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Incidental extraspinal findings in the lumbar spine during magnetic resonance imaging of intervertebral discs

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Abstract

Purpose: To calculate the frequencies of incidental extraspinal findings and incidentally detected congenital anomalies or anatomical differences in the lumbar spine on magnetic resonance imaging (MRI) scans of intervertebral discs.

Materials and methods: A total of 379 lumbar spine MRI cases were prospectively investigated in the period spanning from August 2016 to January 2018. Both 1.5 and 0.35 Tesla MRI units (Toshiba and Siemens Medical Systems) were used to examine patients with clinically suspected intervertebral disc abnormalities at three MRI diagnostic centers in Khartoum State, Sudan.

Results: Of the 379(100%) patients, 90(23.7%) patients were presented with incidental findings. Among the incidental findings, 39(10.3%) were renal cysts, 10(2.6%) were retroverted uteri, 5(1.3%) were Nabothian cysts, 4(1.1%) were ovarian cysts, 10(2.6%) were uterine fibroids, 3(0.8%) were endometrial thickening, 11(2.9%) were indicative of hydronephrosis, 4(1.1%) were uncovered

prostatic enlargement, 2(0.5%) were atrophic kidney, and 1(0.3%) each was of an ectopic kidney and bladder wall thickening, respectively.

Conclusions: A high percentage of extraspinal pathological findings were detected during MRI lumbar spine scans of intervertebral discs. Thus, it is important to be aware of the high percentage of patients who undergo further evaluation given the presence of unexpected findings, but for whom clinical confirmation of these abnormalities is not obtained.

Keyword: Medical imaging

1. Introduction

Incidental extraspinal findings (IESFs) on imaging are unexpected asymptomatic abnormalities that differ from expected pathologies, and are typically found during radiological examinations. Currently, advances in digital evaluation of radiological imaging have improved the detection limits of incidental lesions [1]. The detection of such findings poses various practical and ethical issues related to clinical management. For instance, magnetic resonance imaging (MRI) of the lumbar spine employs, signal saturation bands that are used in standard imaging protocols to reduce the number and severity of artifacts; however, incidental findings may include a wide range of abdominal and pelvic organs and the diseases encountered may be extremely vary [2].

We chose to investigate lumbar imaging in this report given that back pain is one of the most well-known medical issues in developed countries [3, 4, 5]. MRI is frequently preferred as it provides multiplanar, non-ionizing imaging of soft tissues, and it has become the most desirable imaging modality since it can be used to evaluate extraspinal regions [6].

Several studies have reviewed the frequency of IESFs, as well as the associated legal issues and costs that are dependent on the type and depth of the investigation being performed [7, 8, 9, 10]. Lee et al. [7] reported that as many as 4.6% of IESFs are presented on lumbar CT; such IESFs include (renal masses, aortic aneurysms, and lymphadenopathies). According to this result, IESFs (>95%) are of minimal clinical significance; however, careful observation of anatomic structures outside the region of interest initiates chances for the early detection of potentially life-threatening conditions [11]. Conversely, Quattrocchi et al. [2] were the first to use a modified CT colonography reporting and data system (C-RADS) to report a wide variety of IESFs found during MRI examinations of the lumbar spine. Their study demonstrated a high incidence of IESFs using the C-RADS system (68.6%). Further, one study suggested that localizer images may be useful in detecting IESFs [12]. However, nowadays, the utilization of lumbar MRI scans was expanded by 307% [13]. Concurrently, the rate of recognizing IESFs has also increased [4, 14]. By describing

these findings and making an accurate, conclusive diagnosis, radiologists may be in the position to prevent the need for unnecessary investigations. Conversely, not specifying these findings may be of clinical concern, as it can extremely influence the patient's life [15].

This study was designed with the aim of calculating the frequencies with which incidentally detected pathological extraspinal findings, congenital anomalies, and anatomical differences are detected on the MRI scans of the intervertebral discs of the lumbar spine. We wish to report the prevalence of these incidental findings and to accentuate their clinical significance too.

2. Materials and methods

2.1. Selection and description of patients

After receiving approval from the local ethics committee of the Faculty of Radiology and Nuclear Medicine Sciences, the National Ribat University, Khartoum, Sudan, a group of 379 patients – 185(49%) males and 194(51%) females – with clinically suspected lumbar spine intervertebral disc diseases, presenting 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 of 17 months (August 2016 to January 2018). A waiver of informed consent was conceded as per institutional rules. The patients who gave any data of a formerly known extraspinal diagnosis were excluded. Incidental findings were categorized as pathological findings and congenital anomalies/anatomical differences.

