Clinical Rheumatology (2019) 38:2309–2318
https://doi.org/10.1007/s10067-018-04422-z

ORIGINAL ARTICLE

Mechanic hands: clinical and capillaroscopy manifestations of patients with connective tissue diseases presented with and without mechanic hands

Saeedeh Shenavandeh[1] · Shaghayegh Habibi[1] · Yasamin Habibi[1] · Mohammadali Nazarinia[1]

Received: 15 October 2018 / Revised: 17 December 2018 / Accepted: 27 December 2018 / Published online: 12 January 2019

Abstract

Objectives The condition known as 'Mechanic's Hands' is a thickened, hyperkeratotic eruption, which is bilaterally symmetric along the fingers, and often occurs in patients with some connective tissue diseases. Nail fold capillaroscopy is a non-invasive technique for evaluation of connective tissue diseases. We evaluated the prevalence of mechanic hands in patients with connective tissue diseases and compared the clinical manifestations and capillaroscopic changes in the patients with and without mechanic hands.

Methods The clinical manifestations and capillaroscopy of 576 patients with scleroderma, dermatomyositis, systemic lupus erythematosus, Sjogren's syndrome, undifferentiated and mixed connective tissue diseases were evaluated and compared in patients with and without mechanic hands.

Results A total of 576 patients were enrolled. Mechanic hands were observed in 17.2% of patients: 50% of mixed connective tissue disease, 35% of dermatomyositis, 15.4% of scleroderma, 14.9% of undifferentiated connective tissue disease, 14.3% of Sjogren's syndrome, and no patient with SLE. Among them, 80.8% had abnormal capillaroscopic findings. In dermatomyositis patients, Raynaud's phenomenon, anti-Jo-1 positivity, and some capillaroscopy findings were detected more frequently in patients with mechanic hand. In scleroderma, positive Scl70 and capillary loss were observed more frequently in patients without mechanic hands.

Conclusions Mechanic hands can be a presenting sign of some systemic connective tissue diseases. Probably, finding this sign on examination, especially together with Raynaud's phenomenon or abnormal capillaroscopy, can be helpful in the early diagnosis of the connective tissue diseases and can be used as a predictive and prognostic tool in future studies.

Keywords Connective tissue diseases · Dermatomyositis · Mechanic hands · Nailfold capillaroscopy · Scleroderma · Undifferentiated connective tissue disease

Introduction

The condition known as 'Mechanic's Hands' was first reported by Stahl et al. [1] in 1979 as thickened, hyperkeratotic eruptions that were bilaterally symmetric along the ulnar aspect of the thumb and radial aspect of the index and middle fingers, similar to the findings in manual workers. Sometimes, it is difficult to be differentiated from hand eczema [2–4]. It can be differentiated clinically by the following criteria: (1) there is no evidence of pruritus; (2) it is usually bilateral and symmetric, whereas in hand eczema, it is often observed in the dominant arm; (3) it occurs without occupational stimulation, allergens, or irritants; and (4) it often occurs with other general symptoms [4] and unlike eczematous lesions, it is resistant to topical or oral corticosteroids [5]. "Mechanic's hands" have been reported in patients with dermatomyositis (DM), mixed connective tissue disease (MCTD), collagen vascular-related interstitial pneumonia, systemic lupus erythematosus (SLE) [6], and "anti-synthetase syndrome", that is a form of DM associated with the presence of anti-Jo-1 antibodies against histidyl-tRNA synthetase with clinical features of myositis, interstitial lung disease, Raynaud's phenomenon, fever, asthenia, mechanic's

✉ Shaghayegh Habibi
shghyghhabibi@gmail.com

[1] Division of Rheumatology, Department of Internal Medicine, Shiraz University of Medical Sciences, Shiraz, Fars, Iran

hands, and non-erosive symmetric polyarthritis of the small joints [2, 7, 8].

Nail fold capillaroscopy (NFC) is a non-invasive imaging technique and a useful tool for evaluation of systemic connective tissue diseases such as systemic sclerosis (SSc), SLE, MCTD, and DM [9, 10]. According to the pathogenesis of polymyositis (PM) and DM, capillaroscopic alterations are clearly identifiable mostly in patients with DM [11]. We made an attempt to evaluate the prevalence of mechanic hands in patients with connective tissue diseases (CTD) and then compare the clinical manifestations and capillaroscopic changes of patients with definite or probable DM, Sjogren's syndrome (SS), systemic sclerosis (SSc) (diffuse/limited), SLE, and MCTD with and without mechanic hands and differences between them.

Method

In this cross-sectional study conducted from September 2010 to October 2016, we evaluated 576 patients with connective tissue diseases (CTD) who referred to the outpatient clinic of the Rheumatology Unit of Hafez Hospital, the Capillaroscopy Unit, or were admitted in Hafez Rheumatology Ward affiliated to Shiraz University of Medical Sciences. If the patients had signs and symptoms suggestive of a CTD but did not fulfill the existing classification criteria for a CTD, we defined them as undifferentiated CTD (UCTD) [12, 13].

We also included the patients with systemic sclerosis (SSc) who fulfilled the ACR criteria [14] and ACR/EULAR SSc diagnostic criteria [15] for SSc and referred to the Hafez Hospital clinic of scleroderma and the patients who were admitted in Hafez Rheumatology Ward, both affiliated to Shiraz University of Medical Sciences. Patients with SLE who met the criteria [16], those with DM patients who fulfilled the criteria of Bohan and Peter [17, 18] for definite and probable DM, those who suffered primary SS using criteria of 2016 ACR/EULAR Classification Criteria for Primary Sjogren's Syndrome [19], and the patients with MCTD who fulfilled the classification criteria of Alarcon-Segovia et al. [20] were included. They were 16–65 years old. The patients received a checklist with inclusion and exclusion criteria. When a subject was proved to meet the inclusion and exclusion criteria, the data were registered.

