Gear Up For New Fractional Procedures

A review of current and forthcoming fractional resurfacing and radiofrequency devices used for cosmetic purposes.

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The last several years have seen a rapid proliferation of laser and aesthetic technology. Due to this quick rise in laser procedures and technologies, physicians now have a dazzling array of options in their laser armamentarium, including innovations in lasers, light-based, and radiofrequency devices.

Fractional Upgrade

Skin resurfacing continues to be the sine qua non for removing deep wrinkles. The gold standard has been the carbon dioxide (CO_2) laser. Although traditional CO_2 resurfacing offers dramatic results, many patients are unwilling to undergo the significant downtime associated with this procedure. Fractional resurfacing provides an attractive alternative to traditional resurfacing due to significantly less pain and downtime and lower risk of side effects. As a result, fractional resurfacing has become much more popular. However, fractional resurfacing has not turned out to be the "Holy Grail" that we have all been in search of—the perfect treatment that gives CO_2-like results with no downtime.

The search for the "Holy Grail" has led us from CO_2 in the early 1990s to Erbium:YAG in 1997 to non-ablative lasers in 2000 to the first Fraxel laser in 2004 and ironically now back again to Erbium and CO_2. Reliant, manufacturer of the original Fraxel laser, introduced their version of the fractional CO_2 this year. Lumenis (previously Coherent), a name synonymous with CO_2, introduced a fractional CO_2 laser (ActiveFX) in 2006 and a deeper micro-fractional laser (DeepFX) in 2007.

Er:YAG remains a viable alternative to CO_2 resurfacing with slightly inferior results but significantly less downtime. There is a resurgence of interest in Erbium resurfacing, most likely driven by demand for greater results in removal of deeper rhytides that fractional resurfacing could not adequately achieve. As with all devices, increasing the number of passes and performing multiple treatments achieves better results.

The Portrait PSR3 (Rhytec/Gyrus Medical) is an "in-between" product—not as invasive as CO_2 but more invasive than non-ablative modalities. This technology uses nitrogen plasma and radiofrequency to deposit heat in the skin in a process called plasma kinetic rejuvenation. It does not immediately ablate the skin; it leaves the skin intact until day three when the skin desquamates. The effects are very similar to a chemical peel in that the skin turns brown immediately after the procedure until the desquamation starts. Plasma resurfacing produces better results than a chemical peel but inferior results compared to CO_2 or Erbium laser resurfacing. Optimal results with plasma resurfacing occur at three months post-treatment. Final results lack the amount of tightening achieved with CO_2 laser. Performing a series of treatments can improve results.

Table 1. Comparison of Resurfacing Lasers Effects on Wrinkles

Device Type	Wrinkle Reduction Grade	After 1 Treatment	After 6 Treatments	Downtime Wound	Redness
CO_2	A+	70%	N/A	7-10 Days	1-3 Months
ActiveFX	A-	40%	80% (60% after 3 treatments)	3 Days	5-7 Days
Erbium	B+ With Multiple Treatments	30%	60%	1-2 Days	4-7 Days
Plasma	B- With Multiple Treatments	25%	50%	1-2 Days	4-7 Days
Fractional Resurfacing	C+ With Multiple Treatments	20%	40%	Minimal to None	4-7 Days (But more severe than Erbium)
CoolTouch	D+ With Multiple Treatments	<10%	<20%	Minimal to None	1-3 Days

The Basics

Fractional resurfacing falls somewhere between ablative and non-ablative resurfacing. It essentially causes a fraction of the injury but also results in a fraction of the results. The first fractional device introduced in 2004 was the Fraxel (Reliant) laser using fractional photothermolysis, which is the concept of creating microthermal injuries which are spaced apart, called MicroThermal Zones (MTZ).[1] The skin responds to the many little injuries by regenerating newer healthier skin. The Fraxel is also an "in-between" product, but less effective still than the PSR3. It is currently known as the Fraxel re:store and according to the company has been adopted by more than 1,500 dermatologists, plastic surgeons and aesthetic physicians worldwide. It is accepted for use on acne scarring, facial rhytides, and for resurfacing procedures on the face, neck, chest, and hands. The re:pair is also being used for melasma, photodamage, scar remodeling, and striae. There are developments underway to incorporate fractional photothermolysis technology into other lasers to be used for hair and tattoo removal.

