Received: 13 May 2018 | Revised: 20 June 2018 | Accepted: 11 July 2018

DOI: 10.1111/jocd.12761

ORIGINAL CONTRIBUTION

WILEY JCD Journal of Cosmetic Dermatology

Histological findings correlated with clinical outcomes in telangiectasia treated with ohmic thermolysis and 940 nm laser

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Summary

Background: Heat modalities are commonly used as either primary or adjunctive treatment for telangiectasia. Minimal information is available as to the nature of injury to the vessel and surrounding tissue.

Method: A total of 135 patients were treated over a 2-year period using ohmic thermolysis (45), 940 nm laser (50), and 940 nm laser with sclerotherapy (40). After treatment, 1 mm biopsies were done in selected patients in each group. Clinical correlation was studied in each group by observing vessel response at 4-6 weeks post-procedure.

Results: Ohmic thermolysis produces electrodessication of the squamous epithelium, reticular dermis, and fusion of the target vessel. 940 nm laser results include squamous epithelial damage, subcutaneous water blister, collagen denaturation, and vessel endothelial cell loss with thrombus at point of maximal impact. The addition of sclerotherapy at time of laser potentiates vessel damage. There was no long-term skin sequelae after treatment when each device is used at recommended settings and on appropriate vessel size.

Conclusion: Each device causes damage to the squamous epithelium and papillary reticular dermis that is transient. Ohmic thermolysis provides vessel clearance of >90% in telangiectasias <0.5 mm. 940 nm laser effectiveness is <70% for vessel clearance, but improves to >90% when sclerotherapy is performed at time of treatment.

1 | INTRODUCTION

Treatment for telangiectasias includes chemical, thermal, and microsurgical modalities. The thermal modalities commonly used include radiofrequency (RF) energy, laser, and intense pulsed light.[1–6] Ohmic thermolysis is electrodessication with RF energy. Lasers used for the treatment of telangiectasia commonly are in the 532-1064 nm spectrum. Minimal information is available as to how the intradermal telangiectasia is affected by targeted thermal injury.

Two modalities of heat injury using the 940 nm laser (Dornier Med Tech, Kennesaw, GA, USA), and ohmic thermolysis, (VeinGogh), (AP Medesthetics, Inc, Wayland, MA, USA), are examined in the study. Histological results are correlated with clinical findings in vessels measuring 0.3-1 mm in diameter.

By understanding the histological effects of various thermal applications to telangiectasias, more accurate decisions can be made as to the appropriate treatment based on size and depth of the targeted vessel. Potential complications may be minimized.

2 | METHODS

A total of 135 patients over a 2-year period were included in the study. Group I (45) received ohmic thermolysis for leg telangiectasia

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ranging in size 0.3-1 mm. Group II (50) were treated with the 940 nm laser for veins ranging in size from 0.3 to 1 mm. Group III (40) were treated first with a 940 nm laser followed immediately by sclerotherapy at concentrations described previously by the authors.[7] Vein size was 0.5-1 mm in diameter. Using a 1 mm punch, samples were obtained 15 minutes postprocedure in the area where the dermal perforator gave rise to the spider complex. Thirty specimens were obtained; Group I (10), Group II (12), and Group III (8). Specimens were fixed in formalin and embedded in paraffin. Four-micron cuts were completed through the specimens and stained with hematoxylin (560 MX) and eosin (4515). The specimens were evaluated using light microscopy at 250-450×. Correlation to clinical outcomes was completed for each group.

Patients with Fitzpatrick V or VI were not included in this study due to potential of skin hypopigmentation after thermal injury.

3 | RESULTS

Histological findings for ohmic thermolysis of a 1 mm telangiectasia include the following: (a) electrodissection of the squamous epithelium and papillary reticular dermis to the level of the treated vessel; (b) endothelial cell destruction; (c) vessel wall alteration; and (d) fusion of the vessel wall with minimal intraluminal area remaining (Figure 1). Longitudinal injury was 50-75 μm. Depth of injury is 500-750 μm. Histological findings after treating telangiectasia <0.5 mm are similar with complete vessel fusion. Epithelial layer and reticular dermis demonstrate findings compatible with electrodessication. Longitudinal injury is less since the target vessel is smaller. Group II (1 mm): 400 joules/cm 20 ms pulse width. Findings include (a) separation of squamous epithelial layers from dermis by a subcutaneous water blister; (b) alteration of the papillary reticular dermis consisting of intense thermal damage; (c) loss of endothelial cells in treated vessel; (d) thrombus at point of maximum impact; and (e) patent lumen (Figure 2). For 0.3-0.5 mm telangiectasia treated with laser (0.5 mm spot size), the average energy was 1000 joules/cm and pulse width of 20 ms. Similar findings are present except in some of these smaller vessels, there may be intraluminal thrombus.

