Clinical Evaluation of a Novel Blended Mode Diode Laser for Hair Removal

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Abstract

Introduction: Photoepilation by lasers is a popular procedure in aesthetic dermatology for removing unwanted body and facial hair. The use of the most appropriate laser wavelength is crucial as it affects treatment depth and melanin absorption. The three commonly used hair removal lasers are of specific wavelengths, 755nm, 810nm, and 1.064nm, each preferred for a certain type of skin and hair characteristics. The current evaluation reports the safety and efficacy of a unique blended mode 755/810nm and 810/1064nm diode lasers for hair removal.

Methods: Hair removal results from 50 patients treated with the 755/810nm handpiece and 50 patients treated with the 810/1064nm handpiece were gathered from a few clinics. 3 treatments on various body areas were conducted 6 weeks apart and patients were followed 6 months after the last treatment. Results were evaluated by baseline and follow-up photographs and hair counts.

Results: Treatment area photos demonstrated hair reduction in the treated body and facial areas. Average hair count reduction at 6 months follow-up was 84% for the 755/810nm handpiece and 81% for the 810/1064nm handpiece. No significant or unexpected adverse events were detected in any of the patients.

Conclusions: The novel blended mode hair removal diode lasers are proven to be safe and effective for hair removal in facial and body areas, for patients of various skin types and hair characteristics.

Running Title: Blended mode laser for hair removal

Key words: Laser hair removal, 755nm diode laser, 810nm diode laser, 1064nm diode laser
1 Introduction

Laser hair removal treatment is based on the principle of selective photothermolysis. In this process, the absorbed optical energy is converted into heat, coagulating the hair follicle\textsuperscript{1}. There are relatively preferential wavelengths for melanin absorption. At three specific wavelengths, 755nm, 810nm, and 1,064nm, absorption by melanin is greater than competitive absorption by oxyhemoglobin and water. These wavelengths correspond to three popular hair removal lasers: 755nm alexandrite, 810nm diode, and 1,064nm Nd:YAG lasers\textsuperscript{2}.

Numerous published clinical studies are demonstrating the safety and efficacy of different lasers at various wavelengths for hair removal\textsuperscript{1,3}.

Based on clinical evidence, hair removal diode lasers of 810nm are considered as the universal hair removal for all skin types, and these lasers are commonly used in the market\textsuperscript{1-3}. Light color or fine hair may be resistant to the treatment due to scarcity of pigmentation in the hair shaft, whereas treatment of dark skin type patients is difficult due to skin melanin absorption\textsuperscript{1}. Light color and fine hair respond better to 755nm, while a wavelength of 1064nm is more suitable for dark skin\textsuperscript{2}.

Recently new diode lasers of 755nm and 1064nm were developed to enable suitable diode laser treatments for a wide variety of skin and hair types\textsuperscript{4-6}.

This manuscript describes the evaluation of a newly developed device with two different handpieces generating optical energy from diode bars at 755 and 810nm simultaneously and at 810 and 1064nm simultaneously. The novel blended wavelengths handpieces are applied to the skin for selective hair removal for a variety of hair and skin types.

The manuscript presents results of a multicenter evaluation of the the blended wavelength modes lasers 755/810nm and 810/1064nm for hair removal.

2 Material and Methods

The Device

The InMode Triton/DiolazeXL device (InMode MD Ltd., Invasix Corp, Canada) is designed to deliver optical energy to the skin via a pre-cooled sapphire block. The good optical contact between the sapphire block and the skin is achieved by using water-based gel. The device provides individual adjustment of light fluence and pulse duration to achieve maximum efficiency and safety for each patient. The hand piece has integrated skin cooling to enhance safety and comfort of the treatment.

The device is shown in Figure 1.
The diode laser hand pieces are available in 3 wavelength configurations:
Mix of 755nm/810nm, 810nm alone and a mix of 810nm/1064nm.

Each of the hand pieces comprises a diode laser stack with 20 diode laser bars stacked vertically. In the blended modes the corresponding diode bars are alternated and the two wavelengths of 755/810 or 810/1064 are emitted simultaneously through a chilled sapphire light guide.

A schematic representation of the alternating diode bars is illustrated in figure 2.

1. Figure 2: Illustration of the diode bars in the blended mode handpieces. 755/810nm (Left) and 810/1064nm (Right).

The diode laser produces up to 3000W peak optical power.

