

## LASER TREATMENT OF TATTOOS with QS Nd:YAG

Tattooing is a technique for decorating the skin surfaces obtained by introducing various types of pigments into the skin. It can be performed either manually or via the use of electrical devices.

In order to achieve the desired pigmentation it is only necessary to inject small amounts of pigment. Pigments injected in excess are difficult, if not impossible, to remove.

Once introduced into the skin the pigment does not react like a static, stable structure but rather, goes through a series of extremely dynamic adaptations thanks to its ongoing interaction with the biological structures that house it.

In the hours after performing the tattooing, the ink remains at quite a superficial level and is contained inside the cytoplasm of the keratinocytes and the dermic cells like the macrophages, fibroblasts and mastocytes. A part of the ink will be eliminated trans-epidermally over the following weeks, however its presence in the tissue naturally determines an alteration both in the cutaneous structures involved and those immediately adjacent.

Over the following months the pigment will undergo a gradual “sinking” process:

- 30 days later it will be possible to observe how the dermo-epidermic union has been perfectly reconstructed and how a large part of the pigment is present inside the phagocytic cells, along the basal membrane and immediately underneath the same, separated from the overlying structures by a granulation tissue. A small amount of the pigment will still be found inside the keratinocytes in the basal site at an epidermic level.
- After the second month
  - the trans-epidermic elimination of the pigment will cease completely, and will only be found in the derma
  - the granulation tissue will disappear and be replaced by a fibrosis which tends to isolate the pigment-seeped tissue
  - there may also be more significant reactive phenomena similar to granulomas caused by foreign bodies.

The ideal therapy for removing tattoos should ensure the disappearance of the chromatic alteration without leaving any scars or permanent dyschromias.

Before the evolution of short-pulse laser systems, the methods used were extremely invasive and left severe scarring due to the total lack of selectivity.

More recently, Q-switched lasers (with a pulse duration in nsec) have represented the greatest step forward in the treatment of tattoos thanks to their capacity to interact selectively with the dermic tissular structures containing the exogenous pigment. This specificity derives from the possibility of emitting very brief pulses at a high power (“MegaWatt” that means 1,000,000 Watt) with extremely selective wavelengths for the chromophores responsible for the chromatic alterations.

**ACTION MECHANISM:** The interaction of the laser light (very short pulses in the range of nsec, and elevated power peaks in the range of MegaWatt) with the chromophore brings about deep molecular variations in the pigment itself, thanks to the complex interaction of the various photobiological mechanisms, like the photothermal, photomechanical and photochemical effects, which give rise to the fragmentation of the ink particles (mainly induced by the photoacoustic effect) and optical changes to the pigment itself. The fragmentation of the pigment, induced mainly by the photoacoustic effect of the laser beam, favours the elimination of the deepest pigment by the

phagocytary cells, whereas the more superficially located pigment will largely be eliminated trans-epidermally, thanks to its sudden change into a fatty state due to the rapid thermal expansion of the target.

## GENERAL FEATURES

- **CHOICE OF WAVELENGTH:** Obviously in order to obtain a selective destruction of the ink particles it is necessary to choose the wavelength which is best absorbed by the target, in order to minimise any aspecific thermal effects. For the same reason moreover, with a longer wavelength which is equally well absorbed by the ink of the tattoo, it is preferable to use one which is less selective for the natural chromophores (melanin and haemoglobin). Correct knowledge of the absorption capacities of the pigments depending on the various laser wavelengths is essential for optimising the most suitable treatment. Black pigments absorb wavelengths of between 450 and 1100 nm in the same manner, while absorption by the melanin diminishes with the increasing of the wavelength. Therefore, in order to treat a black tattoo in a patient with a IV-VI phototype it is best to choose higher wavelengths so as to reduce the risk of leaving hypochromic results. The most commonly used colours in tattooing are blue, green, and red, while yellow, orange and purple are less frequently found. Moreover, it is necessary to consider pigments used increasingly more for permanent makeup, like flesh pink and brown. Blue and green have very similar absorption spectra, with a peak for wavelengths of between 625 and 755 nm. Instead red, orange, brown and purple interact well with wavelengths of less than 570 nm, whereas the “fleshy” colours are intercepted well by wavelengths of less than 535 nm. Finally, yellow unfortunately reflects wavelengths over 520 nm.

