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EFFECTS OF ULTRAVIOLET AND INFRARED LASER ON CHOLESTEROL CRYSTALS: IMPLICATIONS FOR HEART ATTACKS AND STROKES

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Background and Objectives: We recently demonstrated that cholesterol expands when it crystallizes from a liquid to a solid. This process can lead to plaque rupture causing heart attacks and strokes. To investigate the effects of lasers we irradiated cholesterol crystals using excimer and Ho:Yag lasers.

Study Design/Materials and Methods: Cholesterol crystals were made by melting cholesterol powder (mp 148 °C) and cooling at 22 °C. Samples of crystal were either placed in tubes or embedded in a gel. Excimer lasing (308 nm; 40 mJ/mm²; 25 Hz) was delivered via a 1.7 mm catheter and water injected in a central channel to pump up debris. The Ho:Yag (2100 nm; 2.5 J/mm²; 4 Hz) laser was used in a similar fashion. Forty passes were made in gel with crystals. Debris was collected and attached gel melted at 40 °C. Crystals were filtered through various mesh sizes (53, 100, 500 μm) and scanning electron microscopy (SEM) performed.

Results: Lasing in gel with both wavelengths had the greatest amount of particles in the smallest filter (1–53 μm) while solid crystals and control powder had the greatest amount of particles in the largest filter (> 100–500 μm; P < 0.05). SEM demonstrated that cholesterol crystals were melted into globs by irradiation with loss of pointed tipped morphologies.

Conclusions: Lasing was effective in fusing cholesterol crystals into globs with loss of pointed morphologies and reducing particle sizes in gel. This suggests that lasing may be effective in reducing potential organ damage caused by crystals formed during myocardial infarction and strokes.

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IMAGING STENTED BLOOD VESSEL MIMICS WITH OPTICAL COHERENCE TOMOGRAPHY

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Background and Objectives: Optical coherence tomography (OCT) is a minimally invasive tool appropriate for visualizing the microstructure of in vivo tissues as well as in vitro tissue constructs. A study was performed to evaluate the effectiveness of OCT to visualize stented blood vessel mimics (BVMs) and to quantify the response of each mimic to the deployed vascular stent.

Materials and Methods: We developed a rigid side-firing endoscope with a rotating distal mirror that acquires radial or longitudinal scans over long (30–40mm) segments of vascular construct. Twelve BVMs were developed within the sterile environment of the bioreactors. After an initial maturation period, two types of vascular stents were deployed within the constructs. Two bioreactor flow rates were used after stent deployment to modulate the cellular response. Images were acquired at stent deployment and 3, 7, 14, and 20 days post-deployment. A semi-automated C# program was developed to facilitate the measurement of cellular coverage of the luminal strut surface.

Results: OCT visualized the stent struts, cellular lining, and scaffold of the BVM. Cellular accumulation on the stent struts as measured with OCT was dependent on both the flow conditions and stent types. These response differences were verified with scanning electron microscopy, epi-fluorescence staining, and histological sections.

Conclusions: Optical coherence tomography can be a valuable tool for aiding in vitro evaluations of vascular stents.

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ABLATION OF SUBSURFACE TUMORS USING FOCUSED BEAM FROM SHORT PULSE LASERS

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Background and Objectives: The objective of this paper is to analyze the thermal ablated damage zones during ablation of subsurface tumors by a novel approach of using a converging laser beam from short pulse laser sources focused directly at the tumor site.

Study Design/Materials and Methods: Experiments have been performed on live anaesthetized mice with subsurface tumors using two lasers—Nd:YAG laser (1064 nm, 200 ns), and Raydiance Desktop Laser (1552 nm, 3 ps). Temperature at the tumor location is measured by inserting a needle-type thermocouple probe and the surface temperature is monitored using a thermal imaging camera. The ablation phenomenon is modeled considering two-phase transient heat conduction model. Histological studies are also performed using frozen section technique to observe morphological changes in normal tissue and tumor in response to laser irradiation.

Results: It is observed that a focused laser beam produces a smaller localized heat affected zone compared to a collimated laser source. A parametric study of various laser parameters like power, pulse repetition rate, and irradiation time is performed to determine the ablation threshold.

Conclusions: Numerical modeling results are in very good agreement with experimentally measured ablation depths and will provide a tool for selection of appropriate laser parameters for ablation. Histological studies show the importance of selecting proper laser parameter to control the size of ablation crater and surrounding damage zone.
INTRODUCTION OF A NEW 1318 nm HIGH POWER QUANTUM DOT LASER IN SURGERY OF THE LUNG

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Background and Objectives: To demonstrate the indications and advantages of a new 1318nm quantum dot 60 W power laser for lung surgery.

