Analysis of portwine stain disfigurement and pulsed dye laser treatment results
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Summary

In Chapter 1 the study “Treatment of portwine stains by laser, the younger the better?” is described. Treatment results were quantified using color measurements. The average reduction in color difference between portwine stain and normal skin was 40 percent after an average 5 treatments of the entire portwine stain. The differences between the four age groups (0-5, 6-11, 12-17, 18-30 yr) in the average reduction in color difference were not significant. Hence, no evidence was found that treatment of portwine stains with flashlamp pumped pulsed dye laser is more effective during early childhood than later in life.

Chapter 2 describes the development and evaluation of a questionnaire for the assessment of the following portwine stain characteristics: color, sharpness of boundary, pigmentation, size, shape, skin surface-structure, and hypertrophy of underlying tissue. The questionnaire was shown to be a reliable tool to describe these 7 characteristics of a portwine stain.

Subsequently, photographs of patients before and after 5 treatments of the entire portwine stain were rated by a professional panel using the questionnaire. Treatment results were assessed by comparing ratings before and after treatment. After 5 treatments of the entire portwine stain the most considerable changes were measured in the ratings for color (lightening of the stain by 33 percent), boundary (sharpness reduced by 38 percent), and size (13 percent decrease).

In Chapter 3 the relation between portwine stain disfigurement and the 7 portwine stain characteristics from the questionnaire described in Chapter 2 was established. Portwine stain disfigurement was assessed by a panel of lay persons who assigned a mark for disfigurement to each portwine stain. These ratings were compared with the ratings of the items on the questionnaire, and the percentual contribution of each of the characteristics to overall portwine stain disfigurement was calculated. Size turned out to be the most important portwine stain characteristic, being responsible for almost half of the overall disfigurement. Color and boundary are the next two most important characteristics, contributing respectively 18.7 percent and 12.4 percent to overall portwine stain disfigurement.
In Chapter 4 the risk of redundant tissue damage caused by overlapping pulses was studied by determining the histopathological effects on normal human skin. This study was performed on healthy skin of pre-operative volunteers who were hospitalized for either breast reduction or abdominal wall correction.

Overlapping of pulses on normal human skin enhances depth of vascular damage with approximately 30 percent. Using clinically relevant radiant exposure levels (6-8 J/cm²), no histological signs of serious damage to epidermis or dermal connective tissue were found. Reasoning that these results will also be valid for portwine stains, we conclude that overlapping of pulses is safe. This conclusion is also supported by our clinical experience as described in Chapter 2.

In Chapter 5 the general belief that portwine stains darken with age is investigated. Color parameters L*, a*, and b* for both portwine stain and normal skin, their differences (ΔL*, Δa*, and Δb*), and the corresponding color difference (ΔE) are plotted as a function of age. The differences between the three components (ΔL*, Δa*, and Δb*) change significantly with age, but the perceived color difference (ΔE) between portwine stain and normal skin shows no significant change. Darkening of portwine stains with age is based on a decreased lightness (L*), a small decrease in redness (a*), and virtually unchanged yellowness (b*).

Surprisingly, the darkening of the portwine stain with age is not reflected by the perceived color difference between portwine stain and normal skin, due to compensating changes in the normal skin. Portwine stains require a variable and unpredictable number of treatments with the flashlamp pumped pulse of the laser to achieve the best possible clearance. In Chapter 6 a simple model to predict treatment outcome based on color measurement results is described. It is demonstrated that portwine stain clearance can be represented by an exponentially decreasing function of the number of treatments. After the first few treatments the number of treatments to achieve the best possible clearance can be predicted based on the rate of decay of the fitted curve.