Clin Rheumatol (2014) 33:1113–1118
DOI 10.1007/s10067-014-2675-2

ORIGINAL ARTICLE

Clinical course and outcomes of Iranian children with juvenile dermatomyositis and polymyositis

Abdolreza Malek · Seyed-Reza Raeeskarami · Vahid Ziaee · Yahya Aghighi · Mohamad-Hassan Moradinejad

Received: 24 January 2014 / Revised: 9 May 2014 / Accepted: 12 May 2014 / Published online: 31 May 2014

Abstract This study evaluated the clinical features, course, and outcomes of Iranian children with juvenile dermatomyositis (JDM), juvenile polymyositis (JPM), and other uncommon connective tissue disorders. A chart review of 85 Iranian children with JDM and JPM was performed during a 10-year period from 2003 to 2013. The patients' clinical signs and symptoms, laboratory data, and other factors affecting clinical outcomes were recorded using questionnaires. Statistical analysis was performed using SPSS software version 20. In all, 40 boys and 45 girls were included in the study (*F*/*M*, 1.1:1). Disease frequency was significantly higher in boys aged <5 years (*F*/*M*, 0.4:1) and girls aged >5 years (*F*/*M*, 1.6:1). The combined mean age at diagnosis was 7.5 years. Muscle weakness, particularly in the proximal muscles of lower extremities (96 %); fatigue (83 %); and heliotrope rash (71 %) were the most frequently recorded symptoms. Elevated lactate dehydrogenase level was the most common enzyme disturbance (98 %). Monocyclic course was seen in 60 % of patients. The mean treatment duration was 3 years. The incidence rate of complications such as calcinosis, lipodystrophy, and growth disturbances was 20, 9, and 30 %, respectively. The occurrence of these complications in patients with monocyclic disease was significantly lower. Vital organ involvement led to the death of four patients. The incidence of calcinosis was significantly lower in patients having a shorter interval between disease onset and treatment. Two important complications, failure to thrive and lipodystrophy, were significantly higher in patients having antinuclear antibodies. The incidence of the above three complications was higher in patients with polycyclic or continuous chronic disease. Respiratory failure was the most common cause of patient mortality.

Keywords Children · Clinical course · Dermatomyositis · Outcome · Polymyositis

A. Malek · S.-R. Raeeskarami · V. Ziaee
Pediatric Rheumatology Research Group, Rheumatology Research Center, Tehran University of Medical Sciences, Tehran, Iran

S.-R. Raeeskarami · V. Ziaee · Y. Aghighi
Department of Pediatrics, Tehran University of Medical Sciences, Tehran, Iran

V. Ziaee · M.-H. Moradinejad
Growth and Development Research Center, Tehran University of Medical Sciences, Tehran, Iran

V. Ziaee (✉) · M.-H. Moradinejad
Children's Medical Center, Pediatrics Center of Excellence, Tehran, Iran
e-mail: ziaee@tums.ac.ir

Introduction

Juvenile dermatomyositis (JDM) is a multisystem rheumatic disease leading to the chronic inflammation of muscles and skin. It is the most common cause of chronic idiopathic inflammatory myopathies during childhood. The incidence rate is 0.19/100,000 children per year in the UK and Ireland and 0.16/100,000 children in Japan [1, 2]. In general, in 16–20 % of patients, dermatomyositis sets in during childhood. There is a bimodal distribution of ages for disease onset, with the first peak occurring in children aged 5–14 years and the second peak occurring in individuals aged 45–64 years [3]. Juvenile polymyositis (JPM) is a chronic myositis without cutaneous changes, which causes inflammatory myopathies in 4–8 % of children [2].

Diagnosis is confirmed by the presence of pathognomonic rash and three of four Bohan and Peter criteria (proximal muscle weakness, elevated serum levels of muscle enzymes,

electromyographic changes of chronic inflammatory myositis, and histopathological changes of inflammatory myositis) [4, 5]. A monocyclic patient is a patient experiencing a single episode of the disease with only one remission and no relapse, while a polycyclic patient is a patient experiencing greater than one remission and relapse within the total duration of the disease. A third disease cycle, called chronic continuous disease, is a continuously active disease course for >4 years without definite remissions [6].

