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Clinical Observation of Telitacicept and Belimumab Combined with Standard Therapy in the Treatment of Lupus Nephritis

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Abstract

Objective

To evaluate the efficacy and safety of telitacicept or belimumab combined with standard therapy for lupus nephritis (LN), and compare outcomes with standard therapy alone.

Methods

Clinical data of 120 LN patients admitted to the First Affiliated Hospital of Zhengzhou University from September 2022 to April 2025 were retrospectively analyzed. Patients were divided into three groups (40 per group): standard therapy group, telitacicept group and belimumab group. All patients received glucocorticoids plus conventional immunosuppressants. The telitacicept group was given 160 mg subcutaneous telitacicept once weekly, and the belimumab group received intravenous belimumab per standard protocol. All patients were followed up for ≥ 24 weeks. Renal function, disease activity, laboratory markers and adverse events were compared, with subgroup analyses performed.

Results

Baseline demographics and most clinical indicators were comparable among three groups, while disease duration, SLEDAI-2K score and total cholesterol differed significantly ($P < 0.05$). After 24-week treatment, complete remission rate was 47.5% in telitacicept group, 27.5% in belimumab group and 20% in standard group, without statistical significance ($P = 0.096$). Both biologic groups achieved significantly greater improvements in urine protein-to-creatinine ratio (UPCR), serum albumin and SLEDAI-2K score versus standard therapy ($P < 0.05$). Subgroup analysis showed telitacicept was superior in reducing UPCR, inducing complete remission and decreasing anti-dsDNA antibodies in patients with type III/IV + V LN and disease duration ≥ 3 years; belimumab yielded higher partial remission rate in type III LN. Both biologics facilitated more steroid tapering to < 7.5 mg or discontinuation ($P < 0.05$). The telitacicept group had the lowest overall adverse event rate (25%), and its pulmonary infection rate (7.5%) was markedly lower than the standard group (40%) and belimumab group (20%) ($P < 0.001$), though 3 herpes zoster cases occurred.

Conclusion

Telitacicept and belimumab combined with standard therapy are superior to standard therapy alone for LN. Telitacicept shows better efficacy in patients with complex pathological types, long disease duration and moderate-to-severe disease activity, with lower pulmonary infection risk.

1. Introduction

Systemic lupus erythematosus (SLE) is an autoimmune disease with diverse clinical manifestations that can affect multiple organs[1], with renal involvement being the most common complication. Studies have shown that almost all patients with SLE have varying degrees of renal damage, and approximately 40%-70% meet the clinical diagnostic criteria for lupus nephritis (LN) [2].Approximately 10%-30% of patients progress to renal failure within five years after diagnosis, requiring hemodialysis, peritoneal dialysis, or kidney transplantation, which significantly reduces patients' quality of life[3,4].The standard treatment for LN is a combination of glucocorticoids and immunosuppressants[5];Nevertheless, this approach has limitations, including a low complete remission rate, a high relapse rate, and significant toxicity[6,7].

Studies have shown that B cells play an important role in the occurrence and development of LN[8]. Telitacicept and belimumab, as specific biological agents targeting B cells, are currently widely used in the treatment of LN. Belimumab targets and binds soluble human B lymphocyte stimulator (BLyS), blocks its binding to B cells surface receptors, and mainly inhibits the survival and differentiation of transitional and mature B cells[9]. Telitacicept can simultaneously inhibit BLyS and a proliferation-inducing ligand (APRIL), two key factors for the differentiation and maturation of B cells[10], thereby suppressing the development, maturation, differentiation, and survival of B cells and plasma cells at various stages.

This study evaluated the efficacy and safety of telitacicept and belimumab combined with standard therapy for lupus nephritis (LN), compared with standard therapy alone. The results offer evidence to guide clinical practice.

2. Materials and Methods

2.1. General Information

Clinical data of 120 patients with LN treated at the First Affiliated Hospital of Zhengzhou University between September 2022 to April 2025 were retrospectively reviewed. According to different therapeutic regimens, patients were categorized into three groups: standard therapy group (n = 40), telitacicept group (n = 40), and belimumab group (n = 40). All patients initially received standard therapy consisting of glucocorticoids in combination with conventional immunosuppressive agents including hydroxychloroquine (HCQ), mycophenolate mofetil (MMF), cyclophosphamide (CTX), and calcineurin inhibitors (CNIs). The dosages of glucocorticoids and immunosuppressants were determined based on the patients' disease status and laboratory findings. Patients in the telitacicept group received additional telitacicept at a dose of 160 mg administered subcutaneously once weekly alongside standard therapy. In the belimumab group, received additional belimumab 10 mg/kg intravenously every 2 weeks for the first 3 administrations, followed by every 4 weeks starting from the 4th dose. The follow-up duration for all patients in the three groups was at least 24 weeks.

Inclusion criteria:▯ Met the 2019 EULAR/ACR diagnostic criteria for SLE and were diagnosed with active LN by renal biopsy or clinically;▯ Systemic Lupus Erythematosus Disease Activity Index (SLEDAI-2K) score ≥ 8;▯ Aged between 18 and 65 years;▯ Positive for antinuclear antibody or anti-dsDNA antibody;▯ Urine protein-to-creatinine ratio (UPCR) ≥ 0.5 g/g after treatment with glucocorticoids and immunosuppressants.

Exclusion criteria:▯ Presence of other renal diseases, such as diabetic nephropathy, hypertensive nephropathy, primary glomerulonephritis, etc.▯ Severe comorbid condition, including active infection (requiring anti-infective treatment), malignant tumor, end-stage renal disease (eGFR < 15 mL/min/1.73m^2).▯ Concomitant use of other biological agents during the study period, such as obinutuzumab, rituximab.▯ Receipt of plasma exchange or high-dose cyclophosphamide pulse therapy within 3 months prior to enrollment.▯ Co-existing rheumatic immune diseases, such as Sjögren's syndrome, Behçet's disease, rheumatoid arthritis, etc.▯ Pregnancy or lactation.

