

# CASE REPORT: Q-switched Nd:YAG Laser Treatment of Phytophotodermatitis Caused by Contact with Plants from Umbelliferae Species

Jasmina Kozarev

*Dr. Kozarev dermatology laser clinic, Sremska Mitrovica, Serbia*

## ABSTRACT

Phytophotodermatitis (PPD) or plant dermatitis is a common cutaneous phototoxic reaction. Acute dermatitis is a result of interaction of plant compounds, most often psoralens, with human skin and ultraviolet light, principally long wave UVA 320-400 nm.

This paper presents Q-switched 1064 nm laser treatment of two cases with phytophotodermatitis caused by contact with phototoxic substances found in the vegetable family Umbelliferae (celery and parsley). Celery contains furanocoumarins, including psoralens, xanthotoxin, bergapten and 5-methoxypsoralen, which are chemicals that react to sunlight.

Following an acute inflammatory phase, and 96 hours after contact with plants, two female patients underwent low fluence Q-switched Nd:YAG 1064 nm laser treatment. The entire hyperpigmented area was treated homogeneously; with three to five passes of laser irradiation. Three days after the procedure, the whole treated area appeared homogeneously pink, with smooth texture. Complete re-coloration took seven days, during which a temporary skin color contrast was hardly noticeable.

This case report highlights the underappreciated immunoregulatory influence of laser light on the inflammatory process. Low fluence Q-switched Nd:YAG laser light proved to be efficacious and safe for fast clearance of hyperpigmentation caused by PPD inflammation.

**Key words:** phytophotodermatitis, Q-switched Nd:YAG 1064 nm laser, hyperpigmentation

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## I. INTRODUCTION

Contact with plant-derived phototoxic substances (like certain furanocoumarins) followed by sunlight

exposure, produces cutaneous inflammation. These plants can be irritants (e.g. cactus spine injuries), urticarial, contact allergic (from plants such as *Primula abconica*) or phytophototoxic in nature [1].

Phytophotodermatitis is generally a toxic reaction due to direct skin exposure to certain plants or plant parts, followed by exposure to ultraviolet light. These phototoxic substances are found in various vegetable families (Umbelliferae, Moracea, Rutaceae and Leguminous) [1, 2]. Exposure occurs most commonly in the spring and summer when the furanocoumarins are at their highest concentration in plants, during fruit and vegetable picking and processing, but exposure can happen also during hiking, jogging, or by the use of plant-derived medicines and cosmetics [1-6]. Sometimes this dermatosis can be confused with more common forms of occupationally related dermatosis or type IV allergic dermatitis.

## II. MATERIALS AND METHODS

Two middle-age female patients were working in their home garden with celery, carrots, parsley and cleaning up the garden after storm damage. The work took place in a mountain village around noon, on a dry, very clear summer day, with 40% relative humidity, a temperature of 28 degrees Celsius, and the patients had about 2 hours of sun exposure time with a UV index of 6. Both women were Fitzpatrick skin type II and dressed in short-sleeved shirts.

Six hours later, the first patient noted burning sensations on the inner part of her left arm and the second patient in both hands interdigitally. Over the next 12 hours, the skin on these areas became erythematous, slightly swollen, and was sore to touch. Three days (72 hours) later hyperpigmentation appeared in a large area of the inner portion of the left arm in the first patient and as punctiform hyperpigmentation interdigitally in both hands in the second patient. On the fourth day (about 96 hours) after contact with the plants, the patients visited the dermatology clinic. Neither of the patients had a history of previous dermatological diseases or were taking any medication on a regular basis.

The laser system used in this study was a Q-switched Nd:YAG laser (QX MAX, Fotona, Slovenia) with a wavelength of 1064 nm and pulse duration of 5 ns. In this study we predominantly employed 2.5 to 3.0 J/cm<sup>2</sup> at 4 mm spot size with a pulse repetition of 10 Hz. The lasing pattern was spot by spot in a continuous row, allowing 30% overlapping between spots. The entire hyperpigmented area was treated homogeneously and three-to-five passes of laser irradiation were applied. During lasing we used the chilled air cooling technique to minimize patient discomfort.

Immediately after treatment, application of a cold gel compress for a few minutes aided in minimizing postoperative discomfort. At the end of the treatment, a moisturizing cream with UV sun block was applied to each area. The patients were instructed to avoid excessive exposure to direct sunlight for a few months. Immediately after laser irradiation, the treated area became reddish and slightly elevated a few minutes later. Patients reported a mild stinging sensation. Three days after the procedure, the whole treated area appeared homogeneously pink with smooth texture. Complete re-coloration took seven days and this temporary contrast was hardly noticeable.

### III. RESULTS

Both patients responded very quickly to the Q-switched Nd:YAG laser treatment without the need for any other local or systemic therapy. The symptoms gradually resolved seven days after laser treatment (Figures 1-4). Two independent observers evaluated the clearance of hyperpigmentation in both cases. The average clearance rate was 95% in case 1 and 100% in case 2.