According to one study, one third of JDM patients die, one third show spontaneous improvement, and one third develop disabilities and disease complications in the pre-steroid phase [7]. According to another study, cardiopulmonary failure and gastrointestinal disorders are the main causes of mortality in the acute phase of the disease [8]. Patients with longstanding JDM develop serious complications such as cutaneous calcinosis, lipodystrophy, metabolic disorders, and growth disturbances [9–12]. The survival rate of JDM patients has increased to 95–98 % because of the availability of improved medications and thorough follow-up [13].

The present study was performed on Iranian children with JDM and JPM from 2003 to 2013. Patients' clinical and laboratory data and clinical outcomes, including disease cycles, morbidity, and mortality, were evaluated.

Material and methods

A chart review of 85 children with JDM and JPM from across Iran who were referred to two referral pediatric rheumatology centers in Tehran was performed during the 10-year period from 2003 to 2013. Patients were diagnosed using the Bohan and Peter criteria [4, 5]. Clinical and laboratory data, disease complications (calcinosis, lipodystrophy, growth disturbances, and vital organ involvement), disease cycle, different treatment regimens, and mortality rates and causes were recorded using questionnaires. Some patients did not come back for follow-up after diagnosis and were consequently excluded from the study. This study was approved by the ethical committee of the Tehran University of Medical Sciences, Iran.

Mean and standard deviation (SD) were used for the descriptive analysis of quantitative variables, and total and partial frequencies were used for the descriptive analysis of qualitative variables. Chi-square tests (Pearson's and Fisher's exact tests) were used for comparing ratios.

Statistical analyses were performed using SPSS software version 20, and P value of ≤ 0.05 was considered statistically significant.

Results

In this study, 85 children (40 boys and 45 girls; F/M ratio, 1.1:1) with JDM and JPM were evaluated. In all, 71 % of boys were aged <5 years (F/M, 0.4:1), and 61 % of girls were aged >5 years (F/M, 1.6:1), which was a significant age/gender difference ($P=0.01$).

Of the 85 children, 76 were diagnosed with JDM, and 9 were diagnosed with JPM. The mean age at diagnosis was 7.5 ±3.5 years (range, 1.5–15 years). The mean time from disease onset to treatment was 5 months (range, 0.3–24 months). The average number of hospital admissions was 2, and the mean duration of patient follow-up was 4 years. In all, six children had a family history of rheumatoid arthritis (mothers in a case of two children, aunts in a case of three children, and grandmother in a case of one child).

Cutaneous manifestations were present in all children with JDM, with heliotrope rash being the most common cutaneous manifestation. Fatigue was the most common constitutional symptom. Muscle weakness, especially in the lower extremities of proximal muscles, was present in 96 % of children at disease onset. Table 1 shows the frequency of cutaneous, muscular, and constitutional manifestations.

Laboratory tests, including antinuclear antibody (ANA) and rheumatoid factor (RF) tests, were requested at the time of diagnosis for all cases. The RF test yielded negative results in all patients. A positive titer of ANA (≥1/80) was found in 17 patients (20 %). In all, 76 patients were screened for anti-Jo-1, of which 12 (15 %) tested positive. Muscle enzyme assessment at disease onset showed the highest elevation in lactate dehydrogenase (LDH) levels (in 98 % of patients). Other enzymes having elevated levels were keratin kinase (87 % of patients), aldolase (72 % of patients), and aspartate aminotransferase (AST; 48 % of patients).

