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# RESEARCH ARTICLE

## CLINICAL EFFECTS OF THE BLACK PEEL PROTOCOL USING THE 1320 NM Nd: YAG LASER

**Thaís Rodrigues[1], Taís Amadio Menegat[2], Michele Akemi Nishioka[3], Fabiele Chieregato[3]; Diogo Francisco da Silva de Oliveira[4]; André Eduardo Hilário Amaral[4]; Fábio Alexandre Pinto[4]; José Ricardo de Souza[5] and Patricia Brassolatti[3]**

[1]Technical Support Department at Brazilian medical equipment industry - IBRAMED, Amparo, SP, Brazil; [2]Postgraduate Program of the Department of Plastic Surgery, University of São Paulo, Santos, SP, Brazil; [3]Department of Research, Development, and Innovation at Brazilian medical equipment industry - IBRAMED, Amparo, SP, Brazil; [4]Department of Engineering at Brazilian medical equipment industry – IBRAMED, Amparo, SP, Brazil; [5]Brazilian medical equipment industry - IBRAMED, Amparo, SP, Brazil

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***Corresponding author:**
***Thaís Rodrigues***

## ABSTRACT

Skin rejuvenation is a common procedure in current clinical practice. Various technologies are employed for these therapeutic purposes, with some types of lasers being beneficial due to their safety and low risk of complications. The 1320 nm wavelength is strongly absorbed by water molecules, which produce considerable heating in the skin, contributing to skin rejuvenation. Furthermore, activated charcoal masks can be combined to enhance the desired results. The objective of this study was to evaluate the effects of the black peel procedure on skin rejuvenation, which uses an activated charcoal mask capable of absorbing energy and triggering potential tissue changes. A patient was selected who presented tissue characteristics with the presence of fine and deep wrinkles, enlarged pores, and acne scars. For the evaluation, a comparison of photographs taken before and immediately after the procedure was used, and a 3D camera was used to assess wrinkles and enlarged pores. The results demonstrated that the technique improved skin appearance, particularly in terms of wrinkle reduction and a significant reduction in pore size, with just one application. No adverse events were recorded, and the patient reported comfort and satisfaction with the protocol employed. In conclusion, the non-ablative high-power laser technology, using a wavelength of 1320 nm and the black peel protocol, is safe and provides effective results with just one application.



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# INTRODUCTION

Skin aging is a physiological and progressive phenomenon characterized by reduced collagen synthesis and changes in the extracellular matrix.Clinically, it manifests as loss of elasticity, wrinkle formation, and changes in skin texture and color. Extrinsic factors, such as chronic sun exposure, enhance this process, resulting in photoaging, which manifests as deep wrinkles, depigmentation, and telangiectasia. In contrast, intrinsically aged skin becomes smooth and finely wrinkled (CHUNG *et al*., 2001). With the advancement of technologies aimed at improving skin quality and the consequent treatment of skin aging, non-ablative lasers have been gaining increasing popularity. Unlike ablative rejuvenation, performed with lasers such as $CO_2$ or Erbium:YAG, which remove the epidermis and part of the dermis, the non-ablative procedure promotes superficial skin renewal in a non-invasive manner, aiming to improve signs of photoaging without removing the deeper skin layers. Although ablative lasers provide faster and more significant results, they are associated with a higher risk of complications, such as scarring, infections, pigmentary changes, and prolonged recovery time (DEHORATIUS; DOVER, 2007).In this context, non-ablative treatments present an effective alternative, providing good aesthetic results, with shorter recovery time and a reduced risk of complications. Among these technologies, the Neodymium: Yttrium-Aluminum-Garnet (Nd:YAG) laser stands out, especially in the 1320 nm wavelength range. Its distinguishing features include high dermal penetration capacity and relative safety in different skin phototypes (SADICK *et al*., 2004). This laser acts predominantly through the mechanism of selective photothermolysis, promoting controlled heating of the deep dermis, with preferential absorption by tissue water. This thermal heating triggers partial denaturation of aged collagen fibers and stimulates neocollagenesis, resulting in remodeling of the dermal matrix and improved skin texture, elasticity, and firmness (DANG *et al*., 2005). Therefore, from a clinical point of view, the 1320 nm Nd:YAG Laser has wide applicability, being indicated for the treatment of fine to moderate wrinkles, sagging, enlarged pores and overall improvement in skin quality (EL-DOMYATI *et al*., 2011). Studies demonstrate the safety and efficacy of this technology for facial rejuvenation; however, there is no consensus regarding the parameters used, particularly those related to energy and pulse duration. This makes it difficult to compare the main

findings and determine the best protocol to use. Therefore, given the growing demand for non-invasive, effective, and shorter recovery methods for treating skin aging, this study aimed to evaluate the clinical effects of the Q-Switched 1320 nm Nd:YAG laser combined with an activated charcoal mask for skin rejuvenation.

