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ORIGINAL ARTICLE

Lung involvement is a risk factor for treatment resistance in patients with polymyositis and dermatomyositis

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ABSTRACT

Objectives: This study aimed to investigate the factors that lead to treatment change in patients with polymyositis (PM) and dermatomyositis (DM) and to present its contribution to our clinical approach.

Patients and methods: A retrospective analysis was conducted on 141 patients (103 females, 38 males; mean age: 51.2±14.3 years; range, 22 to 74 years) diagnosed with PM (n=87; 61 females, 26 males; mean age: 50.2±13.4 years; range, 22 to 74 years) or DM (n=54; 42 females, 12 males; mean age: 52.7±15.8 years; range, 22 to 72 years) between January 2003 and May 2024. Patients were evaluated for treatment changes, reasons for these changes, and disease characteristics, including disease duration, creatine kinase, erythrocyte sedimentation rate, and C-reactive protein levels.

Results: Treatment changes were observed in 86 (60.9%) patients, comprising 58 (67%) PM and 28 (33%) DM cases. The primary reasons for treatment modification included drug intolerance in nine (10.5%) patients and uncontrolled disease in 77 (89.5%) patients. Among the uncontrolled patients, 34 (44.7%) exhibited lung involvement, 16 (21%) had peripheral joint involvement, one (1.3%) cardiac involvement, and 26 (34.3%) showed increased muscular symptoms. Statistical analysis revealed that lung involvement was an independent risk factor influencing the necessity for medication changes, while other analyzed factors exhibited no significant impact.

Conclusion: The findings underscore the critical role of lung involvement in the management of PM and DM, highlighting the need for heightened awareness of respiratory symptoms in these patients. These results provide valuable insights for clinical practice, emphasizing the importance of individualized treatment strategies in managing PM and DM patients.

Keywords: Dermatomyositis, lung involvement, polymyositis, treatment resistance.

Polymyositis (PM) and dermatomyositis (DM) are heterogeneous diseases characterized by proximal muscle weakness and signs of inflammation in muscle tissue. Although muscle and skin involvement is common, involvement of organs such as the lung, gastrointestinal system, and heart may also be observed due to vasculopathy and systemic inflammation. Organ involvement other than muscle and skin involvement usually affects morbidity and mortality.[1]

Although the pathogenesis of DM and PM is not fully understood, CD28 null T cells, a subset of apoptosis-resistant T cells, are involved in the pathogenesis and contribute to treatment resistance.[2] In addition, autoantibodies with affinity for various antigens such as aminoacyl transfer RNA synthases and type 1 interferon signaling play an important role in the development of these diseases.[3-6] Since inhibition of the JAK (Janus kinase)-STAT (signal transducer and activator of transcription) pathway decreases interferon, active substances inhibiting this pathway such as tofacitinib have been investigated, and successful results have been obtained.[7-9] Today, targeted biological therapies such as anti-CD20 monoclonal antibody rituximab in combination with glucocorticoids as well as traditional immunosuppressants, including methotrexate, azathioprine, mycophenolate mofetil, and cyclophosphamide, are widely used in the treatment of these diseases.

The mortality rate in patients with DM or PM is three times higher than in the general

population. The most important causes of morbidity and mortality in these patients are cancer, lung involvement, cardiac complications, and infections.[10] The interstitial lung disease (ILD) rate in these patients is around 18% for DM and 5% for PM.[11] The six-month mortality rate is 50% in ILD cases associated with anti-melanoma differentiation-associated gene 5 (MDA5) antibody.[12] In addition, publications are showing that DM-associated ILD has a mortal course even in the absence of MDA5 positivity.[13] Although this shows the vital importance of early detection of ILD in patients with PM/DM, pulmonary function testing and radiological imaging are insufficient. Publications show that detecting KL-6 (Krebs von den Lungen-6) levels in serum can be used as a screening biomarker for ILD.[14] All these studies aim to prevent morbidity and mortality by providing early detection and effective treatment of DM- and PM-related ILD.