Table 1 The frequency of clinical findings in JDM/JPM patients

Sign or symptom	JDM/JPM patients at presentation (%)
Cutaneous features	
• Heliotrope rash	54 (71)
• Gottron's rash	45 (59)
• Malar/facial rash	35 (46)
• Nail fold capillary changes	16 (21)
• Shawl rash	4 (5)
Muscles weakness	
• Proximal lower extremity	82 (96)
• Distal lower extremity	14 (16)
• Proximal upper extremity	59 (69)
• Distal upper extremity	4 (5)
• Neck	20 (23)
• Dysphagia	16 (19)
Constitutional features	
• Easy fatigue	71 (83)
• Muscle pain or tenderness	41 (48)
• Fever	18 (21)
• Anorexia	18 (21)
• Weight loss	17 (20)
• Limb edema	7 (8)

JDM juvenile dermatomyositis, *JPM* juvenile polymyositis

Table 2 The relationship of serious complications with clinical and laboratory variables in JDM/JPM

Variables	Calcinosis *n*/total (%)	Lipodystrophy *n*/total (%)	Failure to thrive *n*/total (%)
Sex			
Male	9/40 (22)	4/40 (10)	10/40 (25)
Female	8/45 (17.7)	4/45 (9)	16/45 (36)
P value	0.6	1.0	0.2
Antinuclear antibody			
Positive	6/17 (16)	4/17 (23)	10/17 (23)
Negative	11/68 (20)	4/68 (6)	16/68 (59)
P value	0.08	0.047	0.005
Anti-Jo-1			
Positive	4/12 (33)	2/12 (17)	4/12 (33)
Negative	13/64 (20)	6/64 (9)	21/64 (33)
P value	0.4	0.6	1.0
Cycle disease			
Monocyclic	5/51 (10)	1/51 (2)	6/51 (12)
Polycyclic	7/22 (32)	5/22 (23)	12/22 (54)
Chronic continuous	5/12 (42)	2/12 (17)	8/12 (67)
P value	0.01	0.01	<0.001
Time from disease onset to treatment			
<1 month	0/8 (0)	0/8 (0)	1/8 (12)
1–3 months	4/39 (10)	2/39 (5)	9/39 (23)
3–6 months	1/21 (5)	2/21 (9)	7/21 (33)
≥7 months	12/17 (72)	4/17 (23)	9/17 (53)
P value	<0.001	0.1	0.1

JDM juvenile dermatomyositis, *JPM* juvenile polymyositis

Electromyography (EMG) was performed on all patients. Inflammatory myositis was recorded in 82 (96 %) patients. Diagnosis of patients with probable JPM was confirmed using histopathological examination. Muscle biopsy was performed on samples obtained from 48 patients with probable JDM, but who did not satisfy the Bohan and Peter criteria. Chronic inflammatory myositis was observed in 45 of the above 48 patients. The remaining three patients had normal findings on muscle biopsy and electromyographic examination and normal muscle enzyme levels. Cutaneous biopsy of suspected dermal lesions showed amyopathic JDM in these three patients.

Table 3 Treatment protocols in JDM/JPM patients

Treatment protocols	*N* (%)
Protocol 1 (prednisolone+nonbiological DMARDs)	56 (66)
Protocol 2 (protocol 1+immunosuppressive agents)	9 (10)
Protocol 3 (protocol 1±2 and PMPL or IVIG or CYC)	16 (19)
Protocol 4 (protocol 1±2 and biologic DMARDs)	4 (5)

JDM juvenile dermatomyositis, *JPM* juvenile polymyositis, *DMARDs* disease-modifying antirheumatic drugs, *PMPL* pulses methylprednisolone, *IVIG* intravenous immunoglobulin, *CYC* cyclophosphamide

Table 4 The characteristics of the deceased patients and cause of mortality

Sex	Age at diagnosis (years)	Time up to diagnosis (months)	Duration of disease	Cause of death
Female	9	1	6 months	Respiratory failure
Female	6.5	3	1 year	Respiratory failure
Male	7	18	4 years	Intestinal perforation due to calcinosis
Female	13	1	7 months	Cardiopulmonary failure and sepsis

With respect to disease cycles, monocyclic course was observed in 51 (60 %) patients, polycyclic course in 22 (26 %), and continuous chronic course in 12 (14 %). Serious complications such as calcinosis occurred in 20 % of patients, lipodystrophy in 9 %, and growth disturbances in 30 %. Failure to thrive was defined as weight and height less than 2 SD of normal curves for age and sex (according to NCBI). The relationship between the complications and clinical and laboratory variables, including gender, disease cycles, time from disease onset to treatment, and ANA and anti-Jo-1 titers, is shown in Table 2.

