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Research Article

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Observational Study on the Safety and Efficacy of Rituximab in Multiple Sclerosis: Insights from North-Eastern Iran

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Abstract

Multiple sclerosis (MS) is a chronic autoimmune and inflammatory disease that affects young people and causes demyelination and axon loss in the central nervous system. According to several studies, rituximab (RTX) reduces inflammation and relapse in patients with relapsing-remitting MS. This study aimed to evaluate the efficacy and safety of RTX in patients suffering from MS. MS patients were treated in the comprehensive MS clinic of Ghaem Hospital, Mashhad, Iran, and RTX administration was approved for them (1000 mg). Before initiating the study, demographic characteristics (e.g., age, gender, and type of MS disease), clinical variables (e.g., annual relapse rate [ARR] in the year before the intervention, Expanded Disability Status Scale (EDSS) score, and magnetic resonance imaging [MRI] findings), laboratory variables (e.g., complete blood count [CBC], liver and kidney function tests) for the patients were recorded. After the intervention, the variables were checked and re-recorded, and the patients were followed up at 6 and 12 months. In total, 50 patients with relapsing-remitting MS (RRMS), primary progressive MS (PPMS), or secondary progressive MS (SPMS) with mean age and treatment duration of 37.60±8.91 and 6.72±5.28 years, respectively, were included in the study. The results showed no significant difference among the three time periods regarding the mean disability level (P=0.73). Moreover, the mean ARR decreased significantly after the intervention (P=0.007). This study showed that RTX administration effectively reduces the ARR, and no significant safety issues were recorded. However, the results of this study could not prove RTX's efficacy in preventing confirmed disability progression.

Keywords: Annual relapse rate; EDSS values; MRI findings; Multiple sclerosis; Rituximab.

1. Introduction

Multiple sclerosis (MS) is a progressive disease where the immune system attacks the CNS. This disorder causes inflammation, demyelination, gliosis, and nerve damage due to misdirected lymphocytes migrating into the CNS. B cells play a significant role in linking genetic

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predispositions and environmental triggers. MS is identifiable by CNS lesions characterized by demyelination and nerve damage, which vary across MS variants. Clinicians rely on identifying lesions across time and locations, supported by lab tests and magnetic resonance imaging (MRI) scans [1]. The etiology of MS is still unknown, but it is evident that a complex interaction between environmental, genetic, and epigenetic factors triggers an autoimmune reaction against the CNS compartment [2]. The most accredited hypothesis is that peripheral T and B lymphocytes, primed against a still-unknown antigen, drive a cross-reaction against CNS epitopes, including oligodendrocytes proteins, such as myelin basic protein, proteolipid protein, and myelin oligodendrocyte glycoprotein. Despite several limitations, animal modeling has been crucial to understanding MS pathogenesis [3].

In 2020, the worldwide count of MS cases reached approximately 2.8 million, representing 35.9 cases per 100,000 individuals. The typical age for MS diagnosis is 32. Also, women have a twofold risk for developing MS compared to men [4]. The prevalence of MS in Tehran, Iran, in 2014 was 101.39 per 100,000. Prevalence rates were higher in females (134.03 per 100,000) compared to males (42.45 per 100,000) [5]. MS rates in Iran have sharply increased from 1990 to 2017. This increase is believed to be caused by urbanization, lifestyle changes, environmental pollutants, stress, and fast-food consumption. The disease course may be milder in these regions, leading to lower DALYs for MS [6].

Recent MS treatments focus on managing acute attacks, providing symptomatic relief, and reducing disease activity through modifying therapies. These therapies target relapse rates, MRI lesion accumulation, and disability progression in relapsing-remitting MS (RRMS) [7]. Initial approved drugs like interferons and glatiramer acetate moderately reduce MS relapses [8]. Later discoveries include T-cell involvement in MS and therapies that block lymphocyte CNS access, such as natalizumab and S1P receptor modulators (fingolimod, siponimod, ozanimod) [9, 10].

