

# Beyond pigment : dermal remodeling with the PicoPlus picosecond laser. My personal experience in enlarged pores, acne scars & hypertrophic scars.



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## Abstract

The PicoPlus™ laser from Lutronic, Goyang, South Korea, is an evolutionary system entering the picosecond (ps) domain following on from, and building on, the very successful series of nanosecond (ns) Q-switched Nd:YAG lasers developed by the manufacturer over the previous decade and a half. With a 450 ps pulsewidth, approximately an order of magnitude shorter than that of the proven ns-domain systems, tissue reaction moves more into the photomechanical from the photothermal. As a result, treatment times in pigmented lesions can be shorter, with greater efficacy, fewer side effects and a shorter downtime. I have found that the PicoPlus, with its versatile collection of handpieces, not only deal with complex pigmented lesions, but can also offer effective treatment in nonpigmented cutaneous conditions, such as enlarged pores, acne and hypertrophic scars, using a multimodal approach. This combination approach makes use of both the multiple handpieces, and the two pulsewidths (ns and ps) available with the system. The current article presents a cross-section of my personal experience with this multifunctional system over the past 18 months, during which the PicoPlus has become an essential treatment option in my clinic.

**Key words:** Picosecond laser; photomechanical effect; selective mechanolysis; stress relaxation time; LIOB; combination treatment.

## INTRODUCTION

The PicoPlus is a Nd:YAG laser operating in the picosecond (ps) domain with a pulsewidth of 450 ps. Four wavelengths of ps laser energy are available, namely 1064 nm, 532 nm, 595 nm and 660 nm. In addition to the 450 ps pulsewidth, the system can also emit a 2 nanosecond (ns) pulsewidth laser beam.

A picosecond is one trillionth of a second, or  $1 \times 10^{-12}$  s. For any given fluence, a shorter pulsewidth creates a higher peak power density in the tissue. In other words, at the same energy density, the ps laser can produce a much higher peak power density than the nanosecond laser. For an energy density, or fluence, of  $1 \text{ J/cm}^2$ , a 5 ns laser will develop  $200 \text{ MW/cm}^2$  in the target tissue. At 450 ps, the same  $1 \text{ J/cm}^2$  gives a peak power density of  $2.3 \text{ GW/cm}^2$ , as illustrated in Figure 1.

At such a short pulsewidth, the ps laser maximizes a photomechanical effect with less photothermal effect compared to the nanosecond laser [Figure 2]. The photomechanical effect is related to the generation of physical force or stress within the target, not the concept of intense photothermal production. This can be explained by the stress relaxation time (SRT) associated with the ps-domain laser, which is the time that a target chromophore is stressed to destruction with no thermal damage to surrounding tissue, compared to the thermal relaxation time associated with the ns-domain laser. We move from selective photothermolysis to super-selective photomechanolysis.

Because the ps laser can create high peak power in a shorter

period of time, the physical phenomenon of explosion and expansion becomes stronger than the ns laser. Therefore, the ps laser can treat the skin lesions with less heat damage than the ns laser, even at low fluences.

NANO VS. PICO

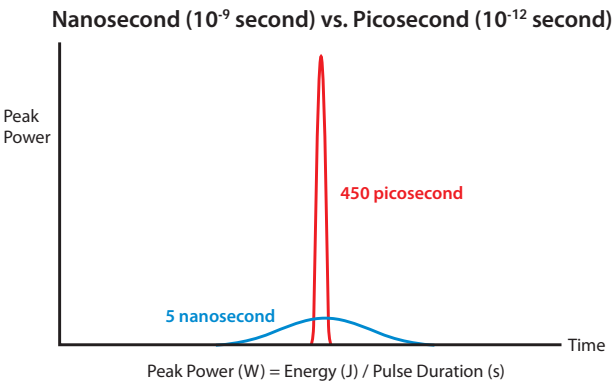


Fig 1.  
Graphic comparison of peak power density achieved between a picosecond laser and a Q-switched nanosecond laser for the same fluence (Details of peak power densities in the text).

