Early postoperative magnetic resonance imaging in glioblastoma

MRI remains the preferred imaging investigation for glioblastoma. Appropriate and timely neuroimaging in the follow-up period is considered to be important in making glioblastoma treatment decisions. There is a paucity of evidence-based information in current UK, European and international guidelines regarding the optimal timing and type of neuroimaging following initial neurosurgical treatment.

A study of Booth et al. assessed the current imaging practices amongst UK neuro-oncology centres, thus providing baseline data and informing future practice.

The lead neuro-oncologist, neuroradiologist and neurosurgeon from every UK neuro-oncology centre were invited to complete an online survey. Participants were asked about current and ideal imaging practices following initial treatment.

Ninety-two participants from all 31 neuro-oncology centres completed the survey (100% response rate). Most centres routinely performed an early post-operative MRI (87%, 27/31), whereas only a third performed a pre-radiotherapy MRI (32%, 10/31). The number and timing of scans routinely performed during adjuvant TMZ treatment varied widely between centres. At the end of the adjuvant period, most centres performed an MRI (71%, 22/31), followed by monitoring scans at 3 monthly intervals (81%, 25/31). Additional short-interval imaging was carried out in cases of possible pseudoprogression in most centres (71%, 22/31). Routine use of advanced imaging was infrequent; however, the addition of advanced sequences was the most popular suggestion for ideal imaging practice, followed by changes in the timing of Early postoperative magnetic resonance imaging.

Variations in neuroimaging practices exist after initial glioblastoma treatment within the UK. Multicentre, longitudinal, prospective trials are needed to define the optimal imaging schedule for assessment [1].

Case series

2016

To evaluate early post-operative magnetic resonance (EPMR) as a prognostic tool after resection of glioblastoma.

Sixty EPMR examinations were evaluated for perioperative infarct, tumour growth between diagnosis and EPMR, contrast enhancement pattern, and extent of resection (EOR). The EOR was approached with the subjective evaluation of radiologists and by quantifying volumes. These parameters were tested as predictors of survival using the Kaplan-Meier method.

Contrast enhancement was found in 59 patients (59/60; 98 %). Showing a thin-linear pattern of enhancement was the most favourable finding. Patients with this pattern survived longer than patients with thick-linear (median overall survival (OS) thin-linear=609 days; thick-linear=432 days; P = .023) or nodular (median OS = 318 days; P = .001) enhancements. The subjective evaluation of the EOR performed better than its quantification. Patients survived longer when resection was total

(median OS total resection=609 days; subtotal=371 days; P = .001). When resection was subtotal, patients survived longer if it was superior to 95 % (median OS resection superior to 95 %=559 days; inferior to 95 %=256 days; P = .034).

EPMR provides valuable prognostic information after surgical resection of glioblastomas. A thin-linear pattern of contrast enhancement is the most favourable finding. Further prognostic stratification may be obtained by assessing the EOR.

• Some kind of contrast enhancement may be found in most EPMR examinations. • Thin-linear enhancements in the EPMR may be considered benign findings. • The EOR evaluated in the EPMR may stratify prognostic groups of patients. • The subjective evaluation of the EOR performs slightly better than its quantification [2)].

2003

Ekinci et al retrospectively analyzed pre- and post-operative magnetic resonance imaging results from 50 adult patients who underwent surgical treatment for supratentorial glial tumor. There were glioblastoma multiforme in 25 patients, astrocytoma (grades II and III) in 11 patients, oligodendroglioma (grades II and III) in 9 patients, and oligoastrocytoma (grades II and III) in 5 patients. EPMR imaging was performed within 24 h after surgery. EPMR findings were compared with the neurosurgeon's intraoperative estimation of gross tumor removal. Patterns of contrast enhancement at the resection site, in residual and developing tumor tissue and blood at the resection site were evaluated on EPMR and in follow-up studies. 'Residual tumor' was defined as contrast enhancing mass at the operative site on EPMR. 'Regrowth' was defined as contrast enhancing mass detected on follow-up in the same location as the primary tumor. 'Recurrence' was defined as appearance of a mass lesion in the brain parenchyma distant from the resection bed during follow-up.