According to the above inclusion and exclusion criteria, 40 patients with LN were enrolled in the standard therapy group, including 9 males and 31 females. Among them, 36 patients underwent renal biopsy. The renal pathological types were as follows: 1 case of type III focal proliferative lupus nephritis, 13 cases of type IV diffuse segmental proliferative lupus nephritis, 18 cases of type III/IV + V lupus nephritis, and 4 cases of type V membranous lupus nephritis. A total of 40 patients with lupus nephritis were enrolled in the telitacicept group, including 10 males and 30 females. Among them, 27 patients underwent renal biopsy, including 3 cases of type II mild mesangial proliferative lupus nephritis, 9 cases of type III focal proliferative lupus nephritis, 6 cases of type IV endocapillary proliferative lupus nephritis, 8 cases of type III/IV + V lupus nephritis, and 1 case of type V membranous lupus nephritis. A total of 40 patients with lupus nephritis were enrolled in the belimumab group, including 10 males and 30 females. Among them, 32 patients underwent renal biopsy, including 5 cases of type III focal proliferative lupus nephritis, 12 cases of type IV endocapillary proliferative lupus nephritis, 10 cases of type III/IV + V lupus nephritis, and 5 cases of type V membranous lupus nephritis.

2.2. Methods

A retrospective analysis was conducted. Baseline was defined as the last clinical assessment before the first administration of telitacicept or belimumab.Clinical efficacy was evaluated as follows:▯Complete remission: UPCR decreased to below 0.5 g/g, no casturia or leukocyturia, serum albumin level above 35 g/L, and serum creatinine normal or increased by no more than 15% from baseline.▯ Partial remission: UPCR ranged from 0.5 to 3.0 g/g, urinary protein reduced by more than 50% from baseline, and renal function remained relatively stable.▯ No response: UPCR unchanged or still above 3.0 g/g, serum creatinine increased by at least 50 μmol/L or more than 15% from baseline.

2.3. Observation Indicators

Clinical information collected in this study included disease duration, age and sex distribution, body mass index, current medication, history of hypertension, and other related factors.For laboratory examinations, the key indicators monitored included urine protein-to-creatinine ratio (UPCR), blood urea nitrogen, serum creatinine, serum uric acid, estimated glomerular filtration rate (eGFR), serum albumin, total cholesterol, triglycerides, white blood cell count, hemoglobin, platelet count, positive rates of antinuclear antibody and anti-dsDNA antibody, as well as immunological parameters such as immunoglobulins IgA, IgG, IgM and complements C3, C4.

Adverse events (AEs) during treatment were recorded in all 120 patients:local reactions such as injection-site rash and pruritus;gastrointestinal adverse events including diarrhea, nausea, and upper abdominal pain;neurological adverse events including headache, dizziness, and hypoesthesia;infectious adverse events including upper respiratory tract infection, urinary tract infection, herpes zoster, pharyngitis, and conjunctivitis.

2.4. Statistical Analysis

Statistical analyses were performed using SPSS version 26.0 statistical software. Continous data with normal distribution were presented as mean ± standard deviation ($x \pm s$). Comparisons across groups were conducted using one-way analysis of variance (ANOVA), while repeated-measures ANOVA was applied to assess changes over time within the same group. Variables that did not follow a normal distribution are reported as median (interquartile range) [M (Q1, Q3)] and were compared using the Kruskal-Wallis H test. Categorical data were presented as numbers (percentage) [n (%)] and compared using the χ^2 test or Fisher exact test as appropriate. A P value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of baseline clinical data among enrolled patients

Table 1
Comparison of clinical characteristics among the three groups at baseline

Clinical characteristics	Standard therapy group	Taitacept group	Belimumab group	P value
Age (years)	34.00(27.25, 46.50)	30.5(27.25, 35)	33.5(25.5, 45.25)	0.402
Female, n (%)	31(77.50)	30(75.00)	30(75.00)	0.091
Disease duration (years)	0.17(0.08, 3.50)	4.50(1.00, 8.75)	0.835(0.17, 9.75)	<0.001
BMI	23.79 ± 3.71	22.96 ± 3.28	23.32 ± 4.57	0.638
SLEDAI-2K	11.20 ± 4.60	13.65 ± 3.40	11.43 ± 4.55	0.024
Systolic blood pressure	133.63 ± 23.74	126.78 ± 14.29	130.10 ± 16.24	0.282
Diastolic blood pressure	85.88 ± 16.60	83.08 ± 10.58	87.55 ± 12.44	0.221
Laboratory indicators				
WBC count,10^9/L	5.75 ± 3.56	7.18 ± 5.13	7.06 ± 3.24	0.155
RBC count,10^12/L	3.49 ± 0.68	3.92 ± 0.69	3.81 ± 0.53	0.905
HB(g/L)	99.67 ± 21.73	116.15 ± 20.54	113.53 ± 14.66	0.840
PLT count,10^9/L	181.23 ± 112.728	203.45 ± 88.91	223.03 ± 79.95	0.148
ALB(g/L)	28.09 ± 8.04	34.62 ± 7.94	33.05 ± 8.60	0.630
SCr(umol/L)	119.58 ± 108.01	80.68 ± 59.01	91.23 ± 75.57	0.146
BUN(mmol/L)	9.31 ± 7.04	6.47 ± 3.87	7.51 ± 3.67	0.083
UA(umol/L)	372.4 ± 114.29	404.55 ± 136.22	355.872 ± 97.71	0.176
eGFR(ml/min/1.73m²)	82.42 ± 37.88	101.89 ± 30.91	92.20 ± 30.25	0.055
TC(mmol/L)	4.55(3.79, 6.10)	4.07(3.41, 5.12)	4.98(4.53, 5.92)	0.037
TG(mmol/L)	1.76(1.15, 3.00)	1.27(1.04, 2.09)	1.62(1.08, 2.40)	0.901
C3(g/L)	0.67 ± 0.45	0.77 ± 0.34	0.87 ± 0.25	0.058
C4(g/L)	0.08(0.05, 0.14)	0.14(0.06, 0.22)	0.16(0.09, 0.27)	0.278
CRP(mg/L)	2.19(0.77, 9.59)	1.24(0.61, 3.42)	1.47(0.68, 3.53)	0.353
ESR(mm/h)	60.00(28.73, 86.25)	19.00(8.00, 41.00)	17.00(7.75, 27.00)	0.631
IgA(g/L)	2.28(1.59, 3.63)	2.37(2.348, 2.760)	2.29(1.57, 2.45)	0.528
IgG(g/L)	12.48(9.07, 18.85)	12.66(9.87, 14.38)	12.67(6.55, 14.69)	0.411
IgM(g/L)	1.00(1.63, 1.80)	0.97(0.62, 0.97)	0.97(0.56, 1.14)	0.287
B cells (cells/μL)	146(71.50,216)	142(73.34,219.74)	144(62.50,305)	0.330
$CD4^+$ T cells (cells/μL)	647.53 ± 247.03	670.60 ± 191.91	606.34 ± 232.03	0.092
U-RBC,/ul	16.00(0.00, 112.00)	3.00(0.00, 13.75)	12.00(1.00, 46.23)	0.242
U-WBC,/ul	14.00(5.00,50.00)	4.50(0.00, 21.25)	3.50(0.00,31.75)	0.133
UPCR(g/g)	2.91(1.10, 6.71)	1.32(0.73, 3.00)	2.08(0.72, 3.86)	0.062
Positive-ANA antibody(%)	40(100.00)	37(92.50)	37(92.50)	0.075
Positive-anti-dsDNA(%)	30(75.00)	31(77.50)	29(72.50)	0.828
Positive-anti-SSA(%)	18(45.00)	19(47.50)	13(32.50)	0.291
Positive-anti-SSB(%)	4(10.00)	5(12.50)	2(5.00)	0.485
Positive-anti-Sm(%)	11(27.50)	10(25.00)	5(12.50)	0.145
Positive-anti-RNP(%)	15(37.50)	20(50.00)	11(27.50)	0.112
GC dosage(mg)	35.75 ± 20.00	30(8.50, 40)	24(8, 40)	0.052

