ON INVESTIGATION OF HUMAN BRAIN USING WATER DIFFUSION METHOD

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Using the method of water diffusion, the DWI (Diffusion Weighted Imaging), is one of the advances in clinical research of human brain. It can help neurosurgery to avoid the different kind of risks, for instance, disability of walking, talking, moving the arms, and so on. Human brain research in this direction makes possible to make tumour surgery using the DTI (Diffusion Tensor Imaging) mapping. The experiments done with phantom give us the histograms which shows the results in form of homogeneous signals in different areas of the phantom which means that human resources can be replaced with phantom and experiments done with it. This advantage gives us reason to develop this approach further.

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Introduction

Research in the structure and activities of brain involves experiments. We have carried out experiments involving measurements in phantom cylindricals. Phantom experiments are important for many reasons, for example, brain scan is not always possible and therefore various forms of phantom (cylindrical, transversal, parallel etc.), which are almost exactly what is in brain fibers adhesion, can be used instead. Using a phantom in turn leads to various challenges. But these will be considered in details later.

Experimental

Presented work was conducted in the direction of brain research using diffusion magnetic resonance imaging (MRI).[1,2] For the experiments a cylindrical phantom has been used.

The design constitutes a cylindrical form made of plastic materials. Plastic tube was wrapped around 10 mm filamentary fibers which in our case constitutes analogue of regional connectivities in brain. The main part of the experiments conducted in the condition of homogeneity of the signal since for the cylindrical phantom signal from fibers directed along the magnetic field is stronger than that from fibers which are positioned perpendicularly to the magnetic field. It also depends on the magnetic field susceptibility.

In this case, there is a signal from fibers directed along the magnetic field, but from the perpendicular fibers there is a noise and accordingly obtained results seem to be wrong.

The experiments in a cylindrical phantom were conducted during approximately 40 min with different number of parameters.

The most important safety issue in the process of the experiment is that it is necessary to keep the safety rolls and to enter the scanner room without any metal thing. Otherwise in many cases the situation can be dangerous for both the patient as well as for the responsible person.

Results and Discussion

The main idea was that, we wanted to get homogeneous signal for different areas of the phantom placed in the magnetic field. For this task first experiment was conducted with only water at different time points: 7.4 and 120 ms.

Second experiment was performed by fibers and with 10 different time points. It is necessary to explain the use of different time points. In some time-interval we can see how water molecules are distributed so that water diffusion can be visualized (Figure 1). In these histograms we can see some conditions affecting direction of movement of water molecules but we cannot see how really signal looks. So we need to make maps from this signal (Figures 2 and 3).

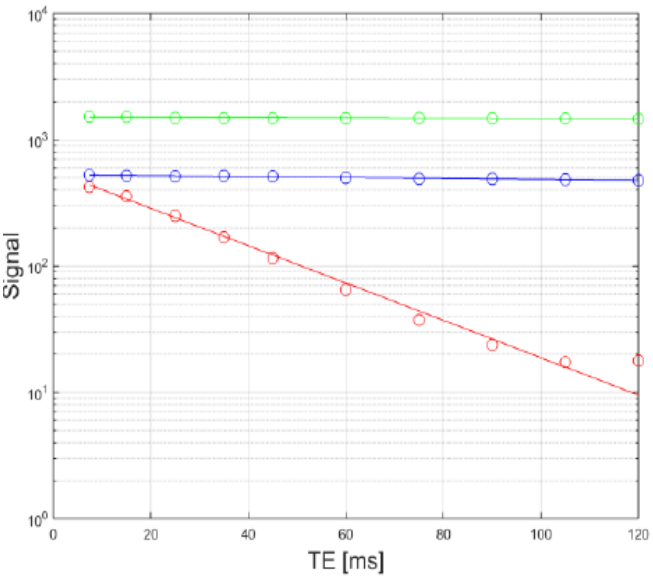

Figure 1. Histogram with 3 different areas and 10 time points.

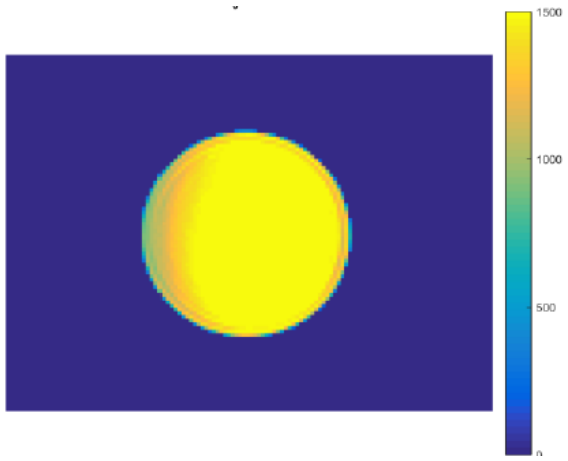

Figure 2. S_0 map giving signal visualization.