Vital organ involvement was observed in 26 (30 %) patients and led to the death of four patients. Vital organ involvement was as follows: cardiac involvement in 2 (2.5 %) patients, kidney involvement in 4 (5 %), lung involvement in 7 (8 %), and gastrointestinal involvement in 18 (21 %).

The mean duration of follow-up was 4 years, and the average number of hospital admissions was 2 (range, 1–10). Four treatment protocols were used for patients included in this study (Table 3).

Four (4.7 %) patients (one boy and three girls) diagnosed with JDM died; however, no significant difference between the genders was evident (P=0.6). The age at disease onset was >6 years for all these patients (Table 4).

Discussion

Clinical course

In the present study, clinical course of JDM and JPM was evaluated in 85 children. The mean age at diagnosis was 7.5 years, and female to male ratio was 1.12:1. Disease frequency was significantly higher in boys aged <5 years and girls aged >5 years. A study by Patwardhan et al. [6] on 78 patients with JDM comparing two age groups (under and over 3 years) had a female to male ratio of 5.4:1 in the first age

group, which is not consistent with that in our study. However, the female to male ratio in the second age group was 1.4:1, which is consistent with that in our study [6]. Two studies from the USA and UK reported a mean age at onset of 7 years. In these studies, 25 % of patients were aged <4 years, and the female to male ratio was 2.2:1 [14, 15]. Another study in Arabic children reported equal disease frequency in both the sexes [2] and history of rheumatoid arthritis in the first- and second-degree relatives of 7 % of patients. Another study in Japan reported a history of rheumatic disease, including rheumatoid arthritis and Sjogren disease, in second-degree relatives of 8 % of patients [16].

The mean interval between clinical onset and diagnosis/treatment was 5 months. Patients were followed up for an average of 4 years, and the mean number of hospital admissions was 2.

A four-centered study conducted from 1984 to 1995 in Canada reported a mean follow-up time of 7.2 years [17]. Another study conducted in New York from 1991 to 2006 reported a mean follow-up time of 3.7 years [18].

Cutaneous disorders were present in all patients with JDM, with heliotrope rash being the most common cutaneous disorder. Muscle weakness, predominantly in the lower extremities of proximal muscles, was evident in 96 % of patients. Fatigue, muscle tenderness, and pain were the most common constitutional signs. Ramanan and Feldman reported Gottron's papules as the most common cutaneous disorder, followed by heliotrope rash, and myalgia as the most frequent constitutional sign [9]. Results reported by Hashemzadeh et al. were similar to those observed in the present study. Heliotrope rash was the most common dermal sign, while muscle weakness was observed in 78 % of patients [19].

RF test yielded negative results in all patients, and ANA test yielded positive results in 20 % of patients. Muscle biopsy showed inflammatory myositis in all patients with JPM and in 93 % of patients with JDM. A study by Cassidy and Lindsley also reported negative results for RF test in all patients, positive results for ANA test in 10–85 % of patients, abnormal findings on EMG in 81–95 % of patients, and inflammatory changes on muscle biopsy in 80–89 % of patients with JDM and JPM [2].

In most studies, the most common enzyme disturbance was due to LDH, which is similar to that observed in our study [2, 6, 16, 19]. In all, 76 patients were screened for anti-Jo-1, of which it was present in 15 % of patients. The reported frequency of this marker is 20 % in adults and 1–5 % in children [20]. However, higher levels of this marker were reported in the children included in our study.

Clinical outcome

Evaluation of the disease during the study period showed monocyclic course in 60 % of patients, polycyclic course in 26 %, and continuous chronic course in 14 %. A similar study by Huber et al. on 83 children with JDM during a 10-year period reported a monocyclic course in 37 % of patients and polycyclic and chronic continuous courses in 63 % of patients [17]. Another multicenter study on 490 patients with JDM reported a monocyclic course in 41 % of patients and polycyclic and chronic continuous courses in 59 % of patients [3]. A study by Stringer et al. reported monocyclic disease course in one third of patients and chronic continuous disease course in 60 % of patients [21].