BMI,Body Mass Index; WBC, white blood cells; RBC, red blood cells; HB, hemoglobin; PLT, platelet; ALB, albumin; SCr, serum creatinine; BUN, blood urea nitrogen; UA, uric acid; eGFR, estimated glomerular filtration rate; TC,Total cholesterol; TG,Triglyceride; CRP,C-reactive protein; ESR,Erythrocyte Sedimentation Rate; IgA, immunoglobulin A; IgG, immunoglobulin G; IgM, immunoglobulin M; UPCR,Urinary Protein-to-Creatinine Ratio; GC, glucocorticoids;

A total of 120 LN patients were enrolled in this study and divided into three groups based on treatment regimens. Overall, baseline clinical characteristics were largely comparable across the three groups, indicating good baseline balance. Female patients predominated in all groups, consistent with the epidemiological feature that SLE is more common in women. There was a highly statistically significant difference in disease duration among the three groups (P<0.001):the telitacicept group had the longest duration [4.50 (1.00, 8.75) years] ,followed by the belimumab group （0.835 (0.17, 9.75) years）,and the standard therapy group had the shortest duration （0.17 (0.08, 3.50) years）.This suggests that patients treated with biologic agents tended to have a longer disease course, whereas the standard therapy group mainly included treatment-naïve patients. There was a statistically significant difference in baseline SLEDAI-2K score among the three groups (P = 0.024).The telitacicept group had the highest score (13.65 ± 3.40),while the belimumab group (11.43 ± 4.55) and standard therapy group (11.20 ± 4.60) had similar and lower scores, indicating significantly higher disease activity in the telitacicept group than in the other two groups. No statistically significant differences were observed among the three groups with respect to demographic data (age, sex),or in serological and immunological parameters including white blood cell count, red blood cell count, hemoglobin, albumin, IgA, IgG, IgM, serum creatinine, eGFR, and UPCR (Table 1).

3.2. Comparison of clinical parameters among the three groups

3.2.1. Renal remission

At week 24 of follow-up, the complete remission rate in the telitacicept group was 47.5% (19 patients), which was higher than that in the belimumab group (27.5%, 11 patients) and the standard therapy group (20.0%, 8 patients), however, the difference among the three groups was not statistically significant (P = 0.096).The partial remission rate was 27.5% (11 patients) in both the telitacicept group and the belimumab group, and 30.0% (12 patients) in the standard therapy group, with no significant difference among groups (P = 0.959).

Regarding the improvement of UPCR (urine protein-to-creatinine ratio), levels declined significantly from baseline in all three groups after treatment (P < 0.05), indicating that each treatment regimen was effective in reducing urinary protein excretion. Further between-group comparison showed that reduction in UPCR at weeks 4, 12, and 24 were significantly greater in both the telitacicept and belimumab groups than in the standard therapy group (P<0.05) (Table 2). However, there was no significant difference in UPCR between the telitacicept group and belimumab group (P = 0.479). At week 24, the median UPCR was slightly lower in the belimumab group [0.30 (0.14, 0.74) g/g] than in the telitacicept group [0.35 (0.13, 1.50) g/g], although this difference was not statistically significant (P = 0.396), suggesting that belimumab may provide a somewhat more sustained reduction in UPCR..

Regarding changes in plasma albumin, levels increased significantly from baseline in all three groups after treatment (P<0.05), indicating that each treatment regimen was effective in correcting hypoalbuminemia. Between-group comparisons showed that at weeks 4, 12, and 24 of follow-up, plasma albumin levels in the telitacicept group and belimumab group were both significantly higher than those in the standard therapy group (P<0.05) (Table 2).Further comparison between the two biologic groups revealed that at weeks 4 and 12 of follow-up, plasma albumin level in the telitacicept group was significantly higher than that in the belimumab group (P<0.05), suggesting that telitacicept may have a more obvious short-term advantage in improving plasma albumin level.

There was no significant difference in eGFR among the three groups during follow-up. At weeks 4, 12, and 24 of follow-up, eGFR in the telitacicept group was higher than that in the belimumab group and the standard therapy group, but the differences were not statistically significant (P > 0.05) (Table 2).

