

# Co-registration of MRI via a Learning Based Fiducial-driven Registration (LeFiR) Scheme: Evaluating Laser Irradiation Changes for Glioblastomas and Epilepsy

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## Purpose

To co-register pre- and post-ablation MRI images for laser-induced interstitial thermal therapy (LITT) of neurological disorders, in order to build an improved model for therapy planning and evaluating imaging related treatment changes in terms of MRI markers for LITT.

## Materials and Methods

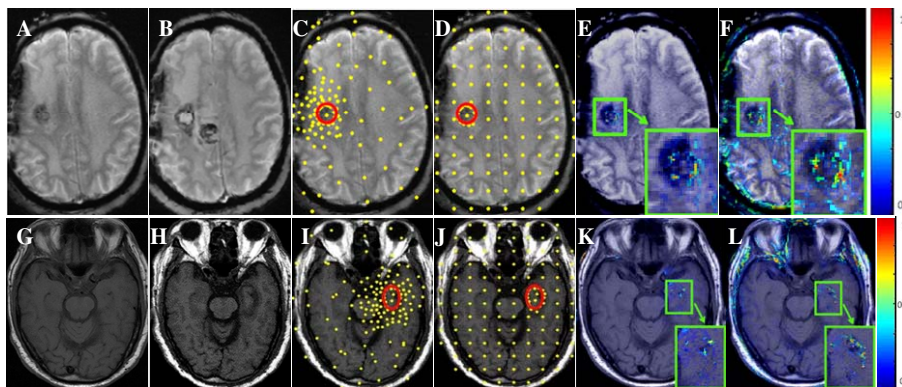
Despite being a promising treatment option for multiple brain diseases, the effect of LITT on the focal site is currently unknown. The objective of this work is to develop a learning based fiducial driven registration method (LeFiR) for accurately registering pre- and post-LITT brain images. The localized nature of deformation induced by LITT can be well captured and precisely aligned to pre-LITT image via a supervised learning scheme. The identified optimal landmark set is utilized to drive a thin-plate spline (TPS) image registration [1]. The LeFiR method was performed to register pre- and post-LITT brain MR images for treating glioblastoma multiforme (GBM) [2] and epilepsy [3] with LITT. One GBM patient and one epilepsy patient were monitored post-LITT via MRI guidance after initial 3-Tesla MRI. The patients were reimaged after 24 hours post laser ablation. Both patients were identified as successfully treated (a reduction of 99% for GBM and seizure free for epilepsy).

## Results

The registration results were evaluated by using the sum of squared intensity difference (SSD) computed within the ablation site. For comparison, we examined the LeFiR method via a uniformly selected landmark placement. The LeFiR method yielded a SSD of 9.56 and 6.38 within the ablation zone for the GBM case and epilepsy case, respectively, compared to 13.75 and 8.55 obtained from the uniformly spaced landmarks, which are consistent with the visual examination on the difference images between the registered and pre-LITT images as shown in Figure 1.

## Discussion

Due to the heterogeneity of the tissue properties and the variety of the physical processes involved, conventional therapy planning techniques may fail to accurately predict the extent of the induced tissue damage [4]. Thus, a good image registration to spatially and accurately align pre- and post-LITT images is necessary and critical to quantitatively evaluate tissue changes after treatment. The experiments demonstrated that the LeFiR method achieved superior registration performance, particularly in recovering local deformation, compared to the uniformly selected landmarks. Thus, the imaging related changes caused by LITT can be more accurately evaluated and quantified based on the LeFiR registration results. The findings could assist clinician in determining the optimal irradiation regimen before treatment and evaluating treatment success post-LITT.



## Conclusion

By using LeFiR, more accurate and robust registration results can be achieved according to two registration experiments performed on brain MRI for GBM and epilepsy. The local deformation induced by the LITT procedure can be better captured and recovered by the identified landmark fiducials than simply uniformly picking landmarks. Given that only spatial information is used to determine landmark locations, the LeFiR method has the potential to be adopted in various clinical applications for the purpose of registering different image modalities.

## References

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