DM/PM is a rare and heterogeneous disease with different clinical spectrums depending on disease subtype, organ involvement, and autoantibody positivity, and is difficult to treat. This study aimed to comprehensively investigate the factors that lead to treatment modification in patients with DM or PM and to emphasize the importance of individualized treatment in patients with these factors.

PATIENTS AND METHODS

The retrospective study was conducted with 141 patients (103 females, 38 males; mean age: 51.2±14.3 years; range, 22 to 74 years), including 87 PM (61 females, 26 males; mean age: 50.2±13.4 years; range, 22 to 74 years) and 54 DM (42 females, 12 males; mean age: 52.7±15.8 years; range, 22 to 72 years) patients, who applied to the rheumatology clinic of the Çukurova University Faculty of Medicine between January 2003 and May 2024 and were diagnosed using Bohen and Peter diagnostic criteria.[15] All PM/DM patients older than 18 years of age, without additional rheumatic disease, without known lung disease other than disease involvement, without malignancy, and followed up in our clinic were included in the study. ILD detected by spirometry and high-resolution computed tomography was considered lung involvement. Nonspecific interstitial pneumonia (NSIP), usual interstitial pneumonia, and bronchiolitis obliterans were considered lung involvement. Demographic data, including age, sex, diagnosis, electromyography (EMG), muscle biopsy, lung imaging results, creatine kinase (CK), C-reactive protein (CRP), and erythrocyte sedimentation rate (ESR) results at the time of diagnosis, treatments received, and reasons for treatment change were obtained from the hospital electronic system and patient files. Written informed consent was obtained from all participants. The study protocol was approved by the Çukurova University Faculty of Medicine Ethics Committee (date: 06.09.2024, no: 2024/147). The study was conducted in accordance with the principles of the Declaration of Helsinki.

The patients' treatment status was analyzed in detail and the reasons for treatment changes were recorded. These reasons were categorized as drug intolerance and drug resistance (uncontrolled disease). Laboratory abnormalities such as cytopenia, impaired liver or kidney function, gastrointestinal system intolerance, and other side effects were included in the drug intolerance group. Despite >3 months of immunosuppressive treatment, persistence or worsening of muscle weakness symptoms, addition of lung involvement to existing disease or progression of existing lung disease, and addition of organ involvement such as peripheral joint, heart, and esophagus were defined as drug resistance (uncontrolled disease). Switching to maintenance treatment after induction treatment was not recorded as a drug change.

Statistical analysis

The statistical analyses were conducted using IBM SPSS version 25.0 software (IBM Corp., Armonk, NY, USA). The variables' normality was assessed through visual (histogram and probability graphs) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk tests). A p-value >0.05 in the Kolmogorov-Smirnov test indicated that the data followed a normal distribution. When normal distribution was not determined, the patient and control groups were compared using the Mann-Whitney U test. Median values were taken. The chi-square test

was used for group comparisons of qualitative variables. A logistic regression analysis was performed to assess the diagnostic power of the measurement parameters. A p-value <0.05 was considered statistically significant.

RESULTS

Clinical and laboratory characteristics of the patients, including diagnosis, sex, EMG findings, presence or absence of pulmonary involvement, disease duration, CK, CRP, and ESR results at the time of diagnosis, are given in Table 1. When muscle biopsies were analyzed, the muscle biopsies of 110 (78%) patients were compatible with myositis, while 31 (22%) patients had no muscle biopsy or were not accessible. Twenty-eight (32%) of 87 PM patients and 11 (20%) of 54 DM patients had lung involvement. In other words, among 39 patients with lung involvement, 28 (72%) had PM, and 11 (28%) had DM.

When all patients were analyzed, 86 (60.9%) patients underwent drug switching, while 55 (39.1%) patients were maintained with the initial treatment. Of the 86 patients who were switched, 58 (67%) were PM, and 28 (33%) were DM patients.

