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Treatment of Penile Lesions Suggestive of Neoplasia with Erbium:YAG Laser: A Multiple Case Report

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ABSTRACT

Squamous cell carcinoma (SCC) is the most prevalent histological type of penile cancer. Traditional treatments often involve aggressive surgical resection, which can result in physical and psychological morbidity. This study reports on the clinical approach and outcomes for three patients with penile lesions suggestive of neoplasia who were treated using Erbium:YAG laser therapy. Three male patients (ages 39–66) with histologically confirmed penile neoplasms were treated between 2023 and 2025 in Cuiabá, Brazil. Ablative Erbium:YAG laser (2,940 nm) was used with individualized parameters (fluence, frequency, and pulse mode) until pinpoint bleeding was achieved. Follow-up included clinical inspection and control biopsies at 30 days, 3 months, and 6 months. All cases achieved satisfactory outcomes. Biopsies post-treatment confirmed the absence of neoplastic features, showing only reparative inflammatory processes. In one case, a G2 lesion was downgraded to intraepithelial neoplasia grade II. Organ anatomy and functionality were preserved in all patients. Erbium:YAG laser therapy is a promising, less invasive alternative for selected penile lesions, promoting organ preservation and maintaining quality of life.

Key words: Penile Neoplasms, Squamous Cell Carcinoma, Laser Therapy

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I. INTRODUCTION

Penile cancer is a rare malignant neoplasm with a higher incidence in developing countries. The clinical presentation can range from superficial lesions to infiltrative and ulcerated tumors. A definitive diagnosis is established through biopsy and histopathological examination.

Traditionally, treatment involves surgical resection, which can range from local excision to partial or total penectomy, depending on the extent of the disease. Such procedures, although effective from an oncological perspective, can result in significant physical and psychological morbidity, leading to detrimental consequences for the male lifestyle.

In this scenario, organ-preserving therapies have been investigated to promote the quality of life for these patients. Accordingly, the use of lasers in dermatology and other medical fields has expanded, and their application in treating pre-malignant and malignant skin lesions has shown promising results [1].

In the early stages of laser technology, the primary method used for rejuvenation and the focal treatment of dermatological lesions was the carbon dioxide (CO_2) laser [2]. Currently, however, new models have emerged that utilize solid-state materials for light energy production, such as the erbium-doped yttrium-aluminum-garnet (Erbium:YAG) laser [3].

The Erbium:YAG laser, approved for therapeutic use by the U.S. Food and Drug Administration (FDA) in 1996, operates at a wavelength of approximately 2,940 nm. This wavelength is virtually the same as the peak absorption of water molecules in the body (3,000 nm), resulting in a greater interaction between the emitted light energy and the tissue of the epidermis and papillary dermis [4]. While the Er:YAG laser traditionally facilitates rapid healing through the recruitment of adnexal stem cell niches, this effect is anatomically dependent in the penile region. In the hair-bearing proximal shaft, follicular recruitment aids in re-epithelialization; however, in the distal shaft and glans (where adnexal structures are sparse) healing relies predominantly on keratinocyte migration from the wound margins and deeper epithelial ridges [5]. Furthermore, the thermal injury from high energy absorption in the tissue stimulates collagen production, improving the appearance of photodamaged skin [6].

Conversely, the Nd:YAG (Neodymium-doped Yttrium Aluminum Garnet) laser operates at a wavelength of 1064 nm, facilitating penetration into deeper tissue layers and notably enabling the treatment of telangiectasias. This modality is classified as non-ablative, as it spares the epidermis while inducing

controlled thermal injury to stimulate collagen and elastin synthesis [7]. Such procedures are generally preferred by patients due to their more favorable safety profiles and reduced post-treatment downtime. Nevertheless, achieving clinical outcomes comparable to a single ablative laser session typically requires multiple non-ablative treatments.

Moreover, non-ablative laser therapy does not remove the epidermis but still induces controlled thermal injury, stimulating the production of collagen and elastin [8]. This category presents a lower risk profile and a shorter post-treatment recovery time.