Group III (a): separation of the squamous epithelium from the papillary reticular dermis; (b) thermal alteration of the dermal tissues; (c) endothelial cell loss; (d) thrombus at point of maximal impact; and (e) intraluminal area filled with fibrin and cellular debris (Figure 3).

Vein clearance was >90% in Group III, and <50% in Group I and Group II when 1 mm telangiectasia was treated. The clearance rate was >90% in Group I and <70% in Group II when telangiectasia <0.5 mm was treated. Vein clearance was determined by comparing pretreatment high resolution photographs with comparison of photos taken at 4-8 weeks follow-up.

4 | DISCUSSION

Vessel clearance was defined as total obliteration of the treated vein with one firing (3 pulses of energy with Bristle® needle; AP Medesthetics, Inc), of ohmic thermolysis and no more than two firings per area using the 940 nm laser. Parameters of treatment were selected because repeated firings in the same location with ohmic thermolysis produced unwanted prolonged skin sequelae.

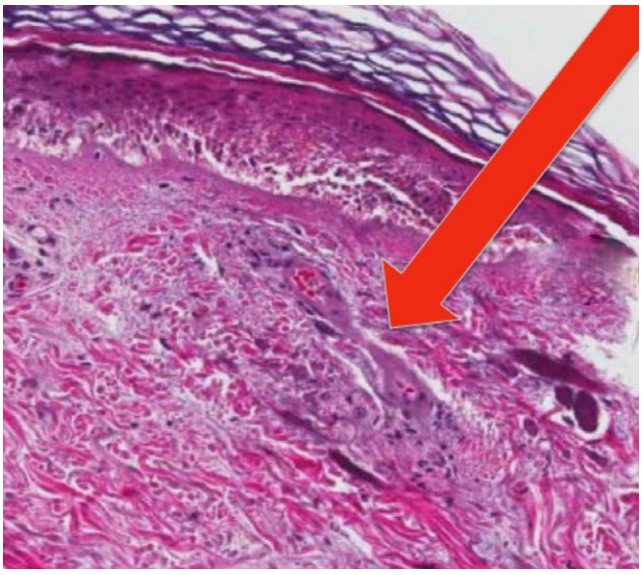

FIGURE 1 Telangiectasia treated with ohmic thermolysis. Red arrow points to fusion of vein wall

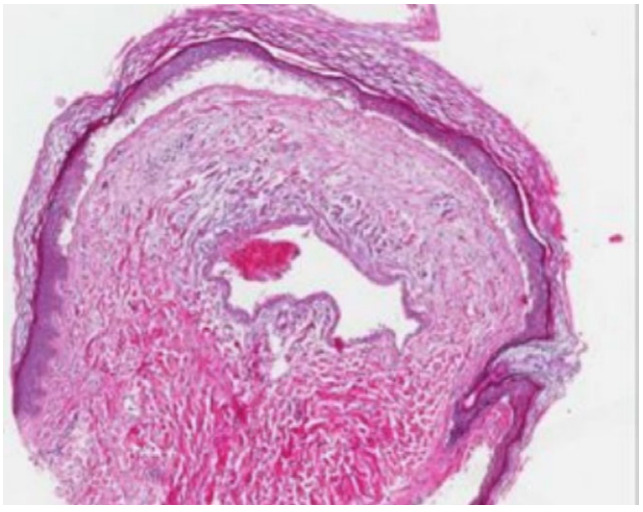

FIGURE 2 940 nm diode laser to 1 mm telangiectasia

Ohmic thermolysis is essentially electrocoagulation with RF energy. In the study, only the "Bristle," needle 33 gauge was used as collateral skin injury is much less than with the standard K" 1" ballet needle (Ballet Technologies, LTD, UK) The settings used are 5%-10% power with three pulses (lowest power setting). For veins 0.8-1 mm with one firing, the clearance rate is <50% and skin sequelae such as prolonged hyperemia and or staining can occur. For vessels <0.5 mm, the results are much better with clearance rates of >90%. Skin sequelae are less and limited to pin point tracking that subsides in 4-6 weeks in most patients. There is a learning curve when using this modality and only gentle pressure on the vein is needed when

