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Practice Points

Revisiting laser test spots: The paradigm shift with long-pulse potassium-titanyl-phosphate systems

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ABSTRACT

Laser test spots are critical tools in dermatologic laser therapy, enabling clinicians to assess both the clinical response and safety of laser parameters before full-scale treatment. Historically, test spots have lacked consistent methodology and documentation, limiting their utility in guiding effective treatment strategies. This paper explores the evolution of laser test spot practices, highlights their importance, and underscores the transformative potential of long-pulse potassium-titanyl-phosphate (KTP) lasers. With their advanced capabilities, including cryogen cooling and large spot sizes, KTP lasers are redefining the role of test spots by improving safety, precision, and treatment outcomes.

Keywords: Dermatology, KTP laser, Laser therapy, Potassium-titanyl-phosphate laser, Test spots

INTRODUCTION

In dermatologic laser treatments, laser test spots serve as a crucial preliminary step. These small-scale trials allow clinicians to evaluate clinical efficacy, predict safety outcomes and customize treatment plans. Test spots help gauge how the target skin or lesion will respond to specific laser parameters (e.g., fluence, pulse duration, and wavelength). Test spots also help identify the likelihood of adverse effects, such as post-inflammatory hyperpigmentation (PIH), scarring, purpura, or unwanted thermal damage. Furthermore, individual variability in skin type, lesion characteristics, and prior treatments necessitates a personalized medicine approach, making test spots invaluable.

Despite their importance, the methodology surrounding laser test spots has been inconsistent, often underreported or poorly described in published literature. This has led to variability in outcomes and a lack of standardized guidelines. Traditional lasers, such as pulsed dye lasers (PDL) and Nd systems, while effective in treating vascular and pigmented lesions, often require higher fluences or smaller spot sizes. These parameters increased the risk of adverse effects such as purpura, PIH, and thermal injury. Furthermore, there is a clear lack of standardized protocols, where laser test spot methods have varied widely, with no consensus on optimal location, size, or parameters. Early systems also lacked advanced cooling mechanisms, leading to higher rates of epidermal damage, and exposing limited safety measures.

The emergence of advanced laser systems, such as long-pulse potassium-titanyl-phosphate (KTP) lasers with integrated cryogen cooling, has addressed many of these challenges, offering safer and more predictable test spot outcomes.

METHODOLOGY

A literature review was conducted to synthesize findings from a scoping review of laser test spots and clinical case studies on vascular and pigmentary lesions. Key insights were drawn from 103 studies comprising 959 test spots conducted on human subjects. The analysis focused on the location of test spots (whether applied to lesional or non-lesional skin), laser parameters (variables such as wavelength, fluence, pulse duration, and spot size), and assessment objectives (safety, clinical efficacy, or both).

Current practices in laser test spots

1. Test Spot Locations: Most studies placed test spots on lesional skin (89.3%), reflecting a pragmatic approach to directly evaluate efficacy on the target area. However, this increases the risk of unintended adverse effects like hyperpigmentation in highly visible areas.
2. Parameter Adjustments: The most commonly adjusted parameter was fluence, either alone (30.1%) or in combination with pulse duration or spot size. These adjustments aimed to identify the lowest effective fluence to minimize adverse effects while achieving desired clinical outcomes.
3. Reassessment and Follow-Up: Test spots were reassessed at subsequent visits (ranging from 2 to 4 weeks) to evaluate both short-term efficacy and potential delayed adverse effects.

Innovations with long-pulse KTP lasers

The incorporation of long-pulse KTP lasers, particularly the Derma V system, into test spot protocols represents a significant advancement:

- Spot size and coverage: Spot sizes of 7–8 mm were used to simulate treatment conditions while reducing procedural variability.
- Fluence and pulse duration: Fluences of 5–8 J/cm^2 with a pulse duration of 10 ms allowed for effective targeting of vascular lesions without causing thermal injury to surrounding tissues.
- Cooling mechanism: Cryogen cooling (15/15 ms) protected the epidermis, significantly reducing the risk of dyspigmentation and scarring. This technology demonstrated particular value in treating darker skin types, where traditional lasers pose higher risks of complications.[1]

DISCUSSION

Test spots are an essential component of individualized laser therapy, offering a controlled means of predicting treatment outcomes. Their value lies in three primary functions:

1. Assessing treatment feasibility: By simulating full treatment conditions, test spots help determine whether the chosen parameters are likely to yield satisfactory results.
2. Identifying adverse effects: Early identification of complications such as erythema, hyperpigmentation, or scarring allows for proactive parameter adjustments.
3. Tailoring Treatments: Test spots enable clinicians to account for individual patient variability, such as skin type, lesion location, and prior treatment history.

