Qualitative and Quantitative Tumour Edge Characteristics for the Assessment of Glioma on Conventional MRI – Interobserver Agreement.

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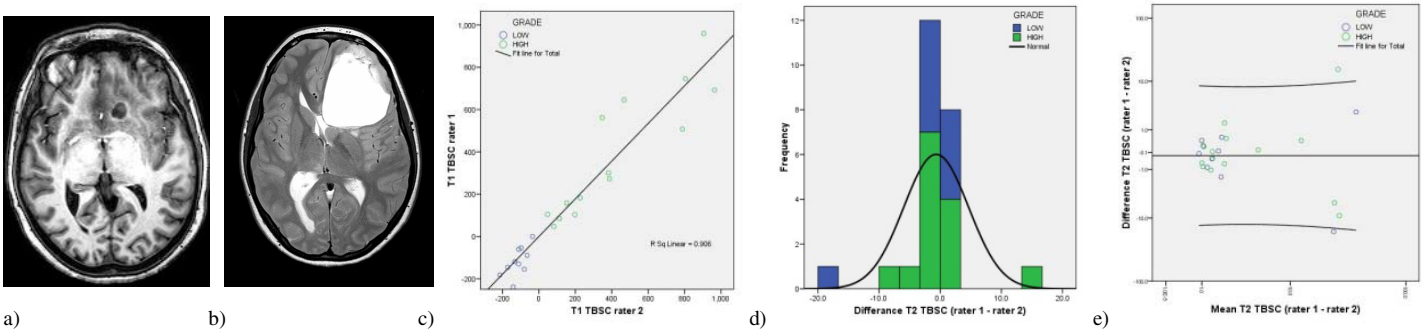
Introduction: General descriptive features of tumour shape, size, location and signal characteristics on conventional MRI are used to aid diagnosis in glioma. Both novel quantitative measures, such as the tumour border sharpness coefficient (TBSC), and subjective qualitative measures (e.g. descriptors of tumour margins) have shown potential in differentiating between histological and genetic subtypes of gliomas [1-3]. These techniques, however, will only be of clinical value if they are relatively simple to perform and there is good interobserver reproducibility. The aim of this study was to evaluate the interobserver reproducibility of both quantitative measures of TBSC and qualitative descriptors of tumour morphology in cerebral gliomas.

Methods: A retrospective analysis was performed on 23 patients (24 tumours; one patient had bilateral distinct tumours of different histological subtype). Tumours consisted of 10 grade II and 14 grade IV. All imaging was performed prior to surgery on a 3.0T Philips Achieva system. Imaging sequences used for this analysis consisted of T2W and post contrast T1W. Analysis was performed independently by two radiologists (GT and JRC). Measurement of TBSC was adapted from Aghi et al, 2005 [1]. For T2W images a (0.01-0.025cm^2) region of interest (ROI) was placed as close as possible to the anterior edge of the area of T2 brightness (such that the grayscale units did not deviate from that of an ROI in the same location in the contra-lateral hemisphere) and the mean voxel grayscale measure was recorded. This was repeated for 3 more alternate ROI's running into the tumour. The slope of linear regression was calculated. This was repeated for the medial, lateral and posterior tumour borders on the same slice showing greatest transaxial area. T2W TBSC was calculated from the mean of these four values. This process was repeated for T1W TBSC on the post contrast T1W imaging. Qualitative descriptors were assessed as follows: sharp versus indistinct border, smooth versus irregular contour, and homogenous versus heterogeneous signal intensity [2, 3]. Inter-observer variability of the qualitative dichotomous data was assessed using a non-weighted kappa analysis, with >0.7 deemed as an acceptable agreement [4]. Quantitative measures of TBSC were analysed using bivariate method [5].

Results: Generation of TBSC and subjective analysis took less than 10 minutes per tumour. Excellent agreement was found for both T1W and T2W TBSC (Figure 1) and the majority of the qualitative descriptors (K>0.7, p<0.001, Table 1). The T1W TBSC intraclass correlation coefficient (ICC) type A = 0.950 (95% CI 0.889-0.978) the T2W TBSC ICC type A = 0.895 (95% CI 0.777- 0.954). Only the qualitative T2W border descriptors failed to reach an acceptable level (T2 border regularity K=0.526, p<0.01 and T2 border sharpness K=0.577, p<0.02). Performing separate analysis based on grade showed that this poor reproducibility was limited to grade IV but not grade II tumours (Table 2).



a) b) c) d) e)

Figure 1: a) T1W slice showing heterogeneous tumour with indistinct, irregular border b) T2W slice showing high grade tumour with smooth distinct border. c) Bivariate comparison of T1 TBSC with line of equality. d) Interobserver differences of T2 TBSC frequency histogram showing normal distribution. e) Interobserver difference versus mean of T2 TBSC's with 95%CI.

Qualitative Measure	*κ*	*Significance*
TI border regularity	0.750*	<0.001
T1 border sharpness	0.915*	<0.001
T2 border regularity	0.526	<0.01
T2 border sharpness	0.577	<0.02
T1/T2 heterogeneity	0.739*	<0.001

Table 1. Non-weighted Kappa analysis of qualitative descriptors for tumours of all grades (n=24).
*κ>0.7 considered acceptable level of agreement.

Qualitative Measure	*κ*	Significance
T2 border regularity (grade II)	0.800*	0.01
T2 border sharpness (grade II)	0.783*	0.011
T2 border regularity (grade IV)	0.34	0.209
T2 border sharpness (grade IV)	0.429	0.286

Table 2. Non-weighted Kappa analysis of T2W qualitative border descriptors for high (n=14) and low (n=10) grade tumours.

Discussion: This study has demonstrated excellent interobserver reproducibility of TBSC on T1W and T2W imaging. Acceptable reproducibility was demonstrated for all quantitative measures and qualitative descriptors of signal characteristics, except for T2W border descriptors in high grade tumours. This is thought to reflect their larger T2 bright volume in our sample, which often extended to ventricular and cortical borders, dramatically reducing the proportion of qualitatively assessable tumour edge. Qualitative assessment of tumour border sharpness and irregularity is open to greater subjective interpretation than TBSC demonstrating poorer reproducibility in high grade tumours. Thus we propose that TBSC should be used in preference to qualitative sharpness observation in the analysis of cerebral glioma especially T2W images. Measurement of TBSC is simple, reproducible, practical using freely available software, and does not require additional observer training.

References:

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