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P31

Towards Longitudinal Characterization of Multiple Sclerosis Atrophy Employing SynthSeg Framework and Normative Modeling

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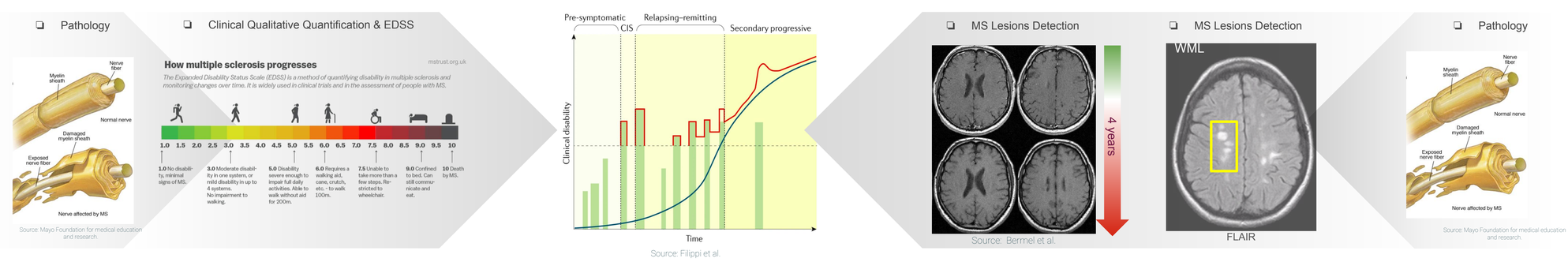
BACKGROUND

- Multiple Sclerosis (MS) is an autoimmune disease with unknown cause[G].
- MS is always progressive beyond MRI & clinical measures[L,F].
- MRI essential for Disease Progression Modeling (DPM).
- Lesion quantification alone misses MS progression.
- MS-accelerated subcortical atrophy enables continuous DPM

CHALLENGES & AIMS

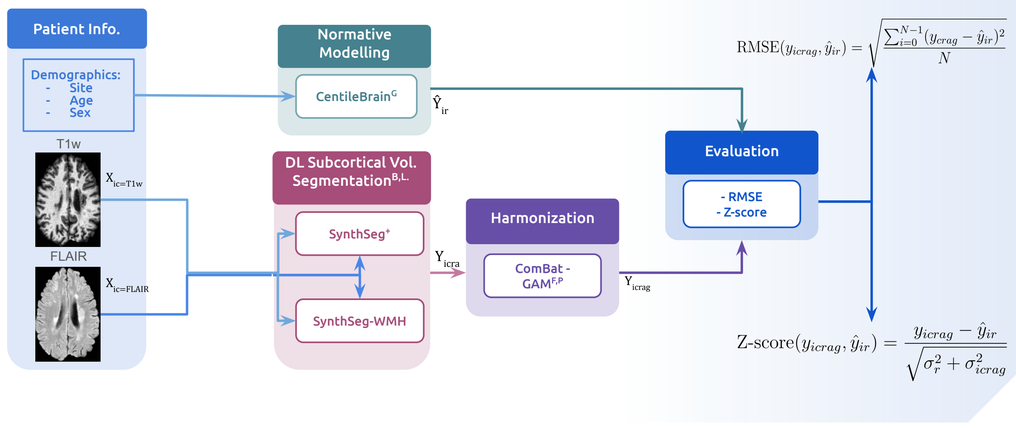
- Challenge 1: Need for robust clinical segmentation of T1w and FLAIR in MS.
  - SynthSeg+ and SynthSeg-WMH provide DL-based subcortical segmentation.
- Challenge 2: Small samples fail to capture MS evolution heterogeneity.
  - Normative modeling[M] on large healthy populations enables comparison



[F] Filippi et al. Nature. 2018. [G]Granziera et al. Brain. 2021. [L]Lublin et al. Brain .2022 [B] Bermel et al. Lancet. 2010, [M] Marquand et al.Nature Molecular Psychiatry. 2019

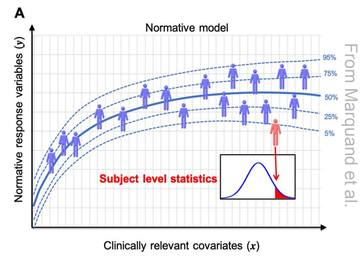
METHODS

- Processing workflow for heterogeneous dataset: 326 MS patients, 460 FLAIR/T1w scans from 5 sources

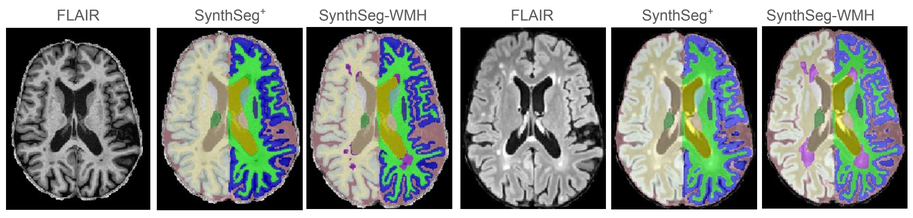


[B]Billiot et al. PNAS 2023. [L] Laso et al. ISBI. 2024, [F] Fortin et al. NeuroIm. 2017. [P] Pomponio et al. NeuroIm. 2021, [Ge] Ge et al. Lancet 2024.

