News

Research Highlights

Interview

Color-coded images of the lung represent severity of lung disease

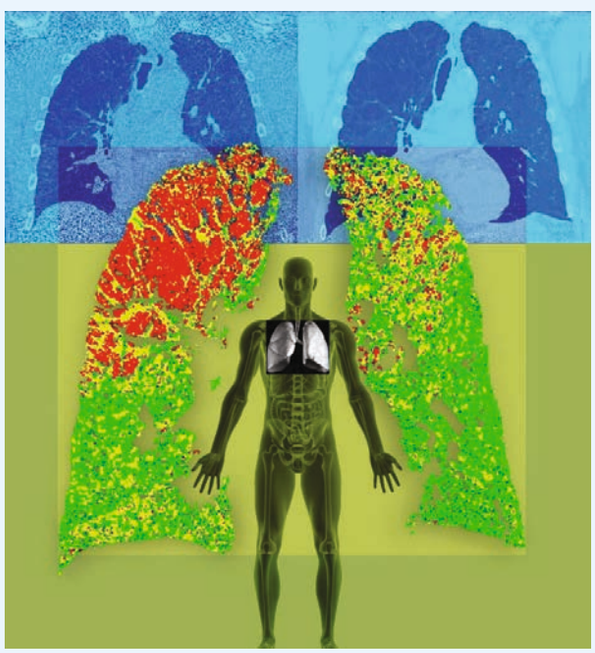
Researchers from the University of Michigan Medical School (MI, USA) have unveiled an innovative approach to lung scanning. The method, called parametric response mapping (PRM), involves producing a colorful 3D 'map' of the patient's lungs from CT scans. Published in *Nature Medicine,* it is anticipated that PRM will herald great improvements in the diagnosis and treatment of specific forms of the lung disease, chronic obstruction pulmonary disorder (COPD).

Speaking to *Imaging in Medicine,* senior author of the paper Brian Ross (University of Michigan, MI, USA) commented, "our work provides for the first time the ability to use CT lung images to spatially visualize and quantify the contributions of both emphysema and functional small airways disease." This he hopes will now present new opportunities when treating patients with COPD. It also, for the first time, allows CT detection of small airway diseases to be achieved.

Using PRM to interpret CT scans holds the potential to greatly improve the ability of researchers to distinguish between the many different symptoms which come under COPD, such as chronic bronchitis, where inflammation is ongoing and emphysema, where the alveoli sacs are damaged. These matters also lead to the semireversible narrowing of the lungs airways, "we have taken an important first step in the development of a new imaging approach for delineation of the underlying tissue types contributing to COPD," commented Ross.

One of the surprising finds from the study, Ross observed, was "the relationship between functional small airways and emphysema. Based on our PRM analysis of CT scans, functional small airway disease was found to precede emphysema. While this was indicated by other recent histologically-based research, the results obtained from these studies revealed the process of disease progression."

Due to the varying forms of COPD, it is becoming increasingly recognized that subtypes of image biomarkers are required to individualize treatment for this highly heterogeneous disorder that affects millions of people worldwide. It is commonly associated with smoking but can also be caused by long-term exposure to certain chemicals and gases. "Although our understanding of the complexity of this disorder is expanding, there has been no major improvement in the diagnosis of the underlying components of this disease thus clinical management of these patients remains suboptimal," commented Ross.



The parametric response map produces a multicolor lung overlay in which green denotes normal healthy lung, red denotes regions of emphysema and yellow reveals areas of small airways disease. This map is computer generated from changes in signals observed between inspiratory and expiratory CT scans.
Image provided by Brian Ross (University of Michigan, MI, USA).

Whilst CT scans over the last two decades have greatly helped researchers to visualize emphysema, imaging small airway diseases have remained impossible. "In the last decade, CT scan techniques for imaging COPD have improved steadily, but PRM is the missing link, giving us a robust way to see small airway disease and personalize treatment," continued Ross.

The study involved analyzing CT scans from 194 patients diagnosed with COPD. The patients were all registered with the national COPDGene study, which is funded by the National Heart, Lung and Blood Institute (MD, USA).

PRM involves the researchers using complex computer techniques to superimpose a CT scan taking from a patient during inhalation with one taken during exhalation. Due to these CT scans having an identical geometric area, the lung tissue from both of them line up. The concentration of healthy lung tissue will vary more between the inhalation and exhalation images then the concentration of diseased tissue which therefore enabled the team at the University of Michigan to create a map.