The original intent for Fraxel was to remove rhytides with minimal downtime, but results were disappointing. Clinicians have found turning up the settings can improve results but also increases the amount of injury to skin and subsequent downtime, making it a more invasive procedure. Typical treatments result in erythema and edema for five to seven days; longer with more aggressive treatments. Treatment can be quite painful, so is best used with topical anesthesia and external dynamic cooling.

The following comparison (see Table 1 for additional detail) may assist in understanding the available treatment modalities for wrinkle reduction in terms of results and effectiveness of treatment: *CO_2 > Fractional CO_2 > Er:YAG > PSR3 > Fraxel > nonablative lasers.*

Not surprisingly, effectiveness directly correlates with amount of injury caused to the skin. And there is some interchangeability between the fractional CO_2 and Erbium lasers in terms of results depending on the particular brand. In other words, not all fractional CO_2 lasers are better than all Erbium lasers. Some Erbium lasers can outperform some fractional CO_2 lasers.

New to the Market

Many new devices for fractional resurfacing by different manufacturers became available in the last year. The original fractional device, Fraxel (Reliant, Mountain View), a 1550nm erbium-doped fiber laser, now has considerable competition from four other companies in the arena of fractional microthermal resurfacing. The newer devices (Table 2 offers a comparison) are:

- 1540nm Lux Fractional Laser (Palomar)
- 1440nm Affirm (Cynosure)
- 2940nm Profractional (Sciton)
- 2940nm Er:YAG Pixel (Alma)
- 10,600nm CO_2 ActiveFX (Lumenis)
- 10,600nm CO_2 DeepFX (Lumenis)

The main differences between the devices are the wavelengths, depths of penetration, distances between the microthermal columns, methods of cooling the skin, pulse durations, lengths of procedure time, spot sizes, and costs of devices.

In comparison to the original Fraxel, all of the newer fractional procedures are faster to perform (i.e., they have quicker treatment times), do not require application of the blue optiglide gel (the newest version of the Fraxel no longer requires the blue gel), are less painful and better tolerated by the patient, and do not require application of topical anesthetic.

The newest version of the Reliant Fraxel was launched in 2006 called the Fraxel SR1500. This upgrade had greater depth of penetration to 1mm, faster treatment time, lighter more ergonomic handpiece, an additional smaller handpiece that could be used around the eyes, and no longer required the blue gel. In 2007, Reliant changed the name of the SR1500 to Fraxel re:store and introduced a more superficial version called the Fraxel re:fine intended for OB/Gyns and family practitioners and the medispa market. Completing their portfolio would be the 2008 launch of the more invasive Fraxel re:pair (fractional CO_2) intended for more serious users such as experienced plastic surgeons and dermatologists. The Fraxel family of lasers requires use of a cooled-air blower for patient tolerance.

The Lux1540 Fractional Laser (Palomar) has up to 1mm depth of penetration and two different spot sizes (10 and 15mm). The 10mm spot size head delivers fluences up to 100mJ per microbeam (mb) and creates a 100mb/cm^2 array of columns for deep coagulation. The 15mm spot size head delivers fluences up to 15mJ/mb and creates a 320 mb/cm^2 array of narrower columns for relatively shallow coagulation. The 15mm head is used mostly around the neck and chest region where the skin is thinner. The Lux1540 has a maximum fluence of 70mJ per microbeam and utilizes direct contact cooling. The treatment time is shorter compared to the Reliant Fraxel.

