Hypothesis on Shape Features of Lesions: Eccentricity, Convex Area & Volume

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SHAPE FEATURE: CONVEX VOLUME

Automatic Follow-up of Individual Lesions (AFIL) distinguished 328 individual MS lesions with a 0.9% error rate to track persistent or new lesions based on expert assessment. A total of 121 new lesions evolved within the observed time period. The proportional courses of 69.1% lesions in the persistent lesion population exhibited varying volume, 16.9% exhibited stable volume, 3.4% exhibiting continuously increasing, and 0.5% exhibited continuously decreasing volume.
This algorithm tracked individual lesions to automatically create an individual lesion growth profile of MS patients. This approach may allow for the characterization of patients based on their individual lesion progression.[1]

Algorithm Workflow[2] :

1. Automatic assignment of labels in longitudinal lesion masks.
2. Identification of lesion label intersections in consecutive lesion masks: Overlaid baseline mask and appropriate follow-up mask.
3. Determining new lesions in the time series:
   a. Note that the third labelled lesion in follow-up 1 and first and second labels in follow-up 2 do not intersect with lesions of the previous time point.
   b. new lesions continue in step 2 and were tested for intersection
4. Assigning a global label to corresponding lesions in a time series: Corresponding local labels and newly identified lesions of the time series were tracked in rows of the LLTM. Note that a consecutive global label was assigned for a new lesion.
5. Determining confluent and separating lesions in the corrected LLTM. Two entries were found for global label 2, which indicates a separated lesion, and two intersections were found for local label 1 in follow-up 3 with previous time points, which indicates a confluent lesion.
6. Relabelled lesion masks: Local labels of the time series of corresponding lesions were overwritten by an appropriate global label.[3]

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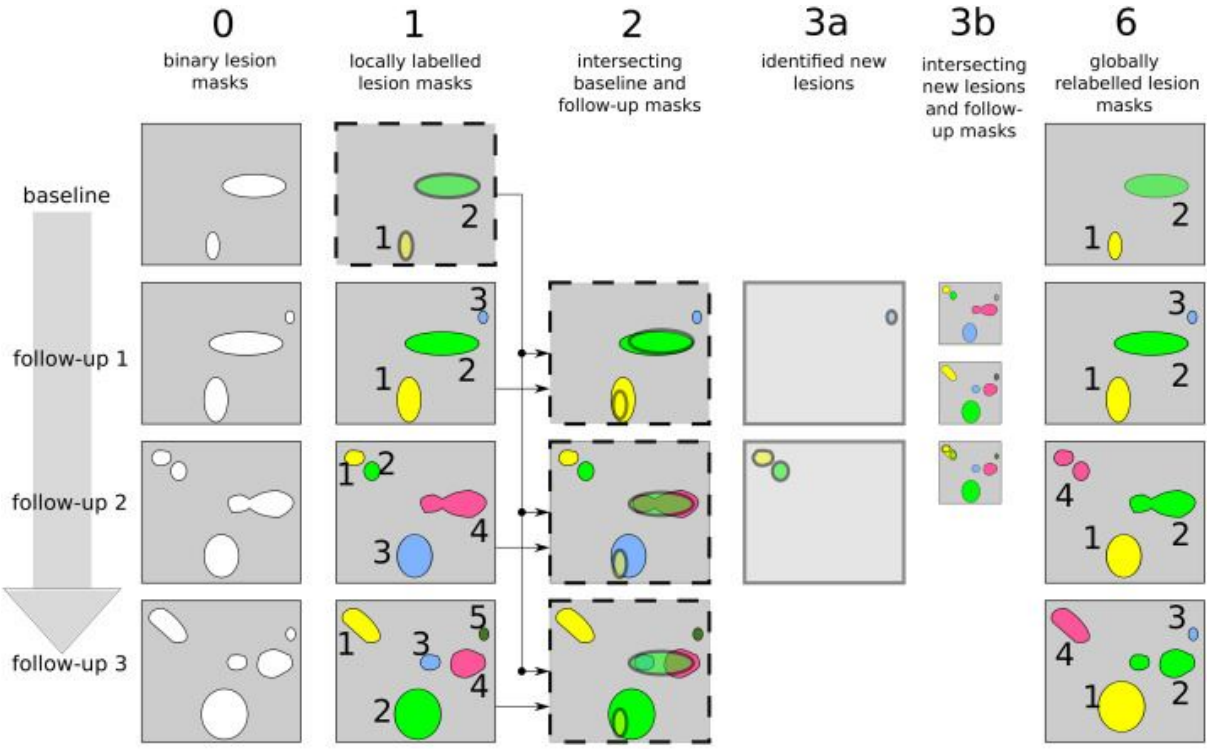
[1] "Exploring individual multiple sclerosis ...."
https://www.sciencedirect.com/science/article/pii/S2213158218303711. Accessed 17 Feb. 2020.
[2] "Exploring individual multiple sclerosis ...."
https://www.sciencedirect.com/science/article/pii/S2213158218303711. Accessed 17 Feb. 2020.
[3] "carolinekoehler/AFIL: An Automatic Follow-up of ... - Codeberg."
https://codeberg.org/carolinekoehler/AFIL. Accessed 17 Feb. 2020.



