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## 4.1 Laser Treatment

### 4.1.1 Principle of Laser Therapy

Laser has five effects on organisms: thermal interaction, photochemical action, mechanical action, electromagnetic action and bio stimulation.

Medicine mainly uses its thermal interaction and photochemical action. Its therapeutic effects include physiotherapy, acupuncture and surgery.

1. Laser physiotherapy: weak laser directly irradiates the lesions could produce the anti-inflammatory analgesic effect and the vascular relaxation, promote the blood circulation and the metabolism and so on. It usually applies the He-Ne laser and the CO<sub>2</sub> laser;
2. Laser acupuncture: the laser acupuncture irradiation can approach the therapy purpose by penetrating skin without pain, asepsis;
3. Laser operation: the high-power laser-beam replaces the scalpel to operate, whose advantages are: less bleeding; high accuracy rate, light injury to target cell surroundings; relatively-lighter postoperative tissue swelling, less reaction; quicker wound healing, less infection, relatively-lighter scar.

During laser therapy, there should be strict secure measures, the medical personnel who contract the laser should wear the protective glasses, the patients' eyes should be pasted with unguents, the operation field surroundings

should be under the saline gauze protection, especially while transferring oxygen through the airway, beware of breaking the air sac and cause a burning.

The laser has many advantages, such as its good directionality, high brightness, high monochromasis, good coherence; so it is widely used in medical field. The common otorhinolaryngological laser devices include the Nd: YAG optical maser, the CO<sub>2</sub> laser device, the argon-ion optical maser, and semiconductor laser device.

#### 1. Nd:YAG Optical Maser

It is a solid laser device, its laser wavelength is 1.06 μm, whose laser is the near infrared invisible light, its beam type is the pulse or the continuous wave, its output power is 1–100 W, its tissue penetration depth is about 4 mm, it can complete the solidification, the cutting, the gasification and so on and it is transmitted by the 300–700-μm quartz optical fiber. It could operate or treat in the deep intra cavum sites through various shapes of rigid tubes or endoscopes.

#### 2. CO<sub>2</sub> Laser Device

It is a gas laser device; it belongs to the non-contact laser. Its laser wavelength is 10.6 μm, the nearly infrared invisible light, its tissue penetration depth is about 0.23 mm, its beam types include the pulse, ultra-pulse and continuous wave, which are transmitted through the light-guide articulating arm and connected with the operative microscope and various endoscope through the adapters. Its general output power is 2–30 W, which could accomplish the burning, solidification, cutting, gasification and so on. Especially the folding light-guide arm and the microscopic sighting device passing through multiple joints, both of them make the focal spot smaller and the operation more accurate.

#### 3. Argon-Ion Optical Maser

It is a gas laser, its laser medium is the strongly ionized low-pressure argon, it's in the visible blue light spectrum, its wavelength is 488–515 nm and it is transmitted by the quartz optical fibers. Its beam type is the continuous

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wave, whose laser efficiency is 0.1%, output power is 1~10 W and tissue penetration depth is 0.84 mm, it has special affinity with the hemoglobin, and It is suitable for the therapy of the hemorrhagic diseases and the hemangioma.

#### 4. GaAIs Semiconductor Laser Device

It is a relatively-new type laser device, its laser wavelength is  $810 \text{ nm} \pm 25 \text{ nm}$ , its tissue exposure mode contains the continuous, the single and the repeated pulses; it could be passed through the flexible optical fiber transmission, its output power is 0.5~20 W, It could operate the non-blood cutting, the gasification, the solidification.