3.2.2. Disease Activity Assessment

Regarding the improvement of SLE disease activity, the SLEDAI-2K scores declined significantly from baseline in all three groups starting at week 4 of follow-up (P<0.05), suggesting each treatment regimen was effective in controlling disease activity in patients with LN. Further between-group comparison showed that at weeks 4, 12, and 24 of follow-up, the SLEDAI-2K scores in the telitacicept group and belimumab group were significantly lower than those in the standard therapy group (P<0.05) (Table 2), indicating that biologic agents combined with standard therapy were superior to standard therapy alone in improving overall disease activity. Although the reduction in SLEDAI-2K score was more pronounced in the telitacicept group than in the belimumab group during the entire follow-up period, the difference between the two groups was not statistically significant (P>0.05), suggesting that the two biologic agents had comparable efficacy in regulating the overall disease activity of SLE patients.

Regarding the improvement of inflammatory activity markers, erythrocyte sedimentation rate (ESR) was significantly decreased in all three groups compared with baseline (P<0.05), indicating that all three therapeutic regimens could effectively inhibit inflammation in patients with LN. Further intergroup comparison showed that the reduction in ESR in the telitacicept group was significantly greater than that in the standard therapy group at weeks 4, 12, and 24 of follow-up (P<0.05) (Table 2). Its anti-inflammatory effect was rapid and remained stable throughout the follow-up period.In the belimumab group, the decrease in ESR was significantly superior to that in the standard therapy group only at week 12 (P = 0.037), with no significant difference at weeks 4 and 24.During the entire 24-week follow-up, there were no statistically significant differences in ESR level or its reduction between the telitacicept group and the belimumab group (P>0.05), suggesting that both telitacicept and belimumab could effectively control inflammatory activity in patients.

Regarding the improvement of hematological parameters, hemoglobin levels were significantly increased in all three groups compared with baseline (all P<0.05), indicating that all three regimens could improve anemia in patients. Pairwise comparison showed that hemoglobin levels in the telitacicept group were significantly higher than those in the standard therapy group at weeks 4, 12, and 24.In contrast, there was no significant difference in hemoglobin levels between the belimumab group and the standard therapy group at any time point. Further comparison revealed that hemoglobin level in the telitacicept group was significantly higher than that in the belimumab group at week 12 (P = 0.046), suggesting that telitacicept has a more favorable effect on improving hemoglobin level.

From week 4 to week 24 of follow-up, the positive rate of anti-dsDNA antibody decreased significantly in all three groups compared with baseline: from 77.50% to 27.50% in the telitacicept group, from 72.50% to 42.5% in the belimumab group, and from 75.00% to 40.00% in the standard therapy group.

However, there were no statistically significant differences among the three groups at any time point (all P>0.05).