Exclusion criteria: cases with diabetes mellitus, patients with malignancy and vibration associated jobs like jack hammer workers, and smokers were excluded from the study. We excluded the patients with pure PM due to their low number (we only had six patients with definite PM); all of them had only non-specific capillaroscopy changes, and no one had mechanic hands. This condition correlated with the article conducted by Senecal et al. in 2017 [21] indicating that the prevalence of pure polymyositis group of patients were < 5% in adult autoimmune myositis. All the patients were required to sign the consent form, before being included in the study.

All clinical manifestations of the patients and their organ involvement were recorded during the evaluation. The patients with SSc were divided into diffuse (dcSSc) and limited cutaneous SSc (lcSSc) forms. All patients were divided into two groups with and without mechanic hands.

Capillaroscopic evaluation was done by a rheumatologist involved in this research and the data were saved in a chart. The collection of patients and clinical examination of the patients were done by the physician involved in this research. All patients were assessed for sex, age, disease duration, serological (anti-Scl70, sm, snRNP, anti-RO/SSA, anti-LA/SSB, anticentromere, anti-Jo1, and antinuclear antibody) and clinical subsets, and skin scoring in SSc patients according to the definition by LeRoy et al. by MRSS scoring (Modified Rodnan Score) [22]. Also, SSc patients were evaluated for joint contracture measured by Finger to Palm index (FTP), which is used for measuring the FTP distance (from the tip of the third finger to the distal palmar crease in maximal active flexion) [23]. Pulmonary involvement was assessed by HRCT at first screening, after detecting low DLCO<80% or low FEV1 < 75% in PFT or bilateral basilar crackles in examination. Pulmonary artery hypertension (PAH) was assessed by echo as a basic evaluation of the clinic proved by a cardiologist work-up.

On the same day of clinical evaluation, the patients underwent NFC by streomicroscope Euromex ST. 1740, made in Holland by × 250 power and video camera Cmex D.C.5000 (5 megapixels). The patients whose fingers were hard to look through including those with very thick skin and traumatized fingers were excluded from the study. The data including distribution (disturbed or normal), shape of the capillaries (normal hairpin, subtle changes including tortuocity and crossing, anomalies including, ectasia, ramification/bushy/arborization/branching [neoangiogenesis], and bizzar), the largest diameter of arterial or venous side (dilated loops was defined as irregular or homogeneous increase of capillary diameter ≥ 20 μm), capillary length (normal or elongated ≥ 300 mm), mean capillary density (capillary loss was defined as reduction of the normal number of capillaries below seven per linear millimeter), avascular area (intercapillary distance > 500 μm), microhemorrhages, and neoangiogenesis were recorded in a form [10, 18, 19]. The whole findings were defined as normal, specific changes for early, active, and late scleroderma pattern or non-specific changes. According to Cutolo et al. [24], erythrocyte sedimentation rate (ESR) was measured by the Westergren method. Serum C-reactive protein (CRP) by nephelometry; rheumatoid factor (RF) was checked by latex test; antinuclear antibody (ANA) and extractable nuclear antigen (ENA) profile by enzyme-linked immunosorbent assay (ELISA) method. To compare the difference of manifestations between patients with SSc with and without mechanic hands,

we used twice the number of the same dcSSc and lcSSc patients with the same duration of disease as the control group. In addition, for the DM group, we compared the data between patients with and without mechanic hands. Assessment and analysis were done through SPSS-16 using variation analysis and κ-square test. Results are shown as mean ± standard deviation. We considered $p < 0.05$as statistically significant. We also described four normal control patients that were detected during the time of the study presented with mechanic hands at the end.

Results

A total of 576 patients with SSc (331), SLE (124), DM (97), UCTD (47), primary SS [14], and MCTD [10] were studied from September 2010 to October 2016. Among these patients, mechanic hands were observed in 99 (17.2%) patients: in 5 out of 10 patients with MCTD (50%), 34 out of 97 patients with DM (35%), 51 out of 331 patients with SSc (15.4%), 7 out of 47 patients with UCTD (14.9%), 2 out of 14 patients with SS (14.3%), and none of 124 patients with SLE (0%) (Fig. 1). In all of these groups, the correlation between the presence of mechanic hand and age, sex, and disease duration was not statistically significant ($p > 0.05$).

In all 99 patients with mechanic hands, the female/male ratio was nearly 9:1; 89 (89.9%) patients were female and 10 (10.1%) were male. Raynaud's phenomenon was the most common clinical manifestation seen in our patients with mechanic hands (70.7%). A total of 80.0% of our patients with mechanic hands had scleroderma pattern of capillaroscopy and the other 19.2% had non-specific changes. Capillary dilatation, microhemorrhage, and disturbed distribution of capillaries were the most common abnormal findings in their capillaroscopy. Demographic manifestations, laboratory data, and their capillaroscopic features are presented in Table 1.

We randomly selected 145 patients with SSc and divided them into two groups with and without mechanic hands that were matched in sex, age, and disease duration. Among all of the patients, 125 were female (86.2%) and 20 were male (13.8%). Their age ranged from 18 to 75 years with a mean ± SD of 44.13 ± 12.5, and the disease duration ranged from 6 months to 25 years with a mean ± SD of 5.46 ± 5.4. The clinical and capillaroscopic features compared in patients with and without mechanic hands are reported in Table 2. In the patients with scleroderma, 58 out of 100 patients (58%) had dcSSc and 42 out of 100 patients (42%) had lcSSc; mechanic hand was seen more frequently in dcSSc patients (46.6%) compared with lcSSc patients (19.2%) ($p = 0.004$). Raynaud's phenomenon was seen more frequently in patients without mechanic hand (94.7%) compared with patients with it (86.3%), but the correlation between Raynaud's phenomenon and presence of mechanic hand was not significant ($p = 0.07$). In evaluation of the capillaroscopic changes, early scleroderma pattern was seen more commonly in patients with mechanic hand and the correlation was significant ($p = 0.019$). Low capillary density, anomalia, and disturbed distribution were detected more commonly in patients without mechanic hands ($p = 0.01$, $p = 0.02$, and $p = 0.01$, respectively). In addition, higher incidence of positive Scl70 was seen in the patients without mechanic hands ($p = 0.007$). No significant differences were seen in other clinical or laboratory data between the two groups of patients with and without mechanic hands ($p > 0.05$).

