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ORIGINAL ARTICLES

Anti-mutated citrullinated vimentin antibodies as a biomarker for interstitial lung disease in patients wi-thrheumatoid arthritis

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ABSTRACT

Objectives: We aimed to assess the anti-mutated citrullinated vimentin (anti-MCV) antibodies in RA patients' serum and to explore their association with interstitial lung disease (ILD).
Methods: Eighty rheumatoid arthritis (RA) patients and forty healthy controls were included in this case-control study. Of these patients, forty had ILD, and forty without ILD. Patients were subjected to clinical and laboratory assessment, measurement of anti-MCV serum levels by ELISA, X-ray of hands and feet, pulmonary function tests, and high-resolution computed tomography (HRCT) of the chest.
Results: Increased serum level of anti-MCV antibodies was found in RA patients compared with the controls and in RA patients with ILD compared to those without ILD. The serum anti-MCV level was correlated positively with disease activity score 28 (DAS28), Larsen, erythrocyte sedimentation rate (ESR), and anti-citrullinated peptides antibodies (ACPA) and negatively with the diffusing capacity for carbon monoxide (DLCO), and forced vital capacity (FVC). Patients' age, disease duration, ACPA level, anti-MCV level, and anti-MCV positivity were predictors of ILD in our patients. At the 42.5 U/ml cut-off, the anti-MCV antibodies have 78.8% sensitivity and 80% specificity for RA, and at the 155.5 U/ml cut-off, their sensitivity is 80%, and their specificity is 75% for ILD.
Conclusion: Anti-MCV antibodies are increased in RA patients with ILD with high sensitivity and specificity; thus, they may represent a promising marker for early detection and prediction of RA-related ILD. In addition, anti-MCV antibodies positively correlate with the Larsen score; hence, they may be a valuable serological marker for predicting joint damage in RA patients. More research with large sample sizes is recommended to support our findings.

Keywords: Rheumatoid arthritis; Interstitial lung disease; Anti-MCV antibodies.

KEY MESSAGES

- Anti-MCV antibodies are a potentially valuable diagnostic marker for RA
- Anti-MCV antibodies may be a promising marker for RA- related ILD

INTRODUCTION

Rheumatoid arthritis is a relatively common autoimmune disease manifested by symmetric peripheral joint involvement. It frequently causes physical impairment and joint damage. Being a systemic illness, RA can cause a wide range of extra-articular manifestations, such as subcutaneous nodules, vasculitis, peripheral neuropathy, tiredness, pericarditis, lung involvement, and hematologic abnormalities[1]. ILD is a frequent extra-articular feature of RA, which occurs in between 4 and 50% of RA patients. The frequency of ILD has grown among RA patients, accounting for 13% of the total RA mortality. The diagnosis of ILD has been improved due to early detection by HRCT[2]. However, biomarkers predicting RA-related ILD are still unknown[3].

Reduced joint damage and adequate disease control can be achieved through early diagnosis and treatment of RA[4]. Therefore, searching for suitable serological markers and starting treatment as soon as possible is crucial to prevent complications and disability[5]. Numerous serological markers, including autoantibodies, are utilized to diagnose RA. However, the only antibodies widely accepted are those against ACPA and rheumatoid factor (RF)[6].

Nonetheless, several antibodies have been investigated in RA; these antibodies are specific to RA and target ACPAs. Since these antibodies were discovered, many studies explored the identity and presence of

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citrullinated proteins in RA patients' joints. The most well-recognized antigens that bind ACPAs are vimentin, alpha-enolase, Type II collagen (CII), citrullinated filaggrin, and fibrinogen[7]. These citrullinated peptides may be involved in specific pathways in the pathophysiology of RA since they bind to HLA-DR4 on antigen-presenting cells to activate T-lymphocytes[8].

One anti-citrullinated antibody that can be used as a serological marker for RA is the anti-MCV[6]. However, it's still unknown if the anti-MCV antibodies' overall diagnostic value is similar to ACPA's. Previous studies on ACPA and anti-MCV diagnostic accuracy revealed contradictory results[9]. The MCV is an intermediate filament found in the synovium and widely expressed by macrophages and mesenchymal cells. The protein is modified in the apoptotic macrophages. Deficient removal of the apoptotic material leads to increased antibodies to citrullinated vimentin[10].

