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Prevalence and clinical importance of the incidental findings in brain MRI examinations

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Incidental findings (IFs) are an asymptomatic abnormality found while examining a patient for an unrelated reason. The impact of finding incidental abnormalities on patient health outcome is not certain, but it is worth remembering that IFs may be more significant than the suspected disease that prompted imaging. This study aimed to calculate the frequencies and emphasize the clinical importance of IFs in the brain magnetic resonance imaging examinations. A prospective descriptive, analytical study, including 60 subjects was investigated in the period from 2016 to 2019. Both 1.5 and 0.35 Tesla MRI machines (Toshiba and Siemens Medical Systems) were used to examine the patients at three hospitals in Khartoum state, Sudan. Overall, 10 incidental findings (10% of the sample) were found. Various incidental findings (IFs) were seen, including Chiari I malformation, multiple sclerosis, polyps\retention, mucosal thickening in the paranasal sinuses and Tornwaldt cyst. Out of these IFs, 1.7% was considered major importance. MRI examinations paying attention to incidentally detect pathological findings and congenital anomalies/anatomical variations are very important because they can alter the treatment of the patient or affect the patient's life.

Keywords: Incidental findings, MRI Brain, Multiple sclerosis, Polyps

INTRODUCTION

The evolution of new diagnostic techniques has revolutionized the practice of medicine and in fact, the nature of medicine itself, technology has also expended the visual field of medicine. However, there are unintended consequences. One of which is the discovery of anomaly during the course of looking for something else - incidental finding or incidentalomas. Technology in general and imaging, specifically offer much in service to a physician and the patients. However, it behaves a physician to ensure that technology supplements, but does not replace good clinical judgment (Wagner et al., 2002).

In fact, incidental findings are the findings that are obtained in an unrelated investigation, but are of great clinical importance. These findings could range from normal variants to life-threatening

issues which may affect the quality and quantity of life in patients. These findings may in some cases be of more clinical value compared to the issue that has caused patients to have MRI tests. These findings cause clinical and behavioral concerns in patients for seeking treatments on the one hand, and may even be life-threatening and impose costs on the individual and their health system on the other hand (Wagner et al., 2002). Therefore, it's vital that the radiologist can judge whether the disease requires any further investigations (e.g. Solitary pulmonary nodules, soft-tissue sarcoma, etc.) or just a mention in the report without necessarily needing further follow-up (e.g. Simple renal cyst, small uterine fibroid, thyroid goiter, etc.) (Paluska et al., 2007). MRI has dramatically enhanced the spine, brain, abdomen imaging, due to its superior tissue resolution, multiplaner imaging capabilities noninvasive nature, and freedom from the artifact produce by bone in CT (Gunderman, 2006).

This study aimed to calculate the frequencies and emphasize the clinical importance of IFs in the brain magnetic resonance imaging examinations.

MATERIALS AND METHODS

Population selection and ethical considerations:

The local ethics committee of the Faculty of Radiology and Nuclear Medicine Sciences, the National Ribat University, Khartoum, Sudan, confirmed this study. A group of 60 subjects – 37 (49%) males and 23 (51%) females – The patients who gave any data of any brain abnormalities were excluded, the subjects were presented at the MRI diagnostic center of Al Zaytouna Specialist Hospital, Dar Al Elaj Specialized Hospital, and El Nilein Medical Diagnostic Centre, Khartoum, Sudan, were recruited for this prospective study over a period from August 2016 to January 2018. A waiver of informed consent was conceded as per institutional rules.

Brain MRI acquisition characteristics:

The MRI images were obtained from a 1.5-Tesla (Toshiba Medical Systems, Tokyo, Japan) at the Al Zaytouna Specialist Hospital and Dar Al Elaj Specialized Hospital and on a 0.35 Tesla MRI unit (Siemens Medical Systems, Munich, Germany) at the El Nilein Medical Diagnostic Centre.

The same MRI protocol was performed on all participants, including mainly the following sequences: Axial and sagittal T_1-weighted sequences. The acquisition parameters were TR/TE = 650/10 ms, slice thickness = 4-5 mm and a matrix size of (256×256×128). Besides, Axial and sagittal T_2-weighted sequences TR/TE = 5000/110 ms, slice thickness = 4-5 mm and a matrix size of (256×256,128) were acquired: axial fluid attenuation inversion recovery (FLAIR: TR/TE/TI = 5000/110/2000 ms, slice thickness = 4-5 mm and a matrix size of (256×256,128) and axial diffusion-weighted image (DWI isotropic: TR/TE = 4500/110 ms and a matrix size of (256×256,128).

Radiological reporting:

The brain MRI images were evaluated by three radiology radiologists, each with at least 5 years' experience. The images were evaluated on the same computer. We used a picture archiving and communication system (PACS) and also using CD, and reported the pathologies, congenital anomalies, and anatomical variations, all of which could be detected during the interpretation of the images.