### 4.1.2 Laser Therapy for Ear Diseases

#### 1. Otic Diseases' Laser Therapy

- (a) Laser operation could be applied to the external otic surgeries, such as the pseudo auricular cyst, the mole, the wart and the otic benign tumor on the auricular, the external auditory canal, the lateral mastoid skin; the sebaceous cyst, the pre auricular fistula, the accessory auricles, the auricular and the periauricular skin micro lesion squamous carcinoma or the basaloma; the mid-ear surgeries, such as the tympanic laser boring, the tympanoplasty, the strapes laser fenestration surgeries and so on.
- (b) Local irradiation therapy could be applied to the acute external otitis, the external otitis furunculosa, the herpes zoster, the auricular eczema, the dermatitis, the anterior auricular fistula infection, the sebaceous cyst infection, the acute and the chronic secretory otitis media, the suppurative otitis media, the operation incision infection, the irradiation therapy reaction and so on. Joining the acupuncture irradiation as the adjuvant therapy could help treat the severe tinnitus Meniere's disease, etc.
- (c) Dos and Don'ts
  - Strict aseptic blanket should be applied during the auricular and the external ear canal laser operation to avoid the complicate postoperative auricular cartilage suppurative infection;
  - The intra-extra-ear canal laser operation is better in the operative microscope;
  - The local auricular irradiation therapy could be under an accurate laser dosage to avoid the auricular cartilage injury.

#### 2. Rhinal Diseases' Laser Therapy

The auricular and the rhinovestibular diseases should be applied to the low-power  $\text{CO}_2$  laser irradiation therapy, and the YAC laser irradiation operation therapy could be

applied to the chronic rhinitis, the chronic nasal sinusitis, the rhinopolyps and the epistaxis.

- (a) The laser operation could be applied to the external nose, the rhinovestibular cutaneous nevus and thymion, the angioma, the anterior rhinoaditus atresia, the rhinal cavum adhesion, the rhinal septum capillary hemangioma and papilloma, the middle turbinate polyposis, the inferior turbinate hypertrophy, the rhinopolyps.
- (b) The local irradiation operation could be applied to the allergic rhinitis, the rhinal vestibular inflammation and furuncle, the middle septum anapetia and mucosal erosion, the intractable epistaxis and the olfactory disorder as well.
- (c) Dos and Don'ts

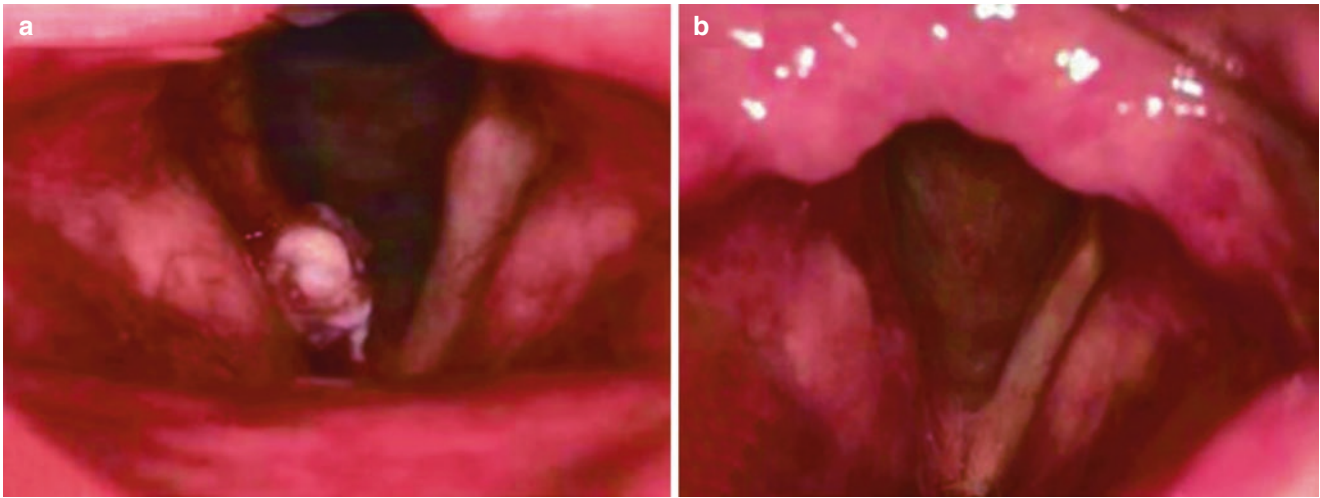
While the laser operation is applied to the external rhinal sites adjacent to the eyes, protect the eyes as much as we can by wearing the laser-protection glasses or covering the eyeball with the gauzes soaked by normal saline; it is suitable to operate under the endoscopic surveillance, the light beam should be focused as much as possible, the irradiation time should not be too long, and pay attention to injure the lamina cribosa and the orbital contents while applying the laser operation on the rhinocavum topical and extratopical wall.

