CLINICS

CLINICAL SCIENCE

Assessment of light touch sensation in the hands of systemic sclerosis patients

Paula Gabriel Silva, Anamaria Jones, Pola Maria Poli Araujo, Jamil Natour

Universidade Federal de São Paulo (UNIFESP) - Disciplina de Reumatologia, São Paulo/SP, Brazil.

INTRODUCTION: Systemic sclerosis is a relatively rare connective tissue disorder characterized by severe and progressive fibrosis of the skin. Due to the current lack of available information on this subject, the aim of the present study was to assess light touch sensations in the hands of patients with systemic sclerosis.

METHODS: We completed a cross-sectional comparative study. Light touch sensations were evaluated in 30 individuals, including 15 patients with systemic sclerosis who exhibited changes in the dermis of their hands without loss of the distal phalanx and 15 subjects who did not exhibit changes in the upper limbs (control group). The groups were age- and sex-matched. Tactile sensory evaluations were performed using the Semmes-Weinstein monofilament test and the two-point discrimination test.

RESULTS: Statistically significant differences were found between groups in the monofilament test. The study group had lower scores across all points of the hand when compared with the control group. Differences were also found when dominant and non-dominant hands were compared ($p<0.05$). Statistically significant differences were found between groups for a subset of the assessed points in the two-point discrimination test.

CONCLUSIONS: The results of a monofilament test showed that tactile sensation, specifically light touch and deep pressure sensations, is altered in the hands of systemic sclerosis patients.

KEYWORDS: Sensation Disorders; Hand; Systemic Sclerosis.

Silva PG, Jones A, Araujo PM, Natour J. Assessment of light touch sensation in the hands of systemic sclerosis patients. Clinics. 2014;69(9):585-588.

Received for publication on March 20, 2014; **First review completed on** March 20, 2014; **Accepted for publication on** April 10, 2014

E-mail: jnatour@unifesp.br

Tel.: 55 11 5576-4239

INTRODUCTION

Systemic sclerosis (SSc) is a chronic autoimmune disease of unknown etiology characterized by excessive collagen production, endothelial cell injury, microvascular obliteration, cutaneous fibrosis and progressive visceral disease (1). In SSc patients, the dermis appears smooth, shiny and firmly adhered to the deep layers of the skin; furthermore, patients often present with dyschromia (2,3).

The hands are commonly affected in patients with SSc, and Raynaud's phenomenon, finger swelling and joint pain are the primary manifestations of the disease (4,5). Vascular impairment leads to pain in the fingers and ischemic ulcers. At more advanced stages of the disease, the fingers may become atrophic and stiff, with possible tissue loss (2,6). Muscle weakness in the upper limbs and impaired dexterity during activities requiring precise movements are common complaints among individuals with SSc.

Copyright © 2014 **CLINICS** – This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (http://creativecommons.org/licenses/by-nc/3.0/) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

No potential conflict of interest was reported.

DOI: 10.6061/clinics/2014(09)02

There are four classic types of tactile sensations, including pain, heat, cold and pressure or vibration. The Semmes-Weinstein monofilament test and the two-point discrimination test are often used to assess light touch sensations in the hands (7-10). A light touch is perceived through receptors on the surface layer of the skin, while firmer pressure is perceived by receptors in the subcutaneous and deep layers of the skin. Pressure sensibility is a protective sensation that prevents exposure to deep pressure or repetitive light pressure that can result in injury to the skin. Light touch sensibility is a necessary component for the discrimination of fine touch (11).

The monofilament test is a threshold assay used to determine the minimum stimulation that can be felt by a subject. This test is also known as light touch/deep pressure testing (11). The two-point discrimination test is a functional test used to assess the quality of tactile sensibility. It is also regarded as an integrative test because it requires a high degree of sensory processing. A number of perceptive resources are needed to identify the type of stimulus being presented during the two-point discrimination test. For example, the subject may be instructed to identify an object by handling it while blindfolded (11).

Bajocchi (12) evaluated a group of SSc patients using the cold face test, which involves the activation of cutaneous nociceptive sensory fibers. The results of this test were

abnormal in almost all patients, suggesting that epidermal small fibers (C-fibers) may be deficient in SSc. C-fibers control the neurovascular dilatory response, which is involved in cold nociception and itching sensations.

Considering the various skin problems in SSc patients and the lack of research on this subject, the aim of the present study was to assess light touch sensations in individuals with SSc using the Semmes-Weinstein monofilament test and the two-point discrimination test.