The reasons for treatment change in 86 patients were analyzed. While the reason for treatment change was drug intolerance in nine (10.5%) patients, drug resistance (uncontrolled disease) was observed in 77 (89.5%) patients. Of the drug-resistant patients, 34 (44.1%) had lung involvement, 16 (20.7%) had peripheral joint involvement, 25 (33.9%) had increased muscle symptoms, and one (1.3%) had cardiac involvement. Of the 34 patients with lung involvement, 24 were PM (total number of PM with lung involvement: 28), and 10 were DM (total number of DM with lung involvement: 11). Of the 34 patients with lung involvement, 30 (88%) had NSIP, two (6%) had usual interstitial pneumonia, and two (6%) had bronchiolitis obliterans. One patient with a NSIP pattern died due to hypoxia. There were no known cases of aspiration pneumonia.

Patients with and without treatment change were analyzed in terms of year of diagnosis, CK, ESR, and CRP at diagnosis, PM or DM diagnosis, presence of myogenic motor unit potentials on baseline EMG, and presence of lung involvement. The results are given in Table 2. In this evaluation, the presence of lung involvement was found to be significant between the groups with and without treatment change (p<0.005). According to the logistic regression analysis between the group with and without treatment change, lung involvement was found to be an independent risk factor for treatment change (regression coefficient (B)=2.200,

Table 1. Clinical and laboratory characteristics of the patients

	n	%	Mean±SD	Median	Min-Max
Diagnosis (female) Polymyositis Dermatomyositis	 87 54	 70 77.7	 50.2±13.4 52.7±15.8		
Duration of disease (year)				8	<1-31
Interstitial lung disease	39	27.6			
EMG Myogenic motor unit potential Normal Result unknown	 78 8 55	 55.3 5.7 39			
CRP at diagnosis			6.7±23		
ESR at diagnosis			22.1±21		
CK at diagnosis Polymyositis Dermatomyositis				657 895 224	16-12389 16-12389 24-9612

SD: Standard deviation; EMG: Electromyography; CRP: C-reactive protein; ESR: Erythrocyte sedimentation rate; CK: Creatinine kinase.

Table 2. Evaluation between patients with and without treatment switching

	Treatment exchange (n=86)					No treatment exchange (n=55)					
	n	%	Mean±SD	Median	Min-Max	n	%	Mean±SD	Median	Min-Max	*p*
Diagnosis Polymyositis Dermatomyositis	 57 28	 67 23				 30 26	 53.5 27.5				0.107
Duration of disease (year)			8.36±5.5					8.93±5.4			0.586
Interstitial lung disease	34	89.4				5	10.6				<0.001*
Joint involvement	16	62				10	38				0.074
Cardiac involvement	1	100				-	-				-
EMG positivity	48	62				30	38				0.569
CRP at diagnosis			9.1±28					3±6			0.104
ESR at diagnosis			22±20					20±21			0.101
CK at diagnosis				637	17-9612				887	16-12389	0.892

SD: Standard deviation; EMG: Electromyography; CRP: C-reactive protein; ESR: Erythrocyte sedimentation rate; CK: Creatinine kinase; * p<0.05.

standard error=0.564; odds ratio=9.1, 95% confidence interval 3-27, p<0.05).

When the treatment protocols were analyzed, in addition to steroid treatment, methotrexate was given as initial treatment in 113 patients, azathioprine in 23 patients, and cyclophosphamide in five patients. Among 113 patients who started treatment with methotrexate, 63 (56%) had their treatment changed or drugs were added. Methotrexate was switched to azathioprine in 40 (63.4%), rituximab in three (4.7%), mycophenolate mofetil in seven (11.7%), cyclophosphamide in one (0.2%), and hydroxychloroquine, sulfasalazine, or leflunomide was added to the treatment of 12 (20%) patients. Of the 23 patients who started azathioprine, 21 (91%) had their treatment changed or added drugs. Fourteen (66.6%) patients had their treatment changed to methotrexate, two (10%) to mycophenolate mofetil, two (10%) to rituximab, and three (23.5%) to disease-modifying agents such as hydroxychloroquine, sulphasalazine, or leflunomide. In two (40%) of five patients who started treatment with cyclophosphamide, maintenance therapy was changed from azathioprine to mycophenolate mofetil. Of the 40 patients who switched from methotrexate to azathioprine treatment, 27 (68%) were PM, and 16 (32%) were DM. Of the 14 patients who switched from azathioprine to methotrexate treatment, 11 (79%) had PM, and three (21%) had DM.

