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Original Article

Effect of *Astragalus membranaceus* Extract Combined with Nursing Intervention on Serum Inflammatory Factors and Therapeutic Effects in Patients with IgA Nephropathy

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ABSTRACT

Background and Objectives: IgA nephropathy is a common immunologically mediated kidney disease. This work investigated the impact of *Astragalus membranaceus* Extract (AME) combined with nursing intervention on serum inflammatory factors in patients with IgA nephropathy and its potential influence on treatment outcomes. **Materials and Methods:** AME was analyzed by High Performance Liquid Chromatography (HPLC) and Ultraviolet spectrophotometry (UV) to determine its active components and content. A total of 153 patients with biopsy-confirmed IgA nephropathy were randomly rolled into three groups: control group (treated with irbesartan), NI group (treated with irbesartan, placebo and nursing intervention) and AME group (treated with irbesartan, AME therapy and nursing intervention). After 2 months, clinical efficacy, serum inflammatory factors, renal function parameters and safety were evaluated across the three groups. **Results:** Analysis revealed that the main components of AME were Calycosin-7-glucoside (C7G, 152.4 mg), Astrapterocarpan (117.4 mg), Ononin (97.8 mg) and Calycosin (47.4 mg). The total flavonoid content was 46% determined by HPLC or 50% measured using UV. After two months of treatment, the Total Effective Rate (TER) in the AME group was significantly higher than that in control group and NI group ($p<0.05$). Before treatment, there were no significant differences among the three groups in levels of Tumor Necrosis Factor-α (TNF-α), Interleukin-6 (IL-6), Interleukin-15 (IL-15), high-sensitivity C-Reactive Protein (hs-CRP), Monocyte Chemoattractant Protein-1 (MCP-1), or Transforming Growth Factor-β1 (TGF-β1) ($p>0.05$). After treatment, serum concentrations of inflammatory factors decreased in all groups, with the AME group showing a significantly greater reduction ($p<0.05$), except for TGF-β1, which showed no significant difference ($p>0.05$). Similarly, no significant differences were observed in renal function parameters, including 24-hr Urinary Protein excretion (24 hr-Upro), Serum creatinine (Scr), Blood Urea Nitrogen (BUN) and Abnormal urinary Red Blood Cell count (ARBC), among the three groups before treatment ($p>0.05$). Following treatment, all renal function parameters improved, with values in the AME group significantly lower than those in the control group and NI group ($p<0.05$). However, there were no notable changes in estimated Glomerular Filtration Rate (eGFR) before and after treatment across all groups ($p>0.05$). Additionally, the 1-year cumulative renal survival rate in the AME group was significantly higher than in the other groups ($p<0.05$). The Incidence of Adverse Reactions (IoAR) showed no significant difference among the groups ($p>0.05$). **Conclusion:** AME combining with nursing intervention exerted an improving effect in clinical symptoms and renal function of patients with IgA nephropathy by hindering inflammatory factors in conjunction. Further research into the mechanism underlying AME treatment for IgA nephropathy may offer strong support for developing new strategies and medications, leading to better clinical outcomes for patients.

Keywords: *Astragalus membranaceus* Extract, IgA Nephropathy, Nursing Intervention, Renal Function, Serum Inflammatory Factors.

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INTRODUCTION

IgA nephropathy is identified by the buildup of IgA immune complexes in the glomeruli, which initiates inflammatory processes and localized immune reactions, resulting in the impairment of the glomeruli's structure and function in kidney conditions with an immunological etiology.[1] Although the exact pathogenesis remains unclear, abnormal activation of the immune system is considered a key factor in its development.[2]

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Additionally, there is an immune regulatory imbalance that leads to abnormal aggregation and deposition of IgA.[3] Furthermore, the glycosylation status of IgA may also influence its deposition and inflammatory effects in the kidneys.[4] Treating nephrotic syndrome primarily involves effectively controlling it by suppressing the immune and inflammatory responses, which may include glucocorticoid therapy, cytotoxic drugs and immunosuppressants.[5]

Astragalus membranaceus is a traditional Chinese medicine herbal with various therapeutic properties, including tonifying Qi, diuresis, detoxification and wound healing.[6] It contains a range of active components such as flavonoids, polysaccharides, amino acids and saponins, which collectively contribute to its pharmacological activities.[7] The pharmacological actions of *Astragalus membranaceus* encompass immune modulation, anti-inflammation, antioxidation and potential anti-tumor effects, making it a possible intervention strategy.[8] *Astragalus membranaceus* is widely regarded as a natural immune modulator. Studies have shown that it can enhance the body's immune function, promote the generation and activity of immune cells and its polysaccharide components can activate immune cells like macrophages, lymphocytes and NK cells, thereby strengthening the body's resistance. It also possesses significant anti-inflammatory properties.[9] Research indicates that *Astragalus membranaceus* can suppress inflammatory mediators.[10] Its anti-inflammatory effects may be achieved through multiple mechanisms, including the modulation of immune cell activity, reduction of inflammatory cell infiltration and inhibition of inflammatory signaling pathways. Moreover, *Astragalus membranaceus* contains flavonoids and polysaccharides with antioxidative properties that can neutralize free radicals and reduce oxidative stress, protecting cells from oxidative damage. This characteristic is crucial in mitigating tissue damage caused by inflammation. Additionally, *Astragalus membranaceus* has been found to have some anti-tumor potential, with its polysaccharide components believed to modulate immune cell activity and enhance the body's anti-tumor immune response.[11] When used in the treatment of IgA nephropathy, *Astragalus membranaceus* primarily leverages its immunomodulatory and anti-inflammatory properties.[12] The polysaccharide components of *Astragalus membranaceus* can activate immune cells and enhance immune function.[13] In IgA nephropathy, abnormal activation of the immune system is closely associated with the pathological process. The immunomodulatory action of *Astragalus membranaceus* helps balance immune responses, reducing excessive inflammation and immune activity, thus alleviating inflammation and immune-mediated kidney damage. Furthermore, the anti-inflammatory properties of *Astragalus membranaceus* are beneficial in the treatment of IgA nephropathy, where inflammation is a major driving force in the pathological process. Its anti-inflammatory action can alleviate the inflammatory response and damage to the glomeruli in IgA nephropathy.

This work investigated the impact of AME combined with nursing intervention on patients with IgA nephropathy. It was hoped to reveal the potential role of *Astragalus membranaceus* for treating IgA nephropathy through clinical observations, explore its regulatory effects on serum inflammatory factors and assess its influence on renal function. This research exhibited the potential to offer new insights into IgA nephropathy treatment, improving clinical outcomes for patients. Additionally, it may open new avenues for the application of herbal remedies in the field of kidney diseases.

MATERIALS AND METHODS

Analysis and determination of AME

The chemical composition and content analysis of AME were conducted using HPLC (Henan Aupos Instrument Equipment Co., Ltd., China). The chromatographic conditions involved a C18 column (250×4.6 mM, 5 μM) with acetonitrile-water (Sigma, USA) as the mobile phase. The elution conditions were as follows: 0-8 min, acetonitrile (20%)-water (80%); 8-15 min, acetonitrile (30%)-water (70%); 15-30 min, acetonitrile (43%)-water (57%); 30-40 min, acetonitrile (60%)-water (40%); 40-60 min, acetonitrile (100%)-water (0%); and 60-65 min, acetonitrile (20%)-water (80%). Flow rate of the mobile phase was 1.0 mL/min and detection was realized at 230 nm. Eight reference standards, including Calycosin-7-Glucoside (C7G), Ononin, Astrapterocarpan, 2'-Hydroxy-3',4'-dimethoxyisoflavone-7-O-β-D-glucoside, Calycosin, Ononin (Aladdin Scientific Corp., USA), 3-Hydroxy-9,10-dimethoxy-phenanthrene (Chengdu Ruifen Saide Biotechnology Co., Ltd., China) and 7,2'-Dihydroxy-3',4'-dimethoxyisoflavone (Nanjing Puyi Biotechnology Co., Ltd., China), were dissolved in chromatographic methanol to prepare a blended standard solution with concentrations of 56.48, 81.28, 75.48, 86.70, 9.808, 8.352, 24.52 and 83.68 μg/mL, respectively, for later use. Approximately 10 mg of flavonoid extract was positioned in a 10 mL volumetric flask, followed by an addition of methanol to the mark and the contents were thoroughly mixed. The solution was then filtered through a 0.22 μm microporous membrane to obtain the sample solution.

