A comparison of intense pulsed light and laser treatment of telangiectases in patients with systemic sclerosis: a within-subject randomized trial

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Abstract

Objective. Cutaneous telangiectases are a characteristic and psychologically distressing feature of SSc. Our aim was to assess the efficacy of two light-based treatments: pulsed dye laser (PDL) and intense pulsed light (IPL).

Methods. Nineteen patients with facial or upper limb telangiectases underwent three treatments with PDL and IPL (randomly assigned to left- and right-sided lesions). Outcome measures were clinical photography (assessed by two clinicians), dermoscopy (assessed by two observers), laser Doppler imaging (LDI) and observer and patient opinion, including patient self-assessment psychological questionnaires [Hospital Anxiety and Depression Scale (HADS), Adapted Satisfaction with Appearance Scale (ASWAP)].

Results. Comparison between 16-week follow-up and baseline photography scores (from −2 to +2 on a Likert scale, with >0 being improvement) were a mean score for PDL of 1.7 (95% CI 1.4, 2.0) and for IPL 1.4 (0.9, 1.8), with a mean difference between PDL and IPL of −0.3 (−0.5, −0.1) (P = 0.01). Dermoscopy scores also improved with both therapies: PDL 1.3 (1.1, 1.5) and IPL 0.8 (0.5, 1.1), again greater with PDL (P = 0.01). LDI showed decreases in blood flow at 16 weeks, indicating a response to both therapies. All patients reported benefit from treatment (more preferred PDL at 16 weeks). Psychological questionnaires also indicated improvement after therapy with mean change in ASWAP of −13.9 (95% CI −20.5, −7.4). No side effects were reported for IPL; PDL caused transient bruising in most cases.

Conclusion. Both PDL and IPL are effective treatments for SSc-related telangiectases. Outcome measures indicate that PDL has better outcomes in terms of appearance, although IPL had fewer side effects.

Key words: systemic sclerosis, telangiectases, treatment, laser, intense pulsed light.

Introduction

Cutaneous telangiectases are a characteristic feature of SSc, caused by dilatation of microvessels. They commonly occur in the skin of the face, neck and upper limbs, although other areas may also be affected. Telangiectases are part of the microvascular pathology that is a major contributor to the SSc disease process [1]. Their pathogenesis is not fully understood, but increased levels in serum of the TGF-β receptor endoglin may be contributory [2, 3]. Telangiectases have not been widely studied, with only a small number of studies having examined their pathology [4–6], which includes dilation of the post-capillary venules of the upper plexus [7, 8]. More recently it has been shown using laser Doppler imaging (LDI) that the size of a telangiectasis on the skin does not predict its depth and that blood flow in telangiectases is increased more in deeper than in superficial skin layers [9]. Telangiectases might appear to be a relatively trivial issue for patients with SSc compared with severe digital
ischaemia and potentially life-threatening internal organ involvement. However, they are often a major source of psychological distress, disfigurement and body image dissatisfaction [10–13]. Conventional treatment with pulsed dye laser (PDL) can be painful and does not prevent recurrence. In addition, PDL is associated with side effects, including transient but significant bruising and oedema and possible hypopigmentation and (rarely) scarring. Intense pulsed light (IPL) is a treatment that potentially offers the same efficacy with fewer side effects. A pilot study [14] suggests that IPL may be a suitable alternative for SSC-related telangiectases.

The specific objective of this study was to carry out an intrapatient comparison of PDL and IPL treatment of SSC-related telangiectases to determine their relative efficacy and tolerability. A secondary objective was to investigate changes in psychological distress following PDL/IPL treatment.

**Patients and methods**

Patients >18 years of age with either limited or diffuse cutaneous SSC [15] and telangiectases on the face or upper limbs were recruited into the study, which was approved by Wigan, Wrightington and Leigh Research Ethics Committee. All participants gave written consent. Participants were enrolled by T.M. and G.D. In order to achieve 80% power to detect a standardized effect size of 0.66, it was necessary to recruit 20 participants to the study. This was a split-face study. Study procedures, including all imaging and IPL treatment, were carried out in a temperature-controlled laboratory at 23°C at Salford Royal Hospital, with the exception of the PDL treatment, which was performed in the dermatology laser theatre.

