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REVIEW ARTICLE

Safety of Lasers in Treatment of Warts

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ABSTRACT

Background: Cutaneous warts are a proliferative condition caused by human papillomavirus (HPV) infecting keratinocytes. These viral warts are widespread, affecting 7–12% of the population. HPV, a double-stranded DNA virus, encompasses over 200 identified types, broadly classified into high-risk and low-risk groups based on their potential to cause cancer. The virus's life cycle is intricately tied to epithelial cell growth and differentiation. Treating persistent warts has long posed a significant challenge for dermatologists due to their tendency to recur. While warts can be managed, eliminating the HPV virus entirely remains unattainable. Numerous treatment methods are currently available, including surgical removal, cryotherapy, pharmacological approaches (e.g., salicylic acid, trichloroacetic acid), and immunotherapies (e.g., Candida antigen and HPV vaccination). Laser therapy has emerged as a promising option for stubborn warts, with several types being evaluated, such as carbon dioxide (CO2), pulsed dye (PDL), erbium:yttrium-aluminum-garnet (Er:YAG), neodymium:YAG (Nd:YAG), and Alexandrite lasers, as well as their combinations.

Conclusions: Laser treatments have been shown to be both safe and effective, often yielding higher success rates compared to traditional methods.

KEYWORDS: Human papillomaviruses; Laser; Warts; Treatment.

INTRODUCTION

HPV triggers the development of viral warts, leading to benign proliferative lesions in humans. Diagnosing these warts is straightforward and relies on recognizing lesion features through clinical examination, laboratory tests, and histopathology. Common warts, flat warts, plantar warts, condyloma acuminatum, and epidermodysplasia verruciformis are among the forms of warts that are classified clinically [1].

Warts significantly impact patients' quality of life, causing cosmetic concerns, functional limitations, and physical discomfort, especially when they show up on the palms of the hands or the soles of the feet. As a result, cutaneous warts rank among the most frequently addressed conditions in dermatology clinics [2].

However, many current treatment options come with limitations and side effects. Topical therapies require prolonged application, making their success heavily reliant on patient adherence. Surgical approaches, while somewhat effective, often involve pain, extended recovery times, and incomplete results, leading to high recurrence rates [3]. Laser therapy, by contrast, provides a promising alternative, utilizing precise tissue destruction with minimal risks and greater efficacy [2].

Laser treatment in dermatology harnesses photothermal and photomechanical mechanisms to precisely target and destroy specific tissues. By emitting focused, monochromatic light at a defined wavelength and energy level, the laser interacts selectively with structures in the treatment area. This light energy is transformed into

heat, producing the intended effect on the targeted tissue. Depending on the energy density and pulse duration, the process can either coagulate the structures through thermal action or shatter them using mechanical force [4].

Ablative lasers:

Over the past decade, laser technology has seen remarkable advancements, cementing its role as a cornerstone in modern treatment options. The CO_2 laser, introduced in the 1980s, continues to hold its reputation as the benchmark for ablative lasers in wart removal. As one of the pioneering laser technologies, it operates by emitting infrared light at a wavelength of 10,600 nm, which is selectively absorbed by water in the target tissue. Reported success rates in clinical studies vary widely, ranging from 32% to 100%, highlighting its efficacy across diverse cases [5].

The CO2 laser, emitting an invisible infrared beam at 10,600 nm, specifically targets both intracellular and extracellular water within tissues. When this light energy is absorbed by water-rich cells, it triggers vaporization of the skin [6]. Using a focused beam, the CO2 laser acts like a precise scalpel, cutting through the wart down to the subcutaneous layer. The remaining base of the wart is then eradicated by applying a defocused beam, ensuring thorough removal [7].

Moghaddas [8]**.** highlighted several complications associated with CO2 laser treatment. These include prolonged healing times, the high expense of laser equipment, and the risk of damaging the nail and nail matrix. Other concerns involve scarring, the potential for laser-induced burns, postoperative pain, and even the possibility of practitioner infection due to HPV particles present in the laser-generated plumes.

The Er:YAG laser, like the CO2 laser, belongs to the class of ablative lasers. Functioning water absorbs a lot of it at a wavelength of 2940 nm., making it an effective tool for targeting water-rich tissues. Renowned for its safety, the Er:YAG laser has become a trusted option for treating viral warts. However, its efficacy is tempered by significant recurrence rates, especially among patients with plantar warts, often requiring additional treatments to achieve long-term success [9].

A retrospective study conducted from January 2019 to July 2023 examined 245 patients who underwent their first Er:YAG laser treatment for viral verruca. Comprehensive data were available for 201 patients who completed the follow-up. The participants, aged between 6 and 80 years (mean age: 33.7), had warts persisting for over a year on average before treatment. All cases involved symptomatic warts, causing varying levels of pain and discomfort. On average, each patient presented with 7.2 warts (ranging from 1 to 23). The treatment demonstrated an overall success rate of 71.6%, with complete resolution of warts observed at the 12-month follow-up [10].

Non-ablative lasers:

Targeting the dilated blood vessels in the papillary dermis, which are a characteristic of warts, might cause ischemia and, as a result, cause the disease to resolve. The most popular non-invasive laser for treating warts is a non-ablative pulsed-dyed laser that operates at 585–595 nm and uses a chromophore as the oxyhemoglobin. The greatest absorption peak of hemoglobin occurs between 585 and 595 nm, while the more moderate absorption peak is between 800 and 1100 nm. 1064 long-pulsed Neodymium Nd: Yttrium-Aluminum-Garnet Hemoglobin in the blood arteries is the target of the laser [11].