Among 97 patients with DM, 73 were female (75.3%) and 24 were male (24.7%); the mean duration of the disease was 2.7 (± 4.2) years. We divided all of them into two groups with and without mechanic hands that were matched in sex, age, and disease duration. Clinical/capillaroscopic features are reported in Table 3. Raynaud's phenomenon and Gottron papule were more frequent in patients with DM with mechanic hands ($p = 0.029$ and $p = 0.003$, respectively). Normal capillaroscopic pattern was observed only in 4 (4.1%) and scleroderma pattern in 60 (61.8%) patients. Early scleroderma pattern was seen more commonly in patients with mechanic hand and the correlation was significant ($p = 0.035$). Non-specific capillaroscopic pattern was found more commonly in patients without mechanic hand (41.3%) compared with patients with mechanic hand (20.6%), and the difference was significant ($p = 0.04$). Disturbed distribution and presence of anomalia (including branching and bizarre shape capillaries) in capillaroscopy were more frequent in patients with DM with mechanic hands ($p = 0.001$ and $p = 0.014$, respectively). Also, positive anti Jo-1 antibody and high level of CRP (> 6) were seen more frequently in

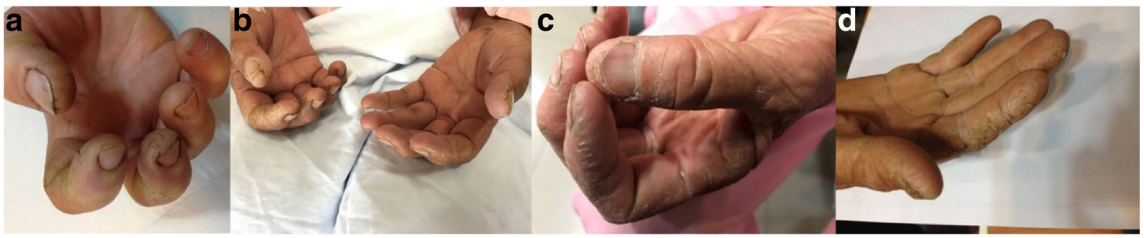

Fig. 1 Mechanic hands in patients with **a** scleroderma, **b** dermatomyositis, **c** Sjogren's syndrome, and **d** normal with no connective tissue disease

Table 1 Clinical features, laboratory data, and capillaroscopic findings of all patients with mechanic hand

	Scleroderma ($n = 51$)	Dermatomyositis ($n = 34$)	UCTD ($n = 7$)	MCTD ($n = 5$)	Sjogren's disease ($n = 2$)	Total ($n = 99$)
Age (mean ± SD)	48.37 ± 11.9	38.26 ± 12.6	38.7 ± 10.3	41.40 ± 11.7	53.5 ± 9.5	43.2 ± 14.3
Duration (mean ± SD)	8.12 ± 8.4	2.75 ± 4.6	4.8 ± 5.0	3.80 ± 3.9	2.25 ± 1.75	5.7 ± 7.2
Clinical manifestations						
Raynaud's phenomenon (%)	44 (86.3)	12 (35.3)	7 (100)	5 (100)	1 (50)	69 (69.7)
Arthritis (%)	4 (7.9)	10 (29.4)	0 (0)	0 (0)	0 (0)	14 (14.1)
Puffy hand (%)	14 (27.5)	2 (5.9)	0 (0)	0 (0)	0 (0)	17 (17.2)
Periungual erythema (%)	0 (0)	15 (44.1)	0 (0)	0 (0)	0 (0)	15 (15.2)
Digital pitting scar (%)	13 (25.5)	0 (0)	0 (0)	0 (0)	0 (0)	13 (25.5)
GI involvement (%)	25 (49)	0 (0)	0 (0)	1 (20)	0 (0)	26 (26.3)
Lung involvement (%)	19 (37.3)	10 (29.4)	0 (0)	1 (20)	0 (0)	30 (30.3)
PAH (%)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Laboratory findings						
High ESR (%)	12/35 (34.3)	14/18 (77.8)	0/5 (0)	2/5 (40)	0/2 (0)	28/65 (43.1)
High CRP (%)	6/27 (22.2)	11/16 (68.8)	0/5 (0)	1/5 (20)	0/2 (0)	18/55 (32.7)
ANA (%)	30/30 (100)	9/14 (64.3)	7/7 (100)	5/5 (100)	2/2 (100)	53/58 (91.4)
Ds DNA (%)	1/17 (5.9)	0 (0)	0/5 (0)	0/5 (0)	0/1 (0)	1/28 (3.6)
RF (%)	1/13 (7.7)	2/7 (28.6)	1/18 (5.6)	1/2 (50)	1/1 (100)	6/41 (14.6)
Low C3 C4 (%)	0/13 (0)	1/4 (25.0)	1/6 (16.6)	1/2 (50)	0/1 (0)	3/26 (11.5)
Anti Ro (%)	7/23 (30.5)	3/9 (33.3)	0 (0)	2/4 (50)	2/2 (100)	14/38 (36.8)
Anti sm (%)	2/23 (8.7)	0/9 (0)	0 (0)	3/4 (75)	1/2 (50)	6/38 (15.8)
Anti La (%)	5/23 (21.8)	1/9 (11.1)	0 (0)	0/4 (0)	1/2 (50)	7/38 (18.4)
Anti jo-1 (%)	2/23 (8.7)	5/9 (55.6)	0 (0)	0/4(0)	1/2 (50)	8/38 (21.1)
Capillaroscopic pattern						
Normal pattern (%)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Sclerodermal pattern:	48 (94.1)	27 (79.4)	2 (28.6)	3 (60)	0 (0)	80 (80.8)
Early (%)	24/48 (50)	7/27 (26)	1/2 (50)	0/3 (0)	0 (0)	32 (32.3)
Active (%)	19/48 (39.6)	15/27 (55.6)	1/2 (50)	3/3 (100)	0 (0)	38 (38.4)
Late (%)	5/48 (10.4)	5/27 (18.5)	0/2 (0)	0/3 (0)	0 (0)	10 (10.1)
Nonspecific pattern (%)	3 (5.9)	7 (20.6)	5 (71.4)	2 (40)	2 (100)	19 (19.2)
Capillaroscopic findings						
Disturbed distribution (%)	26 (51)	30 (88.2)	1 (14.3)	3 (60)	0 (0)	60 (60.6)
Subtle (%)	6 (11.8)	13 (38.2)	3 (42.8)	0 (0)	1 (50)	23 (23.2)
Anomalia (%)	16 (31.4)	30 (88.2)	0 (0)	4 (80)	0 (0)	50 (50.5)
Dilatation (%)	45 (88.2)	30 (88.2)	6 (85.8)	5 (100)	2 (100)	88 (88.9)
Giant loop (%)	32 (62.7)	14 (41.2)	1 (14.3)	2 (40)	0 (0)	49 (49.5)
Capillary loss (%)	19 (37.2)	18 (35)	0 (0)	2 (40)	0 (0)	49 (49.5)
Avascular area (%)	15 (29.4)	16 (47)	1 (14.3)	0 (0)	0 (0)	32 (32.3)
Hemorrhage (%)	33 (64.7)	21 (61.8)	2 (28.6)	3 (60)	2 (100)	61 (61.6)
Elongation (%)	20 (39.2)	15 (44.1)	0 (0)	1 (20)	0 (0)	36 (36.4)
Abnormal blood Flow (%)	5 (9.8)	3 (8.8)	0 (0)	0 (0)	0 (0)	8 (8.1)

