Consistency of longitudinal brain volume loss assessment in MS using SIENA/FSL

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Background and Purpose

The Structural Image Evaluation using Normalisation of Atrophy (SIENA/FSL version 5.0) toolbox is a widely used application to quantify brain volume loss (BVL).There are different ways of calculating the total BVL if more than two MRI scans are available. BVL can be calculated by comparing the baseline directly to the latest MRI scan (first to last change). Alternatively, BVL can be calculated by taking all intermediate MRI scans into account (accumulative change). We aimed to determine the consistency of SIENA by comparing the accumulative with the first to last change.

Methods

Two independent, longitudinal single scanner cohorts were used (see Table 1). The first cohort was acquired at the University Hospital Zurich and consisted of 37 RRMS patients who received at least three consecutive MRI examinations. The second cohort was part of the longitudinal Open Access Series of Imaging Studies (OASIS). The overall BVL between baseline and latest MRI scan was computed both, the first to last and accumulative change (multiplying all intermediate BVL rates) using SIENA (see Figure 1). For each patient the error [%] was defined as the difference between the accumulative and the first to last change. We compared the error distribution between the two cohorts.

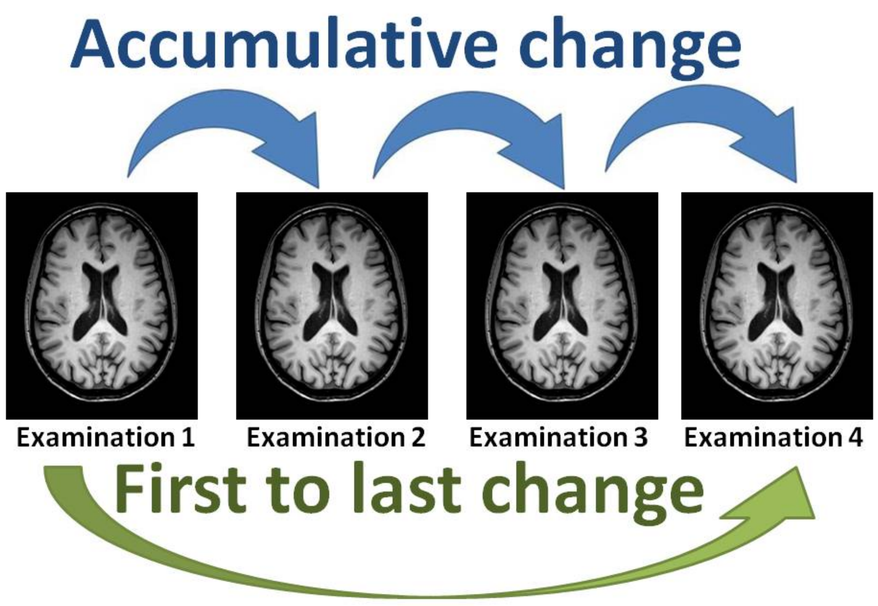

Figure 1 The overall BVL can be calculated by comparing the baseline directly to the latest MRI scan (first to last change) or alternatively, by multiplying all intermediate BVL rates (accumulative change).

Table 1 Characterization of the two cohorts.

	Zurich cohort	**OASIS cohort**
scanner	Philips 3T	Siemens 1.5T
protocol	3D MPRAGE	3D MPRAGE
composition	37 RRMS patients	34 healthy controls
		22 demented patients
age (years)	33 $\pm$7 (mean $\pm$ std)	75.5 $\pm$ 7.3
scan interval (years)	1.7 $\pm$ 0.8	4.4 $\pm$ 1.2
total annual BVL (%)	0.43 $\pm$ 0.61	0.63 $\pm$ 0.47
disease duration (years)	3.6 $\pm$ 5.8	-
EDSS at baseline	1.5 $\pm$ 1.1	-
3 MRI examinations	20	43
4 MRI examinations	12	9
5 MRI examinations	4	4
6 MRI examinations	1	0

Results

For the Zurich cohort the mean error ($\pm$std) was 0.01 $\pm$ 0.17 %. The median of the absolute error was 0.08 %; the 90th percentile was 0.31 %. For the OASIS cohort the corresponding results were 0.03 $\pm$ 0.26 %, median 0.1 %, and 90th percentile was 0.31 %.

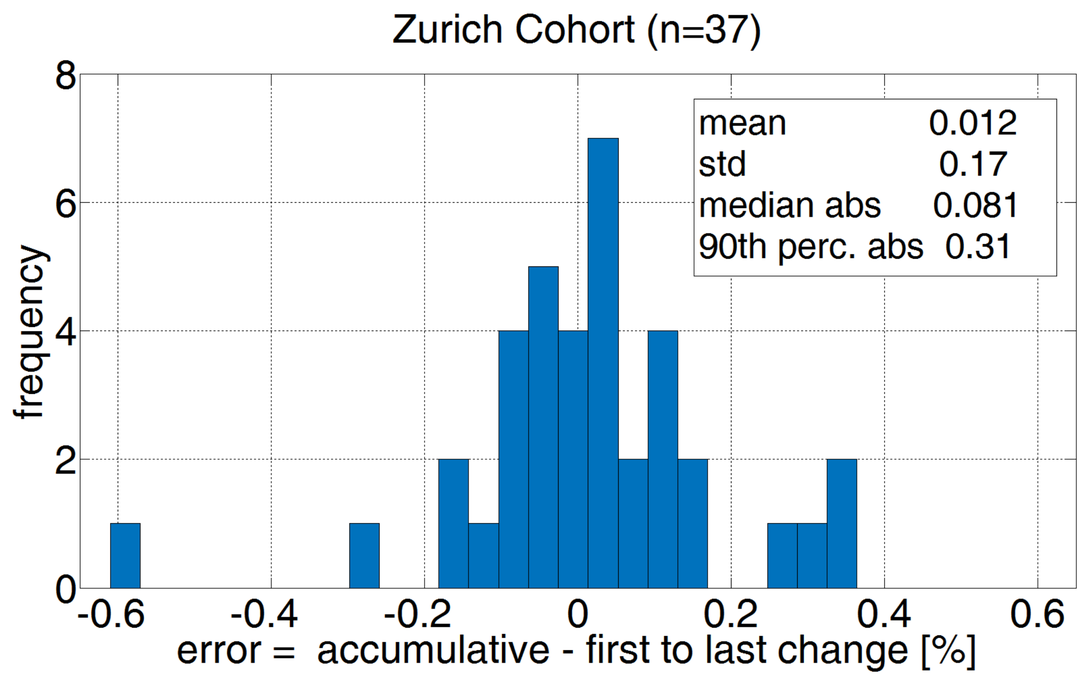

Figure 2 Figure show the SIENA consistency error distributions (accumulative-first to last change) for the Zurich and OASIS cohort.

Conclusions

In case more than two consecutive MRI examinations are available the accumulative and the first to last change yield very consistent results. For both cohorts the median error between the two methods was smaller than 0.1%. The error distribution in both cohorts was similar, suggesting that the consistency error is independent of disease characteristics, age distribution, and the MR scanner.

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