## HIGH-POWER LASER

The goal of non-ablative lasers is to promote selective dermal injury to induce a repair response while preserving the overlying epidermis. The neodymium-doped yttrium-aluminum-garnet (Nd:YAG) laser is one of the non-ablative modalities studied for reversing signs of skin aging. This was the first laser developed to promote selective dermal heating, generating controlled thermal damage to the dermis and stimulating tissue remodeling (EL-DOMYATI *et al*., 2011). The basic principle of these types of lasers is selective photothermolysis, described in 1983 by Anderson & Parrish, which is directly related to the production of tissue heat from selective interaction with the target chromophore. Treatment efficacy depends on specific parameters such as a pulse width shorter than the tissue's thermal relaxation time, sufficient energy to produce thermal damage, and an appropriate wavelength capable of interacting with the target chromophore. For the process to be efficient, the target must have a high optical absorption coefficient, a condition achieved both by interaction with endogenous chromophores and by the use of exogenous substances (ANDERSON & PARRISH, 1983). Specifically, the 1320 nm wavelength is characterized by a higher scattering coefficient, promoting dispersion of thermal energy in the vertical and horizontal directions, with significant backscattering, resulting in an area of action larger than the beam diameter (TRELLES, ALLONES, LUNA, 2001; LEVY *et al*., 2001; SADICK *et al*., 2004). The dermis, composed of a high water content, constitutes the main target of the 1320 nm wavelength, allowing effective dermal heating and remodeling of the extracellular matrix, while the epidermis remains preserved (EL-DOMYATI *et al*., 2011). In this context, water acts as the primary chromophore of the 1320 nm Nd:YAG, with virtually no competition from other chromophores, which reduces the occurrence of adverse effects related to skin pigmentation. The absorption of light by water promotes homogeneous dissipation of thermal energy, generating heating that can reach up to 2 mm in depth, allowing light energy to efficiently reach the papillary dermis and mid-reticular dermis, with the advantage of minimal interference from absorption by hemoglobin or melanin, unlike shorter wavelengths, a characteristic that makes this wavelength particularly suitable for non-ablative rejuvenation procedures (FATEMI, WEISS, WEISS, 2002; DANG *et al*., 2006; HARDAWAY; ROSS, 2002). This aspect gives the 1320 nm laser significantly superior absorption compared to the 1064 nm Nd:YAG laser. The exact mechanism of non-ablative rejuvenation is not yet fully understood. However, according to the theory of selective photothermolysis, indirect heating of water in the dermis stimulates the activation of fibroblasts and the synthesis of new collagen. This process offers significant advantages, as it promotes non-ablative skin rejuvenation, associated with shorter recovery time, minimal tissue damage, and a low incidence of complications compared to ablative lasers such as $CO_2$ and Er:YAG. In the procedure known as Black Peel, a topical suspension of activated charcoal is applied to the skin, which acts as an exogenous chromophore, also called a photopotentiator. The Nd:YAG laser radiation is strongly absorbed by the charcoal, in contrast to other cutaneous chromophores, such as melanin. After application, the charcoal particles form a thin film on the stratum corneum, concentrating primarily in the dilated ostia. When exposed to ultrashort high-energy pulses (10 ns), these particles undergo abrupt heating and subsequent explosive destruction, releasing kinetic energy capable of mechanically removing the stratum corneum, resulting in skin smoothing and reduced ostium diameter (CHUNG *et al*., 2011). According to Roh *et al*. (2011), although the exact mechanism of ostium size reduction with the Q-switched Nd:YAG laser is not fully understood, remodeling of perifollicular dermal collagen may contribute to this effect. Furthermore, it is suggested that photothermal energy promotes volumetric reduction of sebaceous glands, favoring the maintenance of ostium diameter reduction and sebum production in the long term. In summary, the 1320 nm Nd:YAG laser presents significant advantages, consolidating itself as an effective and safe modality for non-ablative rejuvenation. Its characteristics, such as greater tissue dispersion, high water absorption, induction of neocollagenesis and dermal remodeling, result in relevant clinical and histological benefits, with minimal adverse effects and rapid recovery, when compared to ablative lasers (MENAKER *et al*., 1999; TRELLES, ALLONES, LUNA, 2001; LEVY *et al*., 2001).