Fig 1: Case 1: 96 hours after contact with celery and parsley.



Fig. 2: Case 1: 7 days after the Q-switched laser treatment.



Figure 3. Case 2: 96 hours after contact with celery and parsley.



Figure 4. Case 2: 7 days after Q-switched laser.

Both patients tolerated the treatment very well; the discomfort, erythema and edema were of mild and transient nature.

### IV. DISCUSSION

Celery (*Apium graveolens*), belongs to the Umbelliferae (*Apiaceae*) family, which includes angelica, carrot, coriander, dill, fennel, parsnip and parsley. Celery contains furanocoumarins, including psoralens, xanthotoxin, bergapten and 5-methoxypsoralen, which are chemicals that react to sunlight. If celery comes into contact with the skin, it can make the skin very sensitive to sunlight. Celery is prone to infection with pink rot, which significantly increases the available amount of photo-sensitizing chemicals.

In these two cases, the history and clinical appearances were pathognomonic of phytophotodermatitis. It is usually a phototoxic reaction as opposed to a photoallergic reaction. Acute dermatitis results from the interaction of plant

compounds, most often psoralens, with ultraviolet light (principally long wave UVA 320-400 nm) on human skin.

Phytophotodermatitis usually begins 24 hours after exposure, with peaks at 48 to 72 hours. These reactions may be amplified by high humidity and perspiration. Burning erythema, sometimes subsequent blistering and post inflammatory hyperpigmentation (PIH) may last weeks to months. The most common cause of hyperpigmentation on sunlight-exposed skin is likely a postinflammatory response to UV damage to the skin [7, 8]. Production of epidermal melanin can be enhanced by external factors such as UV irradiation and inflammation.

PIH response may be the result of an obvious acute inflammatory event with suberythematous exposures to UV. Inflammation may result with hyperpigmentation through several mechanisms. Among them is direct stimulation of melanocytes by inflammatory mediators such as IL-1- $\alpha$ , endothelin-1, and stem cell factor [9].

Reactive oxygen species (ROS), such as superoxide and nitric oxide, generated in damaged skin or released by inflammatory cells, are also known stimulators of melanocytes. Damage induced to epidermal cells can lead to the release of endocrine inducers of pigmentation, such as melanocyte-stimulating hormone (MSH). The resulting hyperpigmentation induced by all these effects provides some measure of protection against subsequent insult, as melanin has both UV absorption and ROS scavenging capacity. The melanin produced during inflammation can enter the dermis where it is engulfed by macrophages, forming melanophages. These cells are often retained in the upper dermis for prolonged periods [10].

Phototoxic reactions cause increased sensitivity to the sun and resemble exaggerated sunburns characterized by erythema and occasional blistering. Acute symptoms of phytophotodermatitis include skin eruption with edema and erythema, whereas the main chronic symptom is hyperpigmentation at the contact site. This non-immunologic reaction occurs in all individuals if the threshold dosage is reached. In phytophotodermatitis, the reaction is typically confined to the initial site of contact (in the absence of itching) and to residual hyperpigmentation. This type of reaction differs from an allergic contact dermatitis, which requires exposure to ultraviolet light and does not require a period of sensitization. In addition, an allergic dermatitis is usually pruritic.

Laser therapy for PIH is based on laser light targeting the melanin as the chromophore. The most commonly used lasers for PIH are Q-switched lasers working with nanosecond pulses and having wavelengths of: 532 nm (KTP), 694 nm (ruby), 755 nm (alexandrite), and 1064 nm (Nd:YAG).

The Q-switched Nd:YAG laser has been widely used in cosmetic laser dermatology. This laser system employs the principle of selective photothermolysis. The Q-switched laser's selective wavelength and ability to produce a nonspecific dermal wound may induce selective destruction of melanin and new collagen formation [11].

After Q-switched laser treatment, melanocytes have fewer dendrites in the epidermis. The ultrastructural changes in the melanosome show selective photothermolysis on stage IV melanosomes [12].

However, in this case report of phytophotodermatitis, the symptoms resolved 7 days after one laser treatment, in contrast to the literature's data of conventional therapeutic approaches with a reported resolution time over weeks and months [13].

It is well known that Nd:YAG Q-switched lasers stimulate the wound healing process, so that with low fluence Q-switched Nd:YAG we can achieve photoacoustic clearing of melanocyte content in the inflammatory infiltrate [14, 15]. In this case, we achieved fast healing and a resolution of PIH ten days after the initiation of phytophotodermatitis.

## V. CONCLUSIONS

Q-switched Nd:YAG studies such as this highlight the largely underappreciated immunoregulatory influence of laser light on the inflammatory response. Photoacoustic destruction of melanin particles with a low-fluence Q-switched Nd:YAG laser quickly cleared the patients' pigmentation and inflammation with minimal discomfort, thus proving to be an excellent new treatment possibility for phytophotodermatitis.

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