Laser Doppler Skin Perfusion Pressure in the Assessment of Raynaud’s Phenomenon

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Objectives. In the assessment of Raynaud’s phenomenon, objective evaluation of digital microcirculatory flow is important, and so we investigated whether the measurement of laser Doppler skin perfusion pressure could be of use.

Materials and methods. Ten fingers of five patients with secondary Raynaud’s phenomenon due to systemic sclerosis, 22 fingers of 11 patients with primary Raynaud’s phenomenon and 10 fingers of five control patients were examined. Skin perfusion pressure was measured on the third finger of both hands at rest, and then again 3 min after local cold exposure.

Results. Laser Doppler skin perfusion pressure at rest in patients with secondary Raynaud’s phenomenon was significantly lower than that in patients with primary Raynaud’s phenomenon and the control patients (p < 0.05). Skin perfusion pressure decreased significantly in both patient groups upon local cold exposure (p = 0.005). There were significant differences in perfusion pressure after cold exposure among both groups (p < 0.05).

Conclusions. The low skin perfusion pressure at rest in patients with secondary Raynaud’s phenomenon suggested the presence of obstructive arterial lesions. The marked pressure decrease in all Raynaud’s patients after local cold exposure might be due to vasoconstriction of the microvasculature in the digits. These results indicate that the measurement of laser Doppler skin perfusion pressure is valuable in the diagnosis of Raynaud’s phenomenon.

Key Words: Raynaud’s disease; Skin perfusion pressure; Laser Doppler flowmetry; Systemic sclerosis; Measurement; Microcirculation.

Introduction

Raynaud’s phenomenon is a common symptom of systemic sclerosis and often causes skin complications such as ulceration of the fingertips. The decrease in digital blood flow is due to structural and functional changes in the arteries.1 In clinical practice, differentiation between the primary and secondary forms of Raynaud’s phenomenon is the main diagnostic task. Whether or not these patient groups would show a different response to a cold provocation test remains an open question. Although various measurements were reported when assessing these types of vascular dysfunction, none of them has been commonly accepted.2 Skin perfusion pressure measurement has been applied in Raynaud’s phenomenon.3 The conventional method using radioisotopes is cumbersome and takes at least 30 min for measurement. However, laser Doppler skin perfusion pressure measurement (LDSPP) is non-invasive and takes only a few minutes.4 In this study, we applied this technique to Raynaud’s phenomenon and revealed its diagnostic value.

Materials and Methods

Patients

The local ethics committee had approved the protocol used in this study and all subjects provided informed written consent. This study was carried out on five patients (10 fingers) with secondary Raynaud’s phenomenon due to systemic sclerosis, on 11 patients (22 fingers) with primary Raynaud’s phenomenon and on five healthy control patients (10 fingers). Patients with systemic sclerosis were all female with a mean age of 66 years (range 59–76). All patients fulfilled the criteria of the American Rheumatism Association,5 and the disease duration was 8–27 years. All patients had severe Raynaud’s phenomenon with a triphasic color change, and had experienced ulceration of their fingertips, but no active ulceration was found at the time of examination. Of the patients with primary Raynaud’s phenomenon, five were male and six...
female, with a mean age of 61 years (range 33–76). None had clinical or serological evidence of underlying connective tissue disease. The healthy controls were all female with a mean age of 62 years (range 47–78).

Measurement of laser Doppler skin perfusion pressure

Using a Laserdopp PV-2000 (Vasamedics, USA), the skin perfusion pressure was measured with the patient in the supine position at room temperature (24–26 °C) with a laser Doppler probe enclosed within the bladder of a cuff wrapped around the palmar aspect of the middle phalanx of the finger. The third finger on both hands was used for the measurements. The technique of LDSPP measurement has been described by Castronuovo et al. The pneumatic cuff was inflated above systolic pressure. At this pressure, the laser Doppler flux was less than 0.1 v%. The cuff was deflated stepwise in decrements of 10 mmHg until 50 mmHg, and then 5 mmHg decrements below 50 mmHg. Deflation was continued until two consecutive increases in the laser Doppler scan flux were noted. The first increase in the laser Doppler output represents the initiation of blood flow into the regional microcirculation and was taken as LDSPP.

