High power focused ultrasound can be delivered in a non invasive manner to very discrete sites within the brain utilising a dedicated brain focussed sound systems which can cross the intact skull. Utilising this system targeted sites can be ablated to achieve functional results in the brain and the most common approach is currently to treat tremor by targeting the nucleus ventralis intermedius at the lateral aspect of the thalamus.
Effective sonication and tissue ablation at this precise site can improve or abolish severe tremor in an entirely non invasive manner . Exact targeting is essential and the whole process is controlled by MR targeting and exact MR thermometry.
This presentation discusses the technology required for this implementation and demonstrates a full case in the treatment of essential tremor. The safety and efficacy of this treatment methodology will be discussed and future research pathways for this exciting modality will also be examined.

Clinical Evaluation of Three MRI Tractography Software

Sam Butler, Clinical Scientist, University Hospitals of North Midlands NHS Trust

Background

MRI tractography is used to generate representations of white matter fibres within the brain. There are multiple methods for producing tractography images. Diffusion tensor imaging (DTI) is a common technique, but can be prone to false positives due to high noise sensitivity and false negative results in areas of crossing/kissing fibres [1]. More complex methods such as multi-shell multi-tissue spherical deconvolution can offer potential improvements by estimating probability distributions instead of tensors, but requires longer acquisition time and more advanced processing techniques. This work compares the potential clinical implementation of three different software applications which utilise different pre-processing and tract generation techniques: *Software 1* (mostly based on the principles of the DTI), *Software 2* (multi-shell multi-tissue spherical deconvolution) and *Software 3* (DTI).

Methods

Nine patients were scanned on a Siemens Vida 3T as part of the standard pre-surgical clinical protocol. Diffusion weighted images were acquired with three b-values (b0, b1000 and b1500) with phase encoding in the AP direction, as well as b0 images with the reverse phase encoding direction. 30 diffusion directions were used for diffusion images. A 3D T1 MPRAGE was also acquired.

The corticospinal tract (CST) and arcuate fasiculus (AF) were reconstructed for each patient for each software, giving six images per patient. Image quality as well as ease of use and functionality capabilities of each software was assessed by a medical physicist and consultant neuroradiologist.

Results

Software 1 can utilise automatic tract generation and showed high quality CST tracts in most cases and high quality AF tracts in around half of the cases. Image quality improved when manual ROIs were chosen and FA thresholds optimised, particularly for AF tracts. *Software 2,* which uses manual ROIs only, produced high quality CST and AF tracts in all cases. *Software 3*, which uses just two manual ROIs, produced high quality CST and AF tracts is less than half of the cases.

Discussion

Software 2 gave the highest image quality, likely due to the more advanced pre-processing techniques (e.g. eddy current correction, distortion correction) and tract generation algorithms. Processing is very time consuming, taking approximately four hours to process one patient. Knowledge of where to position ROIs is essential and incorrect ROI placement may lead to misleading tracts.

Software 1 showed slightly reduced image quality when compared to Software 2. Software 1 can automatically generate a much wider range of tracts through its automatic ROI generation. However, multiple automatic Software 1 tract reconstructions gave misrepresentative or no tracts where manual ROI placement could produce diagnostic quality tracts, and as such automatic tract generation should be used with great care.

Software 3 showed the lowest image quality.

Conclusion.

Knowledge of processing technique is essential for high quality tractography. Software 2 was evaluated as having the highest image quality, but can be time consuming and requires manual ROI placement. Software 1 showed slightly reduced image quality, but has the advantage of automated fibre tracking for a range of fibres. However, automatic fibre tracking should be used with great care. Software 3 showed the lowest image quality.

Key references. [1] Yang, C. Yeh, C. Poupon and F. Calamante, "Diffusion MRI tractography for neurosurgery: the basics, current state, technical reliability and challenges", Physics in Medicine & Biology, vol. 66, no. 15, pp. 15TR01, 2021. Available: 10.1088/1361-6560/ac0d90.

