Table 3. The CDAI showed a significant negative correlation with IFX level, indicated by a correlation coefficient of -0.34 (p=0.025), which indicate disease activity decreases as, the serum levels of IFX increase. Conversely, a positive correlation was shown between CDAI and free ADA, represented by correlation coefficient of 0.36 (p=0.019). This implies that disease activity increases with increase of ADA level, which may reflect the immune response against the therapy.

Notably, IFX level negatively correlated with the duration of IFX treatment (p=0.03). This suggests that prolonged exposure to IFX therapy is associated with lower serum levels of the drug. Additionally, a negative correlation between IFX levels and the ESR was also observed, with a correlation coefficient of -0.36 (p=0.02). This reflects greater inflammatory activity, as measured by ESR, corresponds to lower IFX levels in the serum.

In contrast, a significant positive correlation was noted between the dosage of IFX administered and serum level of IFX, with a correlation coefficient of 0.38 (p=0.011). This finding suggests that increasing the dose of IFX leads to higher serum concentrations of the medication.

Furthermore, a significant positive correlation (p=0.03) was observed between ADA and the duration of IFX treatment, suggesting that extended therapy duration might be associated with an increase in antibody production. However, it should be emphasized that disease duration did not demonstrate any significant correlation with the other variables examined in this study. These findings contribute to a deeper understanding of the interactions between treatment variables and disease activity in patients receiving infliximab therapy.

Discussion

As this study aims to explore the IFX and ADA levels in coordination with CDAI and other variables during maintenance therapy, the patient's remission was about half, with a mean use of infliximab of 78.1 weeks. Despite the high rate of response of more than 80% in the induction phase, as mentioned in earlier studies[11,12], the response decreased over time to reach 64% [13] despite using concomitant immune suppressors in the majority of patients and 43% [12] at week 45. In another study in Iraq, it was found that patients who achieved the target IFX level and were in remission were 63.6%[14]. Secondary loss of response is reported to be up to half of patients[15].

Infliximab plasma level means in this study was 3.28 ±5.19 with a median of 1.26. However, there is a significant difference in the level between the remission group (4.91 ± 6.65) and the active disease group (CDAI ≥150) (1.73 ± 2.56). Similar to what was found in an earlier Iraqi study[13], this may indicate the necessity to explore the benefit of dose escalation in order to increase the response rate based on the presence of ADA[16].

In Iraq, a high prevalence of ATI has been reported, with over 60% of patients having detectable antibodies and 80.6% exhibiting inadequate drug concentrations [17]. A meta-analysis assessed how ADA affect the maintenance of clinical remission in IBD, showing that patients undergoing IFX therapy and developing ATIs face a threefold higher risk of loss of response compared to those without ADA. Additionally, ADA development correlates with reduced serum IFX levels[14,18].

Despite some recommendations to use the immunosuppressant to increase the efficacy of IFX[8,19], this study found no difference in response between patients who use this medication and those who do not use it. This is also found in other studies, which show no significant difference between groups[12,20]. Since the addition of immunomodulators is appropriate to add to IFX in case of high ADA presence and the case of low or undetectable IFX concentrations, an increased dose with or without adding an immunomodulator to achieve detectable IFX concentrations appears to be an appropriate approach[21]. however, this approach can't be done appropriately without performing the TDM, as it is the situation in Iraq. It was seen that high ADA and low IFX levels in active disease patients[14] .

From the correlations in the current study, it was found that the CDAI negatively correlated with IFX level (p=0.25) and positively with ADA(p=0.019). In addition, IFX level correlated negatively with ADA(p=0.037). The same correlation was seen in a previous study[20,22]. Over

weight and obesity is a growing concern in the management of IBD, with a reported prevalence ranging from 15% to 60%. This is particularly significant because obesity is associated with increased systemic inflammation, which can complicate the course of IBD[23]. However in our study the correlation between BMI and IFX and free ADA were not significant.

The strong negative correlation between infliximab levels ESR ($p<0.02$) confirms the fundamental mechanistic relationship between drug exposure and inflammatory suppression established in population pharmacokinetic studies. These correlations validate the use of inflammatory markers as surrogate indicators of treatment adequacy, particularly in settings where immediate drug level results are not available[24,25].

It is essential to recognize that clinical remission in IBD, which based on symptom assessment only, can be misleading, as persistent deep systemic inflammation may still be present. Therefore, achieving endoscopic remission is more accurate and critical target in IBD management, since it helps prevent flares and complications [26]. This study reveals underutilization of dose intensification patterns and optimization strategies, with only about ten percent of patients receiving dose intensification despite the majority showed subtherapeutic IFX levels. This finding highlights a critical gap for therapeutic drug monitoring and real world implementation. The effectiveness of dose intensification was clearly demonstrated in CD patients who achieved therapeutic levels, with 36.36% having received dose intensification compared to none in the subtherapeutic group ($p=0.003$)[27].