2.2. MRI lumbar spine examination protocol

MRI lumbar spine scans were conducted on a 1.5 Tesla MRI machine (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 with a spine coil while the patient was in supine position. At the aforementioned medical centers, the lumbar spine MRI protocol included the following: i) sagittal T₁-weighted turbo spin echo (TSE) images (repetition time [TR]/echo time [TE]: 400/9 ms; slice thickness/interslice gap: 4/0.4 mm; number of excitations [NEX]: 3), ii) sagittal T₂-weighted TSE images (TR/TE: 3,000/120 ms; slice thickness/interslice gap: 4/0.4 mm; NEX: 3); and iii) axial T₂-weighted TSE images (TR/TE: 3,000/110 ms; slice thickness/interslice gap: 4/0.4 mm; NEX: 3). During the lumbar spine MRI scan, an evaluation was performed of the liver, kidneys, suprarenal glands, and surrounding lymphatic and vascular structures. Saturation bands to null peristalsis and aorta artifacts were placed over the anterior abdomen on sagittal imaging, which represented

an important factor for determining the type of data available on the anterior paravertebral structures. In addition, the three-plane localizer series images were reviewed during the imaging assessment. This is important as these images contain data that would otherwise not be visualized on diagnostic axial and sagittal imaging.

2.3. Analysis of lumbar spine MRI images

The obtained lumbar spine MRI images from the areas of study, were evaluated by the same radiologist with at least 5 years experience. The following pathologic conditions were recorded: i) renal cysts; ii) retroverted uterus; iii) Nabothian cyst; iv) ovarian cyst; v) uterine fibroid; vi) endometrial thickening; vii) hydronephrosis; viii) prostatic enlargement; ix) atrophic kidney; x) ectopic kidney; xi) and bladder wall thickening.

The Nabothian cyst, ovarian cyst, and renal cysts (Fig. 1), were diagnosed when the obtained signal intensity was decreased and increased on T₁- and T₂-weighted images respectively. A uterine fibroid was identified as a well-defined mass of low-signal intensity when compared to the myometrium on T₂-weighted images, and iso-intense to the myometrium on T₁-weighted images; it also had a high-intensity rim on T₂-weighted images (Fig. 2). In addition, a thickened endometrium appears to be homogeneously hyperintense on T₂-weighted images. Hydronephrosis was diagnosed on the basis of finding a dilatation of the renal collecting duct system (renal calyces and pelvis), as presented in Fig. 3.

Furthermore, a retroverted uterus is diagnosed when the body of the uterus is tilted backwards (Fig. 4). In cases of prostatic enlargement, the prostate appears to be enlarged in size and featuring a heterogeneous signal. It has an intact low-signal pseudocapsule in the periphery. Renal hyperplasia is diagnosed as a small kidney with smaller calyces featuring with normal residual parenchyma. An ectopic kidney

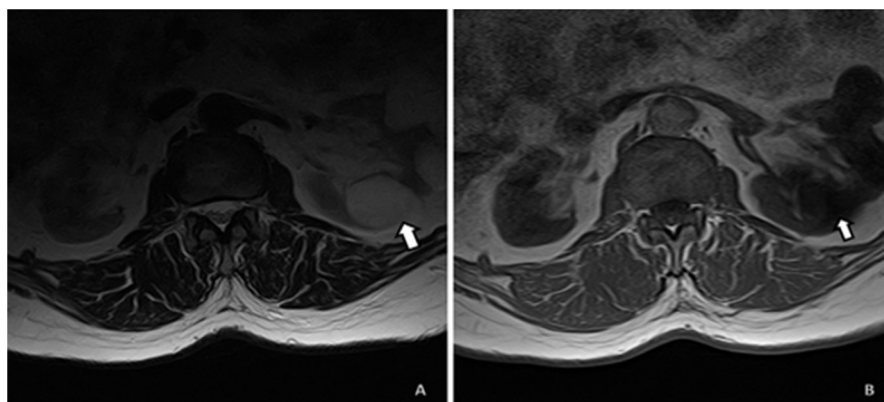


Fig. 1. Axial MRI shows a large left simple renal cyst that is hyperintense on T₂-weighted images (T₂; arrow in A) and hypointense on T₁-weighted images (T₁; arrow in B).

