

## DIODES LASER IN ENT SURGERY

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*[Laser a diodi nella chirurgia O.R.L.]*

### SUMMARY

The LASER, a surgical instrument introduced in the 70's in ENT surgery, has been object of ceaseless improvements thanks to constant technological evolution.

Diode LASER contributes to a more selective and less invasive surgery, minimizing the risk and post-operative period in hospital, it is indeed able to transmit to the fabric up to 60 W of LASER energy at a wavelength of 810 nm; this ensures a precise cutting/coagulation and a excellent tissue vaporization.

The possibility of using different sizes optical fibers (400, 600 and 1000 nm), both in "contact" and "no contact" modality, allows a very effective use in endoscopy.

Technological progress on the LASER, and the Diode LASER employment at the Department of Otolaryngology have made interesting to report our experiences with this surgery means in several pathology in ENT.

### RIASSUNTO

*Il LASER, strumento chirurgico introdotto negli anni 70 nella chirurgia O.R.L., è stato oggetto di continui perfezionamenti grazie alla continua evoluzione tecnologica.*

*Il LASER a Diodi contribuisce a rendere sempre più selettivo e meno invasivo l'intervento chirurgico riducendo al minimo i rischi e i tempi di degenza post-operatoria; infatti è in grado di trasmettere al tessuto fino a 60 W di energia LASER alla lunghezza d'onda di 810 nm; questa garantisce un preciso taglio/coagulazione e un'ottima vaporizzazione dei tessuti.*

*La possibilità di utilizzare fibre ottiche di diversa grandezza (400, 600 e 1000 nm), sia nella modalità a "contatto" che a "non contatto", consente un efficace utilizzo a livello endoscopico.*

*Gli avanzamenti tecnologici sul LASER, e l'impiego del LASER a Diodi presso la Clinica Otorinolaringoiatrica hanno fatto ritenere degno di interesse riferire le nostre esperienze di tale mezzo chirurgico in diversa patologia O.R.L..*

**Key words:** Diodes laser, CO<sub>2</sub> laser, ENT pathology

**Parole chiave:** Laser a diodi, laser CO<sub>2</sub>, patologia ORL

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### E.N.T: laser applications

#### *Ear*

LASER in the otology field was used to perform tympanotomy and for the placement of ventilation tubes, vaporization of horny pearls and adhesion in the eardrum, remobilisations and ossicular modelings, "spot-welding"; in this field the most argued area of applicability of LASER is the surgery of the otosclerosis<sup>(1)</sup>.

The otosclerosis treatment with surgical LASER started with Perkins and Di Bartolomeo in 1980 using Argon LASER; afterwards were used also other sort of LASER: CO<sub>2</sub>, KTP<sup>(2)</sup>.

Laser benefits in the surgical therapy of otosclerosis are the bleeding control and the limitation

of the handling of the platina reducing the risk of "floating platina" and acoustic vibratory trauma.

These advantages allow to optimize the functional result and to reduce risks of cochlear damage connected with surgical treatment.

The ideal property of tissue interaction of the laser radiation in the otosclerosis surgery is the laser's energy absorption of the platina, that allows the vaporization and avoids the perilymph thermal dispersion.

The modality of supply of the pulsate energy enables the tissue cooling between the pauses and reduces the risk of thermal damage of the surrounding structures.

The argon laser is used for vaporize the stapedius tendon, the posterior crus of the stapes, as

well as produce a holes rose on the platina, the adhesions worn, the stapediotomy and the ossicular modelling. The audiological results are excellent with absence of dizziness on the post operative time<sup>(1)</sup>.

The ktp laser has tissue interaction features overlapping with the argon laser. Both the laser's radiations are transmitted through the aquos medium whereas are electively absorbed by the red pigment (ex. Haemoglobin).

It was noticed weak uptake of the laser radiation from the platina (a 150 micron platina absorbs the 50% of argon or ktp light); the not absorbed amount is transmitted to the perilymph and so taken by the inner ear pigmented structures, with risk of damage of the neuroepithelium and of the vascularity.

The performance of osseous holes by ktp laser with power of supply up to 2W allows the development of regular osseous reparative process, whereas with power of supply up 3.5 W it is created a thermal damage with alterations of the reparative processes<sup>(3)</sup>.

