

A Comparison Between CT & MRI Imaging In The Histopathological Diagnosis Of Brain Lesions

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Summary

Background: To evaluate the role of diagnostic imaging, CT and MRI, in relation to the histopathological diagnosis of brain lesions.

Methodes : Seventy five patient with brain lesions who had both CT and MRI were assessed

Results: The study was done at Al-Shaheed Adnan Khairalla Surgical Specialties Hospital from October 1999 to June 2000 . The CT was of Seimens somatom HIQ 3rd generation with 150 Mas . MRI Gyroscan ACS-NT 3000 super conductive Type (Philips) . A correlation between CT and MRI findings and the histopathological was made. Six pathological groups were studied . This showed that MRI was more accurate in detecting posterior fossa lesions , brain stem gliomas, CPA abnormalities, cortical metastasis, lesions at the inferior portion of temporal lobes, multiple sclerosis, and infections. CT was superior in identifying bony involvement and calcifications.

Conclusion: MRI is much superior than CT in identifying pathological diagnoses of brain lesions while CT is better for bony abnormality. This confirms the fact that they compliment each other.

Key words : CT MRI Brain tumors skull lesions neuropathology

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Introduction

Diseases of CNS and skull have been found to be remarkably and significantly better visualized by the new imaging techniques, CT scan and MRI. In comparing the technical aspects of CT and MRI, the physical principle in CT is x-ray attenuation coefficient while in MRI the different behavior of processing nuclei in magnetic field and varying RF field. Structural appearance on CT is constant, bone is very white (high attenuation), while fat is gray .On MRI, using different sequences, fat is bright (large number of protons, relatively short T1, long T2), and bone is black (no mobile protons). Unlike CT, the MRI is strongly operator and instrument dependent due to contrast image generation These and others are shown in details in table (1) In this study the aim is to compare between the provisional (radiological) dignosis of CT and MRI and compared it with the final histological dignosis .It was also aimed to stress the value of the features of images in the radiological diagnosis.

Patient and Methods

Seventy five patients with brain lesions referred for MRI at AL- Shahid Adnan Khairalla Surgical Specialties Teaching Hospital (SSH) in Baghdad from October 1999 to June 2000.

Patients were referred by neurosurgeons, neurologists and other physicians. All patients were examined by MRI, 18 of them already had CT and was normal. For the remaining 57, CT was done after referral at SSH. Out of the 75 patients, histopathological diagnosis was proved in only 55 while the diagnosis of the remaining 20 cases was clinical and radiological as shown in (table 2). The age ranged from 2 years to 65 years with a mean of 34,4 year (table 3), which shows that the highest incidence of brain lesions occurred in the 4th and 5th decade of life.

In AL-Shahid hospital, CT examination was carried out using *Seimens somatom HIQ 3rd* generation with 150 Mas. The range of gantry angulation is + 25degree° MRI examination was done using 1.5 Tesla Gyroscan ACS-NT 3000 Super conductive Type, from *Philips* company, with adequate aperture. A head coil is used as receiver of the radio-frequency Protocols.

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Table (1)
Main comparative points between CT & MRI scanners Ref

Main points	CT	MR
Innovated by	Goftry N.Hounsfield (UK) (Shared Nobel prize 1979) 1st CT image of a patient brain 1971	Purcell & Bloch (USA) (Shared Nobel prize 1952) Application of NMR in medical imaging (1971) R.Damadian,P.Lauterbur (USA) R.Ernst et al.
Introduction into clinical practice	1972	1982
Main components of equipment	X-ray tube (100-140 kv)	Magnet up to (4.0 T)
Efficiency of unit depends on:	X-ray tube & generator	Software Magnet field strength
Physical principle	X-ray attenuation coefficient	Different behavior of precessing nuclei in a magnet & varying RF field
Measurements	Rad or Gray (100 rad = 1 Gray)	Magnet field(Telsa=T), 1T=1000 (Gauss)
Biological hazards	radiation	Not known with current
Contra-indications Contrast media used	Pregnancy iodine based contrast media (Urografin,Gastragrafin, Omnipaque	Pregnancy(?),Pace maker,cochlear implants,shell and bullet,metallic surgical clips.. Paramagnetic contrast Media (Gadolinium DTPA),magnevist,
Soft tissue contrast	7%	500%
Structural appearance	constant	Variable,according to Imaging sequence
Hard bone appearance on images Fat appearance	very white (high attenuation) Grayish(darker than middle gray)	black(no mobile protons) Bright(high amount protons Relatively short T1& long T2)
Examination time	could be within ONE min	5-30 minutes(dependin g on No.of scans & used Sequences),usuall y not More than 3-4 patients per ht.
Standard descriptive terms	Dense,hypodense, isodense	intense,hypointense, isointense,hyperintense

CT examination done with gantry angulation relative to the Reid's baseline ((the anthropological baseline drawn from the lower margin of the orbit to the superior border of the external auditory meatus (EAM) (Ried's or Frankfurt line), or from

the outer canthus to the center of the meatus, orbitomeatal (OM line) when there was a suspected supratentorial lesion, while it was zero (parallel to the Reid's baseline) when the site of interest was in the posterior fossa. Slice thickness was 10 mm, 2-7 seconds scans time per slice, and routinely nine slices were taken for each patient with additional slices taken in suspicious area when needed. Most of the patients were examined contrast media after non-enhanced scan based on clinical and imaging findings.

