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New methods of the noninvasive diagnostics of malignant diseases of the larynx

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We report results of systematic clinical studies using conventional optical coherence tomography (OCT) and its modification – cross-polarized OCT (CP OCT) for differential diagnostics of laryngeal diseases.
Materials and methods: A total of 128 patients participated in the study. The patients were consented in writing. A total of 2805 OCT images were collected and correlated with results of histological analysis of the 322 suspicious tissue sites.
Results: The correlation analysis of OCT images and morphological findings allowed to establish the following optical features in OCT images: structure (presence of two horizontal layers corresponding to the epithelium and stroma); homogeneity or heterogeneity (presence of optical inclusions, i.e. areas in OCT images with sufficient variations of intensity); in-depth decay rate of useful informative OCT signal (slow decay rate – an OCT image is informative for all depths, and fast decay rate – only the upper part of an OCT image is informative). Optical features of OCT images corresponding to malignant conditions differ significantly from those of benign conditions. The blinded recognition of OCT images performed by physicians familiar with the method of OCT yielded high specificity (90%), high sensitivity (83%), high diagnostic accuracy (87%) and interobserver agreement index 0.64. The number of false positive and false negative cases (hyper and hypo diagnostics of laryngeal cancer) caused by similar appearance of OCT images can be reduced by means of CP OCT. The method of CP OCT allows obtaining OCT images in parallel and orthogonal polarizations simultaneously. As it was in CP OCT provides additional information on optical properties of biological tissue. The CP OCT image of laryngeal carcinoma appears dark which means that tissue does not depolarize the probing light due to morphological processes such as active cellular proliferation and degradation of stromal tissue accompanying carcinoma. The CP OCT images of carcinoma differ significantly from CP OCT images of other pathological conditions of the larynx, and, thus, CP OCT provides an additional tool for more reliable differentiation among various pathological conditions.
Conclusions: Conventional OCT allowed for differential diagnostics of various pathologies of the larynx. CP OCT proved to facilitate differential diagnostics of pathological conditions characterized by a similar conventional OCT images in appearance.

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Clinical application of 11C-Choline PET in patients with biochemical relapse of prostate cancer

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Background/Purpose: To evaluate ^{11}C-Choline PET sensitivity in identifying the site of clinical relapse in patients (pts) with rising PSA values after radical treatment for prostate cancer in order to define optimal treatment.
Materials/Methods: 36 pts with biochemical relapse after radical treatment for prostate cancer were studied. Mean age was 63.4 years (range 44–83 years). Previous treatments were: Radical Prostatectomy (RP) 17 cases, External Beam Radiation Therapy (EBRT) 14 case, Hormonal therapy (HT) 3 cases, RP+EBRT 1 case and Hyperthermia (HIFU) 1 case. Staging at first diagnosis resulted as follows: Stage I: 2 pts, stage II: 21 pts, stage III: 10 pts and stage IV: 3 patient (pT4 or with pelvic nodal involvement). All pts underwent ^{11}C-Choline PET scan at the moment of biochemical relapse. Analysis with prognostic factors was performed using a Chi-square test.
Results: Mean PSA value at time of PET scan was 4.37 ng/ml (SD 5.37). ^{11}C-choline PET scan was negative in 17 pts and positive in 19 pts. A total of 23 site of relapse were found: prostatic fossa in 9 cases, lymph nodes in 11 cases (pelvic nodes 8, para-aortic 2 and mediastinal 3), bone 3 case. Correlations between age, stage, Gleason score, total administered dose and HT with PET positivity were not statistically significant. PSA values at initial diagnosis were well correlated with positive ^{11}C-choline PET scan ($p = 0.0077$). Mean PSA values were statistically different in positive and negative PET scans. In fact 17 negative Choline PET scan had mean PSA value of 2.20 ng/ml (range 0.12 – 7.98 ng, SD 2.16) and 19 positive Choline PET scan had mean PSA value of 6.31 ng/ml (range 0.54 – 25.7 ng, SD 6.60) [t test $p = 0.019$]. Futhermore we observed 78% negative Choline PET scans in pts with PSA level <1 ng at the moment of biochemical relapse (7/9 pts) and 100% positive Choline PET scan in pts with PSA level >8 ng (7/7 pts). Patients with PSA between 1 and 8 ng showed a 50% probability of having positive Choline PET scan (10/20 pts)
Conclusions: In our experience ^{11}C-choline PET is a sensitive diagnostic test to restage patients with biochemical relapse after radical treatment for prostate cancer. Local recurrence in prostatic fossa, lymph node or bone metastasis can be defined by ^{11}C-choline PET in a single scan. The study is going on for better defining the range of positivity and help clinicians in treatment decision making.