Total flavonoids were determined using ultraviolet spectrophotometry (Waters, USA). C7G reference standards were prepared to create solutions with concentrations of 1.086, 2.172, 4.344, 8.688 and 17.376 μg/mL. Approximately 10 mg of *Astragalus membranaceus* flavonoid extract was put in a 10 mL volumetric flask, added with methanol to the mark and the contents were thoroughly mixed to obtain the sample solution. The wavelength was set at 260 nm for analysis. Based on the experimental results described above, the chemical formula of the main active components in AME was displayed in Figure 1.

Study subjects

A total of 153 patients with biopsy-confirmed IgA nephropathy from January 2019 to June 2022 were enrolled in the study, comprising 87 males and 66 females, who were 32-69 years ((48.71±5.39) years averaged), with a Disease Duration (DD) of 3 to 15 (6.94±2.21) years. The patients were aware of the content of the trial and signed informed consent. The trial obtained approval from the ethics committee of hospital.

Inclusion Criteria

(1) age of 18-70 years; (2) patients who were diagnosed with IgA nephropathy through renal biopsy by referring to the criteria outlined in the Clinical Diagnosis and Treatment Guidelines for Nephrology; (3) 24-hr Urinary protein (24 hr-Upro)>1.0 g; (4) Serum creatinine (Scr)<1.5 mg/mL; (5) absence of a history of mental illness and willingness to participate in postoperative examinations and follow-ups; and (6) patients and their family members knowing the research content and with signed informed consent forms.

Exclusion criteria

(1) patients with abnormal liver or renal function; (2) pregnant patients or those within 2 years post-pregnancy; (3) patients with chronic diseases such as heart, liver, or lung conditions; (4) patients with a history of allergies to Irbesartan, AME, or other specified medications; and (5) patients with advanced diabetes, purpura nephritis, systemic lupus erythematosus, or any other known systemic diseases associated with secondary IgA nephropathy.

Grouping and treatments

The patients were randomly divided into three groups: control group (treated with irbesartan, *n*=51), NI group (treated with irbesartan, placebo and nursing intervention, *n*=51) and AME group (treated with irbesartan, AME therapy and nursing intervention, *n*=51). All patients received standard nursing, including hygiene nursing (ensuring patient cleanliness and necessary room disinfection), dietary nursing (scientifically arranging diets according to the condition and providing adequate nutrition), sleep nursing (creating a peaceful environment to ensure adequate rest and sleep for patients) and psychological nursing (continuously monitoring the psychological status of patients and providing timely communication).

In the control group, patients were administered Irbesartan tablets (Zhejiang Huahai Pharmaceutical Co., Ltd., China) at 150 mg per dose, taken orally once a day, for a total treatment duration of 8 weeks. When necessary, angiotensin-converting enzyme inhibitors were employed to lower blood pressure, reduce proteinuria and protect renal function.

In the NI group, in addition to the standard nursing provided to the control group, patients received AME injection (prepared with sterile injection water to a concentration of 0.25 mg/mL, 4 mL/d) administered via intramuscular injection. The treatment course spanned a total of 8 weeks. During the treatment, patients were provided with life care (taking care of the patient's cleanliness and necessary disinfection of the ward), diet care (according to the condition of the scientific and reasonable arrangement of diet, supplement enough nutrition), sleep care (creating a quiet environment to ensure that patients have sufficient rest and sleep) and psychological care (always paying attention to the psychological trend of patients and provide timely communication). Simultaneously, the diet of the patient should be standardized, emphasizing a diet primarily composed of high-quality proteins, low in oil, low in fat and low in sodium. Patients were advised to strictly avoid consuming raw, cold and spicy foods. Blood pressure was maintained below systolic blood pressure<130 mmHg and diastolic blood pressure<80 mmHg and patients were encouraged to ensure adequate sleep, engage in regular outdoor exercise and maintain physical fitness.

In addition to receiving standard care provided to the control group, the AME group underwent intramuscular injections of AME (0.25 mg/mL, 4 mL/day). The treatment course lasted for 8 weeks, during which they also received the same nursing interventions as the NI group.

Treatment effectiveness evaluation

8 weeks later, the Total Effective Rate (TER) of patients in different groups was calculated and compared.

Ineffective

Clinical symptoms persisted after treatment and the reduction in 24 hr-Upro was less than 10%.

Effective

Clinical symptoms showed some improvement after treatment, with a reduction in 24 hr-Upro of more than 10% but less than 20%. Significant effect: after treatment, most clinical symptoms improved and there was a reduction in 24 hr-Upro of more than 20% but less than 30%. Cured: clinical symptoms disappeared after treatment, 24 hr-Upro reduction exceeded 30% and 24 hr-Upro was<0.5.

Serum-related indicators: Serum inflammatory factors

At the start of treatment (Week 0), Week 4 and Week 8, 5 mL of Fasting Venous Blood (FVB) was treated by a 15-min centrifugation at 3,000 rpm to collect supernatant and then stored at -20°C until analysis. ELISA was employed to determine TNF-α, IL-6, IL-15 (Keaibo Biosciences, China) and hs-CRP (YOYOBIO, China). For the ELISA procedure, plates were equilibrated at room temperature for 20 min. Standard and test sample wells were set up. 50 µL of standards at varying densities

and 50 µL of samples were applied. Blank wells were left empty. Afterwards, 100 µL of horseradish peroxidase-labeled antibodies were applied, sealing the plates. Incubation was carried out at 37°C for 60 min. The plates were then rinsed using a plate washer (KD-660-670X, Kedi Yunxiang Biological Technology (Nanjing) Co., Ltd., China), followed by the addition of 50 µL of substrate to each well. Incubation at 37°C was continued for 15 min. Ultimately, the reaction was terminated by addition of 50 µL of stop solution and the Optical Density (OD) at 450 nm was measured. The measurement results were subjected to comparative analysis.

Immune regulation indicators

At Week 0, Week 4 and Week 8, 5 mL of FVB was centrifuged at the same conditions with descriptions in above paragraph and the upper liquid was kept at -20°C until analysis. ELISA was employed for measuring the TGF-β1 (Shanghai Jianglai Industrial Co., Ltd., China) in the patient samples and the measurement results were subjected to comparative analysis.

Cell chemotaxis and signaling indicators

At Week 0, Week 4 and Week 8, 5 mL of FVB was processed with the same procedures for storage of supernatant at -20°C until analysis. ELISA was utilized to measure the Monocyte Chemoattractant Protein-1 (MCP-1) (Shanghai Yaji Biotechnology Co., Ltd., China) in the patient samples, followed by a comparative analysis.

Indicators related to renal function

For the evaluation of renal function, several parameters were tested, including 24 hr-Upro, Scr, BUN, eGFR and the number of ARBC in urine. In particular, 24 hr-Upro and the number of ARBC required the collection of all urine produced by the patients within a 24 hr period at the start of treatment (Week 0), Week 4 and Week 8. These samples were analyzed using an automated biochemical analyzer.