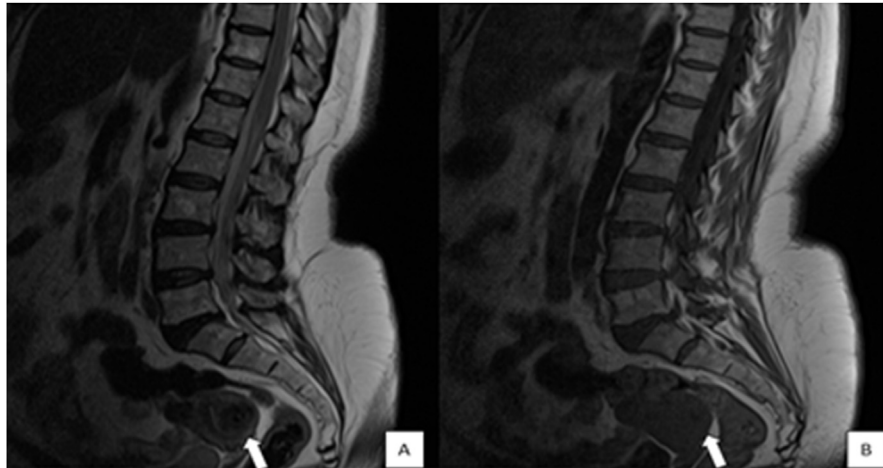


Fig. 2. Sagittal T₂-weighted image (A) and sagittal T₁-weighted image (B), showing a large uterine fibroid (arrows).

is diagnosed as normal-shaped kidney located within the bony pelvis (Fig. 5). Finally, in bladder wall thickening, the bladder wall does not appear to be distended on MRI, but the wall thickness appears to be >6 mm.

2.4. Statistical analysis

All measurable data were initially summarized in a comparison table. Statistical analysis was performed using the Statistical Package for the Social Sciences version 20 for Windows (IBM Corporation, Armonk, NY, USA). IESFs, congenital anomalies, or anatomical differences that were parenthetically detected during MRI scans of the intervertebral discs of the lumbar spine were expressed as frequencies of cases and corresponding percentages (%).

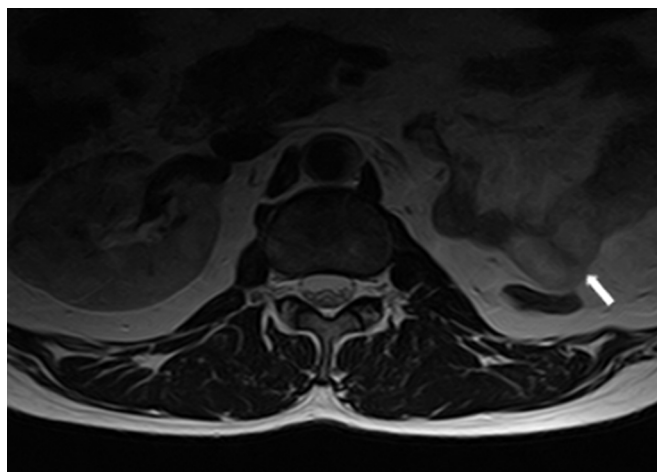


Fig. 3. Axial T₂-weighted MRI image showing the left kidney with hydronephrosis (arrow).