The novel positive correlations we identified between infliximab levels and hematological parameters (hemoglobin, $p=0.01$ and hematocrit, $p=0.024$) provide important insights into the systemic effects of adequate anti-TNF therapy. These relationships suggest that optimal infliximab exposure may ameliorate the anemia of chronic disease commonly observed in IBD patients, potentially through suppression of inflammatory cytokines that interfere with iron metabolism and erythropoiesis. This finding has clinical implications for monitoring treatment adequacy, as improvement in hematological parameters may serve as an early indicator of therapeutic response before clinical or endoscopic improvements become apparent[25,28]. The reduction in inflammation may explain the positive correlation between disease activity and Hb and Hct. While ESR is less accurate than CRP for diagnosing IBD, it remains useful in conjunction with CRP for monitoring inflammation flare-ups and assessing treatment efficacy[29]. Nonetheless, endoscopy with multiple biopsies remains the primary procedure for accurate IBD diagnosis[30]. In addition, the implantation of genetic studies might be helpful in prediction of response and kinetic parameters of IFX[31].

This study, along with other present studies, indicates the urgent need for implementation of TDM in order to tailor the IFX dose to increase the response rate in addition to decreasing the overall cost of treatment and adverse events of concomitant medications

Conclusion

This study demonstrated a significant association between clinical activity in Crohn's disease and IFX therapeutic parameters. Patients in remission exhibited significantly higher IFX serum levels and lower levels of anti-drug antibodies (mean difference: 26.09 ng/ml, $p=0.049$) compared to those with active disease, suggesting a potential correlation between adequate drug exposure and favorable clinical outcomes in this patient population.

Limitation

The small sample size and single-center design may bound the generalizability of the findings and reduce statistical power. Additionally, the cross-sectional design prevents the establishment of causality. The analysis may not have fully accounted for potential confounding factors, such as concomitant medications, smoking, diet, and treatment adherence.

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Conflicts of Interest

The authors declare no conflict of interest

Ethics Statements

Ethical approval was obtained from the Najaf Health Directorate, Ministry of Health, to conduct the research (No. 7798). .

Author Contribution

The authors confirm contribution to the paper as follows: study conception and design: Ahmad K. Al-Jalehawi. Samer Imad Mohammed; data collection: Mahmoud Alkindy. Muslim Alkafaji . Ahmad K. Al-Jalehawi; analysis and interpretation of results: Ahmad K. Al-Jalehawi. ; draft manuscript preparation: Samer Imad Mohammed. All authors reviewed the results and approved the final version of the manuscript.

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تأثير مستوى علاج الإنفليكسيماب و الأجسام المضادة للعلاج على النتائج السريرية لدى مرضى مرض كرون: دراسة مقطعية في العراق

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الخلاصة

تحد الاستجابة العلاجية الأولية والثانوية، التي غالبًا ما تتوسطها تطور الأجسام المضادة للدواء، من فعالية علاج الإنفليكسيماب. يُعد المراقبة العلاجية للدواء أمرًا حاسمًا لتحسين العلاج من خلال ربط مستويات الدواء بالنتائج السريرية. هدفت هذه الدراسة المقطعية إلى استكشاف العلاقة بين مستويات الإنفليكسيماب، وجود الأجسام المضادة للدواء، والنشاط السريري لدى مرضى عراقيين مصابين بداء كرون. شملت الدراسة ٤٣ مريضًا بالغًا مصابين بداء كرون ويتلقون علاج الإنفليكسيماب. تم جمع البيانات الديموغرافية والسريرية، وقياس مستويات الإنفليكسيماب والأجسام المضادة للدواء باستخدام تقنية الإليزا(ELISA) . بلغ معدل الاستجابة حوالي ٥٠% لدى المرضى أثناء العلاج المستمر وكان متوسط مستوى الإنفليكسيماب في البلازما ٣,٢٨± ٥,١٩ميكروغرام/مل، مع مستويات أعلى بشكل ملحوظ في المجموعة المستجيبة مقارنة بالمجموعة النشطة (٤,٩١± ٦,٦٥مقابل ١,٧٣ ± ٢,٥٦ ميكروغرام/مل). أظهر المرضى المستجيبون مستويات أعلى من الإنفليكسيماب وأقل من الأجسام المضادة للدواء مقارنة بمجموعة المرض النشط كما و ارتبط مؤشر نشاط داء كرون (CDAI) سلبيًا بمستويات الإنفليكسيماب، وإيجابيًا بمستويات الأجسام المضادة للدواء. لوحظ أيضا ارتباط مستويات الإنفليكسيماب سلبيًا بمدة العلاج ومعدل ترسيب كريات الدم الحمراء، وإيجابيًا بجرعة الإنفليكسيماب؛ بينما ارتبطت مستويات الأجسام المضادة إيجابيًا بمدة العلاج. لم يُلاحظ فرق ذو دلالة إحصائية في الاستجابة بين المرضى الذين يستخدمون أدوية مرافقة وأولئك الذين لا يستخدمونها. تؤكد النتائج، المتوافقة مع دراسات أخرى، على وجود ارتباط قوي بين مستويات الإنفليكسيماب والنشاط السريري في داء كرون. يشير ذلك إلى الحاجة الملحة لتطبيق المراقبة العلاجية للدواء لتخصيص الجرعات، تحسين معدلات الاستجابة، خفض التكاليف، وتقليل الآثار الجانبية للأدوية المرافقة – خاصة في مناطق مثل العراق حيث تكون هذه المراقبة محدودة حاليًا. يمكن أن يساهم ذلك في تصميم أنظمة علاجية فردية، مما يعزز النتائج السريرية.

الكلمات المفتاحية: الاجسام المضادة الذاتية، مرض كرون ، داء الأمعاء الالتهابي، انفليكسيماب ، المراقبة العلاجية للدواء.