The delivery of energy by an ablative solid-state laser can be administered in two distinct ways: full-field or fractionated beam. While the former treats the entire area of interest with energy emission, the latter delivers ablative beams in microscopic parallel columns within the target area, which allows for the preservation of dermal appendages, promoting re-epithelialization and reducing adverse side effects [5], [9]. This effect is therefore expected to reach neoplastic lesions, in order to generate cellular irritation with loss of homeostasis, without necessarily causing damage to a large area of adjacent healthy tissue.

Therefore, the present study, structured as a case report of 3 patients with similar neoplastic lesions treated with Er:YAG and Nd:YAG laser therapy, aims to demonstrate the outcomes and the clinical parameters found in these cases. Thus, this study aims to aid in the development of treatment parameters for similar cases by demonstrating the clinical management and follow-up of patients with penile lesions treated with laser technology, thereby generating useful knowledge regarding this therapeutic approach.

II. CASE REPORTS

Three male patients were selected based on histological confirmation of penile lesions. All procedures were performed under locoregional anesthesia, achieved via a penile nerve block at the base using a solution of 15 mL of 2% lidocaine diluted with 5 mL of 0.9% saline, in a sterile setting. The laser therapy was performed using the Fotona SP Dynamis® platform.

a) Case 1: 66-year-old male with verrucous squamous cell carcinoma (Broders' grade I) on the glans.

A patient with a histopathological diagnosis of squamous cell carcinoma, verrucous type, Broders' grade I histological differentiation. The patient was staged as cT1aN0M0 according to clinical and radiological findings and the lesion was located on the glans (Figure 1A).

Initially, the patient underwent the first treatment session with an Erbium:YAG laser (2940 nm), using an R04 handpiece with a 3 mm spot size, a frequency of 3 Hz, and a fluence of 6 J/cm², with multiple passes until pinpoint bleeding was achieved. After the procedure, a topical compound of neomycin sulfate and bacitracin zinc was prescribed, and a follow-up visit was scheduled for 30 days.

The patient showed good initial progress (Figure 1B). A second session was performed with the same Erbium:YAG laser, R04 handpiece, and 3 mm spot size, but with a fluence of 6.6 J/cm² and a frequency of 3 Hz, aiming for greater energy penetration into deeper layers and reducing the number of sessions required to achieve a satisfactory result. The procedure consisted of passes with a 3 mm spacer around the lesions; subsequently, the spacer was removed to allow for closer approximation of the handpiece to the tissue surface. This maneuver was intended to concentrate the ablative potential, with multiple passes delivered until the clinical endpoint of pinpoint bleeding was achieved.

The following month, a new session was performed with the laser in SP (short pulse) mode, using the R04 handpiece, a 3 mm spot size, with 7 J/cm² and 3 Hz, employing a technique similar to the previous applications. Approximately 30 days after this third session, a control biopsy was performed at two points with a 2 mm punch (Figure 1C). The result of the subsequent biopsy indicated a chronic reparative inflammatory process, with no evidence of neoplasia.

Six months later, the patient presented with reactive hyperemia on the glans. The clinical appearance showed preserved glans anatomy and no clinical features suggestive of a neoplastic process (Figure 1D).

Figure 1. Verrucous squamous cell carcinoma. **A** - Baseline clinical presentation showing the exophytic lesion before treatment.

Figure 1. Verrucous squamous cell carcinoma. **B** - Clinical appearance one month after the first session of Erbium:YAG laser therapy

Figure 1. Verrucous squamous cell carcinoma. **C** - Clinical appearance after three sessions of Erbium:YAG laser therapy. A control biopsy was made.

Figure 1. Verrucous squamous cell carcinoma. **D** - Clinical appearance after six months of the last session, demonstrating complete remission of the lesion and preserved glans anatomy.

b) Case 2: 66-year-old male with grade I penile intraepithelial neoplasia (PeIN I) associated with HPV cytopathic changes on the glans.

A patient with a histopathological diagnosis of penile intraepithelial neoplasia grade I, associated with viral HPV-related cytopathic changes, was staged as cT1aN0M0 according to clinical and radiological findings. The lesion was located on the glans penis (Figure 2A).

The initial approach involved a treatment session with an Erbium:YAG laser (2940 nm), with an R04 handpiece and a 3 mm spot size, in SP mode, at 7 J/cm² and 3 Hz. The pinpoint bleeding effect was achieved on the first pass, and the procedure continued with multiple passes over the lesion to establish a 3 mm safety margin. Postoperative care included a topical compound of neomycin sulfate and bacitracin zinc applied for five days to prevent secondary bacterial infection and facilitate wound healing.