The ktp laser seems the most suitable for the surgery of the chronic otitis indeed the presence of pigmented tissues and of haemoglobin allows an excellent uptake of the wavelength of the laser ktp<sup>(4)</sup>.

### Nose and paranasal sinus

The diode laser was used in the treatment of the nose pathology with different methods depending on the entity and the localization of the lesions. The utilization was both dissection and photocoagulation.

In the treatment of the lower turbinate hypertrophy, turbinatums are pre-coagulated and devascularized by the diode laser; the vaporization was performed with both the contact method and the not in contact method, applying a bigger amount of energy. The nose polyp treatment with the in contact method in the diode laser surgery is innovative: the fibre is inserted inside the polyp and maintained until its disappearance. This method does not cause any haemorrhage<sup>(5)</sup>.

In the treatment of the coana atresia are utilized CO<sub>2</sub> lasers<sup>(6)</sup>, but also Nd: yag and ktp, for the vaporization of the membranous atresia, obtaining low bleeding and lower formation of scar tissue, or in case of bony atresia, after the performance of the

breach in the atresia plate by other instruments, for seal the fringes of the bloody surfaces: it is made to the purpose of reduce the postoperative oedema and of avoid the formation of granulation tissue. The utilization of CO<sub>2</sub> laser does not eliminate the necessity of apply probe of the adequate gauge in the nasal fossa for a period of 2-3 months<sup>(6)</sup>.

The laser effects on the bone can determine, for the high temperature, damages on the surroundings tissues, necrosis, bone seizures and excess of scars.

The laser exploit for the nasal cavity pathology, as polyps or coana atresia, seems objectionable because of in those cases the traditional surgery techniques allow to perform more rational interventions and so to assure better results.

### Oral cavity and pharynx

The oral cavity and pharynx pathology treated by the laser surgery is made of inflammatory lesion, both the benign (hypertrophic gingivitis, chronic tonsillitis, epulidi, papillomas, angiomas, lichen) and the malignant.

The most utilized laser is the CO<sub>2</sub>, but also the argon and the ktp have founded application. The torpid ulcers tend to recur also after surgical interventions of excision. The CO<sub>2</sub> laser sterilize the operative field because of the elevated temperature developed by the ray, making faster and definitive the cicatrization.

The tonsillotomy and the tonsillectomy performed by the CO<sub>2</sub> laser do not seem to show particular advantages, rather can involve in hitches: the bleeding is reduced compared to the traditional method, but it is quite the same to that obtained using the electric scalpel; moreover the pain is more intense and the time of the cicatrization process is higher.

The treatment of the chronic tonsillitis by diode laser tonsillotomy or tonsillectomy was performed only by the use of in contact procedure. The haemorrhage risk is easily controlled and the coagulation is made possible using a power of 15 W<sup>(5)</sup>.

In the surgery of the chronic snoring by uvuloplate-pharynx -plastic surgery, the diode laser was utilized in the in contact method; the advantages of the laser methodology are the cut precision, the control of the deepness of the incision, the marked haemostatic effect and the reduction of the post operative oedema<sup>(7)</sup>.

## Larynx

In the past, for the treatment of the larynx pathologies, were utilized various genres of lasers (argon, Nd: yag), actually the most chosen for this kind of intervention is the CO<sub>2</sub> laser. The energy delivered by this laser is decidedly better than the one delivered by the argon laser. The CO<sub>2</sub> laser is considered a very advantageous instrument for the microsurgery, offering, compared with the traditional techniques, substantial and undeniable advantages. The pathologies treated by the CO<sub>2</sub> laser are wide-ranging: inflammatory, degenerative, neoplastic, obstructive.

The CO<sub>2</sub> laser finds special application for the treatment of: vascular chord disease, hemangiomas, granulomas, reinke oedema, iatrogenic post-radiotherapy or post-surgery oedemas.

The use of the CO<sub>2</sub> laser for the treatment of larynx lumps, initially disputed for the functional outcomes that were not always the best because of vaporization, today has a reliable application thanks to the aging of the instruments (micro-spot) and of the surgical techniques.

Catalano was one of firsts users of the CO<sub>2</sub> laser for the treatment of the benign larynx pathology. The larynx papillomas are treated by the majority of laryngologist with the CO<sub>2</sub> laser: the little lesions are vaporized, the big ones are removed from the base.