PATIENTS AND METHODS

A cross-sectional study was performed to assess tactile sensation in 30 individuals in two groups: SSc group (SScG; n = 15) and a control group (CG; n = 15). The criteria for inclusion in the SScG were a positive SSc diagnosis and alterations in the dermis of the hands. Patients were excluded if they had lost the distal phalanx or had never received rehabilitation for sensory retraining. The CG comprised healthy subjects; individuals with upper limb abnormalities or diabetes were excluded from this group. Both groups were matched for sex and age. The subjects in the SScG were sequentially recruited from an outpatient clinic at the Federal University of São Paulo (Brazil). The volunteers in the CG were recruited from the same location and included individuals who were university employees, individuals from the community or individuals who had accompanied the SSc patients.

All subjects completed the Semmes-Weinstein monofilament test (Sorri, Bauru, Brazil) and the two-point discrimination test (Dellon® Discriminator; North Coast Medical Inc., Gilroy/CA, USA). These tests were administered using standard testing procedures.

The monofilament test involves five monofilaments that are scored in terms of milligrams (mg) [green (0.05 mg), blue (0.2 mg), violet (2.0 mg), dark red (4.0 mg) and magenta (300 mg)], beginning with a baseline value of 0.05 mg, which indicates a ''normal sensation''. Table 1 displays the test results and respective interpretations. The monofilament was applied to the fingertip of the subject at least three times. The smallest monofilament that was felt by the subjects (as indicated by a ''yes'' response and a correct identification of the finger that was being touched) was used to generate the test score. The stimulation site was based on the innervation territories of the radial, ulnar and median nerves. The distal points of the thumb, index, middle, ring and little finger as well as the first space between the thumb and index finger on the dorsum of the hand were tested on both hands.

For the two-point discrimination test, the subjects were instructed to say ''one'' if they felt the sensation at a single point and ''two'' if they felt the sensation at two points separated by a small distance. The distance between the two points was measured in millimeters and the device was placed at intervals ranging from 2 to 12 mm. Table 2 displays the two-point discrimination test results and respective interpretations. One-point and two-point stimulations were alternated randomly. The smallest distance between two separate points in which a correct response was given for a total of three consecutive stimulations was used. The stimulation was applied to the sides (radial and ulnar) of the tips of all fingers, with perpendicular and longitudinal orientations and light pressure applied in a random sequence.

Before the execution of the tests, a demonstration was given on how the tests would be administered. During the tests, a screen was placed between the individual and the examiner so that the hand being submitted to the test was outside the subject's field of vision. All tests were administered to both hands in a quiet, appropriate setting by an occupational therapist with experience using the methods applied.

Statistical analysis

Based on the variables studied, data from the two groups were analyzed and compared using non-parametric tests. The Mann-Whitney U test was used and a p-value<0.05 was considered statistically significant. The analysis was performed using the SPSS 15 program (IBM Corporation, Armonk, NY, USA). The results of the monofilament and two-point discrimination tests were expressed as median values in mg and mm, respectively, with the corresponding 25-75% interquartile intervals.

RESULTS

The groups were similar in age, sex and dominant hand. The mean age was 48.86 ± 11.11 years in the SScG and 45.93 ± 8.79 years in the CG. Each group included two men and 13 women. All individuals in both groups were right-handed. Individuals in the SScG had a mean duration of 8.4 years since the original diagnosis of the disease.

The SScG had significantly lower scores across all points analyzed in the monofilament test when compared with the CG (Table 3). None of the subjects received a score of zero. An intra-group comparison of the right and left hands during the monofilament test revealed that the right hand of subjects from the SScG achieved a significantly lower score on all points tested when compared with the left hand. No statistically significant differences were found in the CG (Table 4).

The SScG showed a significant reduction in sensibility in a subset of the points assessed during the two-point discrimination test when compared with the CG (Table 5). The intra-group comparisons revealed no statistically significant differences between the right and left hands.

Table 1 - Monofilament test results and interpretations.

Monofilament	Interpretation
Green: 0.05 mg	No alteration (normal sensibility in the hand)
Blue: 0.2 mg	Reduced sensibility in the hand, with difficulty in fine discrimination
Violet: 2.0 mg	Reduced protective sensibility of the hand, with enough sensibility remaining to prevent injury; difficulty in discriminating between shapes and temperatures
Dark red: 4.0 mg	Loss of protective sensation in hand; vulnerable to injury; loss of hot/cold sensation
Magenta: 300.0 mg	Sensibility to pressure, able to feel pain
None: (.....)	Loss of sensibility to deep pressure; normally unable to feel pain

Table 2 - Two-point discrimination test results and interpretations.