Materials and Methods: In 3/96 we introduced the 1318nm wavelength in thoracic surgery and consecutively published the benefits for all types of lung resections. Initially a modified Nd:YAG laser emitting only 40 W was used, strained with time consuming operations for patients with a high number of metastases, or large segmentectomies. Based on nanotechnology we developed a new quantum dot semiconductor laser delivering 60 W power output at 1318nm. Further improvements derive from a higher wall plug efficiency, less heat excess and increased robustness against mechanical shock.

Results: From 3/96 to 10/06 1514 laser operations in 865 patients were performed using the 1318nm wavelength. Indications were metastastectomies (n = 1135, 75%), range 1–265/pat. segmentectomies (n = 153, 10%), resections of benign nodules (n = 176,12%) and others (3%). Recently we used our new quantum dot laser for all types of operations and found a significant reduction of time for resection beside easier handling and welcomed reduction of noise based on lower heat excess.

Conclusions: This new 1318nm quantum dot laser offers the estimated coagulation, cutting and sealing properties on lung tissue but due to higher power resections are significantly accelerated and indications can probably be extended to liver, spleen, kidney and pancreas.

ENDOVENOUS LASER ABLATION OF SAPHENOUS VEIN- A COMPARATIVE STUDY OF OUTCOME AND COMPLICATIONS WITH HIGHER AND LOWER AMOUNTS OF LASER ENERGY DELIVERED

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Aim: Endovenous Laser Ablation of the Great Saphenous Vein (GSV) is an established treatment modality for reflux disease. But the amount of laser energy delivered per centimeter of the vein for a successful outcome and with minimal complications is still controversial. The aim of this study is to compare two methods of treatment, one using ~50Joules/cm of saphenous vein segment and the other using ~100Joules/cm.

Methods: 70 consecutive patients with established GSV reflux, who underwent laser ablation were retrospectively studied. The follow up was for one year. In the initial 42patients (44 limbs) the amount of laser energy used was 46J–50J/cm (mean of 106J/cm) of the ablated vein segment and in the later 28 patients (28 limbs) the amount of laser energy used was 46J–50J/cm (mean of 48J/cm).

Results: There were two recurrences (4%) in the 106J group due to recanalization of lower one-third of the vein. No cases of neuropathy or skin-burns were seen in either goup. There were 7 cases (15%) of ecchymosis of about 10 × 8 cm (80sqcm) in the 106J group. In the 48J group 3 cases (10%) ecchymosis were seen but was limited to about 15sqcm.

Conclusions: Recurrence was not significantly difference between the two groups (p = 0.5) but ecchymosis was significantly higher with higher (106J/cm) amounts of laser energy used (p = 0.038). ~50J/cm of laser energy is as effective and has lower complication rates compared to ~100J/cm.
Laser-Induced Interstitial Thermal Therapy (LITT): Correlation Between Lesion Size and Temperature Mapping Using Low-Field MRI

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Background and Objectives: The introduction of open MRI systems has made possible the use of reproducible thermosensitive sequences in order to determine the temperature distribution inside biological tissue. This study aimed to perform thermal mapping during Laser-induced Interstitial Thermal Therapy (LITT) when using this technique.

Study Design/Materials and Methods: Laser irradiation was performed with a 980nm laser (Pharaon, Osyris France) in porcine liver ex-vivo in a low-field open scanner (Hitachi Airis 0.2 T). The laser light was transmitted through a 1040 μm (outer diameter) bare-tip silica fibre. The laser energy was applied on an intermittent mode (10 s laser-on, 10 s laser-off) for 12 minutes, power: 6W, energy: 2360 J. MR-T1 method was used for its simplicity and its efficiency at low magnetic field. Gradient-echo images acquired during laser irradiation were used for real-time temperature mapping. The method was then validated by a comparison between calculated isotherm and macroscopic lesion size.

Results: Images of sufficient quality were obtained with a mean SNR of 50.0. Temperature accuracy was 2.2 °C, temporal resolution was 20 sec. and spatial resolution was 2.5°×2.5°×2.5 mm³. Coagulation necrosis was observed in all laser-irradiated zones. Volumes calculated from isotherms were correlated (r² = 0.64 P<0.05) to lesion size determined from macroscopic measurement.

Conclusion: Using fast gradient-echo sequence, laser monitoring is achieved efficiently with a fast temperature mapping. Using T1-weighted images appears promising for a monitoring of lesion size evolution in future low magnetic field in-vivo studies.

