

Nd:YAG and Broadband Light® (BBL®) Therapy for Removal of Port Wine Stains in Adults

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INTRODUCTION

Port wine stains (PWS), also known as capillary malformations, are benign cutaneous vascular lesions that usually present around the head and neck. The majority of PWS are congenital and have a prevalence of 0.3% in the general population (1). PWS begin as lightly colored superficial lesions at birth but then progress with age, darkening in color and becoming hypertrophic or nodular. If left untreated, hypertrophic PWS can lead to disfigurement and have a negative impact on psychological well-being (2). When grossly enlarged, PWS can also increase the risk for spontaneous bleeding and cause vision impairment or respiratory dysfunction if located close to the orbital, nasal, or oral cavities (3).

Non-invasive treatment with pulsed dye laser (PDL, 585 or 595 nm) has been a gold standard for over 30 years (4, 5). However, despite being the most widely used modality for treating PWS, less than 50% of all patients treated with PDL achieve a high level ($\geq 75\%$) of clearance (4). Resistance to PDL treatment depends on the vascular structure of PWS. The morphology of PWS is highly heterogeneous with a wide range of vessel diameters (6, 7) and depths reaching into the reticular dermis (8). Deep vessels are difficult to treat with PDL. Histological analysis of PWS following treatment with PDL showed that destruction of blood vessels was limited to depths of 0.65 mm below the surface of the skin (7, 9).

An Nd:YAG (1064 nm) laser, which can penetrate further into the skin than PDL, has been proven safe and effective for clearing PWS with deep vessels (10, 11). Biopsies taken from a small sample of PWS treated with Nd:YAG showed vessel destruction at depths of 2.7 mm into the skin on average (12). However, Nd:YAG is not as effective as PDL at clearing superficial vessels (13). Combining these modalities has been considered for improving PWS clearance but, surprisingly, treatment with PDL followed by Nd:YAG did not significantly improve outcomes compared to PDL alone (14). Bleeding from superficial vessels after PDL might shield the deeper vessels and prevent Nd:YAG from penetrating sufficiently (15, 16). Therefore, responsiveness of deep hypertrophic PWS to combination therapy might be improved by treating the deep vessels with Nd:YAG first.

Due to the extreme variability in vessel diameter and depth in PWS, better treatment response may also be achieved by combining Nd:YAG with modalities that deliver a broader spectrum of light, with greater variation in pulse duration and fluence, than PDL. Such modalities include intense pulsed light (IPL) or Broadband Light® (BBL®), which can target a wide range of vessel diameters at varying depths below the skin surface (17). In this report, we present 4 cases of PWS of varying depths that were successfully treated with either a combination of Nd:YAG (ClearV®) and BBL or BBL alone. The objective is to describe optimal treatment parameters for each modality and how they may be adjusted to different skin types.

PRE-TREATMENT ASSESSMENT AND PREPARATION

PWS are first evaluated by appearance in order to determine appropriate treatment parameters. By looking at shape and color, we can identify the presence of components containing superficial and deep vessels. Superficial components are typically located on the outer edges of the PWS, are flat, and are light to dark red or light purple in color. Deep components, on the other hand, are usually centrally located, are nodular, and have dark purple or blue coloration. The depth of deep components is classified as either moderately deep and very deep. Moderately deep components are not nodular but very dark in color while very deep components are very dark and nodular.

Patients are asked to lie in a supine or prone position, depending on where the PWS is located. Pain is managed with external cooling. At the start of each treatment, a Zimmer Cryo is applied to the treatment area until it reaches a temperature between 10 and 15 °C.

TREATMENT PROCEDURES – FIRST SESSION

The modalities used in the first treatment session will depend on the complexity of the PWS. For deep hypertrophic lesions with high vascular complexity, a combination of ClearV followed

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by BBL is applied. For flat, superficial lesions with less vascular heterogeneity, treatment with BBL alone is sufficient.

