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Original Article

Others Section

Incidental Neuroradiological Findings with Magnetic Resonance Imaging of Brain and Spine: A Cross-sectional Study

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ABSTRACT

Introduction: Advanced radiological imaging technology allows detailed anatomical view for diagnosis of diseases. The prevalence of incidental Magnetic Resonance Imaging (MRI) findings is relatively higher.

Aim: To identify and describe the Incidental Findings (IF) in patients undergoing MRI brain and spine at a tertiary care centre in Southern Rajasthan, India.

Materials and Methods: The cross-sectional observational study was carried out for a period of 18 months on patients referred to the Department of Radiodiagnosis for MRI brain and spine at Geetanjali Medical College and Hospital, Udaipur, Rajasthan, India, where report showed any incidental neuroradiological abnormality were included in the study. Patients were subjected to MRI machine (1.5 tesla SEIMENS-MAGNETOM Avanto OR 3 tesla GE SIGNA Architect) with T1-T2 weighted sequences. Incidental MRI findings with provisional diagnosis and clinical history were recorded and analysed for prevalence and proportion of IF (along with age and anatomical location specific IF). After entering data into Microsoft Excel 365, it was analysed for prevalence and proportion of IF (also categorised by age and anatomical location of IF among patients). All the data were in number or percentage.

Results: Total 49 patients had IF with an overall prevalence of 0.82%. Male: female ratio was 1.04:1. Mean age of patients was 47.6±29.03 years. Majority 29 (59.18%) patients were in age group 31-60 years. Most common IF noted was meningioma 13 (26.5%) and 10 out of 13 meningioma patients belonged to 31-60 years age group. Other findings like glioma and pituitary macroadenoma were noted in 5 (10.2%) patients each. Total 22 (44.89%) patients had IF in supratentorial region of brain.

Conclusion: Overall, low prevalence of IF was noted in the present study. Meningioma was one of the most common findings, especially among adults. Review of MRI scans by neuroradiologist, neurophysician and neurosurgeon for diagnosis of IF should be made mandatory.

Keywords: Glioma, Infratentorial, Meningioma, Supratentorial

INTRODUCTION

The utilisation of radiological imaging technology (such as an MRI scan) for clinical diagnosis, research or health check ups has been increasing exponentially day by day. With evolving technology, MRI technology has also become more advanced (e.g., high resolution, high magnification, multi-dimensional views, ability to use different sequences, extraspinal evaluation and digital archiving) [1]; thereby allowing a detailed anatomical view for diagnosis of diseases as well as IF of brain and spinal abnormalities.

An IF is an asymptomatic lesion; which is unexpectedly discovered while examining a patient for an unrelated pathology [2]. They may range from normal to morbid variants. Potential abnormalities that may show up as IF on MRI brain and spine includes cysts, inflammatory lesions, structural vascular abnormalities, chiari malformations, hydrocephalus or neoplasms [3]. The clinical relevance of these findings are mostly unknown and may also differ from those of similar symptomatic abnormalities that the patients had presented with in the first place.

A meta-analysis had reported 10% prevalence of incidental brain findings using high resolution MRI sequences [3]. However, its prevalence in healthy young adults may differ from healthy elderly subjects [4]. Thus, a thorough study of MRI scans for anatomical locations outside the symptomatic area of interest in different age groups is important for early detection and treatment of potentially life threatening IF if any.

There is hardly any study with data on incidental neuroradiological findings with MRI brain and spine in India. Hence, the present study was envisaged at our tertiary care centre with an objective to identify and describe the prevalence of IF in patients undergoing neuroimaging (MRI brain and spine).

MATERIALS AND METHODS

This cross-sectional, observational study was conducted in 49 patients at Geetanjali Medical College and Hospital, Udaipur, Rajasthan, India from February 2019 to July 2020 after obtaining Institutional Ethics Committee approval (Ref: GU/HREC/EC/2019/1563). Patients satisfying the eligibility criteria during the study period were included in the study.

Inclusion criteria: Patients who were referred from Departments of Medicine, Neurology and Neurosurgery to Department of Radiodiagnosis for MRI brain and spine during the study duration, wherein report showed an 'incidental neuroradiological abnormality' (which was not the cause for patient's symptomatology as per primary treating physician's consultation) as well as of either gender, aged 11 years and above, willing to give written informed consent (for ≥18 years patients) or assent along with consent from both parents/legal guardian for participation (for children/minor aged 11-17 years), were included in the study.