The measurements of Scr and BUN were obtained from FVB samples (5 mL) collected from the patients at Week 0, Week 4 and Week 8. These samples were analyzed using an automated biochemical analyzer (Thermo, USA) and the outcomes were compared and analyzed.

eGFR assesses the renal function. It is typically calculated based on measurements of Cre concentration, along with factors such as age, gender and race of patients. There are corresponding measures for eGFR. When eGFR was ≥90 mL/min, at this point, eGFR was considered normal and there existed no remarkable impairment of renal function. When eGFR was 60-89 mL/min, eGFR was mildly decreased, indicating a mild impairment of renal function. When eGFR was 30-59 mL/min, eGFR was moderately decreased, indicating a moderate impairment of renal function. At the same time, Stage 3 of chronic kidney disease is graded into Stage 3a and Stage 3b. Stage 3a corresponds to an eGFR of 45-59 mL/min, while Stage 3b corresponds to an eGFR of 30-44 mL/min. Beyond Stage 3b, the progression of kidney disease towards renal failure and uremia occurs at a significantly faster rate. When eGFR was 15-29 mL/min, eGFR was severely decreased, indicating severe renal function impairment. When eGFR was<15 mL/min, eGFR was extremely decreased, signifying renal function failure. Kidney disease had progressed to the uremic stage and preparations for renal replacement therapy were required.[14,15]

Follow-up

Patients were monitored for at least one-year post-treatment through methods such as telephone, WeChat, or clinic visits. The follow-up endpoints were progression to End-Stage Renal Disease (ESRD), a reduction in estimated Glomerular Filtration Rate (eGFR) of ≥50% compared with baseline kidney biopsy, or a doubling of serum creatinine relative to the levels at the time of kidney biopsy.

Safety evaluation

All adverse reactions that occurred during the treatment in all patients, including nausea, vomiting, gastrointestinal discomfort, rash, abnormal liver function and blood sugar abnormalities, were observed and recorded to assess the safety of the study. Statistical analysis was performed on the results.

Statistical Analysis

Data were processed using SPSS 26.0. Continuous variables were depicted through the mean±SD, with subsequent analysis performed using the *t*-test. Categorical variables were expressed either in terms of frequency or as a percentage and their contrast was conducted using the χ^2 test. The Kaplan-Meier method was used to analyze the cumulative kidney survival rates of the patients and survival curves were plotted accordingly. Statistical meaning was determined at $p<0.05$.

RESULTS

AME component analysis

Figure 2 illustrates the content of AME samples and standard samples. The OD values were graphed on the ordinate, while the concentrations of C7G were represented on the abscissa, thereby constructing a standard curve. The resulting regression equation, A=0.055C, with a R^2 value of 0.9950, signifies a robust linear correlation between the C7G densities ranging from 1.086 to 17.376 µg/mL and their corresponding OD measurements. The research results revealed that the main components were C7G (152.4 mg), Astrapterocarpan (117.4 mg), Ononin (97.8 mg) and Calycosin (47.4 mg). The total flavonoid content determined by HPLC was 46%, while that measured by UV spectrophotometry was 50%.

Treatment effectiveness in different groups: As demonstrated in Figure 3, the clinical TER in the control group was 76.47%. Among them, 13 patients were cured (24 hr-Upro reduction rate ≥30%, 24 hr-Upro<0.5), 16 patients were remarkably effectively treated (20%≤24 hr-Upro reduction rate<30%), 10 patients had an effective response (10%≤24 hr-Upro reduction rate<20%) and 12 patients were considered ineffective (24 hr-Upro reduction rate<10%). The clinical TER of the NI group was 84.31%, including 14 cases of complete recovery, 16 cases with significant improvement, 13 cases with effective relief and 8 cases deemed ineffective. In the AME group, the TER was 90.20%, comprising 16 cases of complete recovery, 18 cases with significant improvement, 12 cases with effective relief and 5 cases deemed ineffective. The therapeutic efficacy in the AME group was significantly higher, showing a notable difference compared with the control group and NI group (p<0.05).

Comparison on serum-related indicators

Changes in serum inflammatory factors

As shown in Figure 4, during week 0, no visible differences were shown in TNF-α, IL-6, IL-15 and hs-CRP for patients enrolled in various groups (p>0.05). After eight weeks of treatment, all evaluated indicators showed a downward trend in each group, with the AME group exhibiting a significantly greater reduction compared with control group and NI group (p<0.05).

Changes in immunoregulatory indexes

The statistical results for the immunoregulatory index were presented in Figure 5. At baseline, differences in TGF-β1 among all patients were not obvious (p>0.05). At week eight, TGF-β1 levels decreased significantly in all three groups compared with the baseline (week 0) (p<0.05). However, there were no significant differences in TGF-β1 levels among the groups at week 8 (p>0.05).

Cellular chemotactic and signal transduction indexes

Figure 6 explicated the cell chemotaxis and signaling indicators. At baseline, MCP-1 was similar for all patients (p>0.05). After 8-week treatment, MCP-1 was downregulated in all patients, exhibiting obvious differences to those at Week 0 (p<0.05). After 8 weeks of treatment, MCP-1 expression was downregulated in all patients, showing a significant difference compared with baseline (week 0) (p<0.05). At week 8, the reduction in MCP-1 levels was significantly greater in the AME group compared with the control group and NI group (p<0.05).

Changes in parameters associated with renal function

Changes in indicators related to renal function: Figure 7 compared the Scr and BUN in patients before and after distinct treatments. All patients had similar levels in Scr and Bun before they were treated, so p>0.05 was marked. After 4, 8, 24 and 48 weeks of treatment, Scr and BUN levels decreased in all patients, with significant differences compared with the baseline (week 0) (p<0.05). The reduction in Scr and BUN levels was significantly greater in the AME group compared with the control group and NI group (p<0.05).

Changes of urine and auxiliary analysis indexes

Figure 8A and Figure 8C illustrated the changes in 24 hr-Upro and the number of ARBC in urine of patients, respectively. 24 hr-Upro and the number of ARBC patients were similar before they were treated (p>0.05). In contrast, they all decreased after 8 weeks

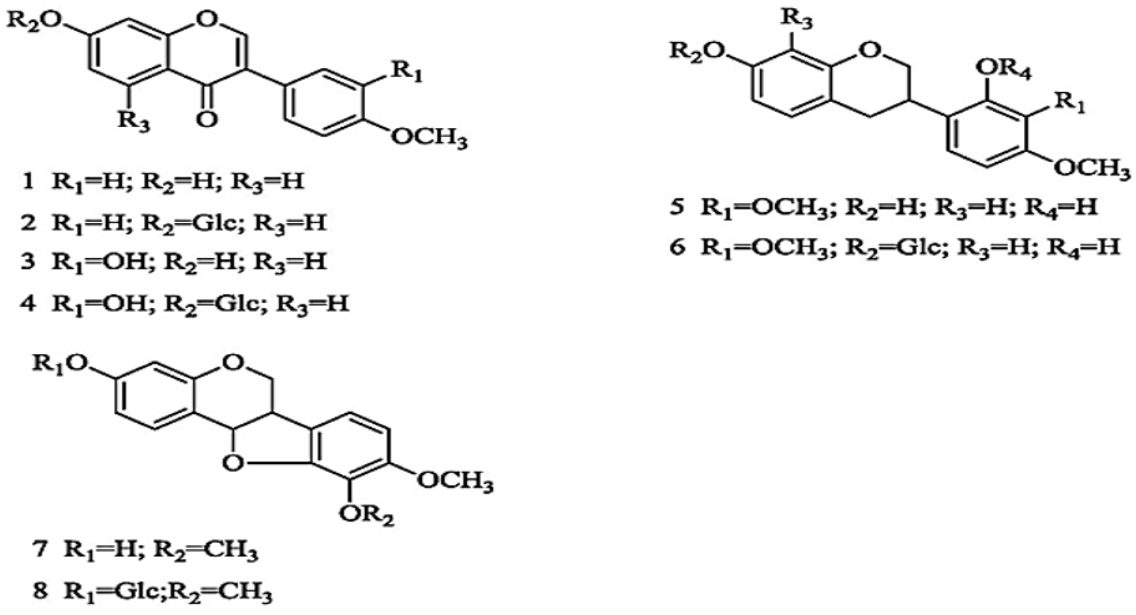

Figure 1: Chemical Formulas of Major Components in AME. 1: Ononin; 2: Ononin; 3: Calycosin; 4: C7G; 5: 7,2′-Dihydroxy-3′,4′-dimethoxyisoflavone; 6: 2′-Hydroxy-3′,4′-dimethoxyisoflavone-7-O-β-D-glucoside; 7: 3-Hydroxy-9,10-dimethoxy-phenanthrene; 8: 9,10-Dimethoxy-3-methylanthracene-3-O-β-D-glucoside.