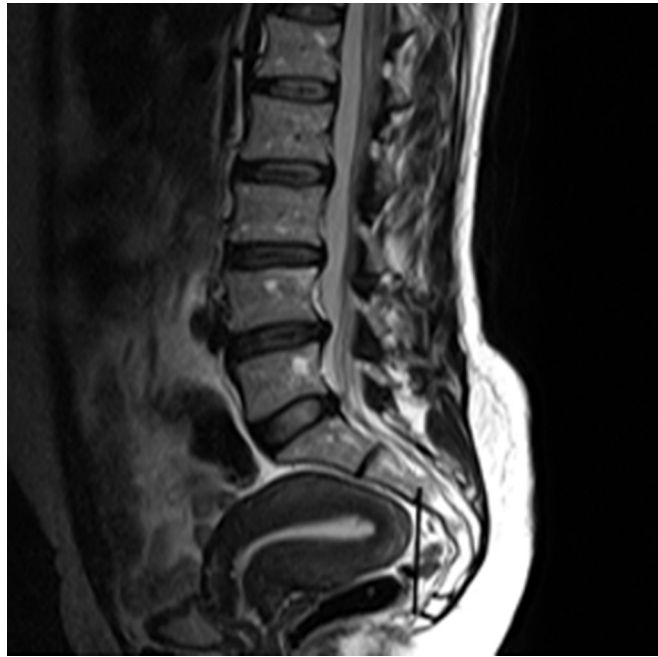


Fig. 4. MRI of the pelvis showing a retroverted uterus. The vertical line represents the posterior border of the lateral field passing through the sacral 2–sacral 3 (S2–S3) junction.

3. Results

In this prospective study, a total of 379 patients – 185(49%) males and 194(51%) females – were examined via lumbar spine MRI and presented with clinically suspected intervertebral disc diseases given the presence of low-back pain or sciatica symptoms. The common clinical features detected in these patients that were related to their complains were as follows: i) hip pain ($n = 20$; 5.3%); ii) burning or tingling

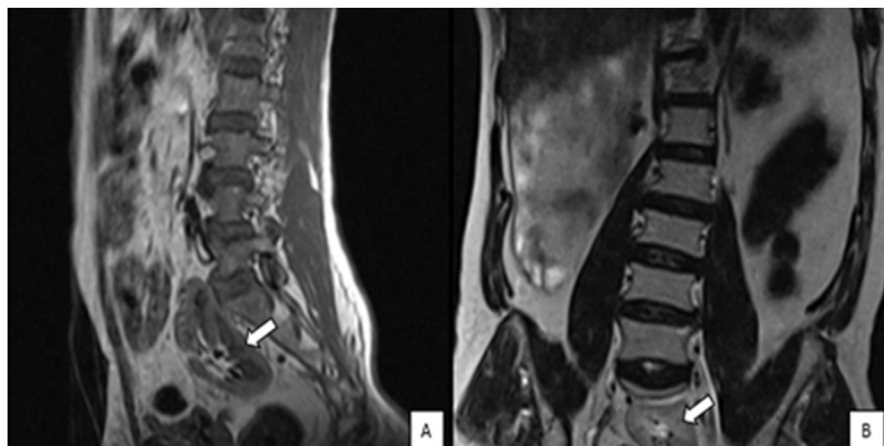


Fig. 5. An ectopic pelvic kidney on a sagittal T₁-weighted image (A) and coronal T₂-weighted image (B), both of which show the kidney in the pelvic region (arrows).

sensation down the leg (n = 175; 46.2%); iii) weakness, numbness, or difficulty moving the leg or foot (n = 210; 55.4%); iv) pain in the rear or leg that is worse when sitting (n = 113; 29.8%); and v) a shooting pain that makes it difficult to stand (n = 320; 84.4%).

The number and percentages of IESFs and congenital anomalies/anatomical differences presented during the lumbar spine MRI scans were 89(23.5%) and 1(0.3%), respectively (Table 1). The incidence percentage of IESFs based on age groups were 2%, 7.5%, 17.9%, 35.8%, 28.3%, and 8.5% for age ranges 1–15 years, 16–30 years, 31–45 years, 46–60 years, 61–75 years, and ≥ 76 years, respectively. In addition, the IESFs were most likely related to the kidneys (n = 53; 13.7%) (Figs. 1 and 3) and were more likely to affect males (n = 4; 1.1%) and females' (n = 32; 8.4%) internal genital organs (Figs. 2 and 4). Renal cysts (n = 39; 10.3%) were the most common IESFs across MRI scans of the lumbar spine (Table 1 and Fig. 1).

On MRI lumbar spine scans for female patients, uterine fibroids and a retroverted uterus were the most common IESFs, with incidence rates of 2.6% (n = 10) respectively (Table 1, Figs. 2 and 4). Prostatic enlargement was detected as an IESFs in a total of 4(1.1%) male patients on their MRI scans of the lumbar spine (Table 1). Only one case of ectopic kidney (0.3%) was registered as an incidental extraspinal congenital anomaly/anatomical variation as shown in Fig. 5.