#### 3. Laryngopharyngeal Diseases

- (a) Pharyngeal operation and therapies, such as tonsillectomy, adenoidectomy, benign pharyngotumorectomy, chronic pharyngitis, lymphatic follicular hyperplasia or hypertrophy, the lateral pharyngeal band gasification and local irradiation, the early nasopharyngeal cancer or the irradiation therapy residual focus gasification and carbonization.
- (b) The laser application in pharyngeal operation benefits from laser micro manipulation device invented in the 1970s, which couples  $\text{CO}_2$  laser and binocular microscope through special adapters, solving the transmission problem of the laser beam directly entering laryngocavum and ensuring laser therapy accuracy.

In recent years, laser fibrescope's invention has made it easier for manipulating laser to clear the lesion remotely, and it has many advantages, including clear operative vision, no hemorrhage, rapid postoperative recovery and good laryngeal function remittance. To protect the vocal cords and the normal peripheral tissues better, certain pulse power (4~6 W) laser should be applied, and to avoid the repeated irradiation at one site, the skipping cutting mode should be applied.

Laser could be applied to treat the vocal nodules, the vocal polyps, the laryngoscar stenosis, the benign laryngotumor, the arytenoid cartilage resection, the



**Fig. 4.1** laryngocancer (glottic type) laser operation effect: (a) Pre-operation (b) 1 year postoperation

T1 stage laryngocancer, especially at the T1~2 stage glottic laryngocancer, the laser therapy has been the first choice (Fig. 4.1).

(c) Dos and Don'ts.

The area dealt every time should be limited as far as possible to avoid the possible laryngeal edema caused by too-large scope. If it is vital to apply the laser operation to the relatively bigger scope lesion, the pre-operative tracheotomy should be performed. Before performing the laser therapy, cautiously inspect the lesion's peripheral vascular channel to avoid accidentally injuring the laryngopharyngeal great vessels.

## 4.2 Cryotherapy

### 4.2.1 Principles of Cryotherapy

Cryotherapy is a therapeutic method, which utilizes the below 0 °C temperature, which could freeze and destroy the tissues, to freeze the lesion to treat. It could cause less tissue deflections, deformation, dysfunction and other complications and thinner and shallower scar. But the cryopreservation would also reduce the molecular motion rate of some substances or in organisms or kill the biological cells.

1. Cryotherapeutic Mechanism

- (a) The refrigeration could induce the intracellular and the extra-cellular ice to cause cellular damage.
- (b) The refrigeration could cause the protein denaturation.
- (c) During the rapid cooling, all the intracellular components would cause the cell rupture because the uneven contraction-distention ratio.
- (d) The refrigeration could also cause the local blood circulation disorders.

Common clinical freezing mediums are the Freon and the liquid nitrogen. The common coolers are the phase-change freezer (liquid nitrogen), the throttling expansion freezer (freon) and the thermal freezer, among which, the liquid-nitrogen phase-change freezer is a common one at otorhinolaryngology apartment.

2. Cryotherapeutic Method

- (a) Contract Method: directly contract the cryo-pencil with the lesion; most common method.
- (b) Spray Method: straightly spray the freezing medium onto the affected part.
- (c) Penetration Method: penetrate the cold scalpel bit into the affected tissue to destroy the lesion.
- (d) Tilt-pouring Method: pour the freezing medium onto the affected part.

### 4.2.2 Otorhinolaryngology Head and Neck Cryotherapy

1. Auricular Pseudocyst Liquid-Nitrogen Low-Temperature Cryotherapy

Firstly, puncture to fetch all the cyst fluid, secondly, set the contract cryo-pencil on the cyst and count the therapeutic times, about 30 s, from -30 °C to -85 °C. One to three days after operation, the evident local swelling and infiltration could be observed, then they would scab and gradually cure 7~10 days later.

2. Chronic Rhinitis Cryotherapy

Set the cryo-pencil on the inferior rhino-concha which will be frozen after performing the mucosal surface anesthesia, start recording time at -30 °C and accomplish the therapy after 30~45 s, remove the cryo-pencil when it warms up, and after the mucosal restoration (normally 1~1.5 min) completes, repeat the cryotherapy once again.