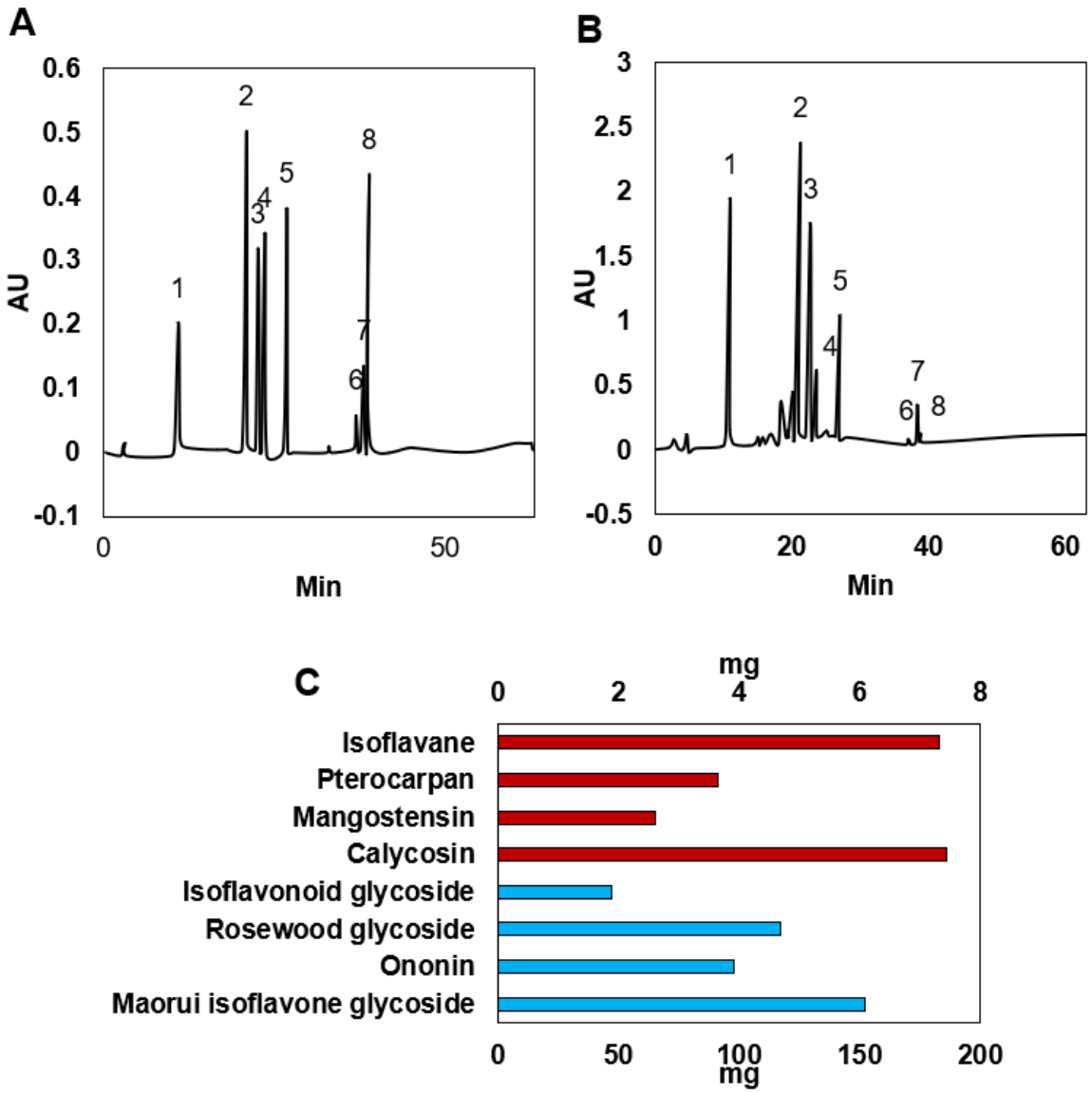

Figure 2: AME component analysis. A and B: HPLC chromatogram of standard samples and AME samples, respectively; C: content of each component in AME C7G. 1: Ononin; 2: Astrapterocarpan; 3: 2′-Hydroxy-3′; 4: 4′-dimethoxyisoflavone-7-O-β-D-glucoside; 5: Calycosin; 6: 3-Hydroxy-9; 7: 10-dimethoxy-phenanthrene; 8: 7,2′-Dihydroxy-3′,4′-dimethoxyisoflavone.

of treatment, showing marked distinctions ($p<0.05$). At weeks 4, 8, 24 and 48, the reduction in 24 hr-Upro and ARBC counts was more pronounced in the AME group, showing significant differences compared with control group and NI group ($p<0.05$) (Figure 8B). After 8 weeks of treatment, eGFR decreased in both groups, but no significant differences were observed ($p>0.05$).

Follow-up

The 1-year cumulative renal survival rate for the three groups was assessed using the Kaplan-Meier method, a statistical tool widely used for survival analysis. The results revealed survival rates of 88.2%, 90.5% and 94.1% for the three groups, respectively. Despite slight variations in survival rates, the analysis indicated no statistically significant differences among the groups, as determined by a p-value greater than 0.05. These findings suggest comparable renal outcomes across the study groups over the 1-year period. To better visualize these results, Figure 9 illustrates the cumulative kidney survival curves for the targeted groups. The graph demonstrates the trajectory of renal survival probabilities over time, highlighting the similar trends in kidney survival among the three groups, further supporting the statistical findings.

Safety

Adverse reactions that occurred during the treatment in all patients were statistically analyzed in Figure 10. Those in control group showed 3 patients (5.88%) with nausea and vomiting, 2 patients (3.92%) with gastrointestinal discomfort, 3 patients (5.88%) with rash, 1 patient (1.96%) with abnormal liver function and 1 patient (1.96%) with abnormal blood sugar. In the NI

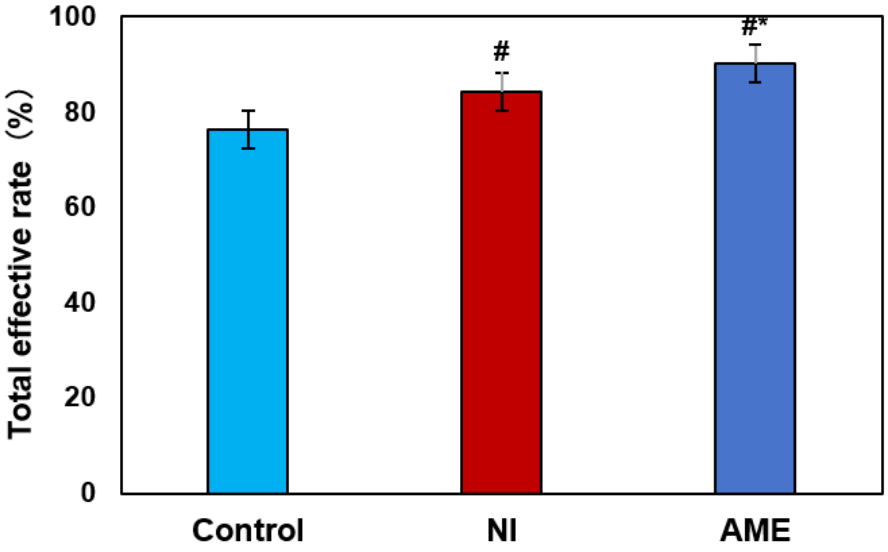

Figure 3: TER of patients after different treatments. Compared with control group, #$p<0.05$; compared with NI group, *$p<0.05$.