**Visit protocol**

Patients had an initial screening visit (visit 1, week –2), at which they completed a photosensitivity questionnaire and bilateral areas to be imaged and treated were identified. Areas were selected to include, where possible, three cardinal lesions (the largest, most obvious telangiectases; where not possible, one or two lesions) which were followed throughout the course of the study. PDL and IPL treatments were randomized to either side using a list generated pre-study by a random number generator (G.D., between 0 and 1, >0.5 was IPL left) in Microsoft Excel. G.D. then assigned participants to interventions. It was not possible to blind patients or those responsible for treatment delivery. Following randomization, a test pulse (patch test) of both treatments was delivered adjacent to the area to be treated to check for possible adverse reactions. If no adverse reaction to either treatment was observed, the patients returned 2 weeks later (visit 2, week 0) for their first treatment session. Patients returned for a further two treatment visits (visits 3 and 4 at weeks 4 and 8, respectively). At each treatment session, pretreatment imaging and evaluation were carried out (described below) prior to the delivery of both treatment methods to the assigned areas. Treatment protocols for the PDL and IPL methods are described in the Treatment methods section below. If patients responded fully to treatment one or two and all telangiectases in the cardinal region were resolved, then they would have no further treatment. Patients were reassessed at week 16 (visit 5) and (for the earlier recruits into the study, in whom this was feasible within the time frame of the study) at month 9 (visit 6). At visits 5 and 6, imaging and evaluation were performed without further treatment and patients were asked to complete a questionnaire regarding their experiences of both treatments.

**Treatment methods**

Lesions were treated on one side with PDL and on the other with IPL. The PDL device used was a Candela V-Beam Perfecta (595 nm, 9 J, 7 mm diameter beam, 1.5 ms pulse duration) with an integrated cooling spray (30 ms duration, 20 ms delay for pulse) (Candela, Wayland, MA, USA). PDL treatment was carried out following the standard clinical protocol by a consultant dermatologist (J.F.). The IPL device used was a Lumina IPL (550–1100 nm, each pulse composed of two shots with a 20 ms delay, 28–30 J/cm², delivered through ultrasound gel and post-treatment cooling with ice water; Lynton Lasers, Cheadle, UK). The IPL treatment protocol was as advised by the manufacturer and was carried out by a trained vascular technician (T.M.). All patients wore appropriate safety goggles during treatments. Cooling was applied post-treatment unless patients requested otherwise. No changes to the protocol or outcome measures were made once the study had commenced.

**Outcome measures**

**Photographs and dermoscopy (visits 2–6)**

The primary outcome measure in this study was the difference in mean improvement of the photographic appearance of telangiectases at week 16; photographs of the treated areas were compared between time points. Week 16 (8 weeks after the final treatment) was chosen as the time point at which treatment response would be assessed, as we expected definitive results to be apparent at this time and for any short-term treatment changes to no longer be visible. The primary outcome had been set in advance in the trial protocol. Following a 20 min acclimatization, clinical photographs (Fig. 1a) of both PDL and IPL treatment areas were taken under standardized lighting and background conditions. Images were taken by a medical photographer following a strict protocol with defined camera exposure settings.

Clinical photographs were assessed independently by two blinded clinical observers (J.F. and A.H.). For each subject the observer was presented with eight pairs of images (four left side, four right) comparing (i) visits 3–5 (weeks 4, 8 and 16) to visit 2 (baseline, week 0) and (ii) (for that subgroup of patients attending at 9 months) visit 6 (month 9) to visit 5 (week 16). The observer compared the later image with the earlier, looking specifically for changes in the appearance of telangiectases. The observed changes were scored on a Likert scale from −2 (appearance much worse at later time point) to +2.
(appearance much better). In addition, observers were asked to directly compare the left and right treatment areas at both visit 5 (week 16) and visit 6 (month 9) and a preference stated for each (left, right, no preference), again based on the appearance of the telangiectases.

Photographs of individual telangiectases were recorded using a dermatoscope and digital camera combination. This allows images with 10× magnification to be captured, showing the lesions in greater detail than conventional photography allows (Fig. 1b). Dermoscopy images

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**Fig. 1** Clinical photographs and dermoscopy images before and after treatment

(a) Top left and right are baseline images of the face prior to treatment. Directly below each image is the same site after treatment (visit 5, 16 weeks). Lower left treated with IPL and lower right treated with PDL. Scale is in centimetres (large divisions).

(b) Dermoscopy images of individual lesions at baseline (left, week 0) and week 16 (right). Optical magnification × 10. Scale bar is 250 μm.
of the cardinal lesions from both the left and right treatment areas were independently assessed as for clinical photographs; up to 24 pairs of images [comparing (i) visits 3–5 with visit 2 and (ii) visit 6 with visit 5 for each of up to three lesions per side] by two observers (G.D. and T.M.).