Early use of high-efficacy therapies is now favored for MS treatment decision-making. This shift is based on studies showing improved outcomes with early high-efficacy treatment. Anti-CD20 therapies and natalizumab are preferred for their efficacy, safety, and manageable administration schedules [7].

When it comes to managing MS, especially for RRMS patients, rituximab (RTX) is the preferred choice due to its ability to reduce inflammation, relapses, and brain lesions significantly. B cells in progressive MS contribute to disease progression by activating T cells and releasing harmful factors. RTX is a standout MS treatment for its efficacy, safety, affordability, and easy administration. It is increasingly used as a primary or supplementary treatment for MS, offering advantages over other antibodies [11-13]. RTX is usually given every six months, with doses between 500 and 2000mg [14]. Clinical trials indicate that RTX is superior to approved alternatives, reducing relapses and lesions on MRI. Observational studies confirm the drug's effectiveness and safety, with low relapse rates and stable disability status. Mild to moderate infusion-related adverse events are experienced by some patients [14]. RTX is being used off-label for MS in Iran and other countries. Off-label status hinders broader adoption despite promising results.

The purpose of this study was to assess how RTX influences the clinical and radiological activity and progression of MS. Individuals with RRMS, primary progressive MS (PPMS), and secondary progressive MS (SPMS) were included in the study conducted at a referral center in Mashhad, Iran. Additionally, we intended to investigate the effectiveness of this drug for treating MS in a developing country despite its lack of specific approval for that purpose. In this study, rituximab is being investigated for the first time in northeastern Iran. The study specifically examined the adverse effects of RTX and why patients in these groups stopped taking it.

2. Materials and Methods

2.1. Study Design and Selection Criteria

This research was a pre-post with longitudinal follow-up clinical study, focusing on those with RRMS, PPMS, and SPMS forms of the disease. The participants were selected from the MS clinic at Ghaem Hospital in Mashhad, Iran. Individuals who met the criteria for eligibility in the study were those with clinically and MRI-confirmed active PPMS and SPMS. This encompassed patients who demonstrated rapid disease

progression. The minimum age of the patients in the study was 18 years old. The study did not include individuals with ongoing infections like hepatitis, human immunodeficiency virus (HIV), or tuberculosis, allergies to RTX, Expanded Disability Status Scale (EDSS) scores higher than 7, pregnancy, severe organ dysfunction, or those currently taking immunosuppressive medication.

2.2. Ethical Approval and Consent

The study protocol was approved by the Organizational Ethics Committee of Mashhad University of Medical Sciences, Iran, with reference number 980298. Approval for the study protocol was obtained from the Ethics Committee of Mashhad University of Medical Sciences (IR.MUMS.MEDICAL.REC.1398.676). Before joining the study, all potential participants or their families were given a brief overview of its procedures. Participants were well-informed about the study's objectives and their rights. All patients who agreed to participate provided informed consent, ensuring that ethical guidelines were followed and that they understood the goals and procedures of the study.

2.3. Baseline Data Collection

The study started by gathering comprehensive baseline data from individuals diagnosed with MS. The information collected consisted of demographic data such as age and gender, as well as details about the type of MS experienced by the individuals. Furthermore, clinical evaluations like the EDSS score, annualized relapse rate (ARR), and MRI findings were incorporated. The laboratory documented the results of various tests, such as the complete blood count (CBC), liver function tests (alanine transaminase [ALT], aspartate aminotransferase [AST], alkaline phosphatase [ALP], total and direct bilirubin), and kidney function tests (creatinine [CR]). We recorded the medical history of the patients with MS, including their previous treatments, reasons for medication changes, and the decision to start RTX treatment. Additionally, we documented the duration of the disease, its activity level, and the frequency of relapses.

2.4. RTX Induction Regimen

The RTX induction protocol involved two injections: the initial injection on the first day and a second injection 15 days later, each 1000 mg or 500 mg. After the first injection, patients were given 125 mg of methylprednisolone intravenously, 10 mg of chlorpheniramine intramuscularly, and one gram of acetaminophen, with subsequent doses administered every six months. The procedures took place in the Neurology ward of Ghaem Hospital in Mashhad, Iran, where the administration and monitoring of the regimen were carefully controlled.