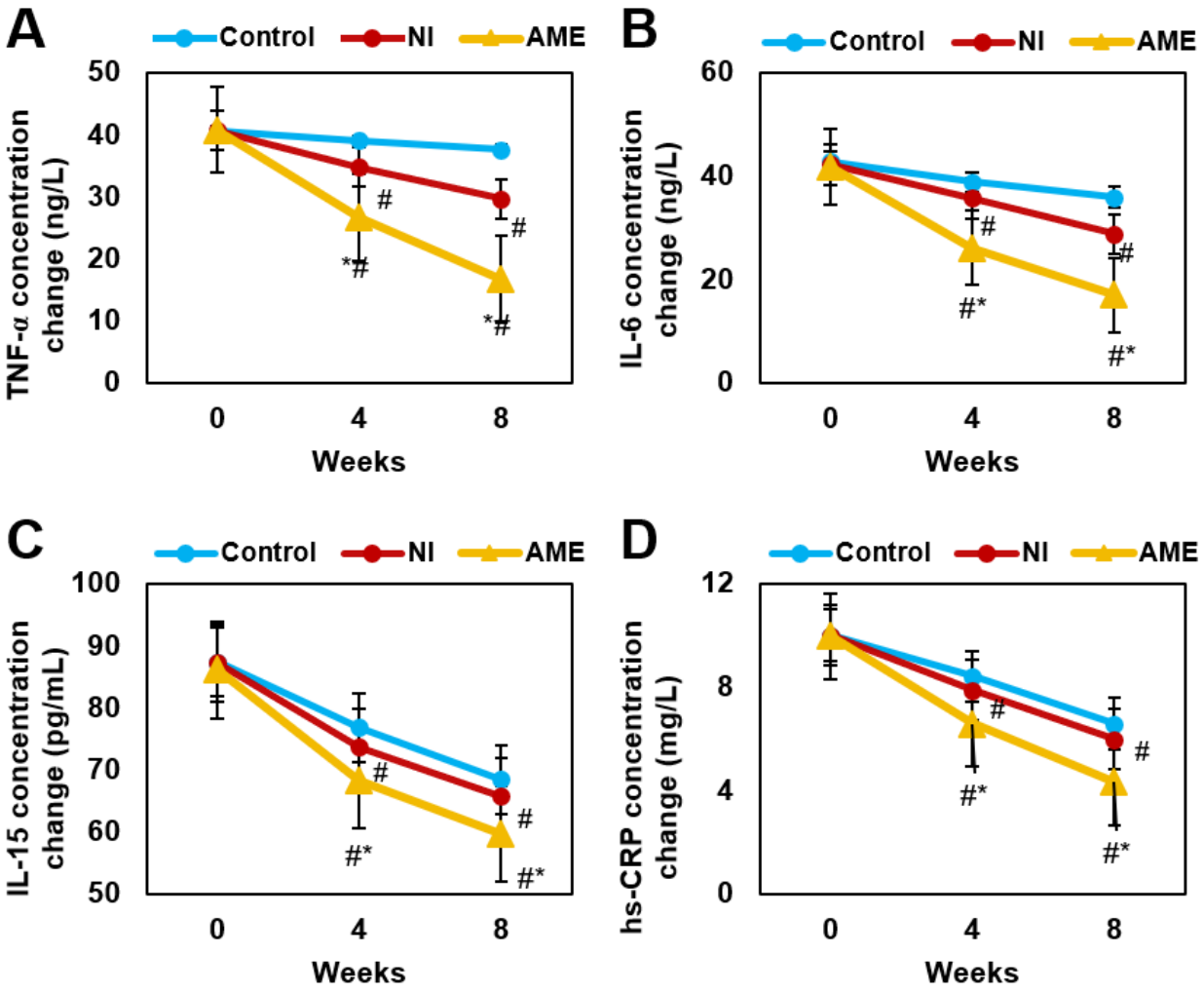

Figure 4: Changes in serum inflammatory factors. A: TNF-α, B: IL-6, C: IL-15 and D: hs-CRP. Compared with control group, #$p<0.05$; compared with NI group, *$p<0.05$.

group, there were 2 cases (3.92%) of nausea and vomiting, 3 cases (5.88%) of gastrointestinal discomfort, 1 case (1.96%) of rash and 1 case (1.96%) of liver function abnormalities. Whereas, the AME group included 3 patients (5.88%) with nausea and vomiting, 4 patients (7.84%) with gastrointestinal discomfort, 1 patient (1.96%) with rash and 1 patient (1.96%) with abnormal liver function. The above data demonstrated no visible distinction in Incidence of Adverse Reactions (IoAR) (p>0.05).

DISCUSSION

In this study, the influence of AME combined with nursing intervention on serum inflammatory factors and therapeutic effect in patients with IgA nephropathy was discussed. The results showed that the total effective rate of AME group was significantly higher than that of control group and NI group, the level of serum inflammatory factors was significantly decreased, the renal function index was significantly improved and the incidence of adverse reactions was not increased. These results showed that AME combined with nursing intervention had significant advantages in the treatment of IgA nephropathy.

Studies have shown that most of the primary glomerular diseases are IgA nephropathy,[16] and many studies have shown that metabolic syndrome can affect the development of IgA nephropathy.[17,18] Rajasekaran *et al.*, (2021)[19] pointed out that up to 40% of patients will progress to end-stage nephrosis. Life nursing can provide diet nursing, health education and exercise nursing for patients on the basis of drug treatment and can carry out follow-up records for patients, so as to improve the metabolic level of patients by improving their daily living habits.[20,21] Lafayette *et al.*, (2023)[22] pointed out that high-quality nursing can improve the development of IgA nephropathy and significantly reduce eGFR. This work explored the effect of AME combined with nursing intervention on serum inflammatory factors in patients with IgA nephropathy. The work showed that after two months of treatment, effectiveness was evaluated using 24 hr-Upro. Higher Upro is usually associated with glomerular injury and decreased renal function. Effective treatment can lead to a significant reduction in Upro, indicating a reduction in glomerular injury and renal function protection. In this work, the clinical TER of AME group was 90.20% and the therapeutic effect of AME group was significantly higher, which indicated that AME combined with nursing intervention played a more positive role in the treatment of IgA nephropathy than conventional drugs, which may be attributed to the pharmacological effect of AME. *Astragalus membranaceus* membrane can relieve renal inflammation,[23] and improve renal function, thereby enhancing the clinical efficacy of AME group.