- **NUMBER OF SESSIONS AND INTERVALS BETWEEN SESSIONS:** The treating of tattoos is a procedure that requires a high number of sessions depending on numerous variables. Some of these are linked to the operator’s decisions, like the choice of fluence and the laser beam spot used. The choice of interval between one session and the next also seems to be important. Seeing that the removal of the pigment is a biologically complex phenomenon which takes time, the majority of authors advise against re-treating tattoos for at least 6-8 weeks after the previous session. However, there are other factors that also considerably influence the number of sessions and the positive results of the treatment, irrespective of the operator and the principles linked to the tattooing typology and methods. It has been demonstrated that the number of sessions required is directly proportional to the surface area and depth of the tattoo, as well as the quantity of pigment used.

- **SIDE EFFECTS:** Contrary to what was observed with traditional methods, the side effects linked to the use of short-pulse laser are very slight. Changes in the skin warp and micro-scars are more frequently observed after treatment with Q-switched Ruby and Nd:YAG laser at 532nm and are often the result of excoriations in the area treated caused by the patients themselves. Hyperpigmentation is a transitory side effect linked mainly to the patient’s phototype (darker phototypes are more prone) and incautious exposure to the sun after the sessions. Hypopigmented lesions, which are instead due to the absorption of the laser light by the pigmented cells and are usually observed when shorter wavelengths are used, fortunately tend to fade over time. An unusual side effect may be represented by a darkening of the tattoo that starts turning black, often observed during laser treatment of permanent makeup with flesh-coloured or brown pigments. This phenomenon seems to be due to the thermal effect on pigments containing ferric oxide. In fact, this substance is transformed due to the high temperatures in the ferrous oxide responsible for the chromatic variation. For this reason it is vitally important to carry out trials before beginning extensive treatment with this type of tattooing. The therapy of this significant effect is problematic,

even though in some cases positive results have been obtained by treating the dyschromy with sessions of Q-switched Nd:YAG laser (photo 2a,2b,2c).

## KNOWN APPLICATIVE PROCEDURE TECHNIQUES

**Q-SWITCHED Nd:YAG LASER.** The 1064 nm wavelength allows for effectively treating black and dark blue tattoos, even on highly pigmented skin, without causing any hypochromic effects. The most common side effects are represented by the onset of post-op purpura in the areas treated due to absorption of the two wavelengths by the haemoglobin.

- Before each session (also on previously tested patients) it is necessary to “try out” the tissular response by delivering two or three “spots” adjacent to the “typical” area”. The optimal response is represented by the onset of the “pop-corn” effect without any micro-bleeding (see picture no.1).
- Start with the fluence selection of 4-6 J/cm<sup>2</sup>, spot size: 4mm. In the course of the treatment, after some sessions, when the tattoo has faded, the fluence should be increased. As usual be careful and perform the test.
- Wide spots are recommended as by minimising the photonic “back-scattering”, moreover the risk of epidermic damage is greatly reduced and as a result, also micro-scarring.
- Always keep the handpiece perpendicular to the skin to be treated.
- Arrange the various light spots on the skin surfaces in such a way as to obtain a slight overlapping of the same and therefore avoid leaving any of the tattooed areas untreated.
- Immediately after finishing treatment
  - Apply an antibiotic ointment with a low allergenic component,
  - Cool the area with ice.
- Instruct the patient to
  - Continue applying the antibiotic ointment until the micro-scabs have completely disappeared
  - Use a strong photoprotection method.

