FRACTIONAL LASER REJUVENATION

Treatment of Wrinkles and Skin Rejuvenation with LASEmaR and LIGHTSCAN 1500.
Introduction:

Laser is a beam of light, which is not existing in nature, amplified, monochromatic, unidirectional, generated by a "stimulated emission" of "active materials" which compose the device generating the laser beam. The term stands for: Light Amplified Stimulated Emission Radiation.

This unique characteristic of a laser beam allows very specific and "selective" interaction when hit few specific targets (chromophores), sensitive to its wavelength.

The chromophores can be endogenous or exogenous substances with a coefficient of specific absorption at a particular wavelength: Endogenous Chromophores: haemoglobin, melanin, water, proteins, amino acids, bilirubin. Exogenous Chromophores: tattoo pigments, metals.

To better understand how laser beam interacts with tissues it is important to consider a laser beam as a group of photons, or particles that can interact with matter only through the transfer of energy as explained by the physical principle of Photothermolysis described by Anderson and Parrish (1983), according to which photons affect chromophores determining structural damage without interacting with tissue neighbours.

Only absorbed photons can produce tissue effects. According to the output wavelength, a photon that meets the skin can be transmitted, reflected, scattered or absorbed.

- If within a tissue there is not an absorbed chromophore, all photons pass through it without effect: total transmission
- When a laser beam passes through water, air, gel or skin, undergoes a refraction.
- The laser beam can also be lost when crossing different medium, as it happens with the skin due to the presence of cells, organelles particles or due to the dermis collagen. The dispersion is inversely proportional to the wavelength.
- absorbed photons cause a mechanical or thermal damage to the chromophore and indirectly to the nearby tissues.

**Light-Tissue Interactions**

Greater dispersion means smaller penetration depth and increased absorption energy.

**Unit of measurement for the LASER**

- **Energy** is measured in joules (J), it is proportional to the number of photons
- **Power** is measured in Watts (W) = 1W = 1J/sec
- **Fluence** = energy per square cm (J/cm²)
- **Irradiance** = power per square cm (W/cm²).

In antiageing medicine, these principles are used for targeting fat and to induce thermal heating into the deep derma that lead to simultaneously stimulate and remodel collagen.
Skin rejuvenation approach:

The possibility to treat skin for rejuvenation using a laser appeared for the first time in the nineties using a CO₂ laser. The CO₂ laser has been immediately proved as an effective tool for skin rejuvenation because of its capability to cause controlled skin ablation either with or without a scanner. On the other hand this characteristic is also a limitation. When using it for aesthetic purposes the operator’s experience is essential and not always sufficient to prevent complications that can occur with the use of ablative lasers. Possible side effects with laser ablative: crusting, pain, long healing times, risk of infection, hypo- or hyperpigmentation, keloids. The skin damage resulting in tissue ablation is the main responsible for all side effects of ablative lasers (normal and fractionals). This aspect cannot go along with rhythms of modern life.

Recently a series of different wavelength for fractional ablative resurfacing have been proposed (CO₂ Super and Ultra pulsed, Erbium-Yag and combination of relative wavelength). The use of this system is also associated with long periods of downtime and with possible complications such as prolonged erythema, hyperpigmentation, acne flares, dermatitis.

To overcome those disadvantages, a variety of non ablative technique have been developed, those technique are associate with less downtime and also with more limited efficacy.

Fractional photorejuvenation

A more recent development is the fractional photothermalisis in which infrared energy combined with fractional scanners with wide areas of treatment produce arrays of microscopic thermal wounds at various depths in the skin without interacting with surrounding tissues. In order to be effective and create minimum discomfort for the patient it is necessary to determine the appropriate wavelength, the correct pulse duration and the right fluence. This procedure is currently performed with near infrared wavelength (1064 nm, 1320 nm, 1550 nm and 1470 nm)

Wavelength of 1470 nm

Among those the wavelength of 1470 seems to be the more indicated, infact it is more absorbed on water and fat and needs lower energy to create the micro thermal wounds than other non-ablative lasers. Considering the general rule that less energy transmitted means less pain for the patient, this means more comfort in the post operatory time, and reduced healing time that can be lowered from minimum of 24/48 hours to a maximum of 10 days.

Why using the non ablative mode?

The effects of a non-ablative laser on collagen IIIrd type are not immediate, but take the time requested for collagen to be re-formed (3 weeks), so if a fractional technique is used, more sessions (3 or 4) will be required to get a visible result.

Nevertheless, fractional laser and non-ablative technology evolved and spread considerably because side effects are minimal, pain is greatly reduced and interruption of social life is not required during the entire treatment cycle (approximately 3 months) The diameter of the spot is only 200 microns and the process of tissue repair (from the intact adjacent areas) is very fast using pixel density not higher than 30% maximum 40%.
Methods and Material

LASEmaR and Lightscan 1500, are the latest evolution for fractional lasers working at 1470 nm wavelength, which create a non-ablative coagulation and a thermal stimulation of the deep dermis.

The system is composed by two parts: the driver generator & handpiece and the laser source that can be used also separately for other applications such as endovascular treatment, surgery and laser lipolysis.