The chronic laryngeal stenosis represent a valid indication for the CO<sub>2</sub> treatment. It is necessary to excise the fibrin depository that were formed in the post operative time, because they could be the starting point for the formation of bridge and scar stenosis. Depending on the pathogenesis the results are better for the treatment of the post traumatic and post surgical stenosis, worse for the post radio-therapy and post-caustical ingestion stenosis. Depending on the seat of the stenosis, results are good for the supraglottic level, uncertain for the glottic level, poor for the under glottic level.

The bilateral chords palsy in abduction could be treated by the CO<sub>2</sub> laser use; it allow the performance of a total arytenoidectomy associated with the vaporization of the posterior portion of the omolateral vocal chords and of the false vocal chords<sup>(8)</sup>.

The CO<sub>2</sub> laser technique shows, compared with traditional methods, the advantage of being of easy execution, it avoids the tracheotomy and assures good breathing and fonator results.

The larynx displastic lesions require the performance of an excisional diagnostical-therapeutical biopsy that requires a good experience for conciliate the complete excision of the lesion with the smaller functional damage.

Some Authors use the CO<sub>2</sub> laser for underpericondrial way to perform a radical intervention on the carcinomas of the glottic plan limited on one true vocal chords, or rather that affect one chords and the surrounding region (anterior commissural, Morgagni ventricol, false vocal chords, controlateral vocal chords) and on carcinomas of larynx vestibulo localized on the upper edge of the epiglottis, on the edge of the ariepiglottical folds or on the false vocal chords.

The only inconvenient is represented by the possibility of the formation of granulations in correspondence to the areas where the cartilagineous skeleton was deprived of his pericondrial cover.

The contraindications of the use of the CO<sub>2</sub> laser are rapresented by the neoplastic infiltration of the cartilagineous skeleton, of the crico-tiroidal membrane or of the io-tiroepiglottical lodge or by the presence of local metastatical adenopathy.

From the technical point of view the endoscopic laser-surgery could be performed in substitution of all the partial or total larynx interventions: the laser ray it is only a peculiar scalpel by that could be performed from an internal way the same action provided in the traditional interventions for an external way<sup>(8)</sup>.

## Case study

The diode laser was employed for the surgical treatment of the patients in the care of the Ear Nose and Throat Clinic of the Catania University.

The case study, still modest, has concerned subjects aged between 32 and 81, of male and female genders, affected by various pathologies of otolaryngological pertinence concerning nose and perinosal sinues, pharynx, larynx and trachea affections.

Whit regard to the rhino-sinusal pathology were treated subjects suffering from turbinatum hypertrofia, chronic sinusitis with polyps, antrostomy results.

The pharynx pathology concerned subjects with adenoidal relapse.

In larynx-tracheal field were treated benign and malign neoformations of larynx and polypoidal formations of the trachea.

The follow-up of the treated subjects is very poor and so we can consider only the post-operative results obtained immediately after the treatment.

The surgical diode laser can transmit to the tissue up to 60 W of laser energy with a wavelength of 810 nm.

The diode laser was utilized both in the "in contact" and in the "not in contact" modality, depending on the entity and on the localization of the lesions.

The "not in contact" modality requires more energy and the evacuation of the smoke produced utilizing a continuous aspiration, for this reason we utilized more the "in contact" method. The utilization was performed with dissectory and fotocauterative proceeding.

The optical fiber utilized for the "in contact" and for the "not in contact" treatments are of two size (600 and 1000  $\mu\text{m}$ ); moreover, the "in contact" ones can have a conical (300  $\mu\text{m}$ ) or a spherical (800 and 1200  $\mu\text{m}$ ) tip. In some cases the optical fiber was utilized through a handful, in other cases was set on traditional pincer, in others it was introduced through the operative channel of the fibroscopy.

The anaesthesia practiced was local in the majority of cases; the general anaesthetic was practiced for the treatment of subjects with benign and malign neoformations of the larynx.

The surgical diode laser was utilized taking advantage of the photothermal effects and interactions to obtain the excision (so the laser ray was utilized as a cutter) or the vaporization, id est the destruction of tissues trough coagulation necrosis. Both the alternative had met requirements.

The vapo-coagulation action was especially employed for the performance of the turbine-plastic, that is made on well vascularized tissues. Only in few cases and for a precautonal purpose was performed a tamponation of the nasal fossa.

