Evaluation of Patients with Vertigo by Cranial Magnetic Resonance Imaging (MRI)

Treefa Salih Hasan (MBChB , DMRD , FRCR)[1]

[1] Department of Radiology, Erbil Teaching Hospital, Erbil, Iraq

email: trefa_77@yahoo.com

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Abstract

Background: Vertigo is a symptom that neurologists and otologists are confronted with. Magnetic resonance image (MRI) is used for imaging.
Objective: To determine the diagnostic yield of MRI in patients with vertigo and to Identify the most common causes.
Patients and Methods: This observational study involved 110 vertigo complaining patients attending the MRI unit of Rizgary teaching hospital examined by 0.2 Tesla MRI between June 2007 and September 2008.Collected variables divided into Group 1 (normal MRI) and Group 2 (abnormal MRI) analysed and compared.
Results: Group 1= (70%) and Group 2=(30%), abnormal MRI findings in male patients was (59.6%), in female (40.4%,) the commonest abnormalities were cerebellopontine angle (CPA) space occupying lesions (SOL) (9.2%), cerebellar SOL (7.4%), 4th ventricle SOL (7.4%) and deep white matter ischemia (7.4%), most of patients with vascular problems were more than 50 years. In (35.4%) of patients, vertigo was less than one month duration, (50%) of which had abnormal MRI findings. Out of seven patients with normal MRI, 5 patients showed vascular lesion on magnetic resonance angiography (MRA).
Conclusion: MRI remains important diagnostic tool for evaluation of vertigo and MRA is necessary when vascular origin is suspected.
Keywords: Vertigo , MRI , MRA

Introduction

Vertigo is one of the most common complaints in neurology and otology. Its prevalence increases with age but it's often underestimated in the elderly [1]. Although most cases of vertigo are self-limiting some cases of vertigo may be life-threatening such as brain stem and cerebellar infarction. Vertigo can also affect the quality of life [2 ,3]. Patients with isolated vertigo are commonly encountered in clinical practice,

but little is known about the underlying cause of their symptoms. The diagnosis and management of the patients complaining of acute vertigo are challenging endeavors for both neurologists and otologists. A thorough understanding of the anatomy and physiology in the peripheral and central vestibular systems, neuro-otological physical examinations, and appropriate laboratory tests can sometimes help to produce and exact the diagnosis[4].

Magnetic resonance image (MRI) is the first choice examination in central vertigo allowing the evaluation of the whole central vestibular pathway. Some patients with vertigo undergo series of neurological and otological examinations including cranial CT examinations and the cause of vertigo remains unclear. The diagnostic value of cranial MRI in these patients is yet to be determined.

In recent years there were several large clinical studies to survey the cause of vertigo most showed that benign paroxysmal positioning vertigo (BPPV) was the most common cause of vertigo and vertigo of unknown cause (VUC) was reported in 4.2-47% [5].

Until now more detailed studies are still rare in patients with VUC and better understanding of the underlying disease in these cases is needed.

Knowledge of anatomy and physiology of vestibular system is particularly important in understanding the mechanism of vertigo.

The peripheral vestibular system is concern inner ear which is an organ of hearing and balance, housed in the protective dense petrous bone[6].

The cortical representation of vestibular system (the central vestibular system) is commonly assumed to be located in distinct parietal and temporal region of brain and even frontal area may involve in vestibular function [4].

Causes : Peripheral causes

• Infectious and inflammatory diseases:, Labrynthitis , vestibuloneuritis and Cholesteatoma Figures (1,2)

• Benign positional paroxysmal vertigo and Meniere's disease , Otosclerosis , Perilymphatic fistula , Enlarged vestibular aqueduct , Hemorrhage in the inner ear [7, 8]

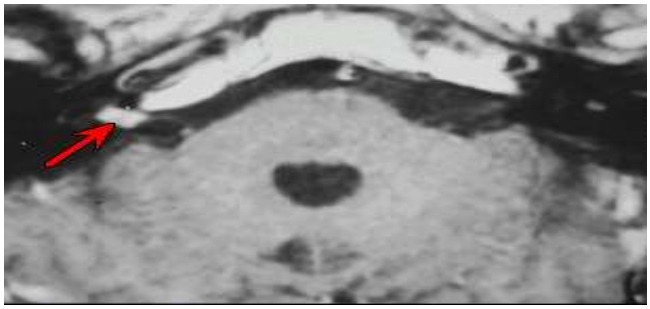

Figure (1): Enhancement of 8th cranial nerve on contrast T1 MRI due to vestibuloneuritis [9]