In the present study, the frequency of serious complications during the course of the disease was 20 % for calcinosis, 9 % for lipodystrophy, and 30 % for growth disorders. According to other studies, the frequency of calcinosis and lipodystrophy was 12–43 and 5–50 %, respectively [2]. A study by Huber et al. conducted in Canada reported calcinosis in 34 % of patients [17]. Another Iranian study on 14 patients over a 7-year period reported calcinosis in 14 % of patients with JDMs [22]. A study by Ramanan and Feldman reported growth disorders defined as reduced height to less than 2 SD of normal curve in 15 % of children and to less than 1 SD of the normal curve in 31 % of children; however, the weight of children included in this study did not decrease significantly during the follow-up [9]. Impaired growth was observed in 30 % of patients included in our study; of these, 10 % showed reduced height and weight to less than 2 SD of the normal curve, and the remaining showed only reduced height to less than 2 SD of the normal curve (for age and sex).

There was no significant correlation between calcinosis, sex, and positive ANA and anti-Jo-1 tests in our study; however, lipodystrophy and failure to thrive were significantly higher in ANA-positive patients. These complications occurred less frequently in monocyclic patients. Calcinosis was significantly higher in patients with a disease onset and treatment interval of >7 months. The study by Ramanan and Feldman showed no correlation between calcinosis, age, sex, disease course, and time from disease onset to treatment [9]. In the study by Patwardhan et al., calcinosis was more common in children aged <3 years at diagnosis [6]. The study by Huber et al. concluded that disease complications occurred more frequently in patients with chronic continuous disease course, which was similar to that observed in our study [17].

Treatment protocol 1 (Table 4) involving prednisolone 1–2 mg/kg/day combined with one of the disease-modifying antirheumatic drugs (DMARDs) such as hydroxychloroquine and/or methotrexate was successfully employed in 56 (66 %) patients. All monophasic patients experienced remission with this protocol. Protocol 2 (immunosuppressive drugs such as azathioprine and/or cyclosporine) was employed in patients with recurrent or refractory disease. In patients with refractory muscle weakness or lethal disease complications, intravenous immunoglobulin (IVIG) was added to the treatment regimen. Four patients experiencing several relapses after discontinuing

the treatment received biologic DMARDs (infliximab) as protocol 4; of these, two patients showed a satisfactory response, and one patient showed decreased calcinosis.

A study by Seshadri et al. did not show a significant difference in the final outcome of patients who received intravenous methylprednisolone 30 mg/kg/day up to 1 g daily or high doses of oral prednisolone (30–50 mg/kg/day) compared with routine dose (1–2 mg/kg/day oral prednisolone) [23]. Studies by Fisler et al. [24] and Klein-Gitelman et al. [25] stated that disease activity, severity, complications, and costs can be decreased using intravenous methylprednisolone. Kim et al. [26] used an aggressive treatment protocol involving intravenous methylprednisolone, routine dose of oral prednisolone, and methotrexate for 3 days, with a follow-up of intravenous methylprednisolone given weekly until complete control of muscle symptoms was achieved, and enzyme levels returned to normal. Comparison of patients in the above study with those under routine regimen showed a significant reduction in final complication, i.e., 57 % of these patients experienced 38 months of remission, and only 4 % of patients developed refractory calcinosis [26]. Huber et al. stated that intravenous corticosteroid therapy was not effective for treating calcinosis [17]. Stringer et al. reported IVIG as an effective treatment in patients with inadequate response to first-line drugs [27]. Martin et al. found that anti-TNF-α drugs such as infliximab as a second- and third-line drug can decrease disease chronicity and calcinosis [28].