In laryngeal field were utilized both the cut action and the vapo-coagulation action. In particular the treatment regarded a subject with a Reinke oedema and collapse of the false chords and a brainvasculopatic subject affected by a supraglottic carcinoma (T2 N0 M0) that underwent a tracheotomy for breathing difficulty.

In the first case the false chords plastic was easy tank to the vapo-coagulation possibility, whereas the chords mixomatosis was treated with the cutter function performing a linear cut on the mucosa of the superior surface of the vocal chords.

In the supraepiglottic carcinoma (carcinoma of the false left chord extended to the inferior part of the suboidal epiglottis and to the beginning of the controlateral false chord -T2 N0 M0-), after the charging of the supra-oidal epiglottis utilizing a Warda laryngoscope, were exposed the ariepiglottical folders and the laryngeal face of the epiglottis.

The section was made starting from the left, on the anterior edge of the arytenoid and going up till the pharynx-epiglottis fold. On the right the section involved the anterior side of the false chords till down to the true chords without touch it and till up to almost the pharynx-epiglottis fold.

So was performed an horizontal section from the left pharynx-epiglottis fold to the right one passing through the epiglottis; the section was made at a minimal distance of 0,5 cm from the neoplastic lesion.

The section was made deepen in medium-lateral sense in the tissue of the superior paraglottis space and of the anterior pre-epiglottis tissue till to arrive to the superior edge of the tiroideal cartilagine; then was performed the section for inner sottopericondrial way till down to arrive in the bottom of the ventricol.

So it was realized a left vestibulectomy enlarged to the omolateral ariepiglottis folder and extended to the inferior portion of the epiglottis and of the pre-epiglottis tissue and a partial right vestibulectomy.

During the performance of the section on the inner pericondrium, or because of the traction of the pincer on the operatory piece, or because of the coagulation necrosis, a piece of the operatory piece broken away: also if some Authors suggest to split in two the operatory piece, making easier the domain of anterior caudal limit of the vestibular excision, we believe appropriate the removal in monobloc of the neoformation and of the surrounding tissues. The surgical trauma in the treatment of this pathology has been drastically reduced; the post-surgical course was fast.

In relation to the use of the diode laser as cutter, also if in a small amount of cases, it seems to us that the cut section it is not as linear as other instruments (scalpel, CO<sub>2</sub> laser), having the impression that the surfaces surrounding the section had a certain depth of carbonization.

In relation to the vapo-coagulation aspect the result was very satisfactory, having the possibility of obtain the result without haemorrhages.

## Conclusions

The LASER employment today is in current use in the ENT clinical practice.

The technical evolution allowed the realization and the improvement of various kind of lasers, supplying the ENT specialist with a wide range of devices. In most cases laser is used as an alternative to the traditional surgery methods, not always providing an advantage.

The laser methodology is particularly useful and presents reliable advantages for the treatment of the recurrent laryngeal papillomas, of the precancerosis (leucoplachiae and eritroplasia) of the mouth and of the larynx, of the limited neoplasm of the oral cavity of the glottic plane, of the nonspecific chronic ulcer of the oral cavity. The advantages offered by the laser are represented by the absence of instrumentation that stand in the way of the surgeon that operates in a tight space, by the precision of the surgical excision allowed by the distinctive features of the laser ray and by the bloodless field, especially in micro-surgery.

The clinical applications of the diode laser unit have allowed to highlight an excellent section on the soft tissues with power of 5-10 W with CW procedure (or pulse) in contact and a good vaporization with power of 10-15 W with CW procedure not in contact for well vascularised soft tissues and 15-25 W with pulse procedure not in contact for bony tissue and hard mother; a good hemostasis with 5-10 W power with not in contact CW procedure (defocalized) on the well vascularized/pigmented tissues.

The diode surgical laser, used as a cutter, does not seem to have a section of cutting as linear as the CO<sub>2</sub> laser: it can be the consequence of the fact that the section surfaces have a higher thickness of carbonization.

Moreover compared to the other kinds of lasers, the diode laser unit presents significant advantages: a compact equipment, portable, manageable, with high performance (30-40%), that does not require maintenance and that uses the common quartz optical fibres, extremely reliable and held down prices.

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