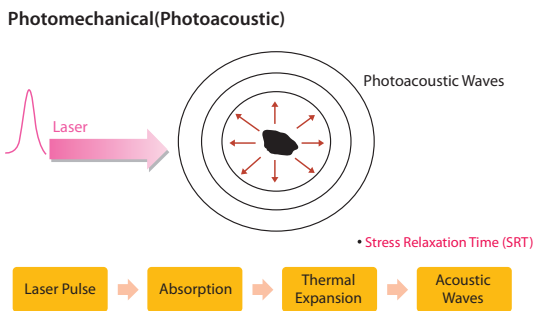


Fig 2.  
Mechanism of the photomechanical effect

PRACTICAL CLINICAL CONCEPTS

Treatment of Complex Pigmented Lesions and Hypertrophic Scars with the PicoPlus System using combined technologies

As mentioned above, the PicoPlus offers both the ps-domain pulsewidth, and a pulsewidth in the ns-domain. These pulsewidths have different reactions in tissue, and I have found that they can be used in combination treatment to achieve very good results in complex conditions. In addition, the system comes with a comprehensive series of handpieces. These include the more conventional focused zoom and focused collimated handpieces operating at both 1064 nm and 532 nm, in addition to two dye-based handpieces delivering a visible yellow 595 nm and visible red 660 nm beam, known respectively as the ‘Gold Toning’ and ‘RuVY Touch+’ handpieces. What makes PicoPlus unique is that it also has two fractional handpieces. The first of these was based on the diffractive optical element (DOE) technology and the more recent and more advanced fractional handpiece is based on microlens array (MLA) technology, (Hexa). They are known simply as the DOE and MLA focused dots (FD) handpieces, because they deliver microbeams which are focused into the tissue, not onto the tissue. The MLA FD handpiece is further differentiated because it can deliver both 532 nm and 1064 nm laser energy, and is therefore known as the dual focused dots handpiece. Both these fractional handpieces can control energy precisely at low fluences, which is an essential and beneficial characteristic of the ps laser. Procedures using these low fluences with the MLA and DOE FD handpieces work really well with pigmented lesions, but to broaden our treatment options they can also be applied for scars and wrinkle treatment.

When patients have complex skin lesions such as solar lentigines, melasma, enlarged pores and others, I prefer a combination of treatment modes consisting of both the ns domain and the ps domain. When I treat a patient who has melasma and solar lentigo, I start the treatment by using Q-switched nanosecond laser toning and then use the PicoPlus DOE focused dots (FD) handpiece [Figure 3]. In case of a melasma patient who is no longer responsive to QSND laser toning, I occasionally treat with the DOE FD handpiece (0.4 J/cm<sup>2</sup>, 10 Hz) alone.

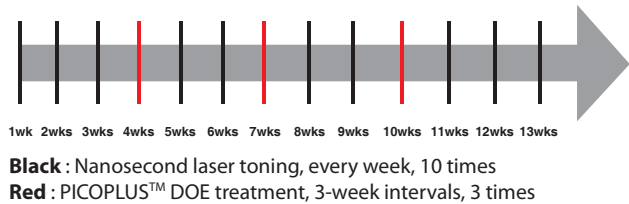


Figure 3.  
Combination treatment for complex pigment skin lesions

Both the PicoPlus FD fractional handpieces produce prominent dermal rejuvenation and this effect can be utilized for the treatment of various kinds of scars. Sometimes, I have been using the DOE or MLA FD handpieces to treat hypertrophic scars.

When a doctor uses the two PicoPlus FD fractional handpieces, patients experience only mild erythema and petechiae which can be covered by make-up and resolve spontaneously within 3 to 4 days. Because of short downtime and the prominent dermal rejuvenation effect, procedures performed with these FD fractional handpieces can be performed safely at an interval of 2-3 weeks.