UCTD undifferentiated connective tissue disease, *MCTD* mixed connective tissue disease, *GI* gastrointestinal, *PAH* pulmonary arterial hypertension, *ESR* erythrocyte sedimentation rate, *CRP* C-reactive protein, *ANA* antinuclear antibody, *dsDNA* double-strand DNA, *RF* rheumatoid factor

patients with mechanic hand, and the difference between these two groups was statistically significant ($p = 0.02$ and $p = 0.03$, respectively). For other laboratory data, the differences were not statistically significant ($p > 0.05$).

In all of 47 patients with UCTD, 46 (97.9%) were female and only 1 (2.1%) was male. Mechanic hands were seen in 7 patients (14.9%) with UCTD. We divided the patients with UCTD in the two groups of with and without mechanic hands

Table 2 Clinical features, laboratory data, and capillaroscopic findings of patients with scleroderma (with and without mechanic hands)

	Scleroderma patients with mechanic hand ($n = 51$)	Scleroderma patients without mechanic hand ($n = 94$)	P value
Clinical characteristics			
Puffy hands (%)	14 (27.5)	37 (39.4)	NS
Pitting scar (%)	12 (23.5)	18 (19.2)	NS
Tip ulceration (%)	3 (5.9)	11 (11.7)	NS
Raynaud's phenomenon(%)	44 (86.3)	89 (94.7)	NS ($p = 0.07$)
Telangiectesia (%)	19 (37.3)	41 (43.6)	NS
Arthritis (%)	4 (7.8)	11 (11.7)	NS
Lung involvement (%)	11 (21.6)	29 (30.9)	NS
PAH (%)	0 (0)	1 (1.1)	NS
GI manifestations (%)	27 (53)	50 (53.2)	NS
Laboratory data			
High ESR (> 30) (%)	12/35 (34.3)	22/65 (33.9)	NS
High CRP (> 6) (%)	6/27 (22.2)	7/61 (11.5)	NS
Scl-70 (%)	13/23 (56.5)	78/92 (84.8)	$p < 0.007$
Anti-centromeric Ab (%)	4/5 (80)	12/13 (92.3)	NS
Capillaroscopic pattern			
Normal pattern (%)	0 (0)	0 (0)	NS
Sclerodermal pattern:	48 (94.1)	91 (96.8)	NS
Early (%)	24/48 (50)	26/91 (28.6)	$p < 0.019$
Active (%)	19/48 (39.6)	48/91 (52.8)	NS
Late (%)	5/48 (10.4)	17/91 (18.7)	NS
Non specific pattern (%)	3 (5.9)	3 (3.2)	NS
Capillaroscopic findings			
Disturbed distribution (%)	26 (51)	67 (71.3)	$p < 0.01$
Subtle change (%)	6 (11.8)	5 (5.3)	NS
Anomalia (%)	16 (31.4)	48 (51)	$p < 0.02$
Dilatation (%)	45 (88.2)	76 (80.9)	NS
Giant loop (%)	32 (62.7)	71 (75.5)	NS
Capillary loss (%)	20 (39.2)	61 (64.9)	p < 0.01
Avascular area (%)	15 (29.4)	38 (40.4)	NS
Hemorrhage (%)	33 (64.7)	66 (70.2)	NS
Elongation (%)	20 (39.2)	25 (26.6)	NS
Abnormal blood flow (%)	5 (9.8)	8 (8.5)	NS

PAH pulmonary arterial hypertension, *GI* gastrointestinal, *ESR* erythrocyte sedimentation rate, *CRP* C-reactive protein

and compared the clinical/capillaroscopic features between the two groups (Table 4). No significant differences were seen between the two groups of patients with and without mechanic hands ($p > 0.05$).

