بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

University Of Sudan For Sciences And Technology

Collage of Graduate Studies

Incidental Findings in Spinal Magnetic Resonance Imaging (MRI) Examinations

النتائج العرضية في فحوصات الرنين المغناطيسي للعمود الفقري

AThesis Submitted for fulfillmentof the Requirement For MSC in Diagnostic Radiological Imaging

BY

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الآيـة

قال تعالى:

(أمن هو قانت آناء الليل ساجداً و قائماً يحذر الآخرة و يرجو رحمة ربه قل هل يستوي الذين يعلمون و الذين لا يعلمون إنما يتذكر أولوا الألباب).

سوره الزمر

الآية (9)

Dedication

TO MY PARENTS

TO MY BROTHERS

TO MY TEATCHERS

TO MY COLLEAGUES

TO ALL MY FRIENDS

Acknowledgment

First, my acknowledgement and great fullness at the beginning and end to ALLAH.

Second, my special gratitude to my supervisorDrAsma Ibrahimwho devoted her/his time and generously gave her/his knowledge and experience to me without limits.

Finally, I am very grateful to my parents, for their support and prayers during this study. Also I am grateful to all my senior staff and colleagues, to whom I owe much , for their sincere feeling and help Thanks to you all for all your support.

Abstract

This was descriptive study has been conducted in Khartoum State Almoalem medical city in MRI department. To calculate the prevalence and clinical importance of incidental findings on spinal magnetic resonance imaging examinations . This study was done in Khartoum States from the period of February 2019 to August 2020 , for 50 patients (23 males and 27 females) , their age ranged between 30 - 90 years old .

The percentage of incidental pathological findings variations on cervical spine MRI the percentage was 5.08%, thyroid nodules being the most common incidental findings. On thoracic spine MRI the percentage was 1.81%, renal cysts were demonstrated as common incidental findings during the thoracic spine MRI, with a percentage of 0.45%. On lumbar spine MRI examinations the percentage was10.19%.

The results of study found MRI spine scan for female patients ovarian cyst(14.8 %), were the most common incidental finding. While prostatic enlargement (17.4%) was detected most common incidental finding in male patients on MRI spine.The study recommended additional studies should be done with large sample size to improve statistical information and more accurate results.

MRI Examinations paying attention to incidentally detected pathological findings and congenital anomalies/anatomical variations is very important due to the fact that they can alter the treatment of the patient or affect the patient’s life.

ملخص الدراسة

أجريت هذه الدراسة الوصفية بمدينة المعلم الطبية بقسم الرنين المغناطيسي. لحساب الانتشار والأهمية السريرية للنتائج العرضية في فحوصات التصوير بالرنين المغناطيسي للعمود الفقري. أجريت هذه الدراسة بولاية الخرطوم في الفترة من فبراير 2019 إلى أغسطس 2020 ، على 50 مريضاً (23 ذكور و 27 إناث) ، تراوحت أعمارهم بين 30 - 90 سنة.

أظهرت نتائج هذة الدراسة أن النسبة المئوية للنتائج العرضية كانت 18.9% وكانت نسبة النتائج العرضية لفحوصات الفقرات العنقية 5.08% ,وقدكانت عقيدات القدة الدرقيةهي الأكثر أنتشارا ضمن نتائج فحوصات الفقرات العنقية.

وفي فحوصات الرنين المغنطيسي للفقرات الصدرية كانت نسبة النتائج العرضية1.81 % .

وقد اوضحت النتائج أن الأكياس الكلوية كانت الأكثرشيوعاً ضمن نتائج فحص الفقرات الصدرية بنسبة 0.45

وفحوصات الرنين المغنطيسي للفقرات القطنية نسبة النتائج العرضية 10.19 %.

وجدت الدراسة أن فحص العمود الفقري بالرنين المغناطيسي (MRI) لمريضات كيس المبيض (14.8 ٪) ، كان أكثر النتائج العرضية شيوعًا. بينما تم الكشف عن تضخم البروستاتا (17.4٪) أكثر النتائج العرضية شيوعًا في المرضى الذكور على العمود الفقري للتصوير بالرنين المغناطيسي. أوصت الدراسة بإجراء دراسات إضافية بحجم عينة كبير لتحسين المعلومات الإحصائية ونتائج أكثر دقة.

ولخصت أن في فحوصات الرنين المغناطيسي الأنتباه إلي الأمراض والتشوهات الخلقية التشريحية والتي تظهر بالصدفة أمر مهم جداً.نظرآلإنها قد تحدث تغير في علاج المريض أوقد تؤثر علي حياته.

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List of Abbreviation

Abbreviation	Meaning
BGRE	Balanced Gradient Echo
CNR	Contrast to Noise Ratio
CSF	Cerebrospinal Fluid
ETL	Echo Train Length
FFE	Fast Field Echo
FST	Fast spin echo
FOV	Field of View
GRE	Gradient Echo
HASTE	Half Fourier Acquisition Single Shot Turbo Spin Echo
HCC	Hepatocellular Carcinoma
IF	Incidental Finding
IR	Inversion Recovery
MRI	Magnetic Resonance Image
MS	Multiple Sclerosis
RCC	Renal Cell Carcinoma
ROI	Region of Interest
RF	Radiofrequency
SPSS	Statistical Package for the Social Sciences
SE	Spin echo
STIR	Short TimeInversion Recovery
SNR	Single To Noise Ratio
TIA	Transient Ischemic Attack

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Chapter One

Introduction

Chapter One
Introduction

1.1: 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 physician and the patients. However it behaves physician to ensure that technology supplements but does not replace good clinic judgment(Wagner and Aron, 2012).

In fact, incidental findings are the findings that are obtained in an unrelated investigation but are of great clinically 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 and Aron, 2012).

There for, it vital that the radiologist is able to 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).

However , MRI examinations of the spine will inevitably show other organs near the spine like the thyroid in cervical spine exams, the lung in dorsal spine exams , the liver ,spleen ,aorta in dorsal and lumbar spine exams, the kidneys , uterus , ovaries in lumbosacral exam, and of course lymph node may be visible in any of the spine MRI examinations , so we amid at this study to search for incidental finding by carefully assessing any of the mentioned organs during spinal MRI examination and to evaluate the frequency of their detection in relation to age ,gender and region of examination and to try to study the advantage and disadvantage of their detection .

1.2. Problems of the study

The physician and radiologist dose not carefully observation of anatomical structure outside of the immediate region of interest and this can't creates opportunities for early detection of potentially life threatening conditions such as malignancies and aneurysms.

If There is an association between the early detection of the unsuspected finding (incidental finding) and the treatment of the disease.

1.3. Objectives of the study

1.3.1. General objective

The objective of this study to calculate the prevalence and clinical importance of incidental findingson spinal magnetic resonance imaging examinations.

1.3.2. Specific objectives

To determine the prevalence and types of the extra-spinal incidental findings on spine MRI examinations.

To determine the distributions of the incidental findings and types of incidental findings according to gender.

To determine the distributions of the incidental findings and types of incidental findings according age groups.

To determine the distributions of the incidental findings according to clinical importance.

1.4 Thesis outline

The flowing research will be consisting of five chapters:

- Chapter one will deal with introduction, problem of study, objectives and thesis out line
- Chapter two will highlights the literature review related to the current study and the theoretical view for the study.
- Chapter three will show the methodology.
- Chapter four will show the results.
- Chapter five will contain the discussion , conclusion and recommendations.

Chapter Two

Theoretical background and Literature review

Chapter Two

Theoretical background and Literature review

2.1 Theoretical background

2.1.1Anatomy

2.1.1.1Anatomy of spine

The vertebral column is a remarkable structure that supports the weight of the body, helps to maintain posture, and protects the delicate spinal cord and nerves. It is made up of 33 vertebrae, which can be separated into cervical, thoracic, lumbar, sacral, and coccygeal sections (Kelley and Petersen, 2007).

Vertebrae vary in size and shape from section to section, but a typical vertebra consists of two main parts: the body and the vertebral arch .The cylindric body is located anteriorly the size of the vertebral bodies progressively increases from the superior portion of the vertebral column to the inferior portion of the spine. Located posteriorly is the ringlike arch that attaches to the sides of the body, creating a space called the vertebral foramen. The succession of the vertebral foramina forms the vertebral canal, which contains and protects the spinal cord. The vertebral arch is formed by pedicles (2), laminae (2), spinous process (1), transverse processes (2), and superior (2) and inferior (2) articular processes

The two pedicles project from the body to meet with two laminae that continue posteriorly and medially to form a spinous process. The transverse processes project laterally from the approximate junction of the pedicle and lamina On the upper and lower surfaces of the pedicles is a concave surface termed the vertebral notch When the superior and inferior notches of adjacent vertebrae meet, they form intervertebral foramina, which allow for the transmission of spinal nerves (Kelley and Petersen, 2007).

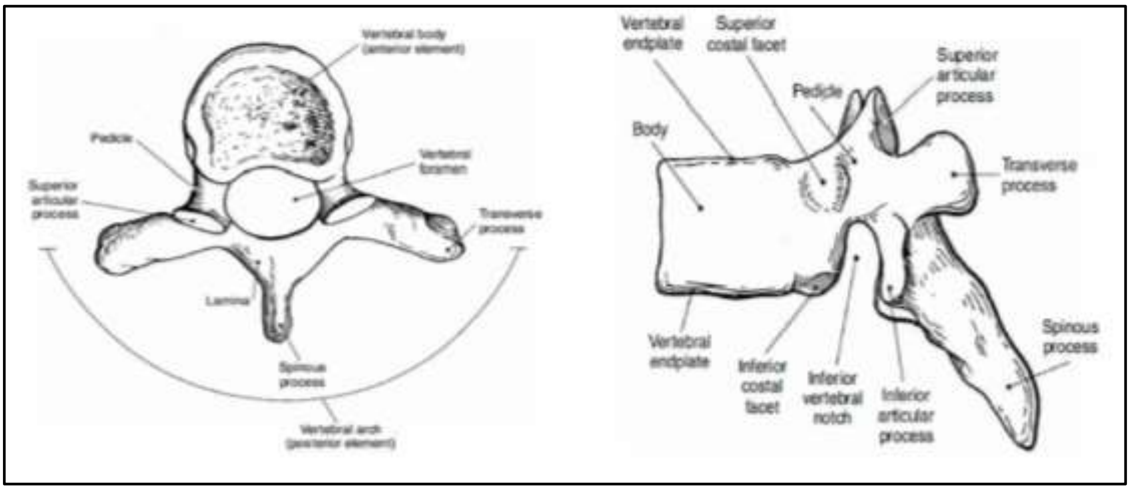


Figure 2.1: The anatomy of the vertebra (Kelley and Petersen, 2007).

2.1.1.1.2Cervical Vertebra

There are seven cervical vertebra that vary in size and shape to a large degree. Within the transverse process of each cervical vertebra is a transverse foramen. These foramina allow passage of the vertebral vessels as they ascend to and descend from the head. The first cervical vertebra is termed the atlas because it supports the head; its large superior articular processes articulate with the occipital condyles of the head to form the adantooccipital joint. The second cervical vertebra, the axis, has a large odontoid process (dens) that projects upward from the superior surface of the body.

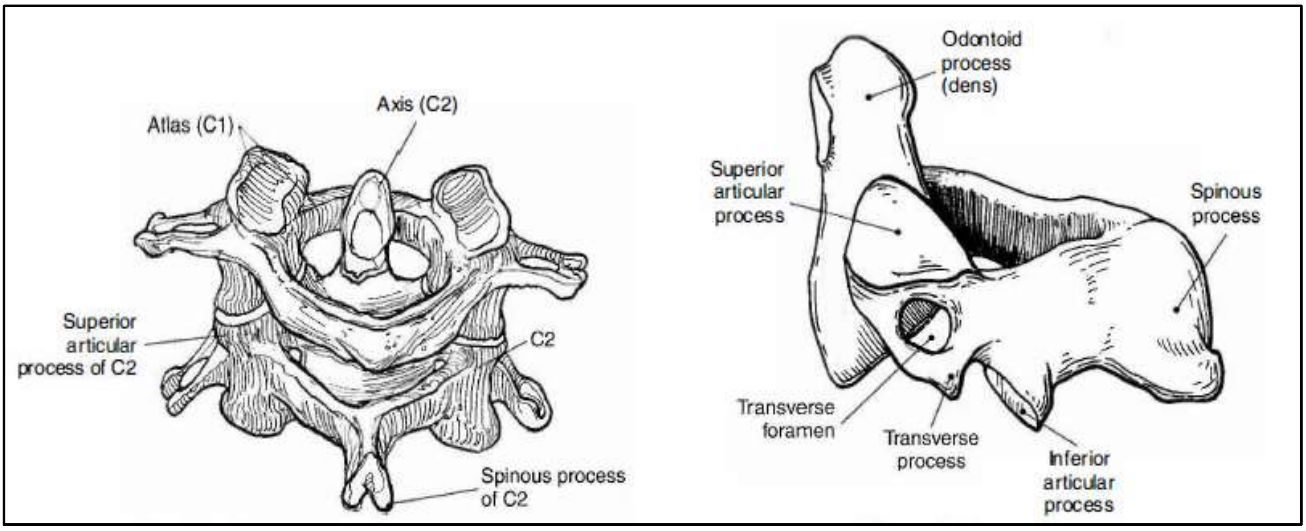


Figure2.2: The anatomy of the cervical vertebra (Kelley and Petersen, 2007).