Exclusion criteria: Those with cardiac pacemakers, prosthetic heart valves, metallic orthopaedic implants, on artificial respiration, with claustrophobia/anxiety disorder or history of hypersensitivity reactions were excluded from the study.

Study Procedure

After a thorough screening (for any metallic objects or cardiac pacemakers), patients were explained about the risks of contrast examination and given disposable earplugs to attenuate the gradient switching noise. They were subjected to MRI machine (1.5 tesla SEIMENS-MAGNETOM Avanto or 3 teslaGE SIGNA Architect) where Geometric Embracing Method Head Neck Unit (GEM HNU) and Geometric Embracing Method Posterior Array (GEM-PA) were used for scanning of brain and spine respectively. The sequences performed

on these patients were T1 and T2-weighted sequence (for any lesion), diffusion-weighted imaging sequence with corresponding Apparent Diffusion Coefficient (ADC) mapping to distinguish between types of oedema and susceptibility weighted imaging sequence. The MRI findings of 'incidental neuroradiological abnormality' with a provisional diagnosis (as per primary treating physician's consultation) and clinical history were recorded in the case record form. These reports were also reviewed by the attending neuroradiologist, in consultation with the neurophysician, and neurosurgeon at centre. They were also given appropriate treatment accordingly.

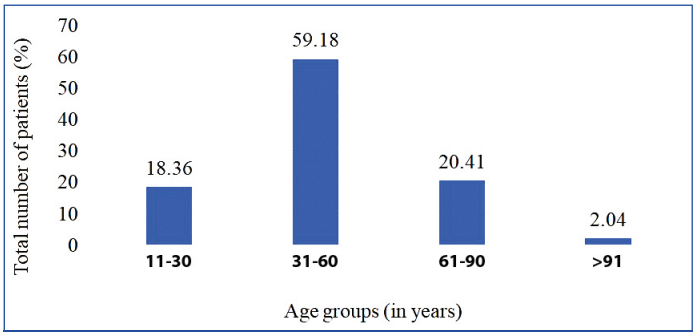
STATISTICAL ANALYSIS

After entering data into Microsoft Excel 365, it was analysed for prevalence and proportion of IF (also categorised by age and anatomical location of IF among patients). All the data were in number or percentage.

RESULTS

A total of 49 patients were diagnosed with incidental neuroradiological findings out of 6000 patients examined during the study duration. A prevalence of 0.82% was noted at the tertiary care centre. Male to female ratio was 1.04:1 with 25 (51%) males and 24 (49%) females. Mean age of patients was 47.6±29.03 years within an age range of 11-96 years. Majority 29 (59.18%) patients were in age group 31-60 years. Only 1 (2.04%) patient belonged to age group of 91 years and above [Table/Fig-1].

Provisional diagnosis by primary clinician, IF of MRI brain and spine and final diagnosis by primary clinician is shown in [Table/Fig-2].

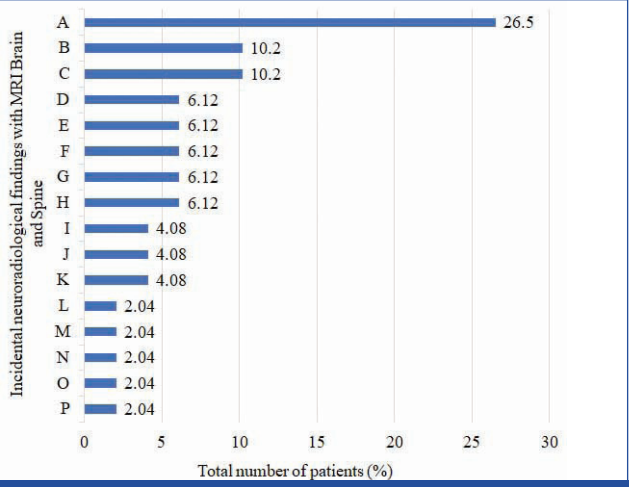


[Table/Fig-1]: Age distribution of patients (N=49).