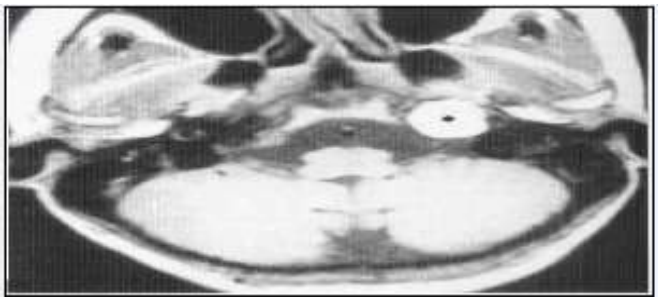

Figure (2): MRI T1WI shows cholesteatoma[10]

Central causes of vertigo

Cerebrovascular diseases Figures (3,4) , Posterior fossa and CPA tumours (acoustic schwannoma , meningioma , epidermoid , hemanhioblastoma)[10,11]Figure(6),multiple sclerosis , Migraine associated vertigo , Cervical vertigo , Craniovertebral junction abnormalities , Causes of vertigo following head trauma: (Postconcussional syndrome ,BPPV ,Destructive labyrinthine lesions ,Perilymphatic fistula ,Delayed endolymphatic hydrops ,Functional.) Psychological , drugs ,Vascular loop compression syndrome[12-14] Figure (5).

Figure (3): Shows pontine hemorrhage on T1 MRI [12]

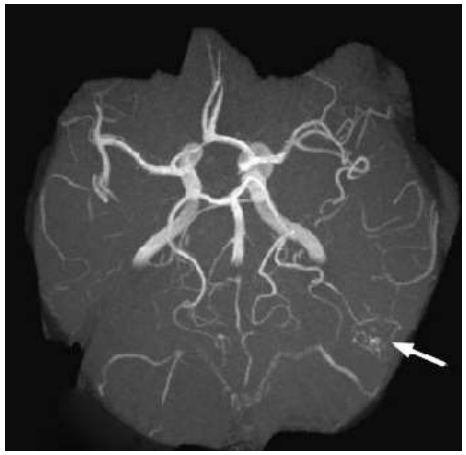

Figure (4): MRA shows AV malformation [15]

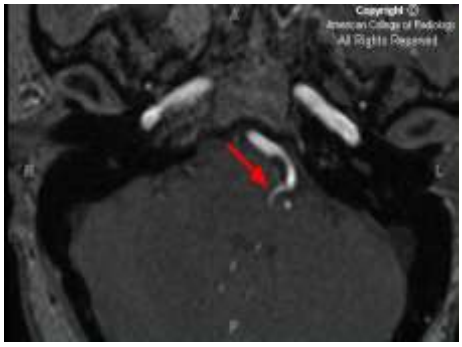

Figure (5): Looping of PICA around cranial nerve in CPA [15]

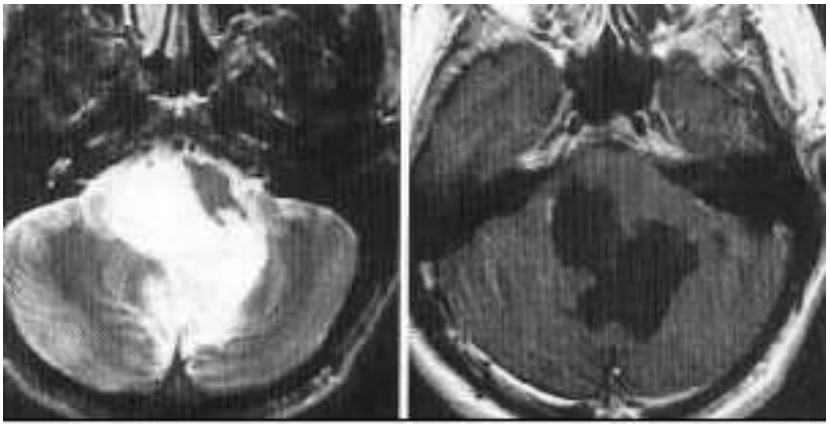

Figure (6): Epidermoid is seen on T2 and T1 MRI[8]

