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**CASE REPORT**

# Treatment of disseminated superficial actinic porokeratosis (DSAP) with the Q-switched ruby laser

MARGARITA S. LOLIS & ELLEN S. MARMUR

*Department of Dermatology, Mount Sinai School of Medicine, New York, NY, USA*



**Abstract**
*Background*: Disseminated superficial actinic porokeratosis (DSAP) is one clinical subtype of porokeratosis, a cutaneous disorder of keratinization. A variety of approaches may be used to treat DSAP. The ruby laser appears to be a promising option for DSAP treatment. Traditionally, the ruby laser is used to treat hair removal and lesions involving hyperpigmentation. Its use may be further applied to treat the hyperpigmented lesions of DSAP. *Objective*: This study examines the efficacy of the ruby laser in treating a case of DSAP. *Methods*: A 48-year-old female, with a history of pseudoxanthoma elasticum and DSAP, received three Q-switched ruby laser treatments (694 nm) to over 50 sites on the lower and upper extremities. Clinical outcome and patient satisfaction was followed-up. *Results*: Minimal to moderate erythema and appropriate whitening was noted after each treatment. The patient tolerated treatments well and hyperpigmentation and erythema of the majority of the lesions decreased. The patient was very pleased with the results and reports satisfactory cosmetic outcome 3 months later. *Conclusion*: The results obtained from the current case suggests that the ruby laser is moderately successful in treating DSAP and may still provide a good alternative to other available treatments. Further studies are needed to investigate the potential of combined ruby laser treatment for DSAP and to determine the appropriate laser pulse duration and fluence for effective treatment.

**Key words:** *Lasers and light sources, surgery*

## Introduction

Disseminated superficial actinic porokeratosis (DSAP) is one clinical subtype of porokeratosis, a cutaneous disorder of keratinization. It is histologically characterized by the cornoid lamella, a thin column of tightly packed parakeratotic cells within a keratin-filled epidermal invagination. The cornoid lamella is formed by clonal hyperproliferation of atypical keratinocytes. Multiple, annular, brown, keratotic lesions commonly appear on sun-exposed areas of patients with DSAP (1). A genetic component is involved in its development, which shows an autosomal dominant mode of inheritance. The locus for DSAP has been identified and confirmed on chromosome 12q (2). Immunosuppression and ultraviolet radiation exposure in genetically predisposed patients may also cause DSAP. Typically, the lesions that develop in DSAP are asymptomatic but the center of the lesion may progress to squamous or basal cell carcinoma (1).

There are five clinical variants of porokeratosis. Porokeratosis of Mibelli typically appears as a plaque on extremities during infancy or childhood. DSAP is the most common type, presenting as multiple thin papules on the legs of adults. Linear porokeratosis consists of plaques similar in appearance to classic porokeratosis but the plaques follow the lines of Blaschko and are most commonly found on extremities. Punctate porokeratosis develops during adolescence as papules on the palms and soles. Porokeratosis palmaris et plantaris disseminata (PPPD) is a variant of punctate porokeratosis with lesions appearing on all areas of the body (3).

A variety of approaches may be used to treat DSAP depending on the size, location, and malignancy of the lesion. Topical 5-fluorouracil has effectively treated porokeratosis of Mibelli, but is limited in the treatment of DSAP because a brisk inflammatory reaction is required for eradicating the lesion (1). Treatment with oral retinoids, such as etretinate, is controversial because relapses typically follow treatment and may cause burning, itching, and painful erosions (4). Malignant lesions are treated by surgical removal. Excision of benign lesions is often used as a treatment but may leave

Correspondence: Margarita Sophia Lolis, Dermatology, Mount Sinai School of Medicine, 5 East 98th Street, Fifth Floor, New York, NY 10029, USA. E-mail: margarita.lolis@mssm.edu

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scars. As a result, many therapeutic alternatives to excision have been implemented but disadvantages may be associated with these alternatives. The efficacy of diamond fraise dermabrasion, one such alternative, is controversial and treatment may require hospitalization and leads to pain and discomfort (1,4). Another alternative is $CO_2$ laser therapy, which removes the lesions but is associated with a rapid recurrence rate. Use of the frequency-doubled neodymium:yttrium-aluminum-garnet (Nd:YAG) laser has also been used to treat DSAP. Treatment has shown to improve the appearance of porokeratosis, which is confirmed by histopathologic findings (4).

In light of the success of the Nd:YAG laser, the ruby laser appears to be a promising option for DSAP treatment. Traditionally, the ruby laser is used to treat hair removal and lesions involving hyperpigmentation, such as congenital melanocytic nevi and tattoos (5). Its use may be further applied to treat the hyperpigmented lesions of DSAP. Thus, the ruby laser may be effective for treatment of DSAP and may provide a valuable alternative to current surgical modalities used for DSAP treatment. This study examines the efficacy of the ruby laser in treating a case of DSAP.