Table 2

Clinical characteristics	4 weeks			P value	12 weeks			P value	24 weeks	
	Standard therapy group	Taitacept group	Belimumab group		Standard therapy group	Taitacept group	Belimumab group		Standard therapy group	Taitacept group
SLEDAI-2K	10.75 ± 3.68	6.48 ± 3.80	7.75 ± 3.05	<0.01	9.33 ± 3.29	5.48 ± 3.79	6.38 ± 3.17	<0.01	7.30 ± 3.31	5.00 ± 3.67
WBC count,10^9/L	7.69 ± 2.90	7.76 ± 3.06	7.71 ± 3.22	0.995	8.26 ± 3.25	8.12 ± 3.51	7.50 ± 2.92	0.544	7.98 ± 3.22	7.05 ± 2.67
RBC count,10^12/L	3.69 ± 0.57	4.14 ± 0.65	3.83 ± 0.53	0.003	3.94 ± 0.57	4.23 ± 0.52	3.91 ± 0.54	0.018	3.99 ± 0.69	4.27 ± 0.57
HB(g/L)	108.11 ± 18.86	122.77 ± 20.17	115.23 ± 16.18	0.003	114.33 ± 14.90	125.99 ± 16.39	118.56 ± 16.15	0.005	117.01 ± 17.74	126.85 ± 17.88
PLT count,10^9/L	221.18 ± 99.82	235.43 ± 73.67	225.13 ± 65.02	0.719	220.50 ± 95.76	252.75 ± 81.09	216.44 ± 72.18	0.110	219.03 ± 90.77	242.08 ± 69.83
ALB(g/L)	29.89 ± 8.26	38.35 ± 5.93	34.78 ± 6.43	0.001	32.96 ± 7.47	40.20 ± 5.06	37.18 ± 5.18	<0.01	34.63 ± 6.84	40.54 ± 5.55
SCr(umol/L)	98.05 ± 100.091	68.13 ± 16.27	79.83 ± 25.46	0.087	85.95 ± 45.98	69.05 ± 16.59	79.13 ± 29.21	0.073	87.83 ± 64.46	69.35 ± 18.66
BUN(mmol/L)	9.04 ± 5.17	5.70 ± 2.28	7.13 ± 3.23	0.052	7.48 ± 3.63	5.26 ± 1.82	6.30 ± 2.53	0.063	7.59 ± 5.37	4.94 ± 1.66
UA(umol/L)	307.43 ± 97.13	374.10 ± 100.39	337.78 ± 113.08	0.078	310.65 ± 99.25	363.40 ± 90.25	328.48 ± 106.71	0.057	317.73 ± 103.52	365.23 ± 104.83
eGFR(ml/min/1.73m²)	90.81 ± 34.60	104.57 ± 25.83	93.54 ± 24.85	0.080	90.74 ± 31.32	106.11 ± 20.93	93.03 ± 24.03	0.083	93.63 ± 31.39	102.74 ± 26.10
TC(mmol/L)	5.54 ± 1.78	5.14 ± 1.32	4.86 ± 1.25	0.147	5.21 ± 1.34	4.77 ± 1.08	4.37 ± 0.88	0.056	5.00 ± 1.92	4.52 ± 1.08
TG(mmol/L)	1.60(1.16, 2.29)	1.24(1.01, 1.75)	1.35(1.03, 1.96)	0.773	1.56(1.23, 2.47)	1.14(0.99, 1.85)	1.40(0.97, 1.91)	0.242	1.37(1.05, 1.89)	1.35 ± 0.561
C3(g/L)	0.93 ± 0.34	0.95 ± 0.24	1.0 ± 0.27	0.510	1.02 ± 0.29	1.06 ± 0.27	1.02 ± 0.25	0.780	1.11 ± 0.27	1.08 ± 0.29
C4(g/L)	0.20 ± 0.09	0.23 ± 0.08	0.23 ± 0.11	0.274	0.23 ± 0.08	0.26 ± 0.10	0.24 ± 0.10	0.365	0.26 ± 0.09	0.27 ± 0.10
CRP(mg/L)	1.33(0.39, 5.21)	1.51(0.63, 3.93)	1.13(0.47, 3.51)	0.418	0.85(0.30, 2.90)	1.63(0.82, 3.33)	1.02(0.39, 2.99)	0.948	0.98(0.27, 4.61)	1.70(0.89 3.78)
ESR(mm/h)	14.00(8.00, 39.75)	13.00(6.25, 20.00)	14.00(6.25, 20.75)	0.033	13.00(7.00, 28.75)	8.00(5.00, 13.42)	10.00(6.25, 17.00)	0.016	13.00(7.00, 43.00)	10.5(5.25 15.42)
IgA(g/L)	1.93 ± 1.08	1.72 ± 0.87	1.93 ± 1.08	0.738	1.84 ± 1.05	1.65 ± 0.68	1.75 ± 0.84	0.768	1.52 ± 0.73	1.79 ± 1.01
IgG(g/L)	9.48(6.57, 14.98)	8.93 ± 4.84	7.16(5.26, 10.65)	0.218	8.36 ± 3.17	8.15 ± 3.16	8.59(6.16, 11.23)	0.514	7.63 ± 2.85	7.90(6.17 11.92)
IgM(g/L)	0.92(0.61, 1.71)	0.50(0.31, 0.71)	0.70(0.43, 0.95)	0.815	0.77(0.44, 1.61)	0.32(0.23, 0.68)	0.65 ± 0.38	0.042	0.52(0.32, 1.54)	0.33(0.24 0.60)
B cells (cells/μL)	138.27 ± 57.10	128.43 ± 78.56	134.79 ± 92.10	0.270	133.49 ± 82.30	117.33 ± 57.81	124.55 ± 80.43	0.062	136.67 ± 78.21	88.55 ± 48.36
$CD4^+$T cells (cells/μL)	678.25 ± 341.33	712.30 ± 468.43	688.46 ± 467.43	0.232	639.35 ± 477.21	684.76 ± 309.21	658 ± 337.88	0.472	636.79 ± 553.10	635.40 ± 268.25
U-RBC,/ul	8.5(0.25, 30.00)	1.00(0.00, 5.00)	2.50(0.00, 14.25)	0.463	6.50(0.00, 0.23)	4.00(0.00, 11.25)	3.00(0.00, 12.75)	0.474	1.00(0.00, 21.75)	3.50(0.00 18.25)
U-WBC,/ul	10.00(2.25, 24.50)	5.50(0.00, 13.75)	1.50(0.00, 7.75)	0.141	3.50(0.00, 9.75)	4.00(0.00, 11.75)	1.50(0.00, 6.00)	0.372	2.00(0.25, 9.00)	5.00(0.00 15.25)
UPCR(g/g)	1.46(0.60, 3.80)	0.54(0.26, 1.60)	0.66(0.28, 2.47)	0.038	0.83(0.23, 2.65)	0.48(0.24, 1.14)	0.48(0.19, 1.28)	0.016	0.42(0.13, 1.86)	0.35(0.13 1.50)

Comparison of laboratory indicators among the three groups at 4, 12 and 24 weeks

WBC, white blood cells; RBC, red blood cells; HB, hemoglobin; PLT, platelet; ALB, albumin; SCr, serum creatinine; BUN, blood urea nitrogen; UA, uric acid; eGFR, estimated glomerular filtration rate; TC,Total cholesterol; TG,Triglyceride; CRP,C-reactive protein; ESR,Erythrocyte Sedimentation Rate; IgA, immunoglobulin A; IgG, immunoglobulin G; IgM, immunoglobulin M; UPCR,Urinary Protein-to-Creatinine Ratio; GC, glucocorticoids;

3.2.3. Effects on Lymphocytes

Changes in B ($CD3^-CD19^+$) and T ($CD3^+CD4^+$) lymphocytes in the three groups were recorded during follow-up. Comparative analysis showed that B cells counts in both the telitacicept group and belimumab group declined significantly at week 24 compared with baseline (both P<0.05), whereas no significant change was observed in the standard therapy group. At week 24 of follow-up, the mean B cells count was 88.55 ± 48.36/μL in the telitacicept group and 119.16 ± 103.91/μL in the belimumab group, both of which were significantly lower than 136.67 ± 78.21/μL in the standard therapy group (both P<0.05) (Table 2). No statistically significant differences in $CD4^+$ T cells were found among the three groups during follow-up, suggesting that the three treatment regimens had no significant effect on $CD4^+$ T cell count in patients.

3.2.4. Glucocorticoid Tapering

At week 24 of follow-up, glucocorticoid doses had declined significantly from baseline in all three groups (all P<0.05). In the standard therapy group, the dose decreased from 35.75 ± 20.00 mg to 13.50 (4.25, 24) mg. In the telitacicept group, it decreased from 30 (8.50, 40) mg to 4 (0, 10) mg, while in the belimumab group the dose declined from 24 (8, 40) mg to 4 (0.5, 8) mg. At week 24, the glucocorticoid dosage in the telitacicept group and belimumab group was significantly lower than that in the standard therapy group (both P<0.05).The proportion of patients whose glucocorticoid dose was tapered to below 7.5 mg was 60% (24 patients) in the telitacicept group and 65% (26 patients) in the belimumab group, compared with 27.5% (11 patients) in the standard therapy group, representing a statistically significant difference (P<0.05). Glucocorticoid discontinuation was achieved in 11 patients in the telitacicept group and 10 patients in the belimumab group, versus only 3 patients in the standard therapy group, and the difference was statistically significant (P<0.05).

