Laser-Induced Urticaria: A Case Report and Review of Physical Urticaria

Natalie Edgar, DO,* Molly Buckland, DO,** Richard A. Miller, DO***

*Dermatology Resident, Nova Southeastern University College of Osteopathic Medicine/Largo Medical Center, Largo, FL
**Traditional Rotating Intern, Nova Southeastern University College of Osteopathic Medicine/Largo Medical Center, Largo, FL
***Program Director, Dermatology Residency, Nova Southeastern University College of Osteopathic Medicine/Largo Medical Center, Largo, FL

Disclosures: None
Correspondence: Molly Buckland, DO; mbuckland@osteowson.edu

Abstract
Mild urtication following laser hair removal treatment is a normal finding, but severe urticarial reactions are rare. Laser-induced urticaria is caused by an external stimulus and is reproducible with subsequent exposures, suggesting that it is a type of physical urticaria. Herein, we highlight a case of a 46-year-old female who developed a severe urticarial reaction following laser hair removal treatment. We also explore potential causes and offer a review of physical urticaria subtypes.

Introduction
Chronic urticaria is a debilitating disease that greatly impacts a patient’s quality of life. Often, disease etiologies and triggers can be almost impossible to determine. In physical urticarias, which are clinical subtypes of chronic urticaria, an external stimulus induces a wheal-and-flare reaction and/or angioedema.1 Responsible for up to 25% of chronic urticaria cases, physical urticarias are divided into distinct subtypes that are categorized based on whether the stimulus is mechanical, thermal, or electromagnetic.1 Exactly how these stimuli trigger urticarial lesions is unclear, but it is postulated that it may result from a heightened sensitivity of mast cells.1,2

While it is not uncommon for urticarial papules to develop around each treated follicle after laser hair removal, it is usually transient and not clinically significant.3 Here, we report a case of severe urticaria that developed in a patient following laser hair removal treatment and explore possible etiologies for the occurrence.

Case Report
A 46-year-old female was treated in the office with a newly acquired diode 810-nm laser (large sapphire optic Vectus® hair removal laser, Cynosure). The patient requested treatment of her legs bilaterally to remove unwanted hair, a procedure she had undergone in the past without complications. She had Fitzpatrick skin type II. Based on her skin type and hair characteristics, laser settings of 38 J/cm² with a pulse duration of 10 ms and a spot size of 23 mm x 38 mm were utilized for her treatment. Throughout the procedure, an overlap of 50% was performed, and Lux Lotion® was utilized as a skin protectant. Upon treatment completion, the patient began to complain of pruritus and redness of the treated areas. The pruritus worsened over time, and she began to develop a diffuse and significant wheal-and-flare reaction. She denied oral and pharyngeal swelling as well as shortness of breath. The urticaria improved 24 hours after the procedure, and by 72 hours post procedure the lesions had subsided.

Approximately six weeks following her initial treatment, the patient requested a second laser hair removal treatment of the lower extremities. The patient believed that her previous reaction was likely secondary to the Lux Lotion® skin protectant used during the initial treatment, as she reported a history of sensitivity to an unknown substance in some topical products, including cosmetics. The patient was treated for a second time with the hair removal laser on the bilateral lower extremities using the same laser settings but without the topical skin protectant. Following this treatment, the patient had a similar reaction that included initial follicular urticarial papules that worsened over hours into diffuse urticaria of the lower extremities (Figures 1-3). Oral diphenhydramine 50 mg every six hours helped to alleviate some of the associated pruritus. Again, the urticarial eruption lasted for about 72 hours. Our patient decided to undergo a third laser hair removal treatment several weeks later, which resulted in an identical outcome.

These recurrent and reproducible reactions prompted the consideration of laser-induced urticaria or another underlying physical urticaria in this patient. The patient denied having a history of regular urticaria but did report one urticarial event four years prior, which was attributed to a shampoo sensitivity that resulted in swelling and pruritus of her scalp and eyelids.

On exam, the patient did not exhibit dermatographism. She also specifically denied any history of an urticarial or other pruritic eruption following exposure to cold, heat, sunlight, pressure, emotional stress, exercise, spicy foods, or previous laser treatments. She denied history of any ongoing medical problems and denied taking any medications.

Discussion
Laser hair removal has become a popular and effective cosmetic procedure for the long-term reduction of terminal body hair. Long-pulse lasers emitting visible and infrared radiation target specific chromophores, such as melanin pigment, contained in the hair shafts, resulting in thermal damage to the hair follicle.3 The resultant inflammatory response triggers anagen follicles to shed terminal hair, which is then replaced by vellus hair.3 Lasers often used for hair removal include those employing the red or infrared wavelengths, such as the 755-nm alexandrite laser, the 810-nm diode laser, and the 1,064 neodymium-doped yttrium aluminum garnet (Nd:YAG) laser.3 Epidermal surface cooling is utilized to protect the epidermis from heat injury if epidermal melanin is inadvertently targeted during laser treatment. The most common adverse effect of laser hair removal treatment is skin hyperpigmentation or hypopigmentation.3 Additionally, transient, small, follicular urticarial papules commonly result immediately following most laser procedures; however, significant urticaria or edema following laser hair removal is rare.4 The normal urticarial response is usually confined to the immediate area surrounding the hair shaft but may be accompanied by a subtle urticarial response in the

Figure 1. Wheat-and-flare reaction of the left lower leg 24 hours following laser hair removal treatment.