## Case report

A 48-year-old female, with a history of pseudoxanthoma elasticum and DSAP, presented to our clinic for laser treatment of DSAP. The patient complained of chronic multiple hyperpigmented and erythematous lesions bilaterally on her upper and lower extremities. On examination, the patient was a well-appearing female with multiple thin dermal papules on the posterior of her neck, and scattered hyperpigmented, erythematous plaques and macules on her upper and lower extremities (Figure 1). The patient received three Q-switched ruby laser treatments (694 nm) at an energy level of 5.0 J to over 50 sites on her lower and upper extremities. Minimal to moderate erythema and appropriate whitening was noted after each treatment (Figures 2 and 3). The patient tolerated treatments well and

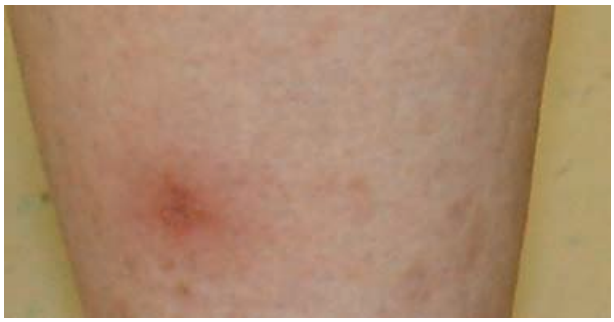

Figure 1. Annular, keratotic lesion characteristic of DSAP (pre-treatment).

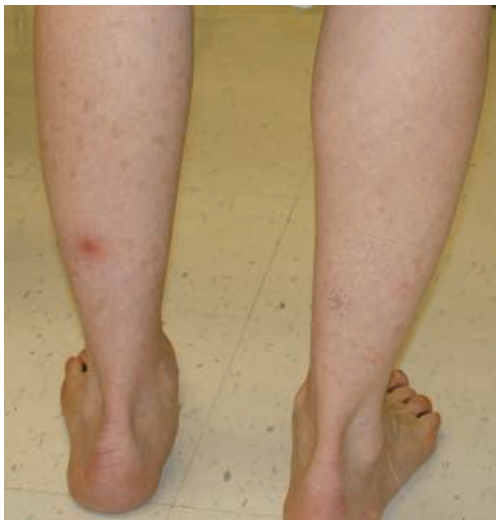

Figure 2. DSAP lesion on left lower extremity of patient pre-laser treatment and on right lower extremity post-laser treatment.

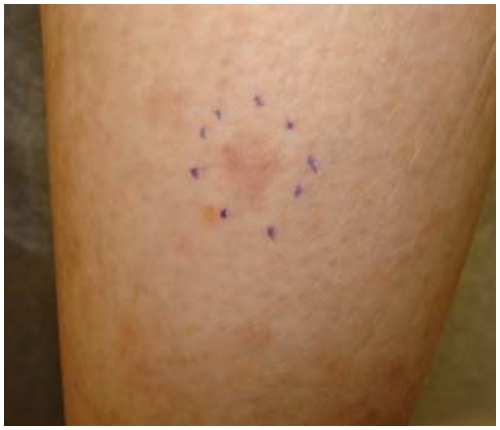

Figure 3. DSAP lesion post-treatment.

hyperpigmentation and erythema of the majority of the lesions decreased. The patient was very pleased with the results.

## Discussion

Effective treatment of DSAP is limited due to complications of currently used treatments. Topical 5-fluorouracil is not an optimal medication because it cannot be used for disseminated lesions since a brisk inflammatory response is required for effective clearance. Oral etretinate has been associated with undesirable side effects, the need for a prolonged period of therapy, and rapid recurrences. Dermabrasion and $CO_2$ laser therapy, although mostly effective, may have recurrences and typically require hospitalization, anesthesia, wound care, and a long healing time (4).

Typically, the Nd:YAG laser at 532 nm is used for the treatment of pigmented lesions (4). The Nd:YAG laser has been reported to effectively treat DSAP. In one study using the Nd:YAG laser with a

532 nm pulse width, 4 mm spot size, 1.5 J/cm$^2$ fluence, and a 2.5 pulses/second delivery rate (4), the appearance of DSAP lesions improved upon treatment for at least 5 months. These clinical effects were confirmed by histopathologic findings: the cornoid lamella was removed and the epidermal invagination was reduced in size. These effects were caused by the absorbance of laser energy by melanin in the lower epidermis, dermoepidermal junction, and in the papillary dermis, which ultimately destroyed the entire epidermis and part of the papillary dermis, as confirmed by the histopathological evidence (4).