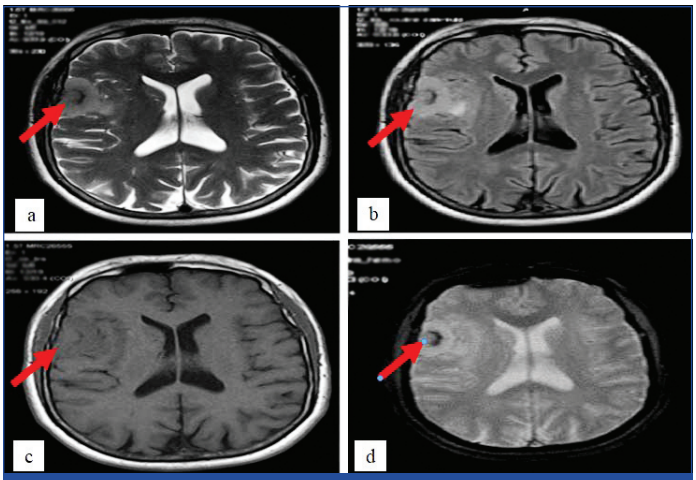
Sr. No.	Provisional diagnosis	Incidental neurora-diological findings	Final diagnosis
1	Somatoform disorder	Lipoma	Briquet syndrome
2	Migraine	Colloid cyst in third ventricle	Migraine without aura
3	Recurrent focal (dysarthric) seizures (secondary to infective granuloma)	Neurofibroma	Focal motor seizures
4	Meniere's disease/ Vertebro-basilar Transient Ischaemic Attack (TIA)	Meningioma	Meniere's disease
5	Depression with somatisation	Meningioma	Anxiety with depression
6	Mental retardation (Post CMV), Vascular headache	Meningioma	Migraine without aura
7	Benign Paroxysmal Positional Vertigo (BPPV)	Dandy Walker malformation	BPPV
8	Schizoaffective disorder	Pituitary macroadenoma	Schizophrenia
9	Left knee osteoarthritis	Neurofibroma	Left knee osteoarthritis
10	Psychogenic headache/ Depression	Cranio-Vertebral Junction (CVJ) anomaly	Tension type headache
11	Somatoform disorder	Arnold Chiari I malformation	Briquet syndrome
12	Dementia	Meningioma	Dementia
13	Right Trigeminal neuralgia	Pituitary macroadenoma	Right trigeminal neuralgia
14	Dementia	Cerebellopontine (CP) angle tumour	Dementia
15	Tension headache	Tonsillar herniation	Tension type headache
16	Somatoform disorder	Meningioma	Malingering
17	Migraine with depression	Pituitary macroadenoma	Migraine without aura depression
18	Grandmal Epilepsy	CVJ anomaly	Idiopathic generalised epilepsy
19	Right Hemi-Parkinsonism disease, Lumbar canal stenosis with L4-L5 anterolisthesis	Cervical cord myelopathy	Sporadic,tremor dominant, idiopathic right hemi parkinsons lumbar canal stenosis with L4-L5 anterolisthesis
20	Depression, psychogenic headache and NEAD	Meningioma	Tension type headache
21	Migraine	Meningioma	Migraine without aura
22	Migraine	Developmental venous anomaly	Migraine without aura
23	Depression, micturition syncope and BPPV	Glioma	Micturition syncope BPPV
24	Large head	CVJ anomaly macroadenoma	Macrocephaly
25	Migraine with BPPV	Meningioma	Migraine without aura BPPV
26	Migraine	Lipoma	Migraine without aura
27	Right focal unilateral epilepsy	Right glioma	Right unilateral seizure
28	Chronic depression	Cervical cord myelopathy	Depression
29	Lower backache and somatoform disorder	Syrinx, Right L3 Neurofibroma	Lower backache somatoform disorder
30	Right trigeminal neuralgia	CP angle tumour	Right trigeminal neuralgia
31	Somatoform disorder	Pituitary macroadenoma	Somatoform disorder
32	Chronic depression	Syrinx	Depression
33	Left focal and generalised seizure	Left glioma	Left partial motor seizure with secondary generalisation
34	Conversion reaction and NEAD	Meningioma	NEAD/PNES (Non epileptic attack disorder
35	Somatoform disorder	Glioma	Briquet syndrome
36	Psychogenic headache	Arachnoidcyst	Tension type headache
37	Focal and generalised seizure (secondary to infective granuloma)	Developmental venous anomaly	Active, symptomatic partial and generalised seizure
38	Left trigeminal neuralgia	Meningioma	Left trigeminal neuralgia
39	Vertebrobasilar insufficiency (VBI)	ICA aneurysm	VBI
40	Grandmal Epilepsy (post traumatic)	Developmental venous anomaly	Post-traumatic generalised seizure
41	Grandmal epilepsy/ temporal lobe epilepsy (Left frontal cavernoma)	Meningioma	Symptomatic ET-CPS, GTCS
42	Schizoaffective disorder	Pituitary macroadenoma	Schizophrenia
43	Somatoform disorder	Glioma	Briquet syndrome
44	Migraine	Arachnoid cyst	Migraine without aura
45	Cervical lymph nodes	Meningioma	Cervical lymphadenopathy
46	Left brachial plexopathy	Meningioma (Left frontal)	Left C5-C6 radiculopathy
47	Migraine	Syrinx	Migraine without aura
48	Acute stroke	Arachnoid cyst	Broca's aphasia
49	Headache	CP angle tumour	Migraine without aura

