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Review article

Three cases of anti-TNF induced myositis and literature review

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ABSTRACT

Anti-tumor necrosis factor drugs are frequently preferred in the treatment of rheumatologic diseases and other inflammatory diseases. The development of myositis after using anti-tumor necrosis factor drugs is a rare clinical condition. Here we aimed to report cases who developed myositis after using anti-tumor necrosis factor drugs and review the current literature. We report two cases of rheumatoid arthritis and a case of ankylosing spondylitis developed idiopathic inflammatory myopathy following anti-tumor necrosis factor therapy. In conclusion, myositis could develop during anti-tumor necrosis factor therapy, so these patients should be evaluated carefully initially for myositis and should be closely monitored due to the potential for developing myositis in treatment process.

Três casos de miosite induzida pelo anti-TNF e revisão da literatura

Palavras-chave:
Fármacos antifator de necrose tumoral (anti-TNF)
Miosite
Jo-1

RESUMO

Os fármacos antifator de necrose tumoral (anti-TNF) são frequentemente preferidos no tratamento de doenças reumatológicas e outras doenças inflamatórias. O desenvolvimento de miosite após o uso de anti-FNT é uma condição clínica rara. Este estudo objetivou descrever casos de pacientes que desenvolveram miosite após o uso de anti-TNF e fazer uma revisão da literatura atual. Descrevem-se dois casos de artrite reumatoide (AR) e um caso de espondilite anquilosante (EA) que desenvolveram miopatia inflamatória idiopática após o tratamento com anti-TNF. Em conclusão, pode haver desenvolvimento de miosite durante o tratamento com anti-TNF, de modo que esses pacientes devem ser cuidadosamente avaliados inicialmente à procura de miosite e devem ser cuidadosamente monitorados em razão do potencial de desenvolvimento de miosite no processo de tratamento.

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Introduction

Tumor necrosis factor alpha (TNF-α) is a proinflammatory cytokine that plays an important role in the pathogenesis of RA, AS and many other inflammatory diseases. Due to its role in the inflammatory process, anti-TNF drugs are frequently preferred in the treatment of rheumatologic diseases and other inflammatory diseases.[1]

Although anti-TNF drugs generally demonstrate their anti-inflammatory effects by antagonizing TNF-α, they have different effects on the immune system and inflammation depending on their chemical structures and physiological characteristics. This different efficacy determines both the clinical indications and side effect profile of the drugs. The main side effects of the drugs are predisposition to infections, allergic reactions, malignancies, demyelinating diseases, congestive heart failure, bone marrow depression, and autoimmune diseases.[2] The development of myositis after using anti-TNF is a rare clinical condition.[3] We aimed to present three cases followed up with the diagnosis of AS and RA which developed myositis after using anti-TNF.

Case 1

A 30-year-old male patient had been followed-up with the diagnosis of AS for ten years. He had been taking non-steroidal anti-inflammatory drugs (NSAID) for 10 years. Etanercept 25 mg 2 times a week was initiated as his complaints have increased. The patient had taken a total of 20 (2.5 months) doses of etanercept treatment and the patient had complaints of weakness, fatigue and difficulty in climbing the stairs within the last three weeks. Upon his physical examination there was weakness in proximal muscles of upper and lower extremities, yet no dermatological involvement was found. Aspartate aminotransferase (AST), alanine aminotransferase (ALT), creatinine kinase (CK) and lactate dehydrogenase (LDH) were 536 U/L, 535 U/L, 6035 U/L, and 739 U/L, respectively. Thyroid stimulating hormone (TSH) and other biochemical tests were normal. ANA was 1/160 positive, anti Jo-1 was positive, and anti dsDNA, anti-SSA, anti-RNP were negative. Electromyography (EMG) findings revealed myopathy in proximal muscles. The deltoid muscle biopsy was consistent with polymyositis. Etanercept was stopped and three-day pulse steroid (1 g) treatment was started with the diagnosis of inflammatory myositis, and subsequently 1 g cyclophosphamide/month treatment was started. At the first month of treatment, CK, AST, ALT and LDH levels decreased. The steroid dose was gradually decreased and stopped. Cyclophosphamide treatment continued for one year and at the end of one year, the patient was started to be followed up with only NSAIDs.