Cynosure also has a fractional resurfacing device (they refer to "microthermal rejuvenation") called the Affirm 1440nm laser using a micro-lens array delivery system. It has a shallower depth of penetration (700µm) compared to the Palomar Lux1540 Fractional (1mm) and Reliant Fraxel re:store (1mm). Using a cooled-air blower (like the Reliant Fraxel), Affirm creates less swelling and post-procedure erythema than the Palomar and Reliant devices, most likely due to less thermal heating and shallower depth of penetration.

Alma's pixelated resurfacing device called the Pixel is a 2940nm Er:YAG laser. Compared to the other devices, it has the shallowest depth of penetration, and thus the shortest healing time. Pixel has a large 11x11mm head and quick repetition rates for short treatment times and utilizes a cooled-air blower.

Sciton introduced a fractional 2940nm Erbium laser in 2006 called the Profractional. Creating micro-ablation channels of 250µm in diameter, this device uses a 20x20mm scanner, reaches 25µm-1.5mm depth, and 1.5-60 percent coverage. There is no collateral thermal necrosis, which results in pin-point bleeding at higher fluences and depths. The presence of pinpoint bleeding is a feature unique to this procedure compared to other fractional procedures. It should be used in conjunction with topical anesthetics and a cooled-air blower. Erythema is slightly more pronounced and has a little more crusting (residual from the pin-point bleeding) compared to other fractional procedures.

Lumenis found they had the right technology all along in its CO_2 laser but just needed to alter the software of the computer-generated scanner to completely change the settings, the spot size, and the scanner pattern. The fractional CO_2 ActiveFX (Lumenis) reduces the spot size of the original CO_2 Ultrapulse and Encore laser to decrease collateral heat. Its CoolScan uses a computer program to place the tiny dots in a non-sequential manner so that each individual tiny dot cools off before the one next to it is placed. This reduces thermal heating and thus erythema/edema and speeds recovery time. The dots are also spread out so that they never touch each other. They leave little "bridges" of healthy, untouched skin between the tiny dots.

Compared to the Reliant Fraxel, the ActiveFX covers more surface area that results in slightly more downtime but also better results. Erythema and edema resolve in a week. Most patients can apply make-up after three to four days. ActiveFX also results in more tightening effects on the skin compared to other fractional devices. The 10,600nm wavelength causes ablation and possesses thermal coagulative properties that result in immediate contraction of loose skin (up to 30 percent) and also removes pigmentation/dyschromias while also providing heat to the dermis. Without ablation and thermal coagulation, there is no immediate contracture.

DeepFX, the newest fractional CO_2 laser by Lumenis, creates smaller microspots placed farther apart but penetrating to deeper depths which allows for faster heating and more skin tightening than seen with other fractional devices.

In comparison to ActiveFX, which has a spot size of 1.3mm, 55-100 percent density, and depth of penetration to the dermal-epidermal junction (100-200µm), the DeepFX has a spot size of 0.12mm, five to 25 percent density, and greater depth of penetration (700µm at 20mJ, 1-2mm at higher fluences). Increasing pulses and fluence increases depth of ablation. Lower density treatments create minimal erythema and edema, thus decreasing recovery time. Mild erythema and edema last for three to five days. Patients with skin types three to four have erythema last two to three days longer and mild transient hyperpigmentation that clears completely. Importantly, adding DeepFX for its deeper penetration can further enhance tightening effects of the ActiveFX without causing more ablation of the epidermis. The sum of these results is greater tightening of flaccid skin and bet-