[Table/Fig-2]: Provisional diagnosis, incidental neuroradiological findings and final diagnosis of study patients (N=49).

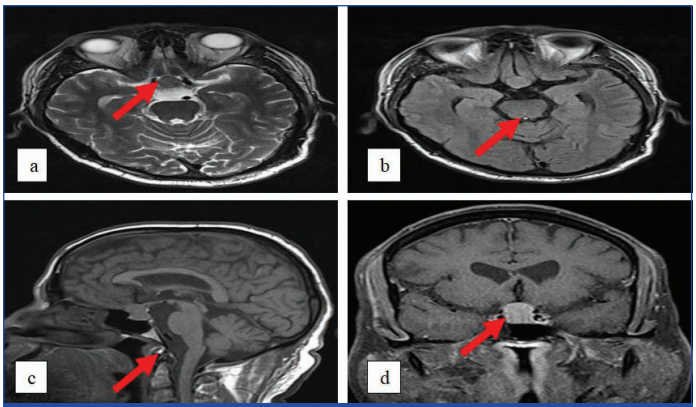
Out of 49 patients, most common incidental neuroradiological finding was meningioma {13 (26.5%)} followed by glioma {5 (10.2%)} and pituitary macroadenoma {5 (10.2%)}. An IF like Arnold chiari malformation, colloid cyst in third ventricle or Internal Carotid Artery (ICA) aneurysm were noted only in one (2.04%) patient each [Table/Fig-3-6].



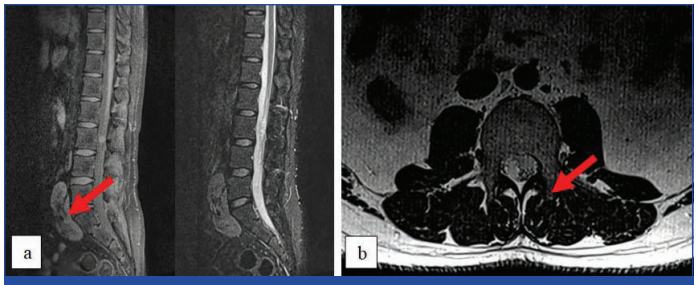
[Table/Fig-3]: Frequency of incidental neuroradiological findings with Magnetic Resonance Imaging (MRI) Brain and Spine among patients (N=49).
A=Meningioma; B=Glioma; C=Pituitary macroadenoma; D=Arachnoid cyst; E=Cerebellopontine angle (CPA) tumour; F=Craniovertebral junction (CVJ) anomaly; G=Developmental venous anomaly; H=Syrinx; I=Cervical cord myelopathy, J=Lipoma; K=Neurofibroma; L=Arnold chiari malformation; M=Colloid cyst in third ventricle; N=Dandy-walker malformation; O=Internal carotid artery (ICA) aneurysm; P=Tonsillar herniation



[Table/Fig-4]: MRI brain images (Meningioma) of 60-year-old male {case 4} with episodic ataxic gait, vomitting and right year tinnitus shows abnormal extraaxial dura based lesion in right frontal region appearing isointense on T1W, hyperintense on T2W sequence with blooming on GRE and perilesional edema on FLAIR sequence [a) Axial T2W sequence; b) Axial FLAIR sequence; c) Axial T1W and; d) Axial GRE sequence].



