Recovery Profiles of Infrared Emissions from Human Hands Following a Quantifiable Provocation Challenge

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Abstract

The aim of the study was to assess the changes in distal to proximal phalangeal temperature difference, via IR thermography, following application of a short duration (2 min) local increase in temperature (8 ^{o}C ± 1 ^{o}C). Results of the experiment showed potential for future symptom assessment using warmth provocation.

Introduction

Raynaud's disease (RD) is characterised by numb, white and often painful distal extremities[1]. Severity varies and it affects 10-20 % of the UK population[2]. Infrared (IR) thermography has previously been used to measure the 'distal-dorsal difference' (DDD) of RD sufferers[3]. The DDD is a parameter for quantifying temperature change in the superficial tissues between the nail-bed and dorsum of the hand; a difference of >1 ^{o}C (when nail-bed is subtracted from dorsum) is considered clinically relevant[3]. Assessment has typically followed evoking of symptoms by cold water immersion at 0-10 ^{o}C from an ambient temperature of 20-24 ^{o}C[4,5]. This method of provocation is often perceived as painful by the sufferer. We report here preliminary findings from a less noxious, and potentially "symptom-alleviating" warmth-provocation challenge, with measurements taken between 2 anatomical points, based on the DDD technique.

Methodology

6 subjects (4 males, 2 females; age=24±3.6 yrs ($\bar{x}$±1SD)) were recruited for the study. Of the 6 subjects, the 2 females had a history of primary RD. This was coincidental, and though proportionately fewer men suffer with the disease, the condition affects male sufferers in exactly the same manner[2,3]. Following a 15 minute acclimatisation period in a room with relatively constant temperature (22 ^{o}C ± 1 ^{o}C), subjects were seated and placed their hands and proximal wrists under a temperature controlled incubator, with an air temperature of 30 ^{o}C for 2 minutes: hands were approximately level with the subjects' heart. IR images were taken of the dorsal aspect of the hands at the following intervals: 5, 3 and 1 minute prior to the provocation, then immediately following (T_0), and at then at 1, 3 and 5 minutes following. For RD subjects only, additional images were taken at 7 and 9 minutes to allow consideration for any delays in recovery of the circulation; a usually employed protocol with RD sufferers[5]. IR images (LAND FTIM vIR camera, LIPS mini V1.10.02) were assessed by subtracting the hottest visible point at the proximal phalanx from the hottest visible point at the nail-bed of the 2nd and 4th digits (Figure 1). Reversing the DDD method of subtracting values meant a value of -1 ^{o}C or greater in a negative direction would be clinically relevant. Statistics were calculated using IBM SPSS Statistics V19, graphs were produced by Microsoft Excel for Windows 2007. Ethical approval by The Faculty of Health Science and Sport Ethics Committee, University of Glamorgan. Written informed consent was obtained.

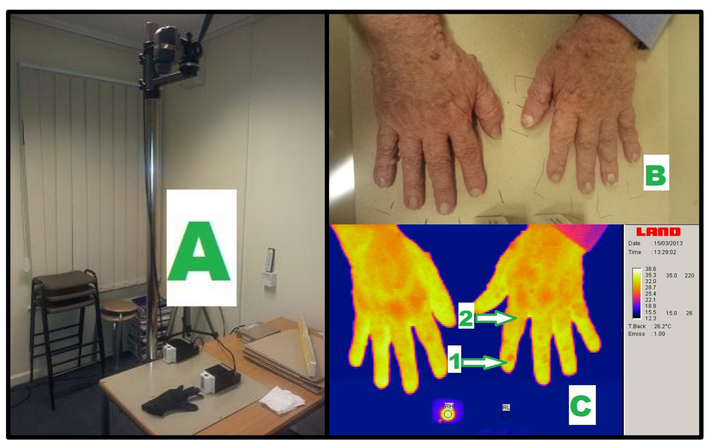

Figure1 – Infrared (IR) Imaging. Typical set up of the infrared camera for viewing hands (A). Images B and C show the hands of one of the subjects as viewed by visible light (B) and through IR imaging (C). Points 1 and 2 highlight the landmarks used for calculating temperature change (subtracting temperature at point 2 from point 1).

Results

Figures 2 & 3 show comparisons between recovery profiles.