Of the 14 patients with Sjogren's syndrome, 1 (7.1%) was male and 13 (92.9%) were female. Raynaud's phenomenon was observed in 4 (28.6%) of them. The lab tests including anti-Ro/SSA and ANA were positive in all patients (100%). ESR was detected in 8 (57.1%), CRP in 2 (14.3%), RF in 8 out of 10 (80%), and anti-LA/SSB in 2 out of 11 (18.2%) patients. During capillaroscopic evaluation, normal capillaroscopic features were found in 1 (7.1%), non-specific capillaroscopic changes in 12 (85.8%), and scleroderma pattern in 1 (7.1) patient which was early scleroderma pattern. As there were only two patients with SS and mechanic hand, we could not evaluate the differences between the two groups of patients with and without mechanic hand.

In 10 patients with MCTD, the female/male ratio was 9:1. In these patients, ANA was detected in all (100%) and anti-Ro in 4 (40%) patients. NFC showed non-specific changes in 4 (40%) and scleroderma pattern in 6 (60%) patients [1 (10%) with early scleroderma pattern, 4 (40%) active scleroderma pattern, and 1 (10%) late scleroderma pattern]. Mechanic hands were seen in five patients (50%). Since the number of

Table 3 Clinical features, laboratory data, and capillaroscopic findings of patients with dermatomyositis

	Dermatomyositis patients with mechanic hand ($n = 34$)	Dermatomyositis patients without mechanic hand ($n = 63$)	P value
Clinical characteristics			
Raynaud's phenomenon (%)	12 (35.3)	10 (15.9)	$p < 0.029$
Heliotrope rash (%)	14 (41.2)	27 (42.9)	NS
Gottron papule (%)	23 (67.6)	23 (36.5)	$p < 0.003$
Gottron sign (%)	7 (20.6)	8(12.7)	NS
Periungual erythema (%)	15 (44.1)	16 (25.4)	NS
Arthritis (%)	10 (29.5)	17 (27)	NS
Muscle weakness (%)	26 (76.5)	50 (79.4)	NS
Lung involvement (%)	10 (29.4)	11 (17.5)	NS
Laboratory data			
High ESR (> 30) (%)	14/18 (77.8)	23/37 (62.2)	NS
High CRP (> 6) (%)	11/16 (68.8)	11/30 (36.7)	$p < 0.03$
Anti Jo-1 (%)	5/9 (55.6)	3/23 (13)	$p < 0.02$
CPK (%)	21/24 (87.5)	36/45 (80)	NS
LDH (%)	21/24 (87.5)	41/47 (87.2)	NS
Capillaroscopic pattern			
Normal pattern (%)	0 (0)	4 (6.3)	NS
Sclerodermal pattern: (%)	27 (79.4)	33 (58.7)	NS
Early (%)	7/27 (20.6)	4/33 (6.3)	$p < 0.035$
Active (%)	15/27 (44.1)	23/33 (36.5)	NS
Late (%)	5/27 (14.7)	6/33 (9.6)	NS
Non specific pattern (%)	7 (20.6)	26 (41.3)	$p < 0.04$
Capillaroscopic findings			
Disturbed distribution (%)	30 (88.2)	35 (55.6)	$p < 0.001$
Subtle change (%)	13 (38.2)	22 (35)	NS
Anomalia (%)	30 (88.2)	41 (65)	$p < 0.014$
Dilatation (%)	30 (88.2)	48 (76.2)	NS
Giant loop (%)	26 (76.5)	14 (22.3)	NS
Capillary loss (%)	18 (53)	25 (39.7)	NS
Avascular area (%)	16 (47)	20 (31.8)	NS
Hemorrhage (%)	21 (61.8)	32 (50.8)	NS
Elongation (%)	15 (44.1)	21 (33.3)	NS
Abnormal blood flow (%)	3 (8.8)	10 (15.9)	NS

ESR erythrocyte sedimentation rate, *CRP* C-reactive protein, *CPK* creatine phosphokinase, *LDH* lactate dehydrogenase

patients with MCTD was small, we could not evaluate the differences between the patients with and without mechanic hand.

Moreover, we assessed four patients without CTD who presented with bilateral mechanic hands in physical examination and without occupational stimulation during the time of the study on our clinic of rheumatology. First, a 62-year-old lady was referred with diagnosis of both knees osteoarthritis. She had typical mechanic hands. She also had complaints of esophageal reflux disease and mild furrowing of her lips but no Raynaud's symptoms. Her lab tests for CTD were negative. Her NFC showed non-specific changes. Second, a 68-year-old man was referred with diagnosis of osteoarthritis. On physical examination, he had mechanic hands and all lab evaluations were normal. Capillaroscopy was not available for him. Third, a 69-year-old lady was referred to rheumatology clinic with the complaint of low back pain and medical history of canal stenosis that had mechanic hands on physical examination. Her lab tests were negative. Her NFC was normal, too. The forth patient was a 61-year-old man who presented with 6-month history of significant weight loss, chronic diarrhea, iron deficiency anemia; he was referred to rheumatology clinic for evaluation of his mechanic hands and high ESR. He had no history of Raynaud's phenomenon. His lab studies for CTD

Table 4 Clinical features, laboratory data, and capillaroscopic findings of patients with undifferentiated connective tissue disease

	UCTD patients with mechanic hand ($n = 7$)	UCTD patients without mechanic hand ($n = 40$)	P value
Clinical characteristics			
Raynaud's disease (%)	7 (100)	40 (100)	NS
Telangiectesia (%)	2 (28.6)	2 (5.0)	NS
Laboratory data			
High ESR (> 30) (%)	0/5 (0)	4/24 (16.7)	NS
High CRP (> 6) (%)	0/5 (0)	0/17 (0)	NS
ANA (%)	7/7 (100)	0/34 (0)	NS
dsDNA (%)	0/6 (0)	2/27 (7.4)	NS
Low c3, c4 (%)	1/6 (16.7)	1/14 (7.1)	NS
RF (%)	0/5 (0)	1/13 (7.7)	NS
Capillaroscopic pattern			
Normal pattern (%)	0 (0)	4 (10.0)	NS
Sclerodermal pattern: (%)	2 (28.6)	8 (20.0)	NS
Early (%)	1/2 (50.0)	8/8 (100)	NS
Active (%)	1/2 (50.0)	0/8 (0)	NS
Late (%)	0/2 (0)	0/8 (0)	NS
Non specific pattern (%)	5 (71.4)	28 (70.0)	NS
Capillaroscopic findings			
Disturbed distribution (%)	1 (14.3)	5 (12.5)	NS
Subtle change (%)	3 (42.9)	20 (50.0)	NS
Anomalia (%)	0 (0)	10 (25.0)	NS
Dilatation (%)	6 (85.8)	30 (75.0)	NS
Giant loop (%)	1 (14.3)	5 (12.5)	NS
Capillary loss (%)	0 (0)	3 (7.5)	NS
Avascular area (%)	1 (14.3)	0 (0)	NS
Hemorrhage (%)	2 (28.6)	18 (45.0)	NS
Elongation (%)	0 (0)	10 (25.0)	NS
Abnormal blood flow (%)	0 (0)	7 (17.5)	NS