Accurate localization of tracts during brain tumour resection in an interventional MRI suite

Laura Mancini*[1,2], Stephen Wastling*[1,2], Adam Kenji Yamamoto[1,2], Caroline Micallef[1,2], Sotirios Bisdas[1,2], Tarek Yousry[1,2] (* equal first authors; [1] Lysholm Dept of Neuroradiology, NHNN, UCLH NHS Foundation Trust; [2]Dept of Brain Repair and Rehabilitation, UCL Institute of Neurology)

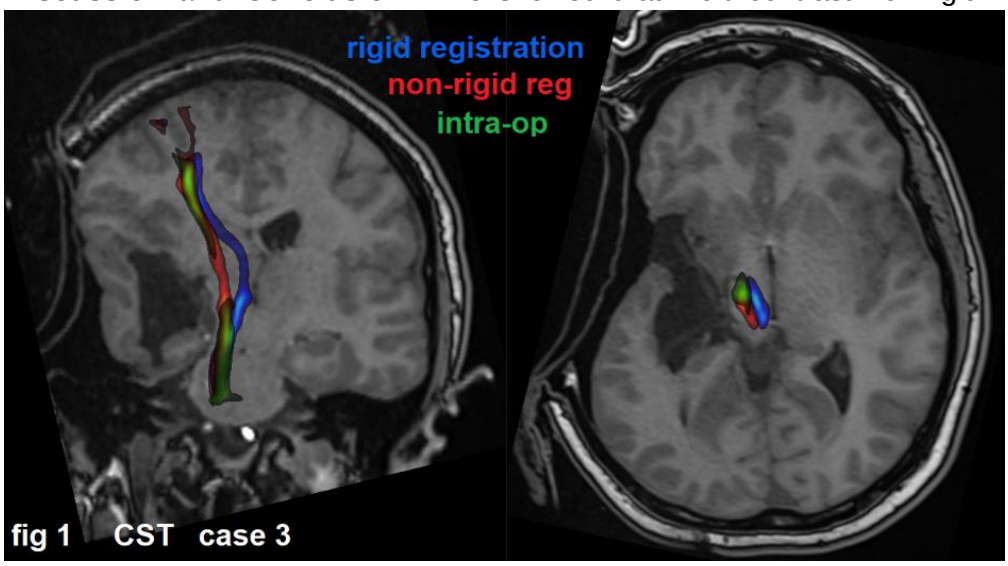
Background. One treatment option for patients with glioma is surgical removal of the lesion. Patient survival is prolonged when tumour resection is maximised whilst minimising post-operative neurological deficit. Such a safe maximal resection is made possible using a neuro-navigation system displaying pre-operative structural, functional and diffusion tractography MR images. In an intra-operative MRI (iMRI) setting MR images can be acquired during the procedure to reduce inaccuracies in the navigation caused by brain shifts and distortions. Updating the tractography intra-operatively is challenging due to the acquisition time and lack of state-of-the-art processing tools in the current generation of neuro-navigation systems. A potential solution is co-registering the pre-operative tracts to the intra-operative structural images, however, current neuro-navigation systems, only perform rigid registrations which do not account for the non-linear deformations. Previously [1] a multi-contrast non-rigid registration of T1-weighted volumetric and fractional anisotropy (FA) images acquired pre- and intra-op was shown to provide more accurate tract localisation in temporal lobe resection for refractory epilepsy. Here we apply the same method to brain tumours of different types, sizes and locations. **Methods.** Fifteen patients operated in iMRI between 2009 and 2015, with tumours variable in location, type, grade, and size (Table1). MRI: pre- (3T) and intra-op (1.5T) T1-w and FA. Diffusion data processed with probabilistic constrained spherical deconvolution (MRtrix3) [2]. Tracts (Table1) dissected pre- and intra-op. Non-rigid registration integrating T1-w and FA was used [1].

case	diagnosis	WHO grade	tumour location	tracts	3 T, pre-op diffusion b-values(s) (directions)	1.5 T, intra-op diffusion b-value (directions)
1	N/A		R pre-central gyrus	CST, AF	1000 (64)	1000 (30)
2	GNONI	3	L insula	CST, AF, OR	1000 (64)	1000 (12 x3)
3	epidermoid	1	R temporal	CST, AF, OR	1000 (64)	1000 (12 x3)
4	OD	2	R frontal	AF	1000 (64)	1000 (12 x3)
5	OD	2	R anterior temporal	OR	1000 (64)	1000 (12 x3)
6	A	2	R frontal cyngulum	AF	1000 (64)	1000 (30)
7	A	2	L insula	CST, AF, OR	2000, 700, 300 (60, 30, 10)	1000 (64)
8	OD	3	R frontal	AF	2000, 700, 300 (60, 30, 10)	1000 (64)
9	A	2	R temporal	CST, AF, OR	2000, 700, 300 (60, 30, 10)	1000 (64)
10	OD	2	R angular/supramarginal	CST, AF, OR	1400 (60)	1000 (64)
11	OD	2	L frontal	CST, AF, OR	2000, 700, 300 (60, 30, 10)	1000 (64)
12	A	3	R superior frontal gyrus	CST, AF	2000, 700, 300 (60, 30, 10)	1000 (64)
13	GBM	4	L anterior temporal	OR	1400 (60)	1000 (64)
14	DNT	1	R fusifom gyrus	AF, OR	1400 (60)	1000 (64)
15	GBM	4	R parietal	CST (Hand, Foot), OR	1400 (60)	1000 (64)

