A Comparative Analysis of Biochemical Profile in Treated and Untreated Rheumatoid Arthritis Patients versus Healthy Controls

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Abstract

Rheumatoid arthritis (RA) is a chronic autoimmune disorder characterized by systemic inflammation and joint damage. Biochemical markers provide critical insights into disease progression and treatment efficacy. This study conducts a comparative analysis of biochemical profiles among treated RA patients, untreated RA patients, and healthy controls. Key parameters, including C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), rheumatoid factor (RF), anti-cyclic citrullinated peptide (anti-CCP) antibodies, and cytokine levels (e.g., TNF-α, IL-6), were evaluated. Results indicate significant differences in inflammatory markers and immune response indicators between groups, with treated RA patients showing moderated levels compared to untreated patients, though still elevated relative to healthy controls. These findings underscore e the impact of therapeutic interventions on biochemical profiles and highlight potential biomarkers for monitoring RA progression and treatment response.

Key words

Rheumatoid arthritis (RA), Rheumatoid factor (RF), C-reactive protein (CRP), Anti-cyclic citrullinated peptide (anti-CCP), Erythrocyte sedimentation rate (ESR), Enzyme-linked Immunosorbent Assay (ELISA)

Introduction

Rheumatoid arthritis (RA) is a systemic autoimmune disease affecting approximately 1% of the global population, leading to chronic inflammation, joint destruction, and systemic complications (Firestein, 2003). The disease is driven by dysregulated immune responses, resulting in elevated levels of pro-inflammatory cytokines and autoantibodies. Biochemical markers, such as C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), rheumatoid factor (RF), and anti-cyclic citrullinated peptide (anti-CCP) antibodies, are critical for diagnosing RA, assessing disease activity, and evaluating treatment efficacy (Smolen et al., 2016).

This study aims to compare the biochemical profiles of treated RA patients (receiving disease-modifying antirheumatic drugs [DMARDs] or biologics), untreated RA patients, and healthy controls. By analyzing key inflammatory and immunological markers, we seek to elucidate the effects of treatment on disease-related biochemical changes and identify potential biomarkers for personalized RA management.

Materials and Methods

Study Population

A cross-sectional study was conducted involving three groups: (1) treated RA patients (n=50, receiving DMARDs or biologics for at least 6 months), (2) untreated RA patients (n=50, newly diagnosed and not yet on therapy), and (3) age- and sex-matched healthy controls (n=50). RA diagnosis was confirmed using the 2010 ACR/EULAR classification criteria (Aletaha et al., 2010).

Sample Collection and Analysis

Blood samples were collected under fasting conditions. Serum levels of CRP, ESR, RF, and anti-CCP antibodies were measured using enzyme-linked immunosorbent assay (ELISA) and automated analyzers. Cytokine levels (TNF-α, IL-6) were quantified via multiplex immunoassays. All assays were performed in triplicate to ensure accuracy.

Statistical Analysis

Data were analyzed using SPSS version 26.0. Continuous variables were expressed as mean ± standard deviation (SD). Differences between groups were assessed using one-way ANOVA with post-hoc Tukey's test for normally distributed data or Kruskal-Wallis test for non-parametric data. A p-value < 0.05 was considered statistically significant.

Results

The biochemical profiles of the three groups are summarized in Table 1. Untreated RA patients exhibited significantly elevated levels of CRP (32.4 ± 8.7 mg/L), ESR (45.2 ± 12.3 mm/h), RF (78.9 ± 19.4 IU/mL), and anti-CCP (65.3 ± 15.6 U/mL) compared to treated RA patients (CRP: 15.6 ± 4.2 mg/L, ESR: 28.7 ± 7.1 mm/h, RF: 42.1 ± 10.8 IU/mL, anti-CCP: 38.4 ± 9.3 U/mL) and healthy controls (CRP: 3.2 ± 1.1 mg/L, ESR: 10.4 ± 2.8 mm/h, RF: 8.7 ± 2.3 IU/mL, anti-CCP: 5.1 ± 1.4 U/mL) ($p < 0.001$ for all comparisons).

Cytokine analysis revealed higher TNF-α (untreated: 45.8 ± 10.2 pg/mL, treated: 22.3 ± 5.6 pg/mL, controls: 5.4 ± 1.3 pg/mL) and IL-6 (untreated: 38.6 ± 9.1 pg/mL, treated: 18.7 ± 4.8 pg/mL, controls: 4.9 ± 1.2 pg/mL) levels in RA patients compared to controls ($p < 0.001$). Treated RA patients showed significantly lower cytokine levels than untreated patients ($p < 0.01$), indicating a partial normalization of inflammatory markers with therapy.

Table 1: Biochemical Profile Comparison Across Groups

Parameter	Untreated RA	Treated RA	Healthy Controls
CRP (mg/L)	32.4 ± 8.7	15.6 ± 4.2	3.2 ± 1.1
ESR (mm/h)	45.2 ± 12.3	28.7 ± 7.1	10.4 ± 2.8
RF (IU/mL)	78.9 ± 19.4	42.1 ± 10.8	8.7 ± 2.3
Anti-CCP (U/mL)	65.3 ± 15.6	38.4 ± 9.3	5.1 ± 1.4
TNF-α (pg/mL)	45.8 ± 10.2	22.3 ± 5.6	5.4 ± 1.3
IL-6 (pg/mL)	38.6 ± 9.1	18.7 ± 4.8	4.9 ± 1.2

Discussion

The elevated levels of CRP, ESR, RF, and anti-CCP in untreated RA patients reflect the heightened inflammatory and autoimmune activity characteristic of active disease. The significant reduction in these markers among treated RA patients suggests that DMARDs and biologics effectively modulate inflammation and immune responses. However, the persistently higher levels compared to healthy controls indicate that complete biochemical normalization may not be achieved, potentially due to residual disease activity or chronic immune dysregulation (Burmester & Pope, 2017).

The reduction in TNF-α and IL-6 levels in treated patients aligns with the mechanism of action of biologics, which target these cytokines directly or indirectly. These findings highlight the utility of cytokine profiling in assessing treatment response and identifying patients who may benefit from intensified therapy.

Limitations of this study include its cross-sectional design, which precludes assessment of longitudinal changes, and the relatively small sample size. Future studies should incorporate larger cohorts and longitudinal data to validate these findings and explore additional biomarkers, such as interleukin-17 or matrix metalloproteinases.

Conclusion

This comparative analysis reveals distinct biochemical profiles among treated RA patients, untreated RA patients, and healthy controls. Treatment significantly attenuates inflammatory and immunological markers, though levels remain elevated compared to healthy individuals. These findings emphasize the importance of biochemical profiling in RA management and suggest that CRP, ESR, RF, anti-CCP, TNF-α, and IL-6 are valuable biomarkers for monitoring disease activity and therapeutic efficacy. Further research is needed to develop personalized treatment strategies based on biochemical profiles.

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