Table 2. Comparison of Competitive Fractional Devices

Company/ Device	Wavelength	Depth of Penetration	Cooling	Unique Aspects	Disposable
Reliant Fraxel SR1500 (re:store)	1550nm	300-1000 microns	External Dynamic Cooling	Optical Tracking 2 Spot Sizes	Yes
Palomar Lux1540	1540nm	700-1000 microns	Sapphire Contact Cooling	2 Spot Sizes	No
Lumenis ActiveFX	10,600nm CO_2 w/scanner	50-150 microns		Variable spot size, fluence, density	No
Lumenis DeepFX	10,600nm CO_2 w/scanner	50-2000 microns		0.12mm spot size, variable fluence, density	No
Sciton Profractional	2940nm	25-1500 microns		0.25mm spot size, 20x20mm scanner, variable fluence, density, depth	No
Alma Pixel	2940nm	30-50 microns	External Dynamic Cooling		No
Cynosure Affirm	1440nm	400-700 microns	External Dynamic Cooling		No
Cutera Pearl Fractional	2790nm YSGG	Up to 1mm	External Dynamic Cooling	Integrated smoke evacuator, variable scan pattern up to 2 cm^2	No

ter results with acne scarring than is seen with other fractional devices as well as greater reduction of rhytides and surface textural irregularities.

Reliant's fractional CO_2 laser (Fraxel re:pair) has FDA clearance specifically for skin resurfacing with a fractional mode of delivery. It has a built-in smoke evacuation system and is capable of treating at depths from 300µm to 1.6mm into the dermis in a single handpiece. It is used for resurfacing on and off the face. The re:pair has disposable tip costs and limitations such as inability to change shape, size, or density. The re:pair is lower power than the Lumenis CO_2. It also does not have any surgical applications, unlike the Lumenis CO_2 which has all the capabilities and surgical applications of the previous UltraPulse and Encore along with the newer fractional applications, ActiveFX and DeepFX, all rolled into one machine.

The Mixto fractional CO_2 laser (Lasering USA, Italy) is a less expensive option but has some limitations such as inability to change shape, size or density. It has fixed settings, and the spot and pattern size can only be changed by manually changing the handpiece (not done by computer generator), which is awkward and time-consuming. Results are similar to those seen with a lower power CO_2 such as the Reliant re:pair.

Erbium Resurfacing

With results from fractional resurfacing at times being less than satisfactory, interest has turned again to the Erbium laser. It has the advantage of less pain and downtime than traditional CO_2 resurfacing while still delivering significant results.

Short pulsed Er:YAG lasers typically ablate 5-20µm of tissue per laser pass with minimal residual thermal damage. This results in faster reepithelialization and fewer side effects. Initial enthusiasm for short-pulsed Er:YAG was dampened due to poor intra-operative hemostasis, less impressive results, and lack of tissue tightening effects when compared to CO_2 laser resur-

facing. The development of short-and-long-pulsed Er:YAG lasers resulted in deeper ablation, improved hemostasis, and increased thermal coagulative properties.

Sciton has been the leader in Erbium resurfacing combining short ablative pulses and long coagulative pulses. Their company was built on the 2940nm Er:YAG laser (Contour) which has dual pulse mode with ablative and coagulative properties. It uses a computer-generated scanner, allowing for treatment depths from 10-120µm. The zone of dermal thermal heating can range from 100-400µm. Increasing the coagulative mode has concomitant effects on tissue healing time to more resemble that of the CO_2 laser. This laser can also be adjusted to create only superficial ablation with minimal thermal injury.

Iridex bought out the 2940nm Er:YAG laser (Venus) previously owned by Laserscope. It has variable spot sizes (1-7mm diameter), a variable pattern scanner, and a lighter, more ergonomic handpiece. Compared to traditional CO_2, it creates less thermal damage, causes less patient discomfort, and has speedier recovery times. Complete re-epithelialization occurs within three to four days. Erythema resolves completely by seven to 10 days. Lower fluences create a "micropeel" that reepithelializes within one day. Erythema is gone by three to five days.

Palomar's 2940nm fractional Er:YAG laser is an add-on handpiece to its StarLux platform. It has three treatment modes: short pulse, long pulse, dual pulse (short pulse/long pulse in sequence). Alma also has a 2940nm Er:YAG laser that has more superficial depth of ablation compared to other Erbium lasers. It is an add-on handpiece to its Harmony multi-headed platform.