Case 2

A 20-year-old female patient had been followed-up with the diagnosis of RA for two years. Adalimumab had been started to the patient who had methotrexate resistance. Following adalimumab treatment, the complaints related to joints completely had regressed and in the sixth month of treatment, the patient had the complaints of weakness, fatigue, pain in the arms and legs, and difficulty climbing the stairs, which had gradually increased within the last two weeks. Upon physical examination, there was weakness in the upper-lower extremities. There was no dermatological involvement in the patient. AST, ALT, CK, and LDH were 1024 U/L, 307 U/L, 4772 U/L, and 1701 U/L, respectively. TSH and other biochemical tests were normal. ANA (titer 1/320) and anti Jo-1 was positive. Anti-SSA, anti-RNP, c-ANCA, and p-ANCA were negative. EMG findings revealed myopathy in the proximal muscles. The deltoid muscle biopsy was consistent with myositis. Adalimumab treatment stopped. Three days pulse steroid (1 g) treatment was administered with the diagnosis of PM. Adalimumab was switched to rituximab. Following the treatment, CK levels rapidly decreased. In the second month following the treatment, the steroid dose was decreased up to 5 mg/day. On the control in the 16th month, there were no complaints and the patient is currently being followed-up with rituximab and methotrexate.

Case 3

A 44-year-old female had been followed-up with the diagnosis of RA for approximately seven years. The patient had been using adalimumab 40 mg/2 weeks for three years. Following adalimumab treatment, all complaints related to the joints had decreased. However, the patient had the complaints of eruption in the arms, forehead, and around the nose, on the metacarpophlangeal joints of hand, fatigue, difficulty in climbing the stairs and dyspnea, which increased with effort within last four weeks. Upon her physical examination, there was weakness in proximal muscles of all extremities and eruptions consistent with erythema on the arms. There was no arthritis or joint deformity. Clinical evaluation showed diffuse pulmonary crackles. Sedimentation rate was 40 mm/h (5–20), and C-reactive protein (CRP) was 45 mg/L (0–5). AST was 169 U/L, CK was 1563 U/L. ANA was in 1/320 homogenous pattern and anti-Jo-1 was positive. Anti-SSA, anti-RNP, c-ANCA, and anti-dsDNA were negative. There was bilateral infiltration in chest radiography. Thorax HRCT was consistent with interstitial lung disease. EMG testing confirmed the presence of proximal myopathy. Muscle biopsy was consistent with myositis. All these findings suggested TNF-induced dermatomyositis and interstitial lung involvement. Three-day pulse steroid (1 g) treatment initially started followed 1 g cyclophosphamide and rituximab treatments. Following the treatment, serum CK levels rapidly decreased. In the first month following the treatment biochemical tests decreased. However, there was partial improvement in dyspnea. The patient is in the 8th month after the treatment, the patient's symptoms related to interstitial lung disease continue.

Methods

Pubmed was searched from 2003 present using the terms: "TNF-α, anti-TNF-α", "dermatomyositis", "polymyositis", "inflammatory myopathy", "etanercept", "lenercept", "infliximab", "adalimumab", "golimumab", "certolizumab". Full

text articles in the English language were selected. Then the following co-indexing terms were used: "pathogenesis", "pathophysiology", "treatment" or "therapy". We didn't consider congress abstracts or unpublished results. We included all cases where a clear baseline diagnosis was made and the onset of DM/PM was recorded after the use of anti-TNF-α agents.

Discussion

We presented two cases of RA and a case of AS which developed PM and DM following anti-TNF use. There was prominent clinical improvement in the two patients; however, in one patient who developed DM, although the clinical findings of myositis regressed, there was partial improvement in pulmonary findings.

Total 21 patients have been reported who myositis developed associated with anti-TNF in previous studies in the literature (Table 1).[4–17] With the addition of our cases, at the total 24 patients, 5 male and 14 were female. 5 patients were not identified gender. The mean age of patients was 4383 ± 1119. There were 19 patients with RA, 2 patients with AS, 1 patient with seronegative arthritis, 1 patient with Crohn's disease and 1 patient with juvenile idiopathic arthritis. The duration of the primary disease in most patients was substantially longer. 12 of the patients developed polymyositis and other 12 with dermatomyositis. 4 patients did not receive DMARDs (disease-modifying anti-rheumatic drugs). Most of the patients were receiving methotrexate as DMARD (11 patients). 10 patients etanercept, 6 patients infiliximab, 5 patients adalimumab and 2 patients were using lenarcept. 10 patients had pulmonary involvement. ANA in 18 patients, anti-jo1 in 7 patients, anti-PM-Scl in 1 patient, anti-dsDNA in 1 patient, anti-PL-7 in 1 patient, anti-PL-12 in 1 patient, anti-U1 RNP in 1 patient were found positive.