Finding biomarkers valid for RA-related ILD could help in the early diagnosis, prediction of disease behaviour, appropriate evaluation, and guidance of therapy[11]. Previous studies highlighted the anti-MCV antibodies as a valuable serological marker for RA. Still, the reported results regarding the relationship between these autoantibodies and pulmonary fibrosis were inconclusive. Based on our information, only one previous study reported the relationship between these autoantibodies and ILD in patients with RA. Thus, our study is one of the few studies shedding light on the association between anti-MCV antibodies and RA-related ILD. We aimed to evaluate the anti-MCV antibodies in RA patients' serum and to explore their relation with ILD.

PATIENTS AND METHODS

Data collection and clinical evaluation

Our study is a case-control study. Forty healthy controls (87.5% females and 12.5% males) and eighty RA patients (90% females and 10% males) diagnosed by the American College of Rheumatology ACR /EULAR RA classification criteria 2010[12] were enrolled in our study (forty patients had ILD and forty without ILD). RA patients were recruited from our university hospital's rheumatology and rehabilitation department from June 2023 to June 2024. The Faculty of Medicine's ethical committee approved the study. We acquired informed written consent from all participants. Smokers, patients with any systemic or autoimmune disease other than RA, and patients with pulmonary affection other than ILD were excluded from the study. Demographic and clinical data about each participant were collected, medical and rheumatologic history was taken, and general and rheumatologic examinations were done. The DAS28 assessed the disease activity, considering 28 tender and swollen joint counts, ESR, and visual analog scale[13].

Laboratory investigations

Routine laboratory measures were performed for all patients, including complete blood count (CBC), C-reactive protein (CRP), ESR, alanine aminotransferase (ALT), aspartate aminotransferase (AST), and serum creatinine. RF and ACPA were assessed in the serum using the ELISA. Following the manufacturer's procedure, we measured the anti-MCV antibodies in the patients' serum using the human anti-MCV antibody ELISA Kit (Cat. No. CSB-E09565h; Cusabio). Antibody levels greater than 20 U/ml were regarded as positive.

Radiological assessment

X-rays of both hands and feet were used to calculate the modified Larsen score[14]. The maximum score is 160. HRCT was used to diagnose ILD.

We assessed the lungs by pulmonary function tests, including DLCO, FVC, forced expiratory volume in one second (FEV1), and total lung capacity (TLC).

Statistical Analysis

We performed the statistical analysis of our data using version 24 statistical package (IBM-SPSS). We represented the data as numbers, percentages, median, mean, and standard deviation (SD). For normally distributed quantitative data, we used the independent-sample t-test to compare the means between the two groups. For non-normally distributed quantitative data, we used the Mann–Whitney test. The chi-square test was used to compare percentages of qualitative variables. The Spearman's Rho test was utilized for correlations. According to the correlation coefficient (r), we classified the correlation into negligible correlation (r from 0.00 to 0.10), weak correlation (r from 0.10 to 0.39), moderate correlation (r from 0.40 to 0.69), strong correlation (r from 0.70 to 0.89), and very strong correlation (r from 0.90 to 1.00)[15]. The receiver operating characteristic (ROC) curve was done through the bi-dimensional plot of the sensitivity versus 1-specificity, and the optimal cut-off point was selected as the value that maximizes the sensitivity and specificity and minimizes the difference between them[16, 17]. We used the logistic regression analysis to examine the association between ILD and different variables.

RESULTS

Demographic and laboratory data of the participants

The study involved 80 rheumatoid arthritis patients

TABLE I. Demographic and Laboratory data of the participants

Parameters	Patients (n=80) (Mean±SD, or n(%))	Controls (n=40) (Mean±SD, or n(%))	P Value
Age (years)	44.49±6.63	43.23±6.48	0.324
Sex			
Females	72 (90%)	35 (87.5%)	0.678
Males	8 (10%)	5 (12.5%)	
Systolic blood pressure (mm Hg)	113.13±7.52	113.25±6.15	0.928
Diastolic blood pressure (mm Hg)	74.06±7.03	73.5±6.99	0.680
ESR (mm/h), median (min-max)	41.5 (10-120)	18 (4-27)	**<0.001***
CRP (mg/dl), median (min-max)	7 (1-55)	4 (0.2-8)	**<0.001***
Hemoglobin (g/dl)	11.64±1.54	11.75±1.03	0.677
WBC (10^3/mm^3)	7.35±2.83	7.58±0.96	0.624
Platelets (10^3/mm^3)	270.46±52.56	264.2±42.59	0.515
Serum creatinine (mg/dl)	0.76±0.21	0.8±0.23	0.343
AST (U/L)	20.95±4.74	19.95±3.23	0.232
ALT (U/L)	25.46±5.9	23.73±5.44	0.122
Anti-MCV (U/ml), median (min-max)	158 (6-296)	15.5 (6-190)	**<0.001***