2.1.1.1.2 Thoracic Vertebra

Twelve vertebra make up the thoracic
section. They have typical vertebral configurations except for their characteristic costal facets (demi facets), located on the body and transverse process, that articulate with the ribs. The head of the rib articulates with the vertebral bodies at the costovertebral joints, whereas the tubercle of the ribs articulates with the transverse processes at the costotransverse joints. The spinous processes of the thoracic vertebrae are typically long and slender, projecting inferiorly over the vertebral arches of the vertebrae below.

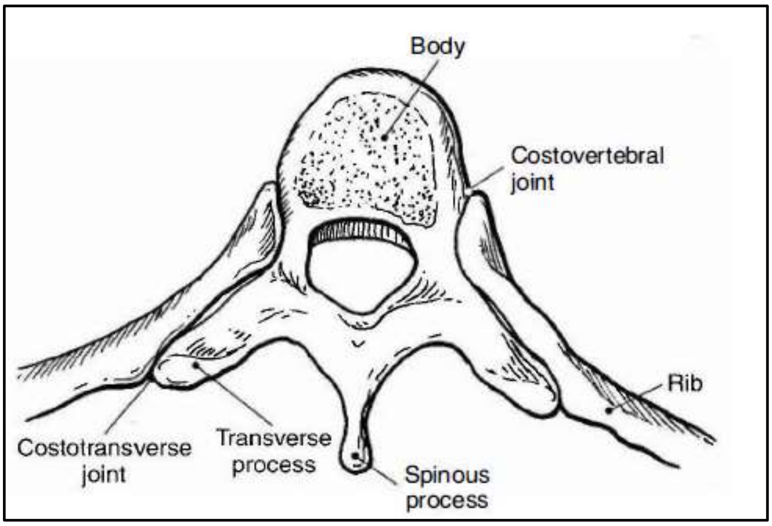


Figure2.3: The anatomy of the thoracic vertebra (Kelley and Petersen, 2007).

2.1.1.1.3 Lumbar Vertebra

The lumbar spine is formed by five vertebra. The vertebra are commonly referred to as L1 through L5. L1 is the most superior vertebra in the lumbar spine, and it abuts the thoracic spine, whereas L5 is the most inferior vertebra and abuts the sacral spine. The anterior or ventral element of each vertebra is called the vertebral body. The vertebral bodies of the middle and lower lumbar spine are more substantial in size to allow them to bear greater loading forces. Posterior, or dorsally, each vertebra has a bony arch that encircles the spinal canal. It is composed of two transverse processes, two sets of facet joints, two pedicles, two laminae, and one spinous process. The bony arch, also referred to as the posterior elements, is quite bulky. It provides the necessary support for upright posture. The non-compromised spinal canal has ample room for the cauda equina and for cerebrospinal fluid (CSF).

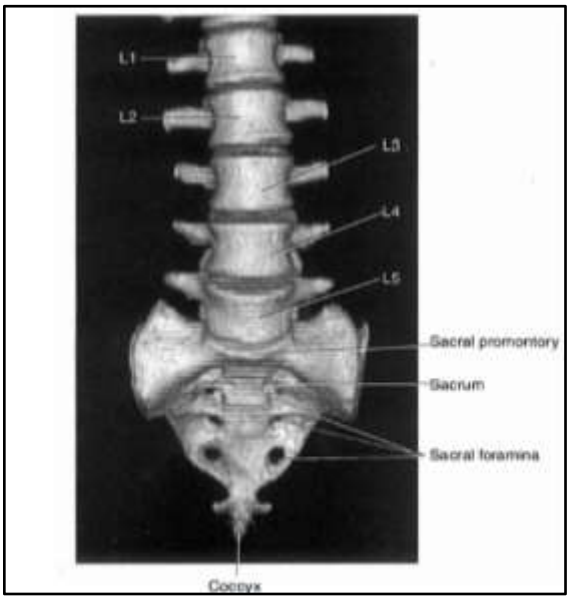


Figure 2.4: 3D View of lumber, scrum and coccyx (Kelley and Petersen, 2007).

2.1.1.1.4 Sacrum and Coccyx

The sacral section consists of five vertebra that fuse to form the sacrum. Their transverse processes combine to form the lateral masses (ala), which articulate with the pelvic bones at the sacroiliac joints. Located within the lateral masses are the sacral foramina that allow for the passage of nerves.

Coccyx, which consists of three to five small fused bony segments Superior projections off of the first coccygeal segment, called cornu, have ligamentous attachments to the sacral cornu that provide additional stability to the articulation between the sacrum and coccyx. The coccyx represents the most inferior portion of the vertebral column.

2.1.1.1.5 Intervertebral Disc

Each Intervertebral disc in the lumbar spine provides support and facilitates movement while resisting excessive movement. The disc permits slight anterior flexion, posterior extension, lateral flexion, rotation, and some circumduction (Shankar et al., 2009).

The disc is the largest a vascular structure in the body. It is composed of the nucleus pulposus and the annulus fibrosus. The fibers of the annulus fibrosus are concentric, like the layers of a radial tire. The concentric arrangement provides great resistance and strength. Each disc is bonded to the vertebral body below and above it by a thin cartilaginous plate, referred to as the endplate, The endplate resists herniation of the disc into the vertebral body and gives the disc its shape.

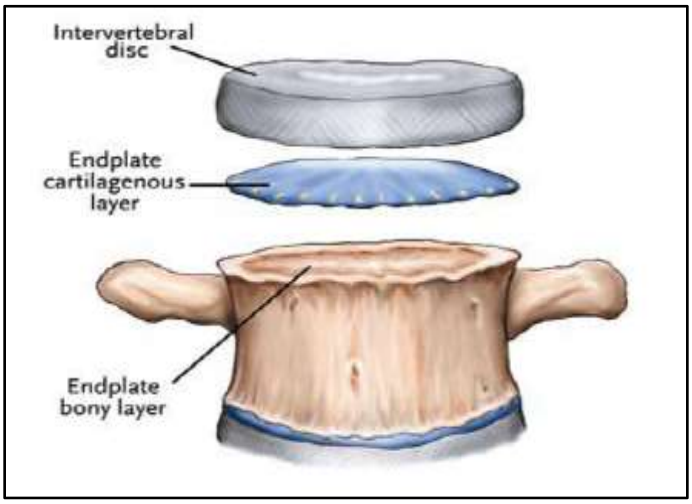


Figure 2.5: Intervertebral disc (Hicks et al., 2009).

2.1.1.1.6.Curvatures of the vertebral column

In the normal adult there are four curvatures in the vertebral column in an anteroposterior plane. These serve to align the head with a vertical line through the pelvis. In the thoracic and sacral regions, these curves are oriented concave anterior and each is known as a kyphosis. In the lumbar and cervical regions the curves are convex anterior and each is known as a lordosis.These latter normal curvatures develop during childhood in association with lifting the head and assuming upright sitting and they are thus known as secondary curvatures. The thoracic and sacral curvatures are the same in adult as they are in fetal life and they are known as primary curvatures (Ryan et al., 2004).

Figure 2.6: Lateral view of the spine (Kelley and Petersen, 2007).

2.1.1.1.7 Ligaments of the Vertebral column

The ligaments are strong fibrous bands that hold the vertebrae together, stabilize the spine, and protect the discs. The three major ligaments of the spine are the ligamentum flavum, anterior longitudinal ligament (ALL), and posterior longitudinal ligament (PLL) (**Fig 2.7**).The ALL and PLL are continuous bands that run from the top to the bottom of the spinal column along the vertebral bodies. They prevent excessive movement of the vertebral bones. The ligamentum flavum attaches between the lamina of each vertebra (Hines, 2016b).

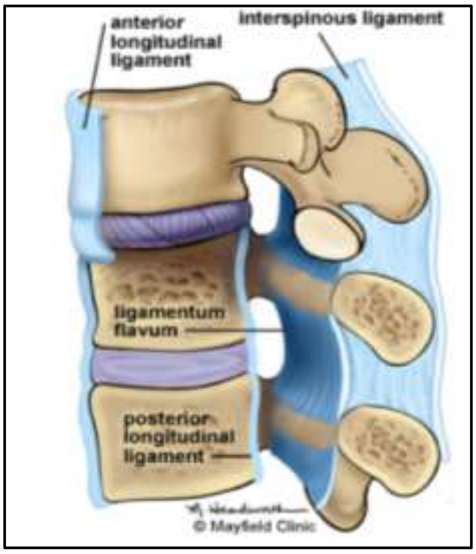


Figure 2.7: The ligament of the spine(Hines, 2016b).

2.1.1.1.8 Spinal cord

The spinal cord is about 18 inches long and is the thickness of your thumb. It runs within the protective spinal canal from the brainstem to the 1st lumbar vertebra. At the end of the spinal cord, the cord fibers separate into the cauda equina and continue down through the spinal canal to your tailbone before branching off to your legs and feet (Hines, 2016b).

2.1.2 Physiology

2.1.2 .1Physiology of the Spine

Vertebrae are the 33 individual bones that interlock with each other to form the spinal column. The vertebrae are numbered and divided into regions: cervical, thoracic, lumbar, sacrum, and coccyx.. Only the top 24 bones are moveable; the vertebrae of the sacrum and coccyx are fused. The vertebrae in each region have unique features that help them perform their main functions.

2.1.2.1.1 Cervical (neck)

The main function of the cervical spine is to support the weight of the head (about 10 pounds). The seven cervical vertebrae are numbered C1 to C7. The neck has the greatest range of motion because of two specialized vertebrae that connect to the skull. The first vertebra (C1) is the ring-shaped atlas that connects directly to the skull. This joint allows for the nodding or "yes" motion of the head. The second vertebra (C2) is the peg-shaped axis, which has a projection called the odontoid, that the atlas pivots around. This joint allows for the side-to-side or "no" motion of the head (Hines, 2016a).

2.1.2.1.2 Thoracic (mid back)

The main function of the thoracic spine is to hold the rib cage and protect the heart and lungs. The twelve thoracic vertebrae are numbered T1 to T12. The range of motion in the thoracic spine is limited(Hines, 2016a).

2.1.2.1.3 Lumbar (low back)

The main function of the lumbar spine is to bear the weight of the body. The five lumbar vertebrae are numbered L1 to L5. These vertebrae are much larger in size to absorb the stress of lifting and carrying heavy objects (Hines, 2016a).

2.1.2.1.4 Sacrum

The main function of the sacrum is to connect the spine to the hip bones (iliac). There are five sacral vertebrae, which are fused together. Together with the iliac bones, they form a ring called the pelvic girdle(Hines, 2016a).

2.1.2.1.5 Coccyx region

the four fused bones of the coccyx or tailbone provide attachment for ligaments and muscles of the pelvic floor(Hines, 2016a).

2.1.2.1.6 Spinal cord

The vertebral column surrounds the spinal cord. It travels within the spinalcanal, a central hole within each vertebra. The spinal cord is part of thecentral nervous system that supplies nerves and receives information fromthe peripheral nervous system within the body. The spinal cord consistsofgrey matter and white matter and a central cavity. Adjacent to each vertebraemerge spinal nerves. The spinal nervous provide sympathetic nervoussupply to the body, with nerves emerging forming the sympathetic trunk andthe splanchnic nerves.The spinal canal follows the different curves of thecolumn; it is large and triangular in those parts of the column which enjoythe greatest freedom of movement, such as the cervical and lumbar regions;and is small and rounded in the thoracic region, where motion is morelimited. The spinal cord terminates in the conus medullaris and caudaequine(Ross and Wilson, 2007).

2.1.3 Pathology

2.1.3.1 Pathology of the spine

2.1.3.1.1 Degenerative Cervical Spine Disorders

Cervical degenerative disease is common and it is often difficult to distinguish pathological changes from the normal aging process. Neck, shoulder, and brachial pain is frequently encountered and the majority of patients presenting with these symptoms do not need consideration for surgery. Patients and doctors may feel that there is “something” that should be done although, in fact, this is rarely the case. MRI scans may well reinforce this delusion by demonstrating Abnormalities (Malcolm, 2002).

