Available online at www.sciencedirect.com
SCIENCE DIRECT
CMIG Extra: Cases 29 (2005) 1–8
Computerized Medical Imaging and Graphics
www.elsevier.com/locate/CMCONL

Case report

Differences between CT and MR imaging in acute closed head injuries

A.H. Karantanas[a,*], A. Komnos[b], K. Paterakis[c], G. Hadjigeorgiou[d]

[a]*Department of Radiology, University Hospital, Stavrakia, Heraklion 711 10-Greece*
[b]*ICU, Larissa General Hospital, 1 Tsakalof Street, Larissa 412 21-Greece*
[c]*Neurosurgery, Larissa University Hospital, Larissa 411 10-Greece*
[d]*Neurology, Larissa University Hospital, Larissa 411 10-Greece*

Received 11 June 2003; revised 28 March 2005; accepted 28 March 2005

Abstract

The authors sought to compare the early MRI and CT findings in patients suffering closed head injury and to investigate the impact of imaging discrepancies on treatment management. A group of 62 patients with closed head injury and discrepancy between the apparently normal or with minor findings CT scan, and their neurological statuses were prospectively studied with MRI. Both CT and MRI were performed within the first 6 days after injury. According to the Glasgow Coma Scale (GCS), 46 patients suffered severe head injury (GCS $\leq$8) and 16 patients moderate head injury (GCS 9–12). Four MRI sequences in various planes were applied using a 1T MR scanner. CT findings were present in 19 out of 62 patients and MRI findings in 61. Extra-axial lesions were found in 52 patients with MRI and in 16 with CT. Subarachnoid hemorrhage (SAH) was observed in 40 patients with MRI and in 12 with CT. Intraventricular hemorrhage was observed in 15 patients with MRI and in 6 with CT. Intraaxial lesions were demonstrated in 54 patients with MRI and in 17 patients with CT. MRI demonstrated diffuse axonal injuries (DAI) type I in 27 patients, type II in 32 and type III in 9 as opposed to 2, 1 and 0 patients with CT respectively. Subcortical gray matter injuries were shown in 12 patients with MRI and 4 with CT. Primary brainstem injuries were shown in 6 patients with MRI and 1 with CT. The FLAIR sequence alone, revealed 89% of the findings demonstrated by all 4 MRI sequences. No statistically significant difference on GCS versus the hemorrhagic and non-hemorrhagic nature of the lesions was found ($p > 0.05$). In conclusion, in closed head injury patients with minor or absent CT findings and severe or moderate injury, MRI findings are almost always present and include particularly DAI lesions and SAH. These differences in favor of MRI do not alter the treatment management.

Keywords: Brain injuries/diagnosis; Head injuries; Closed/diagnosis; Magnetic resonance imaging; Tomography; X-ray computed

1. Introduction

Computed tomography (CT) is the method of choice for the evaluation of closed head injured patients [1–3]. Diffuse axonal injury (DAI) is widely recognized as one of the most common and most severe types of primary cerebral lesions in head trauma patients [4]. However, CT underestimates the extent of DAI lesions due to the fact that more than 80% of them are macroscopically non-hemorrhagic [1,2]. In addition, CT underestimates intra-axial or extra-axial lesions close to the scull base due to beam hardening artefacts [5–7]. It has also been shown that lesions depicted by MR imaging could be associated with the final outcome of the patients [8–10]. MR imaging is the preferred technique in the evaluation of subacute and chronic brain injury. It has been suggested that stable patients with persistent and significant impairment of consciousness or neurological deficits should be studied with MR imaging [1,2], preferentially within the first 2 weeks after injury [4]. Limited data have been reported in the literature on the MR imaging findings in the acute phase after closed head injury [2,10]. Although it has been reported that MR imaging findings in the early phase could predict the clinical outcome [10], no publication, to the best of our knowledge, has addressed their impact on patient management. The purpose of the present study was to compare the early CT and MR imaging findings after moderate or severe closed head injury, in terms of identifying significant findings that could alter the management of the patients.

* Corresponding author. Tel.: +30 2810392541; fax: +30 2810542095.
E-mail address: apolsen@yahoo.com (A.H. Karantanas).

1572-3496/$ - see front matter © 2005 Elsevier Ltd. All rights reserved.
doi:10.1016/j.compmedimag.2005.03.003

2. Materials and methods

Sixty-two consecutive patients, 10 females and 52 males (14–67 year-old, mean 32.3 ± 13.4y) with moderate (GCS 9–12) or severe (GCS ≤ 8) closed head injury were imaged prospectively. All patients were intubated and mechanically ventilated and had an intracranial pressure (ICP) and jugular bulb venous oxygen saturation (SjVO2) monitoring. No patient was extubated until the ICP and SjVO2 values were within acceptable limits (<25 and >55 mmHg, respectively [11]. A CT examination was performed in the hyperacute stage to investigate surgical lesions (Figs. 1a, 2a, 3a). Follow-up CT scans were performed according to clinical demands. No patient with epidural or subdural hematoma with urgent indications for surgical drainage was included in the study. CT scan was performed using a Philips LX plus scanner with 5 mm thin section for the posterior fossa and 10 mm thick section for the supratentorial structures without any contrast administration. The patients were all referred from a single site, the intensive care unit (ICU), under a single criterion, namely discordance between the CT findings and the GCS estimation on admission. All patients were examined in a 5-year period with the same MR scanner (1T Philips-Intera, Best, The Netherlands). MR examinations (Figs. 1b, 2b, 3b) were performed either within 24 h after CT (50 patients) or immediately before or after CT (12 patients). MR examinations were compared only with the latest CT scans, performed during the first 6 days of hospitalization.