ESR, erythrocyte sedimentation rate; CRP, C reactive protein; WBCs, white blood cells; AST, aspartate aminotransferase; ALT, alanine aminotransferase; Anti-MCV, anti-mutated citrullinated vimentin; min, minimum; max, maximum. * significant at p< 0.001.

(90% females and 10% males). The patients' mean age was 44.49±6.63, and their mean systolic and diastolic blood pressure were 113.13±7.52, and 74.06±7.03 respectively, with no statistically significant differences regarding age, sex, systolic and diastolic blood pressure, hemoglobin, platelet, WBC, AST, ALT, and serum creatinine between the cases and controls. However, significant differences were noticed between patients and controls regarding ESR (p<0.001), CRP (p<0.001), and serum anti-MCV antibody levels (p<0.001) (Table I).

Clinical and therapeutic data of the patients

Regarding the clinical data of the RA patients, the average disease duration was 8.11±3.86. 63.8% had morning stiffness, 81.2% had arthralgia, 60% had arthritis, and 2.5% had rheumatoid nodules. The mean DAS28 of the studied patients was 4.06±1.28, the mean Larsen score was 53.58±28.29, the mean RF titer was 109.35±138.7, and ACPA was 79±71.96 (Table II). Regarding the therapeutic data of patients without ILD, 55%, 42.5%, 25%, 12.5%, 15%, 20%, and 15% were receiving methotrexate, leflunomide, hydroxychloroquine, etanercept, golimumab, baricitinib, and corticosteroids respectively (Figure 1a). For patients with ILD, 32.5%, 20%, 15%, 27.5%, 45%, and 5% were receiving mycophenolate mofetil, baricitinib, tocilizumab, cyclophosphamide, corticosteroids, and rituximab respectively (Figure 1b).

TABLE II. Clinical and immunological data of the patients

Parameters	Patients (n=80), (Mean±SD, or n(%))
Disease duration (years)	8.11±3.86
Morning stiffness	51 (63.8%)
Arthralgia	65 (81.2%)
Arthritis	48 (60%)
Rheumatoid nodules	2 (2.5%)
DAS28	4.06±1.28
Larsen	53.58±28.29
RF (U/mL)	109.35±138.7
ACPA (U/mL)	79±71.96

DAS28, disease activity score for 28 joints; RF, rheumatoid factor; ACPA, anticitrullinated protein antibodies.

Comparison of clinical and laboratory data between patients with ILD and those without ILD

When patients with ILD compared with those without ILD, significant differences were noticed regarding disease duration (p=0.009), DAS28 (p=0.001), Larsen score (p<0.001), FVC (p<0.001), FEV1 (p<0.001), DLCO (p<0.001), TLC (p<0.001), ESR (0.024), CRP (0.001), RF (p=0.001), ACPA (p<0.001), and anti-MCV (p<0.001) (Table III).

