



# The validation of the Depth Measurement Videomicroscope (DMV) as a noninvasive tool for the assessment of capillary vascular malformations<sup>☆</sup>

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## KEYWORDS

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**Summary** The assessment of capillary vascular malformation (CM) morphology can be performed using videomicroscopy. Previously only the type of capillary pattern could be demonstrated. The Depth Measurement Videomicroscope (DMV) allows both depth and diameter of CM vessels to be measured. The aim of this study was to examine how videomicroscope recordings correlated with biopsy recordings and to investigate pressure-related changes in recordings when using the device.

For the first part of the study, 10 patients with CMs resting in a temperature-controlled room were assessed with the DMV. Following this a 3 mm punch biopsy of the area was taken. The depth and diameter measurements taken with the DMV were compared to those obtained histologically. For the second part of the study, pressure measurement was used to determine the amount of pressure required on the tip of the DMV to alter the results obtained. Five recordings were taken on the forearm of one volunteer.

When the DMV and biopsy measurements are compared using a Bland and Altman Test to determine their relationship there is a close agreement with the diameter measurements and a correction factor of  $-0.100$  mm for the depth measurements.

The pressure required to alter the skin microcirculation when placing the DMV on the skin surface was found to be 62 mmHg. This corresponds closely with other

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studies of pressure effects on the skin microcirculation and exceeds the pressure used when using the DMV. The DMV thus provides a useful tool for assessing CM capillary structure.

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Capillary Vascular Malformations (CM) or Port Wine Stains are congenital vascular malformations, which consist of ectatic dermal capillaries within the skin.<sup>1</sup> As defined by Mulliken and Glowacki, they have a normal rate of endothelial cell turnover and grow commensurately with the child.<sup>1</sup> This is distinct from haemangiomas, where the rate of cell turnover is increased in the proliferative phase and reduced in the involuting phase. The incidence of these vascular abnormalities is between 1 and 3 per thousand live births<sup>2</sup> and they may cause considerable psychological upset for both the patient and parents.<sup>3–6</sup>

The treatment of CMs by laser has been attempted for a number of years, initially with the Argon Laser<sup>7</sup> and more recently with the Pulse Dye Laser.<sup>8–11</sup> The results of treatment are highly variable, with only a minority of patients receiving full fading of the lesion.<sup>12</sup> This lack of response is believed to be due to the capillary composition of the lesions,<sup>13–15</sup> the flow through the capillaries<sup>16,17</sup> and the amount of melanin in the skin.<sup>18</sup> The principle of selective photothermolysis, on which modern laser treatment is based, states that a wavelength of laser light should be chosen which will match the thermal absorption spectrum of the compound being targeted – in this case oxyhaemoglobin.<sup>18</sup> Furthermore, if this laser light is pulsed so that each pulse lasts less than the thermal relaxation time of the target, that is the time taken for the target to lose half its energy, then heat build up and conduction into neighbouring structures will be minimised. It is the conduction of heat away from the target capillaries and into the surrounding skin that leads to the complications of pigment change and scarring.

The goal of recent advances in the development of laser technology has been to attempt to match the pulse duration of the incident laser light to the thermal relaxation time of the target capillaries, this being dependent on their diameter.<sup>15,19–21</sup> Also, the depth of the capillaries within the skin has important implications for laser treatment.<sup>22–24</sup> By increasing the wavelength of the laser light used it is possible to increase the depth of penetration of the laser to reach deeper capillaries. Unfortunately, due to the absorption spectrum of oxyhaemoglobin, increasing the

wavelength used also requires much more energy (fluence) be used and thus risks complications. Traditionally the only method to assess the capillary characteristics within a CM has been by biopsy.<sup>25</sup>

In an attempt to develop a method of non-invasively determining capillary composition of CMs we have developed the Depth Measurement Videomicroscope (DMV). This consists of a 200× Cy-scope lens attached to a Compact Videomicroscope (PW Allen, Tewkesbury, UK). The advantage of this device over traditional videomicroscope units is that it allows for a higher definition image to be seen and has a focussing scale. This allows individual capillaries to be imaged and their depth and diameter to be calculated.

The aim of this study was twofold. Firstly, to compare the results obtained *in vivo* using the DMV with histological measurements obtained through punch biopsies. Secondly, we have attempted to quantify the pressure that can be exerted on the skin surface before measurements are altered. This is a common criticism of many contact methods of assessing CMs.

## Method

For the first part of the study 10 patients, eight males and two females, with a mean age of 47 (range 28–85), were recruited. These patients were a mix of either resistant patients, those undergoing treatment, or untreated CM patients. Local Ethics Committee approval was gained for this part of the study.

Each patient was allowed to rest for 20 min in a temperature-controlled room at 28 °C. A suitable test area was selected. This consisted of a representative area of CM, which would allow the DMV to be applied to the area without interference, from hair for example. The area was also chosen not to be in an obvious area so that a biopsy would not leave the scar in an unacceptable position.

The DMV consists of a Compact Videomicroscope connected to a 200× Cy-scope lens. Images were viewed through a monitor (Sony Trinitron) and image capture was via a colour printer (Mitsubishi Colour Video Copy Processor).

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