Traditionally, Erbium lasers have been powered by a YAG (yttrium aluminum garnet) crystal. Cutera is the first to use YSGG (Yttrium Scandium Gallium Garnet) crystals in its laser rods. Its 2790nm wavelength Erbium:YSGG laser (Pearl, Cutera) has the following parameters: 1.5-3.5 J/cm^2, 6mm spot, 30x30mm scan size. It has a built-in smoke evacuation system. Depending on the treatment settings, the Erbium:YSGG will ablate 10-30 microns of epidermis and coagulate from 20-60 microns of thermal injury into the dermis. Similar to other Erbium lasers, the Pearl can be used for resurfacing of the face, neck, chest, and hands.

Due to its lesser thermal coagulative properties and depth of ablation, the Erbium lacks the tightening effects of CO_2. Importantly, adding a deep dermal heating device such as ThermaCool (Thermage) or Titan (Cutera) can further augment the resurfacing properties of the Erbium.

Radiofrequency Devices

There is a large demand for nonsurgical alternatives to facelifts for skin tightening. Many companies are attempting to fill that need. The first of these devices was ThermaCool (Thermage), which has received FDA approval for treatment of face and all other body areas. It utilizes monopolar radiofrequency to achieve deep volumetric heating of the skin and underlying tissue. Radiofrequency energy is deeply penetrating and can reach depths up to 4mm. It is also capable of causing fat atrophy at high energy levels. Earlier complications that included fat atrophy, nerve damage, and skin depressions were attributed to overly aggressive treatment settings. Establishing lower fluence settings performed with multiple passes as the standard protocol would eliminate these complications, however. Some initial criticism of the device included pain and slowness of the procedure and inconsistent results. Thermage responded to the criticism by developing better treatment parameters delivering more consistent results. Thermage has also greatly improved upon the system by developing a new 3.0cm^2 tip that has made pain a non-issue and cuts the treatment time in half. The upgraded system called Thermage NXT is a great improvement with faster treatment times (further cuts the treatment time by one-third compared to the older system) and effectively cuts out the mechanical time-outs, which were also time-consuming and inconvenient. Operators have reported much higher satisfaction with the NXT system. Patients are much happier with the new treatment tip, and results have been more consistent. Overall, there is high patient satisfaction with this procedure as long as the physician properly educates the patient and establishes realistic expectation levels.

Newer developments from Thermage were the Eyes for Thermage, the Body for Thermage, ThermaTip DC (Deep Contouring), and ThermaTip CL (Cellulite) tips. Studies performed by ophthalmologists Dr. Brian Beisman and Dr. Jean Carruthers[2,3] proved safety and efficacy of the new 0.25cm^2 tips designed for use specifically over the eyelid regions. The new eye tips cause tightening of skin laxity around the eye region previously not available with any radiofrequency device. This eye tip is the first and only radiofrequency tip that is FDA-approved for use over the eye area.

Body for Thermage is a 3.0cm^2 tip with shallower depth of penetration than the original 3.0cm^2 tip, which allows for treatments of thinner skinned areas of the body with less discomfort.

The newest Thermage tip, the ThermaTip DC (Deep Contouring), is used for body shaping and contouring. It penetrates much deeper and heats the tissue to a higher degree and covers a wider surface area in order to cause circumferential reduction and tightening and shaping of larger body areas. This tip is not recommended for use in the face and neck regions. The ThermaTip CL is another deeper heating tip that Thermage claims helps the appearance of cellulite by its effects on connective tissues and improvement in blood flow with a single treatment.

Although it's not a radiofrequency device, another device called the Titan (Cutera) that causes deep volumetric heating

warrants mention due to its comparisons to the Thermage device. The Titan is an infrared pulsed light device in the 1100-1800nm wavelength range that is also claimed to achieve skin tightening due to collagen remodeling.

Another device aimed at the skin tightening market is the LuxIR Fractional (Palomar), which utilizes infrared light (825-1350nm) coupled with fractional photothermolysis. It is FDA approved for deep heating only—it has not been cleared for skin tightening. It falls in the same category as the Cutera Titan device. Similar to the Titan, it utilizes direct contact cooling.