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Metabolic PET imaging for stereotactic body radiation therapy planning and therapy response assessment of pulmonary malignancies

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Background: Target volume delineation for stereotactic body radiation therapy (SBRT) for pulmonary malignancies is typically based on CT imaging. Metabolic tumor information derived from F18-fluorodeoxyglucose positron emission tomography (FDG-PET) image data may enhance the ability to accurately target pulmonary malignancies and to assess tumor therapy response.
Methods: Between 5/02 and 11/04, 38 patients underwent planned FDG-PET imaging in addition to CT treatment planning simulation for SBRT of pulmonary malignancies. Qualification criteria for SBRT were less than 5 pulmonary lesions with maximum individual diameter <6 cm. A sequential tomotherapeutic intensity-modulated radiation therapy technique was used to deliver 3 fractions of 12 to 20 Gy to total doses of 36 Gy (metastases) to 60 Gy (primary inoperable stage 1 NSCLC). Doses were prescribed as the minimum dose to the planning target volume (PTV) which included safety margins of 5 mm axially and 10 mm cranio-caudally to the gross tumor volume (GTV). We analyzed what impact the metabolic image information derived from FDG-PET had on target volume delineation. In addition, in 30/38 patients FDG-PET studies were acquired in follow-up at 4 to 12 weeks following SBRT. Eighteen of these 30 patients had additional FDG-PET studies (1 to 4, median 1) acquired in follow-up intervals of 6 to 28 months after SBRT.
Results: Since all patients referred for SBRT had prior radiographic tumor staging, the planning FDG-PET study did not change the treatment strategy. A pathologic FDG standardized value uptake (SUV) of >3.0 at baseline was observed in 35/38 studies. Three lesions showed FDG SUV <3.0 (range 2.1 to 2.7). Successful, spatially accurate image co-registration between CT and PET image data, analyzed by anatomical landmark evaluation, was achieved in 34/38 patients. FDG-PET metabolic information changed CT gross tumor volume (GTV) delineation in 8/34 cases where a tumor associated lung atelectasis or regional fibrosis in case of tumor recurrences was observed. In those cases, the uptake region in FDG-PET was used for GTV delineation. Changes in tumor SUV were observed as early as 4 weeks following SBRT. A decline to below a SUV of 3.0 was consistently observed at 12 weeks of follow-up (28/30 patients with PET follow-up, including 2/3 patients with low initial SUV showing minor decline). In patients with long-term PET follow-up, further reduction in FDG uptake to normal tissue levels was observed. Two patients who failed to show a decline in FDG uptake failed SBRT locally.
Conclusions: Although the small patient number studied may limit our ability to comprehensively assess the value of implementing FDG-PET into SBRT treatment planning and therapy response assessment for pulmonary malignancies, our preliminary experience supports three conclusions: (1) FDG-PET may be especially useful for SBRT planning of lesions masked by fibrosis, or atelectasis; (2) early decline in FDG uptake to below proposed favorable uptake values may prognosticate long-term local tumor control; (3) failure to show SUV decline within 12 weeks may indicate resistance to therapy.