My PicoPlus Treatment of Enlarged Pores and Acne Scars

1) PicoPlus Fractional Handpieces

As already mentioned, the Lutronic PicoPlus can be used with either the MLA or DOE focused dots fractional handpieces (Table 1). These handpieces are very effective in the treatment of enlarged pores and acne scars.

In more detail, the DOE FD handpiece produces a 7.4 x 7.4 mm square shape 1064 nm laser beam and is mainly used for the treatment of lax skin texture, enlarged pores and fine wrinkles. Unlike the DOE FD handpiece, the MLA FD handpiece can be used with both the 1064 nm and 532 nm laser wavelengths. The MLA FD handpiece delivers a circular beam, and the size is adjustable. In addition, the focal length of the lens array is also adjustable. These characteristics of the MLA FD handpiece are useful when doctors want to treat a variety of acne scars.

Properties	Handpiece	
	Focused Dots Handpiece (DOE)	Dual Focused Dots Handpiece (MLA)
Wavelength	1064 nm	532, 1064 nm
Scan Shape	Square ■	Round ●
Scan Size	7.4 × 7.4 mm	4-10 mm Ø @ 1064 nm 3.3-9.0 mm Ø @ 532 nm
Micro-beam Size	100 µm	3 steps adjustable (min. 150 µm – max. 300 µm)
Indications	Pores, Texture, Pigment	1064 MLA: various kinds of scars 532 MLA: epidermal and dermal pigmentation
Images		

Table 1.  
Technical specification comparison and images of the two PicoPlus fractional focused dots handpieces

2) LIOB (Laser Induced Optical Breakdown)

The LIOB phenomenon is one of the important basics of the effects associated with the ps laser. When a laser beam with a high power density is absorbed in its target, the very high energy causes dissociation in the atoms making up the target, which splits off electrons, referred to as a photoionization phenomenon.

As the numbers of emitted electrons increase and gather without spreading, they form a state of charged particles called plasma. If the laser irradiation is applied for a sufficient time, the volume of the plasma increases enough to damage the tissue in the form of a blister-like structure or vacuole in the tissue, and that is a laser-induced optical breakdown (LIOB). LIOBs are a histological finding which can be also created by the ns laser. However the ps laser produces a stronger photomechanical effect and higher peak power density than the ns laser, so the ps laser can generate larger and denser LIOBs thus causing marked dermal disruption [Figure 4].

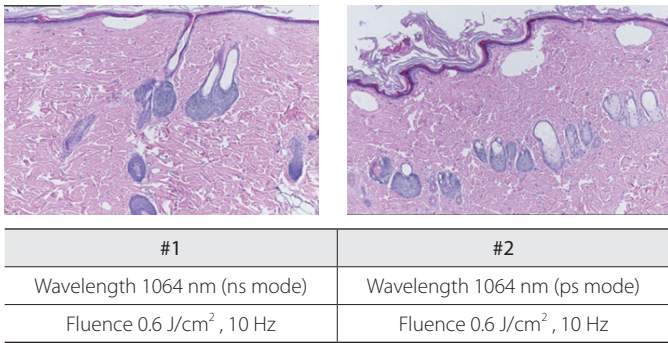


Fig. 4.  
Histological findings in albino rat skin immediately after PicoPlus DOE FD irradiation in both ns mode (left) & ps mode (right) at the same parameters. Much more prominent LIOBs are seen in the ps mode-irradiated tissue compared with the ns-irradiated tissue. (Hematoxylin and eosin stain).

The histological finding at 10 days after DOE FD ps mode irradiation (0.6 J/cm<sup>2</sup>, 10 Hz) showed that the wound healing process was going well. After 21 days, furthermore, the wound healing process was complete and new collagen regeneration could be observed in the dermis [Figure 5].