GNONI = glioneuronal tumour with oligodendroglial neuropil-like island, OD = oligodendroglioma, A = astrocytoma, DNT = dysembryoplastic neuroepithelial tumour, GBM = glioblastoma. CST = cortico-spinal tract, AF = arcuate fasciculus, OR = optic radiation

Results. We observed a mismatch between the position of the tracts resulting from the rigid and non-rigid registrations in 24 of the 32 tracts dissected. These mismatches were typically located close to the areas of greatest brain-shift. Visual comparison with intra-op tractography showed greater overlap to the non-rigid result (fig 1).

Discussion and Conclusion. We showed that multi-contrast non-rigid registration, previously tested on one tract and one specific type of resection, achieves accurate intra-op tracts localisation in a wide range of tumour types, sizes, and locations. This enables the accurate update of neuronavigation without the need of time consuming data acquisition and analysis.



Key references. [1] P Daga et al. IEEE Transactions on Medical Imaging 31(4): 882-91 [2] J-D Tournier et al. NeuroImage, 202 (2019), pp. 116–37.

Ultra High-Field MRI (7T) of the thalamic ventral intermediate nucleus (VIM) to validate 3T diffusion tractography and 3T anatomical targeting for MR-guided focused ultrasound (MRgFUS) of Essential Tremor

Joely Smith, Ayesha Jameel, Rebecca Quest, Brynmor Jones, Wladyslaw Gedroyc
Imaging, Imperial College Healthcare NHS Trust.

Background. The VIM is the primary target in MRgFUS of Essential Tremor (ET). Accurate targeting of the VIM is crucial to both safety and efficacy of treatment, however, the VIM cannot be directly visualised using current clinical protocols and there is much debate on the best targeting techniques. The most used method is anatomical targeting: using stereotactic landmarks and then inferring the location from a set of geometric measurements. This technique does not consider natural variation in neuroanatomy [3]. An alternative technique is to use diffusion tensor imaging (DTI) to infer the borders of the VIM [1,4]. The aim of this proof-of-concept project is to compare anatomical and DTI targeting of the VIM against 7T MRI. Previous studies have shown that contrast-optimised 7T susceptibility weighted imaging (SWI) can be used to delineate individual thalamic nuclei (direct visualisation), including the VIM [2]. By comparing these techniques on healthy volunteer images, this study will review the accuracy of current 3T anatomical and tractography targeting methods.

Methods. Following local ethics approval, five healthy volunteers (3F, 2M, 30.6 ± 1.96 yrs) underwent MRI on both the clinical 3T scanner (Siemens MAGNETOM Verio) and a 7T research scanner (Siemens MAGNETOM Terra). The 3T protocol included elements of the established clinical protocol, including high-resolution volumes and a 2D axial EPI-based DTI sequence acquiring 30 directions. The 7T protocol included high-resolution volumes, T2 star mapping and a SWI sequence. Brain-extraction and segmentation was performed using FreeSurfer (v7.1.0). Image registration was performed using FSL (v6.0.2). Tractography was performed in MRtrix3 (v3.0) using spherical deconvolution and probabilistic streamlines. The DTI-VIM was delineated following the technique described in [4] by an MR Physicist (JS). SWI contrast enhanced images (CE-SWI) were created in MATLAB (R2021a) following the technique described in [2]. A Neuroradiologist (AJ) manually delineated the SWI-VIM on CE-SWI which was verified by a second Neuroradiologist (BJ). Finally, the traditional anatomic method of locating the VIM was performed (ANT-VIM) and this was marked as a single coordinate, reflecting the current practice. Visualisation, VIM segmentation and comparison was performed in 3D Slicer (v4.10.2). Dice similarity correlation (DSC) was performed to compare VIM volumes.

Results. Preliminary results from the left thalamus of one healthy volunteer showed good correlation between the DTI-VIM and the SWI-VIM (Dice coef. 0.52). Both the centre coordinate of the DTI-VIM and the ANT-VIM were located within the SWI-VIM (figure 1).

Discussion & Conclusions. The results from this preliminary dataset are highly promising. Further analysis is required to evaluate the results for all five healthy volunteers. ET patients are typically over 60 years of age and therefore the younger age of our five healthy volunteers is a limitation of the current study. We have already extended this project to a cohort of three 60–80-year-old healthy volunteers with data collection underway.