CLEARV FOR DEEP COMPONENTS – FIRST SESSION

In cases where deep components are identified, begin the procedure by treating these areas with ClearV. Depending on depth classification, start by using the following treatment parameters:

Depth Class	Spot Size	Pulse Duration	Fluence
Moderately Deep	3 to 4 mm	15 to 20 ms	80 to 95 J/cm ²
Very Deep	5 to 6 mm	25 to 60 ms	60 to 85 J/cm ²

The exact settings will depend on how deep the area is based on the initial assessment. Areas of greater depth require a larger spot size, longer pulse duration, and lower fluence because the hemoglobin content increases with thickness of the lesion, meaning the wavelength is more easily absorbed and less energy is required to coagulate the vessels.

While ClearV has a very good built-in cooling system, it is still necessary to use an external cooling device, such as a Zimmer, before and after each pass. The additional cooling will further reduce the skin temperature and optimize the total amount of heat we can apply without burning the skin. Ideally, skin temperature must be between 10 and 15 °C at the start of each pass.

Treatment end points are reached when there is a darkening of the treatment area and, for very deep components, a contraction of the nodules. Contraction of flat areas is not desired since it can indicate a dermal burn and potential scarring. White or light grey areas are also an indication of overheating. If there is any evidence of overheating during a pass, the treatment needs to be adjusted to less aggressive settings by increasing pulse duration, reducing fluence, and applying more cooling.

Treatment end points are usually achieved after one pass. If there is no change in color over the treatment area after the first pass, a second or third pass with more aggressive settings can be performed by an experienced provider. If proceeding with an additional pass, treatment intensity can be increased by reducing pulse duration. Pulse duration can be shortened by 1 or 2 ms increments over flat areas or 5 ms increments over nodular areas, down to a minimum of 10 ms for all deep components. Greater treatment intensities can then be achieved by increasing fluence in increments of 5 J/cm², up to a maximum of 95 J/cm² for moderately deep components or 85 J/cm² for very deep components.

BBL FOR SUPERFICIAL COMPONENTS – FIRST SESSION

After reaching treatment end points with ClearV, superficial components can then be treated with BBL in patients with Fitzpatrick Types I to IV skin. Depending on skin type, we begin with the following settings:

Skin Type	Filter	Pulse Duration	Fluence
Fitzpatrick I - III	515 nm	10 ms	18 to 20 J/cm ²
Fitzpatrick III - IV	560 nm	10 ms	18 to 20 J/cm ²

Begin by doing a test pass to see if the above settings are sufficient to induce a threshold effect (color change). If not, then fluence can be further increased in increments of 1 J/cm² until a threshold effect is achieved within the following limits:

Skin Type	Fluence
Fitzpatrick I - II	21 to 26 J/cm ²
Fitzpatrick III - IV	21 to 23 J/cm ²

Once a threshold effect is achieved, complete two passes over the treatment area, running the second one at 90° to the first to avoid foot printing. Before and after each pass, apply external cooling until the skin temperature is between 10 and 15 °C to avoid burning the skin.

TREATMENT PROCEDURES – SUBSEQUENT SESSIONS

More than one treatment session is usually required in order to achieve maximum clearance of PWS. A clinical re-evaluation of the PWS must be done at the start of each subsequent session so that treatment settings can be adjusted for optimal clearance as the PWS changes in appearance and color. Maximum clearance of the PWS is usually achieved after a total of 5 or 6 treatment sessions spaced four to eight weeks apart.

