**Technical advancement in brain imaging**

**Roberto Gasparotti, MD**

Neuroradiology Unit, Department of Medical and Surgical Specialties, Radiological Sciences and Public Health, University of Brescia, Brescia, Italy

The advent of clinical MR imaging (MRI) in the 1980s opened a new era in the ability to image the

brain in vivo, providing detailed depiction of brain anatomy and pathology with unprecedented spatial resolution and tissue contrast. Nevertheless, the sensitivity and specificity with which structural MRI alone can define the wide range of neurological disease is limited.

The last decade was characterized by the development of physiological and functional MR techniques, able to provide information concerning tissue function as well as structure, which have been more extensively applied to the investigation of the central nervous system disorders.

These new techniques are mainly represented by resting-state functional MRI (RS-fMRI) and Diffusion Tensor Imaging (DTI). Although typically suited for a research environment, RS-fMRI and DTI are now accessible on most MR systems and can readily be incorporated into clinical imaging examinations.

Functional MRI using task-based or stimulus-driven paradigms has been critical to understanding of brain function, using the relative changes from baseline in the BOLD signal during the performance of a task or in response to a stimulus.

In recent years, there has been an increase in interest in the application of the technique at rest, termed resting-state fMRI or functional connectivity MR imaging. RS-fMRI investigates synchronous activations between regions that are spatially distinct, occurring in the absence of a task or stimulus, to identify resting state networks RSNs.

This approach detects temporal correlations in spontaneous blood oxygen level-dependent (BOLD) signal oscillations while subjects rest quietly in the scanner. These temporal correlations are presumed to reflect intrinsic functional connectivity and have been demonstrated across several distinct networks serving critical functions like vision, hearing, language, and salience detection.

Diffusion MRI demonstrates regions of normal and pathological micromolecular motion. Under appropriate conditions, these images can reflect patterns of axonal anatomy and when applied as "fiber tracking" this technique can provide three dimensional displays of the major axonal pathways of the cerebral white matter.

The clinical value of these physiological and functional tools is becoming increasingly appreciated

and can be illustrated by their applications to diseases such as cerebral trauma, neurodegenerative and psychiatric disorders.