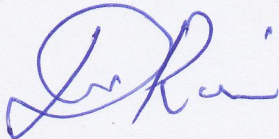# Abstract

The usefulness of CT and MRI in visualization of pathological small lesions

in the brain

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Background

Diseases of the nervous system commonly occur throughout human life and are major contributors to mortality and morbidity. They include two types of stroke (ischemic and haemorrhagic), Alzheimer disease, demyelinating disorders, mental retardation, traumatic brain and spinal cord injury, epilepsy, migraine, meningitis and tumours as astrocytoma, hemangioblastoma and ganglioglioma. The nervous system is built up of nerve cells, neurons, and special kinds of supporting connecting cells, glial. Nerve cells are responsible for the functions that are unique to the nervous system, whereas glial cells are non-neuronal cells that primarily support and protect neurons. Many axons are surrounded with myelin sheath to increase the speed of impulse propagation. Loss of myelin in axons of the central nervous system (CNS) is observed in classic multiple sclerosis (MS). Myelin loss (a nonspecific term) occurs concurrently with other pathological processes that also affect the axons, glial elements, or vasculature. Functions of the nervous system have fine topographic localization, so that focal disease processes can produce numerous signs and symptoms that permit a skilled clinician to locate the affected site precisely. In addition, most neurons are organized in functional arrays, which, if damaged, end up in some of the most vexing neurodegenerative and neuropsychiatric disorders.
Proper and accurate diagnosis of the illnesses and disorders of the CNS is main condition in their therapy. Imaging techniques are very helpful for this purpose and their adequate selection is highly important.

The aim of study is comparison of detection effectiveness of pathological cerebral lesions of small size and different nature with an application of CT and MRI.

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Material and methods

The study material included results of CT and MRI examinations of the head performed in 56 adults (15 males and 41 female) patients of the Department of Imaging Diagnostics of the Central Clinical Hospital of Ministry of Internal Affairs and Administration in Warsaw. The mean age for females was (64.5±14.3) years, whereas for males was (58±12.8) years. All these patients demonstrated clinical neurological manifestations and were ordered CT examinations by neurologists. Next, they were referred to further, more thorough examinations, i.e. MRI, because CT results had not been satisfactory or unclear. The time interval between the two examinations was 45 days or shorter. In the period between the two examinations the patients were not administered any radical therapies of detected cerebral lesions (i.e. surgical interventions, radiotherapy, chemotherapy).

All the patients were examined in the same imaging devices in the Department of Imaging Diagnostics of the Central Clinical Hospital of Ministry of Internal Affairs and Administration in Warsaw by the same examining team. Images obtained during the CT and MRI procedures were registered and archived in the Central Clinical Hospital of Ministry of Internal Affairs and Administration database. After making the data anonymous the management body of the Department of Imaging Diagnostics of this hospital allowed them to be inspected by the author of this dissertation. CT examinations were performed using CT scanner Brightspeed 16 (GE) with protocol axial head. MRI procedures were performed using Toshiba 1.5T scanner with protocol routine brain.

All the images were elaborated using a workstation equipped with e-Film 3.0 by MERGE.

Of 56 patients included in the study 7 of them underwent contrast CT and 11 of them underwent MRI with contrasted SE-sequence T1.

Results of imaging examinations of particular patients were each time analysed by three independent doctors, a radiologist from the Department of Imagine Diagnostics of the Central Clinical Hospital of Ministry of Internal Affairs and Administration in Warsaw, an independent radiologist from a different department of imagine diagnostics and the author of this dissertation. The result was considered final if it had been confirmed by all three doctors.

Results

After making an analysis of all CT and MRI results the patients were divided into two groups; group A includes patients in whom lesions were visible both in CT and MRI images and group B included patients in whom lesions were visible only in MRI image. An evaluation of types of lesions detected in the analysed images revealed that patients from group B demonstrated almost exclusively (except for two cases) demyelinating lesions. With regards to group A, patients demonstrated demyelinating lesions and other pathologies. Thus, group A was divided into two subgroups: group A1 included patients with demyelinating lesions; group A2 included patients with changes other than demyelination.

An introduction of the above division allowed eliminating the effect of differences in the types of detected lesions on an effectiveness of the method used for the purpose of imaging the lesions.

On the base of the analysis of the data recorded for the particular groups the following measurements were made for each patients:

1) the ratio between the number of lesions visible in T2-weighted image and in the FLAIR sequence, i.e. $N(T2)/N(FLAIR)$,

2) signal level in the FLAIR sequence (depending on TR/TE parameters); moreover, only for patients from Group A, the author calculated the ratio between the total size of the area of lesions visible in CT and the total size of the area of lesions visible in the FLAIR sequence $S(CT)/S(FLAIR)$.

The results revealed the following observations:

1) $N(T2)/N(FLAIR)$ values show differences resulting from the inner structure of the visualized pathological lesions;

2) At higher TR/TE values the mean value of signal level is also higher and more compact lesions (with longer relaxation time) are better visible and differentiated;

3) Values of the $S(CT)/S(FLAIR)$ ratio are another way of explaining differences between changes observed in Groups: A1 and A2.

Results obtained in this way were statistically analysed in order to find similarities and differences between particular groups. The most significant differences were found

- for distributions N(T2)/N(FLAIR) between groups A1 and A2,

- for distributions signal intensity between groups A1 and B.

The difference in S(CT)/S(FLAIR) distribution in groups A1 and A2 is also statistically significant.

Conclusions

The obtained results can be the grounds for formulating the following conclusions.

1. CT is highly effective for visualization of such (pathological) lesions in the brain, whose attenuation coefficient is distinctly higher than the area surrounding the lesion as well as the size is at least 5 mm because the low contrast multiplied by diameter of the lesion is constant (LCx$\emptyset$ = const.), i.e. the smaller the size, the higher the contrast is needed in order to ensure detectability).

2. MRI is appropriate for visualization of cerebral lesions of any type; this is especially true for the FLAIR sequence which, together with routinely applied T2 sequence, is particularly efficient because it provides a lot of important diagnostic information. However, in the event of lesions of more compact structure, a result is visible for a higher signal level (longer TR/TE times or (?) higher B_0 field).

With regards to MRI of the brain, T1 sequence does not provide valuable information which could be used for diagnostic purposes.

3. CT is a useful imaging method in preliminary diagnostics; with regards to pathological changes of inner compact structure, this method might provide

sufficient diagnostic information. With regards to demyelinating lesions, MRI is necessary (particularly with the FLAIR sequence).