Editorial comment on “A new method for quantification and 3D visualization of brain tumor adhesion using slip interface imaging in patients with meningiomas”

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Meningioma is the most common primary central nervous system neoplasm, corresponding to 37% of all intracranial tumours [1]. It can be treated effectively by surgical resection or, in selected cases, by radiotherapy [2]. Histological grade and extent of resection are the most important prognostic markers. However, in the last 2016 WHO classification, histopathological evidence of brain infiltration has been integrated as a marker for atypical meningioma, with an impact on prognosis [3]. Even so, some authors remark that histopathological assessment could be biased, as invasive margins may not be surgically resected, therefore impeding histopathological detection [4]. It is also well known that brain invasion or adhesion complicates surgical dissection and increases the risk of stroke, haemorrhage, and other injuries [5]. To summarize, meningioma-brain adhesion assessment could be an “Achilles’ tendon” for meningioma prognostic stratification as well as an important factor for accurate surgical planning, treatment decision, and follow-up strategy.

With these considerations in mind, neuroimaging has focused in recent years on providing new tools to precisely assess the meningioma-brain interface. Magnetic resonance imaging (MRI) plays a pivotal role in meningioma management, but standard static MRI lacks accuracy for assessing tumour-brain adhesion. This weakness opened the door to what has been called “mechanoimaging”: identification of tumour features using biomechanical information. In this sense, Taoka et al [6] tested brain surface motion imaging, based on T2wi during different phases of the cardiac cycle; Zyng et al [7] and Hughes et al [8] evaluated

the utility of slip interface imaging (SII), based on MR elastography (MRE) during the application of an external dynamic vibration; or very recently, Della Pepa et al [9] have tried intraoperative ultrasound elastosonography.

Published in this issue, Yin et al [10] go a step forward into the meningioma-brain adhesion assessment through SII, enabling two innovative advances: precise quantification and volumetric 3D visualizations. With surgical grading as the reference standard, the authors classify meningiomas as complete, partial, or non-adherent. After segmentation of the tumour and brain, resultant masks are registered and resliced to the MRE space. Then, an innovative quantitative metric of change in normalized octahedral shear strain at tumour boundary ($\Delta\text{NOSS}_{\text{bdy}}$) is calculated by means of NOSS data in tumour and brain shells. This novel metric allows precise biomechanical quantifications of the brain-tumour margin, which in the case of standard NOSS measurements are not reliable and therefore limited to visual evaluation. Finally, a 3D map representation of the $\Delta\text{NOSS}_{\text{bdy}}$ values provides a clinician-friendly visual tool. In a training cohort, mean and entropy are the chosen statistic features to describe the $\Delta\text{NOSS}_{\text{bdy}}$ distribution at the tumour boundary. Applied to the test set, $\Delta\text{NOSS}_{\text{bdy}}$ entropy metrics demonstrated sound correlation with the identification of completely adherent tumours, with an AUC and accuracy of 0.9 and 83% respectively.

The paper is an excellent example of the principles which research in clinical radiology should keep on its horizon—innovation, precise quantification, and direct clinical relevance—while maintaining comprehensibility and facilitating clinician-friendly displays.

Finally, this work represents interesting steps forward for SII-MRE technique. For sure, the readers will be looking forward to enjoying further studies on this scenario and maybe relating the $\Delta\text{NOSS}_{\text{bdy}}$ values with WHO grade, histopathological detection of brain invasion, Simpson grade of resection, and long-term patient outcomes.

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Methodology

- Editorial comment

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