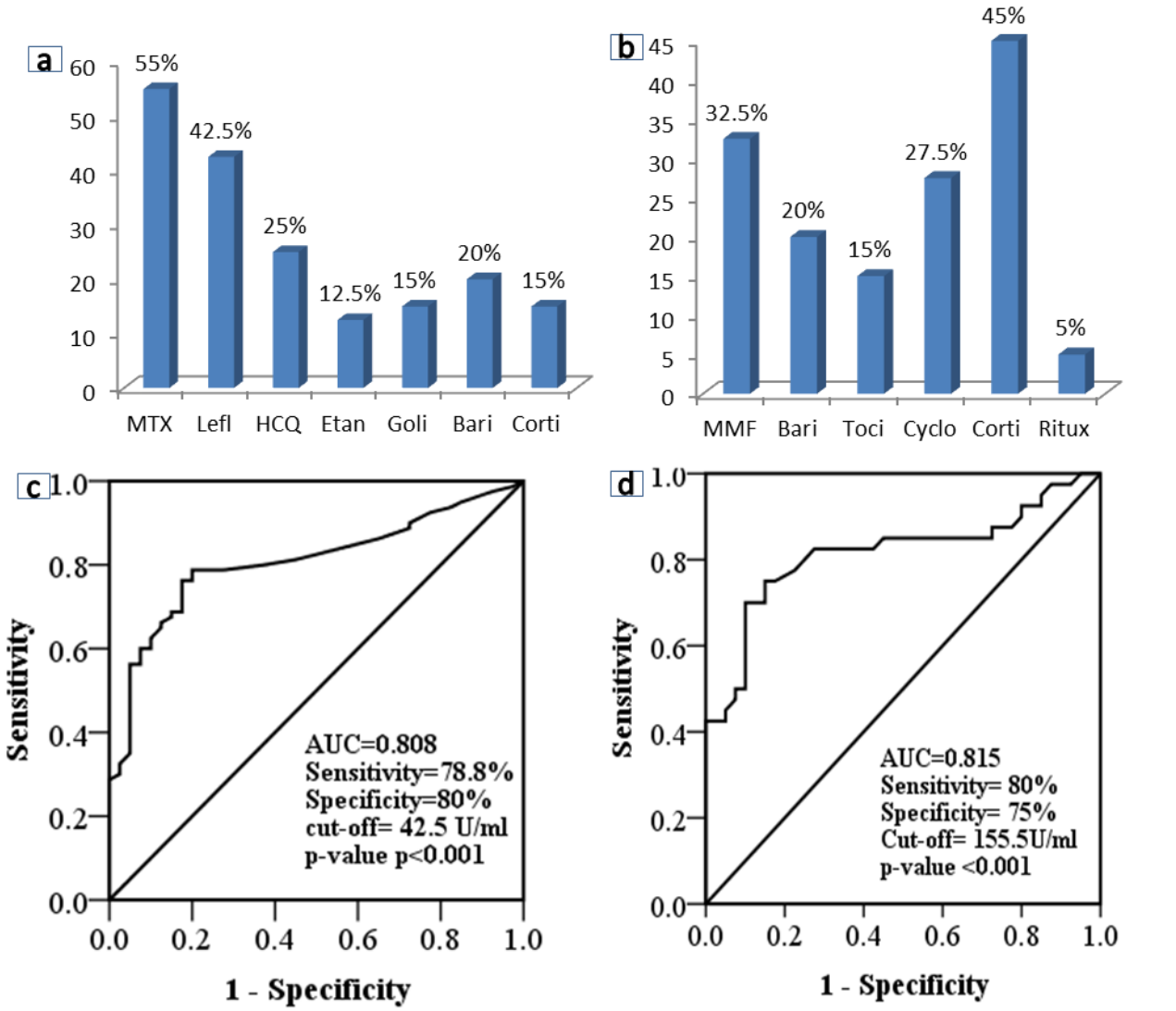

Figure 1. a) Drugs used by patients without ILD b) Drugs used by ILD patients c) ROC curve analysis of anti-MCV for RA d) ROC curve analysis of anti-MCV for ILD MMF, mycophenolate mofetil; Bari, baricitinib; Toci, tocilizumab; Cyclo,cyclophosphamide; Corti, corticosteroids; ritux, rituximab; MTX, methotrexate; Lefl, leflunomide; HCQ, hydroxychloroquine; Etan, etanercept; Goli, golimumab.

Correlation of serum anti-MCV level with the clinical and laboratory data of patients with ILD

The serum anti-MCV level was correlated positively with DAS28 (r=0.368, p=0.019), Larsen score (r=0.529, p<0.001), ACPA (r=348, p=0.028), ESR (r=0.362, p=0.022), and negatively with FVC (r=-0.418, p=0.007), and DLCO (r=-385, p=0.014) (Table IV).

Analysis of factors predicting ILD in our patients

Logistic regression analysis of factors affecting the incidence of ILD revealed that the patients' age, disease duration, ACPA, anti-MCV level, and anti-MCV positivity were risk factors for developing ILD among RA patients (Table V).

