The functional disabilities of the dominant and opposite hands in patients with systemic sclerosis

S. Fourmond[1], S. Parreau[2], S. Dumonteil[2], C. Verdie-Kessler[3], K.-H. Ly[2], P. Lacroix[4], A.-L. Fauchais[2], P. Bernard[1], S. Palat[2]

[1]Division of Dermatology, [2]Division of Internal Medicine, [3]Division of Physical Medicine and Rehabilitation, [4]Division of Vascular Medicine, Dupuytren University Hospital, Limoges, France.

Salomé Fourmond, MD
Simon Parreau, MD
Stéphanie Dumonteil, MSc
Charlotte Verdie-Kessler, MD
Kim-Heang Ly, MD, PhD
Philippe Lacroix, MD, PhD
Anne-Laure Fauchais, MD, PhD
Philippe Bernard, MD, PhD
Sylvain Palat, MD

Please address correspondence to Salomé Fourmond
Service de Dermatologie,
Centre Hospitalier Universitaire Dupuytren 2,
16 rue Bernard Descottes,
87042 Limoges, France.
E-mail: salome.fourmond@chu-limoges.fr

Received on October 19, 2023; accepted in revised form on December 28, 2023.

Key words: systemic sclerosis, disability, hand

Competing interests: none declared.

ABSTRACT

Objective. *Hand involvement in patients with systemic sclerosis (SSc) is responsible for 75% of the overall disability but varies greatly among individuals. No study has yet compared the functionalities between the two hands of SSc patients. We thus evaluated the joint limitations and extent of skin involvement in the dominant and contralateral hands.*

Methods. *This prospective, descriptive, comparative single-centre study enrolled SSc patients diagnosed using the ACR/EULAR criteria. We assessed limitations in the joint range of motion during active and passive mobilisation; the first commissure opening angles; the Kapandji scale and Rodnan hand scores; the digital pressures; the finger brachial pressure indices; and the number of telangiectasias, calcinosis, digital ulcerations, and painful joints on each hand.*

Results. *Thirty patients were included. Spontaneous flexion joint limitations were significantly greater in the dominant hand ($p<0.0001$). The Kapandji score was lower ($p<0.001$) and the Rodnan hand score significantly higher, for the dominant hand ($p<0.001$). The digital pressure was similar between the hands.*

Conclusion. *The dominant hand exhibited significantly more skin sclerosis and mean flexion deterioration, a lower Kapandji score, and a tendency toward reduced mean extension, compared with the other hand. No vascular pathology was noted in either hand. Larger studies are needed to confirm these results and to draw therapeutic conclusions.*

Introduction

Systemic sclerosis (SSc) is an autoimmune disease. The pathophysiology includes inflammatory phenomena, tissue fibrosis, and microvascular damage (1). The effects of SSc on the hands vary greatly but may exhibit extensive skin fibrosis, Raynaud's phenomenon, digital ulcerations, joint damage, and skin calcinosis (2), which together limit joint amplitude. Contracture is the loss of joint mobility caused by stiffening in flexion. Reducible contracture is recorded when, with the help of another person, passive joint mobilisation reduces stiffness and improves extension. Otherwise, contracture is irreducible. Hand involvement accounts for 75% of the overall SSc disability (3), global assessment of which is based on functional scores validated for SSc and clinical evaluation of joint amplitude limitations and their potential reducibility.

To date, no study has compared the functionalities of both hands in SSc patients using validated global scores. We hypothesised that the amplitude limitations would differ between the dominant and contralateral hands. The dominant hand is the hand preferentially used for most fine motor tasks and everyday grasping and exists even in ambidextrous (equal dexterity between the hands) patients. We compared the dominant and contralateral hands of SSc patients.

Ethics

This study adhered to good clinical practice and the principles of the Declaration of Helsinki. In accordance with French law, the ethics local committee gave approval. Patients were given printed information and then provided written informed consent.