The choices for MRI are much wider than for CT. In cooperative patient, it was done with the use of TFE TR13/TE 4.6msec ,FOV 250 done with five slices 10 mm thickness with gap 10 mm .Flip angle used 20° done in about 16 minutes with multistack .T2-TSE done in single stack usually axial TR 4461/TE 10 msec,FOV 230, twenty two slices with 5 mm thickness and 1mm gap .T1 spin echo sequences with TR 560/ TE 14 msec FOV 230 22 slices 5mm thickness 1.0 gap in axial orientation .T2 FLAIR – TR 600 /TE 100 msec .with inversion recovery 200 ,22 slices 5 mm thickness FOV 230 ,gap 1.8 in coronal .FAT suppression techniques T2 spair used in different orientation .MRA done with ART 3DI TR 35/ TE 2.9 msec 10 mm slice thickness ,gap 0.5 FOV 180 ,about 150 slices in 10 minutes with flip angle 25 transverse orientation .T1 with gadolinium have been used to provide enhanced contrast for many tissues and disease types in different orthogonal plane.

Results

The details of radiological imaging of both CT and MRI are summarized in 6 main tables. CT was normal in two cases with the use of multiplaners sagital and coronal. MRI easily localised and demonstrated the extend and relationship of inter-ventricular mass Subtle extension of optic chiasma glioma and medulloblastoma were shown in tow cases MRI abnormalities reflected the pathological findings in hemorrhagic and cystic parts of highly malignant tumors in tow cases. MRI spin echo was insensitive in detecting calcification in slow growing oligodendroglioma , astrocytoma , and optic chiasma glioma . MRI also failed in detecting erosive changes in IAM in CPA glioma . MRI Profound hypervascularity MRI precisely identified profound hypervascularity, and linear low signal void in all spin-echo sequences in meningioma adjacent to planum sphenoidalis, and cerebral convexity. CT was better in detecting thickening and sclerosis, digitation enchanced edema, and tapered extention of enchanced dura –dural tail in two cases .

MRV was of great help in showing prominent veneous drainage ,vessels encasement , and hypervascularity of malignant tumor MRI detected the accordion-like compression of cortical

convolutions by extraaxial tumor and was easily differentiated from intraaxial mass in two cases ; Multiplanar capabilities, dynamic contrast enhancement MRI using rapid field echo-acquisition improved sensitivity by showing delayed enhancement of adenoma compared with normal CT scan in two cases . T1 -weighted images were very helpful in assessing small glomus jugularis tumor ,while CT was normal .

Irregular marginated osseous destruction was reliably inferred on MRI, and very well delineated on CT wide window and high center setting in a case of calvarial epidural metastasis. With the use of MRI, large associated vessels preciously delineated in posterior hemangioblastoma were detected in two cases. MRI demonstrated a portion of thromboses aneurysm and with the help of 3D TOF the occluded vessels clearly elicited in four cases. T1 weighted images typically identified popcorn appearance in CT hyperdense focal area of cavernous angioma. In degenerative brain lesions, CT was normal in one case of multiple sclerosis (MS). T2-weighted images, multiple punctated lesions with signal intensity is a typical early manifestation of this disease. The sensitivity of MRI T2 Weighted images in detecting intense perpendicular periventricular multiple lesions had been clearly assessed. Dawson's finger in one of the cases. T2 weighted images were superior to CT in detecting cerebellar edema and subtle mass effect, and with the use of gadolinium, multilobulated cerebellar abscess was clearly recognized in two cases. Congenital abnormalities were detected by MRI when CT was normal. With sagittal MRI images minimal herniation had been clearly demonstrated. in Chiari malformation. Hydrocephaly was the only abnormality in CT, but t aquiduct stenosis was seen in MRI sagittal sections. Arachnoid cyst had been shown with greater degree of accuracy with MRI. .

Finally, examination time and high accuracy for detecting hemorrhage have made CT the investigation of choice for initial evaluation of head injury MRI was more accurate in detecting extra axial hematoma, contusion, and hygroma in two cases.

Discussion

In this study where all patients have had both CT and MRI , it was possible to compare the diagnostic features of both and matched with established pathological diagnosis.

In intracranial neoplasm, CT was poor in identifying brain stem glioma but with the use of sagittal and coronal sections MRI easily localized and demonstrate the extent.