TNF-α, IL-6, IL-15 and hs-CRP are commonly used as inflammatory biomarkers due to their pivotal roles in the inflammatory process. In patients with IgA nephropathy, inflammation may exacerbate kidney injury and contribute to disease progression. Gembillo *et al.*, (2021)[24] reported that the

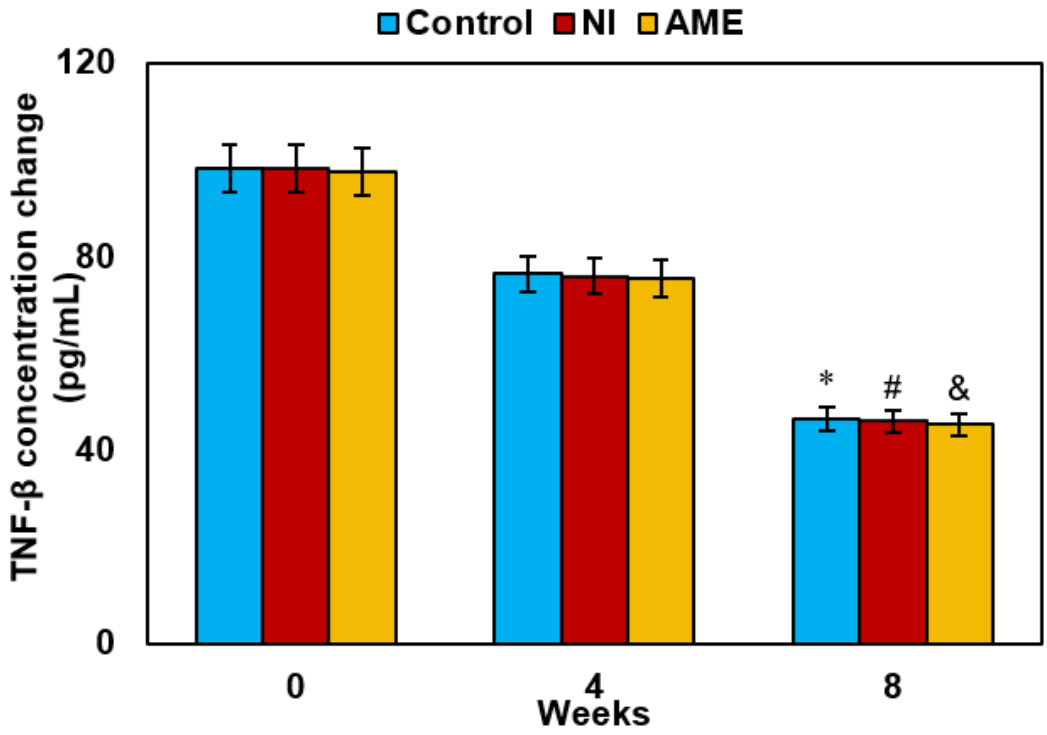

Figure 5: Changes in TGF-β1 level. Compared with the baseline (week 0) levels in the AME group, $^{\#}p$<0.05; compared with the baseline (week 0) levels in the NI group, $^{\&}p$<0.05; compared with the baseline (week 0) levels in the control group, $^{*}p$<0.05.

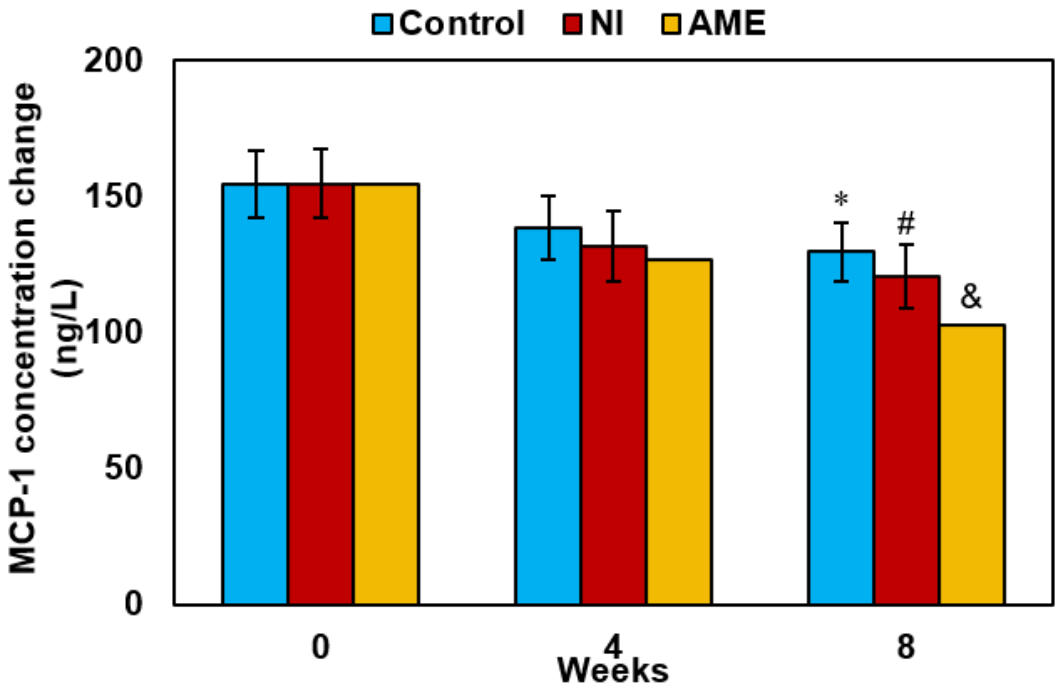

Figure 6: Changes in MCP-1 for patients before and after different treatments. Compared with the baseline (week 0) levels in the AME group, $^{\#}p<0.05$; compared with the baseline (week 0) levels in the NI group, $^{\&}p<0.05$; compared with the baseline (week 0) levels in the control group, $^{*}p<0.05$.

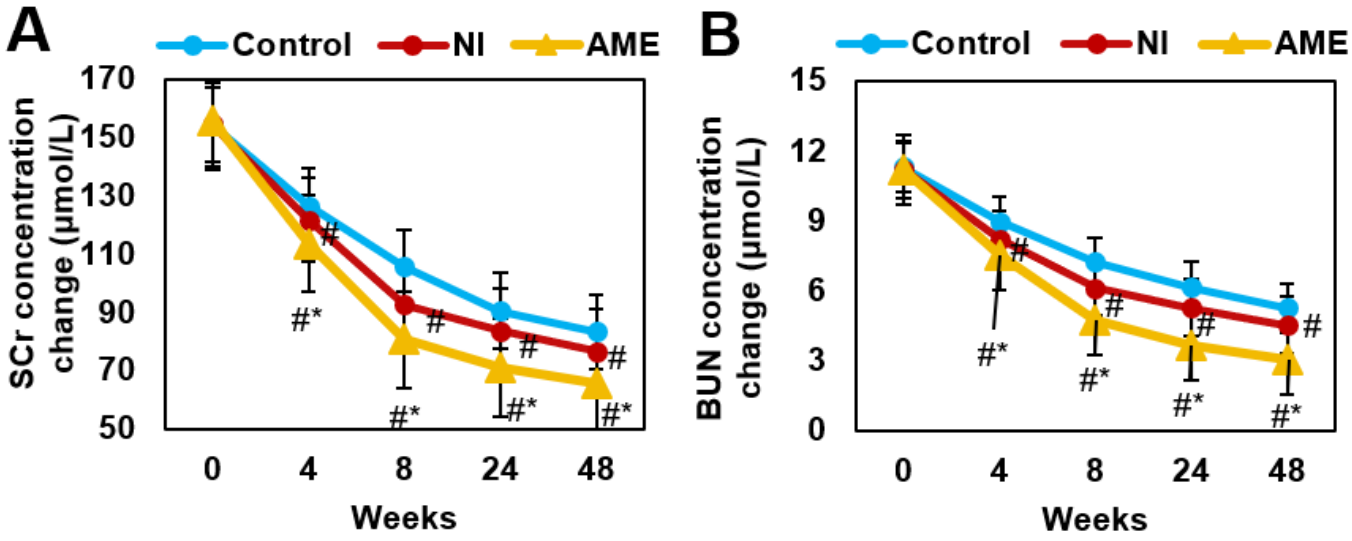

Figure 7: Comparison of indicators related to renal function. A: Scr; B: BUN. Compared with control group, #$p<0.05$; compared with NI group, *$p<0.05$.