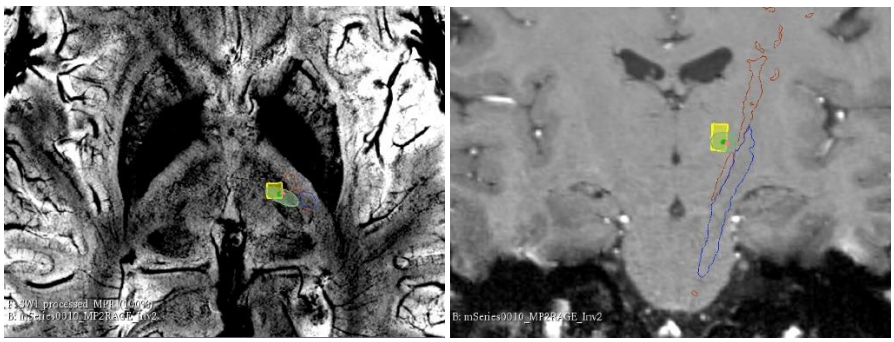


figure 1. Showing axial and coronal views of 7T CE-SWI and MP2RAGE, respectively. Overlaid are the ML (red) and PT (blue) tracts, along with the ANT-VIM coordinate (pink triangle), the DTI-VIM (yellow ROI) and the SWI-VIM (green ROI).

Key references

[1] Krishna, V. et al., 2019. Prospective Tractography-Based Targeting for Improved Safety of Focused Ultrasound Thalamotomy. NEUROSURGERY 84, 160–168.
[2] Najdenovska, E. et al., 2019. Comparison of MRI-based automated segmentation methods and functional neurosurgery targeting with direct visualization of the Ventro-intermediate thalamic nucleus at 7T. Sci Rep 9, 1119.
[3] Nowinski, W.L., 2008. Towards construction of an ideal stereotactic brain atlas. Acta Neurochir (Wien) 150, 1–14.
[4] Sammartino, F. et al., 2016. Tractography-Based Ventral Intermediate Nucleus Targeting: Novel Methodology and Intraoperative Validation. Mov Disord. 31, 1217–1225.

Detection of Vestibular Schwannomas in MRI using Convolutional Neural Networks

Helen Le Sueur[1], Dr Matthew Grech-Sollars[2,3], Dr Sarah Watson[1], Dr Emma Lewis[1]

[1] Royal Surrey NHS Foundation Trust, [2] University College London, [3] University College London Hospitals NHS Foundation Trust

Background

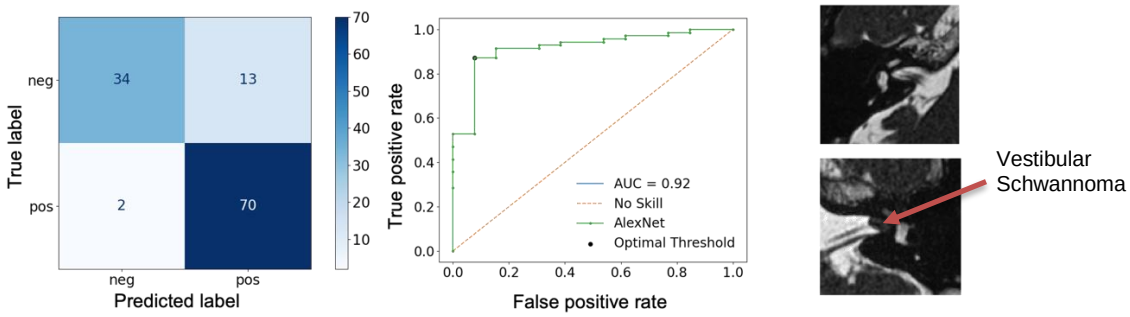
Convolutional neural networks (CNNs) show promise as a potential screening aid for tumour detection, which could help reduce radiologists' workload and speed up diagnosis. A Vestibular Schwannoma (VS) is a benign tumour that most frequently arises from the vestibular portion of the vestibulocochlear nerve (CNVIII), in the internal auditory canal (IAC, also known as internal acoustic meatus) [1]. Early symptoms include unilateral or asymmetric hearing loss, tinnitus and dizziness. If the tumour grows, it can affect the trigeminal nerves and the facial nerve, causing facial numbness, weakness, or paralysis [2]. The primary clinical approach to diagnosing VS is imaging; however, the number of screening scans for VS is large, but VS itself is rare (diagnostic yield of ~1% [3]) which contributes to an already heavy burden on radiologists' time. Automatic VS detection could therefore support screening or diagnostic workflows. Previous work on automatic detection of VS using CNNs is limited to classifying VS as part of a multiclass tumour classification [4] and [5]. Our aim was to detect VS from clinically acquired MRIs.