DISCUSSION

In this study, 141 DM or PM patients were evaluated, and patients who underwent medication changes were analyzed in detail. Drug changes were made more frequently in PM patients than in DM patients, and the most important reason for change in treatment was drug resistance (uncontrolled disease). Lung involvement, peripheral joint involvement, and worsening of muscle findings were the main causes of drug resistance, while lung involvement was found to be an independent risk factor for treatment change, which is the most striking result of the study.

Currently, the primary goal of treatment in patients with PM or DM is to achieve an objective increase in muscle strength and improvement in systemic symptoms. The main concern regarding drug therapy in PM and DM is the lack of controlled trials and the lack of standardized outcome measures to capture meaningful changes to determine correlations between disability and quality of life.[16-18] Uncontrolled disease status indicates inadequate response to treatment, but inclusion body myositis or immune-mediated necrotizing

myopathy should be considered in the absence of response to treatment in patients with PM.[19] In our study, when the patients who underwent drug exchange were analyzed, it was observed that PM patients were higher than DM patients. This may be due to the presence of other myositis group diseases, which are important causes of drug resistance in PM and require confirmation of the diagnosis. In the presence of such a clinical suspicion, the diagnosis should be made by muscle rebiopsy.

Lung involvement is a common extramuscular manifestation of myositis, and the prognosis in PM and DM patients is worse than in those without lung involvement.[20,21] Some studies have even reported that lung involvement is a major risk factor for mortality in patients with PM or DM.[22] Amyopathic DM and anti-MDA-5 antibodies are important risk factors for rapidly progressive lung involvement, which is resistant to immunosuppressive therapy.[23-25] However, lung involvement in PM and DM can be fatal even if anti-MDA-5 antibodies are negative.[13] In the case of anti-Jo-1-associated lung involvement, the presence of high levels of anti-Ro52 antibodies is a cause of more severe acute onset disease and unresponsiveness to immunosuppressive therapy.[26,27] The 2023 American College of Rheumatology guideline, which provides treatment recommendations for lung involvement in connective tissue diseases, recommended treatment with cyclosporine and JAK inhibitors, which are not recommended for lung involvement of other diseases, as first-line treatment in patients with lung involvement in PM and DM, particularly in lung involvement due to anti-MDA5 antibodies.[28] The literature supports the efficacy of tofacitinib, a JAK inhibitor, in patients with positive anti-MDA-5 antibodies.[7-9] Studies showing that lung involvement in PM and DM is associated with poor prognosis, and the fact that different recommendations are provided in the guideline for myositis-associated interstitial lung disease compared to other connective tissue diseases, indicate that an evaluation and individualized treatment plan should be made by a multidisciplinary healthcare team, considering the individual characteristics of this patient group and carefully examining organ involvements. Although our study did not evaluate mortality rates, it found lung involvement to be the most important and independent risk factor for treatment change due to drug resistance. In this sense, we recommend a very careful evaluation of lung involvement at the time of diagnosis and during follow-up to prevent disease progression and poor prognosis that may develop during this period due to treatment unresponsiveness. When lung involvement is detected, immunosuppressive treatment of appropriate intensity should be administered.

Pisoni et al.[29] reported that 20 to 30% of patients with PM or DM remained active despite immunosuppressive treatment (methotrexate, azathioprine, cyclosporine A and cyclophosphamide). In a study in PM patients, relapse rates after complete remission ranged between 6% and 43%.[30] In our study, the rate of drug change was found to be 60%. However, these changes include the addition of new drugs without changing the basal treatment, specifically in patients who later developed lung or peripheral joint involvement. In addition, lung involvement rates were not given in these studies, but in our study, it was 27.6% among all patients (PM and DM). Since many conditions such as lung involvement and concomitant autoantibody positivity may cause treatment resistance, the current difference may have occurred due to these conditions.

