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Diagnosis of Raynaud's phenomenon in quarrymen's traumatic vasospastic disease

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"Students t" ($p = 0.05$, two-sided) and *SD* is the standard deviation of FSP% of the 20 referent subjects.

RESULTS

Questionnaire and medical interview

In the reference group all 20 males were classified as stage 0. For each subject in the vibration-exposed group the stage of TVD, FSP% at 15 and 6°C, exposure time, and latency period (defined as the difference in years between exposure time and duration of Raynaud's phenomenon) are given in table 2. In this group the difference in age distribution (median age 50 and 51 years, respectively) or in the use of gloves (9 and 4 men, respectively) was not significant between the subjects with and without Raynaud's phenomenon. There were 11 smokers with and 1 smoker without TVD. The median exposure time was 23 years (6—41 years) for the subjects with TVD, and 7 years (2—44 years) for four of the subjects without TVD (one subject did not report exposure time). This difference in exposure time between subjects with and without TVD was not significant. Of the 18 vibration-exposed males, four were in stage 0, one was in stage 0_N, none were in stage 1, three were in stage 2 and ten were in stage 3; in other words 13 of the 18 vibration-exposed subjects had TVD, the prevalence being 72 % (95 % confidence limits 47—90 %). The latency period of TVD had a median of 11 years and a range of 0—27 years for the 13 afflicted subjects. One in stage 0_N had a latency period of eight years. Two subjects with TVD could not give exact information about the distribution of TVD in their fingers. In 11 subjects with TVD the number of affected index, middle and ring fingers of the hand contralateral to the preferred working hand were significantly higher than the number of other affected fingers (28 out of 37 affected fingers, $p < 0.0005$). The thumb and little finger of the preferred working hand were not affected. All 11 subjects had affections in the fingers of the hand contralateral to the preferred working hand, and three of these subjects also had

Table 2. Stage of traumatic vasospastic disease, FSP% at 15 and 6°C, exposure time, and latency period in years for each subject in the vibration-exposed group. (FSP% = finger systolic blood pressure on the cold provoked finger as percentage of the pressure at 30°C — the lower normal limit of FSP% is 68 % at 15°C and 58 % at 6°C)

Subject	Stage	FSP% (15°C)	FSP% (6°C)	Exposure time (years)	Latency period (years)
1	0	79	79	2	
2	0	70	80	4	
3	0	63	0	44	
4	0	60	—	—	
5	0_N	42	32	10	8
6	2	48	0	15	11
7	2	11	0	25	20
8	2	0		30	20
9	3	0		6	4
10	3	40	0	10	0
11	3	55	70	12	7
12	3	0		17	7
13	3	0		17	12
14	3	0		23	11
15	3	22	0	26	2
16	3	0		30	20
17	3	0		32	27
18	3	40	0	41	26

symptoms in fingers of the preferred working hand.

Cold provocation test

Precision. At a mean $FSP_{ref,30}$ of 121 mm Hg (range 100—150, 17 subjects) the 95 % confidence limit of a single determination was 7.8 mm Hg. At a mean $FSP_{th,30}$ of 97 mm Hg (range 80—110, 18 subjects) the 95 % confidence limit of a single determination was 6.9 mm Hg. At a mean FSP% (15°C) of 41.5 (range 0—67, 8 subjects) the 95 % confidence limit of a single determination was 18.7 % at 15°C. The precision of FSP% at 6°C was not estimated in this small material (4 subjects).

Arm and finger systolic blood pressures. The difference in arm systolic blood pressure between the reference group (mean 131 mm Hg) and the vibration-exposed group (mean 149 mm Hg) was significant ($p < 0.01$). The difference in $FSP_{ref,30}$ (mean 119 and 120 mm Hg) was not significant. The difference in $FSP_{th,30}$ between the reference group (mean 111 mm Hg) and the vibration-exposed group (mean 98 mm Hg) was significant ($p < 0.01$)

Cold provocation in the reference group. The median FSP% of the reference group was 91 (range 70—105) at 15°C and 83 (range 60—100) at 6°C. There was a significant fall in FSP% from 30 to 15°C ($p < 0.05$) and from 15 to 6°C ($p < 0.05$). Lower normal limits were estimated as 68 % at 15°C and 58 % at 6°C.

