Efficacy of Low Fluence Q-Switched Nd:YAG Quickly Pulse to Pulse Mode (Q-PTP) 1064nm on Melasma: A Case Report

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Abstract

Melasma is a chronic acquired hypermelanosis of the skin that primarily affects women in Fitzpatrick skin types III-IV. The low-fluence Q-switched Nd:YAG laser has recently become quite popular for treating melasma This case report focuses on the treatment of melasma using low fluence Q-switched Nd:YAG Quickly pulse to pulse mode (Q-PTP) laser on a 43-year-old Fitzpatrick type III Chinese lady with a 10 year history of malar melasma. The patient underwent a total of eight laser treatment sessions at intervals of one to three months. The patient expressed satisfaction with the outcome, as the hyperpigmentation over both cheeks had noticeably diminished after the initial session. Q-switched Nd:YAG Quickly pulse-to-pulse mode (Q-PTP) laser at a wavelength of 1064 nm with low fluence reduced risk of exacerbation of melasma by inhibiting melanocyte activity through subcellular selective photothermolysis. The technique reduces the risk of cell death, inflammation, and damage to the basement membrane. Studies have also shown that laser toning can downregulate melanogenesis and melanogenic stimulators, resulting in the diminished function of melanocytes. Q-PTP uses two sub-pulses with brief intervals to create a larger peak power, lead to pressure changes and vibration of melanin, resulting in lesser pain, skin erythema post treatment and better patient acceptance. In conclusion, low fluence Q-switched Nd:YAG laser (PTP mode) has demonstrated efficacy in the treatment of melasma.

Keywords: Melasma, Q-switched Nd:YAG Quickly pulse to pulse mode (Q-PTP) laser, Fitzpatrick type III

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Melasma is a form of symmetrically distributed irregular brown macules on sun-exposed body parts, especially the face. Sun protection and topical lightening therapy are necessary for potential improvement in conjunction with techniques including chemical peels, intense pulsed light (IPL), fractional non-ablative lasers or radiofrequency, pigment lasers (microsecond, picosecond, Q-switched), and microneedling [1].

The Q-switched Nd:YAG laser is the preferred laser for treating mixed epidermal-dermal and dermal pigmented lesions, especially in those with dark skin. Effective targeting of dermal pigment is made possible by the laser's capacity to specifically target melanosomes in melanocytes, keratinocytes, and melanophages, as well as by its ultra-short pulse width (measured in nanoseconds) and configurable spot size.

The wavelength of a laser affects its selectivity and depth of penetration. The longer wavelength of the Q-switched Nd:YAG laser is 1064 nm, while the shorter wavelength is 532 nm. Due to its greater penetration and limited absorption by epidermal melanin, the longer wavelength of 1064 nm is appropriate for melasma. These lasers have a large spot size up to 10 mm, which also allows deep penetration of the laser beam. The mechanism of action of these lasers includes both a photothermal effect and photomechanical/photoacoustic phenomenon that is based on the principle of selective photothermolysis [2].

The low-fluence Q-switched Nd:YAG laser, particularly in Asia, has recently become quite popular for treating melasma. This technique involves multiple sessions at 1064 nm Q-switched Nd:YAG laser treatment with a collimated beam with a large spot size, low fluence (usually 0.8 and 2 J/cm2 depending on the spot size of the laser), and a frequency of 5–10 Hz. The endpoint of the procedure would be faint erythema. It is known to selectively destroy melanin in melanophores, whereas melanin-containing cells are left undamaged, resulting in safe depigmentation of melasma [3].

Quickly-pulse-to-pulse (Q-PTP) is the latest dual pulse mode Q-switched neodymium-doped yttrium aluminum garnet [QS Nd:YAG (QSNY)] laser technology. By producing a greater peak energy and more effective photo-mechanical destruction of melanin particles, Q-PTP enhances effectiveness and minimises negative effects [4].