3.3. Subgroup Analysis

3.3.1. Subgroup Analysis of Patients with Class III Lupus Nephritis

Subgroup analysis was performed in LN patients with class III pathology. After 24 weeks of treatment, UPCR in the telitacicept group decreased from 3.76 ± 1.37 g/g to 0.20 (0.09, 1.52) g/g, with a complete remission rate of 44.40%.In the belimumab group, UPCR decreased from 3.65 ± 4.03 g/g to 0.42 ± 0.25 g/g, with a complete remission rate of 20.00%.There were no significant differences in UPCR or complete remission rate between the two groups (P = 0.606, P = 0.457).However, the partial remission rate in the belimumab group (80.00%) was significantly higher than that in the telitacicept group (22.20%) (P = 0.028),suggesting that the therapeutic effect of belimumab was mainly concentrated in partial remission (Table 3).

Table 3
Comparison of efficacy at 24 weeks between telitacicept group and belimumab group in patients with class III lupus nephritis

Clinical characteristics	Taitacept group(n = 9)	Belimumab group(n = 5)	P value
SLEDAI-2K	5.00 ± 2.74	6.00 ± 4.00	0.587
SCr(umol/L)	72.44 ± 28.16	74 ± 12.39	0.898
eGFR(ml/min/1.73m²)	104.05 ± 26.04	98.32 ± 28.30	0.708
ALB(g/L)	42.80(36.10, 44.35)	39.36 ± 2.01	0.298
UPCR(g/g)	0.20(0.09, 1.52)	0.42 ± 0.25	0.606
C3(g/L)	0.98 ± 0.20	1.12(0.87, 1.15)	0.841
C4(g/L)	0.26 ± 0.11	0.28 ± 0.07	0.742
Positive-anti-dsDNA(%)	6(66.7)	4(80)	0.629
GC dosage(mg)	1.00(0,7.50)	4.00 ± 4.00	0.899
Dose ≤ 7.5 mg, n (%)	7(77.8)	3(60)	0.629
Glucocorticoid tapering/discontinuation, n (%)	4(44.4)	2(40)	1
Complete remission, n (%)	4(44.4)	1(20)	0.457
Partial remission, n (%)	2(22.2)	4(80)	0.028
No remission, n (%)	3(33.3)	0	0.128

SCr, serum creatinine; eGFR, estimated glomerular filtration rate; ALB, albumin; UPCR,Urinary Protein-to-Creatinine Ratio;

3.3.2. Subgroup Analysis of Patients with Class III/IV + V Lupus Nephritis

Subgroup analysis was performed in LN patients with class III/IV + V pathology.After 24 weeks of treatment, UPCR in the telitacicept group decreased from 1.91 ± 0.83 g/g to 0.51 ± 0.42 g/g, with a complete remission rate of 62.50%.In the belimumab group, UPCR decreased from 2.21 ± 1.23 g/g to 1.21 (0.52, 2.03) g/g, with a complete remission rate of 10.00%.There were significant differences in UPCR and complete remission rate between the two groups (P = 0.021, P = 0.037) (Table 4).

Table 4
Comparison of efficacy at 24 weeks between telitacicept group and belimumab group in patients with class III/IV + V lupus nephritis

Clinical characteristics	Taitacept group(n = 8)	Belimumab group(n = 10)	P value
SLEDAI-2K	5.00 ± 4.28	6.10 ± 3.21	0.541
SCr(umol/L)	66.38 ± 15.43	75.50(62.75,80.00)	0.360
eGFR(ml/min/1.73m²)	109.28 ± 19.62	88.32 ± 26.15	0.079
ALB(g/L)	42.41 ± 5.95	39.16 ± 4.94	0.223
UPCR(g/g)	0.51 ± 0.42	1.21(0.52, 2.03)	0.021
C3(g/L)	1.23 ± 0.25	1.15 ± 0.33	0.555
C4(g/L)	0.31(0.28, 0.34)	0.30 ± 0.08	0.633
Positive-anti-dsDNA(%)	3(37.5)	4(40)	1
GC dosage(mg)	4.00(0, 12.25)	5.00(2.00, 12.50)	0.515
Dose ≤ 7.5 mg, n (%)	6(75)	7(70)	1
Glucocorticoid tapering/discontinuation, n (%)	3(37.5)	1(10)	0.286
Complete remission, n (%)	5(62.5)	1(10)	0.037
Partial remission, n (%)	2(25)	7(70)	0.103
No remission, n (%)	1(12.5)	2(20)	1

SCr, serum creatinine; eGFR, estimated glomerular filtration rate; ALB, albumin; UPCR,Urinary Protein-to-Creatinine Ratio;

3.3.3. Subgroup Analysis of Patients with Disease Duration ≥ 3 Years

A subgroup analysis was conducted in patients with a long disease duration (≥ 3 years).After 24 weeks of treatment, in terms of UPCR, the telitacicept group decreased from 1.57 (0.69, 2.82) g/g to 0.42 (0.14, 0.60) g/g,and the belimumab group decreased from 2.11 (0.72, 3.37) g/g to 0.92 (0.55, 1.20) g/g. At week 24, the improvement in UPCR was significantly better in the telitacicept group than in the belimumab group (P = 0.019).The complete remission rate at 24 weeks was 60% in the telitacicept group, which was significantly higher than 27% in the belimumab group (P = 0.004).Further analysis indicated that the therapeutic effect of the belimumab group was mainly concentrated in partial remission (66.67%) (Table 5).

