PSR Technology Creates Unique Surface Microenvironment for Skin Regeneration

By Bob Kronemyer, Associate Editor

Gas plasmas have been used in surgical devices for many years to achieve superficial tissue coagulation. Typically, ionized gas acts as a conducting pathway to deliver radiofrequency (RF) energy with the amount of plasma energy relatively small.

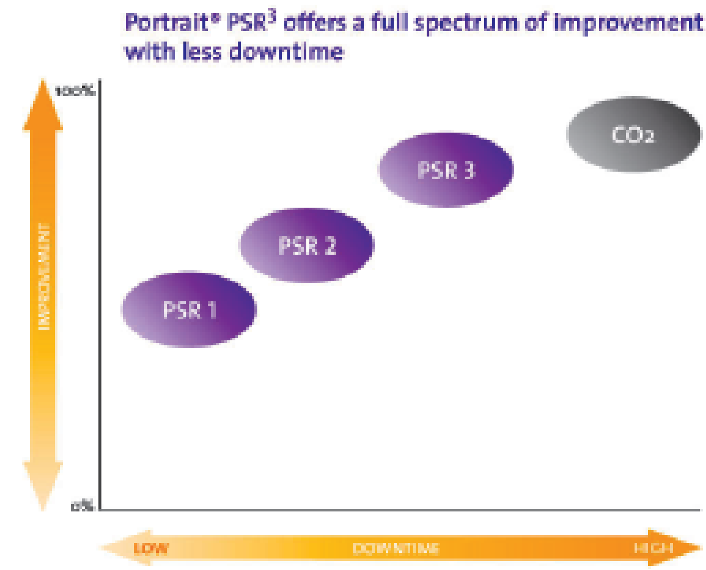
In contrast, the new Rhytec Portrait PSR uses ultra high frequency RF (UHF) energy to ionize a flow of nitrogen gas, producing millisecond pulses of plasma with no UHF energy delivered to the skin. The plasma, characterized by a lilac glow transitioning to a yellowish light called a Lewis-Rayleigh Afterglow as it flows from the handpiece nozzle, produces short-lived rapid elevations in the skin's surface temperature. The result is a uniform and efficient distribution of energy into the dermis.

This is much different than working with high-energy lasers, because the disruptive effect of energy conversion through an intermediate chromophore is avoided. The depth and area of thermal effect are determined by the amount of energy being delivered and the diameter of the various nozzles. Energy settings range from 1 - 4 Joules. The Portrait® PSR³ generator includes a self calibration feature to verify the energy being delivered matches levels set at the beginning of each procedure.

The important clinical reason for selecting nitrogen is that it purges oxygen from the skin's surface so that oxidative carbonization is minimized, eliminating unpredictable hot spots and charring that can produce scarring. The presence of inert nitrogen flowing after the delivery of plasma, combined with the thermal relaxation between pulses, preserves the treated epidermis, a unique attribute of Portrait PSR³ that offers faster healing and supports this unique surface microenvironment for skin regeneration.

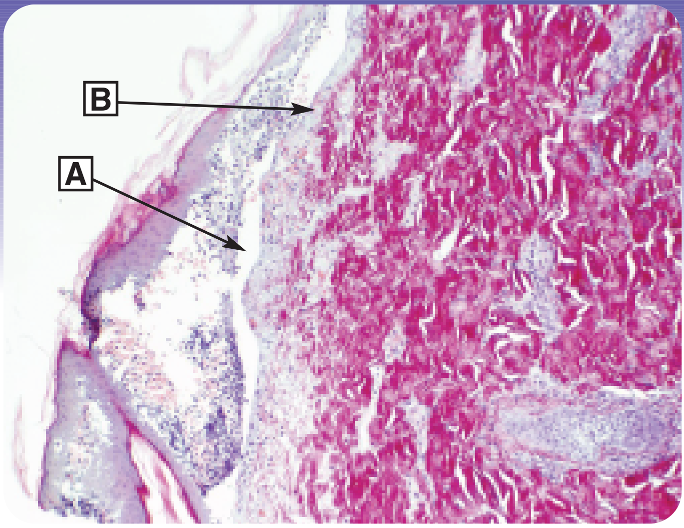
Plasma pulse from the Rhytec Portrait PSR³ handpiece nozzle is characterized by a lilac glow transitioning to a yellowish light called a Lewis-Rayleigh Afterglow.

Inside the handpiece is a tungsten resonator within a quartz tube for plasma generation. It is subjected to the high temperatures of plasma formation and erodes during use; replacement is automatically indicated by the generator. The handpiece includes a non-contact targeting feature that assists in creating a series of non-overlapping pulses 5 mm from the skin's surface. The frequency of pulses can be varied based on user experience and the area of skin being treated. Upon impact, rapid heating occurs; heating of the upper dermis is through thermal conduction from the skin's surface. A wide range of skin types can be treated with plasma given its comparatively low levels of optical energy and significantly less chromophore dependency than a laser. It is easy to learn and use Portrait PSR³, which is similar to using an airbrush, including the ability to feather and blend the treatment edges.



Pre-clinical studies using a porcine model were performed to benchmark tissue effects against the Coherent Ultrapulse CO_2 laser. Five-micron sections from a strip biopsy, taken at various times following treatment, were stained with hematoxylin and eosin (H&E) and picrosirius red.