This case report will be focusing on the treatment of melasma by using the therapeutic efficacy of low fluence Q-switched Nd:YAG Quickly pulse to pulse mode (Q-PTP) laser and their treatment outcome.

Case Presentation

A 43-year-old, Chinese lady, Fitzpatrick type III with no known medical illness, presented to our clinic with pigmentation over bilateral cheeks for 10 years. She claimed that she started noticing her pigmentations after giving birth of her eldest child and gradually worsened over the years. She started to feel insecure and having low self-esteem when her make up can no longer conceals her pigmentations.

She is a married lady and blessed with 2 children, who are 12-years old and 8-year-old respectively. She is an admin clerk and rarely involved in outdoor activities. She is compliant to her basic skin care products, like cleanser, toner, moisturiser. However, she only applied sunblock once daily and uses facial face occasionally. She has not received any depigmentation treatment prior this. There is no family history of similar complains.

On physical examination, there is irregular brown patches with ill-defined borders over bilateral malar region. She was diagnosed with malar melasma.

Management and Treatment

A single physician had treated the patient's complete face with laser therapy after getting

the patient's written informed permission. At treatment intervals ranging from one to three months, a total of eight laser treatment sessions were completed.

The patient had bilateral cheeks hyperpigmentation- melasma. Melasma area severity index (MASI) of 12.3 was graded during initial presentation. She had therapy with a Q-switched Nd:YAG Quickly pulse to pulse mode (Q-PTP) laser at a wavelength of 1064 nm. The fluence ranged from 0.70J/cm2 to 0.85J/cm2, with a spot size of 8mm, and the pulse rate was set at 10Hz (Table 1).

A picture of the patient was taken before and after each treatment session. The examination was carried out utilising standardised digital photography using an iPhone's camera in a predetermined photo corner of the room under same illumination. Throughout the process, the patient was asked if they experienced any pain or discomfort.

After 8 sessions of treatment, the patient was quite pleased with the results, noticing that the confluence of hyperpigmentation over both of her cheeks had been decreased to nearly non-visible compared to the first session. Apart for a minor prickling sensation during the process that was bearable without the need for any local anaesthesia, there were no severe side effects such as post-inflammatory hyperpigmentation (PIH) detected after the treatment.

Table 1: Parameters used in the laser treatment of patient's melasma using Q-switched (PTP) Nd:YAG laser 1064nm.

Session	Date	Mode	Spot Size (mm)	Fluence (J/cm2)	Pulse Rate (Hz)
1	26/5/2022	Q-switched (PTP) Nd:YAG 1064nm	8	0.85	10
2	27/6/2022	Q-switched (PTP) Nd:YAG 1064nm	8	0.85	10
3	25/7/2022	Q-switched (PTP) Nd:YAG 1064nm	8	0.85	10
4	29/8/2022	Q-switched (PTP) Nd:YAG 1064nm	8	0.9	10
5	15/11/2022	Q-switched (PTP) Nd:YAG 1064nm	8	0.8	10
6	13/12/2022	Q-switched (PTP) Nd:YAG 1064nm	8	0.8	10
7	11/1/2023	Q-switched (PTP) Nd:YAG 1064nm	8	0.8	10
8	8/2/2023	Q-switched (PTP) Nd:YAG 1064nm	8	0.75	10

Figure 1: Right face (45 degree), front and left face (45 degree) view photos of patient during the first presentation.

Figure 2: Right face (45 degree), front and left face (45 degree) view photos of patient after five sessions of treatment.

Figure 3: Right face (45 degree), front and left face (45 degree) view photos of patient after eight sessions of treatment.