The sapphire light guide is located at the front of the hand piece and delivers the laser beam energy to the treated tissue, while cooling the skin. The sapphire block is surrounded by a chilled gold-plated metal frame. This structure provides increased cooling to a temperature of about 7ºC of the treatment spot and a few millimeters around

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The handpiece cooling flow is demonstrated in Figure 3. The arrow indicates the tip progress direction on the skin. One part of the metal frame is responsible for pre-cooling, the sapphire light guide is responsible for the cooling stage and the other part of the metal frame is responsible for post cooling during handpiece progression.

The dimensions of the sapphire light guide are 11mm x 27.5mm.

A temperature sensor is located on the enclosure of the sapphire cooler and measures the temperature of the tissue cooler to ensure stable sapphire temperature.

**Evaluation Design**

The objectives of this multicenter evaluation were to gather safety and efficacy hair removal data of the newly developed diode laser blended modes 755/810nm and 810/1064nm hand pieces.

Results from 50 subjects treated with the 755/810nm handpiece and 50 subjects who were treated with the 810/1064nm handpiece were accumulated from a few clinics in the USA, France and Canada.

Subjects underwent 3 treatment sessions 6 weeks apart and were followed 6 months post their last treatment.

Subjects were treated in different areas such as the legs, underarms, bikini, chest, back and face.

The study efficacy was assessed by average hair reduction at 6 months follow-up visit comparing to baseline count. Hair counts were performed on photographs taken form the subjects’ treatment areas.

Safety of the device was evaluated by assessing the incidence, severity and persistence of adverse events, if occurred during the study period.
Photography

Photos of the treatment areas were taken at baseline and at 6 months follow-up visit in a reproducible manner. The hair was trimmed to 1-3mm length and the area before trimming as well as the trimmed area was photographed.

Hair counts were performed by marking visible hairs on photographs of subjects’ treatment area. Figure 4 demonstrates counting examples.

![Figure 4: Example of hair counts conducted in photos before (Left) and at follow-up visit (Right).](image)

3 Results

Hair removal results from 50 subjects treated with the 755/810nm laser and 50 subjects treated with the 810/1064nm laser were included in the study. All subjects had completed all treatment and follow-up regimen.

Results of hair removal using the 755/810nm handpiece

44 female subjects and 6 male subjects, who requested hair removal treatments were treated with the 755/810nm handpiece. The mean subject age was 25.4 with minimum and maximum age of 19 and 36, correspondingly. Subjects had the following Fitzpatrick skin types: type II (66%) and type III (34%).

Subjects were treated on various treatment areas for hair removal with the 755/810nm blended mode hand piece including underarm, bikini, legs, face, men’s' back and chest.

Analysis of hair count change from baseline to 6 months follow up (Table 1) resulted in a weighted average hair count reduction of 84% (range of 75-89%).
Table 1: Weighted average hair count reduction according to different treatment areas

<table>
<thead>
<tr>
<th>Treatment area</th>
<th>No.</th>
<th>Average % Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underarm</td>
<td>12</td>
<td>88</td>
</tr>
<tr>
<td>Bikini</td>
<td>13</td>
<td>86</td>
</tr>
<tr>
<td>Leg</td>
<td>13</td>
<td>83</td>
</tr>
<tr>
<td>Face</td>
<td>6</td>
<td>75</td>
</tr>
<tr>
<td>Back</td>
<td>3</td>
<td>78</td>
</tr>
<tr>
<td>Chest</td>
<td>3</td>
<td>77</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>84</td>
</tr>
</tbody>
</table>

Representative photos of various areas treated with the 755/810nm diode laser handpiece taken at baseline and at 6 months follow-up time points are presented below in Figures 5-7.

Figure 5: Leg treated with 755/810 handpiece at baseline (Left) and at 6 months after last treatment (Right).

Figure 6: Underarm treated with 755/810 hand piece at baseline (Left) and at 6 months after last treatment (Right).
Figure 7: Underarm treated with 755/810 hand piece at baseline (Left) and at 6 months after last treatment (Right).

Results of hair removal using the 810/1064nm handpiece

50 female subjects who were interested in hair removal treatments were treated with the 810/1064nm handpiece. The mean subject age was 24 with a range of 19-36. Subjects had the following Fitzpatrick skin types: type IV (37.5%), type V (41.5%) and type VI (21%).

Subjects were treated on various treatment areas for hair removal with the 810/1064nm blended mode handpiece, including underarm, bikini, legs and face.

Analysis of hair count change from baseline to 6 months follow up resulted in an average weighted hair count reduction of 81% (range of 70-84%).