Patients and Methods

A total of 110 patients complained of vertigo wererecruited randomly from 15th of July 2007 to 10th of September 2008 , they were referred to MRI unit in Rizgary Teaching Hospital for MRI examination, additional information was collected through interviewing the patients in the radiology department prior to MRI examination. The MRI machine used for examination. Siemens Erlangen/Germany and 0.2 Tesla . A special head coil was used.The minimum imaging protocol used consists of T1, T2, and FLAIR sequences of the head, optional addition depends on findings after baseline scanning which were T1 with contrast and MRA sequences, the contrast was gadolinium DTPA (0.5 mmol/ml) , MRA was don for those patients whom their MRI finding point to vascular lesions and they were only 10 patients. Each examination was checked for: Size and contour of basal cisterns, ventricular system and CSF spaces appropriate to patient's age,any blockage to flow of CSF or signs of brain edema (i.e.effaced sulci). Asymmetries due to head position or true asymmetry, any abnormal enhancing tissue after contrast injection. Periventricular white matter and cortex signal intensity, any focal lesion or local edema ,basal ganglion and internal capsule,brain stem and cerebellum, CP angles and mastoid area, visible parts of sinuses .

The patients were divided in to two groups :

Group 1: patients with normal scan , and

Group 2: patients with radiological findings.

Statistical analysis

The collected variables were entered into computer using microsoft Excel version 17 spread sheet, descriptive statistics were used to characterize the investigated cohort. Comparison between group 1 and 2 were performed using Chi-square test where appropriate and was performed using statistical package for social sciences SPSS software. A p value of less and equal 0.05 was considered as statistically significant.

Results

The sample which consists of 110 patients was analysed. Results showed that the mean age (± SD) of the sample was 44.5± (17.2), ranging from 8-77 years, the median age was 45.5 years, male: female ratio was 1.07:1.

Table (1): Distribution of sample by age

Age intervals	G1(normal) No. (%)	G2(abnormal) No. (%)	Total No. (%)
<10	0 (0)	2(100)	2 (100)
10-19	3 (50)	3 (50)	6 (100)
20-29	7(70)	3 (30)	10 (100)
30-39	21 (84)	4 (16)	25 (100)
40-49	18 (85)	3 (15)	21 (100)
50-59	14 (60)	9 (40)	23 (100)
60-69	6 (54)	5 (46)	11 (100)
70-79	8 (66)	4 (36)	12 (100)
Total	77 (70)	33 (30)	110 (100)

It's seen that peak no. of patients are located within age group 30-39 year (25 cases =23% of total cases), however the number of patients with normal MRI in this age limit is (21 cases = 27% of total Group 1) i.e. only (4 cases =12% of total Group 2) have abnormal MRI. The peak number of patient in Group 2 is present within age limit of 50-59 years (9 cases =27% of total Group 2 = 40% of total patients of this age limit) but in regard of a given age interval the peak number of abnormal MRI found in ages <10 (100% were abnormal), 10-19 (50%) and 50-59 (40%) respectively. The total number of patients with normal MRI Group (1) is (77) which represent (70% of total cases) about two third of total while patients with abnormal MRI Group (2) is (33) which represent (30% of total cases) about one third of total number Table (1). Since in more than 20 % of the cells the expected values were <5 so χ^2 is not applicable in statistical evaluation for data in this table.

Table (2): Distribution of sample by gender

Gender	Group 1 (Normal) No. (%)	Group 2 (Abnormal) No. (%)	Total No. (%)
Male	38 (40.4)	19 (59.6)	57 (100)
Female	39 (60.4)	14 (40.4)	53 (100)

* χ^2= 5.277 P<0.024

A total number of male patients included in this study is (57) corresponds to (51%) while female patients were (53) corresponds to (49%). Pathological MRI findings were detected in a higher number of male patients (19cases = 60% of total male cases) compared with female patients (14cases = 40% of total female cases) Table (2). The differences between the data in this table are significant.