1. To obtain the estimations of counterfactual healthy subcortical volumes from CentileBrain Model[G]

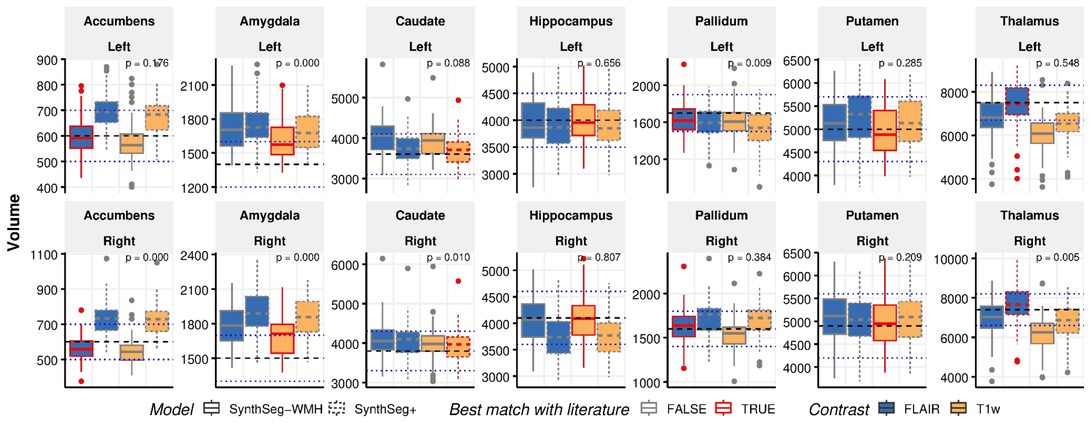


2. To obtain surrogate truth volumes by employing SynthSeg+ and SynthSeg-WMH on T1w and FLAIR

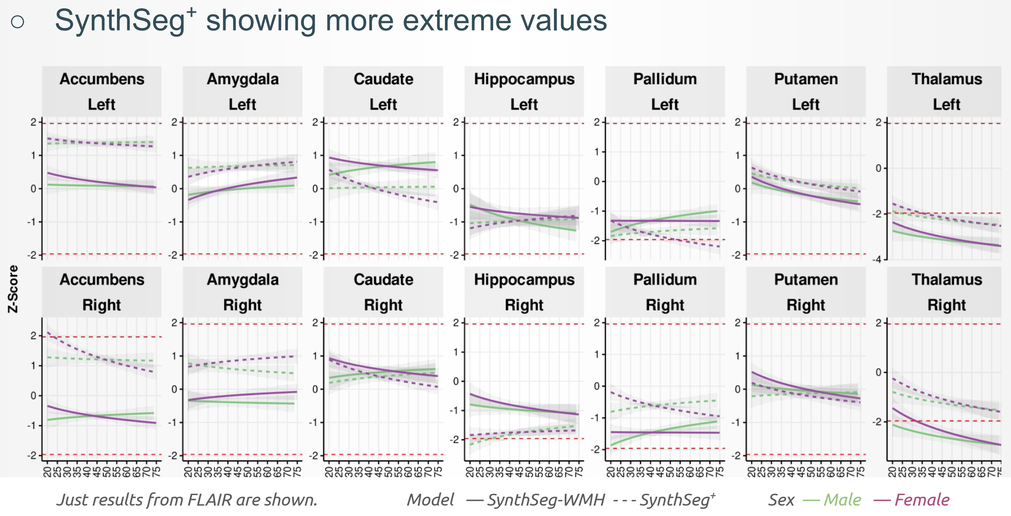


RESULTS

- Experiment 1: Reliability of Subcortical Segmentations:
  - Comparing (K-S) literature-reported[P] subcortical volumes with SynthSeg.
  - SynthSeg-WMH closer to reference values.
  - Modality independence. Except for the thalamus



- Experiment 2: Volumetric Deviations from Normative Trajectories:
  - Consistent trend of increasing deviation with age.
  - SynthSeg+ showing more extreme values



CONCLUSIONS

- Methodological Advances:
  - Novel DL integration with normative modeling.
  - Multi-modal analysis framework.
- Key Implications:
  - FLAIR sequences highly relevant.
  - Reliable lesion-aware processing.
- Future Directions:
  - Lesion load analysis integration.
  - Confirm findings and establish clinical relevance.

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