Al-Sabak and Jaafar. [12] conducted a study involving 22 patients with a total of 478 lesions, utilizing the ND:YAG laser at 532 nm. The participant age span was from 6 to 45 years, comprising 13 females and 9 males. The findings revealed remarkable results, with 19 patients (86.36%) demonstrating excellent responses, including 15 who achieved complete clearance (78.94%). At the three-month mark, responses consisted of one good (4.545%), one fair (4.545%), and one poor outcome (4.545%). These results were statistically significant (P = 0.002). The cumulative clearance rates after each treatment session were reported as 58.4%, 77.7%, and 89.9%. Notably, only one patient experienced a recurrence, and the mild side

effects reported did not interfere with their daily lives.

Smith et al. [13] employed the Nd:YAG laser to address persistent verruca plantaris with impressive results, achieving complete resolution in 69.8% of cases and notable improvement in 9.4%. Critically, there were no reported adverse effects such as hyperpigmentation, scarring, or infections, underscoring the treatment's safety and efficacy for difficult cases of verruca plantaris, with only rare recurrences noted.

Pharaon et al. [14] shown that the long-pulsed 755 nm alexandrite laser was successful in treating two cases of recalcitrant hand warts, achieving positive outcomes in both situations. These results underscore the laser's potency in tackling resistant warts on the hands.

Park et al. [15] examined the effectiveness and safety of the Nd:YAG laser used alone compared to its application alongside a palmoplantar wart treatment using an alexandrite laser at 755 nm. Patients were split into two groups, one of which received a combination therapy and the other Nd:YAG alone. Treatment outcomes were evaluated based on clearance rates, degrees of vascularity/hyperkeratosis, patient satisfaction, and pain assessments. The results revealed no significant differences in effectiveness ($p = .348$), satisfaction ($p = .560$), or pain levels ($p = .728$) between the two approaches, indicating that both methods are comparably effective against stubborn palmoplantar warts.

PDL is recognized as a non-ablative laser used for wart treatment. While the precise mechanism of action remains partly understood, it is believed that PDL hinders the blood supply to warts through selective photothermolysis, leading to cellular destruction in the lesions [16].

Al-Mutairi and Elkashlan [16] carried out a study involving forty participants, evenly split between 20 males and 20 females, suffering from stubborn plantar warts. The subjects were organized into two matched groups: one group received pulsed dye laser (PDL) therapy, while the other was administered a placebo using PDL machine coolant. Analysis showed no significant difference in treatment response between the genders when assessing PDL effectiveness. The PDL-treated group achieved a 45% clearance rate and 55% partial clearance, with these results deemed statistically significant compared to the coolant group. Importantly, no major side effects emerged during the study, affirming that PDL therapy is a safe, well-tolerated, user-friendly, and effective option for treatment.

Ibrahim et al. [17] conducted a comparative analysis of the effectiveness of Nd:YAG laser against PDL in treating multiple stubborn plantar warts. The study involved thirty patients suffering from these warts. Warts in half of the subjects were treated with PDL, while the other half received treatment with Nd:YAG laser. Complete clearance was achieved in 20 patients (66.7%) treated with the Nd:YAG laser, compared to 19 patients (63.3%) treated with PDL, revealing no statistically significant difference between the two laser modalities. However, pain levels during the laser treatments were notably higher with the Nd:YAG laser, reaching statistical significance ($p = .0001$). Overall, both Nd:YAG and PDL proved to be effective and safe options for addressing recalcitrant plantar warts.

Jiryis et al. [18] conducted a study with 24 patients involving 240 lesions, all clinically classified as recalcitrant warts following unsuccessful treatments with topical applications and cryotherapy. In this research, 120 lesions received a combination of Er:YAG and Nd:YAG laser therapies, while the other 120 lesions were treated exclusively with Er:YAG laser. The clearance rate in the combined Er:YAG + Nd:YAG laser group was significantly higher than that of the Er:YAG-only group ($p = 0.008$). Specifically, the complete response rate was 48% (58 out of 120 warts) for the combined laser group, compared to just 29% (35 out of 120 warts) for the Er:YAG group alone. This indicates that the joint application of Er:YAG and long-pulsed Nd:YAG lasers is more effective in addressing recalcitrant warts after a single treatment session.

An extensive review of 35 studies conducted from 1989 to 2015, encompassing a total of 2,149 patients, provided insights into the

effectiveness of various lasers for treating both common and stubborn non-genital warts. The response rates varied by laser type, with the CO2 laser achieving results between 50% and 100%, the Er:YAG laser ranging from 72% to 100%, the PDL displaying rates from 47% to 100%, and the Nd:YAG laser showing responses from 46% to 100%. Recent randomized controlled trials (RCTs) have demonstrated that PDL treatment delivers results on par with traditional therapies such as cryotherapy and cantharidin [19].

A thorough search was conducted on articles published from 2000 to July 2020 regarding laser therapy for genital and non-genital warts, ultimately selecting 50 studies for comprehensive review. This compilation included 22 focused on PDL, Nd:YAG, 3 on Er:YAG, 14 on CO2 laser, and one systematic review. Complete response rates varied significantly depending on the laser type, ranging from 0% to 100% for PDL, 9.1% to 100% for Nd:YAG, 83.3% to 100% for Er:YAG, and 59.15% to 100% for CO2 laser. There was no notable difference in efficacy or recurrence rates between laser treatments and conventional therapies. Additionally, combining lasers with immunomodulators, keratolytic medicines, and photodynamic therapy may be helpful, especially for patients with recurring and resistant lesions or those with immunosuppressed conditions. Interestingly, when compared to other laser modalities, PDL showed the lowest rate of side effects [20].

CONCLUSION

The application of laser therapy for wart treatment is considered safe and offers numerous advantages, such as favorable clinical results, reduced recurrence rates, and minimal side effects. Therefore, utilizing lasers as a primary treatment option for warts is highly recommended.

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