Following the success of the Nd:YAG laser, the ruby laser seemed to be an appealing treatment for DSAP for various reasons. First, the ruby laser (694 nm) has a greater degree of penetration than the Nd:YAG laser (532 nm), allowing it to treat pigmented lesions which occur deeper in the dermis (6). Second, the ruby laser uses the principle of selective thermolysis, in which melanin acts as the target chromophore (7). Melanin absorbs energy more strongly at 694 nm than it does at 1064 nm, the wavelength at which Q-switched and normal mode Nd:YAG laser operates (6). Therefore, the ruby laser is an advantageous option, since it offers a combination of better absorbance than the 1094 nm lasers and greater penetration than the 532 nm lasers. It is also very effective in treating hyperpigmentation, is simple to use, does not require hospitalization or anesthesia, and does not usually cause scarring at appropriate settings. The present case suggests that the ruby laser is only moderately successful in treating DSAP, which raises the question of whether the laser actually affects the epithelialization or simply treats the post-inflammatory hyperpigmentation of the lesions.

The histopathologic hallmark of porokeratosis, the cornoid lamella, did not appear to be obliterated by the laser treatment. The papillary dermis beneath the cornoid lamella is typically infiltrated with lymphocytes (Figures 4 and 5) (1). For effective treatment of DSAP, obliteration of the epidermis and part of the papillary dermis, the layers where the pathologic changes of DSAP occur, is necessary. As mentioned previously, in the case of the Nd:YAG laser, the melanin in the lower epidermis, dermoepidermal junction, and papillary dermis absorbed the laser energy, which led to the destruction of the epidermis and part of the papillary dermis, thereby eliminating the cornoid lamella (4). It is known that the frequency-doubled Nd:YAG laser is a mixture of 532 nm and 1064 nm. Although melanin absorbance may be compromised at this wavelength, the 1064 nm light energy penetrates deeper, up to 7 mm into the dermis, compared with the ruby laser, which penetrates up to 2 mm. This may confer a benefit to using the Nd:YAG system rather than the ruby 690 nm system Therefore, one possible explanation of the obtained results may be that the ruby laser, unlike the Nd:YAG laser, did not penetrate the lower epidermis and papillary dermis. A greater degree of penetration of laser light may be needed to target the melanin in the lower epidermis and part of the papillary dermis. Alternatively, the pulse duration of the laser may not have been sufficient for thermal destruction or the fluence may not have delivered enough thermal energy for destruction.

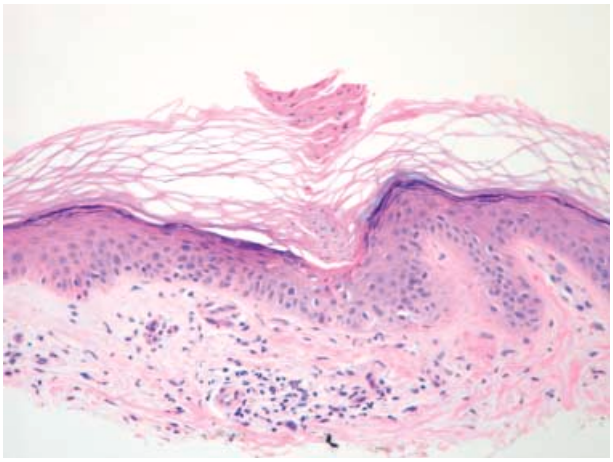

Figure 4. Histopathologic image of DSAP. The hallmark of porokeratosis is the cornoid lamella, shown here.

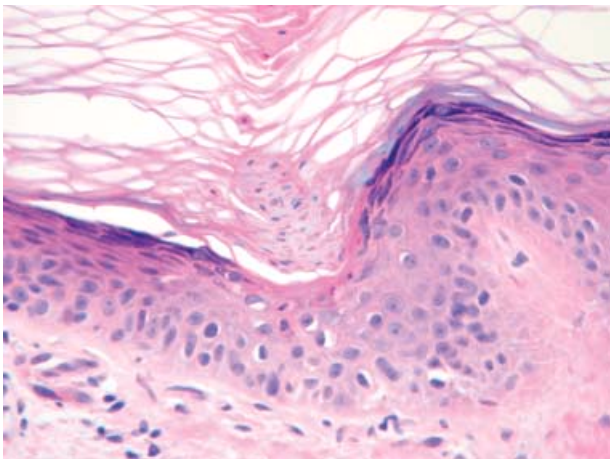

Figure 5. The papillary dermis, beneath the cornoid lamella, is infiltrated with lymphocytes.

A recent paper reported using combined ruby laser to treat congenital melanocytic nevi (CMN) (5). Combining the normal mode (NMRL) and Q-switched (QSRL) ruby laser provided a greater degree of penetration of laser light. The method employed involved initially using NMRL to remove the epidermis followed by use of the QSRL. Removal of the epidermis enables a greater penetration by the QSRL. This method may be effective in penetrating the lower epidermis and papillary dermis to ultimately obliterate the cornoid lamella and parakeratosis of DSAP (5).

## Conclusion

The results obtained from the current case suggest that the ruby laser is moderately successful in treating DSAP and may still provide a good alternative to other available treatments. The Q-switched ruby laser may be a temporary measure for treatment, requiring appropriate follow-up every few years. Further studies are needed to investigate the potential of combined ruby laser treatment for DSAP and to determine the appropriate laser pulse duration and fluence for effective treatment.

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