**Figure 1. Illustrative representation of the clinical application of the 1320nm wavelength in the Black Peel protocol**

### Methods

**Subjects Selection:** The patient was selected based on a prior history taken to identify their classification according to the previously established inclusion criteria. Exclusion criteria included decompensated diabetes, coagulation problems, autoimmune diseases, active infections or dermatitis, cancer and autoimmune diseases, pregnant or lactating patients, and those who did not agree to sign the informed consent form for this study.

**Protocol:** To apply the treatment protocol, a multi-regenerative activated charcoal mask (Mezzo Dermocosméticos) and the *Syrius Yag* device, developed and manufactured by the Brazilian Medical Equipment Industry – IBRAMED, were used. Initially, local asepsis was performed with 0.5% alcoholic chlorhexidine, followed by a light exfoliation of the skin with Microscrub Repair (Vitamédica) physical exfoliant. After adequately cleansing the skin, a thin layer of the activated charcoal mask was applied to the entire face. Next, a Q-Switched Nd:Yag laser with a wavelength of 1,320 nm, 300 mJ, and a frequency of 8 was applied to the entire face, aiming to remove the mask. Following this, the skin was cleaned with sterile gauze and water. Sunscreen was applied to complete the treatment.

**Assessment:** Assessments were performed before and immediately after the protocol application by the same evaluator, blinded to the treatment.

### Phototype classification

Skin phototype was classified according to the Fitzpatrick Scale (table 1).

**Table 1. Fitzpatrick scale for classifying skin phototype**

| Phototypes | Characteristics | Sensitivity to the sun |
|---|---|---|
| I - White | Burns easily, never tans | Very sensitive |
| II - White | Burns easily, tans very little | Sensitive |
| III - Light Brunette | Burns moderately, tans moderately | Normal |
| IV - Moderate Brunette | Burns little, tans easily | Normal |
| V - Dark brunette | Burns rarely, tans a lot | Not very sensitive |
| VI - Black | Never burns, fully pigmented | Insensitive |

Source: Suzuki *et al.,* 2011.

**Photo analysis:** The iPhone 16 Pro camera was used for photographic recording, at a standardized distance of 80 cm from the patient's

position. To assist, a tripod was positioned in front of the patient and adjusted according to their height to properly frame their face. The tripod was centered, and the patient was asked to move their body to reach predetermined positions: frontal, lateral, and 45° (between frontal and lateral), with their gaze directed toward the horizon. The background was kept dark blue, using standard lighting (central focus of white light). The shots were taken at zoomof 1.2 mm, using top flash. The images were captured before treatment and immediately after the protocol was applied. The analyses focused on changes in the appearance of the patient's skin, particularly related to improvements in pores, luminosity, and skin texture.

**Evaluation of expertise committee:** To evaluate the before and after photos, three independent evaluators were recruited who were experienced in the field, blinded to the treatment and did not take part in any step of the study design and data collection. The captured photos were sent to the three evaluators, who, based on their expertise in the field, evaluated the progress of the treatment, focusing primarily on the improvement in overall aesthetic appearance.

**Evaluation of the patient's sensory perception in relation to treatment:** During the procedure, the patient was asked about the sensation of pain, discomfort and warmth. To collect information, the Visual Analogue Scale (VAS) was used with the number that best represents the sensations reported by the patient. The VAS ranges are detailed in Table 2.

**Table 2. Representation of the subjective visual analog scale**

| Grade | Description |
|---|---|
| 0 | No sensation |
| 1 - 2 | Light sensation |
| 3 - 7 | Moderate sensation |
| 8 - 10 | Intense sensation |

**Source:** Adapted from Omi, 2017.

**Evaluation of Satisfaction of the patient to the treatment:** Participants satisfaction with the results and comfort in the area where the techniques were applied will be assessed using a subjective scale of 1-5 (1 = very dissatisfied/very uncomfortable, 2 = dissatisfied/uncomfortable, 3 = no difference/no opinion, 4 = satisfied/comfortable, 5 = very satisfied/very comfortable) (Noyman *et al*., 2021).