Protocol

After 15 min rest in the supine position at room temperature, bilateral brachial blood pressure and laser Doppler skin perfusion pressure at rest were measured. Then the hands were exposed to ice–water for 1 min and gently wiped with a dry towel. A second measurement of LDSPP was then carried out after a 3 min interval.

Statistical analysis

Data are expressed as means with 95% confidence intervals. One-way analysis of variance with the Tukey–Kramer multiple comparison post-hoc test was used for comparing the three groups, and the Wilcoxon test was used for comparing the changes within a group. A p-value of less than 0.05 was considered significant.

Results

In all patients with systemic sclerosis, symptoms were induced with local cold exposure, and the second measurement was performed during the pallor phase. In the patients with primary Raynaud’s phenomenon, only one patient revealed symptoms. There was no significant difference in age among the groups (p = 0.48). There was also no significant difference in brachial blood pressure at rest among the groups (p = 0.37) (systemic sclerosis: 128 ± 7 mmHg, primary Raynaud’s phenomenon: 126 ± 11 mmHg, controls: 119 ± 5 mmHg). Fig. 1 shows the results of LDSPP measurements. LDSPP at rest in systemic sclerosis was significantly lower than that in primary Raynaud’s phenomenon and the controls (p < 0.05), while there was no significant difference in LDSPP at rest between primary Raynaud’s phenomenon and the controls (p = 0.81). LDSPP in systemic sclerosis and primary Raynaud’s phenomenon decreased significantly after local cold exposure (p = 0.005), while that in the controls showed no significant change (p = 0.48). There were significant differences in LDSPP after cold exposure amongst all groups (p < 0.05).

Discussion

Measurement of skin perfusion pressure by an isotope washout technique has been reported to be a reliable predictor for the healing of amputations and ischemic ulceration. However, this method has not been widely used because measurement cannot be performed repeatedly due to its cumbersome method and the need for an intradermal injection of radionuclide. Castronuovo et al. reported a new non-invasive technique for skin perfusion pressure measurement using laser Doppler. Measurement with a laser...
Doppler probe can be performed in a few minutes and its result correlates well with the results of skin perfusion pressure by means of the radionuclide washout method.\textsuperscript{6,12}

Non-invasive examinations with the laser Doppler method have now been widely used in vascular laboratories. However, there are few data on LDSPP in patients with Raynaud’s phenomenon, since most studies on LDSPP have been performed in patients with peripheral arterial occlusive disease such as when predicting the healing of an amputation site,\textsuperscript{13} or of clinical outcome in revascularisation,\textsuperscript{14} determining the distribution of arterial disease\textsuperscript{15} and monitoring toe blood pressure.\textsuperscript{16} Because LDSPP reflects blood pressure at the arteriolar level in thermoregulatory skin,\textsuperscript{12} we studied LDSPP in Raynaud’s phenomenon on the palmar aspect of the finger.

Finding that LDSPP at rest in systemic sclerosis was significantly lower than that in primary Raynaud’s phenomenon or the controls suggests the presence of an obstructive lesion of the digital artery. This is supported by a previous report using the conventional radionuclide washout method.\textsuperscript{3} LDSPP at rest is useful in identifying the underlying structural vascular disease.

LDSPP in primary Raynaud’s phenomenon and systemic sclerosis significantly decreased after local cold exposure, while the controls showed no significant change. This result demonstrated that LDSPP has the potential to detect vasoconstrictive hypersensitivity of the digits. The finding of a significant difference in LDSPP after cold exposure in systemic sclerosis is also useful in discriminating between systemic sclerosis and the controls.

LDSPP in patients with primary Raynaud’s phenomenon significantly decreased after local cold exposure. This result demonstrates that LDSPP has the potential to assess invisible changes in skin blood flow. However, it is still unclear whether LDSPP decreases more markedly in those patients with primary Raynaud’s phenomenon who show obvious signs of Raynaud’s phenomenon, because most of them did not show symptoms. Further investigation into a reproducible method to induce Raynaud’s phenomenon in those patients with primary Raynaud’s phenomenon is needed.

**Conclusion**

In conclusion, the measurement of LDSPP has a potential role in identifying underlying occlusive lesions and the hypersensitivity of digital arteries to cold exposure in Raynaud’s phenomenon.

**References**


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