2.5. Follow-Up and Outcome Assessment

The patients were given follow-up appointments 6 and 12 months after the intervention. The follow-up assessments focused on these factors: disease relapse, improvement or worsening, disease activity, treatment failure, and adherence to the No Evidence of Disease Activity (NEDA) criteria.

A relapse was characterized as the persistence of new or aggravated neurological symptoms lasting more than 24 hours, excluding fever or infection, and confirmed through neurological examinations. We evaluated the ARR both before and after the intervention.

Disease progress was assessed by observing a reduction in EDSS scores, while confirmed disability advancement was defined similarly, requiring six months of stability (one unit if EDSS<5 and 0.5 unit if EDSS>5). The deterioration of the disease was identified by an increase in the EDSS score based on the same criteria.

The research included two MRI scans: one at the beginning as a baseline and another after 12 months for follow-up. The latest radiological findings in T2 or Gadolinium Enhancement Lesions (GEL) were primarily paid attention to.

Disease activity refers to the presence of relapses, ongoing disability progression, and new T2 or GEL radiological findings on an MRI. Furthermore, tests were conducted to assess liver and kidney functions, including ALT, AST, ALP, and CR. We monitored infusion-related adverse events as a measure of disease activity.

Treatment failure was defined by considering the frequency of relapses, changes in MRI results, and EDSS scores. The confirmation of treatment failure was based on the presence of one of the following: 1) Two instances of recurrence in one year, The occurrence of a mild relapse, and the appearance of a new GEL in MRI, both happening at least three months after the initial relapse.

A relapse that resulted in a significant two-point alteration in the EDSS score, leading to debilitation. The EDSS tracks disease progression and treatment outcomes in MS patients. It measures clinical severity and functional limitations in the MS. It is administrated by the clinician on a scale ranging from 0 (normal neurological function) to 10 (MS-related death)—the steps increase by 0.5 starting at EDSS 1. Lower scores indicate neurological impairments, while scores above 6 reflect disability levels related to walking ability from EDSS 4 to 6 [15]. A six-month absence of clinical and radiological signs defines NEDA.

2.6. Post-Study Procedures

Following the completion of the study, the patients received a comprehensive briefing on the impacts of RTX. The purpose of this debriefing was to provide participants with information about the treatment results, possible side effects, and overall effectiveness seen in the study.

2.7. Statistical Analysis

Data collected in the study were analyzed using SPSS software, version 14. Qualitative data were visually represented in tables and graphs, applying appropriate distribution and centrality indices. Quantitative data were presented as mean and standard deviation (mean±SD). The Kolmogorov-Smirnov test assessed the normality of the data distribution. Paired sample t-tests or Wilcoxon tests were used, depending on the normality of the data, to compare data before and after the intervention.

3. Results and Discussion

The research focused on evaluating RTX treatment's efficacy and side effects in 50 MS patients at Ghaem Hospital, Mashhad, Iran. These patients' average age and treatment duration were 37.60±8.91 years and 6.72±5.28 years, respectively.

Out of the initial group, six patients were excluded. The reasons included one death due to septicemia, one patient's choice to stop treatment, and four patients discontinuing treatment due to worsening clinical symptoms (three with SPMS, one with PPMS).

Analysis of the patient's data considered gender, MS type, and medications used. Among the patients, 74% were female, and 46% had SPMS. The most prevalent medications were fingolimod and interferon beta 1-alpha, each used by 24% of the patients. This was followed by mitoxantrone and interferon beta 1-beta, each at 8%.

The study utilized the Kolmogorov-Smirnov test to analyze data distribution. Variables like ARR, pre- and post-intervention, AST post-intervention, and ALT pre- and post-intervention displayed non-normal distributions. In contrast, other variables exhibited normal distributions (**Table 1**).