Our standard MR imaging protocol (Table 1) consisted of:

(1) axial T2-weighted (w) Gradient Spin Echo (GraSE) for the detection of edematous and/or parenchymal lesions;
(2) axial T2-w Inversion recovery fast spin echo (TSE-FLAIR) for the detection of sabarachnoid hemorrhage and intraventricular hemorrhage and further characterization of the intra-axial lesions and extra-axial effusions;
(3) coronal T1-w gradient echo Echo Planar images (EPI) for the detection of hemorrhagic foci (e.g. in diffuse axonal injury);
(4) sagittal T2-w fast spin echo (TSE) for the detection of DAI II or III lesions in the corpus callosum and brain stem respectively.

The total acquisition time was approximately 11 min. A pulse oxymeter in the MR room was used for close monitoring of the patients.

The CT and MR imaging findings were evaluated in random by two radiologists, who were not aware either of the admission CT or of the clinical findings. All imaging findings were classified by consensus as follows:

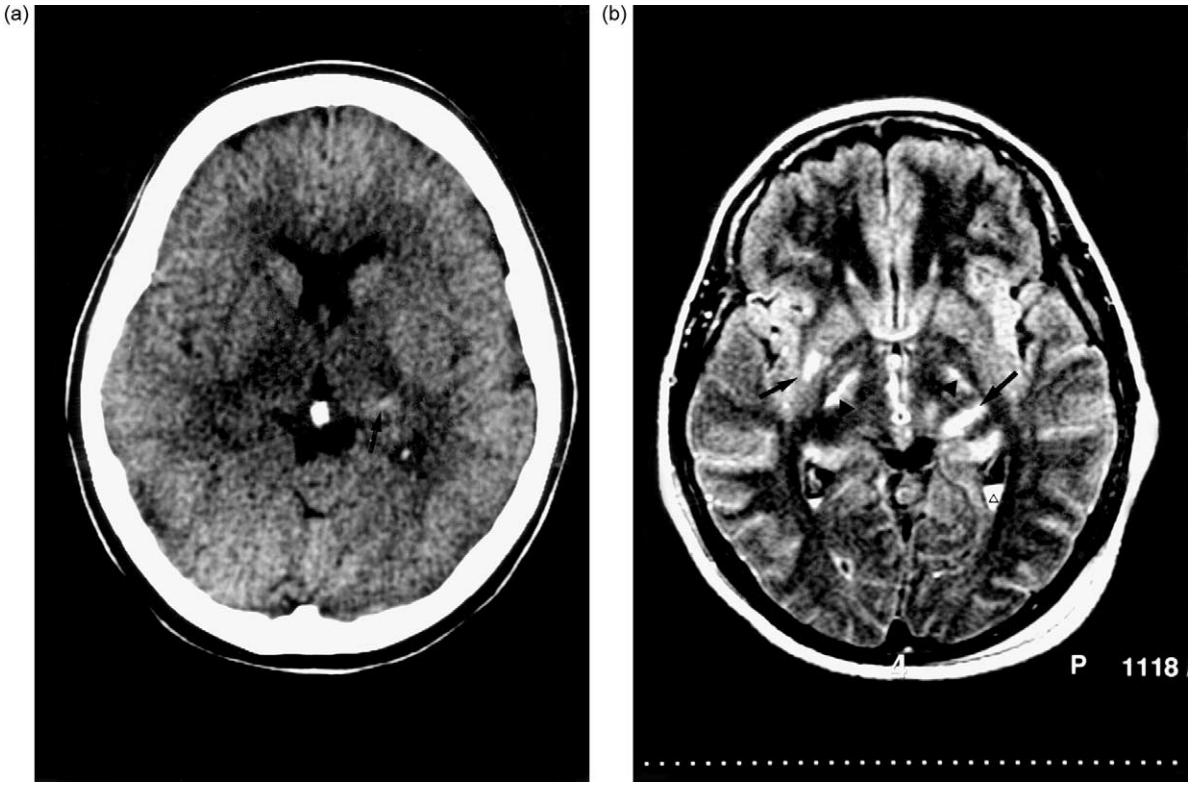

Fig. 1. Male 19-year-old with severe closed head injury. (a) CT scan in the axial plane 3 h after injury, discloses a small hemorrhagic lesion in the left thalamus (arrow). (b) MR imaging FLAIR sequence in the transverse plane performed immediadely after the CT, demonstrates the thalamic lesion (arrow), and in addition edematous right SCGMI lesion (small arrow), DAI II in the posterior limb of the internal capsule bialeterally (arrowheads) and intraventricular hemorrhage in the occipital horns of the lateral ventricles (open arrowheads). The last is only retrospectively seen on CT.