2.1.3.1.2 Spina bifida

Spina bifida is a congenital disorder in which there is a defective closure of the vertebral arch. Sometimes the spinal meninges and also the spinal cord can protrude through this, and this is called Spina bifida cystica. Where the condition does not involve this protrusion it is known as Spina bifida occulta. Sometimes all of the vertebral arches may remain incomplete. Another, though rare, congenital disease is Klippel-Feil syndrome which is the fusion of any two of the cervical vertebrae. Spondylolisthesis is the forward displacement of a vertebra and retrolisthesis is a posterior displacement of one vertebral body with respect to the adjacent vertebra to a degree less than a dislocationSpinal disc herniation, more commonly called a "slipped disc", is the result of a tear in the outer ring (annulus fibrosus) of the intervertebral disc, which lets some of the soft gel-like material, the nucleus pulposus, bulge out in a hernia. Spinal stenosis is a narrowing of the spinal canal which can occur in any region of the spine though less commonly in the thoracic region. The stenosis can constrict the spinal canal giving rise to a neurological deficit.Pain at the coccyx (tailbone) is known as coccydynia(Gray et al., 2017).

2.1.3.1.3 Curvature

Spinal curvature is classed as a spinal disease or dorsopathy and includes the following abnormal curvatures Kyphosis is an exaggerated kyphotic (concave) curvature in the thoracic region, also called hyperkyphosis. This produces the so-called "humpback" or "dowager's hump", a condition commonly resulting from osteoporosis. Lordosis as an exaggerated lordotic (convex) curvature of the lumbar region, is known as "lumbar hyper lordosis" and also as "swayback". Temporary lordosis is common during pregnancy Scoliosis, lateral curvature, is the most common abnormal curvature, occurring in 0.5% of the population. It is more common among females and may result from unequal growth of the two sides of one or more vertebrae, so that they do not fuse properly. It can also be caused bypulmonary atelectasis (partial or complete deflation of one or more lobes of the lungs) as observed in asthma or pneumothorax(Gray et al., 2017).

2.1.3.1.4 Spinal stenosis

Spinal stenosis is the narrowing of the spinal canal through which the spinal cord passes. Vertebral foramina enclose the spinal canal. Stenosis can be very serious if it compromises the spinal cord, resulting in pain, strange neural sensations, and even paralysis. It can be caused by a number of conditions, such as a ruptured disk or a dislocation of vertebrae, but here we will focus on the narrowing of the foramen because of vertebral degeneration withaging, the stability of the vertebra, especially at the facet joints degenerates. To counter these stresses, the bone in the vertebrae thickens and the ligaments become thick and stiff. This results in a narrowing of the spinal canal. Stenosis can occur in the cervical, thoracic, lumbar, or all three regions (Gray et al., 2017).

Lamenectomy is the most common surgical technique to relieve spinal cord or nerve branch compression due to stenosis. It involves the cutting of the vertebral lamina and the removal of the posterior portion of the vertebra. In the traditional "open" procedure, the muscles are cut in the approach, increasing recovery time. If done laparoscopically, the muscles are merely pushed aside, reducing recovery (Gray et al., 2017).

2.1.3.1.5 Trauma to the spinal column

Fractures occur when internal or external forces on the vertebrae exceed their structural strength. Common causes are vehicle accidents, sports, violence, and falls. Fractures can be further classified into two more groups: minor and major.

When a posterior column element, such as the facet joint, is fractured it is "minor" because that structure is not vital to the stability of the spine. On theother hand, if the vertebral body is fractured (middle or anterior column), it is "major" because the stability of the spine may be at risk or damage to the spinal cord may occur. Vertebral body fractures may be further termed as stable or unstable. If a fracture is unstable, the bone fragments can damage the spinal cord and immediate intervention is necessary (Gray et al., 2017).

2.1.3.1.6 Spinal injury

The spinal cord contains the nerves that carry messages between your brain and body. The cord passes through your neck and back. A spinal cord injury is very serious because it can cause loss of movement (paralysis) below the site of the injury spinal cord injury may be caused by Bullet , stab wound Traumatic injury to the face, neck, head, chest, or back (for example, a car accident),Diving accident. Electric shock extreme twisting of the middle of the body, landing on the head during a sports injury, Fall from a great height (American College of and Committee on, 2004).

2.1.3.1.6 Tumors of the spine

Spinal tumors are relatively uncommon. They can be benign or malignant (cancerous). Primary malignant spinal tumors are rare. Spinal malignancies usually result as a metastasis (spreading) from another malignant tumor. Lateral CT scan showing sagittal view of a sacrococcygealteratoma, the most common tumor found in newborns. SCTs also can occur in adolescents and adults. and may be benign or malignant. Lateral CT scan showing sagittal view of an ependymoma. These are tumors of the ependyma, a tissue of the central nervous system. The majority are slow growing and benign (American College of and Committee on, 2004).

2.1.3.1.7Infection

Pyogenic Vertebral Body and Disc Infections- Epidural Spinal Abscess(Boling, 2007).

2.1.4MRI Technique

2.1.4.1MRI Spine Technique

2.1.4.2.1 MRI cervical Spine Technique

2.1.4.2.1.1 Equipment

Posterior cervical neck coil/volume neck coil/multi-coil array spinal Coil, Immobilization pads and straps, Pe gating leads if required And Ear plugs (R. George 2017).

2.1.4.2.1.2 Patient positioning

The patient lies supine on the examination couch with the neck coil placed under or around the cervical region.

Coils are often moulded to fit the back of the head and neck so that the patient is automatically centered to the coil. If a flat coil is used, placing supporting pads under the shoulders flattens the curve of the cervical spine so that it is in closer Proximity to the coil. The coil should extend from the base of the skull to the sternoclavicular joints in order to include the whole of the cervical spine. The patient is positioned so that the longitudinal alignment light lies in the midline, and the horizontal alignment light passes through the level of the hyoid bone (this can usually be felt above the thyroid cartilage/Adam’s apple. The patient’s head is immobilized with foam pads and retention straps. Pe gating leads are attached if required (Westbrook, 2008).

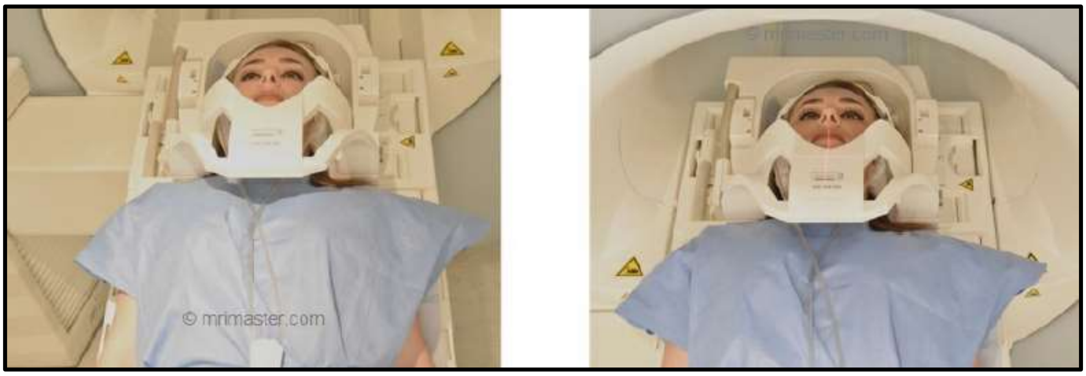


Figure 2.8: The patient position and part position in C/S(R. George 2017).

2.1.4.2.1.3 Protocols

2.1.4.2.1.3.1 Localizer

A three plane localizer must be taken in the beginning to localize and plan the sequences. Localizers are normally less than 25sec. T1 weighted low resolution scans.)

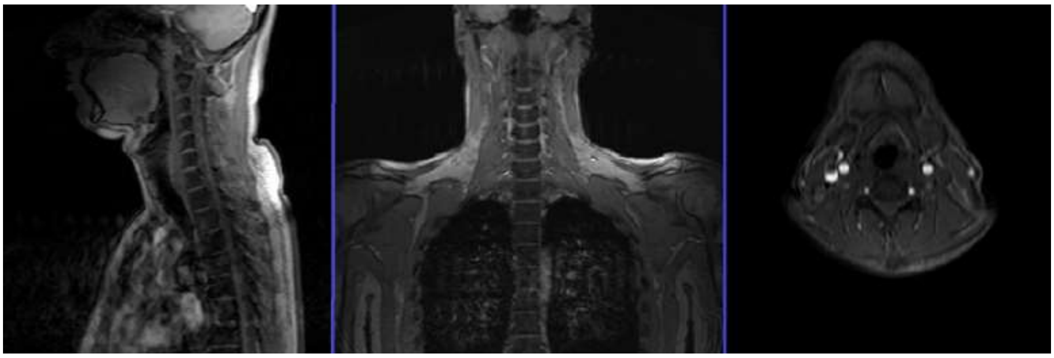


Figure 2.9: Three plan localizer(R. George 2017).

2.1.4.2.1.3.2 Sagittal SE/FSE T1/T2

Plan the sagittal slices on the coronal plane; angle the position block parallel to spinal cord. Check the positioning block in the other two planes). An appropriate angle must be given in the axial plane on a tilted patient (parallel to the line along the center of the vertebral body through the length of the spinous process). Check the position block in the sagittal plane; FOV must be big enough to cover the whole cervical spine from pons down to T4 (normally 280mm). Slices must be sufficient to cover the spine from the lateral border of RT transverse process to the lateral border of LT transverse process. A saturation band must be placed over the neck (in front of the esophagus) in the sagittal plane. This is to avoid swallowing artifacts over the spinal area. Phase direction should be head to foot to avoid motion artifacts from the neck (R. George 2017).

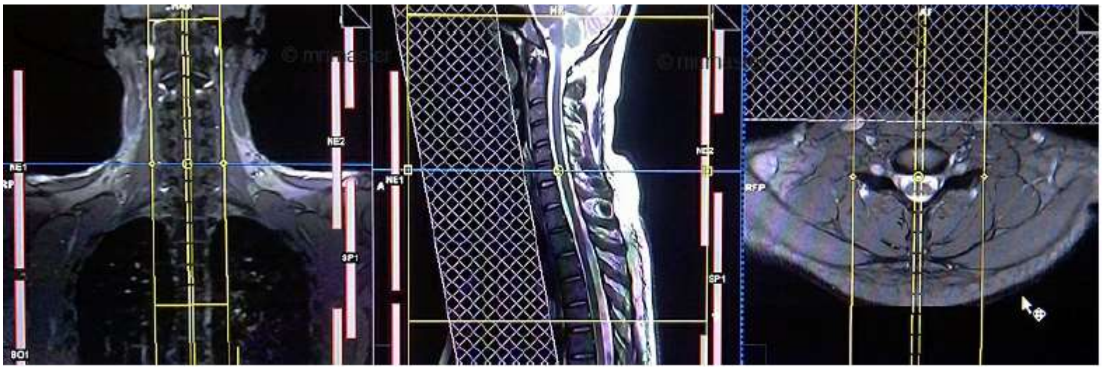


Figure 2.10: The planning in axial C/S (R. George 2017).

2.1.4.2.1.3.3 Axial/oblique SE/FSE T1/T2 or GRE T2*

Plan the axial slices on the sagittal plane; angle the position block perpendicular to the spinal cord. Additional blocks must be placed if there is a disc prolapse at any other level (eg.T2, T3). An appropriate angle must be given in the coronal plane on a tilted spine (parallel to the intervertebral disc space). Slices must be sufficient to cover the whole C spine from C2 to T1. A saturation band must be placed over the neck (in front of the esophagus) in the sagittal plane. This is to avoid swallowingartifacts over the spinal area (R. George 2017).

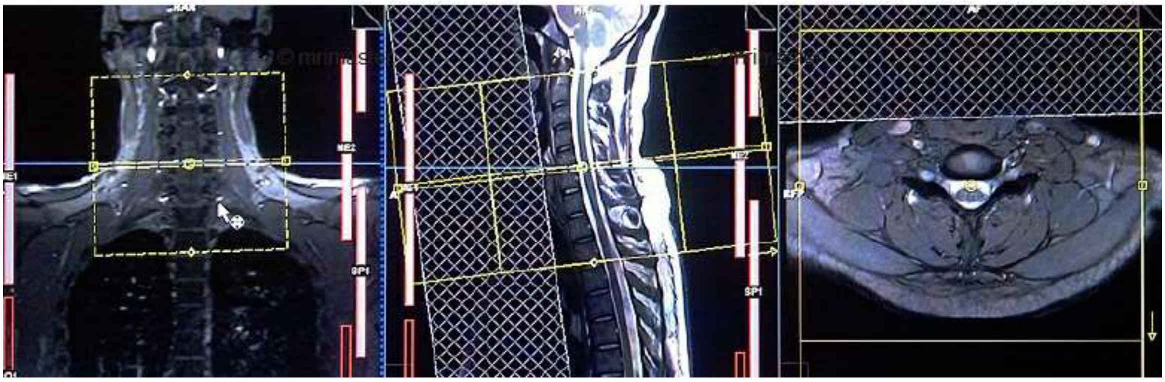


Figure 2.11: The Planning in Axial cervical spine (R. George 2017).