Measurement	Interpretation
2 mm to 5 mm	Normal
6 mm to 10 mm	Fair
11 mm to 15 mm	Poor
One point of perception	Protective
No point perceived	Anesthesia

DISCUSSION

SSc often affects the hands. In the present study, alterations in light touch sensations were analyzed. The monofilament test demonstrated statistically and clinically significant deficits in sensation in the SScG, as shown by the diminished ability to discriminate fine, light touch sensations. In contrast, the scores in the CG were 0.05 mg for nearly all points tested, which is regarded as normal sensibility for touch and pressure. When the right and left hands were compared, significant differences were found in the SScG, with the dominant hand generating higher scores for all points. This finding demonstrates that a decrease in light touch sensations and discrimination of fine sensations may impair performance during certain activities. These deficits are important problems that should be investigated in future studies.

In the two-point discrimination test, the SScG showed higher scores for the ''ulnar middle'' and ''little radial'' tests on the right hand and for the ''thumb radial'', ''ulnar thumb'', ''ulnar middle'', ''ring ulnar'' and ''ulnar little'' tests on the left hand when compared with the CG. These differences reached significance for the ''ulnar middle'' and ''little radial'' on the right hand and for the ''thumb radial'' and ''ulnar little'' test on the left hand. For these points, a mean score of 6 mm was achieved in the SScG, which denotes fair sensitivity. In contrast, the CG exhibited normal sensitivity. The mean score for the other test points was 4 mm in the SSCG and 2 mm in the CG group; however, this statistically significant difference is not clinically significant because both groups were within the normal range. No statistically significant differences were found between the left and right hands in either group.

Table 3 - Results of the monofilament test for each point tested on the right and left hand of control and systemic sclerosis subjects.

		CG	SScG	*p*
Right hand	Thumb	0.05 (0.05 – 0.05)	2 (0.2 – 2.0)	<0.001*
	Index	0.05 (0.05 – 0.05)	0.2 (0.2 – 2.0)	<0.001*
	Middle	0.05 (0.05 – 0.05)	2 (0.2 – 2.0)	<0.001*
	Ring	0.05 (0.05 – 0.05)	0.2 (0.2 – 2.0)	<0.001*
	Little	0.05 (0.05 – 0.05)	0.2 (0.2 – 2.0)	<0.001*
	Dorsum	0.2 (0.05 – 2.0)	2 (0.2 – 2.0)	=0.001*
Left hand	Thumb	0.05 (0.05 – 0.05)	0.2 (0.05 – 2.0)	<0.001*
	Index	0.05 (0.05 – 0.05)	0.2 (0.05 – 2.0)	<0.001*
	Middle	0.05 (0.05 – 0.05)	0.2 (0.05 – 2.0)	<0.001*
	Ring	0.05 (0.05 – 0.05)	0.2 (0.05 – 2.0)	0.011*
	Little	0.05 (0.05 – 0.05)	0.2 (0.05 – 2.0)	0.004*
	Dorsum	0.2 (0.5 – 2.0)	0.2 (0.2 – 2.0)	0.002*

Median (IQ 25-75%) values expressed as mg; SScG = systemic sclerosis group; CG = control group; * statistically significant difference between groups ($p<0.05$, Mann-Whitney U test).

Table 4 - Intra-group comparison of the monofilament test results for the dominant and non-dominant hands of the control and systemic sclerosis groups.

		Right hand	Left hand	*p*
CG	Thumb	0.05 (0.05 – 0.05)	0.05 (0.05 – 0.05)	0.317
	Index	0.05 (0.05 – 0.05)	0.05 (0.05 – 0.05)	0.317
	Middle	0.05 (0.05 – 0.05)	0.05 (0.05 – 0.05)	0.157
	Ring	0.05 (0.05 – 0.05)	0.05 (0.05 – 0.05)	0.157
	Little	0.05 (0.05 – 0.05)	0.05 (0.05 – 0.05)	0.157
	Dorsum	0.2 (0.05 – 2.0)	0.2 (0.5 – 2.0)	0.336
SScG	Thumb	2 (0.2 – 2.0)	0.2 (0.05 – 2.0)	0.011*
	Index	0.2 (0.2 – 2.0)	0.2 (0.05 – 2.0)	0.039*
	Middle	2 (0.2 – 2.0)	0.2 (0.05 – 2.0)	0.014*
	Ring	0.2 (0.2 – 2.0)	0.2 (0.05 – 2.0)	0.017*
	Little	0.2 (0.2 – 2.0)	0.2 (0.05 – 2.0)	0.007*
	Dorsum	2 (0.2 – 2.0)	0.2 (0.2 – 2.0)	0.034*