### 3. Cryotherapy of Cervico-Cranial Diseases

It could be applied to benign cervico-cranial tumors, including angioma, papilloma, small fibroids, keloid etc. The post-cancer operation cavum cryotherapy could reduce the restoration and it could also be applied to the malignant tumors' palliative therapy.

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## 4.3 Radiotherapy

The microwave's therapeutic effect mainly depends on the endogenous thermal and the thermal effect. The endogenous heat could enhance the local blood circulation, the lymphatic circulation, and the irradiated tissues' metabolism, improve nutritional status, accelerate tissue repair and regeneration process, and improve the tissues' immunity response ability. The mechanism of the thermal effect is unclear, but it is very effective on acute inflammation and endocrine gland diseases.

### 4.3.1 Mechanism

1. The clinical electromagnetic wave frequency is generally 500~2500 MHz, and it could help our body produce the bio microwave thermal effect.
2. While the low-power microwave irradiate on the affected area, it produce little heat but enough to dilate the capillaries and the arterioles, finally improve the local tissues' blood circulation and enhance tissue metabolism.
3. The microwave could increase local leucocyte nucleus antibody and enhance local immunity ability; therefore, inflammation development is under control. This mechanism could apply on the microwave irradiation therapy.
4. When the microwave carries too much energy; heat production would be high, which could promote protein denaturation, tissue coagulation, necrosis and eventual defluvium. During the therapy, the microwave help solidify the tissues. If there isn't any hemorrhage the microwave dosage output would be effected by the tissue coagulation. It's characterized by its even heating with uniform depth, its non-heating process, its limited action range, its clear boundary, its non-coke, its non-hemorrhage, its less-smoke production and its clear operation vision. This mechanism could be applied on the microwave operation therapy. Recently, the microwave material work-station has been developed, which could be Figured with various heating methods.

### 4.3.2 Otorhinolaryngology Head and Neck Surgery Microwave Therapy

1. Hypertrophic Rhinitis and Allergic Rhinitis Microwave Coagulation Therapy  
Through the tissue endogenous thermal effect occurrence, it helps locally instantaneous high temperature coagulation, tissue denaturation and vascular occlusion, so as to effectively reduce turbinate volume and improve rhino-cavum ventilation.
2. Cervico-Cranial Recurrent Malignant Tumor Microwave Irradiation Therapy  
The malignant tumor's water content differs from the normal tissues of which the former one is higher than the latter one, so the microwave radiation absorption is higher. The characteristic of the radiation makes it possible to efficiently kill the tumor cells and protect the normal cells to the hilt. Applying the interstitial microwave radiation combing with the radiotherapy and the chemotherapy, is very effective on the cervico-cranial recurrent cancer.

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## 4.4 Low-Temperature-Plasma Radio-Frequency Ablation Therapy (LTPRFAT)

### 4.4.1 LTPRFAT Principle

It decomposes the lesion intra tissue cells at 100-kHz radio-frequency, then cut and ablate them at relatively-low temperature (40~70 °C). Its principle is to form a plasma film between the electrode and the tissues, in which the free electrophorus particles are accelerated to obtain the kinetic energy, the electric field and disrupt the intracellular molecular bonding to disintegrate in addition, so that the hyperplastic lesion tissues would be reduced or eliminated. So the LTPRFAT can be applied to treat chronic rhinitis, rhinopolyps, epistaxis, chronic pharyngitis, epiglottic cyst etc.

### 4.4.2 Otorhinolaryngology Head and Neck Surgery LTPRFAT

1. Rhinal Diseases LTPRFAT  
It includes treatment of rhinal active hemorrhage and rhinal easily bleeding benign tumors, such as the nasal hemangioma. After treating the peripheral lesion, treat the