In a study in which patients with PM or DM with steroid-resistant lung involvement were analyzed, the rate of change due to drug toxicity was 15%, whereas it was 11% in our study.[31] While the rate of drug change due to drug unresponsiveness was 38%, this rate was 89% in our study, which is significantly higher.[31] We know that 44 to 60% of lung involvement in DM is resistant to high-dose corticosteroid treatment.[32] The patients in this study received steroid treatment for a long time and were considered resistant to this treatment, and the majority of them were given very strong immunosuppressive treatment such as cyclophosphamide.[33] The fact that steroid-resistant patients were not separated in our study and that the treatment was given so intensively at the beginning in this study may have decreased the rate of drug change. This situation underlines the importance of careful evaluation of PM and DM patients in terms

of the need for intensive immunosuppressive treatment from the time of diagnosis.

This study had some limitations. The myositis-related autoantibodies of PM and DM patients were not investigated, and their effect in the group with treatment change could not by analyzed. Additionally, whether rebiopsy was performed to exclude inclusion body myositis or immune-mediated necrotizing myositis in patients diagnosed with PM in the uncontrolled disease group could not be determined. In the group in which no drug change was made, it was not known whether the patients supported their immunosuppressive treatment with nonpharmacological treatments such as diet, exercise, and physical therapy. Furthermore, steroid doses and steroid taper protocols of the patients were unknown, and intervening opportunistic infections were not examined. Interruption of immunosuppressive treatment due to infection and exacerbation of the disease after infection may have led to drug changes. This situation was not due to the nature of the disease itself but because immunosuppressive medication was interrupted. However, this was not considered in this retrospective study. Since there is a limited number of studies analyzing the reasons for treatment changes in patients with PM and DM in the literature, we believe that our study provides useful data for physicians who follow and treat this rare disease group. The retrospective nature of our study provided us with the opportunity to analyze the data of PM and DM patients whom we might not have encountered in a short time.

In conclusion, the study found that the most important reason for treatment switching in PM and DM patients was drug resistance, and the most important reason for drug resistance was lung involvement. Additionally, lung involvement was also an independent risk factor for drug switching. This study highlights the complexity in the management of PM and DM, particularly when complicated by interstitial lung disease. A multidisciplinary management strategy is needed, taking into account the presence of lung involvement and potential complications. For example, in patients with joint involvement, methotrexate, which is usually the initial treatment of choice, provided adequate treatment but required a change of therapy in patients with lung involvement. This situation shows the necessity of evaluating all organ involvement of patients separately from the moment of diagnosis and applying individualized treatment methods. While it is recognized that this study provides valuable data to the PM and DM literature, future research is needed to more thoroughly investigate the association of specific myositis-associated antibodies with treatment outcomes. Given the rarity of these diseases, it is clear that improving treatment strategies requires continued endeavor. By prioritizing early diagnosis and aggressive management of lung involvement, the associated morbidity and mortality may be reduced; and this may contribute to improving patients' quality of life.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Idea/concept, design, control/supervision, critical review: E.A.K.,S.Ö.; Data collection and/or processing, analysis and/or interpretation, literature review: E.A.K., B.E.D.; Writing the article, references and fundings, materials: E.A.K., B.E.D, S.Ö.

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REFERENCES

1. Özel E, Öncel İE. Inflammatory Diseases of Muscle and Peripheral Nerve: Inflammatory Myositis, Dermatomyositis, Polymyositis, Antibody Associated Myositis. Turkiye Klinikleri J Pediatric Neurology-Special Topics 2024;5:168-172.
2. Venalis P, Lundberg IE. Immune mechanisms in polymyositis and dermatomyositis and potential targets for therapy. Rheumatology (Oxford) 2014;53:397-405. doi: 10.1093/rheumatology/ket279.
3. Mimori T, Imura Y, Nakashima R, Yoshifuji H. Autoantibodies in idiopathic inflammatory myopathy: An update on clinical and pathophysiological significance. Curr Opin Rheumatol 2007;19:523-9. doi: 10.1097/BOR.0b013e3282f01a8c.
4. Mammen AL. Dermatomyositis and polymyositis: Clinical presentation, autoantibodies, and pathogenesis. Ann N Y Acad Sci 2010;1184:134-53. doi: 10.1111/j.1749-6632.2009.05119.x.