UCTD undifferentiated connective tissue disease, *ESR* erythrocyte sedimentation rate, *CRP* C-reactive protein, *ANA* antinuclear antibody, *dsDNA* double-strand DNA, *RF* rheumatoid factor

were negative. His NFC was non-specific, too. He was referred to the gastroenterology clinic for evaluation of his gastrointestinal manifestations, including chronic diarrhea and bloody stool, especially for malignancy of GI tract (Fig. 1).

Discussion

In the present study, we detected mechanic hand in 17.2% of patients with CTD, 50% of patients with MCTD, 35% of patients with DM, 15.4% of those with SSc, 14.9% of those with UCTD, 14.3% of those with SS, and none of the patients with SLE. Other studies on DM reported mechanic hand in 20–45% of patients, which is similar to our study [25–28].

In our study on SSc patients, mechanic hand was observed in both types of SSc (including dcSSc and lcSSc) although it was more in dcSSc patients. In addition, the presence of positive Scl70 antibody and disturbed distribution, anomalia, and low capillary density in capillaroscopy was significantly more frequent in patients without mechanic hands. As we previously knew [29–32] about the association of low capillary density and disturbed distribution and presence of Scl-70 as poor prognostic factors, can the presence of mechanic hands in a patient with scleroderma be associated with better future prognosis? Further studies will be helpful.

In DM, the incidence of almost all clinical features, laboratory data, and capillary abnormalities was higher in patients with mechanic hand than in those without it. The differences were statistically significant in the presence of Raynaud's phenomenon and Gottron's papule, some laboratory data such as high CRP and positive anti Jo-1, and some capillaroscpic findings such as disturbed distribution and anomalia (including branching and bizarre shape capillaries). In a study by Sebastiani et al. in 2018 [33] on association of capillaroscopy

and clinical manifestations of patients with anti Jo-1 syndrome, they found no correlation between an SSc-like pattern of capillaroscopy and presence of mechanic's hands. We found more disturbed distribution and anomalia including branching and ramification in patients that presented with mechanic hands compared to those without mechanic hand although some of our patients with mechanic hands did not fulfill the criteria for anti Jo-1 syndrome. In Sato et al. study on dermatomyositis [34], they evaluated the clinical differences between the two groups of patients with ($n = 9$) and without mechanic hands ($n = 30$), and the results showed that periungual erythema and interstitial pneumonia were more common in patients with mechanic hand, and CPK was detected more in patients without mechanic hand. Thus, it seems that in our study, similar to previous research, the mechanic hand in patients with DM was more frequently seen with other clinical manifestations of anti Jo-1 syndrome although it was seen in patients without all other manifestations of this syndrome, too.

No previous studies on patients with scleroderma, MCTD, UCTD, SLE, or SS have evaluated the clinical differences regarding the presence of mechanic hands, and the association of this symptom with prognosis was examined broadly.

In both groups of patients with SSc or DM, early pattern of capillaroscopy was seen more in patients with mechanic hands. As we have not assessed the presence of mechanic hands during the treatment of the diseases over time, our study cannot demonstrate the effect of treatment on reduction of the prevalence of mechanic hands and this may help us in our future studies to evaluate the effect of treatment on disappearance of mechanic hands and changing the pattern of capillaroscopy. Mugii et al. [35] studied the effect of treatment on capillaroscopic pattern in patients with DM, showing that a rapid change happened in nail fold capillaries during the time and treatment.

Also, we found a significant frequency of the presence of mechanic hands in patients with UCTD, MCTD, and SS. The most common dermatologic manifestations described in patients with MCTD [36] were lupus-like skin lesions and puffy hands although in few studies [37, 38], DM-like rash was described in these patients. The number of our studied patients with MCTD was not so high and further studies on more patients are recommended. We did not find this sign in patients with SLE, so can the early presence of this sign in a patient with UCTD be helpful as a negative association with SLE? Further long-term prospective studies are needed.

Although mechanic hand often occurs in patients with connective tissue diseases, it may be observed in some healthy individuals too, as we described. Further studies may help us to define the presence of mechanic hands and other signs or symptoms for connective tissue diseases like Raynaud's phenomenon, or presence of mechanic hands along with abnormal capillaroscopy as a strong predictor of a connective tissue disease in a healthy person that only referred for evaluation of the presented mechanic hand. In a previous case report, the association of mechanic hands and interstitial lung disease has been described [38].

The limitation of this study was low number of control non-CTD group with presence of mechanic hands (only four patients during study time) and maybe it was due to the low incidence of it in normal population, or some missing data as we only evaluated the patients referred for capillaroscopy and to our clinics and did not focus on the normal population. Another limitation of our study was our inclusion criteria for myositis patients as the patients with overlap myositis including anti-Jo-1 syndrome patients were not defined as a separate group in this criterion and also in new ACR/EULAR criteria [39] and it should be evaluated in future studies.