Cold provocation in the bibration-exposed group. All 13 employees with TVD had a reduced FSP% in comparison to the lower normal limits. Seven of these subjects showed arterial zero pressure at 15°C, five had zero pressure at 6°C, and one had an FSP% of 55 at 15°C without closure at 6°C. In a comparison of the seven and five subjects with zero pressure at 15 and 6°C, respectively, the difference in stages, exposure time, or latency period was not significant. The five subjects without TVD (stage $0 + 0_N$) had a significantly higher FSP% at 15°C than the subjects with TVD ($p < 0.01$). One in stage 0 with an exposure time of 44 years had zero pressure at 6°C. One in stage 0_N had an FSP% of 42 at 15°C and an FSP% of 32 at 6°C. One in stage 0 had an FSP% of 60 at 15°C, but the value at 6°C was missed. Two subjects in stage 0 responded normally to cold and had exposure times of two and four years.

Sensitivity and specificity. The sensitivity and specificity of the combined finger and body cooling test has been estimated from a study of the 13 stonecutters with anamnestic and clinical evidence of TVD and the 20 referents. Twelve of the 13 subjects with TVD had an FSP% of 0 at 15 or 6°C, the sensitivity therefore being 0.92 (95 % confidence limits 0.64—1.00). None of the reference subjects had zero pressure, and therefore the specificity was 1.00 (95 % confidence limits 0.83—1.00).

DISCUSSION

The cold provocation test presented in this paper has several advantages. The digital arterial temperatures in the cold provoked finger are standardized, and the repeatability is good (6). The temperature of the test finger can be regulated at rather low levels (6°C). Raynaud's phenomenon with digital arterial closure (5) can be objectively verified if the finger systolic pressure is zero in the cold provoked finger. One drawback of the method is that only one phalanx of one finger is cold provoked. Therefore hemodynamically important stenoses in arteries proximal to the tested phalanx are not investigated.

The presented diagnostic test was found to have a high sensitivity. Lewis proposed a generally accepted test involving finger or hand cooling supplemented by body cooling during visual inspection of the cooled fingers (5). In the investigation of lumberjacks with anamnestic TVD by Hyvärinen et al. (4), the cold provocation tests were done at an environmental temperature of 24—25°C with the subjects nude above the waist, a cold wet towel on their

shoulders, and both hands compressing flexible metal tubes immersed in cold water (13—15°C) for a maximum of 15 min. The test yielded positive results (white fingers), validated by visual inspection, for 25 (65 %) of the subjects. The difference in sensitivity between this method and the present one is not significant.

In the same material (4) finger-pulse plethysmography during vibration exposure revealed spastic reactions in the vessels of the fingers of 18 (42 %) of the patients studied; the method therefore has a significantly lower sensitivity than the procedure used in the present study. Pyykkö (10) had used nearly the same cold provocation test as Hyvärinen et al. (4), but with a room temperature of 20°C and a towel temperature of 13—15°C and with the arms of the subjects submerged to their shoulders in water (13—15°C) while the hands compressed flexible metal cylinders. By visual inspection after 15 min of provocation he found Raynaud's phenomenon in 21 (45 %) lumberjacks with anamnestic TVD, the sensitivity of the method therefore being significantly lower than that of the method presented in this paper.

Hellstrøm and Myhre (2) found that Raynaud's phenomenon in TVD was provoked by a combined general and local cold exposure. In their cold provocation test the subjects sat naked in a room temperature of 10 to 12°C for 40 min and exposed their hands to water with a temperature of 13 to 16°C during the last 20 min. All 11 forest workers with anamnestic TVD showed blanching of the fingers by visual inspection. The result gives a sensitivity not significantly different from the present value. In conclusion the other provocation tests mentioned, with combined general and local cold exposure, had a broad range of sensitivity in diagnosing Raynaud's phenomenon, and the best results had sensitivities of the same value as in the method presented in this paper.

Chatterjee et al. (1) had used a neurological test named the Ridge Test for Somatic Space-Sense. In this study 19 of 21 miners with anamnestic TVD had an abnormal ridge test, and therefore the sensitivity of this test does not significantly differ from that of the present method. — But the ridge test diagnoses an associated neurological phenomenon and not Raynaud's phenomenon in TVD.

In the present study there was no significant difference in the temperature releasing Raynaud's phenomenon between stage 2 and stage 3. A possible explanation of this result could be that only three subjects were in stage 2 and only two test temperatures (15 and 6°C) were used.