Endo—peri Luminal 808nm Laser for the Treatment of Collateral and Reticular Legs Veins

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Background: Endovenous lasers treat great saphenous veins GSV. Collateral and reticular legs veins have thin vessel wall compared with GSV ratio 9:3.

Objective: We valued 808nm laser in Endo-Peri luminal procedure for treatment of collateral and reticular leg veins. If the fiber is in perivasal side, first target could be the adventitial vasa venarum.

Materials and Methods: Since 2001, 100 patients (80 female, 20 male) presenting varicose veins (50 collateral and 50 reticular) were treated with endo-peri luminal 808nm Laser (Eufoton Trieste, Italy). After local anaesthesia (Emla cream), a optic fiber 600um, in collateral, and 200um in reticular veins was inserted into or peri varicos veins wall, associated with skin cooling system. The fibre with pilot light was put where the reflux originated, then it was gently withdrawn 2–3mm/sec and 5–6watts power was applied for 250–500msec, immediately photocoagulating venous blood and wall. Some vessels required two or more overlapped irradiations. A pressure with a cylinder of cotton, and 20–30 mmHg of elastic stocking were applied.

Results: 95 patients obtained good results; 5 (3 collateral, 2 reticular veins) required a second sclero foam treatment. Transitory side effect were 10 superficial phlebitis, 5 hyperpigmentations, 3 small burns. One year follow up achieved 2 reticular veins) required a second sclero foam treatment. Transitory side effect were 10 superficial phlebitis, 5 hyperpigmentations, 3 small burns. One year follow up achieved 5 partial relapsed.

Conclusions: Effective treatment of collateral and reticular legs veins was achieved with endo-peri luminal 808nm laser. The vessel shrinking was achieved for selective photothromolysis of endo- Hbs and peri-luminal Hbs of vasa venarum, wall myoglobin and wall collagen.
NON-THERMAL DENTAL ABLATION USING ULTRA-SHORT PULSED, NEAR INFRARED LASER
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Background and Objectives: An ultra-short pulsed laser was utilized for a precise targeted ablation of carious dentin, enamel, composite material and sealant without thermally damaging the pulp of human and bovine teeth.

Study Design/Materials and Methods: A desktop pulse laser (Raydiance, Inc.) having 3 picoseconds pulse duration (1552 nm wavelength) was focused using converging optics. During ablation, a thermal camera (IR Flexcam Pro) was used to monitor the teeth’s surface temperature. Temperature measurements throughout the entire tooth were compared with numerical solutions of three-dimensional transient heat conduction model using the finite difference method.

Results: The scanning electron microscope generated images of precise clean ablations when the ablation threshold for each material was achieved. Through a parametric study of the laser parameters of time average power and repetition rates, it was found that composite material, sealant, and carious dentin were ablated at thresholds much lower than the healthy enamel and dentin. The thermal energy deposited on the teeth during the initial ablation stage was found to be minimal, thus preserving the integrity of the pulp.

Conclusions: The novel use of ultra-short pulsed lasers as compared to long pulse lasers allows for precise, smart ablation with higher efficiency and smaller thermal and mechanical damage zone while protecting the safety of the nerves within the pulp of the tooth.

Nd:YAG LASER THERAPY OF BENIGN STENOSIS IN THE UPPER RESPIRATORY TRACT
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Background and Objective: benign stenosis in the upper respiratory tract arises in all ages. While infancy is predominated by vascular findings like haemangioma and vascular malformation, in higher ages postinterventional stenosis after long-term tube and tracheotomy is relevant.

Materials and Methods: in our department we have treated in the last 10 years 95 patients with benign, functional relevant stenosis of the larynx or trachea with the Nd:YAG laser under endoscopic approach. The Nd:YAG laser light (1.064nm) was exposed via bare fibre. The application mode was adapted to the finding: coagulation in near contact (e.g. haemangioma) or contact (e.g. granuloma) respectively with pre-conditioned fibre tip as contact vaporisation (pellicular stenosis, mucocele).

Results: in acquired stenosis up to tree interventions were necessary, in subglottic haemangioma up to five interventions, in vascular malformations up to fifteen treatments were performed, due to the specific tendency of recurrence. In all acquired findings as well as in all haemangioma a total removal of the pathology succeeded, in vascular anomalies at least a considerable reduction in the grade of stenosis. It has to be emphasized, that in all children with subglottic tracheal haemangioma a tracheotomy could be avoided. In none of the cases relevant side effects occurred, only in four children a postoperative protecting intubation up to 48 hours was necessary, due to the reactive temporary swelling.