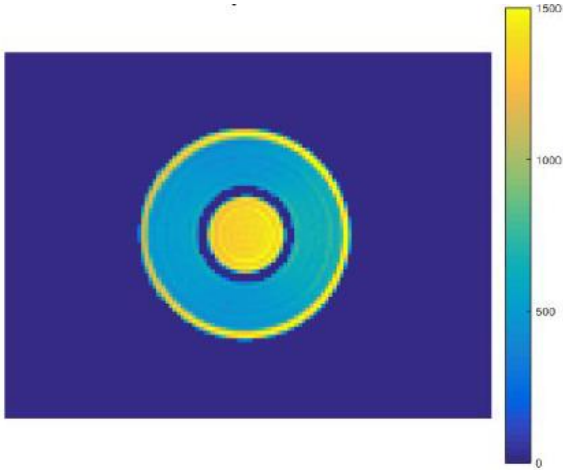

Figure 3. S_0 map with fibers and NaCl.

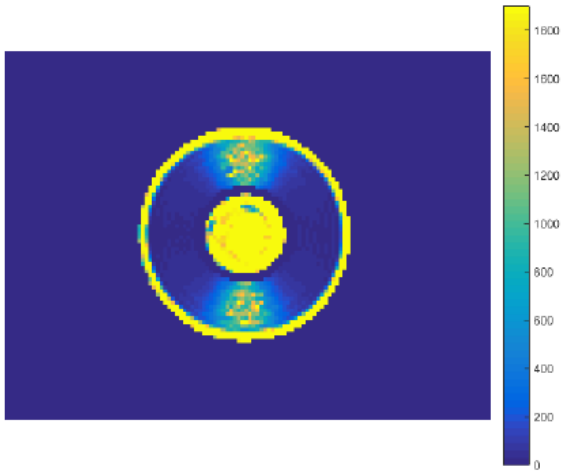

Figure 4. T^2 map for case with fibers. Yellow dots represent noise.

There was clear that during next experiments in T^2 maps we have not exactly homogenous signal – in some regions there was a noise (Figure 4). That's why we tried to add in the water a chemical mixture which is sensitive to diffusion and makes pathological areas looking differently. We used NaCl in condition: 0.6 L of water + 300 g NaCl. We performed two more experiments with chemicals added in water but, third one has to be scraped as during the experiment the phantom was counted wrongly in scanner. The next experiment gave us the expected results (Figure 5).

As it was mentioned, third experiment was not successful but fourth experiment gave us the good results.

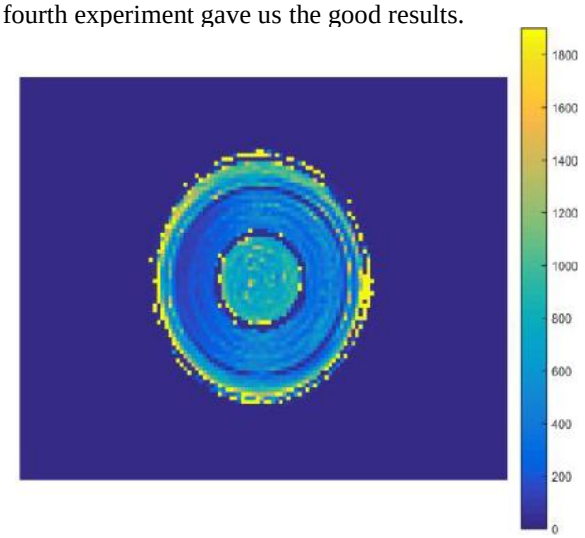

Figure 5. T^2 map for water and chemical mixture (NaCl) and with no noise.

Conclusion

The fundamental result of this work is that the studies of human brain experiments can be performed with phantom structures. It is apparent that the present research is not conclusive. However, the preliminary results can be termed as successful as the data gives us general view about what was anticipated and the result obtained is line of assumption. The major task, undertaken in the present work was to obtain homogeneity of the signal, which was achieved in the last experiment.

It is established that diffusion studies are a step forward for the neurosurgical operations for treatment of tumours.

Acknowledgments

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References

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