# RESULTS

The results of this study demonstrated significant changes in skin appearance. Photographic analysis revealed changes related to improved tissue appearance and superficialization of wrinkles in the periocular region and nasolabial folds. These findings were confirmed by 3D camera analysis. In the 3D camera photos, the imaging program marked the medium wrinkles located in the nasolabial fold region, and the evaluation was guided by coloration, where the greater the blue coloration, the greater the tissue depression. In this case, it was possible to identify the superficialization of wrinkles in this region after treatment, evidenced by the difference in coloration between before and after. In the periocular region, fine wrinkles were marked, and a significant improvement in the tissue was observed, due to the superficialization of wrinkles and improved tissue quality. Through pore marking, a visible improvement was also detected, with a reduction in blue staining in the treated area. The expert committee's evaluation revealed two main improvements when comparing the before-and-after photos, which are consistent with the 3D camera assessment: the superficialization of fine wrinkles in the periocular region and the reduction in pore diameter in the region near the zygomatic bone. No adverse events were recorded after the treatment, and the patient's assessment indicated that pain and discomfort were considered mild, rated at 2. Furthermore, the patient reported satisfaction and comfort with the treatment.

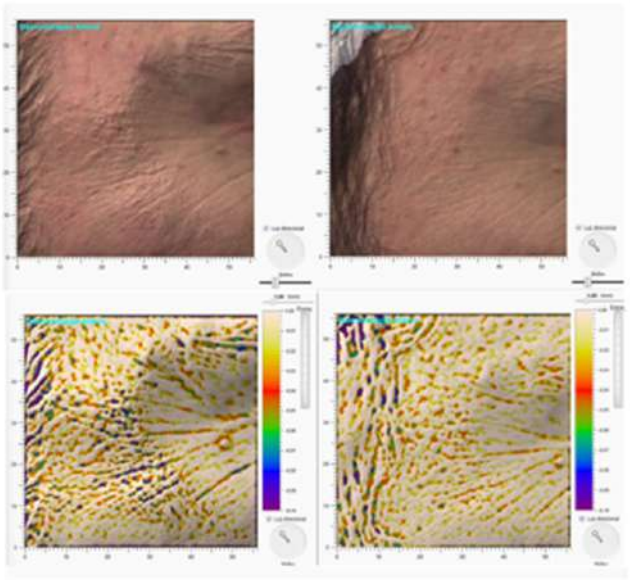

**Figure 2. Representative photo of the evaluation with the 3D camera, demonstrating the difference between before and after in relation to the reduction of wrinkles**

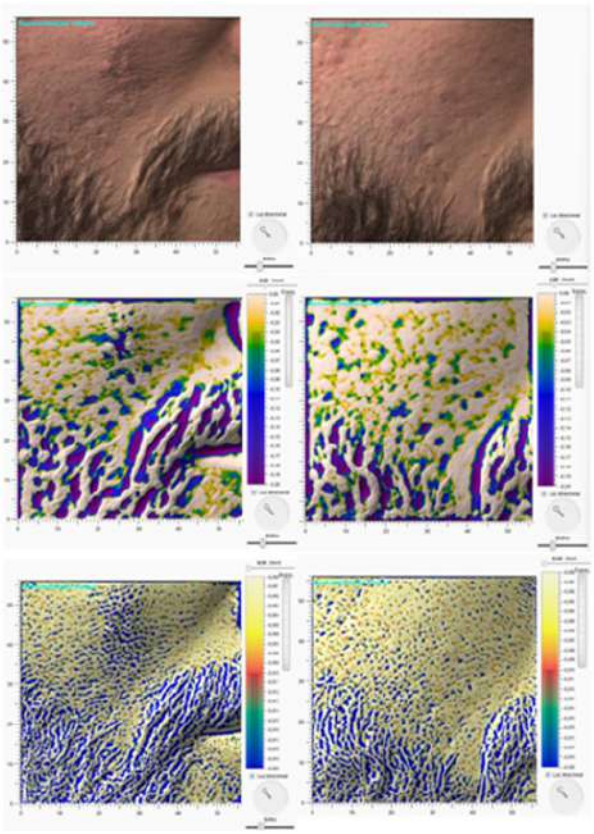

**Figure 3. Representative photo of the evaluation with the 3D camera, demonstrating the difference between before and after in relation to the superficialization of wrinkles, improved skin appearance and reduced pores**