LDI (visits 2–6)
LDI maps blood flow over an area, producing a perfusion image in arbitrary perfusion units. The system used was a modified MoorLDI-vr (Moor Instruments, Axminster, UK) incorporating two lasers with wavelengths of 532 nm (green) and 633 nm (red). Due to the different penetration depths of the two wavelengths in skin, the green laser images superficial, smaller blood vessels such as capillaries, whereas the red laser images deeper, larger blood vessels [9]. Thus dual wavelength imaging allows the apparent depth of a lesion to be assessed; those that are only shallow will show mostly in the green rather than red image, while those lesions that are deeper will show clearly on both images. A decrease in perfusion would indicate improvement. The cardinal lesions referred to above were identified using non-reflective arrow markers applied to the patient’s skin (as shown in Fig. 2) that show up clearly on the scan. Typically one image per treated region was required, taking ~5 min.

The perfusion of the cardinal lesions within the LDI images from each of the left/right treatment areas was assessed using a standard region of interest for each lesion. The mean perfusion of the lesions was taken for each side. The mean change in perfusion was compared between treatments from baseline to visits 3–5 and from visit 5 to visit 6.

Non-imaging outcome measures
Observer opinion. At visits 2–6 the appearance of telangiectases was graded in terms of colour and spread (0–3 scale: none, mild, moderate, severe) by the study observer (G.D.). This was done for each treated area individually (i.e. left and right). The numbers of telangiectases in each treatment area were also documented.

Patient opinion. At visits 5 and 6 participants were asked whether they perceived an overall improvement in their telangiectases due to the treatments and were also asked to assess whether each treated area (left and right) was improved, the same or worse, following treatment. They were then asked which side they thought now had the best appearance (left, right or no difference) and (regardless of any improvements in appearance) which treatment they found preferable (in terms of pain, after effects and overall experience). Side effects for both treatments were recorded at visits 2–5 immediately following treatment or at the next visit.

The Hospital Anxiety and Depression Scale (HADS) [16] and Adapted Satisfaction with Appearance Scale (ASWAP) [17] were completed at visits 2, 5 and 6. The HADS is a 14-item scale assessing anxiety and depression. Lower scores indicate lower levels of distress and depression. The ASWAP is a 15-item questionnaire designed to measure body image dissatisfaction and social discomfort related to appearance. Again, lower scores indicate lower dissatisfaction and distress. Both scales have been validated in previous studies of SSc [11, 18, 19]. Negative values of change suggest improvement in psychological response. A clinically significant change is represented by at least a 4-point change.

Statistical analysis
Mean improvements from baseline for PDL and IPL, calculated across two assessors’ scoring of photographs and dermoscopy, were compared using paired t-tests. Mean improvements in perfusion measurements obtained using LDI were used to compare PDL and IPL using the

![Fig. 2 Red wavelength laser Doppler images of three cardinal lesions at baseline and 16-week follow-up](image-url)
same method, for both red and green measurements. Overall changes in other scores from baseline to week 16 were assessed using paired \(t\)-tests.

Statistical significance was set at the 5% level (\(P\)-values < 0.05 indicated statistical significance). All analyses were based on participants who completed the scheduled treatments as allocated at each time point. The analysis set was stated in advance in the protocol.

**Results**

**Patients**

Twenty-four patients were screened for the study (Fig. 3). Five patients withdrew following screening and patch testing for personal reasons not related to the study or the outcome of the patch test, leaving 19 (18 female, median age 59 years (range 49–72); 17 limited cutaneous SSc, 2 diffuse cutaneous SSc). Disease duration, measured as the time since the first non-RP clinical feature, was 14 years (range 2–31). All patients attended for the maximum of three treatment sessions during the study. Sixteen patients attended up to at least the first follow-up visit (visit 5, week 16) and nine attended at 9 months (Fig. 3). Patients were recruited between 23 April 2010 and 18 February 2011. The final follow-up visit was 5 August 2011. The trial was completed when all available patients had completed their final visit.

**Outcome measures**

**Photographs and dermoscopy**

Results are shown in Table 1 and example photographs in Fig. 1a and b. Positive scores suggest improvements in appearance at almost all time points for both PDL and IPL. The observers disagreed by < 0.5 point on the scale on average (mean 0.4). They disagreed by as much as 2 points (the largest observed disagreement) on just two occasions. The observers never disagreed as to the direction of the change. PDL had greater improvement than IPL at week 16 compared with baseline for both photographs [mean difference –0.3 (95% CI –0.5, –0.1)] and dermoscopy [mean difference –0.5 (95% CI –0.8, –0.1)], and at week 8 for dermoscopy [mean difference –0.3 (95% CI –0.6, 0.0)].