4 LLTM

Global Label	Local Label			
	baseline	follow-up 1	follow-up 2	follow-up 3
1	1	1	3	2
2	2	2	4	3,4
3		3	-	5
4			1	1
5			2	1

5 corrected LLTM

Global Label	Global Label			
	baseline	follow-up 1	follow-up 2	follow-up 3
1	1	1	1	1
2	2	2	2	2
3		3	-	3
4			4	4

Figure : Algorithm Workflow

Table 1
Clinically isolated syndrome and early MS patient characteristics. During the study course 5/7 patients received a treatment initiation (Copaxone).

	Baseline	12 Months
Mean EDSS (range)	1,5 (0-2)	1,3 (0-2)
Median T2 lesion load volume in mm (cubed) range	2247 (374–5384)	4053 (1891–7911)
Median number of T2 lesions (range)	21 (6–73)	39 (14–81)

Table 2
Categorized courses of all tracked lesion developments (see Algorithm Workflow Section). Based on AFIL algorithm results all four time points were checked with regard to their global label consistency. Performance verification results of expert visual inspection of relabelled lesion masks are provided (right/false).

	Number of tracked T2 lesions	
	Correct	False
1) Corresponding (growing, shrinking, stable)	162	0
2) New	121	2
3) Resolving	22	0
4) Reappearing	9	0
5) Confluent	24	0
6) Separating[4]	5	0
7) Successively confluent and separating[5]	9	2
Σ	352	3
Corrected total number of lesion courses	328	
Error rate (false/total # of lesion courses)	0.9%	

The automated individual quantification of MS lesion volume changes provides a new in vivo insight into the dynamic nature of these lesions and the possibility to observe meaningful patterns for disease monitoring.

[4] Result of the segmentation of initially confluent conglomerates and subsequently consolidating multiple lesion centres.
[5] Rare lesion course complicating lesion assignment.