The patient reported good progress, with no pain or burning, only local hyperemia that gradually subsided (Figure 2B). Approximately six months later, another laser session was performed using the same parameters. Following this, a control biopsy was performed. The histopathology report maintained findings of lesions on the glans penis suggestive of grade I intraepithelial neoplasia with cytopathic changes characteristic of HPV (Human Papillomavirus), such as binucleation and nuclear halos typical of the viral infection.

Consequently, a third session was performed three months later, maintaining the same parameters previously used, with a new biopsy taken months thereafter (Figure 2C). The report from this last examination showed, in samples from the base, left lateral aspect, and apex, the presence of squamous mucosa fragments exhibiting epithelial flattening with isolated necrotic keratinocytes and focal cytological atypia. These changes were associated with areas of fibrosis and vascular congestion, without features suggestive of a neoplastic process, and the result was considered satisfactory, consistent with the clinical aspect observed in a follow-up six months after the last session (Figure 2D).

Figure 2. Penile intraepithelial neoplasia grade I (PeIN I) with HPV-related changes. **A** - Baseline clinical presentation showing the affected area on the glans before treatment.

Figure 2. Penile intraepithelial neoplasia grade I (PeIN I) with HPV-related changes. **B** - Clinical appearance one month after the first session of Erbium:YAG laser therapy.

Figure 2. Penile intraepithelial neoplasia grade I (PeIN I) with HPV-related changes. **C** - Clinical appearance immediately after the third session of Erbium:YAG laser therapy.

Figure 2. Penile intraepithelial neoplasia grade I (PeIN I) with HPV-related changes. **D** - Post-treatment follow-up six months after the final session, showing the resolution of neoplastic features and healthy tissue repair after laser intervention.

c) Case 3: 39-year-old male with moderately differentiated squamous cell carcinoma (Broders' grade II) on the glans.

A patient with a histopathological diagnosis of moderately differentiated squamous cell carcinoma, Broders' grade II histological differentiation, was staged as cT1aN0M0 according to clinical and radiological findings, with the lesion located on the glans penis (Figure 3A).

Initially, the patient underwent the first Erbium:YAG laser session with R04 tip parameters, SP mode, 14 J/cm², 1.7 Hz, and 3 mm. The procedure was uneventful (Figure 3B).

The second session took place the following month, using the Nd:YAG laser modality – to reach deeper layers of the tissue – in versa mode at 100 J/cm², a 4 mm spot, and a frequency of 1 Hz. This was followed by a session with the Erbium:YAG laser modality with an R04 tip, 3 mm spacer, a frequency of 3 Hz, and an energy of 7 J/cm² (Figure 3C). Three months later, a new biopsy was requested, revealing lesions on the glans penis compatible with grade II penile intraepithelial neoplasia. Thus, a third session was performed 60 days later, using the same parameters as the previous session, while awaiting a new biopsy to confirm the clinical findings of resolution of the neoplastic condition. (Figure 3D)

Figure 3. Moderately differentiated squamous cell carcinoma (Broders' grade II). **A** - Baseline clinical presentation showing the affected area on the glans before treatment.

Figure 3. Moderately differentiated squamous cell carcinoma (Broders' grade II). **C** - Clinical appearance right after the second session with Er:YAG and Nd:YAG.

Figure 3. Moderately differentiated squamous cell carcinoma (Broders' grade II). **B** - Clinical appearance while in session of Erbium:YAG laser therapy.

Figure 3. Moderately differentiated squamous cell carcinoma (Broders' grade II). **D** - Significant clinical improvement and malignancy reduction (downgraded to PeIN II) after laser intervention.