Table 2: Weighted average hair count reduction according to different treatment areas

<table>
<thead>
<tr>
<th>Treatment area</th>
<th>No.</th>
<th>Average % Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underarm</td>
<td>14</td>
<td>84</td>
</tr>
<tr>
<td>Bikini</td>
<td>15</td>
<td>82</td>
</tr>
<tr>
<td>Leg</td>
<td>15</td>
<td>81</td>
</tr>
<tr>
<td>Face</td>
<td>6</td>
<td>70</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>81</td>
</tr>
</tbody>
</table>

Representative photos of various areas treated with the 810/1064nm diode laser handpiece taken at baseline and at 6 months follow-up time points are presented below in Figures 8-10.
Figure 8: Face of a dark skin type subject treated with 810/1064 handpiece at baseline (Left) and at 6 months after last treatment (Right).

Figure 9: Knee of a dark skin type subject treated with 810/1064 handpiece at baseline (Left) and at 6 months after last treatment (Right).

Figure 10: Leg of a dark skin type subject treated with 810/1064 hand piece at baseline (Left) and at 6 months after last treatment (Right).
Safety Analysis

No unexpected or severe adverse events were reported. Mild erythema and edema that appeared following the treatment subsided shortly.

4 Discussion

Hair removal with lasers and light sources is considered as a superior treatment modality comparing to conventional methods such as shaving, waxing and electrolysis.

The choice of an optimal laser for the individual patient is critical for treatment success and safety. One should take into consideration the patient's skin and hair types to match laser wavelength that will reflect melanin absorption and penetration depth.

The wavelength range of 650 to 1300nm is considered generally suitable for typical depth of hair from 1mm to 3mm. The best penetration depth is around 1060nm corresponding to Nd:YAG laser, but in this wavelength absorption in hair melanin is relatively low and efficacy of treatment is not very high. The maximal efficacy is around 650-700nm but penetration depth is limited at this wavelength.

A wavelength of 755nm is considered very effective for light skin treatment while 1064nm Nd:YAG laser became popular for hair removal on dark skin patients but mostly black coarse hair responded to treatment.

One of the compromises between these two ranges is the use of 810nm diode which has better penetration depth than 755nm and much higher absorption coefficient of melanin than Nd:YAG laser. Sometimes better tuning of wavelength is desired especially for darker skin and non-black hairs.

For dark skin it would be a logical step to use a wavelength in between 810nm and 1064nm but a peak of light absorption by water in this range makes these wavelengths less effective for treatment. In addition, not all wavelengths are available in the market because of technology limitations.

One of the solutions is to use combination of two wavelengths which are already well known and clinically proven for laser hair removal treatment.

The use of combination of 810nm and 1064nm would improve penetration depth and safety for darker skin while keeping relatively high efficacy of treatment.

Combination of 755nm and 810nm would allow optimization of treatment for different hair colors.

Because all these wavelengths are recognized as safe and effective for hair removal the combination of the wavelength does not seem to raise any safety issues and enables efficacy optimization.
The novel diode laser Triton/DiolazeXL with the blended mode of wavelengths, 755/810nm and 810/1064nm, enables a range of penetration depths and hair melanin absorption. Figure 11 illustrates the different penetration of the two blended mode lasers.

**Figure 11:** An Illustration of the interaction between the blended mode lasers and the hair structure. 810/1064 (Left) and 755/810 (Right) at various depths.

Clinical experience supports the safety and efficacy of both handpieces for hair removal on light and dark skin in various body and facial areas with various hair types.

The current evaluation demonstrated treatment results from female and male subjects who underwent 3 treatment sessions 6 weeks apart and were followed 6 months following their last treatment. As expected, due to better absorption in melanin of the lower wavelength, subjects treated with 755/810nm hand piece displayed slightly better hair reduction results (average reduction of 84%) than those treated with 810/1064nm hand piece (average reduction of 81%). Comparing different treatment areas, underarms presented the best hair reduction, as expected from a relatively lighter skin and coarser darker hair in these areas. The same applies to bikini areas, but to a slightly lesser degree. The legs that usually have finer hair than underarm and bikini exhibited less hair reduction, as well as deeper hair on men’s back and chest. The lowest percent of hair reduction was expressed on face due to its very fine hair with a limited amount of melanin. All the above is applicable to both handpieces, 755/810nm and 810/1064nm.

No unexpected adverse events were reported in this study.

The clinical data presented here demonstrate that the unique blended mode of wavelengths, 755/810nm and 810/1064nm, have proven to be safe and effective lasers for hair removal on light and dark skin.

The novel combination approach enables more accurate and personalized treatment, thus maximizing hair removal results while minimizing treatment risks. More studies
are planned to further substantiate the potential clinical contribution of the newly developed blended wavelengths concept.

5 References