Colors were applied to the superimposed images to represent the difference in the ability of a patient to push air through certain areas of the lungs. Quite predictably, green was used to represent healthy tissue, yellow indicated reduced air flow and red showed that this reduction was severe. This, therefore, allowed the researchers to determine the severity of the COPD in individual patients.

The team can now see two immediate applications for PRM, "the first is PRM of CT scans will provide an accurate diagnosis of the COPD phenotype, that is, the contribution of emphysema and functional small airway disease, in individual patients. This will allow for more personalized care of these patients. The second is PRM could serve as a complementary readout, and possibly a surrogate end point, for large clinical trials of pharmaceutical agents for treating COPD," continued Ross. The future of PRM will see further validation of the technique using histological sampling of lung tissue and evaluating the temporal changes associated with patients undergoing treatment for COPD. The team will also look towards developing image analysis software through aImbio, LLC – a biotechnology company, which has licensed the technology from the University of Michigan.

Sources: Galbán CJ, Han MK, Boes KL et al. *Computed tomography-based biomarker provides unique signature for diagnosis of COPD phenotypes and disease progression.* Nat. Med. *doi:10.1038/nm.2971 (2012) (Epub ahead of print); University of Michigan press release: breathe in, breathe out: new way of imaging lungs could improve COPD diagnosis and treatment: www.uofmhealth.org/news/archive/201210/breathe-breathe-out-new-way-imaging-lungs-could-improve-copd*

One step closer to catching coronary artery disease before it is too late

A recent study, published in *Radiology*, details how we are one step closer to developing a way of imaging and identifying thickening of the coronary artery wall in individuals. The researchers at the NIH (MD, USA) discovered the potential of MRI in screening patients who were at risk of developing coronary artery disease, the leading cause of death in the USA.

The importance of imaging the thickening of the coronary artery wall is due to its application as an early indicator of arteriosclerosis. Whilst blood tests can indicate atherosclerosis by detecting levels of cholesterol and lipids, directly measuring the thickening of the coronary artery walls is claimed to be a better indicator.

The research involved using MRI to measure the thickness of coronary artery walls in 26 patients with a higher susceptibility for coronary artery disease, and 12 healthy patients. The patients from each group were paired to each other dependant on their BMI. Coronary artery thickness was first measured by single-frame MRI. After this, time-resolved multiframe acquisition was used. This type of MRI involves five uninterrupted images being taken. By taking five images, the team hypothesized that the probability of obtaining blurry hard to interpret images would be decreased.

This hypothesis was found to be correct, with 90% of the images taken by time-resolved multiframe acquisition MRI being of good quality, whilst only 76% of those produced from single-frame MRI were useable. Furthermore, the researchers were also able to distinguish the differences in wall thickness between patients that had coronary artery disease and the healthy controls.

"We are delighted that the technique is showing such practical promise," commented Khaled Abd-Elmoniem, lead researcher on the study (NIH, MD, USA).

Coronary artery disease increases the risk of many things, such as heart attacks. Imaging the early-stages of coronary artery disease would be of great benefit before it has progressed too far because it can be treated with lifestyle changes, such as reducing cholesterol in the diet. At later stages, this treatment would not make a significant difference. However, it is fraught with many difficulties concerned with the biology of the coronary arteries, "imaging the coronary arteries that supply the heart with blood is extremely difficult because they are very small and constantly in motion," explained Abd-Elmoniem.

The future potential of MRI to catch coronary artery disease when intervention is still possible could benefit many people "these results suggest that MRI may be used in the future to screen for individuals at risk for coronary artery disease and may be useful for monitoring the effects of therapies," concluded Abd-Elmoniem.

Sources: Abd-Elmoniem KZ, Gharib AM, Pettigrew RI. Coronary vessel wall 3-T MR imaging with time-resolved acquisition of phase-sensitive dual inversion-recovery (TRAPD) technique: initial results in patients with risk factors for coronary artery disease. Radiology *doi:10.1148/radiol.12120068 (2012) (Epub ahead of print); Radiological Society of North America press release: new MRI technique used to identify early-stage coronary disease: www2.rsna.org/timssnet/media/pressreleases/pr_target.cfm?ID=616*

Measuring the value of imaging agents for the diagnosis of head and neck sqaumous cell carcinomas

Combining PET imaging with 3′-deoxy-3′F-18-fluorothymidine (F-18-FLT) could lead to an earlier and more accurate diagnosis for patients with head and neck sqaumous cell carcinomas (HNSCCs). The study published in the *Journal of Nuclear Medicine* could lead to clinicians being able to determine how successfully a patient is responding to treatment, as well as how carefully they should be monitored.