ROC curve analysis of serum anti-MCV antibodies for rheumatoid arthritis and ILD

ROC curve analysis of anti-MCV for the diagnosis of RA showed that at 42.5 U/ml cut-off, the AUC was 0.808, with 78.8% sensitivity and 80% specificity (p<0.001) (figure 1c). In addition, the ROC curve analysis of anti-MCV for the prediction of ILD showed that at 155.5 U/ml cut-off, the AUC was 0.815, with 80% sensitivity and 75% specificity (p<0.001) (Figure 1d)

TABLE III. Comparison between patients with ILD and those without ILD regarding clinical and laboratory data

Parameters	Patients with ILD (n=40), (Mean±SD)	Patients without ILD (n=40), (Mean±SD)	P Value
Age (years)	45.8±7.78	43.18±4.99	0.076
Systolic blood pressure (mm Hg)	113.5±8.56	112.75±6.4	0.658
Diastolic blood pressure (mm Hg)	73.75±6.28	74.38±7.78	0.694
Disease duration (years)	9.22±3.91	7±3.51	**0.009****
DAS28	4.54±1.36	3.58±1.02	**0.001****
Larsen, median (min-max)	64 (20-120)	38 (17-63)	**<0.001*****
FVC (% of predicted)	70.13±8.36	84.13±1.86	**<0.001*****
FEV1 (% of predicted)	73.18±7.83	83.68±2.42	**<0.001*****
DLCO (% of predicted)	58.93±13.46	84.4±2.23	**<0.001*****
TLC (% of predicted)	66.5±7.12	83.18±2.36	**<0.001*****
ESR (mm/h), median (min-max)	47.5 (10-120)	40 (10-92)	**0.024***
CRP (mg/dl), median (min-max)	11 (1-55)	4 (1-51.7)	**0.001****
RF (U/mL), median (min-max)	96 (6-512)	32 (3-256)	**0.001****
ACPA (U/mL), median (min-max)	129 (10-260)	27.5 (4-200)	**<0.001*****
Anti-MCV (U/ml), median (min-max)	190 (8-296)	119 (6-220)	**<0.001*****

DAS28, disease activity score for 28 joints; FVC, forced vital capacity; FEV1, forced expiratory volume in one second; DLCO, diffusing capacity for carbon monoxide; TLC, total lung capacity; ESR, erythrocyte sedimentation rate; CRP, C reactive protein; RF, rheumatoid factor; ACPA, anticitrullinated protein antibodies; Anti-MCV, anti-mutated citrullinated vimentin; min, minimum; max, maximum. * significant at p<0.05, ** significant at p<0.01, *** significant at p<0.001.

TABLE IV. Correlation of serum Anti-MCV level with the clinical and laboratory data in patients with ILD

Parameters	Correlation Coefficient (r)	P Value
Age	0.307	0.054
Disease duration	0.083	0.612
DAS28	**0.368***	**0.019**
Larsen	**0.529****	**<0.001**
FVC	**-0.418****	**0.007**
FEV1	-0.141	0.384
DLCO	**-0.385***	**0.014**
TLC	-0.265	0.098
ESR	**0.362***	**0.022**
CRP	0.289	0.070
RF	0.252	0.117
ACPA	**0.348***	**0.028**

DAS28, disease activity score for 28 joints; FVC, forced vital capacity; FEV1, forced expiratory volume in one second; DLCO, diffusing capacity for carbon monoxide; TLC, total lung capacity; ESR, erythrocyte sedimentation rate; CRP, C reactive protein; RF, rheumatoid factor; ACPA, anticitrullinated protein antibodies.

DISCUSSION

Rheumatoid arthritis is an autoimmune disease with fibro-inflammatory manifestations affecting different organs and tissues, including the lungs[11]. ILD is a relatively common extra-articular feature of RA[18]. The cumulative incidence of ILD through twenty years is 15.3% or one in every six RA patients[19]. Patients developing ILD exhibited greater incidences of mortality and morbidity than those without ILD[2, 3]. Several serum biomarkers were related to developing ILD, but few have been assessed, discriminating RA-related ILD from other pulmonary affections or prognosticated the disease course[20]. Patients with chronic lung illnesses, including interstitial pneumonia and idiopathic pulmonary fibrosis, have been found to have a higher incidence of anti-MCV positivity. However, these antibodies' clinical significance is still unknown[21].