Alma has a similar competing device, which is an add-on head to its Harmony system. The skin tightening head is a near infrared flashlamp with 780-950nm, five to 15 sec pulse width, large 16 x 40mm spot size, and a cooled-air blower.

Nonablative resurfacing is the use of non-invasive lasers to stimulate collagen remodeling, helping to improve tone and texture of the skin. Its effects on wrinkle reduction have been disappointing. It turns out that in order to effectively treat wrinkles, some kind of injury needs to take place. But nonablative resurfacing still has its benefits and is an important adjunct for photorejuvenation and maintenance of skin health. There are a number of devices on this front utilizing radiofrequency energy. The Aluma (Lumenis) is a bipolar radiofrequency device coupled with vacuum assist. It is based on a theory that bringing the target closer to the laser will result in more efficient delivery of energy and thus better results.

Syneron is a company based on the concept of coupling bipolar radiofrequency with other light or laser sources. The original Aurora, intense pulsed light coupled with radiofrequency for hair removal, skin rejuvenation, and acne treatments, has been renamed the eLight. The Polaris, a 900nm diode laser coupled with bipolar radiofrequency, is used for nonablative rejuvenation. This has been renamed the eLaser. The Aurora and Polaris combined in one unit used to be called the Galaxy and is now called the eMax.

Syneron's newest devices are the ReFirme and the Matrix IR. The ReFirme is an infrared light in the range of 700-2000nm coupled with bipolar radiofrequency that is used for skin tightening. The Matrix IR is a fractional 915nm diode laser coupled with bipolar radiofrequency that penetrates to a depth of 2.5mm used for nonablative resurfacing. Arcing can be seen with bipolar radiofrequency due to the lack of grounding. Arcing occurs when one of the two parallel metal prongs is not in contact with the skin and can result in blistering and burns. The operator must always ensure that there is complete contact of the metal prongs with the skin to avoid arcing.

Cellulite affects 80 percent of the female population. This is an area of rapidly advancing research. Syneron has a device that utilizes three forms of energy in the VelaSmooth which has been replaced by the VelaShape: bipolar radiofrequency plus infrared light plus vacuum/mechanical manipulation. The VelaShape is essentially the same laser with higher amounts of energy. The VelaShape has a higher incidence of bruising and results can be obtained with fewer treatments—six to eight treatments compared to eight to 10 treatments with the VelaSmooth.

The newest device on the cellulite scene is called SmoothShapes (Eleme), a dual wavelength laser using a 915nm laser and a 650nm light coupled with vacuum massage and mechanical manipulation. The 650nm light enhances cell membrane permeability, allowing the transport of liquefied fat into the interstitial fluid. Importantly, 915nm is one of the three peak wavelengths for which absorption by fat exceeds that of water.[4] The 650nm light enhances cell membrane permeability which allows transport of liquefied fat into the interstitial fluid.[5] The mechanical manipulation and vacuum stimulate microcirculation and lymphatic drainage. Clinical studies on this device utilized MRI scans to document circumferential reduction of treatment areas. One of their clinical studies claims that 81 percent of participants experienced significant volumetric reduction in subcutaneous fat.[6]

The Right Stuff

Given the plethora of choices available in the laser technology market, physicians should carefully research new devices and compare them to preexisting devices. New is not always better. Important criteria for laser selection include strength of peer-reviewed publications of clinical studies, performance reviews, comparison studies, reputation of the company, financial viability of the company, FDA approved applications, and long-term follow-up studies of clinical efficacy and safety. Test drive the laser before purchasing—insist on live patient demonstrations in your office. Conduct market research to see how the technology will fare in your local area. Survey your own patient population to see if there would be a demand for the procedure. Compare prices, warranties, and customer service record. ■

Dr. Lee has served as a Clinical Investigator, Consultant, and Speaker for Iridex, Laserscope, Lumenis, Thermage, Cutera, Alma.

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