Our review of previously published papers revealed that few studies have been conducted on the mechanic hands. For the first time, we assessed and analyzed the relationship between the presence of mechanic hands and other clinical manifestations, laboratory data, and capillaroscopic changes in connective tissue diseases. We found that most patients (80.8%) with mechanic hands had abnormal nailfold capillaroscopy (scleroderma pattern of capillaroscopy). There was no significant difference in the manifestations of patients with or without mechanic hands except for higher presence of Raynaud's phenomenon, gottron popule, anti Jo-1 antibody positivity, and presence of disturbed distribution and anomaly including neoangiogenesis in capillaroscopy among patients with DM who presented with mechanic hand and lower anti-Scl-70 antibody expression and lower capillary loss in capillaroscopy among SSc patients with mechanic hands, both of which are poor prognostic signs in patients with scleroderma. Probably, finding this sign on examination will be helpful in early diagnosis of the connective tissue diseases except for SLE, especially when it is associated with another clinical manifestation like Raynaud's phenomenon or abnormal capillaroscopy and it can be a prognostic tool in future studies.

Acknowledgments The authors would like to thank Shiraz University of Medical Sciences, Shiraz, Iran and also Center for Development of Clinical Research of Nemazi Hospital and Dr. Nasrin Shokrpour for editorial assistance.

Funding information The present article was extracted from the proposal financially supported by Shiraz University of Medical Science Grant number: 95-01-01-11391.