Although we identified these IESFs, congenital anomalies, and anatomical variations, further examinations and follow ups were not performed during this study; consequently, we did not obtain information on the outcome of these patients.

Table 1. Distribution of IESFs and congenital anomalies/anatomical variations in the study sample according to location and type.

IESFs location	IESFs type	Frequency (n); percentage (%)
Urinary system	Renal cyst	39(10.3%)
	Hydronephrosis	11(2.9%)
	Atrophic kidney	2(0.5%)
	Urinary bladder wall thickening	1(0.3%)
Female reproductive system	Uterine fibroid	10(2.6%)
	Retroverted uterus	10(2.6%)
	Nabothian cyst	5(1.3%)
	Ovarian cyst	4(1.1%)
	Endometrial thickening	3(0.8%)
Male reproductive system	Prostatic enlargement	4(1.1%)
Location of congenital anomalies/ anatomical variations	Congenital anomalies/ anatomical variations type	Frequency (n); percentage (%)
Urinary system	Ectopic kidney	1(0.3%)

4. Discussion

In the current study, of the 379 patients examined, a total of 90(23.7%) were found to have incidental findings on MRI scans of the lumbar spine, 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.

IESFs and congenital anomalies are more habitually found on MRI scans of the lumbar spine because the abdominal internal structures are situated in this area [\[16\]](#). In six different researches implemented to evaluate the use of MRI scans of the lumbar spine, the rates of incidental findings were described to be 8.1%, 8.3%, 16 %, 16.37%, 18.8%, and 19%, respectively [\[1, 2, 4, 15, 16, 17, 18, 19, 20, 21\]](#). In the present study, this rate was 23.7%, which is higher than the percentages reported in theses previous studies. This is because of the incorporation of all findings related to internal male and female genitalia, such as prostatic enlargement, Nabothian cyst, ovarian cyst, and endometrial thickening.

In the current study, we noticed that patients aged 46–60 years presented with higher incidence rates of IESFs (35.8%) when compared with the other age groups. This age-specific effect for IESFs is consistent with the results of Joori et al. [\[20\]](#) and Zidan et al. [\[22\]](#).

To our knowledge, renal cysts are benign clinical conditions may occur well within the kidney or on its surface. Simple renal cysts usually occur in normal kidneys and become more prevalent as people age. They usually have no symptoms and rarely need treatment. Our results demonstrate that renal cysts are the most frequent reported IESFs (10.3%), as presented in [Table 1](#). The majority of these cysts were solitary ($n = 27$; 69.2%) and a small percentage were multiple renal cysts. Furthermore, 89.7% of patients over 41 years presented with renal cyst; the increasing incidence of renal cysts in older people may be due to the manifestation of progressive nephrons loss that occurs with age. In addition, the incidence of renal cyst was more prevalent in men (male to female ratio: 3:1). Our findings on the prevalence of renal cysts were compatible with the results of Joori et al. [\[20\]](#) and Sobhan et al. [\[21\]](#), where they found incidence rates of renal cysts of 7.2% and 2.9%, respectively. Furter, Carrim and Murchison [\[23\]](#) and Chang et al. [\[24\]](#) reported on the incidence rates for renal cysts and found that these cysts were more prevalent in men than women, with a male to female ratios of 4:1 and 8:2 for each study, respectively.

The incidence rate of a retroverted uterus in the current study was 2.6% ([Table 1](#)), which is higher than the rate (1.8%) reported by Dilli et al. [\[17\]](#). This might be due to the fact that our sample size is smaller than the population they investigated.

Further, Nabothian cysts are common cysts of the uterine cervix, with no particular intervention required. It is quite rare for these cysts to reach sizes >4 cm, and determining whether these lesions are cysts or adenoma malignum remains a diagnostic challenge [25]. The incidence of Nabothian cysts in our study was 1.3% (Table 1), being more predominant in the younger population. In separate studies carried out using MRI of the lumbar spine, the incidences of Nabothian cysts were noted to be 1.3% ($n = 850$) and 0.59% ($n = 507$) [17,20].