Changes in HNSCCs are typically observed by anatomic imaging modalities. This could be accompanied by F-18-fluorodeoxyglucose (FDG) PET; however, a problem with this as an imaging agent is its ability to produce false-positive results. Therefore, the tumor size can be miscalculated and the prescribed treatment is not the most suitable.

Now, researchers at Kagawa University (Kagawa, Japan) have been exploring the efficiency of alternative imaging agents in showing HNSCCs. In their study, F-18-FLT was shown to hold great promise. Although FLT-PET has been previously shown in experimental models to be a more efficient imaging model than FDG-PET, "there are few clinical studies comparing FLT-PET and FDG-PET findings for radiotherapy," explained Hiroshi Hoshikawa (Kagawa University), the lead author on the study.

The experiment involved comparing the level of uptake of F-18-FLT and F-18-FDG in 28 patients with HNSCCs. These patients were all subjected to F-18-FLT and F-18-FDG PET imaging at set intervals; before the start of radiation therapy, 4 weeks into radiation therapy and 5 weeks after the end of radiation therapy. The levels of uptake were taken in the primary and metastatic lesions of the tumor.

The results showed that whilst F-18-FDG disappeared and was, therefore, taken up in 16% of lesions, F-18-FLT was no longer present in 63%. The promising results also found that F-18-FLT had greater accuracy and was more specific in the time intervals during and after radiation therapy.

"We hope that our findings will be helpful in understanding the significance of F-18-FLT-PET," said Hoshikawa "with the development of new molecular imaging agents, it's now up to clinical researchers to utilize them to assess the characteristics of malignant tumors and their therapeutic response to chemotherapy, radiotherapy and molecular targeting therapy."

Sources: Kishino T, Hoshikawa H, Nishiyama Y, Yamamoto Y, Mori N. Usefulness of 3′-deoxy-3′-18F-fluorothymidine PET for predicting early response to chemoradiotherapy in head and neck cancer. J. Nucl. Med. *53(10), 1521–1527 (2012); Society of Nuclear Medicine and Molecular Imaging press release: PET predicts early response to treatment for head and neck cancer patients: http://interactive.snm.org/index.cfm?PageID=12077*

Clinicians provided with hand-held imaging device

A new handheld scanner will present primary care physicians with the opportunity to image the inside of the human body in real time for the very first time. The exciting device was created by engineers from the University of Illinois at Urbana-Champaign (IL, USA) and presented at the Optical Society's Annual Meeting (NY, USA).

The handheld device is comparable with ultrasound imaging; however, it uses light instead of sound to produce high-quality images. This imaging method is called optical coherence tomography. The device is built up from several parts; an optical coherence tomography structure, an near infrared light source, a microelectromechanical-based scanner whose role is to direct the light and a video camera that relays real-time images of the objects it encounters.

Once the time taken for the light to travel between the device and the tissue microstructure is recorded, computer-based algorithms can then be formulated. From these calculations, the clinicians would then be able to develop a picture of the tissue that they are focusing on.

It is anticipated this new hand held device will be particularly useful when treating diabetic patients. Just under half of diabetes sufferers experience retinopathy, a condition where the blood vessels in their retinas leak. With the use of the new device, clinicians will easily and efficiently be able to monitor this and take appropriate action an earlier stage.

The potential of this device could see it being used in developing countries where many other imaging devices are unavailable or in short supply. The team also hope that over time it will be possible to adapt it further so it is smaller and even more compact then the current model.

Source: OSA press release: 3-D medical scanner: New handheld imaging device to aid doctors on the 'diagnostic front lines': www.eurekalert.org/pub_releases/2012–10/osoa-3ms100212.php

– All stories written by Natasha Galukande

About the News

The News highlights some of the most important events and research in the field of imaging in medicine. If you have newsworthy information, please contact: Sarah Miller, Commissioning Editor, *Imaging in Medicine,* s.miller@futuremedicine.com