The Tornwaldt cyst and polyps were diagnosed when they obtained signal intensity was decreased on T_1- weighted images and increased on T_2-weighted images. The mucosal thickening in paranasal sinuses was diagnosed when they obtained signal intensity was decreased and increased on T_1- and T_2-weighted images respectively. This appearance because the mucosal disease usually has high water content.

Multiple sclerosis (MS) was identified as ovoid multiple lesions of isointensity and hypointensity on T_1-weighted images, and hyperintensity on T_2-weighted images; it also had a high-intensity on FLAIR.

Furthermore, Chiari malformations diagnosed when cerebellar tonsils displaced into the upper cervical canal through the foramen magnum.

Clinical importance reporting:

The distribution of clinical importance of incidental findings in our study mainly based on the 10th Revision of the International Statistical Classification of Diseases, Injuries and causes of death (ICD-10): (a) neoplasm, (b) diseases of the genitourinary and digestive system, (c) mental and behavioral disorders, diseases of the nervous system and diseases of the senses, diseases of the circulatory system and endocrine, nutritional and metabolic diseases, (d) diseases of the respiratory system, (e) diseases of the

musculoskeletal system and connective tissue and (f) no specification (categories b–f do not include neoplasms); location of the incidental finding: (a) unspecified location (findings out with the organ under study without a specific localization; for example, extra-urinary findings), (b) abdomen, (c) musculoskeletal system, skin and head-neck, and (d) chest and breast (WHO 2018).

Statistical analysis:

Descriptive statistics were calculated for incidental findings brain MRI analyzes using SPSS software (version 20; SPSS Inc, San Francisco, IL). The frequencies of incidental pathological findings and congenital anomalies/anatomic variations were expressed as the number of cases/corresponding percentages.

RESULTS AND DISCUSSION

For the 60 subjects (37 male, 23 female) included in the study mean age of the study population was 36.3 years (range, 18 to 60 years). The frequencies and percentages of incidental findings presented during the brain MRI scans were 6 (10%) (Table 1). Also, this table demonstrates the frequencies and percentages of each incidental finding that was recorded. The incidence percentage of incidental findings based on age groups were 16.7%, 66.6% and 16.7% for age ranges 1–20 years, 21–40 years and 41–≥60 years (Figure 1). Table 2 presents the incidence of incidental findings, according to gender, where IFs were frequently presented in males groups rather than female groups.

Table 1: The distribution of incidental findings on 60 brain MRI examinations.

Incidental findings	Patient's n (%)
Chiari I malformations	1 (1.7)
Multiple sclerosis	1 (1.7)
Polyps \ retention	2 (3.2)
Mucosal thickening in paranasal sinuses	1 (1.7)
Tornwaldt cyst	1 (1.7)
Total	**6 (10%)**

In this study, 60 consecutive subjects (23 females and 37 males with a mean age of 36 years; were conducted by evaluating a total of 60 MRI examinations of the brain, the subjects who gave any information of a previously known pathology were excluded. In this study; incidental findings (IFs) were classified as pathological findings and congenital anomalies/anatomical variations (Gutknecht, 1992). The congenital anomaly was defined as an abnormal physical condition resulting from defective genes or developmental deficiencies, whereas anatomical variation was defined as marked difference or deviation from the normal or recognized form, function, or structure (Dilli et al., 2014). In this study, of 60 subjects examined, a total of 6 (10%) was found to have IFs on MRI scans of the brain as shown in (Table 1). Some of these findings were not clinically significant because they were not related to the illness or causes that prompted the diagnostic imaging test in the first place, while other findings were important and their early detection plays a crucial role in associated treatment and prevention strategies, potentially decreasing morbidity and mortality rates.

This finding of an incidence of 10% of MR brain imaging scans is lower in the study that recently reported (Orme et al., 2010), in which an IFs of any kind were found in 39.8% of 1055 MRI brain examinations. However, the prevalence rate of potentially clinically relevant incidental brain abnormalities in this study is lower than that reported previously by Haberg et al. (2016) in a similar age group of healthy volunteers 29% versus 10% in this study. This difference in incidence rates could be to the small sample size when compared to other studies.

Figure 1 presents the incidence of IFs according to age group, where IFs were frequently presented in the age group of 21–40 years rather than other age groups, these results are quite consistent with a study done by Zidan et al. 2019 and Joori (2003). Also, this study showed the IFs more prevalent in males than females, (male to female ratio: 4:2) (Table 2). Chiari malformations are a group of defects associated with congenital caudal 'displacement' of the cerebellum and brainstem (Ayla, 2020). The prevalence of Chiari malformation in this study population was 1.7% (n=1). Such findings could be compared to a retrospective study of healthy volunteers that reviewed the findings obtained during an MRI scan of the brain, where the incidence of Chiari malformation was 1% (n=1) (Reneman et al., 2012). In addition, another study carried out by Zoe et al. (2009) found that the incidence rate for Chiari malformation was (0.5%) among 15,559 examined volunteers.