Methods

A retrospective dataset containing scans taken with a dedicated IAMS protocol (either T2 spc iso or FIESTA) was identified from the hospital PACS (Picture Archiving and Communication System) and anonymised as part of a clinical audit. A total of 243 VS positive image patches and 245 VS negative image patches were partitioned into training, validation, and test sets at a ratio of 60:20:20. The AlexNet CNN was optimised using a grid search hyperparameter optimisation process on the training and validation set. Transfer learning, from AlexNet trained on the imageNet dataset [6] was used.

Results

Evaluation of the resulting model on the hold-out test set of 119 images gave an accuracy of 87% and a sensitivity and specificity of 0.97 and 0.72 respectively. Figure 1 shows further evaluation results and example image patches.



(a) Confusion matrix (b) ROC curve (c) Example of a negative (top) and positive (bottom) image patch

Figure 1. Confusion matrix (a) and ROC curve (b) showing model performance on an unseen test set. (c) shows a positive and negative image patch

Discussion

Use of a heterogeneous hospital dataset overcame some of the limitations of previous studies, such as only using post-contrast scans [4], or collecting tumour-negative images from a different database than the tumour-positive images [5]. As the volume of interest was the IAM, the method used will not identify the very rare intralabyrinthine tumours.

Conclusions

A CNN, trained on a hospital dataset demonstrated high performance for classifying MR image patches as VS positive or VS negative. This is the first step towards implementing automatic VS detection as part of a clinical screening workflow.

References

[1] Tos, Charabi & Thomsen, 1998. 10.1007/s004050050012

[2] Matthies & Samii, 1997. 10.1097/0006123-199701000-00001

[3] Basu, Youngs & Mitchell-Innes, 2019. 10.1017/S0022215119000963

[4] Chakrabarty et al. 2021. 10.1148/ryai.2021200301

[5] Windisch et al. 2020. 10.1007/s00234-020-02465-1

[6] Deng et al. 2009. 10.1109/CVPR.2009.5206848

Clinical Translation of the Advanced Neuroimaging Facilities in Scotland

Dr Jennifer Macfarlane, NHS Tayside & SINAPSE Director

From the perspective of an NHS Tayside MRI Physicist and the Director of SINAPSE (Scottish Imaging Network: A Platform for Scientific Excellence, www.sinapse.ac.uk), I'll discuss some of the advanced neuroimaging facilities in Scotland, the extent to which they are made available to NHS patients and some of the challenges faced.

Pre-surgical evaluation in epilepsy patients: clinical reliability of the "Home Town Walk" fMRI paradigm for lateralisation of memory function

Nigel Davies[1], Roya Jalali[1], Roman Wesolowski[1], Robert Flintham[1], Rosa Sanchez-Panchuelo, Vijay Sawlani[2]
[1]RRPPS, Medical Physics, University Hospitals Birmingham NHS Foundation Trust, UK
[2]Radiology, University Hospitals Birmingham NHS Foundation Trust, UK

Background. Memory-activated functional MRI (fMRI) is increasingly implemented in the clinic to assess memory function as part of pre-surgical decision making in refractory epilepsy[1-5]. The Home Town Walking (HTW) fMRI paradigm has been shown to activate the parahippocampal gyri (PHG) and help determine memory lateralization in epilepsy patients[3], however limited data are available on the reliability of this technique. This study aims to assess the robustness of the HTW paradigm for lateralising memory function in surgical planning of a large epilepsy patient sample.

Methods. Between April 2015 and April 2022, fMRI data were collected from 126 epilepsy patients using a block-design HTW memory paradigm as part of a wider language and memory fMRI assessment across 2 Siemens 3T scanners (Verio and Skyra). All patients were asked to attend on two consecutive days for fMRI scans and were instructed to prepare an imagined walk prior to the first scanning session. Instructions were given to start and end at familiar places, divide the route into 10 blocks and have at least five points for each block. During the fMRI scans, patients were asked to visualise their prepared walk in their heads to the best of their abilities, to recount the walk in as much detail as possible during the 'Walk' periods, and to remain relaxed while focussed on the screen during the 'Rest' periods. Data were analysed using a General Linear Model with the manufacturer's (Syngo VIA) BOLD processing package. A single experienced consultant neuroradiologist subjectively varied the threshold and minimum cluster size of the t-statistical maps to optimise a perceived balance between PHG activation and spurious signals for each patient, and produced clinical reports for surgical planning. Activations from repeated fMRI sessions were compared and verified by MR physicists, and results assessed from clinical reports.