CLEARV FOR DEEP COMPONENTS – SUBSEQUENT SESSIONS

Deep components are usually cleared after the first treatment session. However, small nodules sometimes remain and ClearV may need to be applied again in the second session. Since depth of the lesion is usually reduced after the first session, a more aggressive treatment will be required in the second session. Depending on how deep the remaining nodules appear on re-examination, the intensity of the treatment can be increased by a combination of reducing spot size, shortening pulse duration, and increasing fluence within the following limits:

Depth	Spot Size	Pulse Duration	Fluence
Moderately Deep	3 to 4 mm	10 to 20 ms	80 to 95 J/cm ²
Very Deep	5 to 6 mm	10 to 60 ms	60 to 85 J/cm ²

BBL FOR SUPERFICIAL COMPONENTS – SUBSEQUENT SESSIONS

Superficial components usually require a greater number of treatment sessions than deep components. As superficial components get lighter in color, more aggressive BBL treatments are required to achieve clearance. BBL settings used in subsequent treatment sessions are as follows:

Skin Type	Filter	Pulse Duration	Fluence
Fitzpatrick I - II	515 nm	8 to 10 ms	18 to 26 J/cm ²
Fitzpatrick III	515 nm	10 to 15 ms	18 to 26 J/cm ²
Fitzpatrick IV Low	515 nm	10 to 15 ms	18 to 26 J/cm ²
Fitzpatrick IV High	560 nm	10 to 15 ms	18 to 26 J/cm ²

If the patient was initially treated with a 560 nm filter and is Fitzpatrick Type III or low Type IV, begin by switching to a 515 nm filter on the second session. If a threshold effect is not achieved, then fluence can be increased in increments of 1 J/cm². In later sessions, when PWS color turns to light red or pink, an increase in fluence to maximum values and reduction in pulse duration to a minimum value may be required.

RESULTS

Here we present five different cases where PWS of varying complexity were removed with ClearV and BBL. Each patient was a unique case requiring a specific set of treatment parameters.

CASE #1

A 64 year old female, Fitzpatrick Type III who presented to our clinic with hypertrophic facial PWS located over the entire jaw area on the right side. This patient underwent two treatment sessions with ClearV followed by BBL spaced 8 weeks apart. In each session, the patient received one pass of ClearV and two passes of BBL. Treatment settings for each modality were as follows:

Session	ClearV			BBL		
	Spot Size	Pulse Duration	Fluence	Filter	Pulse Duration	Fluence
1	6 mm	20 ms	75 J/cm ²	515 nm	10 ms	22 J/cm ²
2	6 mm	20 ms	80 to 85 J/cm ²	515 nm	10 ms	22 J/cm ²

At the start of each session and between passes, the skin was cooled to 10 °C. In the first session, only the periauricular area was treated. In the second session, both the periauricular and cheek areas were treated. Before and after images are shown in Figure 1. A high level of clearance (≥ 80%) in both the periauricular and cheek areas was achieved after each treatment session.