There have been many challenges in the traditional approaches. Earlier laser systems, such as PDL and Nd lasers, faced significant limitations:

- Risk of Purpura: PDL often causes purpura due to high fluences and short pulse durations. While effective in vascular lesions, this side effect discouraged patient compliance.
- Epidermal Damage: Nd lasers, with their deeper penetration, carried a higher risk of scarring, particularly in areas with thin skin.
- Inconsistent Protocols: Test spot methodologies varied widely, from parameter selection to reassessment timelines, reducing reproducibility and reliability.

KTP lasers address many of these challenges by combining technical precision with patient safety. The 532 nm wavelength is ideal for targeting hemoglobin, while the system's ability to operate at lower fluences reduces thermal injury risks. Key advantages include:

1. Reduced Downtime: KTP lasers eliminate the need for purpura-inducing fluences, allowing for faster recovery
2. Safety in Diverse Skin Types: Cryogen cooling minimizes risks in darker skin types, where melanin absorption can exacerbate thermal damage
3. Broader Applications: Beyond vascular lesions, KTP lasers have demonstrated efficacy in treating erythema, telangiectasia, and PIH.[2]

Broader implications for dermatology

1. Expanding Patient Access: The reduced risk profile of KTP lasers makes them suitable for a wider range of patients, including those with sensitive or darker skin
2. Improved Standardization: The predictable outcomes associated with KTP test spots can serve as a basis for developing standardized protocols, enhancing consistency across clinics
3. Cost-Effectiveness: Although initial equipment costs are high, the reduced number of sessions required offsets long-term expenses.

Limitations and future directions

Despite their advantages, KTP lasers are not without limitations:

- High initial cost: The affordability of advanced systems like Derma V remains a barrier for smaller practices
- Limited long-term data: While short-term outcomes are promising, further research is needed to validate long-term efficacy and safety across diverse conditions
- Need for standardized guidelines: Establishing consensus on test spot protocols, including reassessment timelines and parameter ranges, is critical for widespread adoption.

LEARNING POINTS

1 Laser test spots remain inconsistently applied across clinical practice, highlighting the need for standardised protocols.
2 While test spots are often performed on lesional skin for direct assessment of efficacy, this increases the risk of visible adverse effects.
3 KTP lasers improve safety - particularly in darker skin types - by combining cryogen cooling with lower fluence delivery, reducing risks of purpura, hyperpigmentation, and scarring.
4 Reassessment at 2 to 4 weeks is essential to evaluate both immediate and delayed outcomes, including post-inflammatory hyperpigmentation (PIH).
5 Incorporating KTP systems represents a paradigm shift toward safer, more standardized, and patient-specific laser test spot protocols.

CONCLUSION

Laser test spots remain an indispensable tool in dermatologic practice, providing a foundation for safe and effective treatment planning. Advances in laser technology, particularly the introduction of long-pulse KTP lasers with cryogen cooling, have revolutionized this process. By addressing the limitations of older systems, KTP lasers enhance the precision and safety of test spots, making them a cornerstone of modern patient-centered care. The transformative role of KTP lasers lies in their ability to balance clinical efficacy with minimal adverse effects, paving the way for broader applications across skin types and conditions. Their advantages – such as large spot sizes, low fluences, and advanced cooling systems – enable safer and more predictable outcomes, even in challenging cases, including Port-Wine Stains or post-inflammatory erythema.

Future research should focus on:

1. Standardizing test spot methodologies to improve reproducibility.
2. Expanding long-term studies to validate outcomes across diverse populations.
3. Reducing costs to enhance accessibility and equity in laser dermatology.

In conclusion, the evolution of test spots, driven by technological advancements in KTP lasers, underscores their enduring importance in achieving the dual goals of efficacy and safety in dermatologic care. With continued innovation and research, laser test spots will remain a critical element in optimizing treatment outcomes and advancing the field of dermatology.

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