Figure 2. Urticarial eruption of the right lower leg 24 hours following laser hair removal treatment.

Figure 3. Edematous papules and plaques with surrounding erythema on the lower extremity 24 hours following laser hair removal treatment.
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Laser-induced urticaria is likely to be a physical urticaria due to its inducible and often reproducible nature; however, in some cases, it can be difficult to categorize into an existing subtype of physical urticaria. The following discussion will explore potential causes of our patient's urticaria, including a review of physical urticaria subtypes that might have played a role in our case. These physical urticarias include cold urticaria, cholinergic urticaria, contact urticaria, dermatographism, pressure urticaria, heat-induced urticaria, and cold-induced urticaria.

Cold-induced urticaria
Cold-induced urticaria is a common type of physical urticaria that usually occurs in young adults and has a slight predominance in females. Cold urticaria accounts for 6% to 34% of physical urticarias. Triggers may include cold air, cold liquid, ingestion of cold foods, or handling of cold objects. Symptoms usually occur within minutes after exposure, but delayed types may take up to 24 hours. The skin reaction is typically localized to the area of contact; however, dangerous systemic reactions may occur after extensive cold exposure. The pathogenesis of cold-induced urticaria is unclear, it has been suggested that IgE antibodies may react to skin antigens at certain temperatures, which then causes the release of inflammatory mediators.

Certain lasers use a cooling mechanism to reduce the heat accumulation in the epidermis, which reduces damage to the surrounding skin and aids in patient comfort. Commonly used cooling methods are gel cooling, cryogen cooling, forced air cooling, and contact cooling. Cryogen cooling spray may result in transient erythema and mild urticaria; one study showed transient urticaria one hour to 24 hours after exposure to cryogen cooling spray in three of 27 subjects. The patient in our case had treatments with both the LightSheer® diode 805-nm laser and the Vectus® diode 810-nm laser, both of which utilize contact cooling methods. Our patient’s wheel-and-flare reaction occurred only after each treatment (total of three) with the Vectus laser. Landa et al. described urticaria after treatment with 755-nm alexandrite lasers; however, the persistent urticaria could not be reproduced with the cryogen spray alone. A direct link between the cooling mechanism and persistent urticaria has not been shown. As in our case, none of the reports involved patients with a history of cold-induced urticaria, making cold-induced urticaria an unlikely cause.

Heat-induced urticaria
Heat contact urticaria is a rare type of physical urticaria; however, the persistence of urticaria was reported in fewer than 100 cases reported in the literature. Symptoms usually develop within minutes of heat exposure to the skin and typically resolve within a few hours. The skin lesions are limited to the area exposed and are generally well defined. The diagnosis is confirmed by local heat (45°C) applied for five minutes. It is unlikely that heat-induced urticaria is the cause of the reaction in our case, as the patient had never experienced urticaria upon skin contact with hot objects in the past. The timeline of our patient’s wheel-and-flare reaction also does not fit with the classic symptoms of heat-induced urticaria, which usually resolve within a few hours.

Delayed pressure urticaria
This subtype of physical urticaria is defined by the development of angioedema due to prolonged pressure to the skin. This reaction is delayed in onset and usually occurs six hours to eight hours after the original stimulus, but can occur in as little as 30 minutes. Lesions may persist for up to 72 hours. Unlike the other physical urticarias, delayed pressure urticaria may be associated with burning pain and even systemic symptoms, making it a potentially debilitating disease. There are reports of some patients developing upper airway and gastrointestinal swelling following endotracheal intubation or esophagogastroduodenoscopy. The diagnosis of delayed pressure urticaria is made by provocation testing, by which pressure is applied to the skin for 15 minutes. The test is positive if delayed-onset palpable swelling occurs. It is important to differentiate this from symptomatic dermographism, which would have an immediate wheal-and-flare response.

The patient in this case did not present with pain or any other symptoms outside of pruritus. Her symptoms occurred almost immediately following treatment, and it is unlikely that the laser head was applied to any one location long enough to cause delayed pressure urticaria.