Table 1: Distribution of Variables by Kolmogorov-Smirnov Test

Variables		Baseline (0 Months)	Interim (6 Months)	Follow-up (12 Months)
Laboratory Tests	WBC	0.99	-	0.66
	HB	0.46	-	0.07
	PLT	0.48	-	0.65
	AST	0.62	-	0.01*
	ALT	0.04	-	<0.001*
	CR	0.46	-	0.22
EDSS		0.52	0.48	0.76
ARR		<0.001*	-	<0.001*
Age			0.79	
Treatment period			0.64	

*P<0.05 indicates non-normal distribution; P>0.05 indicates normal distribution.

Abbreviation: WBC, white blood cells; HB, hemoglobin; PLT, platelet; AST, Aspartate transaminase; ALT, Alanine aminotransferase; CR, creatinine; EDSS, Expanded Disability Status Scale; ARR, annual relapses rate.

This table presents the distribution of various laboratory tests, EDSS, ARR, and age over three time points: baseline, 6 months, and 12 months. The Kolmogorov-Smirnov test results indicate whether the distributions are normal or non-normal.

Disability levels were assessed using EDSS values at three stages: before, 6 months after, and 12 months after RTX administration. The mean EDSS values at these intervals showed no significant differences (P=0.73), as detailed in **Table 2**. This led to using repeated measurement tests for further analysis. In groups with RRMS, SPMS, and PPMS, the mean disability levels based on EDSS values remained statistically unchanged across the three-time points (RRMS (P=0.73), SPMS (P=0.46), and PPMS (P=0.12), respectively).

Table 2: EDSS Scores Across MS Types at Different Time Points.

	Relapsing-Remitting MS	**Secondary-Progressive MS**	**Primary-Progressive MS**	**Total**
Time Points	EDSS Index (Mean ± SD) (N= sample size)			
Baseline (0 Months)	3.41±1.23 N=18	5.08±1.44 N=23	5.05±1.79 N=9	**4.48±1.62 N:50**
Interim (6 Months)	3.38±1.23 N=18	5.22±1.48 N=22	5.05±1.79 N=9	**4.54±1.72 N:49**
Follow-up (12 Months)	3.36±1.19 N=18	4.70±1.72 N=20	5.14±2.17 N=7	**4.23±1.74 N:44**
	ANOVA test with repeated measures			
	F=0.19 P=0.74	F=0.59 P=0.46	F=2.48 P=0.12	**F=0.16 P=0.73**

N= sample size; F and P values from ANOVA with repeated measures.

Abbreviation: MS, multiple sclerosis; EDSS, Expanded Disability Status Scale

This table compares the mean ± SD of disability levels (EDSS) among types of MS at baseline, 6 months, and 12 months post-treatment. ANOVA tests assess the significance of changes over time.

Regarding ARR, AST, and ALT, their non-normal distributions necessitated using the Wilcoxon test for within-group mean comparisons (**Table 3**). Significant differences were noted in mean ARR, AST, and ALT levels before and after medication (P=0.007, P=0.04, and P=0.002, respectively).

This table shows the mean ± SD of ARR and blood parameters (WBC, HB, PLT, AST, ALT, Cr) before and after RTX treatment. The paired t-test or Wilcoxon test results indicate the significance of changes.

The study also evaluated white blood cell (WBC) and CR levels, where a paired t-test was applied due to their normal distribution. Significant changes were observed in mean WBC levels post-medication (P=0.003), whereas HB, PLT, and CR levels showed no significant differences (P=0.81, P=0.58, and P>0.99, respectively).

All participants underwent serological tests for viral infections (hepatitis B, C, and HIV) before and after RTX treatment, with no infections detected.