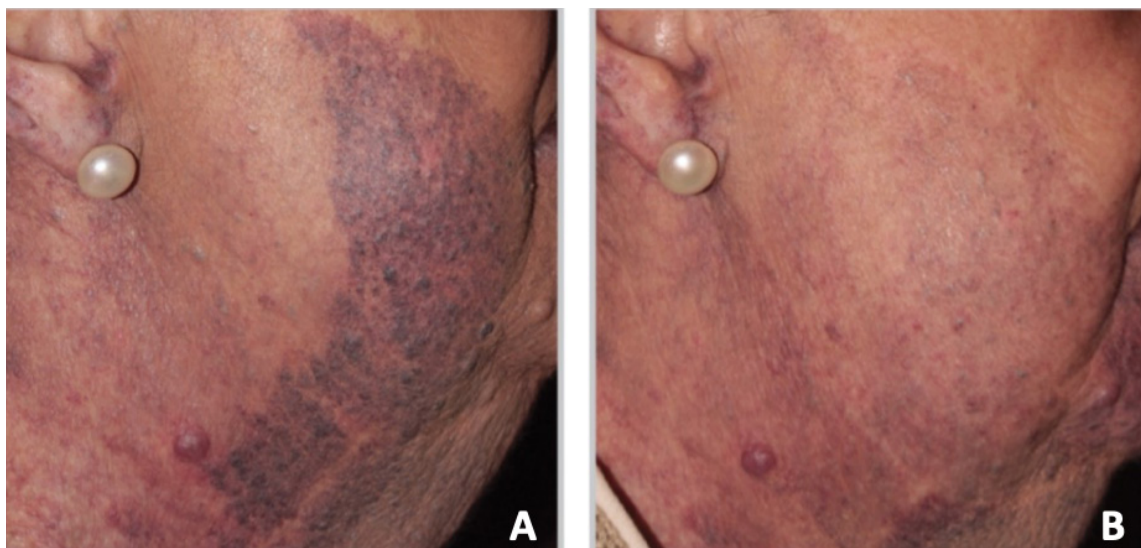


Figure 1: Periauricular area 1 month after the first treatment session and before first treatment of cheek area (A) and preauricular area after 2 treatments and cheek area after 1 treatment (B).

CASE #2

A 48 year old male, Fitzpatrick Type III who presented to our clinic with hypertrophic facial PWS spanning over the temple, cheek and nose on the right side. This patient underwent four treatment sessions spaced 4-8 weeks apart. In each of the first two sessions, the patient received one pass with ClearV followed by two passes with BBL. In each of the last two sessions, the patient received only two passes of BBL. A 15x15 mm finesse adapter was used with BBL in all treatment sessions. Treatment settings for each modality were as follows:

Session	ClearV			BBL		
	Spot Size	Pulse Duration	Fluence	Filter	Pulse Duration	Fluence
1	4 mm	15 ms	70 J/cm ²	560 nm	10 ms	20 J/cm ²
2	4 mm	10 ms	85 J/cm ²	515 nm	10 ms	22 J/cm ²
3	--	--	--	515 nm	10 ms	24 J/cm ²
4	--	--	--	515 nm	10 ms	26 J/cm ²

At the start of each session and between passes, the skin was cooled to 10 °C. In the first session, the deepest components (purple to dark red areas) were treated. In the second session, all remaining deep components (dark red areas) were treated. Superficial components were then treated in the third and fourth sessions. Appearance of the PWS before and one year after treatment is shown in Figure 2. A high level of clearance ($\geq 80\%$) is shown over the entire area.