One subject in stage 0, with an exposure time of 44 years, showed zero pressure at 6°C. This result may be a subclinical Raynaud's phenomenon. Investigating lumberjacks by means of a provocation test, in which the subject put his arms up to his elbows in water with a temperature of 4°C and held them there for 10 min, Tiililä (14) found by visual inspection that 2 of 29 subjects with anamnestic evidence of symptomless fingers had Raynaud's phenomenon. These results may indicate that subclinical Raynaud's phenomenon exists and can be disclosed by cold provocation at low temperatures. In his investigation Pyykkö (10) also observed that in 6 of 47 lumberjacks with TVD more fingers turned white in the provocation test than the subjects themselves had noticed earlier.

In the present study only two subjects in stage 0 with a maximal exposure time of four years showed a normal cold response in the comparison with the referents, while two subjects in stage 0_N and stage 0 with an exposure time of 10 and 44 years, respectively, both had an FSP% that was below the lower normal limits. This result may suggest that it also should be relevant to differentiate between normal and abnormal cold response in subjects without clinical evidence of Raynaud's phenomenon. In an earlier investigation (9) we found that females without any finger symptoms had significantly higher FSP%s than females with "dead fingers." The sensitivity of the method may then be high enough to provoke abnormal reactions in vibration-exposed subjects without clinical symptoms of Raynaud's phenomenon. The present method should be suitable for following the course of TVD in workers who stop working with vibrating hand tools and for observing the effects of vibrating damping measures.

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REFERENCES

1. CHATTERJEE, D. S., PETRI, A. and TAYLOR, W. Prevalence of vibration-induced white finger in fluorspar mines in Weardale. *Br. j. ind. med.* 35 (1978) 208—218.
2. HELLSTRØM, B. and MYHRE, K. A. A comparison of some methods of diagnosing Raynaud phenomena of occupational origin. *Br. j. ind. med.* 28 (1971) 272—279.
3. HIRAI, M., NIELSEN, S. L. and LASSEN, N. A. Blood pressure measurements on all five fingers by strain gauge plethysmography. *Scand. j. clin. lab. invest.* 36 (1976) 627—632.
4. HYVÄRINEN, J., PYYKKÖ, I. and SUNDBERG, S. Vibration frequencies and amplitudes in the ætiology of traumatic vasospastic disease. *Lancet* (1973) 791—794.
5. LEWIS, T. Experiments relating to the peripherial mechanism involved in spasmodic arrest of the circulation in the fingers, a variety of Raynaud's disease. *Heart* 15 (1929—31) 7.
6. NIELSEN, S. L. Raynaud phenomena and finger systolic pressure during cooling. *Scand. j. clin. lab. invest.* 38 (1978) 765—770.
7. NIELSEN, S. L. and LASSEN, N. A. Measurement of digital blood pressure after cooling. *J. appl. physiol.* 43 (1977) 907—910.
8. OKADA, A., YAMASHITA, T., NAGANO, C., IKEDA, T., YACHI, A. and SHIBATA, S. Studies on the diagnosis and pathogenesis of Raynaud's phenomenon of occupational origin. *Br. j. ind. med.* 28 (1971) 353—357.
9. OLSEN, N. and NIELSEN, S. L. Prevalence of primary Raynaud phenomena in young females. *Scand. j. clin. lab. invest.* 37 (1978) 761—764.
10. PYYKKÖ, I. The prevalence and symptoms of traumatic vasospastic disease among lumberjacks in Finland: A field study. *Work environ. health* 11 (1974) 118—131.
11. RAYNAUD, M. *De l'asphyxie locale et de la gangrene symmetriques des extremité.* Leclerc, Paris 1862, pp. 47—48.
12. TAYLOR, W. and PELMEAR, P. L. *Vibration white finger in industry.* Academic Press, London 1975. 166 p.
13. TAYLOR, W. and PELMEAR, P. L. Raynaud's phenomenon of occupational origin: An epidemiological survey. *Acta chir. scand.* (1976): suppl. 465, 27—32.
14. TIILILÄ, M. A preliminary study of the "white finger" syndrome in lumberjacks, using thermographic and other diagnostic tests. *Work environ. health* 7 (1970): 1, 85—87.
15. ———. Vibration syndrome. *Br. med. j.* 2 (1975) 367.

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