Table (3): Distribution of sample by MRI findings

Finding on cranial MRI	Number (%)
CPA SOL	4 (9.2)
Deep white matter ischemia	3 (7.4)
Cerebellar SOL	3 (7.4)
SOL in 4th ventricle	3 (7.4)
Fluid in mastoid air cell	3 (5.6)
Sinusitis	2 (5.6)
Brain stem SOL	2 (5.6)
Brain atrophy + deep white matter ischemia + Brain stem ischemia + Cerebellar infarction	2 (5.6)
Cerebellar haematoma	1 (3.7)
Multiple sclerosis	1 (3.7)
Cerebellar ischemia	1 (3.7)
Brain abscess + Mastoiditis	1 (3.7)
Deep white matter ischemia + Cerebellar infarction	1 (3.7)
Brain stem ischemia	1 (1.8)
Subdural haematoma	1 (1.8)
Partial empty Sella tursica	1 (1.8)
Sinusitis + Vascular anomaly	1 (1.8)
Mastoiditis + Sinusitis	1 (1.8)
Metastasis	1 (1.8)
Brain atrophy + Brain stem ischemia	1 (1.8)
Vascular anomaly + Arachnoid cyst + Cerebellar infarction	1 (1.8)
Total	33 (100)

Among a wide range of pathological MRI findings CPA SOL which is noted in 4 patients (9.2% of total Group 2) of these cases one of them was having bilateral acoustic neuroma, another one was having positive family history of acoustic neuroma in her brother Table (3). χ^2 test is not applicable for statistical evaluation of the data in this table. Vascular abnormalities (deep white matter ischemia, cerebellar haematoma and infarction and brain stem infarction) confined to age >50 years. CPA SOL was found in between ages of (40-59) years, cerebellar, 4th ventricle and brain stem SOL found in patients below 40 years. Multiple sclerosis is found in patients between (30-49) years. Infections (mastoiditis, sinusitis and brain abscess) were observed in nearly all ages.

Table (4): Distribution of the sample by associated symptoms

Symptoms	Group 1 (normal) No. (%)	Group 2 (abnormal) No. (%)	Total No. (%)
Headache	19 (33.9)	17 (53.7)	36 (43.6)
Ataxia	13 (35.7)	21(38.9)	34 (37.3)
Others (Hemiplegia, disturbed vision, abnormal speech, disturbed consciousness….etc).	8 (23.2)	23 (42.6)	31 (32.7)
Nausea and vomiting	15 (30.4)	15 (27.8)	30 (20.9)
Tinnitus	11 (19.6)	7 (11.9)	18 (16.3)
Deafness	8 (14.3)	8 (14.8)	16 (14.5)
Isolated vertigo	5 (8.9)	11 (20.4)	16 (14.5)

Headache was the most frequent associated symptom with vertigo which was observed in 36 patients (43.6%), of these 17 patients (53.7 % of total G2) were having abnormal MRI findings. Ataxia is the second most common vertigo-associated symptom which was reported in 34 patients (37.3%), but only 21 patients (38.9% of total G2) were having abnormal MRI findings. Patients with hemiplegia, disturbed vision, abnormal speech, disturbed consciousness, and other neurological symptoms had a high incidence of pathological MRI Table (4). The differences among the data of this table are highly significant.

Table (5): Distribution of sample by the duration of vertigo

Duration	G1(normal) No. (%)	G2(abnormal) No. (%)	Total No. (%)
< 1 month	19 (21.4)	20 (50)	39 (35.4)
1-6 months	30 (45)	6 (22.22)	36 (43)
6 month-1 year	8 (10.7)	3 (9.2)	11 (10)
> 1 year	20 (25)	4 (18.5)	24 (21.8)
Total	77 (100)	33 (100)	110 (100)

* χ^2= 102, P<0.001

In most of the patients, the duration of vertigo was below one month which is identified in 39 patients (35.4%), of these 20 patients have abnormal MRI findings. Most of these patients' MRI examination showed vascular problems (ischemia or haemorrhage) Table (5). The differences among the data in this table are highly significant.

MRA sequence was done for 10 patients, 7 of them was having normal MRI of which 5 of them showed vascular abnormalities. The remaining 3 patients were having abnormal MRI and MRA. The MRA findings were as following:

Unilateral attenuation of vertebral artery with normal other side was observed in 3 patients.

Wide caliber (hypertrophied) and abnormal course of one vertebral and basilar artery with absent other vertebral artery observed in 3 patients.