In the present study, vital organ involvement was observed in 30 % of patients and led to the death of four (4.7 %) patients. Cardiac involvement was observed in two (2.5 %) patients, of which one died because of cardiopulmonary failure and sepsis. Respiratory failure was seen in seven (8 %) patients because of respiratory muscle weakness (three patients were ventilated, of which two died because of bilateral pneumothorax and severe subcutaneous emphysema). Kidney disease was observed in four (5 %) patients, which led to hypertension. GI disease was observed in 18 (21 %) patients. In patients with GI disease, dysphagia and bowel motility disorder were the most common complaints. One patient with GI disease underwent surgery for massive hemorrhagic perforated duodenal ulcer.

Studies have shown that approximately one third of patients with JDM die because of respiratory failure, myocarditis, acute GI ulcers, and massive GI bleeding due to ulcer perforation in the pre-steroid phase [2, 7]. Another study showed that the survival rate increased up to 98 % since 1972 because of new treatment regimens and thorough follow-ups [13]. The study by Huber et al. on 80 patients with JDM over a 7.2-year follow-up period reported only one death due to myocardial infarction after myocarditis [17]. The multicenter American–Canadian study from 1980 to 2004 reported a mortality rate of 3.1 % [22], which was slightly lower than that reported in our study.

In our study, all monocyclic patients could successfully perform their normal activities such as school attendance, sport classes, playing games, and bathing themselves after the treatment. Because of the chart review nature of the study, assessment of functional outcomes in patients with polycyclic and chronic continuous disease (by using functional ability tools) could not be performed. It is recommended that this should be performed in future studies involving Iranian children.

Conclusions

The present study showed that the overall sex distribution was equal; however, boys aged <5 years and girls aged >5 years showed higher disease frequency. Presence of ANA is a risk factor for disease complications such as lipodystrophy and growth disturbances in patients with JDM and JPM. Most patients with monocyclic course effectively responded to the first-line treatment and showed complete remission; however, regular follow-up and assessment of vital organ involvement are recommended for patients with polycyclic and chronic continuous disease.

Acknowledgments This study was part of a fellowship thesis (of Dr. Abdolreza Malek) supported by Tehran University of Medical Sciences.

Disclosure None.

References

1. Feldman BM, Rider LG, Reed AM et al (2008) Juvenile dermatomyositis and other idiopathic inflammatory myopathies of childhood. Lancet 371:2201–2212
2. Cassidy JT, Lindsley CB (2010) Juvenile dermatomyositis. In: Cassidy JT, Petty RE (eds) Textbook of pediatric rheumatology, 6th edn. Elsevier Saunder, Philadelphia, pp 375–413
3. Ravelli A, Trail L, Ferrari C et al (2010) Long-term outcome and prognostic factors of juvenile dermatomyositis: a multinational, multicenter study of 490 patients. Arthritis Care Res 62:63–72
4. Bohan A, Peter JB (1975) Polymyositis and dermatomyositis (first of two parts). N Engl J Med 292:344–347
5. Bohan A, Peter JB (1975) Polymyositis and dermatomyositis (second of two parts). N Engl J Med 292:403–407
6. Patwardhan A, Rennebohm R, Rennebohm R, Dvorchik I, Spencer CH (2012) Is juvenile dermatomyositis a different disease in children up to three years of age at onset than in children above three years at onset? A retrospective review of 23 years of single center experience. Pediatr Rheumatol 10(1):34
7. Rouster-Stevens KA, Gursahaney A, Ngai KL et al (2008) Pharmacokinetic study of oral prednisolone compared with intravenous methylprednisolone in patients with juvenile dermatomyositis. Arthritis Rheum 59:222–226
8. Ramanan AV, Feldman BM (2002) Clinical features and outcomes of juvenile dermatomyositis and other childhood onset myositis syndromes. Rheum Dis Clin N Am 28:833–857