5. Gunawardena H, Betteridge ZE, McHugh NJ. Myositis-specific autoantibodies: Their clinical and pathogenic significance in disease expression. Rheumatology (Oxford) 2009;48:607-12. doi: 10.1093/rheumatology/kep078.
6. Greenberg SA. Sustained autoimmune mechanisms in dermatomyositis. J Pathol 2014;233:215-6. doi: 10.1002/path.4355.
7. Wang Y, Zou R, Wei J, Tang C, Wang J, Lin M. The efficacy and safety of tofacitinib in anti-melanoma differentiation-associated gene 5 antibody positive dermatomyositis associated interstitial lung disease: A systematic review and meta-analysis. Ther Adv Respir Dis 2024;18:17534666241294000. doi: 10.1177/17534666241294000.
8. Wang Y, Luo J, Lv X, Li Y, An Q, Mo L, et al. Tofacitinib for new-onset adult patients with anti-melanoma differentiation-associated 5 gene antibody positive dermatomyositis. Clin Rheumatol 2023;42:1847-53. doi: 10.1007/s10067-023-06567-y.
9. Ida T, Furuta S, Takayama A, Tamura J, Hayashi Y, Abe K, et al. Efficacy and safety of dose escalation of tofacitinib in refractory anti-MDA5 antibody-positive dermatomyositis. RMD Open 2023;9:e002795. doi: 10.1136/rmdopen-2022-002795.
10. Qiao P, Guo Q, Gao J, Ma D, Liu S, Gao X, et al. Long-term secular trends in dermatomyositis and polymyositis mortality in the USA from 1981 to 2020 according to underlying and multiple cause of death mortality data. Arthritis Res Ther 2023;25:16. doi: 10.1186/s13075-022-02963-y.
11. Hu Q, Huang KC, Goh CH, Tsuchiya Y, Liu Y, Qiu H. Characteristics and risk of interstitial lung disease in dermatomyositis and polymyositis: A retrospective cohort study in Japan. Sci Rep 2023;13:17172. doi: 10.1038/s41598-023-44092-9.
12. Chen Z, Wang X, Ye S. Tofacitinib in amyopathic dermatomyositis-associated interstitial lung disease. N Engl J Med 2019;381:291-3. doi: 10.1056/NEJMc1900045.
13. Yeşilbaş O, Yıldız M, Yozgat CY, Tahaoğlu I, Yazan H, Çakır E, et al. A fatal interstitial lung disease in an anti-melanoma differentiation-associated gene 5 (anti-MDA5) antibody negative patient with juvenile dermatomyositis. Turk J Pediatr 2021;63:903-8. doi: 10.24953/turkjped.2021.05.018.
14. Kilinc AA, Arslan A, Yildiz M, Kucur M, Adrovic A, Barut K, et al. Serum KL-6 level as a biomarker of interstitial lung disease in childhood connective tissue diseases: A pilot study. Rheumatol Int 2020;40:1701-6. doi: 10.1007/s00296-019-04485-4.
15. Bohan A, Peter JB. Polymyositis and dermatomyositis (first of two parts). N Engl J Med 1975;292:344-7. doi: 10.1056/NEJM197502132920706.
16. Dalakas MC. Inflammatory muscle diseases. N Engl J Med 2015;372:1734-47. doi: 10.1056/NEJMra1402225.
17. Dalakas MC. Therapeutic advances and future prospects in immune-mediated inflammatory myopathies. Ther Adv Neurol Disord 2008;1:157-66. doi: 10.1177/1756285608097463.
18. Dalakas MC. Immunotherapy of inflammatory myopathies: Practical approach and future prospects. Curr Treat Options Neurol 2011;13:311-23. doi: 10.1007/s11940-011-0119-8.
19. Dalakas MC. Inflammatory muscle diseases: A critical review on pathogenesis and therapies. Curr Opin Pharmacol 2010;10:346-52. doi: 10.1016/j.coph.2010.03.001.
20. Ye S, Chen XX, Lu XY, Wu MF, Deng Y, Huang WQ, et al. Adult clinically amyopathic dermatomyositis with rapid progressive interstitial lung disease: A retrospective cohort study. Clin Rheumatol 2007;26:1647-54. doi: 10.1007/s10067-007-0562-9.
21. Won Huh J, Soon Kim D, Keun Lee C, Yoo B, Bum Seo J, Kitaichi M, et al. Two distinct clinical types of interstitial lung disease associated with polymyositis-dermatomyositis. Respir Med 2007;101:1761-9. doi: 10.1016/j.rmed.2007.02.017.
22. Danieli MG, Gambini S, Pettinari L, Logullo F, Veronesi G, Gabrielli A. Impact of treatment on survival in polymyositis and dermatomyositis. A single-centre long-term follow-up study. Autoimmun Rev 2014;13:1048-54. doi: 10.1016/j.autrev.2014.08.023.
23. Chua F, Higton AM, Colebatch AN, O'Reilly K, Grubnic S, Vlahos I, et al. Idiopathic inflammatory myositis-associated interstitial lung disease: Ethnicity differences and lung function trends in a British cohort. Rheumatology (Oxford) 2012;51:1870-6. doi: 10.1093/rheumatology/kes167.
24. Lee CS, Chen TL, Tzen CY, Lin FJ, Peng MJ, Wu CL, et al. Idiopathic inflammatory myopathy with diffuse alveolar damage. Clin Rheumatol 2002;21:391-6. doi: 10.1007/s100670200104.
25. Gono T, Kawaguchi Y, Kuwana M, Sugiura T, Furuya T, Takagi K, et al. Brief report: Association of HLA-DRB1*0101/*0405 with susceptibility to anti-melanoma differentiation-associated gene 5 antibody-positive dermatomyositis in the Japanese population. Arthritis Rheum 2012;64:3736-40. doi: 10.1002/art.34657.
26. Betteridge Z, McHugh N. Myositis-specific autoantibodies: an important tool to support diagnosis of myositis. J Intern Med 2016;280:8-23. doi: 10.1111/joim.12451.
27. Johnson SR, Bernstein EJ, Bolster MB, Chung JH, Danoff SK, George MD, et al. 2023 American College of Rheumatology (ACR)/American College of Chest Physicians (CHEST) Guideline for the treatment of interstitial lung disease in people