Corticosteroid treatment was given to all patients. Pulse steroid to 6 patients, high doses of steroids to 5 patients were given. The majority of patients had a response to treatment. Only 2 patients had a partial response to treatment. Therefore, steroid therapy seems successful in myositis induced with TNF therapy. After TNF blockade, duration of myositis development ranges from 2 weeks to 2 years in all patients. The most common autoantibodies in patients were ANA and anti-jo-1 antibody.

Anti Jo-1 (histidyl-tRNA synthetase) is a myositis specific auto-antibody that is most frequently positive in idiopathic inflammatory myopathies (PM and DM). Although it is positive at a rate of 20–30% in PM, it becomes positive at a rate of 60–70% in patients with PM developing interstitial pulmonary fibrosis.[18] In polymyositis, MHC I expression increases in muscle that injured as a result of an unknown cause, such as viral infection, mechanical trauma, or ischemic injury. Finally, soluble Jo-1 emerges. By CD4+ and CD8+ cell activation with soluble Jo-1, both humoral and cellular immune response are activated and this could cause muscle damage.[19]

The current treatment strategy for patients with immune-mediated inflammatory myopathies involves first-line treatment with corticosteroids, alone or in combination with an immunosupressant such as methotrexate, azothioprine or mycophenolate, and in more resistant cases intravenous immunoglobulin or biological therapy.[20] Anecdotal reports have suggested that anti-TNF-α agents (i.e.: infliximab, etanercept, adalimumab) may be helpful in the therapy of patients with active refractory PM/DM.[21] All the clinical trials done to evaluate TNF-α antagonists used an uncontrolled open-label design. Conflicting results were obtained with both the monoclonal antibody infliximab and the soluble receptor etanercept.[22] Although, more recent open-label studies demonstrate that anti-TNF-α agents clearly show no benefit in PM/DM.[21]

Different side effects could develop depending on the use of anti-TNF drugs. Autoimmune diseases associated with anti-TNF use is one of the possible side effects. The most commonly observed autoimmune diseases are vasculitic syndromes, lupus-like syndrome, psoriatic skin lesions, interstitial lung diseases, sarcoidosis, autoimmune hepatitis, uveitis, and antiphospholipid syndrome.[4,7,8,10,11,15,17,18,23] Of these, lupus and vasculitis are the most common, together comprising 60% of documented cases of anti-TNF induced autoimmune disease.[11] Anti-TNF induced dermatomyositis, however, is rare, constituting less than one percent of reported cases of anti-TNF induced autoimmunity. In the previous studies and case series, anti-TNF treatment has been shown to increase muscle weakness and exacerbate the disease.[24] Moreover, the incidence of ANA-positivity increases threefold with anti-TNF therapy, even in the absence of a lupus-like syndrome. One of the auto-immune clinical conditions developing secondary to anti-TNF use is the autoantibody positivity. The most common autoimmune antibody positivity are ANA and anti-dsDNA. Although autoantibody development is observed with all anti-TNF agents, it is reported to be more frequent with infliximab use.[25] ANA positivity and Jo-1 antibody positivity before anti-TNF use in the two patients with RA presented in the current case report were previously known. Thus, ANA positivity and Jo-1 antibody positivity were not due to anti-TNF use. However, autoantibodies in the patient with AS had not been evaluated before anti-TNF use. We retrieved all publications and add our 3 cases describing the new onset of DM/PM after anti-TNF therapy (24 patients total); ANA positivity was 33% (8 cases) and Jo-1 positivity was 20.3% (5 cases). In our opinion ANA and Jo-1 positivity initially is not a contraindication for anti-TNF therapy alone. However, these patients should be evaluated carefully initially for myositis and should be closely monitored due to the potential for developing myositis in treatment process.

In our case series; PM or DM developed in patients who used anti-TNF therapy. Patients have not got any clinical findings associated with myositis before anti-TNF therapy. Two patients had inflammatory arthritis for several years and was thought to be associated with RA. Inflammatory arthritis may occur also in the myositis. Therefore, it is the difficult to determine whether myositis is an early symptom of arthritis or due to another disease in our two patients. Our patient with AS have axial involvement, so it is easy to distinguish from myositis. Therefore, it is easier to associate the anti-TNF treatment with myositis in this patient. However, if myositis had been due to arthritis from the beginning, it is expected that the complaints of patients should increase rapidly in patients with RA. However, initially our patients showed clinically response

Table 1 – The clinical and laboratory characteristics of cases developing myositis after anti-TNF use.