Results. A total of 251 fMRI HTW datasets from 117 patients were assessed, of which 110 patients had repeated the scan at least twice (14 patients had additional follow up scans). BOLD activations were often observed in parahippocampal (PHG) and fusiform gyri (Fig. 1). Table 1 summarize the results; PHG BOLD activations were observed in at least one of the sessions for 76% of patients with repeated scans, while 94% of the PHG activation patterns evoked on patients on day 1 were successfully reproduced on day 2. Bilateral PHG activations were seen in 57% of these patients, with 34% and 9% predominantly left and right sided respectively.

Table 1: *Details of number of patients showing activation in PHG.*

Number of patients	*117*	*N. with 2 scans*	*N. with > 2 scans*
		110	*14*

Number of patients with PHG activation	In any day	In day 1	In both days
	91	*47*	*44*

Lateralisation of reproduced PHG activation pattern	Bilateral	Left	Right
	25	*15*	*4*

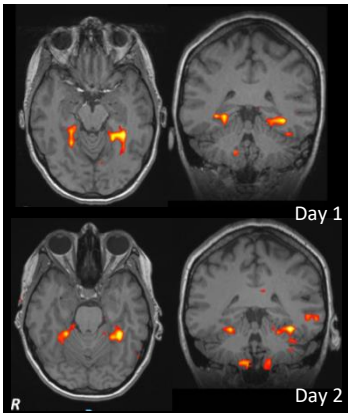


Figure 1: *Reproducibility of activation pattern evoked by HTW task for an example subject.*

Discussion & Conclusion. Despite being relatively difficult, most patients were able to perform the task given adequate preparation and believable PHG activations were achieved in the majority of cases. Successful implementation of a repeated HTW paradigm shows reproducible (94% for positive studies) BOLD activations in medial temporal lobes sufficient to lateralise memory function in patients undergoing pre-surgical evaluation, which can be used as an adjunct to neuropsychological memory assessment. Future work will assess the correlation of fMRI results with postoperative memory outcome.

Key references.

1. Avila C et al. *Memory Lateralization with 2 Functional MR Imaging Tasks in Patients with Lesions in the Temporal Lobe*. AJNR, 2006, 27:498-503.
2. Buck S & Sidhu MK. *A Guide to Designing a Memory fMRI Paradigm for Pre-surgical Evaluation in Temporal Lobe Epilepsy*. Front Neurol, 2020, 10:1354.
3. Janszky J et al., *Functional MRI Predicts Memory Performance after Right Mesiotemporal Epilepsy Surgery* . Epilepsia, 2005,46:244–250.
4. Towgood K, et al. *Bringing Memory fMRI to the Clinic: Comparison of Seven Memory fMRI Protocols in Temporal Lobe Epilepsy*. HBM, 2015,36:1595-608
5. Roland PE et al. *Does mental activity change the oxidative metabolism of the brain?* J Neurosci, 1987, 7:2373–89.

Introduction of a Novel, Convenient ADC Phantom for Multicentre Routine Quality Assurance of Clinical Diffusion Weighted Imaging Protocols

[1]Rebecca Sawbridge [1] Lara Worthington [1]Zack Ravetz [1]Roya Jalali [1]Robert Flintham [1]Nigel Davies
[1] RRPPS, University Hospitals Birmingham NHS Foundation Trust, B30 3HP

Background. Diffusion Weighted MR Imaging (DWI) is commonly used in clinical practice for a number of applications including Neuro studies (1). Quantitative Apparent Diffusion Coefficient (ADC) maps are increasingly used to distinguish between normal and diseased tissue and to diagnose benign vs malignant lesions in clinical practice (2). Phantoms suitable for routine DWI Quality Assurance are needed to assess the accuracy of ADC maps and compare between scanners and protocols. To account for sensitivity of ADC to temperature variations, previous multicentre reproducibility studies have included an ice-water phantom design including the RSNA/NIST phantom (3,4). The aim of this study was to assess the suitability of a novel temperature-calibrated ADC phantom for routine QA of DWI across multiple clinical sites.