with systemic autoimmune rheumatic diseases. Arthritis Care Res (Hoboken) 2024;76:1051-69. doi: 10.1002/acr.25348.

28. Palmucci S, Di Mari A, Cancemi G, Pennisi I, Mauro LA, Sambataro G, et al. Clinical and radiological features of ınterstitial lung diseases associated with polymyositis and dermatomyositis. Medicina (Kaunas) 2022;58:1757. doi: 10.3390/medicina58121757.
29. Pisoni CN, Cuadrado MJ, Khamashta MA, Hughes GR, D'Cruz DP. Mycophenolate mofetil treatment in resistant myositis. Rheumatology (Oxford) 2007;46:516-8. doi: 10.1093/rheumatology/kel336.
30. Lee W, Zimmermann B 3rd, Lally EV. Relapse of polymyositis after prolonged remission. J Rheumatol 1997;24:1641-4.
31. Mira-Avendano IC, Parambil JG, Yadav R, Arrossi V, Xu M, Chapman JT, et al. A retrospective review of clinical features and treatment outcomes in steroid-resistant interstitial lung disease from polymyositis/dermatomyositis. Respir Med 2013;107:890-6. doi: 10.1016/j.rmed.2013.02.015.
32. Kurasawa K, Nawata Y, Takabayashi K, Kumano K, Kita Y, Takiguchi Y, et al. Activation of pulmonary T cells in corticosteroid-resistant and -sensitive interstitial pneumonitis in dermatomyositis/polymyositis. Clin Exp Immunol 2002;129:541-8. doi: 10.1046/j.1365-2249.2002.01933.x.
33 Marie I, Dominique S, Janvresse A, Levesque H, Menard JF. Rituximab therapy for refractory interstitial lung disease related to antisynthetase syndrome. Respir Med 2012;106:581-7. doi: 10.1016/j.rmed.2012.01.001.