	Primary diagnosis/duration	Dmards	Anti-TNF/duration	Clinic	Pul. invol.	Treatment	Treatment Outcome	Antibodies
Case 1 30/m	AS 10y	No	Etanercept 2.5 m	PM	(–)	MP pulse (1.0 g)	Improvement	ANA1:160 Jo-1Anti Jo-1
Case 2 20/f	RA 2y	Mtx	Adalimumab 6 m	PM	(–)	MP pulse (1.0 g)	Improvement	ANA1:320 Jo-1Anti Jo-1
Case 3 44/f	RA 7y	Mtx	Adalimumab 36 m	DM	(+)	MP pulse (1.0 g), CY	Partial response	ANA 1:320 Jo-1Anti Jo-1
Musial 2003[4] 52/f	RA 20y	Mtx	Infliximab 30 m	PM	(+)	MP pulse (1.0 g)	Improvement	ANA 1:320 AntidsDNA1:20 Jo-1Anti Jo-1
Flendrie 2003[5,a]	RA[a]	[a]	[a]	PM	[a]	[a]	[a]	[a]
Flendrie 2005[6] 52/f	RA[a]	[a]	Lenercept[a]	DM	[a]	[a]	Improvement	[a]
Urata 2006[7] 52/f	RA 33y	Mtx	Infliximab 9 m	PM	(+)	30 mg MP	Improvement	ANA 1:640 Jo-1Anti Jo-1
Hall 2006[8] 44/f	RA 1y	Mtx Hcq	Etanercept 6 m	DM	(+)	High dose MP, AZP, MTX	Improvement	ANA1:640 Jo-1Anti Jo-1
Liozon 2007[9] 42/f	RA 1.5y	Mtx Hcq	Etanercept 9 m	PM	(+)	High dose MP, CY	Improvement	ANA 1:2560 Anti-PM-Scl
Kiltz 2008[10] 57/f	RA 26y	Mtx Hcq	Etanercept 30 m	PM	(+)	High dose MP, CY	Improvement	ANA 1:2560
Kiltz 2008[10] 46/m	AS 17y	[a]	Infliximab 6 m	PM	(–)	[a]	Improvement	No
Ramos-Casals 2008[11] 4 patients	RA[a]	[a]	Infliximab (2p) Etanercept lenercept	PM (2p) DM (2p)	[a]	[a]	[a]	[a]
Brunasso 2010[12] 45/f	RA 13y	No	Adalimumab 34 m	DM	(–)	MP	Improvement	ANA 1:320
Klein 2010[13] 33/f	RA[a]	No	Etanercept 5 m	DM	(+)	MP	Improvement	No
Klein 2010[13] 40/f	RA[a]	No	Etanercept 2y	DM	(–)	MP	Partial response	ANA
Klein 2010[13] 29/f	SNA[a]	Mtx	Adalimumab 3 m	DM	(–)	MP, Mtx, AZP, quinacrine	Improvement	ANA 1:640
Ishiguro 2010[14] 52/m	RA 12y	Mtx, Buc,Tac	Etanercept 26 m	DM	(+)	MP pulse (1.0 g)	Improvement	Anti-PL-7
Ishikawa 2010[3] 58/f	RA 2y	Buc,Tac	Etanercept 2 m	PM	(+)	MP pulse (0.5 g)	Improvement	ANA 1:320 Jo-1Anti Jo-1
Ishikawa 2011[15] 63/f	RA 6m	Buc,Tac	Etanercept 2 m	PM	(+)	PSL 1 mg/kg	Improvement	ANA 1:160 Anti-PL-12

Table 1 – (Continued)