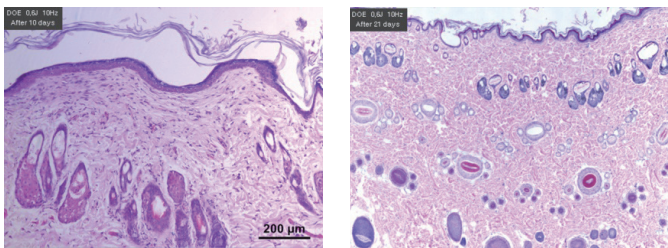


Fig. 5.  
Histological findings in albino rat skin at 10 (left) and 21 days (right) after DOE FD ps mode irradiation. Note the progression of LIOB-induced wound healing. Neocollagenesis with some inflammatory infiltrate is seen on the left at 10 days, with absence of inflammatory response and complete healing of the tissue on the right at 21 days. (Hematoxylin and eosin staining, scale bar as shown)

3) Treatment of Enlarge Pores and Acne Scars by using Two Types Fractional Handpieces

When I treat enlarged pores, I prefer to use the DOE FD handpiece (0.6 J/cm<sup>2</sup>, 10 Hz). On average, 3-5 sessions are usually required and the treatment interval is 2-3 weeks depending on the patient's skin type. The end point is based on the erythema of the entire face. The erythema usually lasts for 3-4 days and it can be covered with make-up. To improve enlarged pores, a strong output is not needed. Therefore the 7.4 x 7.4 mm fractional laser beam of DOE FD handpiece is enough.

As for acne scars, laser resurfacing was the main treatment modality for depressed acne scars in the past. Currently, however, a number of different treatment options are being developed and are being introduced continuously. Among them, I would like to explain my combination treatment technique which consists of the ps laser fractional MLA FD treatment coupled with hyaluronic acid (HA) filler subdermally injected.

Before injecting filler underneath depressed acne scars, I divide the filler into 0.3 cc Becton Dickinson (BD) syringes. Personally, I find, Belotero Soft™ and Balance™ (Mertz, Germany) to be the most appropriate fillers for this combination treatment. First, I inject filler underneath the depressed acne scars. The amount of filler which is injected under the acne scars depends on



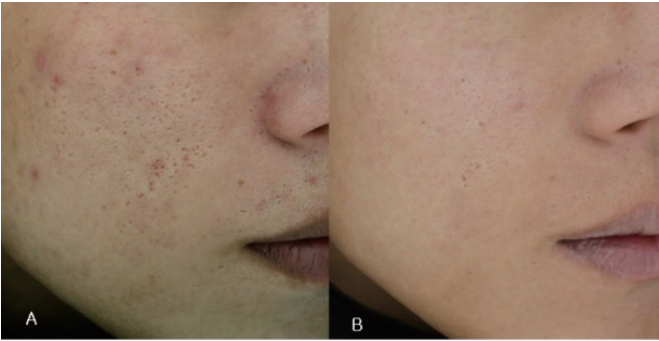
the size and the shape of the scars. On average, 0.03-0.1 cc of HA filler is injected. After filler injection, I treat the scars with the MLA FD handpiece. The parameters are as follows: Laser beam, 6 mm diameter; Fluence, 1.4 J/cm<sup>2</sup>; Repetition rate, 5 Hz; Focal length, Step 1. The end point is petechiae over the acne scars and 4-5 shots for one acne scar are enough to generate petechiae. Depending on the severity of the patient's acne scars, it will take 15 to 20 minutes to treat both cheeks and downtime is generally 3-4 days.

Because treatment with the PicoPlus MLA FD handpiece induces less heat damage and epidermal damage than conventional fractional lasers, the MLA FD treatment shows not only a quicker recovery but also a lower risk of side effects such as post-inflammatory hyperpigmentation or hypopigmentation.