2.1.4.2.1.3.4 Sagittal SE/FSE T2 or STIR

Slice prescription as for Sagittal T2*. An alternative to coherent GRE T2* (Westbrook, 2008).

2.1.4.2.1.3.5 3D coherent/incoherent (spoiled) GRE T2*/T1

Thin slices and a few or medium number of slice locations are prescribed through the ROI. If PD or T2* weighting is desired, then a coherent or steady-state sequence is utilized. If T1 weighting is required an incoherent or spoiled sequence is necessary. These sequences may be acquired in any plane but, if reformatting is required, isotropic datasets must be acquired (Westbrook, 2008).

2.1.4.2.1.3.6 Sagittal SE/FSE T1 or fast incoherent (spoiled) GRE T1/PD

Slice prescription as for Sagittal T1, T2 and T2*, except neck in flexion and extension to correlate the potential relevance of spondylotic changes to signs and symptoms (Westbrook, 2008).

2.1.4.2.1.3.7 3D balanced gradient echo (BGRE)

The contrast characteristics of a BGRE sequence provide for high signal from CSF (high T2 / T1 ratio) and thus produces images with high contrast between CSF and nerve roots. It is important to remember that because these images are not true T2 weighted, subtle cord lesions such asMS plaques may not be seen (Westbrook, 2008).

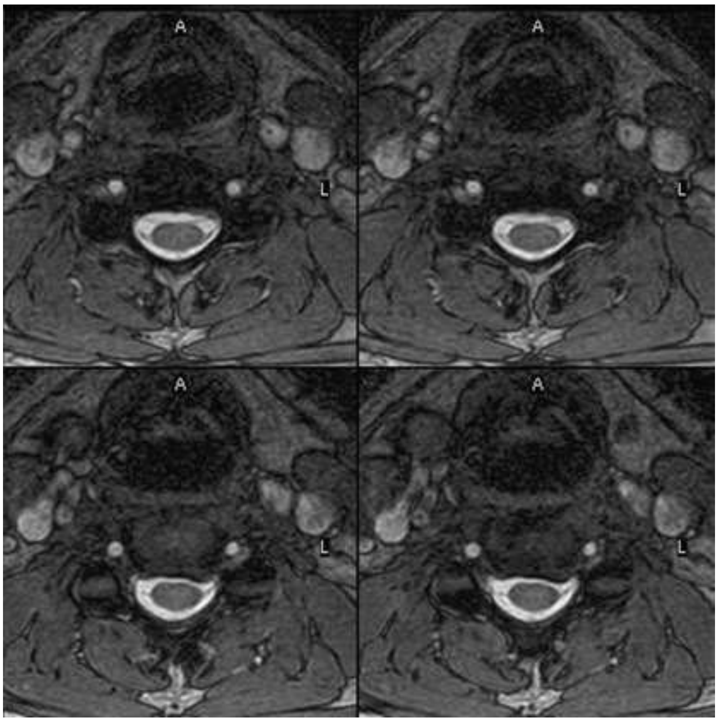


Figure 2.12: Axial balanced GRE through the cervical spine (Westbrook, 2008).

2.1.4.2.1.4 Technical issues

The SNR in this region is mainly dependent on the quality of the coil. Posterior neck coils give adequate signal for the cervical spine and cord, but signal usually falls off at the anterior part of the neck, so they are not recommended for imaging structures such as the thyroid or larynx. In addition, flare from the posterior skin surface can be troublesome in sagittal T1 imaging, where the large fat pad situated at the back of the neck returns a high signal. Volume coils produce even distribution of signal, but the SNR in the cord is sometimes reduced compared with a posterior neck coil. Multi-coil array combinations commonly produceoptimum SNR, and may be used with a large FOV to include the thoracic spine. This strategy is important when pathology extends from the cervical to the thoracic areas of the cord, e.g. syrinx (Westbrook, 2008).

Spatial resolution is also important, especially in axial/oblique imaging, as the nerve roots in the cervical region are notoriously difficult to visualize. Thin slices with a small gap and relatively fine matrices are employed to maintain spatial resolution.(Westbrook, 2008).

2.1.4.2.2 MRI thoracic Spine Technique

2.1.4.2.2.1 Equipment

Posterior spinal coil or multi-coil array spinal coil, Pe gating leads if required and Ear plugs (Westbrook, 2008).

2.1.4.2.2.2 Patient positioning

The patient lies supine on the examination couch with the spinal coil extending from the top of the shoulders to the lower costal margin to ensure total coverage of the thoracic spine and conus. The patient is positioned so that the longitudinal alignment light lies in the midline, and the horizontal alignment light passes through the center of the coil, which corresponds approximately to the level of the fourth thoracic vertebra. Pegating leads are attached if required (Westbrook, 2008).

Figure 2.13: The patient position and part position in thoracic spine (R. George 2017).

2.1.4.2.2.3 Protocol

2.1.4.2.2.3.1 Localizer

A three plane localizer must be taken in the beginning to localize and plan the Sequences. Localizers are normally less than 25sec. T1 weighted low resolution scans.

2.1.4.2.2.3.2 Sagittal SE/FSE T1/T2/ STIR

Plan the sagittal slices on the coronal plane; angle the position block parallel to spinalcord. Check the positioning block in the other two planes. An appropriate angle must be given in the axial plane on a tilted patient (Parallel to the line along the center of the vertebral body and the spinous process).Check the position block in the sagittal plan; FOV must be big enough to cover the whole thoracic and cervical spine from C1 down to T12 (normally 480 mm).Slices must be sufficient to cover the spine from the lateral border of RT transverse process up to the lateral border of LT transverse process.

A saturation band must be placed over the chest as shown in the.in the sagittal plane .This is to avoid the breathing artifacts over the spinal area. Phase in the sagittal plane. This is to avoid the breathing artifacts over the spinal area. Phasedirection should be head to feet to avoid further motion artifacts form the chest.

IPS

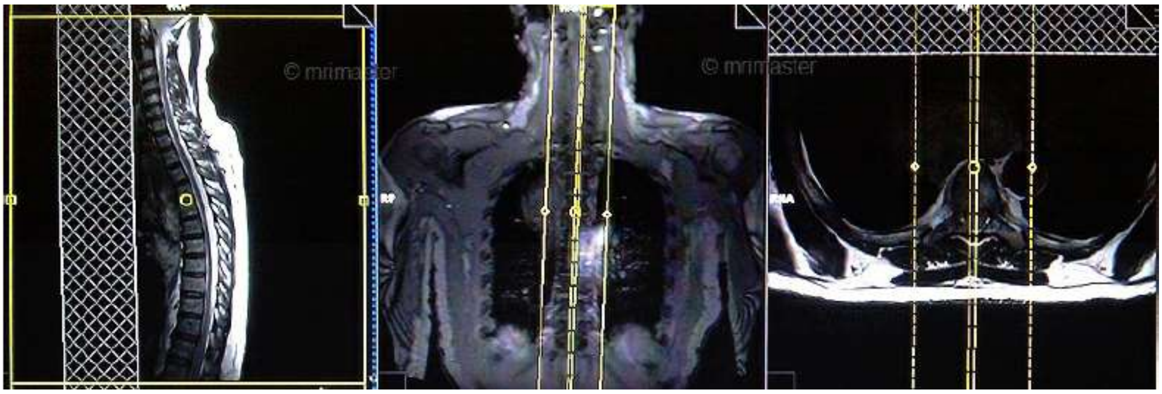


Figure 2.14: The Planning in sagittal thoracic spine (R. George 2017).

2.1.4.2.2.3.3 Axial/oblique SE/FSE T1/(T2 or GRE T2*)

Plan the axial slices on the sagittal plane; angle the position block perpendicular tothe spinal cord. An appropriate angle must be given in the coronal plane on a tilted orscoliotic spine (parallel to theintervertebral disc space. Slices must be sufficient tocover the whole t spine from T1 to T12. A saturation band must beplaced over thechest as shown in.In the sagittal plane. This is to avoid the breathingartifacts over the spinal area (R. George 2017).

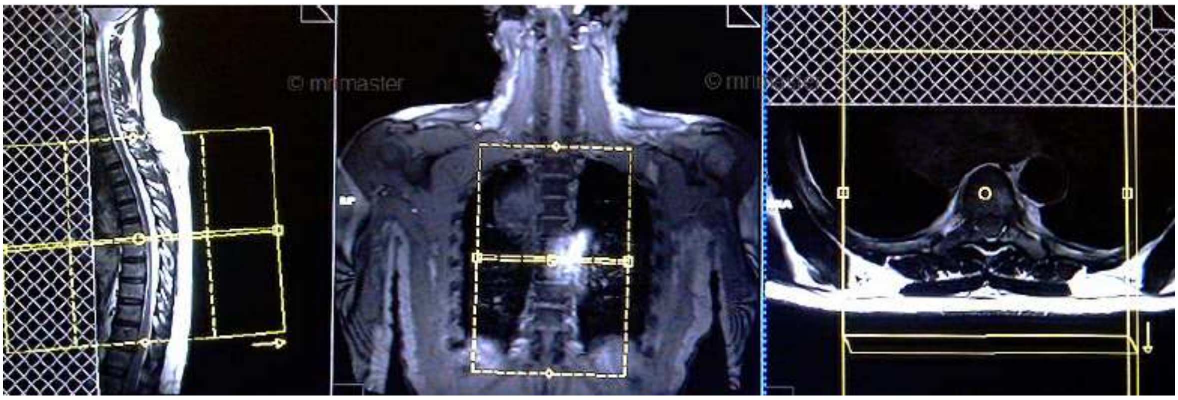


Figure 2.15: The Planning in Axial thoracic spine (R. George 2017).

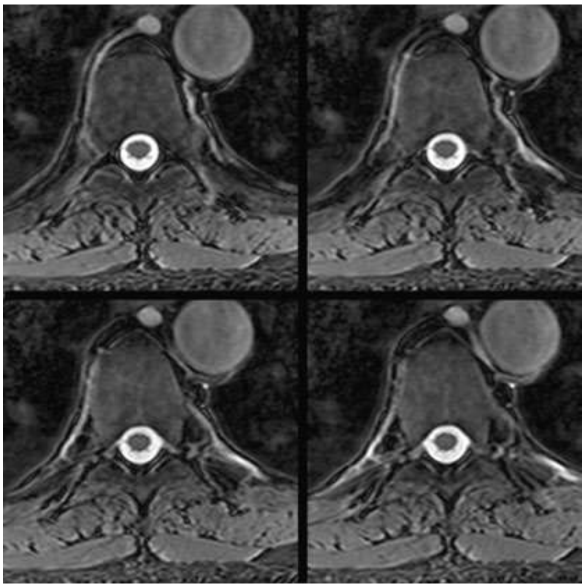


Figure 2.16: Axial/oblique FSET2 weighted images through thethoracic cord (Westbrook, 2008).

2.1.4.2.2.3.4 Additional sequence

Use T1 TSE Fat saturated axial and sagittal after the administration of IV gadolinium DTPA injection (copy the planning outlined above). The recommended dose of gadolinium DTPA injection is 0.1 mmol/kg, i.e. 0.2 mL/kg in adults, children and infants (R. George 2017).

2.1.4.2.2.4 Technical issues

The SNR in this region is mainly dependent on the quality of the coil. Flare from the posterior skin surface may be troublesome, especially in sagittal T1 imaging where the fatty tissues posterior to the thoracic spine return a high signal. In addition, there is signal fall-off from the anterior part of the chest due to its distance from the posteriorly situated coil. For this reason the posterior spinal coil is not utilized to image the thorax, unless the patient is a very small child. Phased array coils are useful toimage the whole of the cervical and thoracic cord whilst maintaining optimum SNR and resolution. Spatial resolution is important especially in axial/oblique images, as the nerve roots in the thoracic region are commonly difficult to visualize. Thin slices with a small gap and relatively fine matrices are implemented to maintain spatial resolution. Multiple NEX/NSA is also advisable if the inherent SNR is poor. Therefore, unless FSE is utilized, scan times are usually of several minutes duration (Westbrook, 2008).

2.1.4.2.3 MRI Lumbar Spine Technique

2.1.4.2.3.1 Equipment

Posterior spinal coil/multi-coil array spinal coil, Foam pads to elevate the knees and Ear plugs (Westbrook, 2008).