	Primary diagnosis/duration	Dmards	Anti-TNF/duration	Clinic	Pul. invol.	Treatment	Treatment Outcome	Antibodies
Riolo, 2012[16]	Crohn	Mtx	Adalimumab 2w	DM	(–)	MP, Mtx	Improvement	ANA 1:640
36/m	1y		Infliximab 1 m					Anti-U1 RNP
Liu 2013[17]	JIA	Mtx	Etanercept	DM	(–)	MP, Mtx	Improvement	No
46/m	36y		10y					
			Adalimumab					
			2 weeks					

y, year; m, month; AS, ankylosing spondylitis; RA, rheumatoid arthritis; JIA, juvenile idiopathic arthritis; PM, polymyositis; DM, dermatomyositis; HCQ, hydroxychloroquine; Mtx, methotrexate; Buc, bucillamine; Tac, tacrolimus; AZP, azathioprine; MP, methylprednisolone; CY, cyclophosphamide; ANA, Antinuclear antibody; Anti dsDNA, anti double stranded DNA; Pul. invol, pulmonary involvement; m, male; f, female; SNA, seronegative arthritis; w, week; PSL, prednisolone; Dmards, disease-modifying antirheumatic drugs.

[a] Not done or not described.

after the anti-TNF therapy. The pattern of arthritis, deformity and erosion will help to the differential diagnosis.

Another possibility is the overlap syndrome. Inflammatory myositis could be observed as a part of overlap syndrome with other rheumatologic diseases. Myositis most frequently overlaps with RA, systemic lupus erythematosus and scleroderma. Aranbicia Aguila et al.[26] reviewed 220 cases with inflammatory myositis in terms of overlap syndrome. They found overlap syndrome in 31 patients (9 DM, 22 PM); however, systemic sclerosis was detected in 15 patients, SLE was detected in nine patients and RA was detected in seven patients. Myositis rarely overlaps with other connective tissue diseases but the exact incidence is not known.

TNF-α is a cytokine produced mainly by activated macrophages and T-lymphocytes. It is an essential pro-inflammatory mediator and is implicated in the pathogenesis of multiple immune-mediated inflammatory disorders, including inflammatory myopathies. There is growing evidence that excessive production of pro-inflammatory cytokines, and in particular TNF-α, may be involved in the pathogenesis of idiopathic inflammatory myopathies.[27] TNF-α and its receptors are increased in myositis. Suggesting a role in this disease and may be used in therapy but on the contrary, it was observed that treatment of anti-TNF may rise the exacerbate. The reason for this is not fully understood. Two possible causes have been suggested. Firstly, according to the cytokine-shift hypothesis; TNF-α inhibition will change the balance in cytokine production as T helper-1 and T helper-2 and promotes the type 1 interferon production. Type-1 interferon has been shown to be increased and the play role in the pathogenesis in patients with myositis. The second possible cause is increase the production of autoantibodies with the TNF blockade interfere to apoptosis. For example, after the TNF blockade in patients with RA, ANA and anti-ds DNA antibodies increased that is known.[13]

TNF inhibitors are important drugs used in the treatment of autoinflammatory diseases. They can rarely induce the development of myositis besides the known their side effects such as infections, congestive heart failure, demyelinating diseases and autoimmune diseases. When complaints arise such as shortness of breath, muscle weakness and skin rash, patients who take TNF treatment should be evaluated for myositis.

Conflicts of interest

The authors declare no conflicts of interest.

REFERENCES

1. Reimold AM. New indications for treatment of chronic inflammation by TNF-alpha blockade. Am J Med Sci. 2003;325:75–92.
2. Kochbati S, Boussema F, Ben Miled M, Ktari S, Daoud L, Ben Rhouma S, et al. TNF alfa modulators in the treatment of RA. Tunis Med. 2004;82:893–904.
3. Ishikawa Y, Yukawa N, Ohmura K, Hosono Y, Imura Y, Kawabata D, et al. Etanercept-induced anti-Jo-1-antibody-positive polymyositis in a patient with RA:

a case report and review of the literature. Clin Rheumatol. 2010;29:563–6.
4. Musial J, Undas A, Celinska-Lowenhoff M. Polymyositis associated with infliximab treatment for RA. Rheumatology (Oxford). 2003;42:1566–8.
5. Flendrie M, Creemers MCW, Welsing PMC, Den Broeder AA, VanRiel PLCM. Survival during treatment with tumour necrosis factor blocking agents in RA. Ann Rheum Dis. 2003;62:30–3.
6. Flendrie M, Vissers WHPM, Creemers MCW, de Jong J, Van de EMG, Kerkhof KCM, et al. Dermatological conditions during TNF-alpha-blocking therapy in patients with RA: a prospective study. Arthritis Res Ther. 2005;7:R666–76.
7. Urata Y, Wakai Y, Kowatari K. Polymyositis associated with infliximab treatment for RA. Mod Rheumatol. 2006;16:410–1.
8. Hall HA, Bernard Z. Evolution of dermatomyositis during therapy with a tumor necrosis factor α inhibitor. Arthritis Rheumatol. 2006;55:982–4.
9. Liozon E, Ouattara B, Loustaud-Ratti V, Vidal E. Severe polymyositis and flare in autoimmunity following treatment with adalimumab in a patient with overlapping features of polyarthritis and scleroderma. Scand J Rheumatol. 2007;36:484–6.
10. Kiltz U, Fendler C, Braun J. Neuromuscular involvement in rheumatic patients treated with anti-TNF therapy—three examples. J Rheumatol. 2008;35:2074–5.
11. Ramos-Casals M, Brito-Zeron P, Soto MJ, Cuadrado MJ, Khamashta MA. Autoimmune diseases induced by TNF targeted therapies. Best Pract Res. 2008;22:847–61.
12. Brunasso AG, Lo Scocco G, Massone C. Dermatomyositis during adalimumab therapy for RA. J Rheumatol. 2010;37:1549–50.
13. Klein R, Rosenbach M, Kim EJ, Kim B, Werth VP, Dunham J. Tumor necrosis factor inhibitor-associated dermatomyositis. Arch Dermatol. 2010;146:780–4.
14. Ishiguro T, Takayanagi N, Miyahara Y, Yanagisawa T, Sugita Y. Antisynthetase (anti PL-7 antibody) syndrome presenting as a skin rash and exacerbation of interstitial pneumonia during treatment for RA. Nihon Kokyuki Gakkai Zasshi. 2010;48:240–6.
15. Ishikawa Y, Yukawa N, Kawabata D, Ohmura K, Fujii T, Usui T, et al. A case of antisynthetase syndrome in a RA patient with anti-PL-12 antibody following treatment with etanercept. Clin Rheumatol. 2011;30:429–32.
16. Riolo G, Towheed TE. Anti-tumor necrosis factor inhibitor therapy-induced dermatomyositis and fasciitis. J Rheumatol. 2012;39:192–4.
17. Liu SW, Velez NF, Lam C, Femia A, Granter SR, Townsend HB, et al. Dermatomyositis induced by anti-tumor necrosis factor in a patient with juvenile idiopathic arthritis. JAMA Dermatol. 2013;149:1204–8.
18. Zampieri S, Ghirardello A, Iaccarino L, Tarricone E, Gambari PF, Doria A. Anti-Jo-1 antibodies. Autoimmunity. 2005;38: 73–8.
19. Ascherman DP. The role of Jo-1 in the immunopathogenesis of polymyositis: current hypotheses. Curr Rheumatol Rep. 2003;5:425–30.
20. Moran EM, Mastaglia FL. Cytokines in immune mediated inflammatory myopathies: cellular sources, multipl actions and therapeutic implications. Clin Exp Immunol. 2014;178:405–15.
21. Marie I. Therapy of polimyositis and dermatomyositis. Presse Med. 2011;40:e257–70.
22. Tournadre A, Dubost JJ, Soubrier M. Treatment of inflammatory muscle disease in adults. Joint Bone Spine. 2010;77:390–4.
23. Ramos-Casals M, Brito-Zeron P, Munoz S, Soria N, Galiana D, Bertolaccini L, et al. Autoimmune diseases induced by TNF-targeted therapies: analysis of 233 cases. Medicine (Baltimore). 2007;86:242–51.
24. Iannone F, Scioscia C, Falappone PC, Covelli M, Lapadula G. Use of etanercept in the treatment of dermatomyositis: a case series. J Rheumatol. 2006;33:1802–4.
25. St Clair EW, Wagner CL, Fasanmade AA, Wang B, Schaible T, Kavanaugh A, et al. The relationship of serum infliximab concentrations to clinical improvement in RA: results from ATTRACT, a multicenter, randomized, double-blind, placebo-controlled trial. Arthritis Rheumatol. 2002;46:1451.
26. Aguila LA, Lopes MR, Pretti FZ, Sampaio-Barros PD, Carlos de Souza FH, Borba EF, et al. Clinical and laboratory features of overlap syndromes of idiopathic inflammatory myopathies associated with systemic lupus erythematosus, systemic sclerosis, or RA. Clin Rheumatol. 2014;33:1093–8.
27. Efthimiou P. Tumor necrosis factor-α in inflammatory myopathies: pathophysiology and therapeutic implications. Semin Arthritis Rheum. 2006;36:168–72.