Table1: Timeline and Therapeutic Intervention

Patient	Session 1 Parameters (Er:YAG)	Sessions 2-3 Parameters	Outcome
Case 1. cT1aN0M0	3 mm spot, 3Hz, 6 J/cm², multiple passes.	Session 2: 6.6 J/cm². Session 3: SP mode, 7 J/cm²	Biopsy: Chronic reparative inflammation; no neoplasia.
Case 2. cT1aN0M0	3 mm spot, SP mode, 7 J/cm², 3 Hz.	Sessions 2 & 3: Same parameters maintained	Biopsy: Squamous mucosa with focal atypia; no neoplasia.
Case 3. cT1aN0M0	3 mm spot, SP mode, 14 J/cm², 1.7 Hz.	Session 2 & 3: Nd:YAG - 4mm, versa mode, 100 J/cm², 1 Hz, 25 ms Er:YAG - 3mm spot, 7 J/cm², 3 Hz	Biopsy: Downgraded to PeIN grade II.

d) Follow-up and Outcomes

In Case 1, a 6-month follow-up biopsy confirmed no histological features of the neoplastic process, despite reactive hyperemia. Case 2 reported local hyperemia but no pain or burning; the final biopsy was compatible with reparative changes. Case 3 is currently awaiting a final confirmatory biopsy after showing a reduction in malignancy.

III. DISCUSSION

The use of laser therapy for the treatment of penile lesions, as demonstrated in this case series, represents an innovative and organ-preserving approach. The choice of the Erbium:YAG laser is based on its distinct properties of precise superficial tissue ablation with minimal thermal damage, owing to its high absorption coefficient in water. In this series, all patients achieved satisfactory clinical and histological remission, with no adverse effects or functional impairment. These results are consistent with previous literature and with what was expected by the multidisciplinary team.

The clinical success observed (remission and malignancy reduction) is linked to the laser's selective mechanism. By targeting water-rich neoplastic tissue until "pinpoint bleeding" is achieved, the clinician ensures deep enough ablation to remove diseased layers while stimulating healthy re-epithelialization [4]. However, the individualization of parameters remains a challenge for standardization. Limitations of this study include the small sample size and the need for longer follow-up to monitor for recurrence.

As demonstrated, the likely effectiveness of the Erbium:YAG laser in reducing the degree of malignancy and addressing HPV cytopathic changes, as observed in the cases, is directly linked to its physical and selective mechanism of action. The solid-state Erbium:YAG laser operates at a wavelength of 2,940 nm. This wavelength closely matches the peak water absorption rate in tissues. Because of this, the laser energy is intensely absorbed by the water present in the epidermis and papillary dermis [10]. This absorption, when applied to neoplastic lesions, generates “cellular irritation” with loss of homeostasis. This application technique, targeting “pinpoint bleeding,” ensures that the ablation has reached the desired depth, physically removing the diseased superficial layers. Because adjacent thermal damage is minimal, the Er:YAG laser can destroy superficial neoplastic tissue without damaging a large area of adjacent healthy tissue. This allows for lesion removal and stimulates the healing process [6]. Furthermore, the inclusion of the Nd:YAG (1,064 nm) modality in the last case was dictated by the lesion’s histological profile (moderately differentiated squamous cell carcinoma; Broders’ Grade II). Unlike the Er:YAG laser, whose penetration is restricted by its high superficial water affinity, the Nd:YAG laser possesses a significantly lower water absorption coefficient, granting it a superior capacity for deep tissue penetration [8]. This physical characteristic enables the induction of controlled thermal damage in dermal regions that pure superficial ablation may not reach, thereby complementing the Er:YAG action [11]. Although standardized protocols for this combined approach are currently scarce in the literature, the clinical outcomes were favorable, demonstrating the potential of multi-wavelength therapy for more infiltrative lesions.

Take-away Lesson: For selected penile neoplastic lesions, Er:YAG laser therapy can achieve disease control and organ preservation, avoiding radical procedures like penectomy.

IV. CONCLUSION

In summary, the presented cases demonstrate the potential of laser therapy as a treatment option for selected penile lesions, including squamous cell carcinoma. The main advantage lies in the possibility of organ preservation, with the consequent maintenance of sexual and urinary function and improved aesthetic results, thereby promoting the psychosocial well-being of the male patient, which is an integral part of the urological approach.

A significant difficulty in evaluating the outcomes of these cases is the absence of a standardized protocol and the scarcity of data in the literature to provide a basis for the specific use of these lasers for penile lesions. The patients' progress, although requiring additional sessions and rigorous follow-up, suggests that disease control can be achieved, thus avoiding more radical and mutilating procedures.