2.1.5.2.3.2 Patient positioning

The patient lies supine on the examination couch with their knees elevated over a foam pad, for comfort and to flatten the lumbar curve so that the spine lies nearer to the coil. The coil should extend from the xiphisternum to the bottom of the sacrum for adequate coverage of the lumbar region. The patient is positioned so that the longitudinal alignment light lies in the midline, and the horizontal alignment light passes just below the lower costal margin, which corresponds to the third lumbar vertebra (Westbrook, 2008).

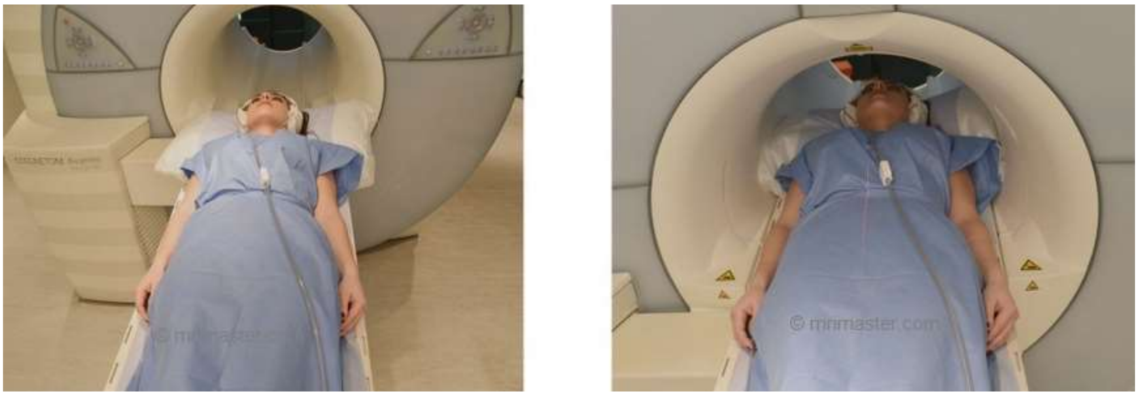


Figure 2.17: The patient position and part position in lumbar spine (R. George 2017).

2.1.4.2.3.3 Protocol

2.1.4.2.3.3.1 Localizer

A three plane localizer must be taken in the beginning to localize and plan the sequences. Localizers are usually less than 25sec. T1 weighted low resolution scans (R. George 2017).

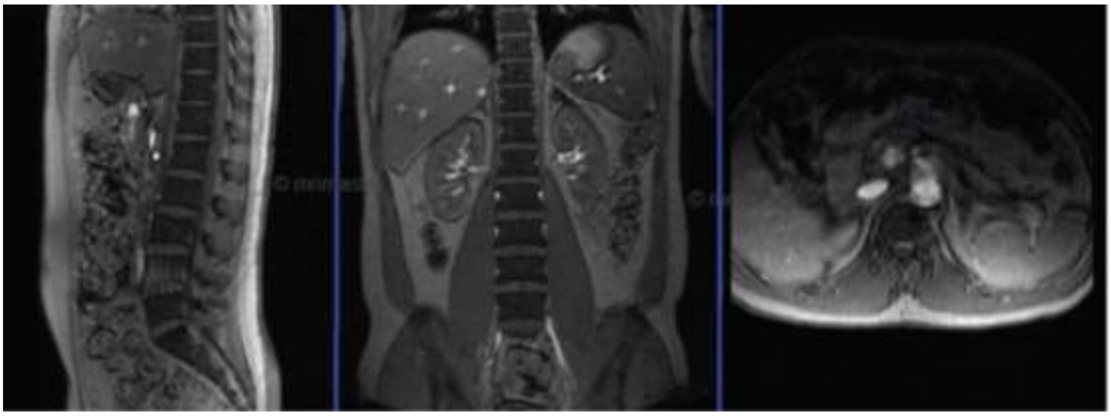


Figure 2.18: Shows the three plain localizer for lumbar spine (R. George 2017).

2.1.4.2.3.3.2 Sagittal SE/FSE T1/T2

Plan the sagittal slices on the coronal plane; angle the position block parallel to spinal cord. Check the positioning block in the other two planes. An appropriate angle must be given in the axial plane on a tilted patient (Parallel to the line along the center of the vertebral body and the spinous process). Check the position block in the sagittal plan; FOV must be big enough to cover the whole lumbar and sacral spine from T11 down to coccyx (normally 350mm).Slices must be sufficient to cover the spine from the lateral border of RT transverse process up to the lateral border of LT transverse process. A saturation band must be placed over the abdomen (in front of the aorta)in the sagittal plane. This is to avoid the peristalsis and breathing artifacts over the spinal area. Phase direction should be head to feet to avoid further motion artifacts form abdomen (R. George 2017).

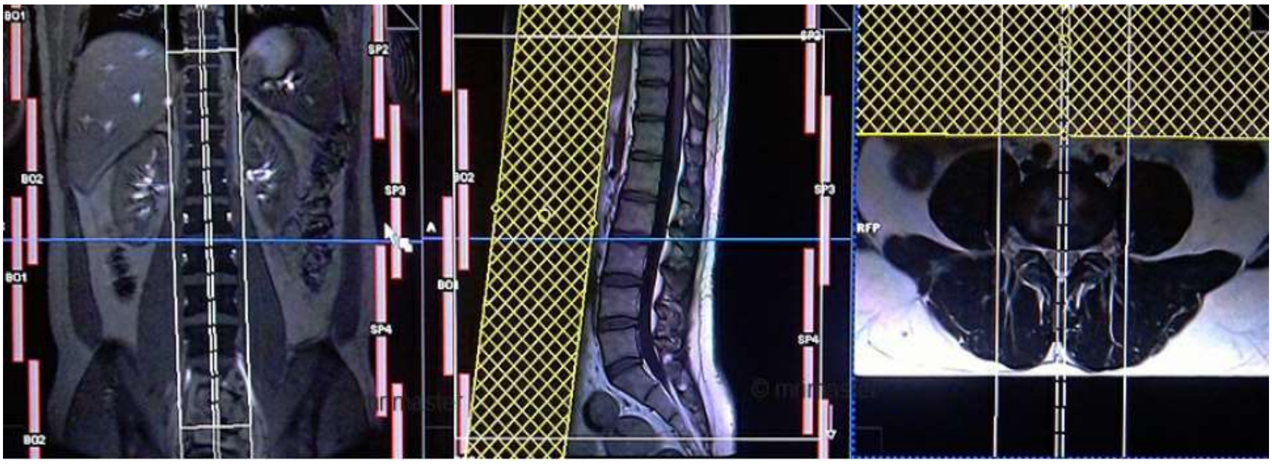


Figure 2.19: The Planning in sagittallumbar spine (R. George 2017).

2.1.4.2.3.3.3 T1/T2 TSE or GRE T2*Axial multi block and multi angle

Plan the axial slices on the sagittal plane; angle the first position block parallel to L5-S1 intervertebral disc, second position block parallel to L4- L5 intervertebral disc, third position block parallel to L3- L4 intervertebral disc and fourth position block parallel to L2- L3 intervertebral disc(only four blocks are needed in a normal spine.

Additional blocks must be taken if there is a disc prolapsed in any other levels. An appropriate angle must be given in the coronal plane on a tilted or scoliotic spine (Parallel to the intervertebral disc space). Slices must be sufficient to cover the intervertebral discs(normally 5 slices for each disc space). A saturation band must be placed over the abdomen (in front of the aorta) in the sagittal plane. This is to avoid the peristalsis and breathingartifacts over the spinal area (R. George 2017)

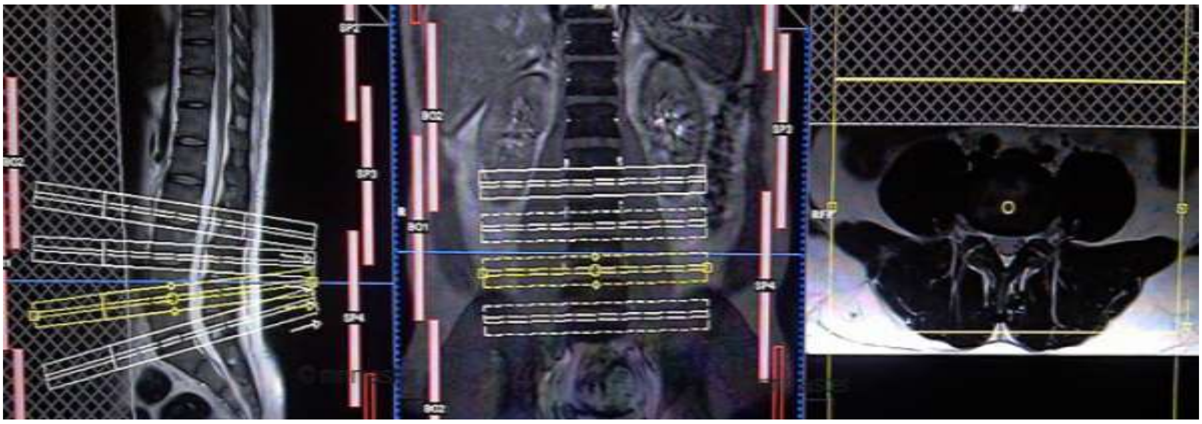


Figure 2.20: The Planning in Axial lumbar spine (R. George 2017).

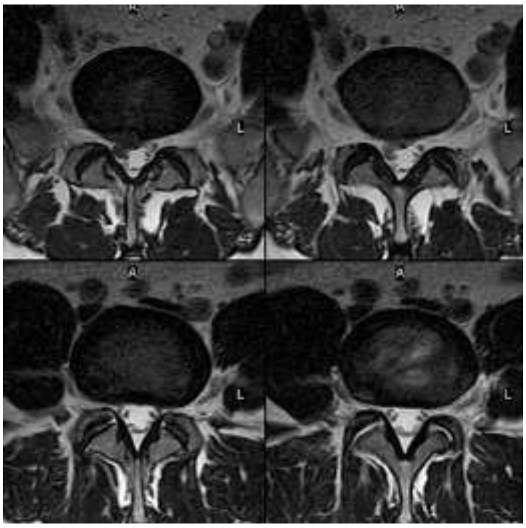


Figure 2.21: Axial/oblique FSE T2 weighted image of the lumbar spine (Westbrook, 2008).

2.1.4.2.3.3.4 Axial/oblique or Sagittal SE/FSE T1

With contrast for determining disc prolapse versus scar tissue in failed back syndrome, and for some tumors. Without contrast in spinal dysraphism. Chemical/spectral presaturation is beneficial to differentiate between fat and enhancing pathology (Westbrook, 2008).

2.1.4.2.3.3.5 Coronal SE/FSE T1

For cord tethering or alternative view of conus when sagittal are inconclusive(Westbrook, 2008).

2.1.4.2.3.3.6 STIR

While FSE sequences provide excellent T2 weighted images of the spine, the signal intensity from the normal fat in the marrow of the vertebral bodies is generally high Even with longer TE times. For that reason, marrow pathology, such as tumors or fractures, may not be adequately visualized on T2 weighted FSE sequences. A STIR sequence can be utilized to visualize bone marrow abnormalities better. This is demonstrated in the images in Figures 9.18–9.20. The T1 weighted FSE shows an acute fracture of the L-1 vertebral body. The T2 weighted FSE also shows the fracture but themajority of the bone marrow signal in the L1 vertebral body appears similar to the other vertebral bodies. The STIR clearly shows the increased signal within the L1 vertebral body consistent with an acute fracture (Westbrook, 2008).

Figure 2.22: Sagittal FSE-STIR of the same patient (Westbrook, 2008).

2.1.4.2.3.4 Technical issues

The SNR in the lumbar region depends on the quality of the coil. Posteriorspinal coils return high signal in the area of the lumbar canal and vertebral bodies, but flare from the fatty tissues in the buttocks sometimes interferes with the image. Phased array coils allow for imaging of the thoracic and lumbar spine in conjunction with good SNR and resolution. As CSF flow is reduced in this area, FSE is routinely used. This enables the implementation of very fine matrices so that spatial resolution is significantly increased (Westbrook, 2008).

Resolution is also maintained by using rectangular/asymmetric FOV in sagittal imaging (with the long axis of the rectangle running from S to I), and a small FOV in axial/oblique imaging. Fine matrices are especially necessary in arachnoiditis to detect nerve root clumping (Westbrook, 2008).

2.1.4.2.3.5 Artifact problems

CSF pulsation is not usually troublesome as the speed of flow is relatively slow. However, phase artifact from the aorta and the inferior vena cava (IVC), and lateral flow from the lumbar vessels, sometimes obscures the lumbar canal. Spatial presaturation pulses brought into the FOV and placed S, I and A in the sagittal images, and A, R and L in the axial/oblique images, reduce phase ghosting. GMN minimizes flow artifact even further but, as it increases the signal in CSF and the minimum TE available, it is mainly reserved for the T2 and T2* weighted sequences (Westbrook, 2008).