When further exploring incidental findings in females, many have benign, non-cancerous growths known as fibroids (myomas). Most fibroids are small and do not cause any problems. In the studies conducted by Dilli et al. [17] and Tuncel et al. [19], the incidence of uterine myomas were 3% and 3.3%, respectively, while the incidence of uterine fibroids in our study was 2.6% (Table 1). The difference in incidence rates could be due to smaller sample size when compared to the other studies. Endometrial thickening is the abnormal thickening of the uterine lining that results from an increase in the number of endometrial glands. This disorder often affects young females who are just beginning to menstruate, as well as females approaching menopause [26]. The incidence of endometrial thickening in our study was 0.8% ($n = 3$) as presented in Table 1. Such findings could be compared to a retrospective study of 507 patients that reviewed the findings obtained during an MRI scan of the spine, where the incidence of endometrial thickening was 0.6% ($n = 3$) [20]. In addition, another study carried out by Tuncel et al. [19] found that the incidence rate for endometrial thickening was (0.47%) among 1278 examined patients.

The incidence of hydronephrosis in our study group was (2.9%) (Table 1), which is in contrast to the rates reported by Dilli et al. [17] and Tuncel et al. [19] 0.7% and 0.2%, respectively. When exploring the pathologies that affect men, an enlarged prostate means that the gland has grown bigger. Prostate enlargement happens to almost all men as they get older [27]. In this study the prevalence of prostate enlargement was 1.1% ($n = 4$) (Table 1). Atrophic kidney is identified as a small kidney where there is an essentially normal residual parenchyma on MRI but smaller calyces [28]. The incidence of the atrophic kidney rate in our study was 1.9% (Table 1), which similar to the incidence rate of 1.1% reported by Dilli et al. [17]. When exploring the incidence of kidney pathologies, it was found that patients who underwent MRI of lumbar spine had atrophic kidney at an incidence rate of 0.23% [19], which is lower than reported rate. Further, when exploring bladder-related issues, the differential diagnosis for bladder wall thickening depended on whether the bladder was adequately distended. The bladder wall may be thickened if it is >3 mm when distended and >5 mm when not distended [29]. Regarding our results, bladder wall thickness was detected in 1 case (0.3%) (Table 1).

Only one case (0.3%) of ectopic kidney was registered as an incidental extraspinal congenital anomaly/anatomical variation as shown in Fig. 5. In addition, an ectopic

kidney may be asymptomatic and may function normally even though it is not in its usual position. In such cases, ectopic kidneys are often found incidentally during investigations for other reasons. However, an ectopic kidney, though benign from a clinical point of view, may have future consequences. It may be associated with other congenital anomalies involving the skeletal, genitourinary and cardiovascular systems [30]. Numerous associated anomalies of the female reproductive system may also be seen [31].

This study is limited by the heterogeneity of the population because of the randomized selection process, which may influence the exactness of our outcomes and lessen the intensity of our conclusions, since it makes other age groups have a lower factual validity if applied in future investigations. Other limitations of this study were: i) there was no second observer for any of the imaging techniques used, meaning that the error/detection rate of inter- and intraobserver variability cannot be calculated; ii) there was a relatively small cohort sample size; iii) the selection criterion may have omitted patients with known congenital anomalies, pathologies, or normal variants; and iv) the authors were not able to include follow-up examinations to further confirm the clinical importance of most of the IESFs congenital anomalies or anatomical differences that were parenthetically detected during the lumbar spine MRI scans. However, to the best of our knowledge, this is the first large cohort study that evaluates the prevalence and clinical importance of IESFs and congenital anomalies or anatomical differences during lumbar spine MRI scans in Sudanese patients, which thus signifies the importance of this study.

5. Conclusion

In conclusion, clinical judgement needs to be exercised when reporting IESFs, congenital anomalies or anatomical variations of the lumbar spine following MRI scans of this region, and guidelines are required to determine when further investigations are necessitated. In addition, IESFs, congenital anomalies, or anatomical variations are common in routine lumbar MRI scans, although their clinical significance is uncommon. Clinically significant IESFs are occasionally omitted from formal clinical reports. Along these lines, a methodical assessment of spinal and non-spinal structures in lumbar MR images may be of significance in clinical practice, as these images can have significant impacts on patient management and on the medicolegal ramifications to the radiologist.

Declarations

Author contribution statement

Mogahid M. A. Zidan, Ikhlas A. Hassan, Abdelrahman M. Elnour, Wadah M. Ali, Mustafa Z. Mahmoud, Batil Alonazi, Abbas Khalid, Salah Ali: Conceived and

designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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