Methods. A customised DWI Phantom containing six ADC compartments (two main compartments (A and B) with lesion and resolution inserts and four tube inserts (C-F) was sourced from HQ Imaging (5). Each compartment contained different concentrations of polyvinylpyrrolidone (PVP) with ADC values at 20C of 1.0 $\mu m^2/ms$ (A), 1.6 $\mu m^2/ms$ (B), 0.4 $\mu m^2/ms$ (C), 1.0 $\mu m^2/ms$ (D), 1.4 $\mu m^2/ms$ (E) and 2.0 $\mu m^2/ms$ (F). The phantom was supplied with two in-built thermometers and temperature calibration coefficients for each compartment. Scanner-generated ADC maps were collected from 4 MRI scanners at 3 hospital sites (Siemens Skyra 3T, Siemens Verio 3T, Siemens Aera 1.5T and Philips Ambition 1.5T) using a total of 19 routine clinical DWI protocols. Phantom temperature was measured before and after each scan using the internal thermometer readings and a hand-held infra-red thermometer (all temperature probes are calibrated against a traceable standard). ROIs were drawn manually to cover at least 65% of each compartment. Temperature corrected ADC mean and standard deviation values were calculated using in-house image analysis software "MIPPY" and compared against expected values and across scanners and protocols.

~~(B) High ADC Compartment B (C) ADC map compartments C-F (D) b0 resolution insert (E) b1000 lesion insert.~~**Results**. ADC values for compartments A and B were <5% different from the expected values across all scanners and protocols. A slightly larger percentage difference range between -8% and +1% was found across the tube inserts. However, the mean percentage difference between calculated and expected was 2.9% with most results within 5% of expected values.

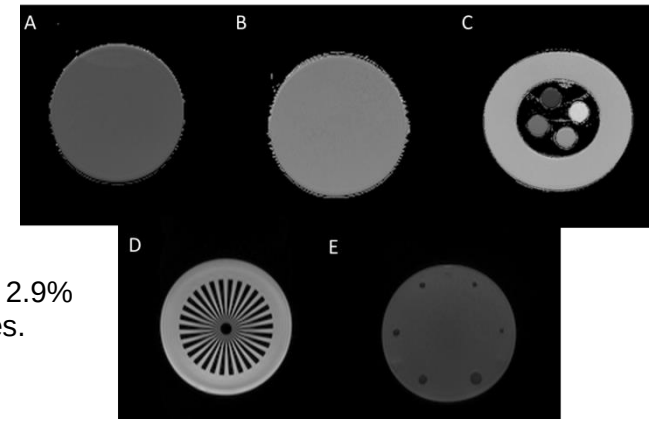


Figure 1. ADC maps of (A) ~~Low ADC c~~Compartment A (B) ~~High ADC~~ Compartment B (C) ~~ADC map~~ compartments C-F, ~~(D)~~ b0 image of resolution insert (E) and b1000 image of lesion insert.

Discussion. All calculated ADC measurements were found to be accurate according to the manufacturer's temperature-calibrated values. The phantom was simple and quick to use requiring no preparation or equilibration time, providing a convenient method for validating scanner-generated ADC maps across a range of clinical scanners and protocols.

Conclusion. A novel ADC phantom has been assessed and shown to provide a convenient and effective method for QA of quantitative DWI protocols in clinical use and multicentre trials.

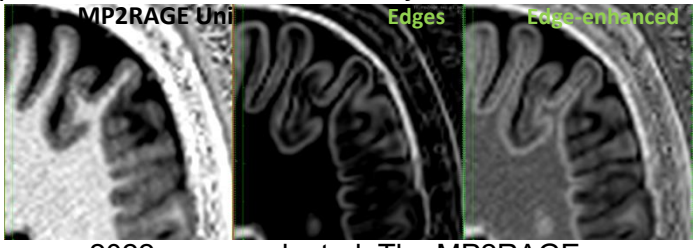
Key references.

(1) Mascalchi M et al., Radiol Med. 2005 Mar;109(3):155-97.
(2) Surov A et al., World Neurosurg. 2016 Apr;88:598-602.
(3) Chenevert TL et al., J Magn Reson Imaging. 2011 Oct;34(4):983-7.
(4) Malyarenko D, et al.. J Magn Reson Imaging. 2013 May;37(5):1238-46.
(5) Wagner F et al., PLoS ONE 2017;12(6): e0179276. https://doi.org/10.1371/journal.pone.0179276