Conclusions: we conclude, that Nd:YAG laser treatment is a safe and successful method in the removal of benign stenosis in the upper respiratory tract.

LASER ASSISTED MANAGEMENT OF CONGENITAL AND ACQUIRED PEDIATRIC AIRWAY DISORDERS
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Background and Objectives: Laser surgery has been used to treat otolaryngologic disorders in adults and increasingly employed in pediatric airway disorders. We report outcomes of laser surgery in a group of infants and children with congenital and acquired airway disorders.

Study Design/Materials and Methods: The medical charts of infants and children who were treated for airway disorders between 7/2005 and 11/2006 were reviewed. Data included history and physical examination, diagnostic work-up, management, and follow-up assessment.

Results: Six patients who had laser surgery for airway lesions were identified. Two infants, aging 3–12 weeks, had laryngomalacia, failure to thrive, and apnea. CO2 laser assisted supraglottoplasty, in combination with microlaryngeal scissors in one infant, resulted in continuing weight gain in one infant 2 months after surgery and no apnea episodes 1 week postoperatively in the other. Two patients diagnosed with recurrent respiratory papillomatosis at ages 6–15 months underwent multiple CO2 and KTP laser ablation of laryngotracheal papillomas in 5 years. Microdebrider removal of papillomas was initiated due to extensive size of the papillomas. Two patients, aged 4–11 years, were burn victims with stridor, hoarseness, or difficulty breathing. After CO2 ablation of subglottic stenosis and posterior glottic web, voice and breathing improved and stridor resolved.

Conclusions: Congenital and acquired airway lesions in infants and children can be treated with laser. A combined approach with other techniques may be considered to decrease duration of the procedure when applicable.
CO2 LASER SURGERY FOR VERRUCOUS CARCINOMA OF THE LARYNX
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Background and Objectives: Laryngeal verrucous carcinoma is a rare tumour that looks clinically malignant but histologically benign. Microscopically, there may be difficulties separating verrucous carcinoma from papilloma, hyperplasia and highly differentiated squamous cell carcinoma. It is curable when treated early but high failure rates of non-oncologic surgical resection have been reported. We reviewed current literature and our experience in treating verrucous carcinoma.

Patients and Methods: From 2003 to 2006 four patients with laryngeal verrucous carcinoma were treated by primary laser surgery. Hybrid tumours were excluded. We retrospectively reviewed the histology, treatment and outcome in these patients and compared our findings with current literature.

Results: Three tumours were assigned clinical stage T2 and the fourth T1. Two patients had subsequent radiotherapy. Two are free of disease (mean follow up of 7.5 months). The third, with a T1 tumour, was lost to follow up when he left the country while the fourth, with a T2 tumour, required total laryngectomy for local recurrence. Histology of these lesions proved difficult both from frozen section and from surgical specimens. These results echo data in current literature.

Conclusions: Treatment of verrucous carcinoma poses a challenge. One needs to balance the risk of clinical over-diagnosis and associated surgical morbidity with that of histological under-diagnosis and associated delay in treatment of a potentially curable malignancy. Need for multiple biopsies, effectiveness of transoral resection and a high risk of local recurrence and anaplastic transformation with radiotherapy mean that endolaryngeal laser surgery is the most accepted treatment modality.

HIGH INTENSITY LASER ACUPUNCTURE ON CHRONIC SOFT TISSUE DISEASES*
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Background and Objectives: The high temperature needle of fire acupuncture (FA) was replaced by high intensity laser irradiation (HIL) and the latter was called high intensity laser acupuncture (HILA). FA has been widely used to treat chronic soft tissue diseases (CST). The mechanism of the primarily studied HILA on CST will be discussed in this paper.

Study Design/Materials and Methods: Interstitial fluid flow (IFF) is present in soft tissues as an important microcirculation component, and it is increased during CST such as fibrosis and tumors. The mechanism of HILA on CST will be studied in this viewpoint.

Results: IFF might induce myofibroblast differentiation and collagen alignment in vitro. The central irradiation of the HIL beam is so intense that it could destroy the target tissue and might modulate IFF, the marginal irradiation is so low that it could induce photobiomodulation on the undamaged tissue cells. Myofibroblasts have been found to appear and disappear slower in laser excision wounds comparing with excision wounds. The collagen alignment has been found to be dose-dependent on HIL in transmyocardial 355 nm laser revascularization. Therefore, HIL might block IFF and inhibit pathological progress of the undamaged tissue if HIL parameters were carefully chosen so that there might be therapeutic effects of HILA on CST.

Conclusions: HILA might be used to treat CST.

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