Table 3: Relapse Rate and Blood Parameters Before and After RTX Treatment

Index	Pre-Treatment (Mean ± SD) (N=50)	Post-Treatment (Mean ± SD) (N=44)	P-value
ARR	0.24±0.43	0.07±0.25	Z=-2.71 P=0.007*
WBC	6399.05±1667.54	5940±1275.93	T=3.20 P=0.003*
HB	13.23±1.33	13.24±1.19	P=0.81 T=-0.23
PLT	245.41±57.01	242.57±48.95	T=0.55 P=0.58
AST	20.80±5.72	22.13±8.86	Z=-2.04 P=0.04*
AlT	22.36±8.28	24.86±15.03	Z=-3.15 P=0.002*
CR	0.93±0.17	0.91±0.13	T<0.001 P>0.99

*P<0.05 denotes statistical significance.

Abbreviation: WBC, white blood cells; HB, hemoglobin; PLT, platelet; AST, Aspartate transaminase; ALT, Alanine aminotransferase; CR, creatinine; ARR, annual relapses rate.

Due to COVID-19 restrictions, only 10 of 44 patients underwent control MRI after 12 months. All patients with EDSS values below 5 showed no new T2 MRI plaques or T1-enhancing lesions post-gadolinium injection.

Side effects of RTX were meticulously tracked. Immediate reactions during injection included hot flashes (n=2), shortness of breath (n=2), tingling in the limbs (n=1), nausea (n=3), headache (n=2), myalgia (n=1), itching (n=2), skin rash (n=1), and heart palpitations (n=1). Within 24 hours post-injection, patients reported fever and chills, myalgia (n=3), intensified muscular spasm (n=3), as well as weakness and lethargy (n=4). Delayed effects comprised septicemia (resulting in one death), hair loss (n=2), menstrual disorders (n=2), liver enzyme elevations more than 3 times (n=1), and contracting COVID-19 (n=5), including one hospitalization and four cases managed with symptomatic treatment without significant complications.

The study involved 50 MS patients, with an average age of 37.60 years, who had been receiving treatment for an average of 6.72 years. Women made up the majority (74%) of our patients, with 46% of them being diagnosed with SPMS.

Four patients, three diagnosed with SPMS and one with PPMS, discontinued RTX due to worsening symptoms. Study protocols and disease stability were the primary factors leading to discontinuation in a study of 225 RRMS patients treated with RTX. Other reasons included immunological concerns, physiological conditions, and adverse events [15]. Infusion reactions caused two subjects to stop taking RTX in a clinical trial of 30 RRMS patients [16]. The findings emphasize the safety issues of RTX, as it has been linked to adverse events and infections.

3.1. Effects of RTX on Disability Progression

The results of this study showed no significant variation in the mean disability level (measured using EDSS) among the entire cohort and subgroups of RRMS, SPMS, and PPMS across the three time periods (prior to treatment, 6 months after treatment, and 12 months after treatment) (P=0.73, 0.46, and 0.12 respectively). Furthermore, there were no significant differences in EDSS levels after RTX administration among patients with RRMS, SPMS, and PPMS during these periods.

Our study examined the impact of RTX treatment on the multifaceted nature of disease activity in MS. A critical component of our investigation involved assessing changes in the EDSS scores. Although we did not notice any significant differences in disability levels across different types of MS after administering RTX, the existing literature presents conflicting findings. In a phase II trial, 75 clinically stable RRMS patients who switched to RTX showed no change in EDSS scores. The results of this study pertain to individuals with a low baseline disability (Baseline EDSS=1.5), signifying a predominantly low level of disability overall [17]. A clinical trial with 195 RRMS patients found no significant difference in disability levels between the RTX and dimethyl fumarate groups, as the mean change in the EDSS score was similar [18].

While our results showed stable EDSS scores, other studies demonstrated improved disability levels with decreased EDSS scores. In a retrospective cohort study, 44 SPMS patients treated with RTX showed significant improvement in their EDSS scores over a 3.5-year period. The patient cohort had a -0.45 reduction in EDSS score. SPMS patients treated with RTX had a lower EDSS score (mean difference, −0.52). The results of our study indicated a stable EDSS score when assessed after one year. This study found that RTX significantly delayed disability progression (hazard ratio, 0.49). The Fakih study found no link between confirmed progression and patient characteristics which might partially explain why we did not find improved EDSS scores due to our shorter follow-up period [19].