Discussion

Melasma is an acquired hypermelanotic condition that manifests as irregular, light-to-dark, brown-colored macules on sun-exposed skin, particularly on the face. Though the condition is benign, it can cause significant negative impacts on individuals aesthetically and psychologically. It is classified into three types: epidermal, dermal, and mixed type. While epidermal melasma shows good response to topical treatments such as hydroquinone, tretinoin, glycolic acid, kojic acid, frequency-doubled neodymium-doped yttrium aluminium garnet (532 nm) laser, and intense pulsed light, such therapies are not effective for the dermal and mixed types of melasma that are prevalent in Asian populations.

In this study, we aimed to demonstrate the therapeutic efficacy of low-fluence Q-Switched neodymium-doped yttrium aluminium garnet (Nd:YAG) Quickly pulse-to-pulse (Q-PTP) mode laser on melasma. Q-switched Nd:YAG laser at 1064nm is the most used laser in the treatment of dermal and mixed type melasma because of its deeper penetrating properties and safety in pigmented skin.

This patient underwent 8 sessions of treatment with a Q-switched Nd:YAG (Q-PTP mode) laser at a wavelength of 1064nm with 3 passes at low fluence (ranged from 0.70J/cm2 to 0.85J/cm2). This method, also known as “laser toning”, was first proposed by Goldberg and Metzler in 1999, has gained popularity in treating melasma in the recent years due to its better outcome and lesser side effects in

comparison to high fluence Q-switched Nd:YAG laser.

The term "laser toning" originates from the improvements in skin tone that result from the use of the laser. The collimated top-hat beam, large spot size, ultra-short pulse duration, low-fluence, and multiple passes of Q-switched Nd:YAG laser are believed to cause minimal damage to the melanocytes. The traditional Q-switched Nd:YAG laser treatment, on the other hand, is based on the principle of selective photothermolysis, which uses a high fluence to destroy the pigment-containing cell. Due to presence of cell death, prostaglandins and proinflammatory cytokines will be released, thus resulting in inflammatory state and damage to basement membrane, leading to relapse, exacerbation of melasma, or pigmentary changes [5].

Several studies have shown that by going through the skin with multiple passes of low fluence Q-switched Nd:YAG laser, the melanosomes would heat up slowly and eventually be destroyed without damaging the melanocytes [6]. Moreover, the cell membrane and nucleus of the cell are kept intact and thus the cell death is avoided. Hence, it inhibits the melanocytes activity by a mechanism known as "subcellular selective photothermolysis" [5].

In a similar study by Kim et al[7], it is proposed that the downregulation of melanogenesis, tyrosinase, TRP-1, and TRP-2 may be responsible for the diminished function of melanocytes. Melanogenic stimulators, including a-MSH and NGF, were also reduced. Consequently, in the absence of cell death and heating of skin kept to a minimum, low fluence Q-switched Nd:YAG laser has not only demonstrated a more superior results in treating melasma compared to the traditional Q-switched Nd:YAG, but also a reduced risk in exacerbation of melasma.

Q-PTP is the latest dual-pulse mode Q-switched Nd:YAG lasers technology in which one pulse is split into successive two sub-pulses by extremely brief intervals in the Q-switched Nd:YAG laser technology, and two relatively weak energy pulses are accumulated from photoacoustic to photothermal to create a larger peak power than the existing single-pulsed Q-switched Nd:YAG lasers. Synergistic dual pulse immediately led to pressure changes and vibration of melanin, and peak energy was accumulated to increase the temperature of the targets. In the study by Guo et al[4] which compared the advantages, efficacy, and safety between laser toning with Q-PTP mode and single-pulsed mode in treating melasma in Chinese patients, showed that there was no significant difference in the treatment outcome with the same treatment parameters. However, a minor procedural pain experience, lesser skin erythema reaction post-treatment and better patient acceptance with Q-PTP mode demonstrated greater treatment safety and superiority than single-pulsed Q-switched Nd:YAG laser.

In conclusion, our data suggested that low fluence Q-Switched Nd:YAG laser (Q-PTP mode) can be used in treatment for melasma to achieve a satisfactory result in lightening of the pigments with low risk of side effects.

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