Several previous studies highlighted the role of anti-MCV antibodies as a valuable diagnostic marker for RA and mentioned the relation between these autoantibodies and joint damage. Other studies suggested the implication of anti-MCV antibodies in lung fibrosis in patients with idiopathic pulmonary fibrosis (IPF). However, to our knowledge, only one previous study conducted by Tian et al.[3] explored the relationship between anti-MCV antibodies and RA-related ILD. Still, they did not determine the sensitivity and specificity of these autoantibodies to RA-related ILD. Thus, our study is one of the few studies aiming to evaluate the anti-MCV antibodies in RA patients' serum and determine the relationship between these autoantibodies

TABLE V. Logistic regression analysis of factors affecting the incidence of ILD in our patients

Parameters	B	S.E.	Wald	P Value	OR	95% C.I.	
						Lower	Upper
Age	-0.157	0.066	5.648	**0.017**	0.855	0.751	0.973
Gender	0.271	1.636	0.027	0.869	1.311	0.053	32.354
Disease duration	0.322	0.163	3.895	**0.048**	1.380	1.002	1.899
DAS28	0.028	0.487	0.003	0.954	1.028	0.396	2.673
Larsen	0.057	0.029	3.835	0.050	1.058	1.000	1.120
ESR	-0.014	0.022	0.401	0.527	0.986	0.946	1.029
CRP	0.044	0.041	1.168	0.280	1.045	0.965	1.131
RF	0.000	0.005	0.000	0.984	1.000	0.991	1.009
RF positivity	-0.560	1.038	0.291	0.590	0.571	0.075	4.368
ACPA	0.027	0.011	6.081	**0.014**	1.028	1.006	1.050
ACPA positivity	-1.348	1.119	1.451	0.228	0.260	0.029	2.329
Anti-MCV	0.062	0.021	8.713	**0.003**	1.064	1.021	1.109
Anti-MCV positivity	-9.644	3.477	7.695	**0.006**	0.000	0.000	0.059

DAS28, disease activity score for 28 joints; ESR, erythrocyte sedimentation rate; CRP, C reactive protein; RF, rheumatoid factor; ACPA, anticitrullinated protein antibodies; Anti-MC, anti-mutated citrullinated vimentin; OR, odds ratio.

and RA-related ILD.

We found significantly high serum levels of anti-MCV antibodies in RA patients compared to the controls (p<0.001). Our findings agree with Reyes-Pérez et al., Mohammed et al., and Hagras et al.[22-24]. Our patients showed higher ESR and CRP levels than controls (p<0.001). Our findings agree with Shen et al. and Nigm et al.[25, 26]. In addition, the serum levels of anti-MCV antibodies were higher among RA patients with ILD than those without ILD (p<0.001). Our findings agree with Tian et al.[3], who found higher anti-MCV antibodies in RA patients with ILD than those without ILD. Moreover, Yang et al. found higher serum anti-MCV antibodies in IPF patients than in healthy controls and suggested a possible role for anti-MCV antibodies in lung injury[27]. Also, Le Guen et al. reported high serum anti-MCV antibody levels in IPF[21].

Although the exact pathophysiology of RA-related ILD is still unknown, it is suggested that the autoimmune process stimulates the molecular pathways of the lung, including chemokines, cytokines, and growth factors promoting aberrant wound healing mechanisms, with proliferation and differentiation of fibroblasts, leading to excessive production and deposition of extracellular matrix and enhanced activity of matrix metalloproteinases resulting in ILD development[28]. Fibroblasts play a nearly similar role in synovitis pathogenesis. Citrullinated vimentins activate NF-κB in a TLR4-dependent manner, enhancing the production of active TGF-β1 and IL-8 with increased TLR4 surface expression in lung fibroblasts[29]. A previous study proved the presence of citrullinated vimentin peptides in tissue samples from the lungs and synovial biopsies of RA patients[30]. These findings suggest a possible role for citrullinated vimentin in pulmonary fibrosis in RA patients and support our results regarding the value of anti-MCV antibodies as a marker for RA-related ILD.