Median (IQ 25-75%) values expressed as mg; SScG = systemic sclerosis group; CG = control group; * statistically significant difference between the right and left hand ($p<0.05$, Mann-Whitney U test).

The findings of the present study demonstrate the importance of assessing tactile sensation in SSc patients because diminished sensation may increase the risk of skin injury and trauma. A single previously published study addressed the tactile sensation in SSc patients; however, these authors only discussed possible sensation impairments and light touch sensations were not evaluated (13). Instead, the authors of this study assessed the dysfunction of peripheral innervation in SSc patients and found alterations in tactile sensations that were likely due to changes in viscoelasticity and other properties of the skin caused by ischemia of the distal nerves.

A study that evaluated peripheral neuropathy in both feet using the monofilament test in conjunction with a vibration test compared SSc patients, healthy controls and patients with type 2 diabetes mellitus. The prevalence of sensory loss

Table 5 - Comparison of points tested on right and left hands in the two-point discrimination test for the control and systemic sclerosis groups.

		CG	SScG	*p*
Right hand	radial thumb	4 (4.0 – 4.0)	4 (4.0 – 6.0)	0.310
	ulnar thumb	4 (4.0 – 4.0)	4 (4.0 – 6.0)	0.331
	radial index	4 (4.0 – 4.0)	4 (4.0 – 6.0)	0.539
	ulnar index	4 (4.0 – 4.0)	4 (4.0 – 6.0)	0.217
	radial middle	4 (4.0 – 4.0)	4 (4.0 – 6.0)	0.367
	ulnar middle	4 (4.0 – 4.0)	6 (4.0 – 6.0)	0.004*
	radial ring	4 (4.0 – 4.0)	4 (4.0 – 6.0)	0.061
	ulnar ring	4 (4.0 – 4.0)	4 (4.0 – 6.0)	0.061
	radial little	4 (4.0 – 4.0)	6 (4.0 – 6.0)	0.029*
	ulnar little	4 (4.0 – 4.0)	4 (4.0 – 6.0)	0.126
Left hand	radial thumb	4 (4.0 – 4.0)	6 (4.0 – 6.0)	0.004*
	ulnar thumb	4 (4.0 – 4.0)	4 (4.0 – 6.0)	0.029*
	radial index	4 (4.0 – 4.0)	4 (4.0 – 6.0)	0.217
	ulnar index	4 (4.0 – 4.0)	4 (4.0 – 6.0)	0.126
	radial middle	4 (4.0 – 4.0)	4 (4.0 – 4.0)	0.367
	ulnar middle	4 (4.0 – 4.0)	4 (4.0 – 6.0)	0.029*
	radial ring	4 (4.0 – 4.0)	4 (4.0 – 6.0)	0.217
	ulnar ring	4 (4.0 – 4.0)	4 (4.0 – 6.0)	0.029*
	radial little	4 (4.0 – 4.0)	4 (4.0 – 6.0)	0.126
	ulnar little	4 (4.0 – 4.0)	6 (4.0 – 6.0)	0.029*

Median (IQ 25-75%) values expressed as mm; SScG = systemic sclerosis group; CG = control group; * statistically significant difference between groups ($p<0.05$, Mann-Whitney U test).

(as determined with a monofilament test) among individuals with SSc was identical to that among diabetic patients (4/20 patients). Individuals with SSc had a considerable prevalence of pedal peripheral neuropathy that was determined by the loss of vibratory sensation and an inability to feel the monofilaments. The authors concluded that further studies were necessary to determine whether routine screening for neuropathy and subsequent podiatric care could reduce complications in the feet for SSc patients (14). Similarly, Bérezné et al. found that SSc has a significant impact on daily living and work activities because the need for assistance outside the home and disability resources was increased among patients with digital ulcers (15).

The limitations of the present study included the small sample size and a lack of evaluation of other clinical aspects of the disease, such as disease activity, sclerodactylia, autoantibodies, organ involvement and other factors associated with sensation.