activation of vitamin D can enhance the antiproteinuric effect of RAAS inhibitors in IgA nephropathy and bolster their therapeutic role in treating glomerulonephritis. This study found that after eight weeks of AME combined with nursing intervention, levels of inflammatory biomarkers decreased. Thus, Astragalus modulates the activity of immune cells, directly leading to a reduction in inflammatory biomarker levels. TGF-β1 plays a complex dual role in immune regulation. By suppressing cellular immune responses and reducing the reactivity of inflammatory cells, it effectively mitigates excessive immune activation and inhibits autoimmune phenomena.[25,26] In renal diseases, TGF-β1 is closely associated with the process of fibrosis. Elevated TGF-β1 activity leads to renal fibrosis and impairs kidney function.[27] The results of this study indicate that AME can influence TGF-β1 levels. D'Avino *et al.*, (2023)[28] confirmed that AME can inhibit the production of IL-1β, TNF-α and nitrite, thereby improving the development of asthma characteristics through its anti-inflammatory properties. This suggests that AME combined

with nursing intervention may alleviate the inflammatory state in patients by suppressing the inflammatory response, thereby improving kidney function. Adesso *et al.*, (2018)[29] demonstrated that AME exerts anti-inflammatory effects by inhibiting the activation of the NF-κB signaling pathway. Tang *et al.*, (2023)[30] showed that AME combined with Chuanqiong can promote the NR2B-ERK/CREB signaling pathway to suppress inflammation in thrombolytic cerebral ischemia rats and exert neuroprotective effects. These findings suggest that AME has anti-inflammatory effects; however, its specific anti-inflammatory mechanisms in the treatment of IgA nephropathy require further investigation.

MCP-1 is primarily produced by various cell types and plays a key role in immune and inflammatory responses. It is released to attract other immune cells to migrate to the site of inflammation.[31] This is very important in immune response and inflammatory response. It can promote the infiltration of inflammatory cells and enhance the inflammatory response. The results showed that AME could affect MCP-1 levels by regulating the activity of immune cells, thereby affecting the production and secretion of chemokines. This in turn affects the pathological process of patients with IgA nephropathy. The decrease of MCP-1 level after treatment reflects the effect of *Astragalus membranaceus* on inflammation and cell chemotaxis. Scr and BUN are the key to evaluate renal function, reflecting the status of glomerular filtration and excretion function.[32] The down-regulation of Scr and BUN means that AME may promote the enhancement of renal function by improving the pathological state of kidney and reducing inflammation.[33] The results showed that compared with the control group and NI group with nursing intervention alone, AME group had more advantages in reducing the excretion rate of SCr, BUN and urinary albumin in the treatment of diabetic nephropathy and improving the level of anti-fibrosis biomarker BMP-7, which shows that AME combined nursing intervention is superior to irbesartan and nursing intervention alone in enhancing renal function of IgA nephropathy patients. In renal diseases, the change of 24-hr Upro can reflect glomerular filtration function, renal tubular excretion function, renal pathological injury and some inflammatory and chronic renal diseases. The number of ARBCs in urine refers to the number of abnormal red blood cells in urine. The increase of ARBCs may be related to glomerular disease, renal tubular disease, urinary tract infection, kidney calculi and other diseases.[34] The results showed that compared with the control group and the NI group with nursing intervention alone, AME group showed significantly reduced urinary protein excretion and decreased number of ARBC in urine, thus better enhancing renal function. Under

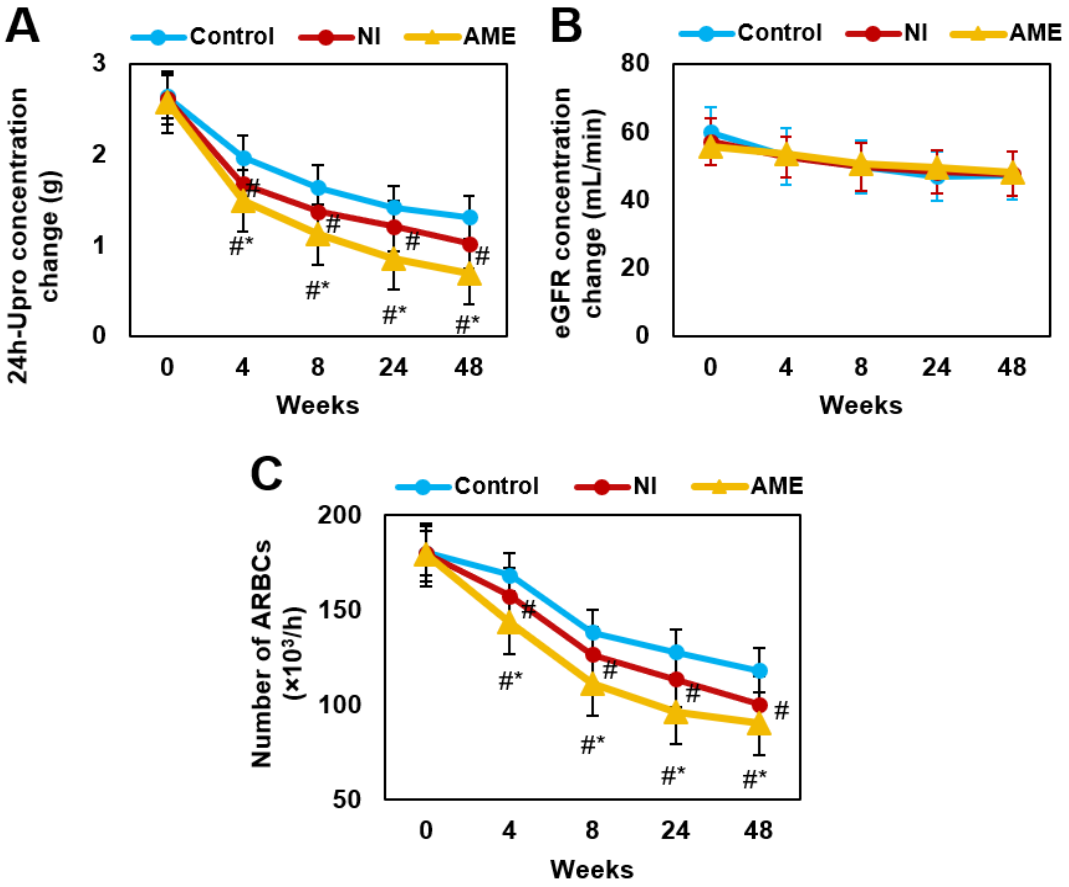

Figure 8: Changes of urine and auxiliary analysis indexes. A: 24 hr-Upro; B: eGFR; C: urinary malformation red blood cell count. Compared with control group, #$p<0.05$; compared with NI group, *$p<0.05$.

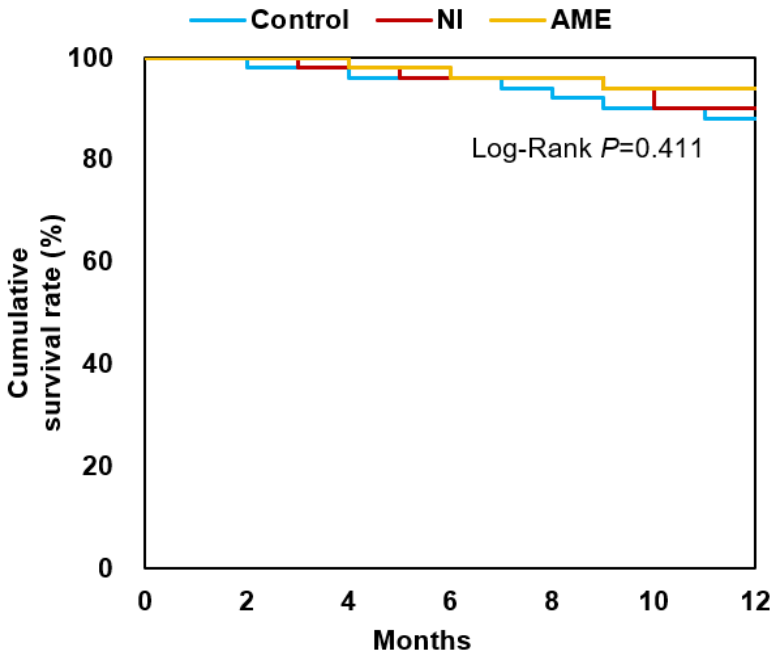

Figure 9: The cumulative kidney survival curves for the targeted groups.