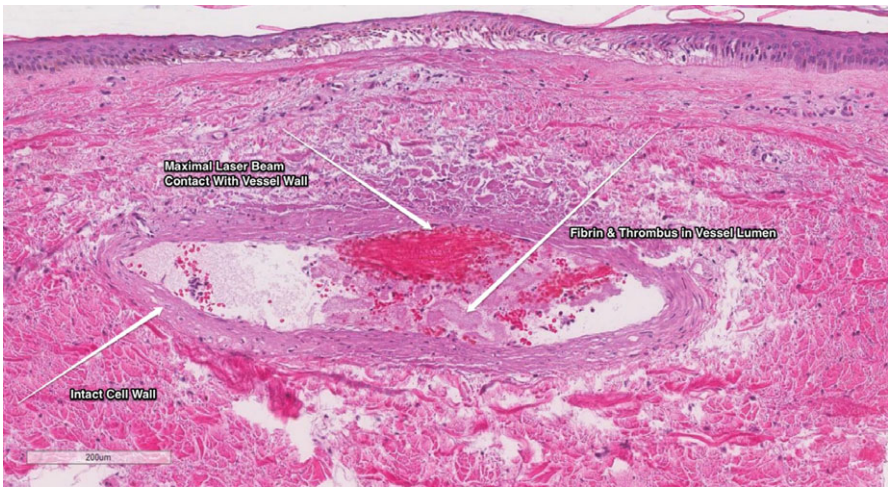

FIGURE 3 940 nm diode laser, followed by Sotradecol 0.1% to 1 mm telangiectasia

firing occurs. The mechanism of action is heat coagulation of the vessel. Approximately 30 μm of the surrounding squamous epithelium and dermal tissue is also damaged. The authors note a significant reduction in epithelial injury with application of a moisturizing plant extract-based cream when using the ohmic thermolysis device, based on our clinic experience.

Laser effectiveness depends on its target. With the 940 nm laser (Dornier, Med Tech), both hemoglobin and water are the targets and the depth of penetration is ideal for 1 mm telangiectasia. For 1 mm vessels, the settings are usually in the range of 350-400 joules/cm, using a 1 mm spot size. The histological findings previously described are squamous denaturation and dermal injury corresponding to the Gaussian Wave effect of the laser. Endothelial cell loss is complete with a thrombus at point of maximum impact. The lumen is patent so the chance of refilling is possible with resultant recanalization. Clinically, there is usually diminution of vessel size but not clearance. As the vessel size decreases and using a smaller spot size (0.5 mm), more clearance can be expected. In telangiectasia <0.5 mm, laser effectiveness is around 70%. Sometimes this result can be improved by defocusing the laser beam a few mm off the skin surface. The more blood volume in the vein, the greater the effectiveness of the laser. When used on appropriate skin type, sequelae after laser application is minimal. In Group III, the addition of sclerotherapy using Sotradecol (Mylan, Canonsburg, PA, USA), 0.15% or Polidocanol (Merz Aesthetics, Raleigh, NC, USA), 0.31% substantially increases damage to the lumen of the vessel. The vessel lumen is completely filed with red cells, cellular debris, and fibrin. In most patients, there is complete clearance of the vessel at one-month postprocedure. However, in >50% of patients, there are varying visible sequelae such as hemosiderin deposition that usually dissipates in 2-3 months.

Both the ohmic thermolysis and the 940 nm laser produce thermal injury similar to, but more pronounced than a second-degree burn. In both applications, there is thermal damage of the epithelium and upper half of the reticular dermis. With the 940 nm laser, there is a subcutaneous water blister with the epithelial layer lifted off the dermis. Ohmic thermolysis produces precise thermal destruction of the epithelial layer, reticular dermis, and target vessel wall. Collateral injury is minimal and limited to the needle length and diameter.

After injury to the epithelium, activation of signaling pathways occurs. Reepithelialization is secured by epithelial stem cells from the hair follicles or sweat glands.[8,9] Follicles and exocrine glands are deep in the reticular dermis and not affected by either modality (940 nm laser, ohmic thermolysis). Since the damaged area is minute in relation to overall skin surface and the main skin components responsible for wound repair are unaffected, injury without scarring is expected.

5 | CONCLUSION

Ohmic thermolysis is an effective modality for treating vessels not amendable to sclerotherapy (<0.3 mm), with clearance rates approaching 90%. With ohmic thermolysis, treatment should be avoided in vessels >0.5 mm due to prolonged skin sequelae. Clearance rates are less when using the 940 nm laser but increase with smaller diameter vessels. Skin sequelae is minimal. Combining sclerotherapy with the 940 nm laser provides clearance of >90% in one treatment. However, hemosiderin deposition may occur which eventually fades over 2-3 months.

ACKNOWLEDGMENTS

The authors wish to thank Dr. Ted Schiff and the staff of Water's Edge Dermatopathology Lab for assistance for the preparation of histological slides used in this study.

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How to cite this article: Bush R, Bush P. Histological findings correlated with clinical outcomes in telangiectasia treated with ohmic thermolysis and 940 nm laser. *J Cosmet Dermatol*. 2018;17:779–782. https://doi.org/10.1111/jocd.12761