Variables

Hand functionality was assessed using the Cochin and scleroderma Health Assessment Questionnaire (sHAQ)hand scores (5). All hands were clinically examined by a physician (SF) blinded to the hand dominance. The mean joint amplitude limitations, spontaneously and after attempted reduction, between the dominant and contralateral hands were measured (Fig. 1). The limitation angles of the metacarpophalangeal, proximal interphalangeal, and distal interphalangeal joints of the second, third, fourth, and fifth radii (measured using a Balthazar goniometer) and the angulation of the first commissure opening on each hand were also collected. Opening is reduced when the angle is between 0° and 30°. Thumb opposition capacity was measured using the Kapandji functional score (6). As a validated score does not exist, we

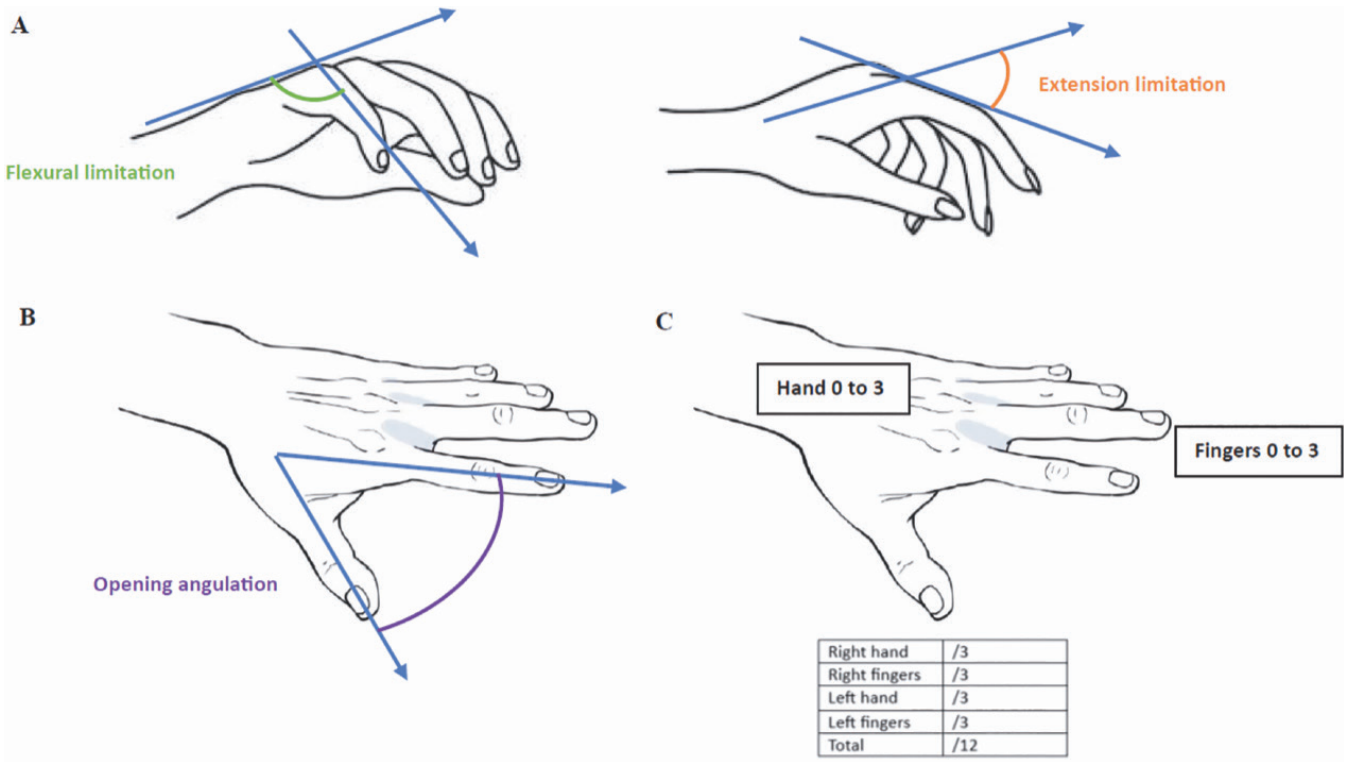

Fig. 1. Assessment of joint mobility and skin sclerosis.
A. Limitation flexural and extension angles. **B**. Opening angulation of the first commissure. **C**. Rodnan score limited to the hands.
0: no sclerosis; 1: superficial sclerosis; 2: mild sclerosis; 3: severe sclerosis.