One case (1.7%) of Multiple sclerosis was registered as IF (Table 1)

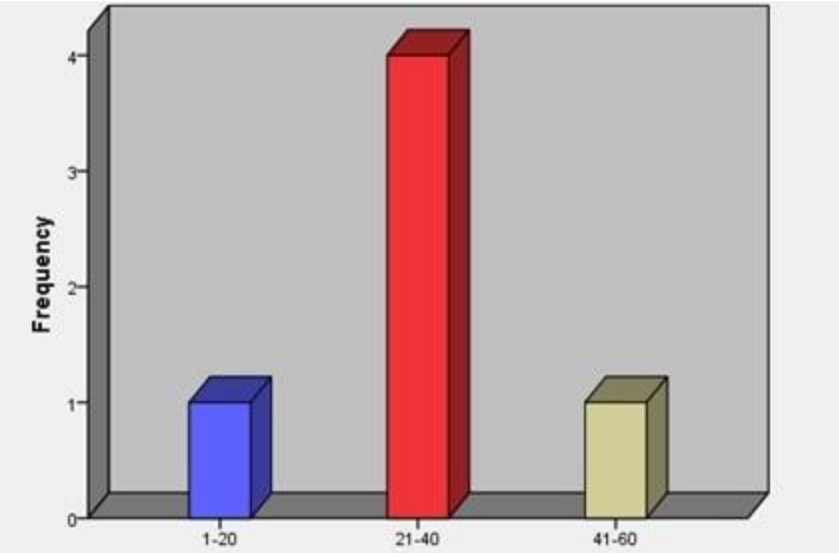

Figure 1: Frequencies distribution of brain incidental findings in different age groups.

Table 2: Distribution of brain incidental finding in both genders.

Incidental findings	Male n (%)	Female n (%)
Chiari I malformations	1	0
Multiple sclerosis	1	0
Polyps \ retention	0	2
Mucosal thickening in the paranasal sinuses	1	0
Tornwaldt cyst	1	0
Total	**4 (66.6%)**	**2 (33.4%)**

Table 3: Distribution of incidental findings, according to clinical importance on 60 brain MRI examinations.

Major importance		Moderate importance		Minor importance	
Incidental findings	**Patient's n (%)**	**Incidental findings**	**Patient's n (%)**	**Incidental findings**	**Patient's n (%)**
Multiple sclerosis	1 (1.7%)	Chiari I Malformation	1 (1.7%)	Mucosal thickening in the paranasal sinuses	1 (1.7%)
-	-	-	-	Polyp/Retention cyst	2 (3.2%)
-	-	-	-	Tornwaldt cyst	1 (1.7%)
Total	**1 (1.7%)**		**1 (1.7%)**		**4 (6.67%)**

However, multiple sclerosis, thought importance from a clinical point of view (Table 3) is very important because it has future consequences. The incidence of Tornwaldt cyst in brain MRI scans in this study group was 1.7 % (n=1) (Table 1).

The variation in incidence rate could be due to differences in sample size. Retention cysts/polyps in paranasal sinuses are common incidental finding at radiographic examinations and are reported internationally to occur in between 1.4% to 9.6% of the general population (Rodrigues et al., 2009). In the literature, retention cysts/polyps have only been reported in the maxillary sinuses. Our study shows that mucosal thickening, polyps, and retention cysts in the paranasal sinuses are frequently incidental findings on MRIs of the head in the general population (3.2%) (Table 1), which lower to the incidence rate of 22% reported by Harar (2007).

When further exploring incidental findings in paranasal sinuses, known as paranasal sinuses

mucosal thickening. In the study conducted by Reneman (Reneman et al., 2012), the incidence of paranasal sinuses mucosal thickening was 6.1%, while the incidence of paranasal sinuses mucosal thickening in this study was 1.7% (n=1). This difference might be due to the fact that the sample size in this study was smaller than the population they investigated.

Regarding clinical importance, some of these findings were not significant clinically, while other findings were important and early detection of them may lead to decrease morbidity and mortality rates.

In this study shown that incidental findings of minor importance were more likely in subject with the initial diagnosis of cysts, mucosal thickening (Tables 3).The role of the radiologist is crucial in deciding whether an image feature is normal or a potentially important diagnostic discovery. Nevertheless, with a different perspective, the incidental finding is also a problem for clinicians, and the collaboration between radiographic technologists, radiologists and clinicians is essential to deal with these abnormalities during the MRI scans (Gutknecht, 1992). However, to the best of our knowledge, this is the first large study that calculates the prevalence and clinical importance of IFs and congenital anomalies or anatomical differences during MRI scans in the Sudanese population, which thus signifies the importance of this study.

CONCLUSION

In conclusion, incidental findings are common in the MRI images of the brain. The implementation of PACS has resulted in increased detection of these incidental abnormalities due to the availability of uncropped and localize images for reporting. These incidental findings may be more significant than the problems being evaluated and can have a significant impact on patient management and medicolegal implications to the radiologist.

CONFLICT OF INTEREST

The authors have declared that the present study was performed in the absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Author contributed in all parts of the paper.

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