Compliance with ethical standards

Disclosures None

References

1. Stahl NI, Klippel JH, Decker JL (1979) A cutaneous lesion associated with myositis. Ann Intern Med 91(4):577–579

2. Bygum A, Velander MJ, Knudsen JB (2010) Mechanic's hands imitating hand eczema. Dermatitis 21(6):334–335
3. Ito A, Yamada N, Yoshida Y, Yamamoto O (2016) Pseudocheckerboard pattern: an interesting histopathological finding in mechanic's hands. J Cutan Pathol 43(1):5–11
4. Mii S, Kobayashi R, Nakano T, Harada H, Okada M, Matsui Y, Fujii T, Eto H (2009) A histopathologic study of mechanic's hands associated with dermatomyositis: a report of five cases. Int J Dermatol 48(11):1177–1182
5. Concha JSS, Merola JF, Fiorentino D, Werth VP (2018) Re-examining mechanic's hands as a characteristic skin finding in dermatomyositis. J Am Acad Dermatol 78(4):769–75.e2
6. Sohara E, Saraya T, Sato S, Tsujimoto N, Watanabe T, Takata S, Tanaka Y, Ishii H, Takizawa H, Goto H (2014) Mechanic's hands revisited: is this sign still useful for diagnosis in patients with lung involvement of collagen vascular diseases? BMC Res Notes 7:303
7. Dandelooy J, van Hal PT, Even P, Lechkar B, Siozopoulou V, Lambert J et al (2016) Not just ordinary hand dermatitis: mechanic's hands revealing dermatomyositis. J European 30(7):1223–1224
8. Katzap E, Barilla-LaBarca ML, Marder G (2011) Antisynthetase syndrome. Curr Rheumatol Rep 13(3):175–181
9. Cortes S, Cutolo M (2007) Capillarosecopic patterns in rheumatic diseases. Acta Reumatol Port 32(1):29–36
10. de Holanda Mafaldo Diogenes A, Bonfa E, Fuller R, Correia Caleiro MT (2007) Capillaroscopy is a dynamic process in mixed connective tissue disease. Lupus 16(4):254–258
11. Manfredi A, Sebastiani M, Cassone G, Pipitone N, Giuggioli D, Colaci M, Salvarani C, Ferri C (2015) Nailfold capillaroscopic changes in dermatomyositis and polymyositis. Clin Rheumatol 34(2):279–284
12. Mosca M, Tani C, Carli L, Bombardieri S (2012) Undifferentiated CTD: a wide spectrum of autoimmune diseases. Best Pract Res Clin Rheumatol 26(1):73–77
13. Mosca M, Tani C, Vagnani S, Carli L, Bombardieri S (2014) The diagnosis and classification of undifferentiated connective tissue diseases. J Autoimmun 48–49:50–52
14. LeRoy EC, Black C, Fleischmajer R, Jablonska S, Krieg T, Medsger TA Jr et al (1988) Scleroderma (systemic sclerosis): classification, subsets and pathogenesis. J Rheumatol 15(2):202–205
15. van den Hoogen F, Khanna D, Fransen J, Johnson SR, Baron M, Tyndall A, Matucci-Cerinic M, Naden RP, Medsger TA Jr, Carreira PE, Riemekasten G, Clements PJ, Denton CP, Distler O, Allanore Y, Furst DE, Gabrielli A, Mayes MD, van Laar JM, Seibold JR, Czirjak L, Steen VD, Inanc M, Kowal-Bielecka O, Müller-Ladner U, Valentini G, Veale DJ, Vonk MC, Walker UA, Chung L, Collier DH, Csuka ME, Fessler BJ, Guiducci S, Herrick A, Hsu VM, Jimenez S, Kahaleh B, Merkel PA, Sierakowski S, Silver RM, Simms RW, Varga J, Pope JE (2013) 2013 classification criteria for systemic sclerosis: an American College of Rheumatology/European league against rheumatism collaborative initiative. Arthritis Rheum 65(11):2737–2747
16. Tan EM, Cohen AS, Fries JF, Masi AT, McShane DJ, Rothfield NF et al (1982) The 1982 revised criteria for the classification of systemic lupus erythematosus. Arthritis Rheum 25(11):1271–1277
17. Bohan A, Peter JB (1975) Polymyositis and dermatomyositis (first of two parts). N Engl J Med 292(7):344–347
18. Bohan A, Peter JB (1975) Polymyositis and dermatomyositis (second of two parts). N Engl J Med 292(8):403–407
19. Shiboski CH, Shiboski SC, Seror R, Criswell LA, Labetoulle M, Lietman TM, Rasmussen A, Scofield H, Vitali C, Bowman SJ, Mariette X, the International Sjögren's Syndrome Criteria Working Group (2017) 2016 American College of Rheumatology/European league against rheumatism classification criteria for primary Sjogren's syndrome: a consensus and data-driven methodology involving three international patient cohorts. Ann Rheum Dis 76(1):9–16
20. Alarcon-Segovia D, Cardiel MH (1989) Comparison between 3 diagnostic criteria for mixed connective tissue disease. Study of 593 patients. J Rheumatol 16(3):328–334
21. Senecal JL, Raynauld JP, Troyanov Y (2017) Editorial: A New Classification of Adult Autoimmune Myositis. Arthritis Rheumatol (Hoboken, NJ) 69(5):878–884
22. Clements PJ, Lachenbruch PA, Seibold JR, Zee B, Steen VD, Brennan P, Silman AJ, Allegar N, Varga J, Massa M (1993) Skin thickness score in systemic sclerosis: an assessment of interobserver variability in 3 independent studies. J Rheumatol 20(11):1892–1896
23. Torok KS, Baker NA, Lucas M, Domsic RT, Boudreau R, Medsger TA Jr (2010) Reliability and validity of the delta finger-to-palm (FTP), a new measure of finger range of motion in systemic sclerosis. Clin Exp Rheumatol 28(2 Suppl 58):S28–S36
24. Cutolo M, Sulli A, Pizzorni C, Accardo S (2000) Nailfold videocapillaroscopy assessment of microvascular damage in systemic sclerosis. J Rheumatol 27(1):155–160
25. Lloyd TE, Christopher-Stine L, Pinal-Fernandez I, Tiniakou E, Petri M, Baer A, Danoff SK, Pak K, Casciola-Rosen LA, Mammen AL (2016) Cytosolic 5'-Nucleotidase 1A as a target of circulating autoantibodies in autoimmune diseases. Arthritis Care Res 68(1):66–71
26. Shenavandeh S, Zarei NM (2015) Association of nailfold capillary changes with disease activity, clinical and laboratory findings in patients with dermatomyositis. Med J Islam Repub Iran 29:233
27. Fiorentino D, Chung L, Zwerner J, Rosen A, Casciola-Rosen L (2011) The mucocutaneous and systemic phenotype of dermatomyositis patients with antibodies to MDA5 (CADM-140): a retrospective study. J Am Acad Dermatol 65(1):25–34
28. Plestilova L, Mann H, Andres Cerezo L, Pecha O, Vencovsky J, Senolt L (2014) The metastasis promoting protein S100A4 levels associate with disease activity rather than cancer development in patients with idiopathic inflammatory myopathies. Arthritis Res Ther 16(5):468
29. Cutolo M, Sulli A, Pizzorni C, Smith V (2010) Capillaroscopy as an outcome measure for clinical trials on the peripheral vasculopathy in SSc-is it useful? Int J Rheumatol 2010:1–6
30. Young A, Khanna D (2015) Systemic sclerosis: commonly asked questions by rheumatologists. J Clin Rheumatol 21(3):149–155
31. Shenavandeh S, Haghighi MY, Nazarinia MA (2017) Nailfold digital capillaroscopic findings in patients with diffuse and limited cutaneous systemic sclerosis. Reumatologia 55(1):15–23
32. Hofstee HM, Vonk Noordegraaf A, Voskuyl AE, Dijkmans BA, Postmus PE, Smulders YM et al (2009) Nailfold capillary density is associated with the presence and severity of pulmonary arterial hypertension in systemic sclerosis. Ann Rheum Dis 68(2):191–195
33. Sebastiani M, Triantafyllias K, Manfredi A, Gonzalez-Gay MA, Palmou-Fontana N, Cassone G, Drott U, Delbrück C, Rojas-Serrano J, Bertolazzi C, Nuño L, Giannini M, Iannone F, Vicente EF, Castañeda S, Selva-O'Callaghan A, Araguas ET, Emmi G, Iuliano A, Bauhammer J, Miehle N, Parisi S, Cavagna L, Codullo V, Montecucco C, Lopez-Longo FJ, Martínez-Barrio J, Nieto-González JC, Vichi S, Confalonieri M, Tomietto P, Bergner R, Sulli A, Bonella F, Furini F, Scirè CA, Bortoluzzi A, Specker C, Barsotti S, Neri R, Mosca M, Caproni M, Weinmann-Menke J, Schwarting A, Smith V, Cutolo M; American and European network of antisynthetase syndrome collaborative group (2018) Nailfold capillaroscopy characteristics of antisynthetase syndrome and possible clinical associations: results of a multi center international study. J Rheumatol. https://doi.org/10.3899/jrheum.180355
34. Sato Y, Teraki Y, Izaki S, Amano K (2012) Clinical characterization of dermatomyositis associated with mechanic's hands. J Dermatol 39(12):1093–1095
35. Mugii N, Hasegawa M, Matsushita T, Hamaguchi Y, Horie S, Yahata T et al (2011) Association between nail-fold capillary

findings and disease activity in dermatomyositis. Rheumatology (Oxford, England) 50(6):1091–1098

36. Gunnarsson R, Hetlevik SO, Lilleby V, Molberg O (2016) Mixed connective tissue disease. Best Pract Res Clin Rheumatol 30(1):95–111
37. Ortega-Hernandez OD, Shoenfeld Y (2012) Mixed connective tissue disease: an overview of clinical manifestations, diagnosis and treatment. Best Pract Res Clin Rheumatol 26(1):61–72
38. Shibuya H, Arakawa S, Kai Y, Hatano Y, Okamoto O, Takayasu S, Fujiwara S (2003) Three cases of 'mechanic's hands' associated with interstitial pneumonia: possible involvement with foot lesions. J Dermatol 30(12):892–897
39. Lundberg IE, Tjarnlund A, Bottai M, Werth VP, Pilkington C, Visser M et al (2017) 2017 European league against rheumatism/American College of Rheumatology classification criteria for adult and juvenile idiopathic inflammatory myopathies and their major subgroups. Ann Rheum Dis 76(12):1955–1964