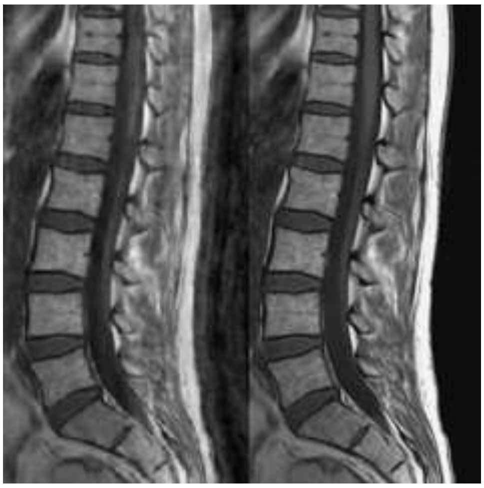


Figure 2.23: Sagittal FSE T1 weighted images of the lumbar spine with phase A to P (left) and S to I (right). The definition of the spinal cord is clearly improved on the right-hand image (Westbrook, 2008).

2.2 Previous Studies:

(Mohammad Sobhan *et al.*,2016) studied the incidental findings of the lumbar spine at MRI in patients diagnosed with discopathy.

The results of this study showed that 73 patients (16%) out of a total of 444 patients (215 males (48.4%) and 229 females (51.6) with a mean age of 42 years and age range of 13 to 87 years), provided incidental findings. The frequency of single vertebral hemangioma, multiple vertebral hemangioma, kidney cysts, liver cysts and Perineural cyst was 31 cases (7.0%), 11 cases (2.5%), 13 cases (2.9%), 2 cases (0.5%) and 3 cases (0.7%) respectively. There was no significant correlation between the frequency distribution of findings in terms of sex (P-value = 0.08), but there was a significant correlation between the frequency distribution of findings in terms of age (P-value = 0.006).

Mohammed sobhan et al concluded that there was a significant correlation between the frequency distributions of these findings and the patients' age, however, no correlation was observed between these findings and patients' sex.

(AlperDilli et al 2014) studied that incidental extraspinal finding on magnetic resonance imaging of intervertebral discs. Alper et al aimed to evaluate pathological extraspinal findings and congenital anomalies/anatomical variations that were incidentally detected on the magnetic resonance imaging (MRI) scans of intervertebral discs, to find the frequencies of these incidental findings, and to emphasise the clinical importance of them.

The results showed that the percentages of incidental extraspinal pathological findings and congenital anomalies/anatomical variations were 16.6% and 3.7%, respectively. The percentage of incidental extraspinal pathological findings on cervical spinal MRI was 25.7%, thyroid nodules being the most common incidental findings. On thoracic spinal MRI (n = 19), inferior pole thyroid nodules were demonstrated as incidental extraspinal pathological findings, with a percentage of 10.5%. On lumbar spinal MRI, incidental pathological findings were detected with a percentage of 14.2%, while the percentage of congenital anomalies/anatomical variations was 4.8%. Eventually, 6.5% of all cases with incidental extraspinal pathological findings underwent surgery.

the researchers concluded that on MRI examination of intervertebral discs, paying attention to incidentally detected pathological extraspinal findings and congenital anomalies/anatomical variations is very important due to the fact that they can alter the treatment of the patient or affect the patient's life.

(Sedat Alpaslan Tuncel*et a*l., (2014)) studied that the prevalence and reporting rate of incidental findings (IF) in adult outpatients undergoing on routine lumbar magnetic resonance imaging (MRI). The study found that out of 253 IFs were found in 241 patients (18.8% of 1278). Among these, clinically significant IFs (n = 34) included: 2 renal masses (0.15%), 2 aortic aneurysms (0.15%), 2 cases of hydronephrosis (0.15%), 11 adrenal masses (0.86%), 7 lymphadenopathies (0.55%), 6 cases of endometrial or cervical thickening (0.47%), 1 liver hemangioma (0.08%), 1 pelvic fluid (0.08%) and 2 ovarian dermoid cysts (0.15%). Overall, 28% (71/253) of IFs were included in the clinical reports, while clinically significant findings were reported in 41% (14/34) of cases.

Sedat*et al*., concluded that the extraspinal IFs are commonly detected during a routine lumbar MRI, and many of these findings are not clinically significant. However, IFs including clinically important findings are occasionally omitted from formal radiological reports.

(C. Ottonello *et al.*, 2014) examined a sample of 98 patients (40 males, 58 females, age 26-64, average 48,1± 9,9 SD) during the period From January 2013 to September 2013.To the evaluation of the incidentally detected thyroid abnormalities rate in patients asymptomatic for thyroid disease who underwent cervical spine MRI.

the results of this study showed that thyroid nodules founded in 5/98 patients (solitary nodule 4/98, more nodules 1/98), hypotrophic gland (12/98, all without nodules, 10 with slight hypothyroidism and 8 with thyroiditis at blood tests, both requiring pharmacological therapy), hypertrophic gland (7/98 without nodules, 1/98 with more nodules, 2 with light hyperthyroidism and 1 with thyroiditis at blood tests, both requiring pharmacological therapy).

C. Ottonello*et al* concluded and recommend that it is very important to perform a complete and accurate evaluation of all obtained images in a cervical spine MRI, in order to identify any thyroid abnormality, because an early diagnosis allows starting an adequate - and sometimes more effective - treatment, before the onset of symptoms.

Uma E. Ramadorai*et al.,* (2014) studied that the magnetic resonance imaging of the Cervical, Thoracic, and Lumbar Spine in Children, to determine the rate of spinal incidental findings on magnetic resonance Imaging (MRI) of the cervical, thoracic, and lumbar spine in the pediatric population.

They founded a Thirty-one of the 99 MRIs had positive findings, with the most common being disk protrusion (51.6%). Spinal incidental findings were most common in the lumbar spine (9.4%) versus the cervical spine (8%) or thoracic spine (4.7%). In this group, Schmorl nodes and disk protrusion were the two most common findings (37.5% each). Other spinal incidental findings included a vertebral hemangioma and a Tarlov cyst. In the thoracic spine, the only spinal incidental finding was a central disk protrusion without spinal cord or nerve root compression.

The study concluded that the MRI is a useful modality in the pediatric patient with scoliosis orComplaints of pain, but the provider should remain cognizant of the potential for spinal incidental findings.

(Chen-Ju Fu1 *et al.*, 2013) studied that the extraspinal malignancies that found incidentally on routine lumbar spine MRI studies.

They found that out of 5104 The incidental extraspinal malignancies included 9 paraaortic lymphadenopathies, 7 renal tumors , 5 iliac bony lesions, 4 adrenal tumors, 2 liver tumors, and 1 colon tumor. The prevalence of newly diagnosed extraspinal malignancies was 0.5%. Among the 26 patients with newly diagnostic extraspinal malignancies, 12 (46%) of them did not have coexisting spinal metastases and the most common etiologies were renal cell carcinoma and iliac bony metastases. The possible reason may be due to these lesions induce back pain similar to degenerative spinal disease.

Chen-ju et al recommended that the extraspinal structures should be carefully and systemic evaluated on routine lumbar spine MRI, especially if the spinal findings cannot explain the symptoms of the patients.

(Kim K *et al.,* 2013) studied an incidental detection of thyroid nodules in patients undergoing magnetic resonance (MR) imaging of the cervical spine. The incidental detection of thyroid lesions in patients was prospectively evaluated on 389 MR images.

The results found that twenty patients (5.1%) had a total of 26 thyroid nodules. Eighteen patients presented with a single dominant nodule (appendix b , case 8), of whom 2 had a multinodular gland with a single dominant nodule (one had 3 and the other had 5 nodules). Two patients had diffusely enlarged gland without a dominant nodule. The mean size of the nodules was 11.6 mm. One thyroid nodule was detected at the C5-6 intervertebral level, 14 at the C6-7, and 11 at the C7-T1. T2-weighted imaging was more useful than T1-weighted imaging for the detection of thyroid nodules because of the hyperintense versus isointense appearance of the lesions. Thyroid carcinoma was identified at surgery in one patient. The

detection rate was low compared with computed tomography with contrast medium and ultrasonography.
The results of this study suggest that MR imaging has limited value for the detection of thyroid lesions and that the presence of such lesions cannot be denied based only on MR imaging of the cervical spine. However, asymptomatic thyroid lesions, including thyroid cancer, can be identified on MR images of the cervical spine, so the studied recommended that the evaluation of these images should consider such lesions.

(Sutherland *et al.*, 2013) studied the incidental extra spinal findings at CT lumbar spine on wide field of view reconstructions, the study aimed to determine if wide field of view soft tissue window reconstructions should be routinely provided for reporting.
They found it out of 355 patients 42.8% being performed in males. 46% of patients had an incidental extraspinal finding and these patients were older, 64 years versus 49 years compared with patients with no incidental finding. Males were more likely to have an incidental finding. 16 of 355 studies (4%) found a major incidental finding.
The researchers concluded that incidental extraspinal findings are common, are typically minor and can be confidently diagnosed on the source data with little need for further investigation. Given the benefit of identifying major findings and also recommended that the wide field of view reconstructions should be routinely provided for reporting.

(Carlo Cosimo*et al.*, 2013) studied the extra-spinal incidental findings at lumbar spine MRI in the general population to determine the prevalence of clinically and non-clinically relevant extra-spinal incidental findings (IF) in patients undergoing magnetic resonance imaging (MRI) of the lumbar spine and to evaluate the rate of undetected findings in archived radiological reports. Carlo et al found it extra-spinal findings were detected in 2,060 (68.6 %) of the 3,000 lumbar spine MRI examinations; 362 (17.6 %) patients had indeterminate or clinically important findings (E3 and E4) requiring clinical correlation or further evaluation. After review of the original archived radiological reports, potentially important C-RADS E3 and E4 extra-spinal IF were respectively reported in 47 of the 265 (17.7 %) and in 8 of 74 (10.8 %) patients. They concluded that the incidental extra-spinal findings at conventional lumbar spine MRI are common but underestimated in radiological reports.

(L. Scarciolla*et al.*, 2013) studied the Extra-spinal incidental findings at lumbar spine MRI in the general population, to determine the prevalence and clinical importance of extra-spinal abnormalities.

The results of this study showed that the extra-spinal findings were noted in 2060 (68, 7%) of the 3000 patients, comprising 595/3000 (19, 8%) men and 1465/3000 (48, 8%) women. L. Scarciolla et al concluded and recommended that it's important to underline that the impact of finding incidental lesions on patient health outcome is not certain, but it is mandatory for a radiologist to remember that an incidental finding may be more significant than the suspected lumbar spinal disease. Incidental asymptomatic extra-spinal findings on lumbar MRI exams, including subclinical pathologic changes, are common in the general population but underestimated in radiological reports.

(Hee-Jin Park *et al*., 2011) studied the evaluation of the frequency and types of incidental findings of the lumbar spine during MR evaluation for herniated intervertebral disk disease. Hee-Jin examined a sample of 1268 patients (male-to-female ratio, 421:847; age range, 1–97 years) with clinically suspected herniated intervertebral disk disease Underwent MRI of the lumbar spine.

The study showed overall, 107 patients (8.4%) had incidental findings. Fibrolipoma was most common (41 cases, 3.2%), followed by Tarlov cyst (27 cases, 2.1%) and vertebral hemangioma (19 cases, 1.5%). Fibrolipoma and sacral meningocele were more common in males ($p < 0.05$). There was no difference in the incidence between the sexes in the other incidental findings ($p = 0.26–0.96$). Four of the five incidental findings were significantly more frequent in individuals younger than 50 years ($p < 0.05$), whereas the incidence of vertebral hemangioma did not differ by patient age ($p = 0.32$). The study summarized that the incidental findings at MRI of the lumbar spine were common and associated with age and sex. Most were benign findings. An awareness of the prevalence of the incidental findings detected at MRI of the lumbar spine is helpful for diagnosing lesions not related to symptoms.

Chapter Three

Materials and Methods

Chapter Three

Materials and Methods

3.1. Materials:

3-1-1. MRI Machine:

MRI device at almoalem medical city(Name is TOSHIBA AVANTO ELAN, Magnetic power is superconductor 1.5 T, Site of device is ALmoalem medical city, Coil is posterior spinal coil, Serial Number : GIA1575036.

3.1.2 Study designs and population:

The study population was composed of group of different patients, they are a 50 of Sudanese patients. Their ages from 30 up to 90 years with different gender underwent MRI examination of spine at Khartoum states. The aim of selecting this sample was to calculate the prevalence and clinical importance of incidental findings on spinal magnetic resonance imaging examinations during the period from February 2020 to August 2020.