These experiments confirmed the unique range of energy-dependent effects that can be achieved using Portrait PSR³ - from a non-wounding rejuvenation in which only superficial layers of the stratum corneum are sloughed, to an ablative effect similar to resurfacing in which the upper dermis is sloughed. Across the treatment range, intense regeneration of the reticular architecture of the upper dermis has been observed in response to thermal modification.

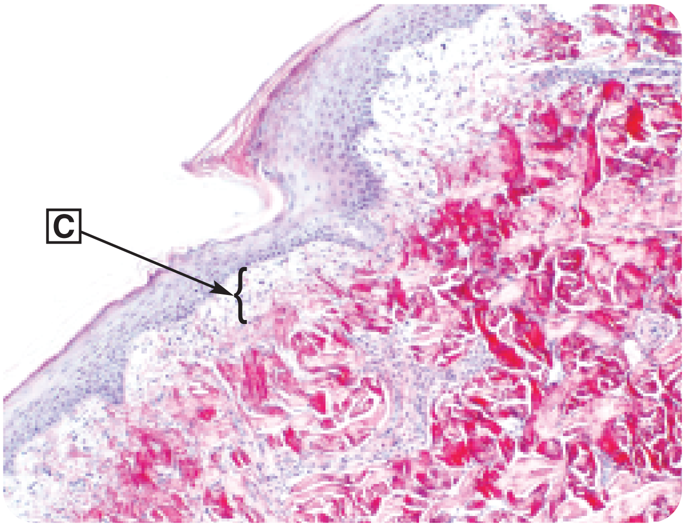


Slide 1: Day four following treatment at 3.5 J. Epidermis and upper dermis separate along a line of cleavage (A). New epidermis regenerates over the zone of thermally modified dermis (B). (Picrosirius red unpolarized.)

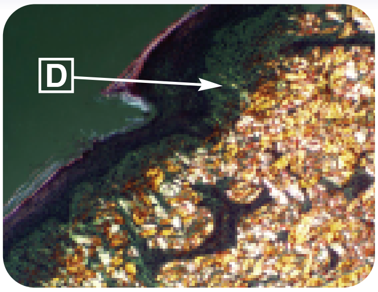
Slide 1 typifies the healing profile at day four after a high energy treatment in which the upper dermis and epidermis are shed and a new epidermis regenerates in the line of cleavage of the dermis. The depth of this line of cleavage is energy dependent; at the lowest energy setting (1 J) the cleavage occurs at five to six cells deep from the stratum corneum.

Beneath the line of cleavage is a zone of residual thermal modification that does not become apparent until the epidermis has completely healed (Slide 2). This zone undergoes a regenerative process, in which the old reticular architecture is progressively replaced. This new architecture is formed by fibroblasts recruited deep to the zone of thermal modification with fresh collagen evident from day ten, as seen in Slide 3.

Results from the clinical studies to date imply that this healing profile produces a range of clinical benefits to photo-damaged skin. At high levels of energy (ablative) the shedding of the upper dermis eliminates the area most subjected to sun damage and elastotic changes. Deeper areas of elastosis in the zone of thermal modification are then replaced by a regenerative process mediated by fibroblasts migrating from the deeper dermis that have been less exposed to UV. This leads to restoration of more normal mechanical and physiological functions of the dermis, leading to a healthier tone and appearance beyond just the reduction in fine lines, wrinkles, and dyschromia that have been demonstrated to accompany clinical treatment.



Slide 2: Day ten following treatment at 3.5 J. Epidermis is completely regenerated. Zone of thermal modification now becomes evident (C), with intense fibroblast activity regenerating the reticular architecture of the upper dermis. (Picrosirius red unpolarized.)



Slide 3: Day ten following treatment at 3.5 J. Under polarized light the birefringence of new collagen appearing in the zone of thermal modification is clearly evident (D). (Picrosirius red polarized.)

Of great interest are the results of low-energy, non-ablative treatment where there appears to be an accumulated benefit of repeat treatments similar to, at least in part, the results observed with high-energy treatment. While the full scope and range of treatment options with Portrait PSR[3] continue to be evaluated, over 250 clinical study treatments have demonstrated the anticipated outcomes based on these pre-clinical studies for both single pass high-energy and single pass non-ablative repeat treatment protocols.

Commenting on the results of the U.S. pre-clinical study, Richard Fitzpatrick M.D. of Dermatology Associates in Encinitas, Calif. and the UCSD School of Medicine stated, "One of the interesting things we found was that when we overlapped, or made two passes with the Portrait PSR[3], there wasn't additive thermal injury. The importance here is that one of the primary errors in the use of the CO_2 laser has been inadvertent overlapping or stacking of pulses, resulting in uncontrolled thermal injury to the skin. We found this did not happen with Portrait PSR[3], at least with two passes. We also found that we could use different fluences and different numbers of passes to control the depth of injury so that we could go from a very superficial procedure, in which the outer part of the epidermis was peeled down, to a procedure that would take away some depth of the dermis by doing multiple passes." ■

Editor's Note: PSR is FDA cleared for the treatment of superficial skin lesions. Clinical studies have been completed to support an application to the FDA for perioral, periorbital, and full face low and high fluence treatment of wrinkles and photodamage.