Left common carotid artery arises from brachiocephalic trunk, absent right vertebral artery and left vertebral artery main contributor for basilar artery noted in one

young male patient. The last one showed a solitary hypervascular tumor (Heamangioblastoma) in which tumor blush arise from the right superior cerebellar artery.

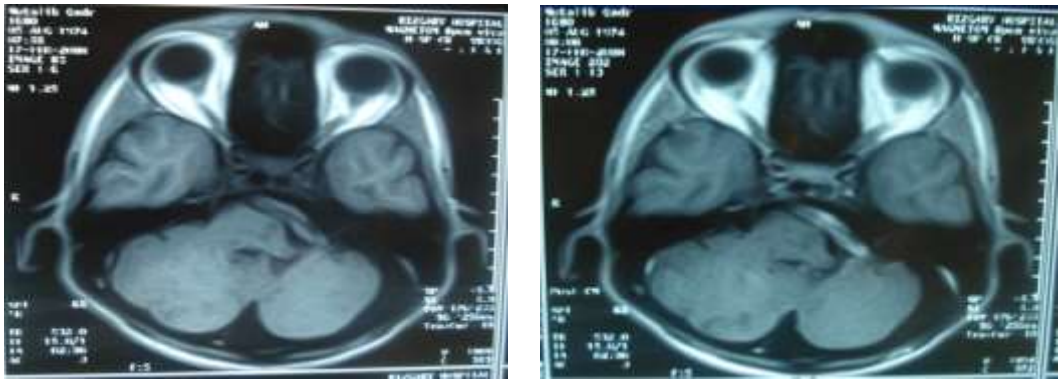

Figure (7): MRI in axial T1WI pre (A) and Post (B) contrast showing thrombosed anomalous vascular shadow traversing left CP angle

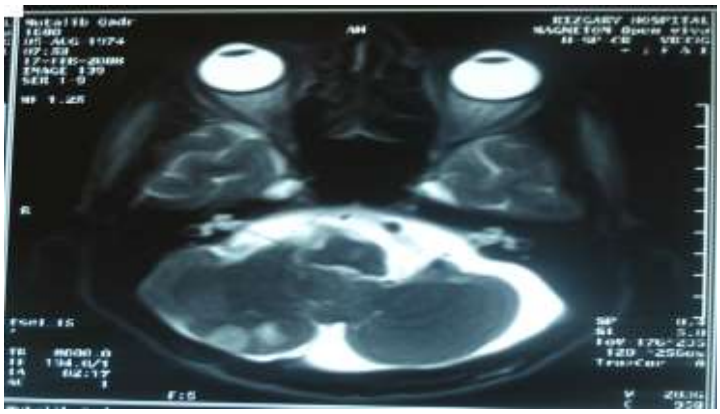

Figure (8): MRI in T2WI axial shows right posterior cerebellar infarction, giant cisterna magna and asymmetry and atrophy of cerebellum and brain stem