Dermographism
Also known as urticaria factitia (UF), dermatographism is the most common subtype of physical urticaria. It is often associated with skin conditions like atopic dermatitis and idiopathic urticaria and may also coexist with other physical urticarias. The condition is characterized by the development of a wheal-and-flare reaction that occurs within seconds to minutes after shearing forces are applied to the skin, such as those associated with mild rubbing, stroking, or scratching. Dermographism is divided into two variants: simple and symptomatic. Simple dermatographism is more common and is characterized by non-pruritic urticarial welts that usually fade within 15 minutes to 30 minutes. Symptomatic dermatographism causes pruritic welts that can last for 30 minutes to 2 hours. The diagnosis of dermatographism is made by provocation testing, by using either a dermographometer or a blunt-tipped object to stimulate the skin. The underlying causes of dermatographism have not been elucidated fully. It has been postulated that some medications (e.g., progesterone, atorvastatin), various infections (e.g., respiratory, dental, hepatitis), or diabetes mellitus might play a role in its pathogenesis.

During laser hair removal treatment using the Vectus diode 810-nm laser, the laser head must be placed firmly on the skin. There is a possibility that the application of the device directly onto the skin caused a dermographism-like reaction in the patient presented in this case. She did experience pruritus along with a wheel-and-flare reaction. However, her lesions lasted much longer than one would expect from symptomatic dermographism. Additionally, our patient did not exhibit dermographism with provocation testing.

Contact urticaria
Urticarial reactions may occur with certain skin exposures. The pathogenesis behind this reaction can be allergic or non-immunologic. Allergic contact urticaria involves an IgE-mediated release of vasoactive compounds after a specific exposure. Alternatively, non-immunologic contact urticaria is not antibody mediated and occurs due to a direct release of vasoactive substances. Often, cosmetic products cause contact urticaria. In this patient, the urticaria following laser hair removal was initially thought to be secondary to the Lux Lotion used during the first session. Lux Lotion contains propylene glycol, water, fructose, liquid glucose (corn syrup), sucrose, and L-glutamic acid. Propylene glycol has been implicated as a common contact allergen, especially in cosmetic products, but the urticaria patients are unlikely to cause a reaction. Despite our patient's history of a single episode of contact urticaria, the diagnosis is not favored because the patient had only one treatment using Lux Lotion® and two subsequent treatments without a skin protecting lotion, and she had similar reactions after all treatments.

Cholinergic urticaria
Cholinergic urticaria comprises about 30% of the physical urticarias and has a higher prevalence in young patients. This type of urticaria can be induced by exercise, passive warming, emotional stress, and hot or spicy food. The typical wheel-and-flare reaction lasts for 15 minutes to 60 minutes and is frequently localized to the trunk. The wheals are usually pruritic, numerous, and start very small but may coalesce.

Cholinergic urticaria often coexists with other physical urticarias, most commonly cold urticaria and dermatographism. In a retrospective study of 92 male patients with cholinergic urticaria, 3.3% had comorbid cold urticaria, and 6.5% had comorbid dermatographism. These patients also had an elevated prevalence of allergic rhinitis and atopic dermatitis. In another study of 220 patients with cold urticaria, 8% had cholinergic urticaria. The diagnosis of cholinergic urticaria is confirmed by provocation testing. It is also important to rule out exercise-induced anaphylaxis, a much more dangerous condition. A diagnosis of cholinergic urticaria due to passive warming of the skin is possible in our patient; however, lack of prior cholinergic urticaria and a symptom duration of more than one hour make it less likely.
**Solar urticaria**

Solar urticaria, another rare subtype of physical urticaria, occurs after exposure to ultraviolet (UV) and/or visible light. Symptoms occur within five minutes to 15 minutes following exposure and usually resolve within 24 hours. Within the UV spectrum, UVA is the most common trigger, followed by visible light and UVB. Solar urticaria is predominant in females, occurs equally in all ethnic groups and skin types, and has a peak age of onset of 20 years to 40 years. Solar urticaria may have a spontaneous onset and may subside after months or years. One study of 87 patients showed complete spontaneous onset and may subside after months or years. A few cases of delayed-onset solar urticaria have been described, with symptom onset after more than one hour and resolution after 24 hours. The pathogenesis is unknown, but it is thought to be IgE-mediated and chromophore-dependent. It is important to distinguish solar urticaria from more common photodermatoses, such as polymorphic light eruption and porphyrias.

Urticaria triggered only by specific light wavelengths has been described. In these cases, solar UV light exposure may not induce a reaction, but phototherapy devices may. Montaudié et al. reported a case of solar urticaria on the face induced by 415-nm LED treatment for rosacea in a patient with no history of urticaria following sun exposure.

We suspect that solar urticaria is the subtype of physical urticaria involved in our case, though we can’t definitively exclude all other subtypes. Our patient denied prior instances of solar urticaria or urtication following previous laser treatments, but it is possible our patient has a specific sensitivity to the 810-nm wavelength involved in this case. A provocation test using 810-nm light in a controlled setting could be performed to confirm this hypothesis.

**References**