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A CONVERSION MODEL FOR THE MEASURED VOLUME OF BRAIN COMPARTMENTS IN TWO DIFFERENT MR IMAGING MODALITY PROTOCOLS

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Introduction: *Usually in all MR imaging centers, scanners are replaced by new version with the same or different specifications. There may always exist MRI studies that started by using former scanner and are continuing by new one. In this paper we propose a model to convert the measured volume of brain compartments by EM-Segmenter from an imaging modality protocol with 1.5 Tesla scanner to another with 3.0 Tesla. This conversion model helps physicians to interpret the volume changing of horizontal patients follow up even by using different specific acquisition MRI modalities.*

Method: *We selected ten patients with MS disease under a treatment scanned by two different MRI equipment. Images were acquired using a 1.5 Tesla scanner entitled Ac1 and 3.0 Tesla scanner entitled Ac2. First, all 10 pairs of images were segmented during 40 hours processing by the EM-Segmenter module in 3DSlicer. After the first analyze of obtained results from this segmentation, a gross anatomical abnormality in one patient's brain was detected, therefore, the sample was reduced to 9 subjects. Using the result of this segmentation enabled us to introduce three conversion models. A combination of these models was examined to convert measured volume for these two acquisitions. Finally the behavior of converted volumes was illustrated.*

Model I: As a preliminary attempt, a general simple model based on graphical sight to cover all overlapping and changing in three matters is

$$\begin{aligned} \widetilde{GM_{Ac2}} &= GM_{Ac1} + \alpha_1 WM_{Ac1} + \beta_1 CSF_{Ac1} + \gamma_1 Vol \\ \widetilde{WM_{Ac2}} &= WM_{Ac1} + \alpha_2 GM_{Ac1} + \beta_2 CSF_{Ac1} + \gamma_2 Vol \\ \widetilde{CSF_{Ac2}} &= CSF_{Ac1} + \alpha_3 WM_{Ac1} + \beta_3 GM_{Ac1} + \gamma_3 Vol \end{aligned} \qquad (1)$$

a linear equation system where $\tilde{A}$ is an approximation of A, B_{Ac1} is the measured volume of B in $Ac1$ protocol and Vol is the total measured volume in $Ac1$.

Model II & III: In addition to model I, linear and nonlinear fitting curves are other proposed conversion models. Let the measured volumes in Ac1 as independent variable x and the Ac2 as dependent variable y means y=f(x) for three compartments (GM, WM and CSF). Three functions can be obtained by linear or nonlinear fitting curves for estimating the volumes in Ac2.

Results and Discussion: *One patient with Multiple Sclerosis disease randomly has been chosen to convert data using our suggestion method. As we can see in Figure 1, the behavior of converted volumes are almost like behavior of Ac1 volumes. It shows that the process of increasing and decreasing volumes of compartments did not experience rough changes in converted volumes.*

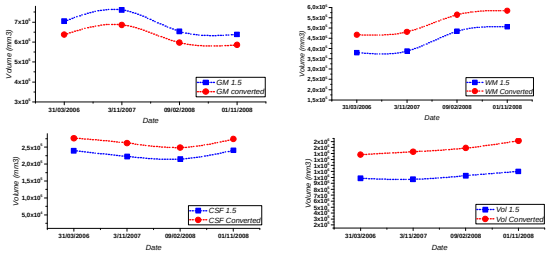

Figure 1. Converted volumes (red line) vs 1.5 Tesla or Ac1 (blue line)

Conclusion: *In this study, a combination model to convert measured volume of brain compartments by EM-Segmenter from one acquisition to another acquisition modality of MRI is suggested. Then the error was calculated for models to illustrate the accuracy of them. Similar behavior should be considered in a conversion model to prevent interpretation error. All the results were tested by 3DSlicer software and EM-Segmenter method. Using the algorithm and the model enabled us to analyze the longitudinal volume changes in GM, WM, CSF and total volume even in two different scanners.*