created a hand Rodnan score which quantified skin sclerosis for each hand and the most severely affected finger. Score of 0 and 3 indicate no skin sclerosis and severe sclerosis, respectively. Digital pressure values, which reflect vascular damage, were also compared. A finger brachial pressure index (FBPI) less than 0.7 or a digital pressure less than 76 mmHg indicates upper limb arteriopathy (7). The numbers of digital ulcers, telangiectasias, subcutaneous calcinosis, and painful joints were counted.

Statistical analyses

In descriptive terms, continuous quantitative variables are presented as means with standard deviations and qualitative variables as percentages. Differences between the dominant and contralateral hands were evaluated using the Wilcoxon signed-rank test. As scleroderma causes global impairment, both hands were considered to be dependent variables even if the extent of impairment differed. To avoid the risk of alpha inflation, the significance level was adjusted using the Holm correction. All calculations were performed using R software v. 4.2.1 (R Foundation for Statistical Computing, Vienna Austria), and a p-value < 0.05 was taken to be significant.

Results

Participant characteristics

We enrolled 30 patients, most patients were males (19/30, 63%), and the mean age was 62.4 ± 9.65 years. The time between the first symptom and diagnosis was 4.11 (±5.34) years on average and the time between the first symptom and the date of inclusion in this study was 15.44 (±8.89) years. Nineteen patients (63%) had a limited cutaneous form of SSc, and 11 (37%) a diffuse cutaneous form. Twenty-four patients (80%) were positive for a specific nuclear extractable antigen (29% anti-topoisomerase I, 58% anti-centromere, and 13% other). Eight patients (26%) had been exposed to vibrating machinery, and 19 (63%) had manual jobs. Twelve patients (40%) had previously suffered hand traumas not related to SSc, but without sequelae. Irreducible flessum and/or amputated phalanges related to SSc were present in the dominant hands of six patients and in both hands of two patients. Three patients (10%) were active smokers, and 12 (40%) had quit smoking. All hands that were dominant before the onset of cutaneous sclerosis remained dominant thereafter. Three patients (10%) were ambidextrous. Nine patients (30%) engaged in physiotherapy exercises, 5 (16.7%) required orthoses, and 5 (16.7%) required daily human assistance. The mean Cochin hand and sHAQ scores were 17.20±20.6 and 0.38±0.52, respectively.

Joint limitations

A comparison of the hands is shown in Table I. Joint flexion limitations were significantly greater in the dominant hand during spontaneous flexion (p<0.0001), passive flexion (p=0.0350), and spontaneous extension (p=0.0105), but not after passive extension (p=0.1359). The Kapandji score was significantly lower (p=0.0006), and the first commissure spacing significantly higher (p=0.0061), for the dominant hand.

Table I. Joint and skin comparison between dominant and contralateral hands.

	Dominant hand Mean (SD) or Median [IQR]	Contralateral hand Mean (SD) or Median [IQR]	*p*-value
Joint limitation			
Active flexion limitation	105.3° (7.0)	103.5° (7.8)	<0.0001
Passive flexion limitation	100.5° (5.5)	98.9° (7.1)	0.035
Active extension limitation	169.3° (14.1)	172.9° (11.0)	0.0105
Passive extension limitation	173.3° (11.0)	175.3° (8.3)	0.1359
Kapandji Score	7.9 (2.3)	9.0 (1.5)	0.0006
Angulation of the first commissure	118.9° (14.0)	114.6° (10.9)	0.0061
Skin evaluation			
Hand Rodnan, median	2.0 [1.0-3.0]	1.0 [1.0-2.0]	0.0003
FBPI	0.9	0.9	0.524
Digital pressure (mmHg)	107.8	108,0	0.524
Telangiectasias (qualitative)	25 (83.3)	21 (70.0)	0.2452
Number of telangiectasias per hand (quantitative)	14.8 (16.7)	15.8 (14.5)	

FBPI: finger systolic blood pressure index.