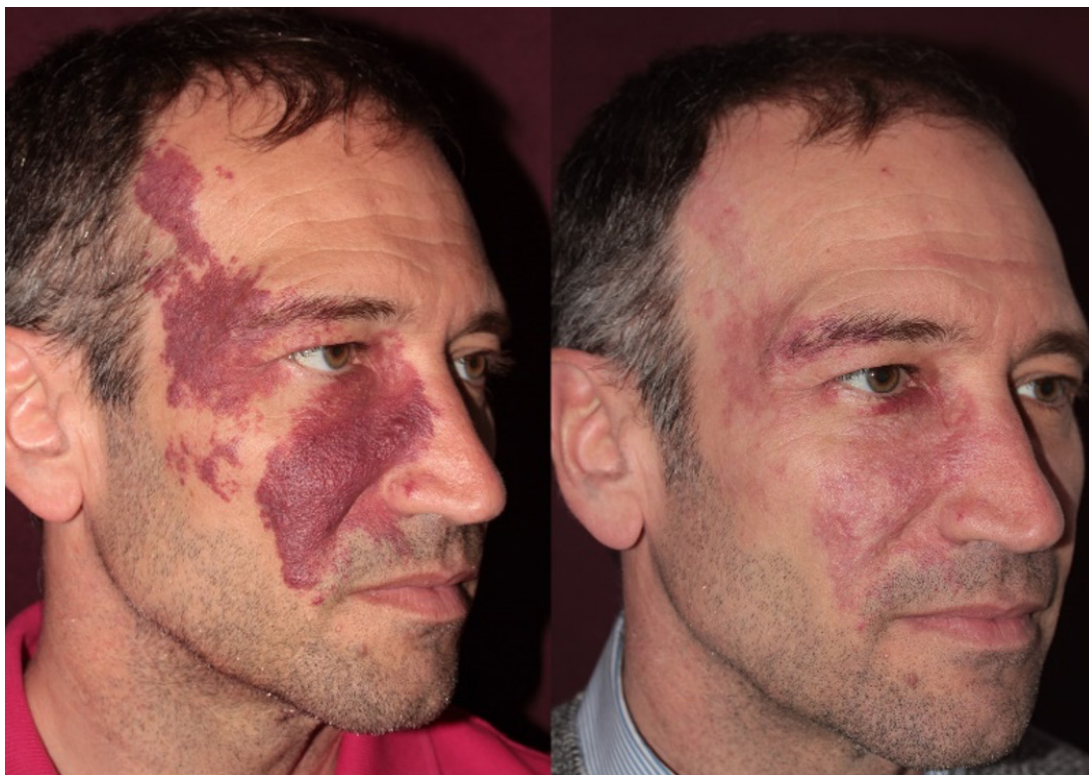


Figure 2: Facial hypertrophic PWS before the first treatment session (A) and 12 months after the final treatment session (B).

CASE #3

A 45 years old male, Fitzpatrick Type II who presented to our clinic with superficial PWS over the jaw and neck on the right side. This patient underwent three treatment sessions spaced 4-8 weeks apart. In each session, the patient received two passes of BBL. Treatment settings were as follows:

Session	BBL		
	Filter	Pulse Duration	Fluence
1	560 nm	10 ms	20 J/cm ²
2	515 nm	10 ms	20 J/cm ²
3	515 nm	10 ms	20 J/cm ²

At the start of each session and between passes, the skin was cooled to 10 °C. The entire area was treated in all three sessions. Appearance of the PWS before and after treatment is shown in Figure 3. A high level of clearance (≥ 80%) is shown over the entire area.



Figure 3: Superficial PWS of the jaw and neck before the first treatment session (A) and 24 months after the final treatment session (B).

CASE #4

A 47 years old female, Fitzpatrick Type II who presented to our clinic with superficial PWS on her trunk. This patient underwent three treatment sessions spaced 4-8 weeks apart. In each session, the patient received two passes of BBL. Treatment settings were as follows:

Session	BBL		
	Filter	Pulse Duration	Fluence
1	560 nm	10 ms	20 J/cm ²
2	515 nm	10 ms	20 J/cm ²
3	515 nm	10 ms	20 J/cm ²

At the start of each session and between passes, the skin was cooled to 10 °C. The entire area was treated in all three sessions. Appearance of the PWS before and after treatment is shown in Figure 3. A high level of clearance (≥ 80%) is shown over the entire area.



Figure 4: Superficial PWS of the trunk before the first treatment session (A) and 24 months after the final treatment session (B).

DISCUSSION

In this report, we presented cases where ClearV and BBL were used to successfully treat PWS. In all cases, clearance of PWS was excellent, greater than 80%. Depending on the structure of the PWS, maximum clearance can be achieved after just two treatments, but the number of treatments can range from two to six. ClearV and BBL are both designed with state-of-the-art built-in cooling, which is ideal for most vein and redness treatments. However, due to the complex structure and variable depth of PWS, it is strongly recommended that external cooling with a Zimmer Cryo be used after every pass. This will bring the tissue temperature down enough to permit optimal treatment while preventing overheating.

It is worth mentioning that not all patients will be good candidates for this treatment. Risk factors for poor response need to be considered prior to treatment. These risk factors include dark skin types (Fitzpatrick IV to VI) and PWS located on distal limbs, hands, or the upper lip. If a patient is insistent on treatment against the physician's recommendations, treatment efficacy can be determined safely after just one session, provided the above protocols are followed.

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Printed in USA

2600-003-38 Rev. A