**LIGHTSCAN 1500 driver generator & handpiece**

Thanks to its specific software the following parameters can be modified:
- laser power (in watts)
- pixel spot size (200 or 400 microns)
- working area (horizontal axis x - y vertical axis) - max. area 14X14 mm, min. area 5X5 mm)
- randomized or linear motion
- pulse time (pixel time)
- pulse repetition (stuck)
- % of pixel density and pixel quantity

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**LASEmaR 1500 laser source**

LASEmaR 1500 is a solid state diode laser with possibility to regulate power, pulse mode, pulse duration, pause between pulses and with internal preset for fast access to saved datas.
Treatment possibilities

The variation of parameters involves an important change in the level of dermal thermal damage that can be briefly summarized as follows.

| DIFFERENT ENERGY LEVELS FOR SKIN FRACTIONAL RESURFACING BY LIGHTSCAN 1500 |
|-----------------------------|-----------------|-----------|---------|---------|
| Not ablative skin refreshing - LOW | Scan type | Pixel size (µ) | Power (W) | sessions |
| Soft wrinkles and moderate aging (no crusting) | random/linear | 200 | 1.0-2.0 | 3/4 |
| Not ablative resurfacing - MID | Scan type | Pixel size (µ) | Power (W) | sessions |
| Wrinkles and medium aging (mild crusting) | random | 200 | 2.0-4.0 | 2/3 |
| Ablative resurfacing - HIGH | Scan type | Pixel size (µ) | Power (W) | sessions |
| Wrinkles, Scars, Acne Scars, severe aging (crusting) | random | 200 | >4.0 | 1 |

Treatment ➔ Soft wrinkles and moderate aging (no crusting)

- Lightscan 1500 in **LOW mode** (1-2 Watt) non-ablative carries out its action directly on the dermis without damaging the skin or indirectly damaging vascular structures and causing the release of chemical mediators that promote the action of new connective tissue.

Treatment ➔ Wrinkles and medium aging (mild crusting)

- The use at **MID mode** (3-4 watt) is a good compromise as it becomes very effective for immediate skin tightening effect combined to a good removal of superficial wrinkles and superficial epidermal stains.

Treatment ➔ Wrinkles, Scars, Acne Scars, severe aging (crusting)

- In **HIGH-mode** (more than 4 Watt), the device becomes ablative.

With LOW mode parameters 1470 nm wavelength provokes cylindrical micro-coagulations of the dermis without damaging the skin also enhancing the formation of new collagen by thermal effect as bio-stimulating effect of neighbourhoods micro columns.

With HIGH mode parameters 1470 nm wavelength provokes a significant effect due to thermal ablation cylindrical necrosis with a depth dictated by the power of the pixel area of coagulation around each spot (pixel versus time) that promotes fibroblast proliferation and the formation of new collagen with bio-stimulating effect as the effect of thermal zones adjacent columns together with an important micro-authoring a strong heating effect of skin tightening (more dependent on the density of pixels%).
Histological investigation on skin treated with LOW parameters

A removal of skin from a patient subject to abdominoplasty was also used to determine the histology of treatment with different powers. The sample was fixed in a solution of 10% formalin and placed in paraffin. Immediately after treatment biopsies were performed.

We can distinguish microthermal zones with columns of modified collagen. The entire stratum corneum remains quite intact. Histological investigations show that immediately after treatment, there are cellular necrosis into the dermis and epidermis, well-defined into an area of around 250 microns, which corresponds roughly to the expanded diameter of the microbeam. The skin damage is located mainly in lower half of epidermis and leads to disintegration of the dermal-epidermal junction. The beginning of formation of a sub epidermal scission is visible.

There were not yet inflammatory infiltrates in the region surrounding the thermal micro column. The blood vessels around each micro column were coagulated and there is no bleeding into the surrounding tissue.

The day after

The epidermis is repaired. Microscopic epidermal necrotic debris shows the elimination of heat-damaged keratinocytes. The microscopic epidermal necrotic debris are full of melanin. These ones reside in a sub granular site and contain a considerable amount of pigment. The sub epidermal scission is now more visible in the thermal zones and covers a well-defined region of homogenized collagen.

7 days after

Epidermis is essentially free of dyskeratosis. There is no trace of division left in the dermo-epidermal junction. The microthermal areas of the dermis still show some collagen cones thermally modified.

An inflammatory infiltrate in regressive phase is visible with new vascularisation surrounding and infiltrating the heating zones.

3 months after

In biopsy after 3 months there is no trace of cutaneous fibrosis or residual cones of modified dermal collagen. Not a trace of inflammatory infiltrate. Microthermal areas always have a diameter of less than 1 mm and a depth of penetration varies according to the pulse energy.
Conclusions

Based on this study, LIGHTSCAN 1500 can be considered a safe and effective treatment for wrinkles, skin spots and acne scars. In low mode typical side effects of ablative devices as marked erythema or crusting in the whole area treated with this new laser technology are totally absent. The images and the histological data of the columns show the thermal treatment of a well-defined and localized, which is surrounded by healthy skin tissue. This study showed that irradiation with 1470 nm wavelength allows the production of neo collagen IIIrd type with a rapid recovery of the skin. The columns of thermal damage after one day are completely repaired. After 3 months, the collagen is completely re-harmonized and is not detected traces of skin fibrosis. The ease of using this new technology, the scarcity of side effects and effectiveness makes it a good method could certainly be interesting if combined with endolaser facial lift procedures Endo (LIGHT LIFT).

Case Study

Case treated at 5 W – Ablative resurfacing HIGH

| 2 days | 6 days | 10 days |

Results

19/02/2009

23/04/2009
Results – female – 37 y.o. – 1 treatment

Before treatment

2 days after treatment

40 days after treatment