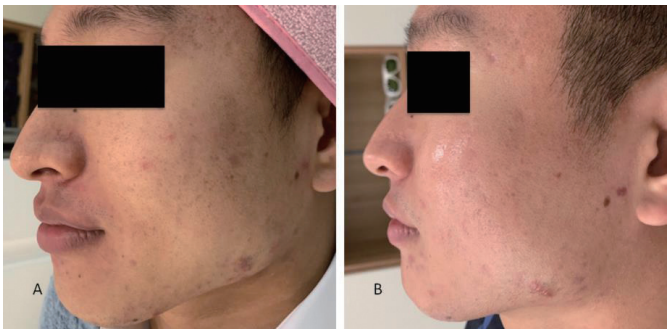
### Case reports

The first case is a 32-year-old male patient. His chief complaint was multiple depressed acne scars. I treated him 4 times at a 2-3 weeks interval with my combination therapy of HA filler injection and the MLA FD handpiece [Figure 6]. Vascular compromise could be a possible concern in the treatment protocol. However, since a small amount of HA filler is superficially injected, there is little possibility of vascular compromise.

The second case is a 29-year-old male patient. His chief complaints were multiple inflammatory acne and depressed acne scars. The HA filler was injected underneath the acne scars at a rate of 0.03-0.05cc per point and the scars were then treated with the MLA FD handpiece. The energy level was enough to generate petechiae (6 mm, 1.3 J/cm<sup>2</sup>, 5 Hz, Step 1, up to 10 shots). For improvement of the overall skin texture and enlarged pores, an additional procedure was given using the DOE FD handpiece (0.55 J/cm<sup>2</sup>, 10 Hz, 3,000 shots across the face) [Figure 7].

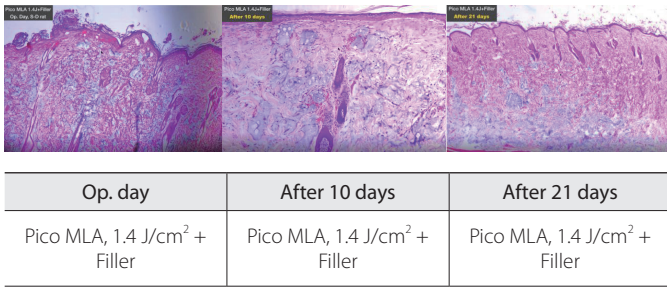


**Fig. 6.**  
Depressed acne scar case (A) Before treatment, (B) After 4 Times treatments at a 2-3 weeks interval with Belotero Balance™ + chemical reconstruction of skin scars (CROSS - 100% TCA Chemical Peel) + MLA FD 1064 nm, Step 1, 6 mm diameter, 1.4 J/cm<sup>2</sup>



**Fig. 7.**  
Inflammatory and depressed acne scars case (A) Before treatment, (B) After Treatment: Belotero Balance™ + MLA FD, 1064 nm, 6 mm diameter, 1.3 J/cm<sup>2</sup>, Step 1, 5 Hz followed by DOE FD, 0.55 J/cm<sup>2</sup>, 10 Hz, 3000 Shots.

The safety and efficacy of the combination treatment techniques were examined in an animal model experiment. The histology showed that the HA filler was injected well into the upper and mid dermis on the first day of treatment. After 10 days of the treatment, wound healing was progressing normally and HA filler was well-settled in the dermis. At 3 weeks after the treatment, the HA filler could still be observed in the dermis and no inflammatory or immune reaction could be observed [Figure 8].



**Fig. 8.**  
Histological findings in an animal model after combination therapy with HA filler injection and treatment with the MLA FD handpiece at the parameters shown. See the text for details.

### Conclusion

Because the ps laser has a shorter laser pulsewidth than the ns laser, in ps laser treatment the photothermal effect is decreased and the photomechanical effect is maximized. This characteristic of the ps laser minimizes heat damage to the tissue. With the ability to combine both ns and ps pulsewidths and the two types of fractional focused dots handpieces, which are characteristics unique to the PicoPlus system, I have found it very effective for clearance of pigmented lesions, improvement of enlarged pores, revision of various kinds of scars, and dermal rejuvenation. Personally, I expect that this combination treatment technique will become one of the promising treatments for depressed acne scars and enlarged pores as well as dermal rejuvenation. In addition, the indications of the ps laser will be expanded gradually through additional research and the accumulation of more clinical data.