The present study revealed that tactile sensation, particularly light touch and deep pressure sensations, is altered in the hands of SSc patients as assessed with a monofilament test. Thus, the investigation of tactile sensations in SSc patients is important for tracking the progression of the disease and because sensation impairment is a risk factor for skin injuries. Our findings suggest that the monofilament test should be performed during routine clinical evaluations of SSc patients. Considering the paucity of studies on this subject, future work should be carried out to evaluate the clinical impact of the loss of hand sensitivity and the effect of interventions, such as formal counseling regarding protection of the hands in SSc patients. These types of evaluations are very important for the rehabilitation and quality of life of SSc patients; in addition, possible hand injuries due to diminished light touch sensations can be avoided.

AUTHOR CONTRIBUTIONS

All authors contributed to the conception and design of the study, analysis and interpretation of data and drafting and revision of the manuscript for intellectual content. All authors approved the final version of the manuscript for submission. Silva PG and Jones A contributed to the data acquisition.

REFERENCES

1. Arroliga AC, Podell DN, Matthay RA. Pulmonary manifestations of scleroderma. J Thorac Imaging. 1992;7(2):30-45, http://dx.doi.org/10.1097/00005382-199203000-00005.
2. Jakubietz MG, Jakubietz RG, Gruenert JG. Scleroderma of the hand. J Am Soc Surg Hand. 2005;5:42-47, http://dx.doi.org/10.1016/j.jassh.2004.11.006.
3. Zvulunov A, Olson JC, Carpenter D, Esterly NB. Familial scleroderma-like deformity of the fingers. J Am Acad Dermatol. 1995;33(2 Pt 1):302-305.
4. Subcommittee for Scleroderma Criteria of the American Rheumatism Association Diagnostic and Therapeutic Criteria Committee. Preliminary criteria for the classification of systemic sclerosis (scleroderma). Arthritis Rheum. 1980;23(5):581-90.
5. Silman A, Harrison M, Brennan P. Is it possible to reduce observer variability in skin score assessment of scleroderma? J Rheumatol. 1995;22(7):1277-80.
6. Idler RS, Strickland JW, Creighton JJ. Scleroderma and its manifestations in the hand. Indiana Med. 1991;84(10):702-3.
7. Schulz LA, Bohannon RW, Morgan WJ. Normal digit tip values for the Weinstein Enhanced Sensory Test. J Hand Ther. 1998;11(3):200-5, http://dx.doi.org/10.1016/S0894-1130(98)80038-0.
8. Dellon ES, Mourey R, Dellon AL. Human pressure perception values for constant and moving one- and two-point discrimination. Plast Reconstr Surg. 1992;90(1):112-7, http://dx.doi.org/10.1097/00006534-199207000-00017.
9. Dellon AL, Mackinnon SE, Brandt KE. The markings of the Semmes-Weinstein nylon monofilaments. J Hand Surg Am. 1993;18(4):756-7, http://dx.doi.org/10.1016/0363-5023(93)90333-X.
10. McAuley DM, Ewing PA, Devasundaram JK. Effect of hand soaking on sensory testing. Int J Lepr Other Mycobact Dis. 1993;61(1):16-9.
11. Boscheinen-Morin J, Conolly WB. Assessment. In: The Hand Fundamentals of Therapy, BH. Oxford, 3rd edition; 2001:1-13.
12. Bajocchi G, Terlizzi R, Zanigni S, Barletta G, Grimaldi D, Pierangeli G, Cortelli P. Evidence of a selective nociceptive impairment in systemic sclerosis. Clin Exp Rheumatol. 2009:27(Suppl. 54):S9-14.
13. Schady W, Sheard A, Hassell A, Holt L, Jayson MI, Klimiuk P. Peripheral nerve dysfunction in scleroderma. Q J Med. 1991;80(292):661-75.
14. Frech TM, Smith G, Reily M, Chamberlain J, Murtaugh MA, Penrod J, et al. Peripheral neuropathy: a complication of systemic sclerosis. Clin Rheumatol. 2013;32(6):885-8, http://dx.doi.org/10.1007/s10067-013-2206-6.
15. Bérezné A, Seror R, Morell-Dubois S, de Menthon M, Fois E, Dzeing-Ella A, et al. Impact of systemic sclerosis on occupational and professional activity with attention to patients with digital ulcers. Arthritis Care Res (Hoboken). 2011;63(2):277-85, http://dx.doi.org/10.1002/acr.20342.