Table 5
Comparison of efficacy at 24 weeks between telitacicept group and belimumab group in LN patients with disease duration ≥ 3 years

Clinical characteristics	Taitacept group(n = 25)	Belimumab group(n = 15)	P value
SLEDAI-2K	5.38 ± 3.99	5.6 ± 3.07	0.974
SCr(umol/L)	69.38 ± 18.096	75(66, 79)	0.292
eGFR(ml/min/1.73m²)	103.04(84.08, 119.25)	89.54 ± 23.84	0.164
ALB(g/L)	40.71 ± 5.39	38.01 ± 4.18	0.142
UPCR(g/g)	0.42(0.14, 0.60)	0.92(0.55, 1.20)	0.019
C3(g/L)	1.10 ± 0.26	1.04 ± 0.15	0.678
C4(g/L)	0.28 ± 0.10	0.23 ± 0.07	0.117
Positive-anti-dsDNA(%)	11(44.00)	9(60.00)	0.322
GC dosage(mg)	4.50(0, 10.00)	6.00(2.00, 12.00)	0.783
Dose ≤ 7.5 mg, n (%)	14(56.00)	8(53.30)	0.835
Glucocorticoid tapering/discontinuation,n (%)	7(28)	3(20)	0.629
Complete remission, n (%)	15(60)	4(27)	0.043
Partial remission, n (%)	7(28.00)	10(66.67)	0.004
No remission, n (%)	3(12.00)	1(6.70)	0.702

SCr, serum creatinine; eGFR, estimated glomerular filtration rate; ALB, albumin; UPCR,Urinary Protein-to-Creatinine Ratio;

3.4. Safety Analysis

Adverse events were recorded during the follow-up period. The incidence of adverse events in the telitacicept group was 25%, which was lower than that in the standard treatment group (47.5%) and the belimumab group (42.5%), but the difference was not statistically significant (P = 0.091).Infectious events were the most common type of adverse reactions among the three groups, with pulmonary infection being the most frequent. The incidence of pulmonary infection in the telitacicept group was 7.5%, which was significantly lower than 40% in the standard treatment group and 20% in the belimumab group (P<0.01).In addition, three cases of herpes zoster were reported in the telitacicept group, accounting for 7.5%.No serious adverse events occurred in any of the three groups during follow-up. Overall, the three treatment regimens showed similar safety profiles (Table 6).

Table 6
Comparison of adverse events among the three groups during follow-up

Adverse event	**Standard therapy group (n = 40)[n(%)]**	**Taitacept group(n = 40) [n(%)]**	**Belimumab group(n = 40) [n(%)]**	**P value**
Injection site reactions (rash, pruritus)(%)	1(2.50)	0(0.00)	2(5.00)	0.357
Gastrointestinal disorders (diarrhea, nausea, upper abdominal pain)(%)	1(2.50)	0(0.00)	1(2.50)	0.602
Infectious events(%)	17(42.50)	10(25.00)	14(35.00)	0.254
Upper respiratory tract infection(%)	1(2.50)	2(5.00)	2(5.00)	0.711
Pulmonary infection(%)	16(40.00)	3(7.50)	8(20.00)	<0.001
Urinary tract infection(%)	0(0.00)	1(2.50)	2(5.00)	0.558
Herpes zoster(%)	0(0.00)	3(7.50)	0(0.00)	0.072
Cutaneous fungal infection of hand(%)	0(0.00)	1(2.50)	2(5.00)	0.558
Total adverse events(%)	19(47.50)	10(25.00)	17(42.50)	0.091

4. Discussion

Lupus nephritis (LN) is closely associated with the prognosis of systemic lupus erythematosus (SLE) and represents a major cause of mortality in patients with SLE. The clinical manifestations of LN range from asymptomatic proteinuria to nephrotic syndrome[11]. The pathogenesis of LN pathogenesis is multifactorial, including immune complex deposition, complement system activation, and abnormalities in immune cells and cytokines, all of which are closely linked to autoimmune responses mediated by abnormal B-cell activation[12]. Although substantial advancements have been achieved in the management of LN,up to 30% of patients with LN still remain at risk of progression to renal failure.

B lymphocytes exhibit abnormal proliferation and activation, producing large quantities of pathogenic autoantibodies that bind to corresponding antigens to form immune complexes, resulting in structural destruction and functional impairment of the kidney and related tissues and organs[13]. Among these, B-cell activating factor (BAFF) and a proliferation-inducing ligand (APRIL) are two key regulatory factors[14].BAFF mainly affects immature B cells, while APRIL predominantly acts on mid-to-late stage B cells and plasma cells. In patients with LN, abnormally high expression of BAFF and APRIL leads to sustained production and elevated levels of autoantibodies, thereby exacerbating injury to the kidney and other target organs[15].

Belimumab is a human monoclonal antibody targeting BAFF. By binding to soluble BAFF, it reduces the number of circulating naive B cells, activated B cells, and plasma cells[16]. In the 2019 European League Against Rheumatism (EULAR) guidelines for the management of lupus nephritis, belimumab in combination with standard therapy is recommended, and it was the first biologic agent approved for the treatment of systemic lupus erythematosus and lupus nephritis. Telitacicept possesses a unique dual-target mechanism of action, enabling simultaneous inhibition of BAFF and APRIL, two key regulators of B-cell function. In addition to suppressing the maturation and differentiation of B cells, it can further induce apoptosis of plasma cells and affect long-lived plasma cells[17]. It is the only dual-target biologic agent approved worldwide for the treatment of systemic lupus erythematosus. Through a retrospective analysis,our study compared the efficacy and safety of telitacicept plus standard therapy, belimumab plus standard therapy, and standard therapy alone in patients with lupus nephritis, so as to provide evidence for clinical decision-making.

In this study, the efficacy of the two biologics combined with standard therapy was significantly superior to that of standard therapy alone. In terms of the speed of onset, the biologic groups showed significant improvement in UPCR as early as week 4 of treatment (telitacicept group: 0.54 (0.26, 1.60) g/g; belimumab group: 0.66 (0.28, 2.47) g/g), and plasma albumin increased significantly at the same time, while the UPCR in the standard treatment group remained at 1.46 (0.60, 3.80) g/g (Table 2). These results indicate that biologics can rapidly alleviate renal damage and reduce the persistent damage to the kidneys caused by proteinuria. A study by Jin et al. showed that the 24-hour urinary total protein (UTP) level of SLE patients was significantly reduced compared with the baseline after 12 and 24 weeks of telitacicept treatment, which is consistent with the results of this study. This study showed that at week 24 of treatment, the complete remission rate (CRR) was 47.5% in the telitacicept group and 27.5% in the belimumab group. In a retrospective study of telitacicept in the treatment of SLE, it was shown that among 34 LN patients treated with telitacicept for 52 weeks, the CRR was 66.67%[18]. A 28-week extension study of belimumab showed a complete remission rate of 48%[12]. The reason for the inconsistency in the CRR percentages between the above two studies and our study may be the shorter treatment duration of the patients included in this study and the relatively severe renal damage. In terms of glucocorticoid tapering, 60%-65% of patients in the biologic groups achieved a glucocorticoid dosage ≤ 7.5 mg at week 24, compared with only 27.5% in the standard treatment group, and 10–11 patients in the biologic groups achieved glucocorticoid discontinuation. Long-term use of glucocorticoids can lead to