Comparative study showed that MRI signal intensity used to distinguish tumor from lesions such as occult cerebrovascular malformations² . Tumors associated with hemorrhage are more

heterogeneous and markedly complex when compared with those seen from non-neoplastic hematomas³ .Low density mass in posterior fossa was difficult to differentiate from low density glioma on CT, but with MRI, the diagnosis was supported with evidence of low signal area adjacent to the tumor in all spin-echo images represented large feeding vessel.

MRI showed internal hemorrhage in three cases , while CT showed nonspecific hyperdense area, MRI showed areas of necrosis or cystic degeneration secondary to hemorrhage or infarction, which are common and may occasionally dominate the clinical picture (pituitary apoplexy) .

With Dynamic contrast enhanced MRI using rapid field echo acquisitions improve sensitivity by showing delayed enhancement of adenoma in patient with clinically pituitary tumor and normal CT scan , This is in agreement with a previous study that showed early T1 weighted images usually demonstrated less enhancement of the area of the adenoma than of the surrounding normal pituitary tissue, relatively hypointense regions with enhanced gland⁴ . Cortical cerebral metastasis was difficult to be detected in two cases on CT , previous literatures showed that cerebral metastasis occur most frequently at the junction of the cortex and the underlying white matter, they appear as rounded homogenously isodense or slightly hyperdense nodules, while in MRI they were easily detected with sagittal and coronal enhanced T1-weighted images⁵ . Meningiomas with bony involvement was easily detected by CT in three cases with the use of bone window but MRI was insensitive in identification these features. Several studies in the literatures showed that erosion or hyperostosis clearly delineated on CT if high center and wide window setting are employed ,while MRI failed to detect it⁶ . Pronounced contrast enhancement of heterogeneous meningiomas on MRI was found in three cases with specific sign of enhancing dura, (dural tail),while this sign was not possible to be demonstrated by CT⁶ . The compression of cortical convolutions by extraaxial tumor-accordion like, had been easily identified by MRI sagittal and coronal images in two cases, sign not found in CT scans. Very small tumors (less than 5-mm in diameter) may be partially or completely obscured on T2 - weighted studies, T1-weighted images flowing intervenes gadolinium are the most sensitive of all diagnostic imaging studies for the delineation of very small (2 to 3 mm) acoustic tumors⁸ . CT failed in detection Glomus jugular tumor ,in patient with deterioration level of consciousness found in T1 as a hypointense mass in the region of jugular bulb . Previous study showed that T1-Weighted MRI images , Glomus jugular tumor appear as a hypointense / iso intense (to brain) soft tissue masses with irregular insinuating

margins replacing the normal signal void of air or cortical bone in this region 7 .

Noninvasive MRI was best to show the delineation of aneurysm and its relation to adjacent structures. Thrombosed aneurysms demonstrate a laminated appearance with intervening layers of hemosiderin and methemoglobin9 .

Retrospective studies examine the accuracy of the 3D TOF MRA method for detecting of aneurysm demonstrated a sensitivity of 95% and a specificity of 100%. Failure to detect area of infarction by CT was found in this studies compared with MRI low signal intensity in the involved area on T1, and high signal intensity on T2 represent edema . Comparative study show that acute infarctions are more frequently visible on MR than on CT scans. In the first 24 hours, approximately 80% of MR scans are positive compared to 60% percent of CT scans. Follow-up scans, approximately 90% of both CT and MR scans are positive10.

Useful techniques, fluid attenuated inversion recovery (FLAIR), as well as high dose contrast enhancement showed oval shaped hyperintense lesions oriented with their long axis perpendicular to the intro-posterior axis of the brain on proton density and T2 W . refer to this pattern of demyelination as a “Dawson’s finger”11

Delineation	CT	MRI
Total Number	75	75
Referred with normal CT	18	-
CT done (Abnormal)	57	-
MRI done (Abnormal)	-	75
Operated patient	55	55
Verified histo-pathologically	40	50
Provisional diagnosis	9	3
Incompatible diagnosis	6	2
Not operated up on-patient	20	20
Evidence of Brain lesion	-ve	20

Conclusion

- ◆ Both CT and MRI are useful in imaging brain lesion and they e complement each other

- ◆ The accuracy of MRI was due to its extraordinarily large innate contrast for two soft tissues due to multiparamagnetic nature with T1,T2, and spin density.

- ◆ The ability of CT scan to rapidly demonstrate surgically correctable traumatic lesions makes it the modality of choice in the evaluation of acute head injury .

The capability of imaging directly in multiple planer made MRI a modality of choic for the evaluation posterior fossa tumor.

- ◆ MRI gives an unprecedented view of the cervicomedullary junction region, with complete detection of the extent of brain stem lesions.

- ◆ MRI excellently improved definition in vascular visualization especially cerebrovascular malformation using different puls sequence design, hardware, and post processing.

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