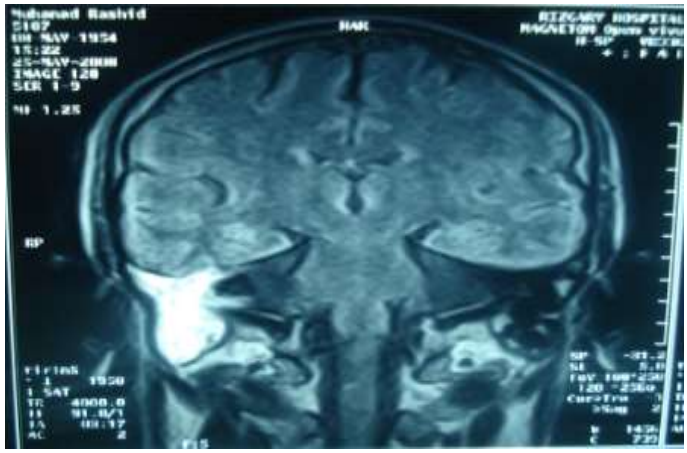

Figure (9): MRI in coronal FLAIR sequence shows right side mastoiditis

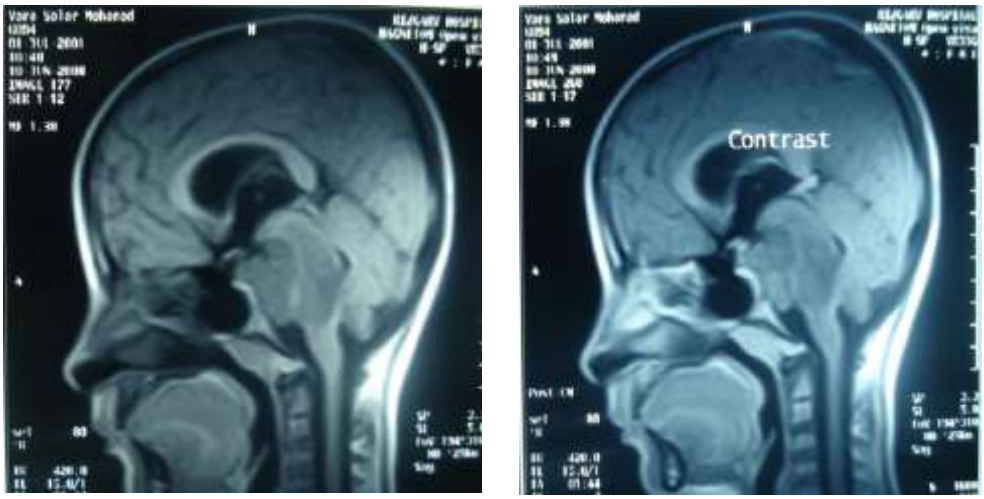

Figure (10): MRI in sagittal T1WI pre & post contrast shows brain stem glioma

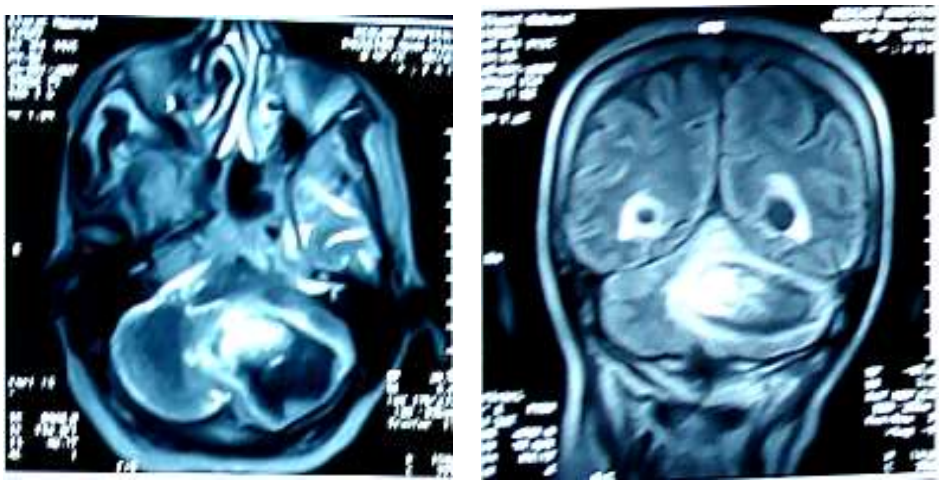

Figure (11): MRI in axial T2WI (A) and coronal FLAIR sequence (B) showing left cerebellar hemisphere hematoma at different stages

Discussion

The current prospective study which includes 110 patients complaining of vertigo, randomly chosen considered a wide range of age limit (8-77) years with a mean age of (44.5±17.2), Ojala et al did a study dealt with patients with age limit ranging from (19-59) years, that's why the frequency distributions of abnormal MRI findings according to age intervals in this study is more expressive of reality[16].

The peak number of patients with abnormal MRI findings was observed within the age interval (50-59) years which were 9 patients (27% of total patients in G2), followed by (60-69) age intervals. It was noticed that most of these patients were having vascular abnormalities in their posterior circulation, which can be due to the high incidence of ischemic stroke in these ages[17]. It was found that for a given age interval abnormal MRI findings were present in 100% of patients below 10 years followed by (10-19) years in which abnormal MRI seen in 50%, these results cannot express the reality since

small number of patients were in these age limits.

The total number of patients who has abnormal MRI findings in this study was 33 patients (30%). Baror et al did a study included 294 patients with vertigo and found abnormal MRI findings in only (26%) of cases [18]. This has a significant difference from this study result, this difference can be attributed to the fact that the patients in this study were referred to MRI examination after proper clinical assessment by specialist neurologists, neurosurgeons, ENT surgeons and internists and they took into consideration the cost of this investigation so they referred the patients on the base of high suspicion of pathological findings.