**LDI**

Example LDI images are shown in Fig. 2 and LDI data are shown in Fig. 4. As discussed above, a decrease in perfusion (a negative change) means improvement. For images taken with the red laser (deeper, larger vessels), perfusion within the telangiectases decreased following treatment by both PDL and IPL. This decrease was sustained for the entire follow-up period. Green laser LDI (superficial, smaller blood vessels) also showed a decrease in blood flow in response to both treatments. However, for IPL this decrease was less at weeks 8 and 16 than at week 4, indicating an actual increase in blood

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Mean scores (95% CI) from comparison of photographs or dermoscopy images at key time points during the study</th>
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</thead>
<tbody>
<tr>
<td><strong>Comparison, time</strong></td>
<td><strong>IPL</strong></td>
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<tr>
<td><strong>Photographs</strong></td>
<td></td>
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<tr>
<td>Week 4 vs baseline (n=17)</td>
<td>1.2 (1.0, 1.4)</td>
</tr>
<tr>
<td>Week 8 vs baseline (n=16)</td>
<td>1.4 (1.1, 1.6)</td>
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<tr>
<td>Week 16 vs baseline (n=15)</td>
<td>1.4 (0.9, 1.8)</td>
</tr>
<tr>
<td>Month 9 vs week 16 (n=8)</td>
<td>0.3 (–0.2, 0.7)</td>
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<tr>
<td><strong>Dermoscopy</strong></td>
<td></td>
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<tr>
<td>Week 4 vs baseline (n=18)</td>
<td>0.6 (0.4, 0.8)</td>
</tr>
<tr>
<td>Week 8 vs baseline (n=17)</td>
<td>0.7 (0.5, 1.0)</td>
</tr>
<tr>
<td>Week 16 vs baseline (n=15)</td>
<td>0.8 (0.5, 1.1)</td>
</tr>
<tr>
<td>Month 9 vs week 16 (n=9)</td>
<td>–0.1 (–0.5, 0.3)</td>
</tr>
</tbody>
</table>

Scores refer to the –2 to +2 Likert scale for measuring telangiectasis worsening or improvement. \(P\)-values relate to the difference in scores for IPL and PDL at each time point. Missing photographs due to equipment issues account for lower than expected numbers for photography. Focus issues with dermoscopy rendered occasional image pairs ungradable, accounting for missing data for that technique. *\(P<0.05\).
In one patient red LDI data are missing because of technical failure. The mean perfusion of lesions in the treated area is shown at each time point for each patient in the study.
Table 2: Observer and patient opinion at relevant time points

<table>
<thead>
<tr>
<th>Measure</th>
<th>Baseline (week 0) (n = 19)</th>
<th>Week 4 (n = 18)</th>
<th>Week 8 (n = 17)</th>
<th>Week 16 (n = 16)</th>
<th>Month 9 (n = 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observer opinion, mean (IQR)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–3 scale IPL side</td>
<td>1.5 (0.7)</td>
<td>1.4 (0.7)</td>
<td>1.3 (0.4)</td>
<td>1.2 (0.5)</td>
<td>1.3 (0.9)</td>
</tr>
<tr>
<td>0–3 scale PDL side</td>
<td>1.4 (0.5)</td>
<td>1.4 (0.8)</td>
<td>1.2 (0.5)</td>
<td>0.9 (0.4)</td>
<td>1.3 (0.7)</td>
</tr>
<tr>
<td>Lesion count (IPL side)</td>
<td>6.8 (3.6)</td>
<td>5.3 (2.8)</td>
<td>4.5 (2.2)</td>
<td>3.9 (2.4)</td>
<td>3.7 (3.3)</td>
</tr>
<tr>
<td>Lesion count (PDL side)</td>
<td>6.3 (4.0)</td>
<td>4.1 (2.0)</td>
<td>3.6 (3.1)</td>
<td>2.9 (2.8)</td>
<td>3.2 (2.1)</td>
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<tr>
<td>Patient opinion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall improvement? %</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>Yes 100 (n = 16)</td>
<td>Yes 100 (n = 9)</td>
</tr>
<tr>
<td>IPL side appearance? %</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>Improved 69 (n = 11), same 31 (n = 0), worse 0</td>
<td>Improved 69 (n = 8), same 11 (n = 1), worse 0</td>
</tr>
<tr>
<td>PDL side appearance? %</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>Improved 88 (n = 14), same 13 (n = 2), worse 0</td>
<td>Improved 67 (n = 6), same 22 (n = 2), worse 11 (n = 1)</td>
</tr>
<tr>
<td>Side preference (appearance) %</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>IPL 25 (n = 4), no preference 25 (n = 4), PDL 50 (n = 8)</td>
<td>IPL 33.3 (n = 3), no preference 25 (n = 4), PDL 50 (n = 8)</td>
</tr>
<tr>
<td>Treatment preference, %</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>PDL 25 (n = 4), no preference 25 (n = 4), PDL 50 (n = 8)</td>
<td>PDL 33.3 (n = 3), no preference 25 (n = 4), PDL 50 (n = 8)</td>
</tr>
<tr>
<td>Patient questionnaire scores, mean (IQR)</td>
<td></td>
<td></td>
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<tr>
<td>HADS</td>
<td>11.8 (7.0)</td>
<td>–</td>
<td>–</td>
<td>10.8 (7.3)</td>
<td>5.8 (4.8)</td>
</tr>
<tr>
<td>ASWAP</td>
<td>35.0 (14.5)</td>
<td>–</td>
<td>–</td>
<td>18.1 (14.4)</td>
<td>20.0 (14.7)</td>
</tr>
</tbody>
</table>