Finally, there is a clear need for more clinical studies, with a larger number of patients and long-term follow-up, to validate this technique and to develop clear clinical guidelines for its use.

V. DECLARATIONS

a) Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper. No financial or personal relationships with people or organizations have inappropriately influenced this work.

b) Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. The study was self-funded by the authors.

c) Ethical Approval and Informed Consent

This study was conducted in accordance with the ethical standards of the National Research Ethics Commission (CONEP) and the Declaration of Helsinki. The project was submitted and is awaiting approval by the Institutional Review Board (Research Ethics Committee - CEP).

Written informed consent was obtained from all patients for the publication of this case report and any accompanying images.

REFERENCES

1. T. S. Alster and J. R. Lupton, "An overview of cutaneous laser resurfacing.," *Clin. Plast. Surg.*, vol. 28, no. 1, pp. 37–52, Jan. 2001.
2. K. Riggs, M. Keller, and T. R. Humphreys, "Ablative laser resurfacing: high-energy pulsed carbon dioxide and erbium:yttrium-aluminum-garnet.," *Clin. Dermatol.*, vol. 25, no. 5, pp. 462–473, 2007, doi: 10.1016/j.clindermatol.2007.07.003.
3. K. Błochowiak, P. Andrysiak, K. Sidorowicz, H. Witmanowski, W. Hędzelek, and J. Sokalski, "Selected applications of Er:YAG and CO2 lasers for treatment of benign neoplasms and tumorous lesions in the mouth," *Postep. Dermatologii i Alergol.*, vol. 32, no. 5, pp. 337–343, 2015, doi: 10.5114/pdia.2015.48053.
4. R. J. Caniglia, "Erbium:YAG laser skin resurfacing.," *Facial Plast. Surg. Clin. North Am.*, vol. 12, no. 3, pp. 373–7, vii, Aug. 2004, doi: 10.1016/j.fsc.2004.03.005.
5. N. N. Nobari *et al.*, "A systematic review of the comparison between needling (RF-needling, meso-needling, and micro-needling) and ablative fractional lasers (CO(2), erbium YAG) in the treatment of atrophic and hypertrophic scars.," *Lasers Med. Sci.*, vol. 38, no. 1, p. 67, Feb. 2023, doi: 10.1007/s10103-022-03694-x.
6. J. D. Holcomb, "Versatility of erbium YAG laser: from fractional skin rejuvenation to full-field skin resurfacing.," *Facial Plast. Surg. Clin. North Am.*, vol. 19, no. 2, pp. 261–273, May 2011, doi: 10.1016/j.fsc.2011.04.005.
7. L. Baldaia, M. Dias-Neto, and J. Almeida Pinto, "Long-pulsed 1064nm Nd:YAG laser in the treatment of leg veins: Systematic review.," *Vascular*, vol. 33, no. 1, pp. 151–166, Feb. 2025, doi: 10.1177/17085381241236587.
8. J. Liu, C. Han, X. Feng, J. Liang, and Y. Qu, "Effective Picosecond Nd:YAG laser on seborrheic dermatitis and its mechanism.," *J. Cosmet. Dermatol.*, vol. 21, no. 6, pp. 2449–2457, Jun. 2022, doi: 10.1111/jocd.14414.
9. A. Kuszka, M. Gamper, C. Walser, J. Kociszewski, and V. Viereck, "Erbium:YAG laser treatment of female stress urinary incontinence: midterm data.," *Int. Urogynecol. J.*, vol. 31, no. 9, pp. 1859–1866, Sep. 2020, doi: 10.1007/s00192-019-04148-9.
10. M. E. Jasin, "Achieving superior resurfacing results with the erbium:YAG laser.," *Arch. Facial Plast. Surg.*, vol. 4, no. 4, pp. 262–266, 2002, doi: 10.1001/archfaci.4.4.262.
11. N. E. Estrin, V. Moraschini, Y. Zhang, G. E. Romanos, A. Sculean, and R. J. Miron, "Combination of Nd:YAG and Er:YAG lasers in non-surgical periodontal therapy: a systematic review of randomized clinical studies.," *Lasers Med. Sci.*, vol. 37, no. 6, pp. 2737–2743, Aug. 2022, doi: 10.1007/s10103-022-03548-6.