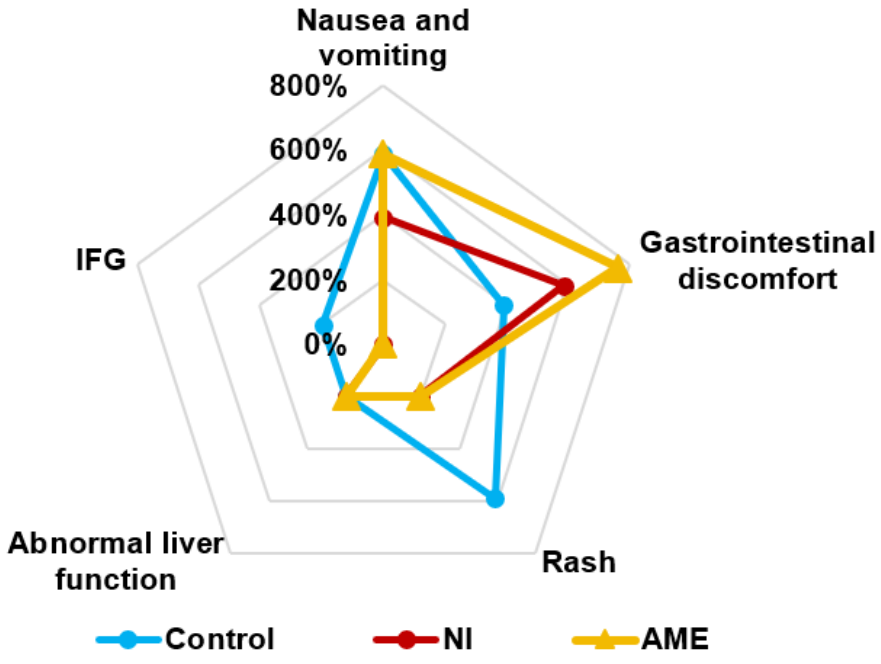

Figure 10: Comparison on IoAR of patients after distinct treatments.

the condition of irbesartan treatment and nursing intervention, the 24-hr urinary protein excretion and the number of ARBC in the NI group were improved, but the improvement degree was not as good as that in the AME group, which indicated that the nursing intervention itself had a positive effect on renal function, but the effect was limited. AME group added AME treatment on the basis of nursing intervention and its curative effect was significantly better than that of NI group only receiving nursing intervention, which indicated that the pharmacological action of AME could better play its therapeutic effect under the combined nursing intervention.

GFR reflects the filtration capacity of the kidney, that is, the efficiency of the kidney in filtering waste and substances.[35] Low GFR may indicate decreased renal function and requires close monitoring and treatment. This work analyzed the eGFR of patients. After 8 weeks of treatment, the eGFR of the subjects decreased slightly. This indicates that AME treatment combined with nursing intervention has no significant effect on eGFR of

patients in the short term. This may indicate that the short-term regulatory effect of *Astragalus membranaceus* on glomerular filtration function is relatively limited, or the treatment time may not be long enough to produce a significant effect. However, this study has certain limitations: (1) eGFR measurements are influenced by multiple factors, including Scr, age, sex and body surface area. A more in-depth analysis of the factors affecting the efficacy of AME in treating IgA nephropathy is needed. (2) The potential mechanisms underlying AME's effects in treating IgA nephropathy were not thoroughly explored. Therefore, future studies should be designed with more comprehensive research protocols to provide reference data for assessing the efficacy and safety of AME in the treatment of IgA nephropathy.

CONCLUSION

This study highlights the significant therapeutic potential of *Astragalus membranaceus* Extract (AME) combined with nursing intervention in improving clinical outcomes for patients with IgA nephropathy. The results demonstrated that AME, alongside irbesartan and comprehensive nursing care, significantly reduced serum inflammatory biomarkers such as TNF-α, IL-6, IL-15, hs-CRP and MCP-1, compared to irbesartan or nursing intervention alone. The pronounced anti-inflammatory effects of AME are likely attributable to its active components, including Calycosin-7-glucoside and Astrapterocarpan, which may modulate immune cell activity and suppress inflammatory signaling pathways such as NF-κB. Renal function parameters, including reductions in 24-hr urinary protein excretion, serum creatinine and blood urea nitrogen levels, further support the superior efficacy of AME. These improvements suggest that AME not only alleviates inflammation but also mitigates glomerular and tubular damage, promoting better kidney health. While the study observed no significant short-term impact on estimated Glomerular Filtration Rate (eGFR), the enhanced 1-year cumulative renal survival rate in the AME group underscores its potential in preserving long-term renal function. Importantly, the incorporation of nursing intervention amplified the therapeutic benefits of AME by addressing lifestyle factors, enhancing patient compliance and optimizing metabolic parameters. This comprehensive approach yielded a higher total effective rate and improved overall patient outcomes, with no significant increase in adverse reactions. AME combined with nursing intervention represents a promising strategy for managing IgA nephropathy by targeting inflammatory pathways and supporting renal function. Future research should explore the long-term effects of AME on eGFR and its detailed molecular mechanisms, paving the way for innovative treatment paradigms in nephrology. This integrated therapeutic approach could significantly improve quality of life and prognosis for patients with IgA nephropathy.

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None.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

HPLC: Performance Liquid Chromatography; **UV:** Ultraviolet Spectrophotometry; **C7G:** Calycosin-7-Glucoside; **TER:** Total Effective Rate; **TNF-α:** Tumor Necrosis Factor-Alpha**; IL:** Interleukin; **hs-CRP:** High-Sensitivity C-Reactive Protein; **MCP-1:** Monocyte Chemoattractant Protein-1; **TGF-β1:** Transforming Growth Factor-Beta1; **Upro:** Urine Protein Excretion; **Scr:** Serum Creatinine; **BUN:** Blood Urea Nitrogen; **ARBC:** Abnormal Red Blood Cells; **eGFR:** Epidermal Glomerular Filtration Rate; **IoAR:** Incidence Of Adverse Reactions; **FVB:** Fasting Venous Blood; **OD:** Optical Density.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the ethics committee of Honghu Traditional Chinese Medicine Hospital. Signed written informed consents were obtained from the patients and/or guardians.

SUMMARY

IgA nephropathy is a common immune-mediated renal disease and inflammatory factors play an important role in its progress. The purpose of this study is to explore the effect of AME combined with nursing intervention on IgA nephropathy patients. This work was randomly divided into three groups: control group, NI group and AME group. The control group received irbesartan treatment, NI group received irbesartan treatment, placebo and nursing intervention, while AME group received AME treatment in addition to the treatment of NI group. After two months of treatment, the clinical efficacy, serum inflammatory factors, renal function parameters and safety of the 3 groups were evaluated. It was found that compared with the control group and NI group, AME group had more advantages in reducing the level of serum inflammatory factors, improving renal function indexes and improving clinical efficacy and did not increase the incidence of adverse reactions. These results showed that AME combined with nursing intervention can better reduce urinary protein excretion and the number of abnormal red blood cells in urine and significantly enhance renal function, which provides strong support for further research on the application of AME in the treatment of IgA nephropathy and may provide a new direction for optimizing treatment.

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