various adverse reactions such as osteoporosis, infection, and abnormal blood glucose[19]. Achieving glucocorticoid tapering or discontinuation as soon as possible is in line with the clinical principles of "treat-to-target" and "minimizing glucocorticoid exposure" for LN.

Our study found that telitacicept showed a significant effect in improving hemoglobin levels. In patients with LN, abnormal activation of circulating B cells produces anti-erythrocyte autoantibodies, leading to autoimmune hemolytic anemia. Excessive inflammatory response results in abnormal iron metabolism and decreased erythropoietin production, which further contribute to reduced erythrocytes and anemia[20].By dual-target inhibition of BAFF and APRIL, telitacicept suppresses the maturation and differentiation of B cells, reduces the formation of autoantibodies, and alleviates hematological manifestations in patients. A retrospective real-world study reported that among SLE patients with LN or hematological abnormalities, anemic patients achieved significantly greater benefits with telitacicept than with belimumab[21], which is in accordance with the findings of our study.

Additionally, this study further analyzed the therapeutic effects of the two biologics according to pathological subtype, disease duration, and disease activity. Class III/IV + V LN is one of the most severe pathological subtypes, with a high risk of glomerulosclerosis and interstitial fibrosis and great therapeutic difficulty. In this study, the UPCR in the telitacicept group decreased to 0.51 ± 0.42 g/g in this subgroup, with a complete remission rate of 62.50%,whereas the UPCR in the belimumab group remained at 1.21 (0.52, 2.03) g/g, with a complete remission rate of only 10.00% (Table 4).These findings suggest that telitacicept is more suitable for patients with complex pathological subtypes. In patients with LN duration ≥ 3 years, UPCR improvement (0.42 (0.14, 0.60) g/g) and complete remission rate (60%) in the telitacicept group were significantly better than those in the belimumab group (0.92 (0.55, 1.20) g/g and 27%, respectively(Table 5).This may be because patients with a long disease duration often exhibit plasma cell infiltration and persistent autoantibody production. Telitacicept-mediated neutralization of APRIL more effectively eliminates long-lived plasma cells, thereby breaking the cycle of chronic disease progression.

In terms of adverse events, there was no significant difference in the overall incidence among the three groups (P = 0.091). However, in the subgroup analysis of infectious adverse events, the incidence of pulmonary infection in the standard treatment group (40.00%) was significantly higher than that in the telitacicept group (7.50%) and the belimumab group (20.00%) (P < 0.001) (Table 6).This may be attributed to the ability of telitacicept and belimumab to precisely regulate B cells, thereby suppressing abnormal immune responses while causing relatively minor impairment to normal immune function.In particular, telitacicept exhibits more targeted regulation of B cells,which reduces the risk of severe infection caused by excessive immunosuppression.Nevertheless, 3 cases of herpes zoster infection (7.50%) occurred in the telitacicept group. Although the incidence was low, clinical vigilance is still required. Herpes zoster results from the reactivation of varicella-zoster virus, and B cells play an important role in the antiviral immune response. Inhibition of B cells by telitacicept may increase the risk of viral reactivation[22]. Therefore, attention should be paid to the history of previous viral infection in clinical practice, and preventive intervention should be administered when necessary.

In summary,both telitacicept and belimumab, when used in combination with standard therapy, represent effective treatment options for LN and are generally superior to standard therapy alone.Telitacicept shows more prominent efficacy in patients with complex pathological types, long disease duration, and moderate-to-severe disease activity. This study has several limitations. First, as a retrospective study, selection bias may exist. Second, the relatively small sample size—particularly in subgroup analyses with few cases per subgroup—may have resulted in insufficient statistical power.;thus, further validation by larger-scale studies is needed. Finally, the 24-week follow-up duration was relatively short. Long-term efficacy and safety still need to be further verified by prospective studies with larger samples and longer follow-up periods.

Abbreviations

AEs
Adverse events
anti-dsDNA
anti-double-stranded DNA
APRIL
a proliferation-inducing ligand
BAFF
B-cell activating factor
BLyS
B lymphocyte stimulator
CNIs
calcineurin inhibitors
CRR
complete remission rate
CTX
cyclophosphamide
eGFR
estimated glomerular filtration rate
ESR
erythrocyte sedimentation rate
EULAR
European League Against Rheumatism
HCQ
hydroxychloroquine

LN
lupus nephritis
MMF
mycophenolate mofetil
SLEDAI-2K
Systemic Lupus Erythematosus Disease Activity Index 2000
SLE
Systemic lupus erythematosus
UPCR
urine protein-to-creatinine ratio

Declarations

Ethics approval and consent to participate

The study was carried out in accordance with the Declaration of Helsinki. The study was reviewed and approved by the Institutional Review Board of the First Affiliated Hospital of Zhengzhou University (# 2025-KY-2069). All participants signed written informed consent after the study protocol was fully explained.

Consent for publication

Not applicable.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Author Contribution

Bingxiao Wang:Writing-original draft,Formal analysis.Guanhua Li:Writing-original draft,Writing-review□editing.Clifford Silver Tarimo:Writing-review□ editing.Zhiqi Liu:Methodology,Data curation.Wenyan Xing:Methodology,Data curation.Miaoyu Yin:Methodology,Data curation.Yan Zhang:Methodology,Data curation.Ge Wu:Writing-review□editing.

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Data Availability

All data supporting the findings of this study are available within the paper and its Supplementary Information.

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