Skin involvement

The hand Rodnan score revealed significantly more impairment of the dominant hand (p=0.00028). The mean digital pressure and the FBPI values that reflect micro- and macrovascular statuses were similar between the hands, but the FBPI decrease was slightly greater in the dominant hand (p<0.0001). Seven patients (23%) had digital ulcers on the dominant hand, and eight (27%) had ulcers on the contralateral hand. Those with digital ulcers on the dominant hand had more ulcers on that hand (2.3±2.2 *vs*. 1.5±1.1 on the contralateral hand). Four patients (13%) exhibited subcutaneous calcinoses in their dominant hand (mean number 2.5±1.7), but only one patient (3%) was affected in the contralateral hand (NS). Of the 21 patients (70%) with hand telangiectasias, 14.8±16.7 were on the dominant hand and 15.8±14.5 on the contralateral hand (NS).

Discussion

To date, no study has reported asymmetric skin sclerosis or joint amplitude limitation between the hands of SSc patients. The asymmetry that we found does not appear to be due to vascular damage. The digital pressure and FBPI values were normal for both hands (FBPI >0.7 and digital pressure >76 mmHg) (8). We hypothesise that the dominant hand experiences more microtraumas because it is used more than the contralateral hand. A strong correlation was evident between fibroblast proliferation and three-dimensional mechanical compressive forces that increased matrix stiffness. However, such forces did not cause transformation of fibroblasts into the myofibroblasts that cause skin fibrosis (9). In the fibrotic process many pathways seem to interplay, among these the role of microRNAs and of long non-coding RNAs has been recently reported in SSc (10). A method for precisely measuring skin fibrosis could be interesting to develop greater reproducibility in studies. The SOFTGRAM method, for example, is currently being evaluated (11).

Overuse of the dominant hand probably plays a key role in our cohort of predominantly manual workers (63%), in line with the higher incidence of trauma to that hand (50% *vs*. 33%). Progressive SSc worsening triggers flaccidity and limited active flexion rather than extension; patients with advanced SSc exhibit "claw hands" (12). We found no significant extension limitations in our cohort. Data on the limitations of thumb articular amplitude differ. The Kapandji score and first commissure spacing are more impaired in the dominant hand compared with the contralateral hand. Such parameters may be affected by rhizarthrosis. Although careful clinical examination can detect this pathology, x-rays of the metacarpophalangeal joints of the first rays of both hands are helpful (13). The differences in amplitude limitations that we found were small (*i.e*. a few degrees for each joint), but hand functionality is complex, several joints are required for each movement, and limitations accumulate. In terms of function, Rannou *et al*. (5) evaluated 50 scleroderma patients and found that the Cochin hand score was correlated with overall hand and wrist mobilities and functional disability.

Several studies evaluating the impacts of physiotherapy found that the Cochin hand and sHAQ scores improved after several months (14, 15). The principles of joint economy and gesture education applied when treating those with other pathologies (such as rheumatoid arthritis) could also be used to prevent deformities in SSc patients or avoid further aggravation (16).

Although this was a pilot study, we present some novel results. The SSc dominant hand appears to be more sclerotic and more limited in terms of articulation compared with the contralateral hand. We hypothesise that dominant hand overuse and repetitive strain injury may explain the observed asymmetry. A larger multicentre study is required to confirm our results.

