

A novel scoring system for assessing neurological damage in acute encephalitis on magnetic resonance images

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Introduction and objectives

Encephalitis is a rare condition, with approximately 5.23 new cases per 100,000 per year in the UK. Most commonly it is caused by a viral infection of which Herpes simplex virus (HSV) is the most common. Although it is rare, its impact is disproportionately large with a huge socioeconomic burden on patients, their carers and the health services.

Magnetic resonance imaging (MRI) is recommended to aid diagnosis of encephalitis. Previous studies of neuroimaging have been mainly descriptive or correlate areas of abnormalities with aetiologies. However, none have quantified the areas of damage, in terms of their volume, nor has a practical score been developed, that could correlate areas of damage with clinical outcomes. The goal of this study was to develop a semi-quantitative scoring system for routine clinical MRI images in encephalitis.

Methods

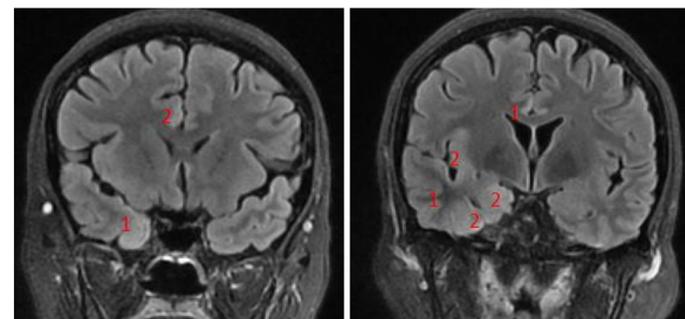
Patient scans were obtained from an NIHR funded programme of studies, ENCEPH UK, which aims to better understand encephalitis and try to improve its outcomes. Easymeasure® software was used to calculate the measurements of temporal lobe and T2 signal abnormality volume using the Cavalieri method of stereology with point counting. A hippocampal architecture score was developed in epilepsy and subsequently used to predict laterality of seizure onset. This inspired our scoring system where a variety of anatomical regions of the brain were given a score depending on the amount of T2/FLAIR signal abnormality and architectural damage (see table 1 and figure 1 for an example).

Table 1. Structures measured in damage scoring system

Structures scored	
Cingulate gyrus	Insula
Temporal pole	Thalamus
Amygdala	Fronto-orbital cortex
Hippocampus	Extra-MTL temporal lobe
Extra-hippocampal medial temporal lobe	

Coronal sections of T2 weighted or FLAIR MR images were used for the damage scoring. 8-10 temporal lobe slices per patient were selected, and nine structures in total were given a score between 0 and 3 in each slice in which it appeared. The scores could then be averaged for each structure, and added to give a total damage score. A normal brain would get a score of 0, while 54 is the highest possible damage score.

Figure 1: Two slices from T2 FLAIR coronal MRI brain of a patient with Herpes simplex encephalitis to demonstrate the novel scoring tool. The total damage score, from 10 slices, was 14.17 and the damage volume was 49.63 cm³



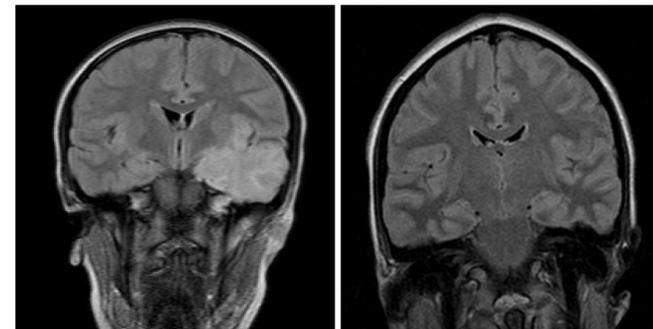
0 = no abnormal signal, 1 = abnormal signal in parts of the structure, 2 = abnormal signal in the whole structure, 3 = atrophy of structure

Results

General observations: Scans from 127 patients were reviewed. Of these 95 patients with coronal T2 or FLAIR images, 30 had HSV encephalitis, 21 had autoimmune encephalitis, 11 had other proven infectious organisms and 33 had unknown aetiologies.