3.2 Methods:

MRI scans of 50 patients are used to quantify the prevalence and types of incidental findings cervical, thoracic and lumbar spine MRI.

3.2.1 Scanning technique:

sagittal T2 FSE, sagittal T1 FSE, axial T1 FSE, sagittal stair, sagital T2 with large field of view, axial T2 FSE

3.2.2 Data collection:

The data was collected by master data sheets using the variables Subject age, gender.

3.2.3 Data analysis:

Descriptive statistics were calculated for incidental findings during spinal MRI (Cervical, thoracic and Lumber). All analyses were carried out using SPSS software (version 20; SPSS Inc, San Francisco, IL). The frequencies of incidental extraspinal pathological findings and congenital anomalies/anatomic variations were expressed as the number of cases/correspondent percentages.

3.2.4 Ethical considerations:

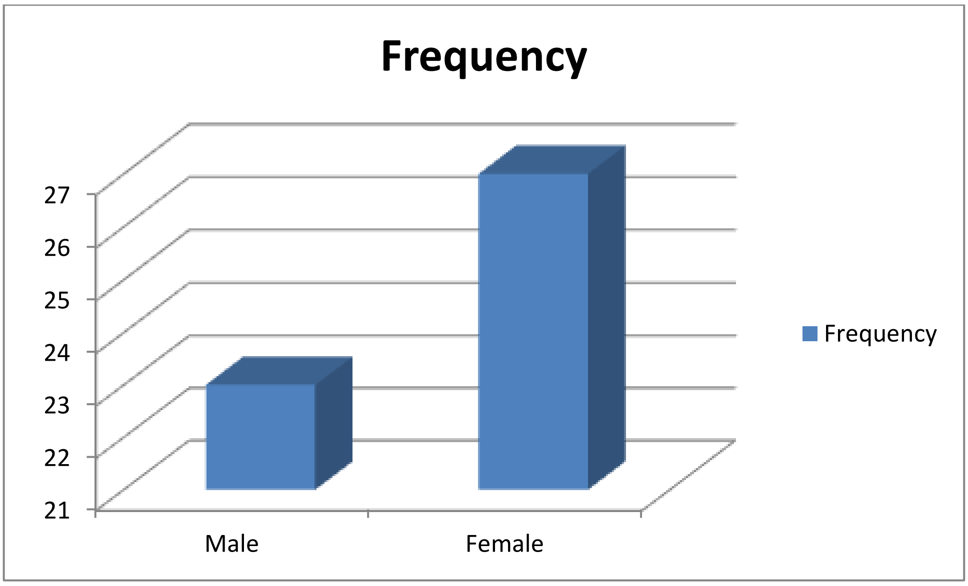
Special ethical consideration, verbal consent approval will obtain from each participating patient prior to his / her inclusion into the study. Clarification of the nature and purpose of the study was done with each patient; the technologist emphasized participation is voluntary and confidential. Privacy, safety and confidentiality were absolutely assured throughout the whole study.

Chapter Four
Results

Chapter Four
Results

Table (4.1): The sample classification according to gender

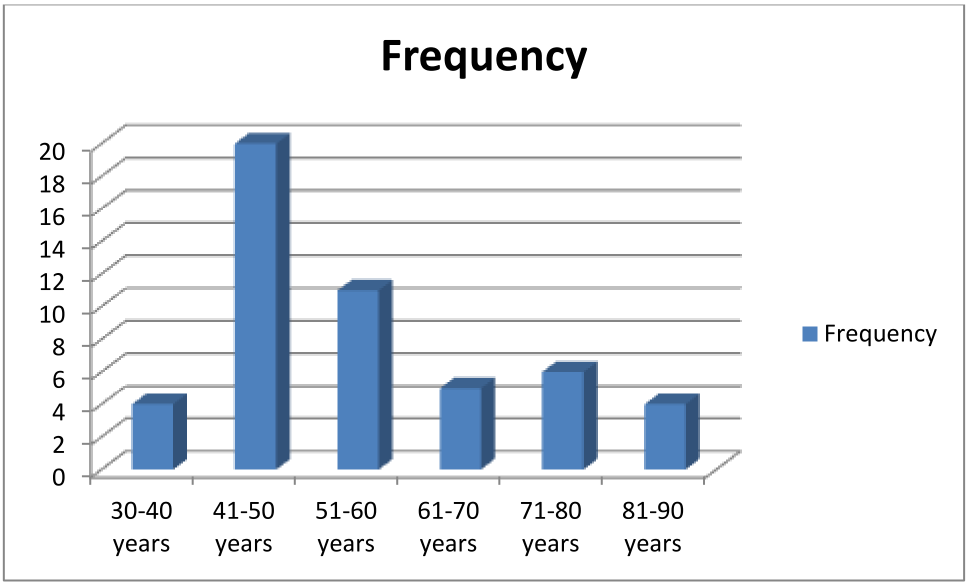
Gender	Frequency	Percentage%
Male	23	46%
Female	27	54%
Total	50	100%



Figure(4.1) The sample classification according to gender

Table(4.2)The distribution of sample according to gender

Age	**Frequency**	**Percentage%**
30-40 years	4	8%
41-50 years	20	40%
51-60 years	11	22%
61-70 years	5	10%
71-80 years	6	12%
81-90 years	4	8%
Total	50	100%



Figure(4.2) The distribution of sample according to gender

Table (4.3) Mean, maximum, mean and STD deviation of age

Statistics		
N	Valid	50
	Missing	0
Mean		56.08
Std. Deviation		13.732
Minimum		30
Maximum		82

Table(4.4) The distribution of the extra-spinal incidental findings on spine MRI examinations.

MRI finding * MRI examination Cross tabulation					
		L/S	C/S	D/S	Total
MRI finding	renal cyst	5	0	0	5
	thyroid nodules	0	3	1	4
	ca thyroid	0	1	0	1
	plural effusion	0	1	3	4
	Fibroid	3	0	0	3
	ovarian cyst	4	0	0	4
	retroverted uterus	3	0	0	3
	nabothian cyst	1	0	0	1
	ectopic kidney	1	0	0	1
	endometrium thickening	1	0	0	1
	liver mass	0	0	4	4
	atrophic kidney	1	0	0	1
	lymphadenopathy	0	2	0	2
	thyroid goiter	0	3	0	3
	bladder wall thickening	1	0	0	1
	multiple sclerosis	0	1	0	1
	colloid cyst	0	1	0	1
	tornwaldt cyst	0	2	0	2
	cervical cyst	0	0	1	1
	splenomegaly	0	0	1	1
	prostatic enlargment	4	0	0	4
	uterine fibroid	1	0	0	1
	splenic cyst	0	0	1	1
Total		25	14	11	50

P_value .000

Table(4.5) The distribution of incidental findings according gender

MRI finding * Gender Cross tabulation				
		Gender		Total
		Male	Female	
MRI finding	renal cyst	4	1	5
	thyroid nodules	1	3	4
	ca thyroid	0	1	1
	plural effusion	3	1	4
	Fibroid	0	3	3
	ovarian cyst	0	4	4
	retroverted uterus	0	3	3
	nabothian cyst	0	1	1
	ectopic kidney	1	0	1
	endometrium thickening	0	1	1
	liver mass	1	3	4
	atrophic kidney	1	0	1
	lymphadenopathy	2	0	2
	thyroid goiter	1	2	3
	bladder wall thickening	1	0	1
	multiple sclerosis	0	1	1
	colloid cyst	0	1	1
	tornwaldt cyst	2	0	2
	cervical cyst	0	1	1
	splenomegaly	1	0	1
	prostatic enlargement	4	0	4
	uterine fibroid	0	1	1
	splenic cyst	1	0	1
Total		23	27	50

P_value .038

Table(4.6)The distribution of incidental findings according to age

MRI finding * Age Cross tabulation								
		Age						Total
		30-40	41-50	51-60	61-70	71-80	81-90	
MRI finding	renal cyst	2	0	1	1	0	1	5
	thyroid nodules	0	3	0	0	1	0	4
	ca thyroid	0	0	0	1	0	0	1
	plural effusion	0	0	3	1	0	0	4
	Fibroid	1	1	0	0	1	0	3
	ovarian cyst	0	4	0	0	0	0	4
	retroverted uterus	0	3	0	0	0	0	3
	nabothian cyst	0	1	0	0	0	0	1
	ectopic kidney	0	1	0	0	0	0	1
	endometrium thickening	1	0	0	0	0	0	1
	liver mass	0	2	1	0	0	1	4
	atrophic kidney	0	0	0	0	0	1	1
	Lymphadenopathy	0	0	0	0	2	0	2
	thyroid goiter	0	2	1	0	0	0	3
	bladder wall thickening	0	0	0	0	1	0	1
	multiple sclerosis	0	0	1	0	0	0	1
	colloid cyst	0	0	1	0	0	0	1
	tornwaldt cyst	0	0	1	0	0	1	2
	cervical cyst	0	1	0	0	0	0	1
	splenomegaly	0	0	1	0	0	0	1
	prostatic enlargment	0	0	1	2	1	0	4
	uterine fibroid	0	1	0	0	0	0	1
	splenic cyst	0	1	0	0	0	0	1
Total		4	20	11	5	6	4	50

P_value .088

Table(4.7) The distribution of incidental findings according patient history.

MRI finding * Patient history Cross tabulation					
		Patient history			Total
		lower back pain	neck pain	back pain in throcic area	
MRI finding	renal cyst	5	0	0	5
	thyroid nodules	0	3	1	4
	ca thyroid	0	1	0	1
	plural effusion	0	1	3	4
	Fibroid	3	0	0	3
	ovarian cyst	4	0	0	4
	retroverted uterus	3	0	0	3
	nabothian cyst	1	0	0	1
	ectopic kidney	1	0	0	1
	endometrium thickening	1	0	0	1
	liver mass	0	0	4	4
	atrophic kidney	1	0	0	1
	Lymph.adenopathy	0	2	0	2
	thyroid goiter	0	3	0	3
	bladder wall thickening	1	0	0	1
	multiple sclerosis	0	1	0	1
	colloid cyst	0	1	0	1
	tornwaldt cyst	0	2	0	2
	cervical cyst	0	0	1	1
	splenomegaly	0	0	1	1
	prostatic enlargement	4	0	0	4
	uterine fibroid	1	0	0	1
	splenic cyst	0	0	1	1
Total		25	14	11	50

P_value .000

Chapter Five

Discussion, Conclusion and Recommendations

Chapter Five

Discussion, Conclusion and Recommendations

5.1Discussion

This prospective study has been conducted in Khartoum State (almoalem medical city) in MRI department. Tocalculate the prevalence and clinical importance of incidental findings on spinal magnetic resonance imaging examinations

Nowadays, in parallel with the technological advances in radiological imaging and the excessed number of radiological examinations in daily routine, detection of incidental lesions has increased. Although studies on this subject have been started recently.

The results of this study showed that 50 patients (100%) had extra spinal finding including 27 females (54%) and 23 (46 %) males (Table and figure4.1) .Their ages ranged between 30 and 90years, with a mean of 56.08 ± 13.732years.(Table and figure 4.2,4.3).

The distribution of the extra-spinal incidental findings on spine MRI examinations, show that lumber spine was the most level of spine affected by disease (50%) then cervical spine(28%) and throcic spine(22%).(Table 4.4).This study found that there was a significant correlation between the frequency distributions of these findings on spine MRI examinations (P_value .000).(No previous study).

The distribution of incidental findings according to gender, show on MRI spine scan for female patients ovarian cyst(14.8 %), retroverted uterus(11.1%), fibroid(11.1%), thyroid nodules (11.1%)and liver mass (11.1%)were the most common incidental finding. While prostatic enlargement (17.4%) was detected most common incidental finding in male patients on MRI spine.(Table 4.5).This study found that there was a significant correlation between the frequency distributions of these findings and gender (P_value .038).This study disagree with Mohammad Sobhan *et al.,* (2016).

The distribution of incidental findings according to age,show that age group(41-50)years were that most age group affected by disease. (ovarian cyst 20% , retroverted uterus 15%, , liver mass10%,cervical cyst 5%) .(Table 4.6). This study found that there no a significant correlation between the frequency distributions of these findings and the patients’ age(P_value .088).This study disagree with Mohammad Sobhan *et al.*, (2016).

The distribution of incidental findings according patient history, the study show incidental finding was the main cause of lower back pain(50%), neck pain (28%)and back pain in thoracic area(22%).(Table 4.7). This study found that there was a significant correlation between the frequency distributions of these findings and patients history (P_value .000).(No previous study).

5.2 Conclusion

This study found that the mean of age was56.08 ± 13.732years and the most common age group was(41-50 years) .also study conclude that there was a significant correlation between the frequency distributions of these findings and patients history .