# DISCUSSION

The use of non-ablative laser has been an effective treatment alternative that aims to improve the extracellular matrix by increasing collagen synthesis. By definition, non-ablative skin rejuvenation involves the application of a laser with an appropriate wavelength and energy to induce a thermal response in the dermis, which stimulates fibroblasts to synthesize new collagen fibers, causing minimal damage to the epidermis (SHANG *et al*., 2010; ZELICKSON *et al*., 2004; Alexiades-Armenakas *et al*., 2008; Paithankar *et al*., 2003; Kelly *et*

*al*., 1999). This occurs due to the mechanism of action of this wavelength, which primarily targets water molecules and is therefore well absorbed by the dermis layer, transferring the energy into heat, which is capable of denaturing key proteins, thus inducing remodeling of the extracellular matrix (GOLDBERG; SILAPUNT, 2000; HANTASH; GLADSTONE, 2009; DEHORATIUS; DOVER, 2007). The objective of this study was to identify the action of the 1320 nm Q-Switched Nd:Yag laser in improving pores and facial rejuvenation using the black peel protocol. The results indicated improved skin appearance, including reduced pores and wrinkles, and immediate whitening. These findings correspond to the action of the 1320 nm laser, which is capable of interacting with the most superficial layers of skin tissue, causing thermal and mechanical exfoliation, in addition to acting on collagen (Sachdeva, 2010). The mechanism of action associated with this wavelength occurs through tissue heating, called selective photothermolysis, which reaches temperatures between 30 and 40°C. This occurs through the absorption of light by water molecules, which in this case is considered the main chromophore (DEHORATIUS *et al*., 2007; GOLDBERG; SILAPUNT, 2000).

From a histological perspective, Dang *et al*. (2005) performed a quantitative and objective analysis of the changes induced by the 1320 nm Q-Switched Nd:YAG laser in mouse skin and observed improved elasticity, increased dermal thickness, and reorganization of collagen fibers. Furthermore, Dang *et al*. (2006) investigated the cellular mechanisms involved in this process, demonstrating that the thermal stimulus induced by the laser promotes collagen denaturation and subsequent stimulation of fibroblast proliferation, favoring the synthesis of collagen types I and III. Similarly, Shang *et al*., 2010, evaluated the effects of laser at a wavelength of 1320 nm in an experimental model, emphasizing the macrophage response and the synthesis of type I and III collagen. They found that after application of the non-ablative laser, the region presented a greater number of macrophages, indicating the inflammatory process. Collagen deposition increased mainly after 21 days of application, while type III collagen increased at 7 and 60 days. The authors found a correlation between the number of fibroblasts and macrophages, as well as the relationship between the amount of collagen and the number of macrophages. Therefore, the study concludes that macrophages are involved in the inflammatory response, fibroblast proliferation, and collagen remodeling.

Complementing these findings, El-Domyati *et al*. (2011) evaluated the clinical and histological effects of 1320 nm Nd:YAG laser treatment on periorbital wrinkles, demonstrating clinical improvement and a significant increase in the expression of types I, III, and VII collagen, as well as newly synthesized collagen and tropoelastin, consolidating the therapeutic potential of this technology for skin rejuvenation. Kelly *et al*.,1999 also investigated the effects of 1320 nm laser on periorbital wrinkles using fluences of 28-36 J/cm2, and the results demonstrated improvement in different types of wrinkles. The study by Goldberg *et al*. (2002) demonstrated an improvement in skin quality in just three sessions. Trelles, Allones, and Luna (2001) investigated the Q-switched Nd:YAG laser at a wavelength of 1,320 nm for facial rejuvenation. The protocol used an energy density between 30 and 35 J/cm$^2$, with 30 milliseconds of cooling (Cryogen) and a 40 millisecond delay between the application of cooling and laser impact. The protocol was applied for one month, with two sessions per week. In the study by Goldberg (1999), ten women treated with the 1,320 nm Nd:YAG laser were evaluated for the degree of clinical improvement and histological changes, demonstrating new collagen formation in the papillary dermis and significant clinical improvement in skin quality. Subsequently, Goldberg and Silapunt (2000) investigated the efficacy and safety of multiple sessions with the Q-Switched Nd:YAG laser for non-ablative rejuvenation of facial wrinkles, corroborating previous results, where six of eight individuals showed visible clinical improvement. In our study, in addition to improving skin appearance in terms of wrinkles and pore reduction, the technology was validated as safe and comfortable through a rating scale and patient reports. Therefore, it is possible to conclude that the use of the 1320nm ND:YAG, using the black peel protocol, is effective in providing an immediate improvement in skin texture, directly reducing expression lines and enlarged pores.

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