[Table/Fig-5]: MRI brain images of a 26-year-old male {case 8} who had presented with headache and had macrocephaly since the age of 1.5 years. Both T1/T2WI images revealed expansion of sella with a well-defined lobulated soft tissue intensity mass lesion appearing isointense and showing moderate homogenous enhancement on post contrast study; diagnosed as a case of pituitary macroadenoma: a) Axial T2W sequence; b) Axial FLAIR sequence; c) Non contrast saggital T1W and; d) Post contrast coronal T1W sequence}.



[Table/Fig-6]: MRI lumbar spinal images of a 35-year-old male {case 3} who had history of low backpain. His provisional diagnosis was recurrent focal (dysarthric) seizures (secondary to infective granuloma). He was incidentally diagnosed as a case of Lumbar neurofibroma. a) reveals contrast T1W fat sat and STIR saggital imagess showing enhanching nodular lesion in spinal canal at L3 vertebral level; b) Shows the same nodular lesion on axial T2W image appearing hyperintense}.

Among 29 out of 49 (59.18%) patients in 31-60 years age group, maximum 10(34.48%) patients were diagnosed with meningioma followed by three (10.34%) patients with pituitary macroadenomaon MRI brain and spine. Remaining incidental neuroradiological findings were noted in few patients among all age-groups respectively [Table/Fig-7].

Incidental neuroradiological findings	Age distribution of patients {n (%)}			
	11 to 30 years {n=9 (18.36%)}	31 to 60 years {n=29 (59.18%)}	61 to 90 years {n=10 (20.41%)}	91 years and above {n=1 (2.04%)}
Meningioma	1 (2.04%)	10 (20.41%)	2 (4.08%)	-
Glioma	2 (4.08%)	2 (4.08%)	1 (2.04%)	-
Pituitary macroadenoma	-	3 (6.12%)	1 (2.04%)	1 (2.04%)
Arachnoid cyst	-	2 (4.08%)	1 (2.04%)	-
CPA* tumour	-	1 (2.04%)	2 (4.08%)	-
CVJ* anomaly	2 (4.08%)	1 (2.04%)	-	-
Developmental venous anomaly	1 (2.04%)	2 (4.08%)	-	-
Syrinx	1 (2.04%)	1 (2.04%)	1 (2.04%)	-
Cervical cord myelopathy	-	1 (2.04%)	1 (2.04%)	-
Lipoma	-	2 (4.08%)	-	-
Neurofibroma	-	1 (2.04%)	1 (2.04%)	-
Arnold chiari malformation	1 (2.04%)	-	-	-
Colloid cyst in third ventricle	1 (2.04%)	-	-	-
Dandy-walker malformation	-	1 (2.04%)	-	-
ICA* aneurysm	-	1 (2.04%)	-	-
Tonsillar herniation	-	1 (2.04%)	-	-

[Table/Fig-7]: Incidental neuroradiological findings categorised by age of patients (N=49).
*CPA: Cerebellopontine angle; CVJ: Craniovertebral junction; ICA: Internal carotid artery

Maximum {22 (44.89%)} patients had IF insupratentorial region of brain whereas spinal cord and infratentorial IF were noted in 14 (28.57%) and 13 (26.53%) patients, respectively [Table/Fig-8].

Incidental neuroradiological findings	Anatomical location {n (%)}		
	Brain (Supratentorial) (n=22, 44.89%)	Brain (Infratentorial) (n=13, 26.53%)	Spinal cord (n=14, 28.57%)
Meningioma			
- Frontal/temporal/parietal/occipital	12 (24.49%)	-	-
- Dorsal/lumbar	-	-	1 (2.04%)
Glioma			
- Low grade thalamic	1 (2.04%)	-	-
- Low grade middle cerebellar peduncle	-	1(2.04%)	-
- Low grade tectal	-	1(2.04%)	-