References

1. GABRIELLI A, AVVEDIMENTO EV, KRIEG T: Scleroderma. *N Engl J Med* 2009; 360(19): 1989-2003. https://doi.org/10.1056/nejmra0806188
2. WANG YJ, HUANG XL, YAN JW *et al*.: The association between vibration and vascular injury in rheumatic diseases: a review of the literature. *Autoimmunity* 2015; 48(1): 61-8. https://doi.org/ 10.3109/08916934.2014.947477
3. MOUTHON L: [Hand involvement in systemic sclerosis]. *Presse Med* 2013; 42(12): 1616-26. https://doi.org/10.1016/j.lpm.2013.10.003
4. VAN DEN HOOGEN F, KHANNA D, FRANSEN J *et al*.: Classification criteria for systemic sclerosis: an American College of Rheumatology/European League against Rheumatism collaborative initiative. *Arthritis Rheum* 2013; 65(11): 2737-47. https://doi.org/10.1002/art.38098
5. RANNOU F, POIRAUDEAU S, BEREZNE A *et al*.: Assessing disability and quality of life in systemic sclerosis: construct validities of the Cochin Hand Function Scale, Health Assessment Questionnaire (HAQ), Systemic Sclerosis HAQ, and Medical Outcomes Study 36-Item Short Form Health Survey. *Arthritis Rheum* 2007; 57(1): 94-102. https://doi.org/10.1002/art.22468
6. KAPANDJI A: [Clinical test of apposition and counter-apposition of the thumb]. *Ann Chir Main* 1986; 5(1): 67-73. https://doi.org/10.1016/s0753-9053(86)80053-9

7. OMARJEE L, METAIRIE A, TUEGUEM MOYO T *et al*.: Performance of finger systolic blood pressure measurement to detect digital occlusive arterial disease in systemic sclerosis. *Rheumatology* (Oxford) 2022; 61(3): 1115-22. https://doi.org/10.1093/rheumatology/keab497
8. BLAISE S, BOULON C, MANGIN M *et al*.: Finger systolic blood pressure index measurement: a useful tool for the evaluation of arterial disease in patients with systemic sclerosis. *Arthritis Care Res* (Hoboken) 2022; 74(5): 828-32. https://doi.org/10.1002/acr.24527
9. WAHLSTEN A, RÜTSCHE D, NANNI M *et al*.: Mechanical stimulation induces rapid fibroblast proliferation and accelerates the early maturation of human skin substitutes. *Biomaterials* 2021; 273:120779. https://doi.org/10.1016/j.biomaterials.2021.120779
10. DI BATTISTA M, LEPRI G, CODULLO V *et al*.: Systemic sclerosis: one year in review 2023. *Clin Exp Rheumatol* 2023; 41(8): 1567-74. https://doi.org/10.55563/clinexprheumatol/ki76s5
11. KOKUBU H, IKUNO Y, UCHIYAMA K *et al*.: Exploratory study on quantitative assessment of skin hardness in patients with systemic sclerosis using SOFTGRAM. *Clin Exp Rheumatol* 2023 Oct 27. https://doi.org/ 10.55563/clinexprheumatol/6z4e7m
12. MOUTHON L: [Hand: a tool for the diagnosis and evaluation of consequences of diseases]. *Presse Med* 2013; 42(12): 1580-1. https://doi.org/10.1016/j.lpm.2013.10.004
13. TSAI P, BEREDJIKLIAN PK: Physical diagnosis and radiographic examination of the thumb. *Hand Clin* 2008; 24(3): 231-7. https://doi.org/ 10.1016/j.hcl.2008.03.004
14. LANDIM SF, BERTOLO MB, MARCATTO DE ABREU MF *et al*.: The evaluation of a home-based program for hands in patients with systemic sclerosis. *J Hand Ther* 2019; 32(3): 313-21. https://doi.org/10.1016/j.jht.2017.10.013
15. GOKCEN N, BADAK SO, SARPEL T, SERT-DEMIR Y, ERKEN E: The efficacy of a home-based, self-administered hand exercise program for patients with systemic sclerosis: a randomized controlled, evaluator-blind, clinical trial. *J Clin Rheumatol* 2022; 28(2): e422-9. https://doi.org/10.1097/rhu.0000000000001752
16. RELAVE E: Polyarthrite rhumatoïde, ergothérapie et qualité de vie. *Médecine Humaine et Pathologie* 2016. https://dumas.ccsd.cnrs.fr/dumas-01398983