Also this study found that there was a significant correlation between the frequency distributions of incidental findings and gender (P_value .038).

It was observed that there is no a significant correlation between the frequency distributions of these findings and the patients' age.

Finally the study found MRI spine scan for female patients ovarian cyst) 14.8 %), were the most common incidental finding. While prostatic enlargement (17.4%) was detected most common incidental finding in male patients on MRI spine.

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5.3Recoomendation:

- Encouraging clinician-radiologist feedback, discussion, and further workup of certain cases are needed.

-Future studies should be done with several body characteristic in correlation with incidental finding.

-Researcher suggests that doing the same studies for all patients complaining of lower back pain to exclude major causes of lower back pain.

-Additional studies should be done with large sample size to improve statistical information and more accurate results.

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Appendices

Appendix:

Appendix (A)

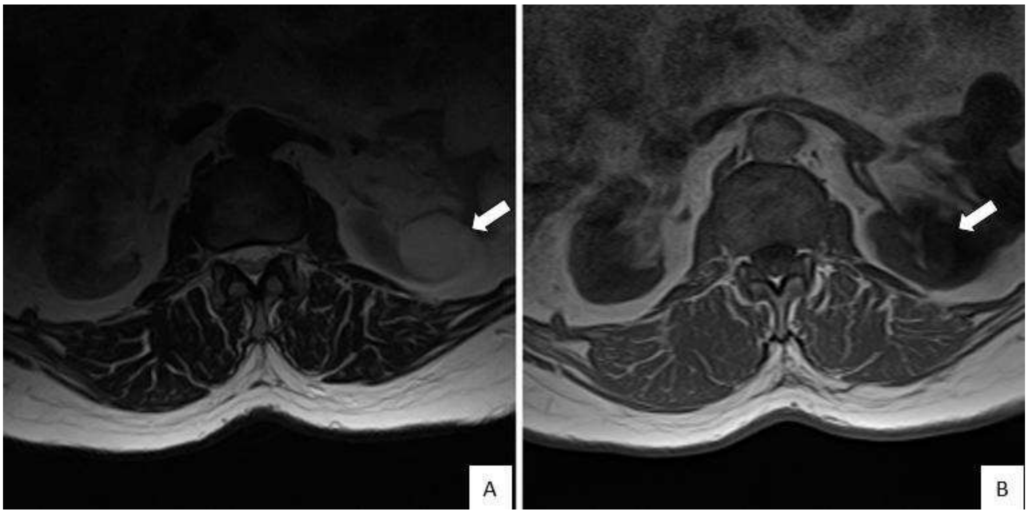
Data Collection Sheet

No	Age	Gender	Patient history	MRI Examination	MRI Findings

Appendix (B)

CASES

Case (1):



A 65-year-old male suffered from lower back pain.

MRI Findings:

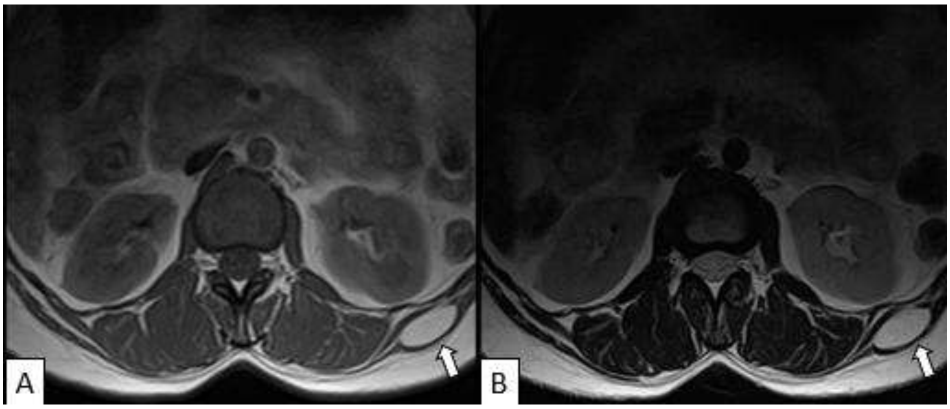
 Lumbar MRI demonstrates rounded lesion with regular thin wall.

 Appear hyperintense lesion on axial T2-weighted (A) and Hypointense T1-weighted images (B) on left kidney (arrows).

Impression:

Simple renal cyst in the left kidney

Case (2):



An 80-year-old male suffered from lower back pain.

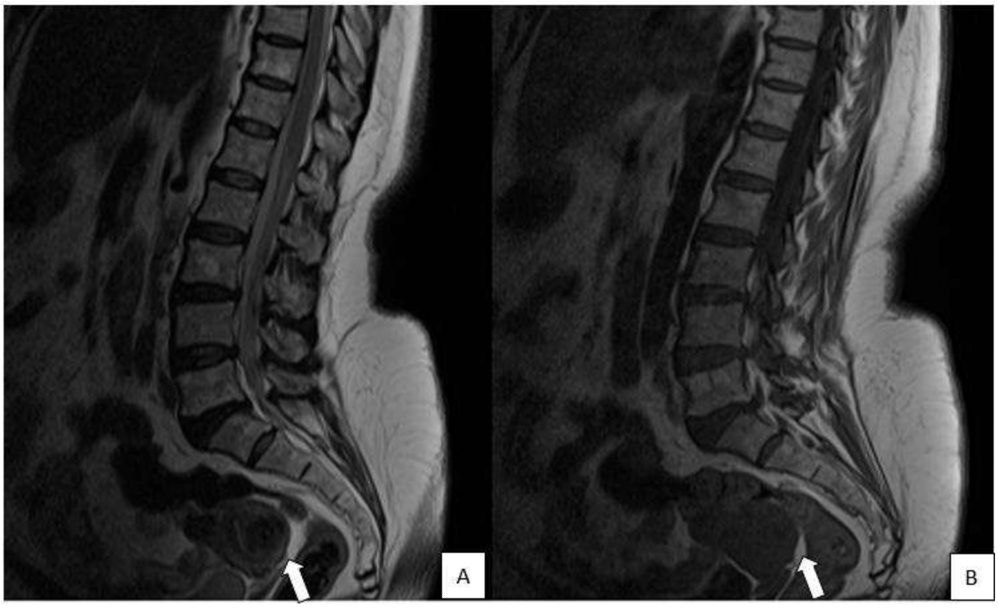
MRI Findings:

- Ovoid lesion appear Subcutaneous on the left side at level of L2
- This lesion shows as hyperintense in both T2 (A) and T1 (B)

Impression:

- Subcutaneous

Case (3):



A 45 years old, Female with 4 years history of lower back pain.

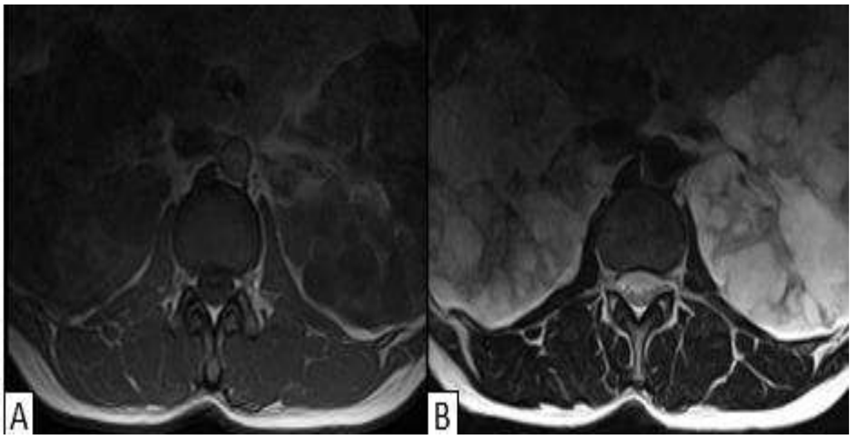
MRI Findings:

Lumbar MRI shows rounded, ill define hypointense lesion on sagittal T2-weighted (A) and T1-weighted images (B) (arrows)

Impression:

Uterine myoma

Case (4):



A 44-year-old male presented with lower back pain.

MRS Findings:

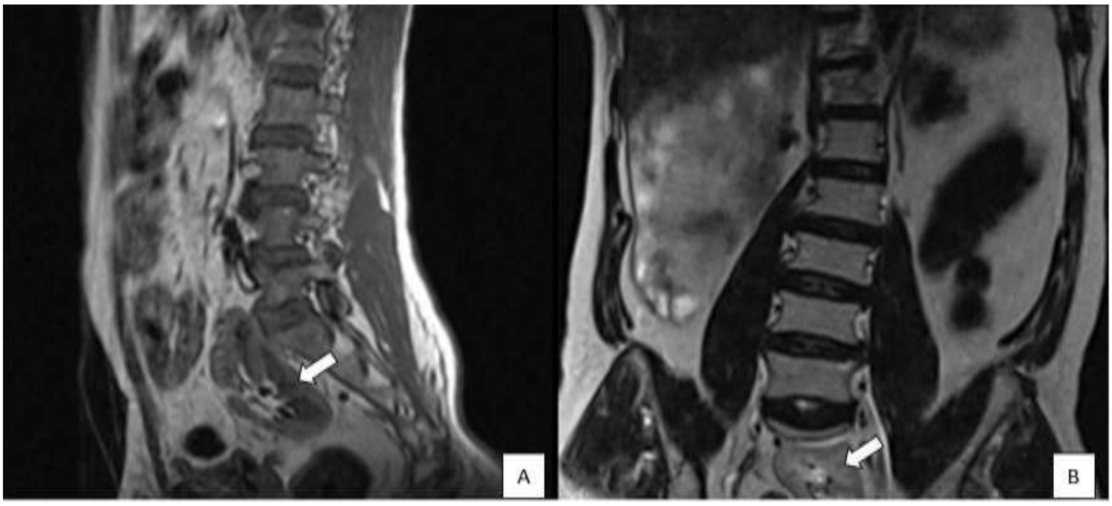
Simple cysts appear on both kidneys as rounded structures with very thin and regular walls.

Cysts shows low signal on T1 weighted image and high signal on T2 weighted images.

Impression:

Autosomal Dominant Polycystic Kidney Diseases (ADPKD)

Case (5):



A 59-year-old male presented with left sciatica.

MRI Findings:
- Normal native kidney located in a presacral position in pelvis.
- The left renal fossa is empty.

Impression:
- Ectopic pelvic kidney

Case (6):

A 36 year old, malewith history of neck pain during movement and occasional stiffness and giddiness since last 1 years.

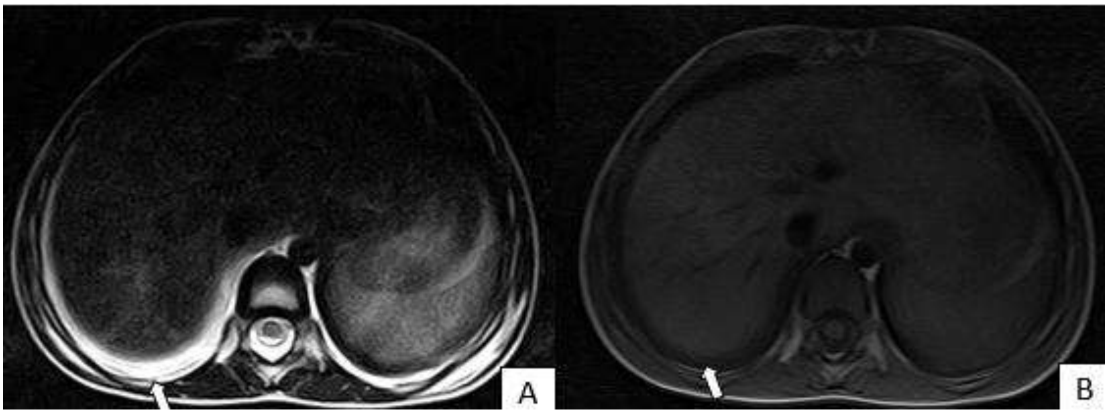
MRI Findings:

□□Well defined, rounded with mild enhancement mass located within nasopharyngeal area (Arrow).

Impression:

□□Tornwaldt Cyst

Case (7):



A 6 year old, male with history of back pain in thoracic area.

MRI Findings:

A small amount of effusion accumulates in the posterior aspect of the chest.

The accumulation of fluid is appear hyperintense in T2 weighted image (A) and hypointense in T1 weighted image (B) (arrow).

Impression:

Plural effusion

Case (8):

A 33 years old, Female c/o neck pain.

MRI Findings:

- Large right lobe thyroideal solitary nodule, nodule is slightly Hyperintense.
- Thyroid morphology is normal; light size increase of right lobe.
- Signal ofremaining glandular tissue is relatively homogenous.

Impression:

- Right Lobe thyroideal solitary nodule