3.2. Effects of RTX on MRI activity

Besides disability levels, changes in MRI lesions are also a determining factor of MS disease activity. Out of the 44 patients in our study, only 10 received a follow-up MRI after 12 months. These circumstances arose due to the limitations imposed by Covid-19 quarantine measures. Although not meeting the requirements for statistical tests, all 10 patients had EDSS scores below five and did not exhibit any new T2 MRI plaques or T1 enhancing lesions after receiving gadolinium injection.

Promising findings from studies indicate that MRI lesions in patients with MS show positive changes after treatment with RTX. A clinical trial found a significant change in MRI for 104 RRMS patients. The RTX group had fewer lesions than the placebo group at weeks 12, 16, 20, and 24 (0.5 vs. 5.5, respectively). The RTX group showed a mean decrease of 163.1 mm^3 in lesions on T2-weighted MRI at week 24 [20].

Other studies that used the same methodology as ours have reported findings similar to those of clinical trials regarding MRI activity in MS patients who received RTX treatment. A study of 822 MS patients found that 26.2% had contrast-enhancing lesions at baseline, decreasing to 4.6% after RTX treatment. Contrast-enhancing lesions were more frequent in the first 6 months ($p<0.001$) [21]. Based on the findings from these studies and our research, it is reasonable to suggest that if more of our patients had received the control MRI, our results may have been more consistent with previous studies.

3.3. Effects of RTX on ARR

Our study's findings are consistent with previous research, showing a significant decrease in relapse rates after RTX treatment (P=0.007). A 24-week clinical trial of 104 RRMS patients found a lower relapse rate (0.4 vs 0.8) in the RTX group compared to placebo [20]. In a trial of 195 RRMS patients, the RTX group showed a significant reduction in ARR compared to the dimethyl fumarate group over 24 months (0.015 vs 0.087) [18]. A study of 822 MS patients found that treatment with RTX significantly reduced ARRs: RRMS at 0.044, SPMS at 0.038, and PPMS at 0.015 [21].

The results suggest that initial use of RTX can reduce relapse rates, but its long-term efficacy may be constrained. In addition, disease activity in MS can be influenced by factors other than RTX treatment, such as the level of disability at the beginning and the response to previous treatments. Patients with higher baseline EDSS scores or who were previously treated with different medications may show different responses to RTX, for example. Additionally, we noticed a notable difference in the average WBC count after the treatment (P=0.003), and we found a correlation between the treatment duration and the patient's age (r=0.29). Therefore, although RTX significantly reduced the average ARR, its effect on the progression of the disease is still uncertain.

3.4. Adverse Effects of RTX Treatment

The FDA recorded 12,448 adverse events from RTX in a 2011 report, with common febrile neutropenia, pyrexia, pneumonia, and anemia. RTX may cause serious side effects like arrhythmia, myelosuppression, and neoplasms. RTX was associated with 476 deaths [22].

In our research, we noticed that the most frequently reported side effects of RTX injection included weakness and fatigue, nausea, and increased liver enzyme levels. Adverse reactions associated with RTX administration are often linked to the drug infusion process. In a study, out of 365 MS patients treated with RTX, 118 (32.3%) reported 156 adverse events, and 61 patients (16.7%) experienced infusion-related adverse events, including two serious cases (CTCAE grade 3-4) [23]. In a clinical trial, RTX-treated patients had 475 adverse events compared to 352 in dimethyl fumarate-treated patients. Infusion-related adverse events were most common in the RTX group (105 events) [18].

Most of these reactions to the infusion are mild or moderate, such as a low-grade fever, skin rash, and coldness. Additional side effects during infusion include queasiness, throwing up, itching, swelling, throat irritation, difficulty breathing, low blood pressure, nasal congestion, hives, headache, muscle pain, dizziness, and high blood pressure. Pretreatment with paracetamol, prednisone, and antihistamines may decrease the likelihood of adverse events associated with infusion [24, 25]. Before the RTX infusion, we administered 250 mg of methylprednisolone intravenously (IV) in our study. Additionally, 1000 mg of oral acetaminophen and 10 mg of chlorpheniramine are given intravenously 30-60 minutes before RTX infusions.