9. Ramanan AV, Feldman BM (2002) Clinical outcomes in juvenile dermatomyositis. Curr Opin Rheumatol 14:658–662
10. Sallum AM, Pivato FC, Doria-Filho U et al (2008) Risk factors associated with calcinosis of juvenile dermatomyositis. J Pediatr 84: 68–74
11. Pope E, Janson A, Khambalia A et al (2006) Childhood acquired lipodystrophy: a retrospective study. J Am Acad Dermatol 55:947–950
12. Huemer C, Kitson H, Malleson PN et al (2001) Lipodystrophy in patients with juvenile dermatomyositis—evaluation of clinical and metabolic abnormalities. J Rheumatol 28:610–615
13. Ponyi A, Constantin T, Balogh Z, Szalai Z, Borgulya G, Molnár K, Tefner I, Garami M, Fekete G, Dankó K (2005) Disease course, frequency of relapses and survival of 73 patients with juvenile or adult dermatomyositis. Clin Exp Rheumatol 23:50–56
14. McCann LJ, Juggins AD, Maillard SM et al (2006) The Juvenile Dermatomyositis National Registry and Repository (UK and Ireland)—clinical characteristics of children recruited within the first 5 yr. Rheumatology 45:1255–1260
15. Mendez EP, Lipton R, Ramsey-Goldman R et al (2003) US incidence of juvenile dermatomyositis, 1995-1998: results from the National Institute of Arthritis and Musculoskeletal and Skin Diseases Registry. Arthritis Rheum 49:300–305
16. Kishi T, Miyamae T, Hara R et al (2013) Clinical analysis of 50 children with juvenile dermatomyositis. Mod Rheumatol 23(2):311–317
17. Huber AM, Lang B, LeBlanc CM et al (2000) Medium- and long-term functional outcomes in a multicenter cohort of children with juvenile dermatomyositis. Arthritis Rheum 43:541–549
18. Levy DM, Bingham A, Kahn PJ, Eichenfield AH, Imundo LF (2010) Favorable outcome of juvenile dermatomyositis treated without systemic corticosteroids. J Pediatr 156:302–307
19. Hashemzadeh A, Heydarian F (2007) Juvenile dermatomyositis; clinical and laboratory assays. Iran J Pediatr 17(3):271–274
20. O'Hanlon TP, Rider LG, Schiffenbauer A et al (2008) Immunoglobulin gene polymorphisms are susceptibility factors in clinical and autoantibody subgroups of the idiopathic inflammatory myopathies. Arthritis Rheum 58:3239–3246
21. Stringer E, Singh-Grewal D, Feldman BM (2008) Predicting the course of juvenile dermatomyositis: significance of early clinical and laboratory features. Arthritis Rheum 58(11):3585–3592
22. Shiari R, Kiumarsi A, Eshgh FA, Allameh MM (2012) Juvenile dermatomyositis in Iranian children; a case series report. Ann Pediatr Rheum 1(1):58–64
23. Seshadri R, Feldman BM, Ilowite N, Cawkwell G, Pachman LM (2008) The role of aggressive corticosteroid therapy in patients with juvenile dermatomyositis: a propensity score analysis. Arthritis Rheum 59(7):989–995
24. Fisler RE, Liang MG, Fuhlbrigge RC, Yalcindag A, Sundel RP (2002) Aggressive management of juvenile dermatomyositis results in improved outcome and decreased incidence of calcinosis. J Am Acad Dermatol 47(4):505–511
25. Klein-Gitelman MS, Waters T, Pachman LM (2000) The economic impact of intermittent high-dose intravenous versus oral corticosteroid treatment of juvenile dermatomyositis. Arthritis Care Res 13(6): 360–368
26. Kim S, Moussa D, Fatma D, Zurakowski D, Fuhlbrigge RC, Sundel RP (2009) Complete and sustained drug free remission of juvenile dermatomyositis resulting from aggressive treatment. Arthritis Rheum 60(6):1825–1830
27. Stringer E, Bohnsack J, Bowyer SL, Griffin TA, Huber AM, Lang B et al (2010) Treatment approaches to juvenile dermatomyositis (JDM) across North America: The Childhood Arthritis and Rheumatology Research Alliance (CARRA) JDM Treatment Survey. J Rheumatol 37(9):1953–1961
28. Martin N, Li CK, Wedderburn LR (2012) Juvenile dermatomyositis: new insights and new treatment strategies. Ther Adv Musculoskelet Dis 4(1):41–50