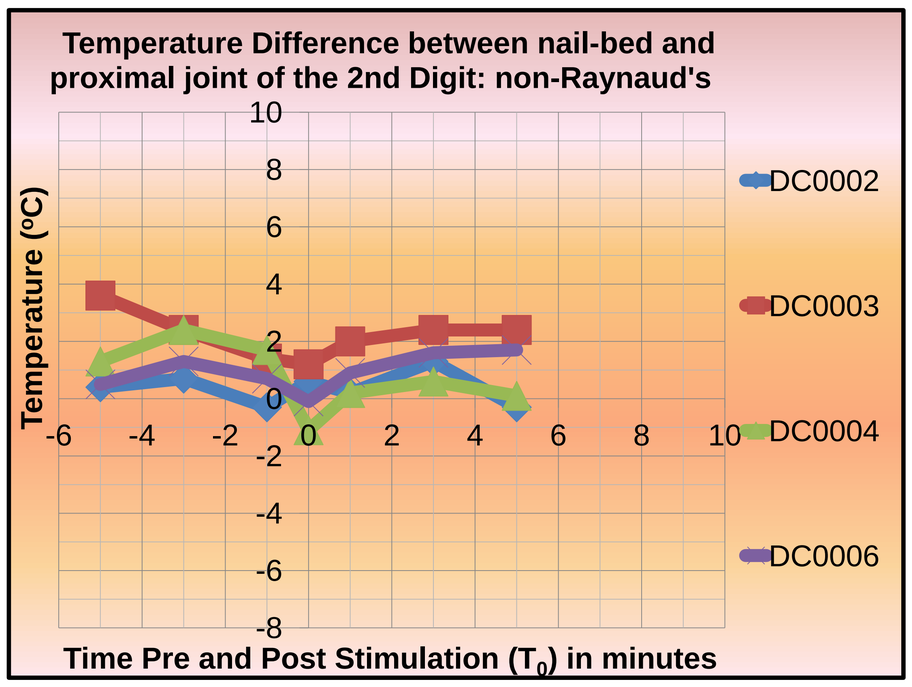

Figure 2 – Variation in recovery profiles for the Right hand 2nd digit non-Raynaud's subjects. This figure shows the limited variation in response from the 4 non-Raynaud's (asymptomatic) volunteers.

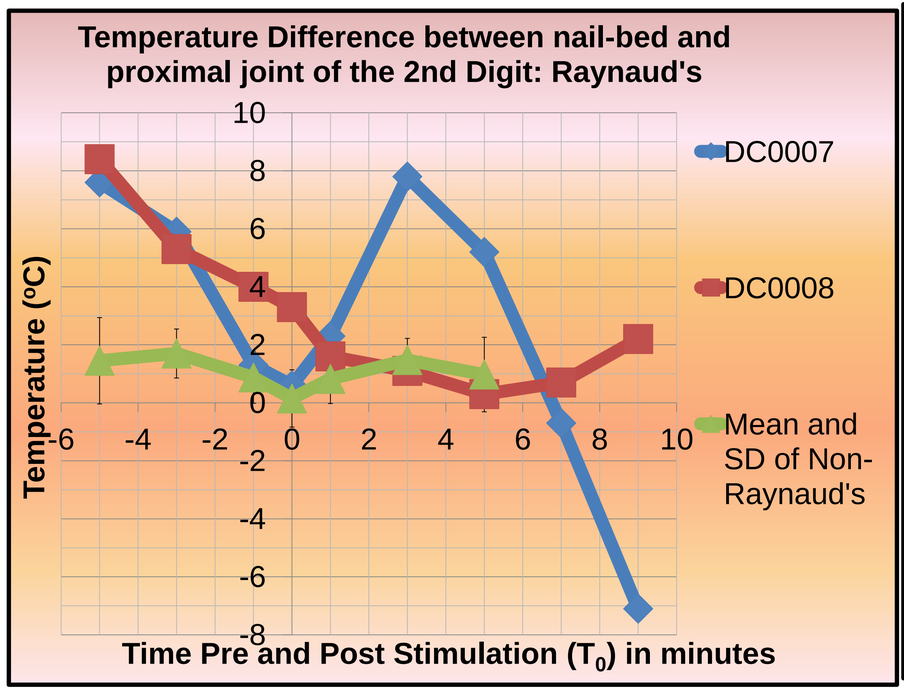

Figure 3 – Profiles for the right 2nd digit of Raynaud's hands compared to non-Raynaud's hands. This figure compares the responses of the Raynaud's sufferers (DC0007, DC0008) to the $\bar{x}$±1SD of the non-Raynaud's (as seen in figure 2). Most notable is the more rapid changes in both Raynaud's sufferers before testing

	D4		D2	
Time(mins)	N	RD	N	RD
-5	1.53(2.5)	5.30(0)	1.45(1.49)	8(0.57)
0	0.83(0.82)	0.4(1.84)	0.15(0.99)	1.95(1.91)
5	1.20(1.16)	1.75(2.9)	0.98(1.28)	2.75(3.46)

Table 1 Legend: Data presented as mean(1SD) temperature (^{o}C) from DDD for the 2nd (D2) and 4th (D4) digits of non-Raynaud's (N; n=4) and Raynaud's (RD; n=2) subjects. The temperature difference was calculated from IR thermographic images taken at 5 minutes prior, immediately following and 5 minutes after (-5, 0 and 5, respectively) a 2 minute duration warmth provocation challenge.

Conclusions

Although only a pilot study, results were encouraging as the recovery profiles of the RD sufferers was visibly different to the non-Raynaud's. The large difference in reaction between the 2 RD sufferers suggests that this test might be sensitive to the underlying cause of the disease, consistent with reports from DDD assessment following cold provocation[3]. Subjects elicited physiologically relevant changes consistent with those changes elicited following cold provocation in previous studies[3]. A larger study has been completed and data is currently being analysed.

References

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