Observer opinion, on a 0–3 scale (none, mild, moderate, severe), on both sides of the face at each visit (before treatment where relevant).
Observer and patient opinion indicated a general improvement in response to both treatments. Patient questionnaires indicated an improvement following treatment for satisfaction with appearance, although anxiety and depression (HADS) scores were unchanged with treatment. It should be noted that these questionnaires measure composite response to both treatments and cannot separate out response to either treatment alone.

Three previous studies of light treatment of SSc-related telangiectases have been reported, two with PDL [20, 21] and our own previous study of IPL [14]. Several further studies have reported intrapatient studies of IPL and PDL for treatment of non SSc-related vascular lesions. Tanghetti et al. [22] found no statistical difference in efficacy or side effects in treating facial telangiectases with IPL and PDL in a split-face study. Nymann et al. [23, 24] performed two split-lesion studies of telangiectases and found both IPL and PDL efficacious but PDL superior. In addition, the authors found that PDL was rated as less painful, more patients preferred it and patients were more satisfied with the results [23, 24]. Faurouchou et al. [25] compared PDL and IPL for treatment of port-wine stains and found that although both treatments were successful, PDL had better efficacy and was preferred by patients. McGill et al. [26] treated vascular lesions previously unresponsive to PDL in a study of several laser systems in the same patients, including IPL and PDL. Both were found to cause further improvement; IPL in six patients and PDL in five, with larger vessels being more responsive to treatment.

In their recent retrospective study of PDL treatment, Halachmi et al. [20] reported that although both SSc-related and sporadic telangiectases (telangiectases in patients without underlying systemic disease) responded to treatment, the number of treatments required to achieve 95% clearance was approximately double for SSc-related lesions (mean number of treatments 1.92 for control (sporadic) patients compared with 3.24 for patients with SSc). The authors suggested that this difference in treatment responsiveness might relate to structural differences (including thicker walls) between SSc-related and sporadic telangiectases [20]. Future dose-finding studies examining both PDL and IPL treatment of telangiectases would help to inform optimal treatment protocols for each.

The outcome measures used in our study have some limitations. Grading of photographs and dermoscopy is subjective and dependent upon good quality images that have been taken under the same lighting conditions at the same exposure and resolution. LDI offers a more objective measure of blood flow, but this may not be directly proportional to the appearance effects as observed by observer or patient. Observer and patient opinion is also subjective and relies upon recollection of the baseline to make comparisons. As a whole, these objective and subjective measures come together to build up a comprehensive picture of treatment response.

PDL and IPL were both well tolerated; however, IPL had fewer side effects. The differences in both efficacy and side effects are due to IPL being a broad spectrum (i.e. white) light source rather than single-wavelength light as in a laser, which influences how the light interacts with the skin and blood vessels. PDL and IPL are easy to use and take a relatively small amount of time and both require the same minimal patient preparation (e.g. no make-up), operator training and observance of safety guidelines. In conclusion, this study suggests that PDL, the current standard, remains the best treatment option for SSc-related telangiectases, but IPL is a suitable alternative. Further work is needed in order to identify the most efficacious protocol for IPL.

Rheumatology key messages
- Telangiectases are a major source of psychological distress in patients with SSc.
- Pulsed dye laser and intense pulsed light are both effective treatments for SSc-related telangiectases.

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References
3 Braverman IM. Do the telangiectases of hereditary hemorrhagic telangiectasia and the calcinosis, Raynaud’s disease, sclerodactyly, telangiectasia variant of scleroderma have a common etiology? Dermatology 2006;213:81–2.
8 Braverman IM, Keh A, Jacobson BS. Ultrastructure and three-dimensional organization of the telangiectases of