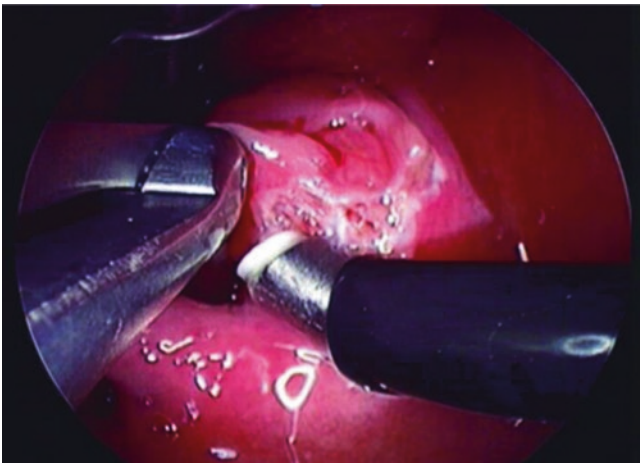
hemorrhagic spot. Its processes are: press the spot with cotton piece, then instantly remove the piece and contract the spot with the cryopencil immediately to accomplish the hemostasis. The rhinitis's therapy mainly focuses on rhinal agger, middle concha, middle meatus's lateral mucosa and the inferior concha's mucosa. While performing the inferior concha's therapy of the chronic rhinitis, the cyberknife could draw a line from inferior to anterior, or singly fire at 4~5 spots. If the watery secretion is too much while treating the rhinal cavity diseases, the therapy could be affected, so wipe them with cotton swabs before treating. Recently, combing the cyberknife with the endoscope could help perform the intra-rhinocavum LTPRFAT.

## 2. Laryngeal and Lingual Root Diseases' LTPRFAT

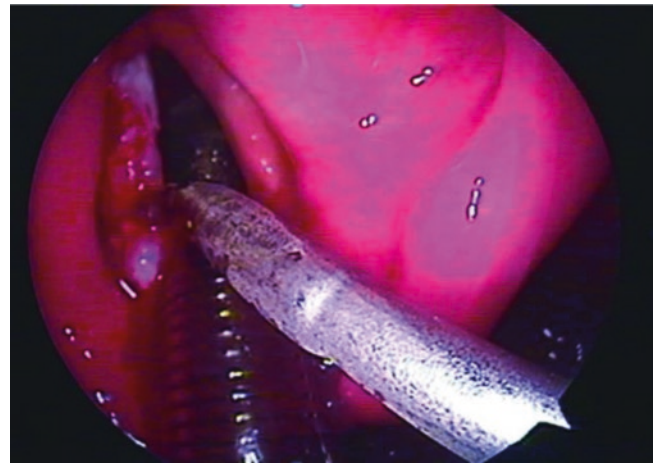
To treat the glandular pharyngitis, muffle the tongue with gauzes and choose the evidently-swelling follicles with the bending cryopencils with the spatula or under the indirect laryngoscope and treat 4~5 of them each time. The chronic amygdalitis LTPRFAT (Fig. 4.2) dissection, during which insert the cryopencil into the tonsillar lacuna till its peripheral skin becomes pale, five to six spots laterally each time. Some laryngopharyngeal tumors and cysts can also be dissected with the LTPRFAT (Fig. 4.3).

## 3. Otic Diseases' LTPRFAT

It is mainly applied to eliminate the accessory auricles, the small external ear canal neoplasms.



**Fig. 4.2** LTPRFAT tonsillar dissection



**Fig. 4.3** LTPRFAT glottic laryngocancer therapy

With recent new technology, low-temperature plasma radio-frequency operation devices cause the low-temperature plasma radio-frequency's energy to eliminate the lesion tissues at a relatively-low temperature. The low-temperature ablation technology can form a highly-aggregated plasma bodies region around the electrode through the electrolyte. The low-temperature plasma radio-frequency has many advantages: indirectly damage tissues which causes less peripheral tissue damage; the electric current doesn't flow through the tissues so the tissue thermal energy is less making the therapeutic temperature low; tissues then ablate at fixed sites, benefiting from the intra molecular interval.

The low-temperature plasma system has been widely applied to treat the obstructive sleep apnea hypopnea syndrome (OSAHS), chronic rhinitis, allergic rhinitis, chronic amygdalitis, tonsillar hypertrophy, and adenoid hypertrophy; all of which has obtained great curative effect [1].

## Reference

1. Du Y, Wang D, Zhang L. Diagnosis key points and treatment method fascicle. 2013.