Patients with HSV presented with a recognisable pattern of inflammation or oedema (and even atrophy) in the medial temporal lobe and insula. Autoimmune patients usually had much more diffuse changes with subtle T2 hyperintensity of the medial temporal lobes or insulae and evidence of generalised swelling (see figure 2).

Figure 2. examples of patterns seen on MRI in HSVE and autoimmune cases

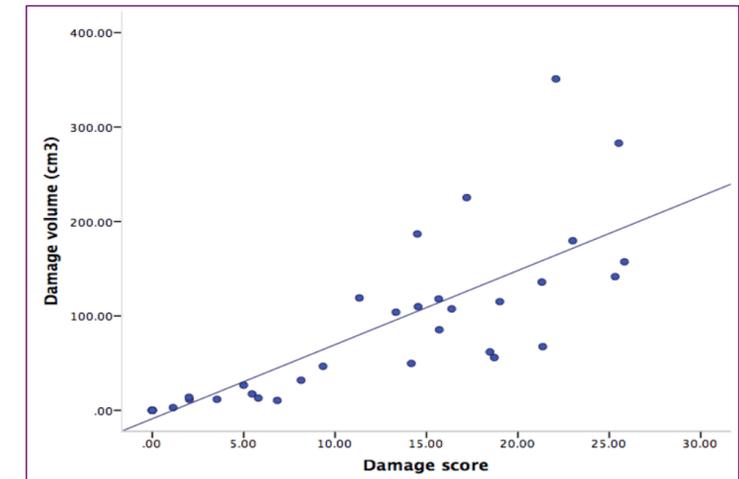


In HSVE the majority of the damage was on one side of the brain, but in 94% of cases there were also abnormalities in the contralateral hemisphere to a lesser degree (see table 2).

Table 2. Summary of volume measurements and damage scores

Aetiology	HSV	Auto-immune	Other pathogen	Unk
Damage score (mean)	15.5	3.1	6.6	4.3
Damage volume (mean, cm ³)	100	18.8	44.9	23.0
Temporal lobe volume (mean, cm ³)	75.7	67.8	67.9	69.4
Normal MRI (%)	0	47	14	48
Bilateral damage (%)	43	29	29	30

Figure 3. Correlation between damage score and damage volume (Spearman's rho = 0.761, p<0.001)



Correlations: As clinical information continues to be collected preliminary results suggest that mean temporal volume for all patients is smaller in patients with good outcome, but not statistically significant except for HSVE patients (oneway ANOVA, $F=2.371$, $p=0.018$). For all patients there was a small, non-significant relationship between high damage scores and damage volumes, and length of hospital stay. This was again significant for the HSVE subgroup (Damage score: Spearman's rho=0.778, $p=0.014$, Damage volume: Spearman's rho=0.845, $p=0.004$)

Conclusions

This work has shown a good correlation between volumes measured by Easymeasure® and a novel scoring system, with the latter being quicker to perform (Volume measurements take on average 9 minutes to perform, while scoring takes 6) and not requiring specialist stereology software. It potentially could be used to correlate with clinical outcomes from encephalitis, but further work is needed to evaluate the usefulness of this method. It may also be useful as a predictive tool for those who may have poorer outcomes and hence require further support and rehabilitation.

References:

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Acknowledgments: We would like to extend our thanks to Encephalitis Society for their support throughout the programme of studies..

This poster is independent research funded by the National Institute for Health Research Programme Grants for Applied Research Programme, (Understanding and Improving the outcome of viral encephalitis, RP-PG-0108-10048). The views expressed in this publication are those of the author(s) and not necessarily those of the NHS, the National Institute for Health Research or the Department of Health.