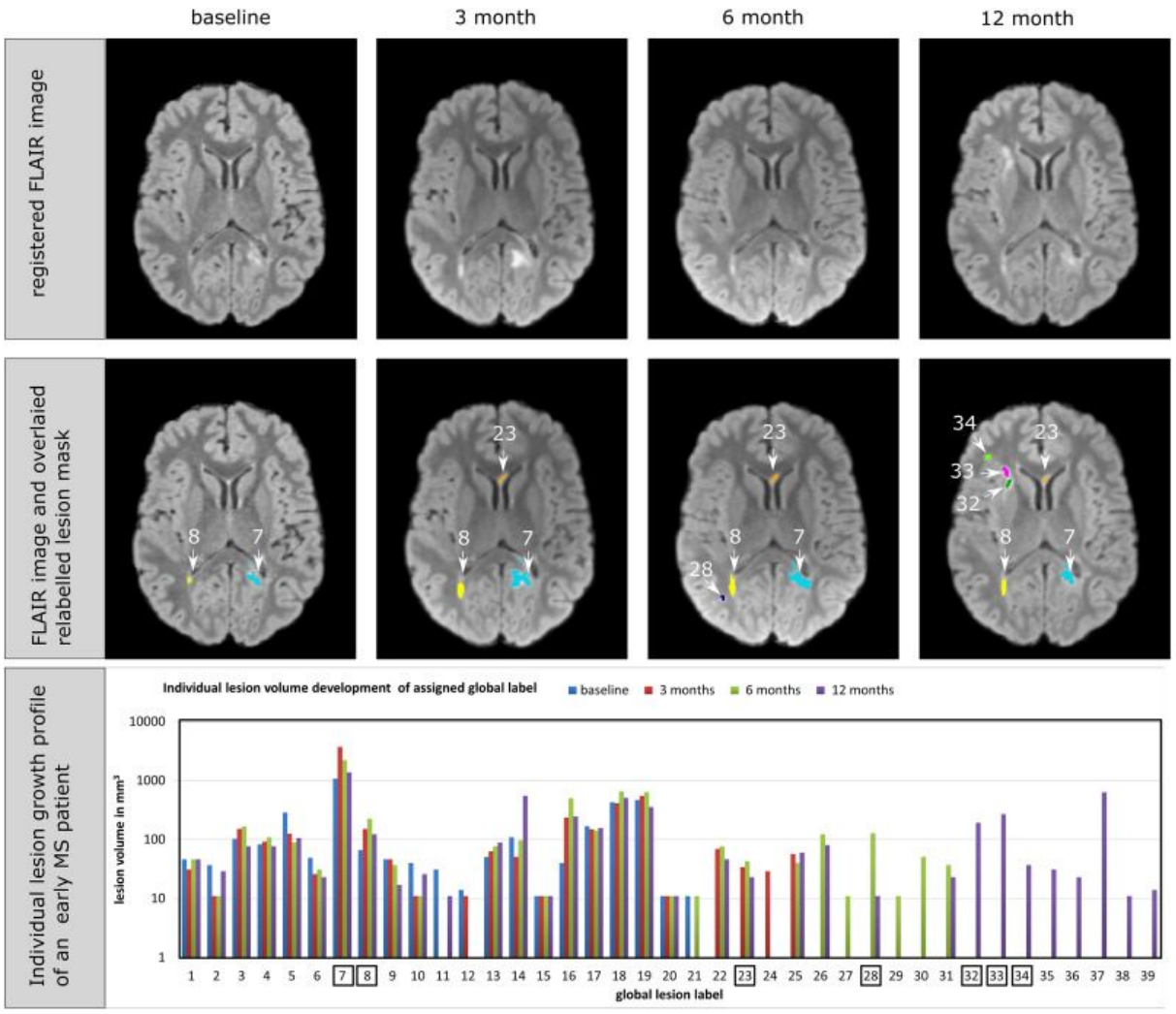


Figure : Lesion Growth Profile

Since this finding primarily affects very small lesions, it may arise due to segmentation failure, variation in the FLAIR signal or volume reduction below the threshold.

SHAPE FEATURE: CONVEX AREA[6789]
SHAPE FEATURE: ECCENTRICITY

[6] "Brain White Matter Lesions Classification in Multiple Sclerosis ...." https://link.springer.com/chapter/10.1007/978-3-642-23960-1_47. Accessed 17 Feb. 2020.
[7] "Quantitative analysis of brain white matter lesions in multiple ...." https://www.researchgate.net/publication/224320922_Quantitative_analysis_of_brain_white_matter_lesions_in_multiple_sclerosis_subjects_Preliminary_findings. Accessed 17 Feb. 2020.
[8] "Quantitative Analysis of Brain White Matter Lesions in Multiple ...." https://www.researchgate.net/publication/224106140_Quantitative_Analysis_of_Brain_White_Matter_Lesions_in_Multiple_Sclerosis_Subjects. Accessed 17 Feb. 2020.
[9] "Brain MR image normalization in texture analysis of multiple ...." http://www.sciedu.ca/journal/index.php/jbgc/article/view/929. Accessed 17 Feb. 2020.