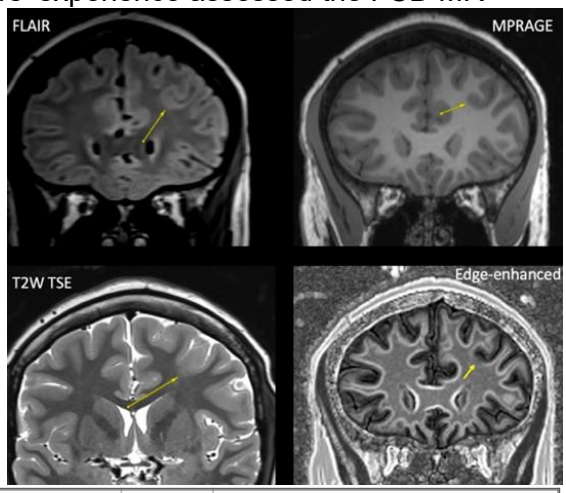
Assessing the clinical benefit of edge enhancement post-processing of MP2RAGE 3D T1-weighted MRI in localising Focal Cortical Dysplasia

Enrico De Vita, Jan Sedlacik, Kiran K Senaurine, Kish Mankad, Felice D'Arco

Background. Focal Cortical Dysplasia (FCD) is a common cause of drug-resistant epilepsy[1]. MRI has a crucial role in localising FCD and various imaging features, such as blurring at the grey-matter and white-matter boundaries and intensity changes on FLAIR and T2 images, are used for this[2]. At our institution the FCD MR protocol differs from a standard epilepsy protocol and is chosen for suspected focal and subtle lesions such as FCD or micropolygyria, in cases of: either a previous 'negative' MR scan, but strong EEG localisation or clinical semiology; or a suspected but nothing definitive focal malformation of cortical development on conventional MR brain scan. Beside FLAIR, T2-weighted TSE and T1-weighted MPRAGE, our FCD protocol is complemented by MP2RAGE and an Arterial Spin Labeling cerebral perfusion measurement. Edge enhancement of MP2RAGE images has been shown to be particularly useful in delineating the centro-median nucleus for targeting deep brain stimulation[3]. In this study we evaluate the benefits of edge enhancement of MP2RAGE to support radiologist's confidence in localising FCD lesions.



Methods. Images of 11 children (age range 2.5-17.4, median 12.9 years) with suspected FCD acquired on a 3T Siemens Prisma MRI scanner with the manufacturer's 20ch head/neck coil since January 2022 were evaluated. The MP2RAGE acquisition had TI=700/2500ms, flip angles 4/5°, TR=5s, TE=2.98ms, BW 240Hz/pix, 176 partitions, 1mm^3 resolution, 8'22" acquisition time. UNI ('Uniform', i.e. B1 corrected) images generated directly on the scanner were further processed offline in MATLAB with a Sobel filter to generate 'edges' and 'edge enhanced' series as in Warren *et al.*[3] (**Figure**). Such series were then uploaded to PACS. A neuroradiologist with 8 years' experience assessed the FCD MR scans for each patient and was asked to assess: a) if the edge-enhanced series helped visualise the lesion better, similarly or worse than the conventional sequences; b) the level of confidence regarding the presence of the lesion (0: not visible; 1: questionable; 2: good; 3: strong).



Results. The **Figure** shows an example of FCD lesion on FLAIR, T1-weighted, T2-weighted and edge-enhanced images in a 10-year old patient. Two scans were MR-negative (no lesion identified). In 3 patients, FLAIR and edge-enhanced images were similarly effective in localising the lesion. In 5 patients the lesion was better seen on edge-enhanced images (**Table**).

ID#	Age(y)	Best Contrast	Confidence	Notes* (*: scores for Confidence)
1	13	FLAIR	2	0 on edge-enhanced (no SEEG confirmation)
2	3	same	3	
3	12	same	3	
4	14	same	3	
5	7	edge-enhanced	3	
6	9	edge-enhanced	3	
7	14	edge-enhanced	3	
8	14	edge-enhanced	2	1 on conventional sequences
9	16	edge-enhanced	2	0 on conventional sequences
10	11	MR negative	-	
11	17	MR negative	-	

Discussion and Conclusions. Though acquisition of MP2RAGE images has a time cost of approximately 8 minutes, once this is acquired, edge enhancement post-processing is relatively straightforward and completely automated. In our small cohort it appears to have a benefit in boosting the confidence of radiological localisation of FCD and as such, wider usage of this methodology in FCD is recommended. Future work aims to expand this cohort and compare the added benefit of edge enhancement with other multi-contrast post-processing methods recently proposed for epilepsy, e.g. MELD[4].

References. [1] Lerner JT, Epilepsia 2009, 50(6):1310. [2] Columbo N, *Neuroradiology* 2012, 54:1065. [3] Warren AEL (2020), *J Neurol Neurosurg Psychiatry*, 91(4):339. [4] Wagstyl K, *Epilepsia* 2022, 63(1):61.