We noticed noteworthy alterations in WBC count (P=0.003), suggesting that the drug might impact the immune system's response. Nevertheless, our findings indicated no presence of infection prior to or following the intervention. It is possible that the small sample size or the exclusion of patients with active infections in our study could be the cause. Additionally, the COVID-19 pandemic led to a significant decline in other infectious diseases, potentially explaining the absence of infection

among our participants. It is important to highlight that long-term RTX treatment increases the likelihood of developing infections [26]. Therefore, the brief duration of our treatment could have influenced the infection rates in our study. While RTX is linked to a higher risk of common infections, it seems to have an acceptable safety record in terms of severe side effects and mortality.

3.5. RTX Regimen

There is currently no agreement or established guidelines on the optimal dosage for the RTX regimen. Studies varied in RTX infusion doses, and intervals for treating MS. Bar-Or (2008) and De Flon et al. (2016) administered 1000 mg initially and repeated the dose at defined intervals. Bar-Or's study had doses on days 1 and 15, with a follow-up at weeks 24 and 26, while De Flon et al. had two doses two weeks apart at 6- to 12-month intervals [27, 28]. In contrast, Hawker et al. (2009) conducted a long-term clinical trial where 439 PPMS patients received two 1000 mg doses every 24 weeks over 96 weeks [29].

The retrospective study by Yamout et al. (2018) and the clinical trial by Svenningsson et al. (2022) had distinct strategies. Both reported starting treatment with a higher initial dose, followed by maintenance doses. Yamout et al. used a 2000 mg loading dose, split into two infusions, and then prescribed 1000 mg every 6–12 months [30]. Svenningsson et al. started with a 1000 mg dose, followed by 500 mg every 6 months [18]. The most common way to administer RTX is to initially give a dose of either 1000 or 2000 mg, followed by subsequent doses every 6 months. In our study, participants were given an initial IV dose of 1000 mg of RTX and regular infusions of 500-1000 mg every 6 months. Furthermore, there is no significant variation in the effectiveness of RTX based on different dosage schedules [21].

3.6. Limitations

The strict protocols followed in clinical trials may restrict their applicability to larger and more diverse groups of people. Our study observes and provides insights into how effective RTX is in real-life situations and how treatment effects can vary across different types of patients and stages of the disease. Our study has limitations because it was not randomized and may be affected by various factors such as the retrospective design, being conducted in a single center, having a small sample size, lacking a control group, having a short follow-up period, a shortage of control MRI, and potential biases related to patient characteristics.

Conclusion

Our discovery emphasizes the potential of RTX in certain groups of patients. Considering patient demographics and specific MRI characteristics is crucial when assessing the effectiveness of treatment. Variations could influence the treatment outcomes with RTX in our study in patient demographics such as age, gender, disease duration, and baseline characteristics. Our research emphasizes the significance of taking RTX into account, particularly when access to approved disease-modifying therapies is restricted or when conventional treatments have proven ineffective. Additionally, our research examines the causes of discontinuation and adverse effects, offering insights into the drug's tolerability and practical use.

The nature of retrospective studies can introduce biases regarding patient selection and data collection. Our study had different objectives, involved diverse patient populations, and offered additional insights into RTX's role in treating MS.

To sum up, our study demonstrated that administering RTX effectively reduces the ARR. Although it has limited usage and lacks phase III study documentation, this medication could be a viable treatment option for MS with manageable side effects. Nevertheless, the findings of this study were unable to demonstrate its effectiveness in halting the advancement of the disease. In order to verify these results, it is crucial to conduct phase III studies that focus on distinct subtypes of MS and implement a specific treatment regimen.

Conflict of interest: none

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Data availability:

The data supporting this study's findings are available from the corresponding author upon reasonable request.

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Using artificial intelligence chatbots

There was no use of artificial intelligence in the making of this article.

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