Nineteen patients showed no evidence of residual tumor, regrowth, or recurrence on EPMR or any of the later follow-up radiological examinations. EPMR identified 20 cases of residual tumor. Follow-up showed tumor regrowth in 10 patients, and tumor recurrence in 1 case. EPMR showed contrast enhancement of the resection bed in 45 of the 50 patients. Four of the 20 residual tumors showed a thick linear enhancement pattern, and the other 16 cases exhibited thick linear-nodular enhancement. No thin linear enhancement was observed in the residual tumor group. Nine of the 10-regrowth tumors showed a thick linear-nodular enhancement pattern, and one exhibited thin linear enhancement in EPMR. For predicting regrowth tumor EPMR sensitivity was 91%, specificity was 100%, positive predictive value 1; negative predictive value was 0.9375.

EPMR, depending on the surgical site enhancement pattern, is a valuable means of demonstrating residual tumors, and can be used to predict possible regrowth after surgery [3)].

1994

In the vast majority of studies that address the role of surgery in the management of high-grade gliomas, the degree of tumor removal accomplished is solely based on the intraoperative perception of the neurosurgeon. Despite its fundamental importance for a comparison of different treatment modalities, little systematic effort has been made to evaluate the residual gross tumor by neuroimaging methods immediately after surgery.

Albert et al. report the results of a prospective study using contrast-enhanced computed tomography and magnetic resonance imaging (MRI) to monitor 60 patients after the resection of a high-grade glioma. In each case, the first scans were obtained between Days 1 and 5 after surgery, followed by serial imaging every 2 to 3 months, usually until the condition of the patient deteriorated severely or the patient died. Gadolinium-enhanced MRI proved to be extremely valuable for assessing gross residual tumor when performed during Days 1 to 3 after the resection of a preoperatively enhancing high-grade glioma. This timing avoided surgically induced contrast enhancement and minimized interpretative difficulties. In delineating residual tumor, MRI was vastly superior to computed tomography. About 80% of tumor “recurrences” emerged from definitely enhancing remnants, as revealed by early postoperative MRI. The neurosurgeon's estimation of gross tumor burden reduction could be shown to be much less accurate (by a factor of 3) than the postoperative assessment by modern neuroimaging. In our series, residual tumor enhancement was the most predictive prognostic factor of survival in patients with glioblastoma, followed by radiotherapy. Patients with a residual tumor postoperatively had a 6.595-times higher risk of death in comparison to patients without a residual tumor. Patients undergoing radiotherapy had a 0.258-times lower risk of death in comparison to patients who were not treated with radiation. Concerning survival, the prognostic significance of both variables surpassed age and performance [4].

1)
Booth TC, Luis A, Brazil L, Thompson G, Daniel RA, Shuaib H, Ashkan K, Pandey A. Glioblastoma post-operative imaging in neuro-oncology: current UK practice (GIN CUP study). Eur Radiol. 2020 Nov 5. doi: 10.1007/s00330-020-07387-3. Epub ahead of print. PMID: 33151394.
2)
Majós C, Cos M, Castañer S, Gil M, Plans G, Lucas A, Bruna J, Aguilera C. Early post-operative magnetic resonance imaging in glioblastoma: correlation among radiological findings and overall survival in 60 patients. Eur Radiol. 2016 Apr;26(4):1048-55. doi: 10.1007/s00330-015-3914-x. Epub 2015 Jul 19. PubMed PMID: 26188660.
3)
Ekinci G, Akpinar IN, Baltacioğlu F, Erzen C, Kiliç T, Elmaci I, Pamir N. Early-postoperative magnetic resonance imaging in glial tumors: prediction of tumor regrowth and recurrence. Eur J Radiol. 2003 Feb;45(2):99-107. PubMed PMID: 12536087.
4)
Albert FK, Forsting M, Sartor K, Adams HP, Kunze S. Early postoperative magnetic resonance imaging after resection of malignant glioma: objective evaluation of residual tumor and its influence on regrowth and prognosis. Neurosurgery. 1994 Jan;34(1):45-60; discussion 60-1. PubMed PMID: 8121569.