Both genders were included in this study nearly in an equal ratio (male/female =1.07/1) in comparison to a study done by Huang which included 108 patients with a male/female ratio of (1/1.6) and showed that abnormal MRI are seen in (46%) of female patients and(54%)of male patients,[4] which agreed with the results of this study that abnormal MRI findings were seen in (40.4%) of female patients and (59.6%) of male patients. The possible explanation of being MRI normal in female more than male patients with vertigo is that certain causes of vertigo is more common in female e.g. migraine which is common problem and have no feature on cranial MRI [18].No relationship between age and gender is noted in this study.

A wide range of pathological findings was noted, the most frequent were CPA SOL in (9.2%), cerebellar SOL in (7.4%), SOL in 4th ventricle in (7.4%) and deep white matter ischemia in (7.4%), also it was noticed that brain atrophy and vascular problems were detected in patients older than 50 years and this is logic since these diseases are commoner in these age groups. SOL was seen in patients below 59 years. Baror et al did a study (2001) who found that deep white matter ischemia is the most frequent findings which were observed in (51%) followed by brain atrophy in (25%) and CPA SOL only in (0.5%) of cases, his results were different from our results which are attributed to the difference in the source of the patient collection. In this study, cases were collected from in and out patients, while Baror collected his cases retrospectively from only hospital admitted cases. its well known fact that cerebrovascular diseases are the most frequent admitted neurological cases to hospital.

Not all the abnormal findings on cranial MRI detected in this study are causes of vertigo. Some findings may be incidental as in empty Sella. Brain atrophy could be a result of aging process and may be pathological.

In addition to vertigo, other symptoms were associated. The two most frequent vertigo associated symptoms were headache in 36 patients (43.6%) and ataxia in 34 patients (37.3%). An important noticeable result was that headache significantly more frequently observed in patients with abnormal MRI findings while ataxia was nearly equally present in both groups, this means that the presence of headache in addition to vertigo makes the case more indicative for cranial MRI study. When vertigo is accompanied by deafness and tinnitus, its most likely to be of peripheral origin which has little or no features on cranial MRI.

In most of the collected patients in this study, the duration of vertigo was less than one month (35.4%) and among whom abnormal MRI findings were high (50%). This means that short- duration vertigo is associated with a higher incidence of abnormal MRI findings,which is observed to be of ischemic origin. However, TIA and acute ischemic infarction as a cause of vertigo may be subtle on standard MRI but diffusion weighted image sequence of MRI is more supportive for the diagnosis.

MRA was done for seven patients with normal preliminary MRI, five of them showed vascular lesions. This indicates that MRI is not adequate investigation which exclude the vascular aetiology of vertigo. Although the anatomy of vertebrobasilar circulation has many variations and abnormalities such as kinking, tortuosity or asymmetry may be of no significance, MRA also is overestimating the degree of stenosis of blood vessel [19, 20].

Conclusions

From this study we can draw the following conclusions:

1-MRI examination of the brain in cases of vertigo remains an important diagnostic tool for assessing the vestibular system.

2-MRI examination of the brain helps in detecting other lesions that are not related to vertigo.

3-Pathological MRI findings are more documented in male patients.

4-Pathological MRI findings are more documented in younger age group patients.

5-MRA is essential for finding the cause of vertigo especially when clinical judgment. suggest a central cause and standard MRI sequence fails to reveal the lesion.

6-The shorter the duration of audiovestibular symptoms the more likely to find the lesion on MRI.

7-The presence of headache in addition to vertigo is more indicative of the central origin of vertigo whereby more likely to find the cause on cranial MRI.

Recommendations

1-Although cranial MRI is the best way to rule out central vertigo, it is costy investigation and time consuming, furthermore abnormal findings are not always detected with MRI, therefore the appropriate use of MRI in patients with vertigo should be considered.

2-It's recommended performing MRA examination of head and neck in all patients besides the standard sequences, use of DWI/ADC especially for patients with risk factors for cerebrovascular disease and IV contrast interrogation also help in the better depiction of the possible underlying cause of vertigo .

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Ethical clearance: From college of medicine / Hawler medical university.

Conflict of interest: Nill

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