- Cerebellar	-	2 (4.08%)	-
Pituitary macroadenoma	5 (10.20%)	-	-
Arachnoid cyst	1 (2.04%)	-	2 (4.08%)
CPA* tumour	-	3 (6.12%)	-
CVJ* anomaly	-	-	3 (6.12%)
Developmental venous anomaly			
- Parietal	1 (2.04%)	-	-
- Cerebellar	-	2 (4.08%)	-
Syrinx			
- Cervical/dorsal/lumbar	-	-	3 (6.12%)
Cervical cord myelopathy	-	-	2 (4.08%)
Lipoma			
- Tectal	-	1 (2.04%)	-
- L2	-	-	1 (2.04%)
Neurofibroma	-	-	2 (4.08%)
Arnold chiari malformation	-	1 (2.04%)	-
Colloid cyst in third ventricle	1 (2.04%)	-	-
Dandy-walker malformation	-	1 (2.04%)	-
ICA* aneurysm			
- Supraclinoid	1 (2.04%)	-	-
Tonsillar herniation	-	1 (2.04%)	-

[Table/Fig-8]: Incidental neuroradiological findings categorised by its anatomical location (N=49).
*CPA: Cerebellopontine angle; CVJ: Craniovertebral junction; ICA: Internal carotid artery

DISCUSSION

The development and frequent use of MRI imaging technology in clinical practice has resulted in an unintended consequence of detection of incidental radiological findings pertaining to varying pathology, thereby aiding to its early diagnosis and treatment. It is important to note that any incidental radiological finding may be more significant than the suspected disease or any of the symptomatology that had prompted the need for radiological imaging [5]. The present study is one of a kind study that identified IF with MRI brain and spine among patients at a tertiary care centre of Southern Rajasthan, India. They were also considered diagnostic as per consultation from neuroradiologist, neurophysician/neurosurgeon.

An overall low prevalence (0.82%) of incidental neuroradiological findings was noted in our study population. However, published literature has reported relatively higher prevalence of clinically relevant IF ranging from 1.7-10.2% [4,6,7]. This variability may be due to wide age range and diversity among patients in these studies. Supposedly, the sensitivity for these incidental neuroradiological findings is more likely when all the MRI scans are reviewed by a neuroradiologist. However, results of Morris Z et al., study were contradictory since IF were not higher in studies that involved neuroradiologists to review MRI scans than in studies involving general radiologists [3].

In the present study, incidental neuroradiological findings were slightly higher in males than females. This is contradictory to results from the published data which has shown a significantly higher female preponderance [4,8,9]. This male dominance in our study may be due to higher number of males visiting the hospital for consultation and getting referred for MRI brain and spine. However, gender distribution may also depend on factors like malignant nature. Few IF such as meningioma (non cancerous) is more likely in females than in males whereas cancerous type may be found equally among males and females as per Kamenova M et al., study [10].

Our study population (11-96 years) had a mean age of 47 years and approximately 59% patients were adults aged 31-60 years. However, elderly patients (≥61 years) with IF were fewer in number. This is in accordance with Abdullah AR et al., study (16-82 years) where mean age was 49 years and 69% patients belonged to 31-60 years age group followed by 22% patients aged ≥61 years [11].

In Vernooij MW et al., study, incidental neuroradiological findings showed an age related increase [6]. Results from Li Y et al., study in paediatric population aged 9-10 years showed 21.1% children with incidental MRI brain findings [12]. Thus, prevalence of incidental neuroradiological findings tends to remain higher in adult age group as compared to the paediatric or elderly population. However, similar studies on Indian population were found to be scarce in the literature.

Meningioma was the most common incidental neuroradiological finding followed by glioma and pituitary macroadenoma in the present study. Some of the other IF noted were arachnoid cyst, neurofibroma, colloid cyst or aneurysm. Aldana PR and Maher CO, study described arachnoid cysts (about 2% prevalence), vascular lesions, brain tumours, congenital lesions such as chiari malformation or lipoma as commonly discovered incidental MRI findings of the nervous system [13]. Similarly, Kamath S et al., study also mentioned of meningioma, aortic aneurysm or cysts of lumbar and sacral regions as frequently encountered incidental neuroradiological findings [5]. Thus, existing literature suggests heterogenicity of incidental neuroradiological findings among patients. It may depend upon factors like prevalence of disease and its geographical distribution, patient's age, availability of imaging technology and most importantly vigilance of neurophysicians, neurosurgeons and neuroradiologists while examining patients and reviewing their radiological scans.