According to our findings, patients with ILD have increased disease duration (p=0.009), DAS28 (p=0.001), Larsen score (p<0.001), ESR (p=0.024), CRP (p=0.001), RF (p=0.001), and ACPA (p<0.001) when compared with those without ILD. Koduri et al. suggested that severe forms of RA, with erosive joint disease, rheumatoid nodules, and high levels of acute phase reactants, may predispose to the development of ILD[31]. Previous studies reported that increased disease activity and duration, positive RF, and anti-CCP are all risk factors for ILD[32, 33]. Patients in the ILD group have decreased pulmonary functions, including FVC, FEV1, DLCO, and TLC, compared to those without ILD (p<0.001). Zamora-Legoff et al. found progressive deterioration of pulmonary functions in patients with RA-related ILD[34]. A restrictive pattern of pulmonary functions was reported by Spagnolo et al. in RA patients with ILD[35].

According to our findings in the ILD group, the patients' anti-MCV antibodies serum levels were inversely correlated with the respiratory function tests, including FVC and DLCO, and positively correlated with their DAS28, Larsen score, ESR, and ACPA. A previous study reported negative correlations between pulmonary functions and anti-MCV antibodies in IPF

patients[36]. Other studies supporting our results documented that the anti-MCV serum levels were positively correlated with predictors of RA disease severity and activity measures such as DAS-28, ESR, CRP, RF, and ACPA[23, 24]. Previous studies documented that anti-MCV antibodies can predict RA disease progression and radiological joint damage[37, 38]. Our results emphasize the critical role of anti-MCV antibodies in joint damage and disease severity, and this can be explained by the fact that anti-MCV antibodies promote osteoclastogenesis and bone loss and that elevated levels of these autoantibodies were linked to increased blood levels of markers associated with cartilage and bone degradation[39, 40].

Among our RA patients, age, disease duration, serum ACPA levels, serum anti-MCV levels, and anti-MCV positivity were risk factors for developing ILD. Our findings agree with Tian et al., who reported that anti-MCV antibodies are potential predictors for RA-related ILD[3]. Samhouri et al. mentioned that age at disease onset, smoking, and severe extra-articular manifestations are considered risk factors for RA-related ILD[19]. Tekaya et al. found that increased disease activity, smoking, and ACPA positivity are risk factors for RA-related ILD[41]. A novel meta-analysis concluded that older age at disease onset, smoking, RF and ACPA positivity, and high ESR, CRP, RF, or ACPA titer were associated with RA-related ILD[42]. Another more recent meta-analysis reported that older age, male sex, smoking, pulmonary comorbidities, longer disease duration, DAS28 ≥3.2, rheumatoid nodules, high ESR, positive RF or ACPA are all risk factors for RA-related ILD[43]. Mixed findings were reported regarding ESR, CRP, RF, and ACPA, with a tendency for patients with RA-related ILD to be more seropositive and have higher acute phase reactants and autoantibody titer[20].

According to our findings, ROC curve analysis of anti-MCV antibodies for RA diagnosis showed that at 42.5 U/ML cut-off, the AUC was 0.808, with 78.8% sensitivity and 80% specificity. In agreement with our findings, a meta-analysis concluded that the anti-MCV antibodies had a sensitivity of 71% and a specificity of 89% for RA, with a comparable diagnostic significance to RF and anti-CCP; hence, it may be a valuable diagnostic marker for RA, and may be added to the future classification criteria[44]. Another study by Mohammed et al. reported that anti-MCV had a sensitivity of 63% and a specificity of 83% for diagnosing early RA[23].

Our study is the first to shed light on the sensitivity and specificity of anti-MCV antibodies for RA-related ILD. The 155.5 u/ml is the cut-off point at which the anti-MCV antibodies showed the maximum sensitivity (80%) and specificity (75%) for ILD. Such findings may help predict RA patients with a high risk of developing ILD. Those patients should be regularly checked, early, and strictly managed, and avoid any medication predisposing them to ILD.

Limitations of the study: lack of follow-up to determine the effect of therapy on ILD and the serum level of anti-MCV antibodies.

CONCLUSION

Anti-MCV antibodies are increased in RA patients with ILD with high sensitivity and specificity; thus, they may represent a promising marker for early detection and prediction of RA-related ILD. In addition, anti-MCV antibodies positively correlate with the Larsen score; hence, they may be a valuable serological marker for predicting joint damage in RA patients. More research with large sample sizes is recommended to support our findings.

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