The age specific distribution of incidental MRI findings in our study showed that meningioma, glioma, CPA tumour, aneurysm or tonsillar herniations were commonly encountered in adults. Very few children and young adults were also diagnosed with developmental anomaly, chiari malformations or colloid cyst in third ventricle. Similarly, few elderly patients were diagnosed with meningioma, glioma, pituitary macroadenoma or cervical cord myelopathy too in this study. Vernooij MW et al., study has reported that meningiomas were highly prevalent (~1.1% in women and 0.7% in men) in population aged ≥45 years [6]. This is because, for most of the patient's lifespan, meningiomas remain asymptomatic due to its slow growth rate and thus, get detected at an older age [14,15]. However, it does require regular follow-up (clinical and radiological) and proper treatment once diagnosed. A meta-analysis by Morris Z et al., study had analysed age specific data on IF which was available from eight out of 16 included studies [3]. It also showed known age specific trends (increased prevalence with age) for neoplastic (meningioma, glioma) and non neoplastic (arachnoid cyst, chiari malformation, aneurysm) IF on MRI brain [3].

In the present study, on categorising these IF based on their location, nearly 50% were located in the supratentorial region of the brain. These mainly included meningioma, pituitary microadenoma or ICA aneurysm. Remaining IF were almost equally distributed between spinal cord region (neurofibroma, syringomyelia, arachnoid cyst) and infratentorial region of brain (cerebellar glioma, tectal lipoma, CPA tumour). According to the published data, IF have been mainly classified as extracranial/intracranial findings and spinal (vertebral and intraspinal)/extraspinal findings. Commonly detected intracranial findings included arachnoid cyst, meningiomas, ICA aneurysms, colloid cyst [3,7], whereas intraspinal IF were lipomas, haemangiomas, syringomyelia [16,17].

It was also observed that some of our study patients had multiple IF. One patient had two left frontal para-falcine meningioma (supratentorial multiple incidentalomas). Two other patients had multiple spinal IF-CVJ anomaly with cervico-dorso-lumbar syringohydromyelia in one patient whereas dorsal syringohydromyeliawith cervico-dorsal arachnoid cyst in the other patient. Both T1 and T2-weighted sequence were performed on our study patients but Kizilgoz V et al., study considered T2-weighted sequence as the best sequence to detect the IF [18]. However, this opinion may be subjective and debatable.

It is essential to subsequently treat the patients of incidental neuroradiological findings once diagnosed and reported as it has a significant impact on patient's mental, social and economic health. Those patients requiring resection should be referred to the neurosurgeon while few may require chemotherapy or radiotherapy or can be managed conservatively for symptom free survival of patients. Thus, the management approach for incidental neuroradiological findings may depend on type and pathology of lesion, its grade and location, symptomatology as well as patient counselling. Alternately, one of the study report does suggest otherwise that reporting IF may not always be beneficial to the patient [18]. It may be a consequence of delayed diagnosis, multiple radiation exposure from scans, anxiety, depression or psychological burden from not being able to afford the treatment in a developing country like India. Nonetheless, early diagnosis, treatment of incidental neuroradiological findings and information on its natural course of development will always aid to reduce morbidity and mortality among patients.

Limitation(s)

This study was one among the handful studies that have been conducted in India to analyse the incidental neuroradiological findings with both MRI brain and spine. However, lack of data confirming the pathological diagnosis of these incidental neuroradiological findings (wherever required) and homogenous composition with lack of ethnicity among study patients remained its few limitations. Therefore, a multi-centric study across India can be planned to analyse the change in pattern of its prevalence (if any) as well as to correlate with patient's clinical features, pathological diagnosis and subsequent prognosis.

CONCLUSION(S)

The present study concludes that IF with MRI brain and spine had an overall low prevalence among patients in Southern Rajasthan, India; with meningioma as the most common IF especially among adults. These were mainly in supratentorial region of brain. Review of MRI scans by neuroradiologists in consultation with neurophysician/ neurosurgeon for diagnosis and appropriate management of IF is of vital importance.

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