بسم الله الرحمن الرحيم

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Msc. Degree in Diagnostic Radiology

Determination of Normal Diameters Range of Lumbar Spinal Canal in Sudanese Population

تحديد المعدل الطبيعي لأبعاد قناة العمود الفقري القطني لدي السودانين

Student Name :

Amel Alsaied Hasan Abd Elrahim

Supervisor :

Dr. Hussein Ahmed Hassan

Assistant Professor Of Radiography

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بسم الله الرحمن الرحيم

يرفع الله الذين آمنوا منكم والذين أوتوا العلم درجات

صدق الله العظيم

Dedication

I would like to dedicate this work to my mother who has been my constant source of inspiration. She gave me drives and discipline to tackle any task with enthusiasm and determination. Without her love and support this project would not have been possible.

Acknowledgement

I would like to acknowledge the inspirational ,instruction and guidance my supervisor

DR. HUSSEIN AHMED HASSAN .

Special thanks to ***DR.ZEINAB ELROUBI*** *who assisted and helped me in this research.*

List of abbreviations

MRI : Magnetic Resonance Imaging.

CT : Computerize Tomography.

DIA: Inter- Articuler Diameter .

DIL: Interligamentous Diameter.

DAP : Anterio-Posterior Diameter.

TR : Time to repeat.

TE : Time to echo.

T1 :T1 weighted image.

T2 : T2 weighted image.

Abstract

Lumbar spinal stenosis is a condition whereby either the spinal canal or one or more of the vertebral foramina (foraminal stenosis) becomes narrowed. If the narrowing is substantial, it causes compression of the spinal cord or spinal nerves, which causes the painful symptoms of lumbar spinal stenosis, including low back pain, buttock pain, and leg pain and numbness that is made worse with walking and relieved by resting

The main objective of this study to determine normal diameters range of lumbar spinal canal.

This study was performed in 100 patients who underwent MRI for lumbar spine complaining from lower back pain, but all diagnosis as normal MRI findings. In this study the measurement of lumbar canal were taken at L 3 in three different cuts from MRI lumbar spine images. The mean of antrio-posterior measurement in the axial cut (1.107±0.2 cm) , mean of transverse measurement in the axial cut (1.694±0.3 cm) , mean of anterio-posterior measurement in the sagittal cut (1.397 ±0.2cm) .

In this study The relationship between the patient age and Anterio-posterior measurement in the axial cut was found to be a weak indirect relationship ,with person correlation coefficient (- 0.111).

ملخص البحث

ضيق العمود الفقري القطني هو حاله تكون فيها القناة الشوكيه أو واحد أو أكثر من فتحات الفقرات صغيرة الحجم اذاكان بمقدار تضييق كبير فانه بسبب ضغط علي الحبل الشوكي أو الاعصاب في العمود الفقري، والذي يسبب اعراض مؤلمه بما في ذلك الام أسفل الظهر ،ألم الأرداف ، وألم في الساق وخدر في ألاطراف السفلي.

الهدف الرئيسي من هذه الدراسة هو تحديد المعدل الطبيعي لأبعاد قناة العمود الفقري القطني.

هذه الدراسه اجرت في 100 مريض يشكو من آلام أسفل العمود الفقري في هذه الدراسة تم قياس ثلاثة قياسات مختلفة في مستوي الفقره القطنيه الثالثه في صورة الرنين المغنطيسي للعمود الفقري القطني .مقدار القاسات في القياس الامامي الخلفي في المقطع المحوري (0.1.107 سم) وفي القياس العرضي في المقطع المحوري (1.694سم) وفي القياس الامامي الخلفي في المقطع الراسي (1.397سم).

في هذه الدراسه تم العثور علي ان العلاقه بين عمر المريض والقياسات المختلفه للقناة الشوكيه علاقه ضعيفه غير مباشره مع معامل ارتباط احصائي (0.111).

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Chapter One

Chapter One

Introduction

1.1 Lumbar spinal stenosis

Lumbar spinal stenosis is a condition whereby either the spinal canal (central stenosis) or one or more of the vertebral foramina becomes narrowed. If the narrowing is substantial, it causes compression of the spinal cord or spinal nerves, which causes the painful symptoms of lumbar spinal stenosis, including low back pain, buttock pain, and leg pain and numbness that is made worse with walking and relieved by resting.(Drake R et al. 2009)

Lumbar spinal stenosis can cause; pain, weakness, numbness, pain, and loss of sensation in the legs.

In most situations, the symptoms improve when the patient is sitting or leaning forward. Typically, painful sensations shoot down the legs with continued walking and diminish with resting. This particular activity-related symptom is sometimes referred to as pseudoclaudication because it mimics the true claudication of poor circulation from peripheral vascular disease. Standing and bending backward can make the symptoms worse. This is because bending forward increases the space in the spinal canal and vertebral foramina, while bending backward decreases this space. It is therefore more comfortable for patients to sit or lean forward. Patients are frequently unable to walk for long distances and often state that their symptoms are improved when bending forward while walking with the support of a walker or shopping cart.(Drake R et al. 2009)

The symptoms commonly worsen with time. This is because degenerative arthritis is a progressive disease that gradually becomes more severe with time. If left untreated, the compression on the nerves from lumbar spinal stenosis can lead to increasing weakness and loss of function of the legs. It can also lead to loss of bowel and bladder control and loss of sexual function.(Drake R et al. 2009)

Many other disorders can cause similar symptoms that mimic lumbar spinal stenosis including: diabetic neuropathy, peripheral vascular disease and vascular claudication.

1.2 Diagnosis of lumbar spinal stenosis

The medical evaluation begins with a complete medical history and physical examination to get clues to the diagnosis of lumbar spinal stenosis. During the medical history, the patient will be asked questions regarding symptoms, including how long they have been present, what makes them better or worse, what prior treatment the patient has had, and what other medical conditions they have. These questions can also help the doctor distinguish lumbar spinal stenosis from other disorders that may produce similar symptoms.(Drake R et al. 2009)

The physical examination often consists of testing the range of motion in the back and feeling for areas of tenderness in the back. The legs may be examined for range of motion, strength, sensation, reflexes, and pulses. The hips and knees may also be examined because problems with these joints can often causes symptoms similar to those of lumbar spinal stenosis.

After the examination, the physician may order imaging studies to detect anatomic signs of lumbar spinal stenosis. This often begins with plain X-rays of the spine. The doctors may also order an X-ray of the patient's pelvis and hips, depending on findings from the physical examination. The X-rays can show the doctor various signs associated with spinal stenosis, including loss of the normal intervertebral disc height, the presence of bone spurs (osteophytes), and spinal instability (abnormal motion between the vertebrae). The ultimate diagnosis of lumbar spinal stenosis is made by an MRI scan or CT scan .These are more advanced tests that are used to visualize the nerves in the lower back and detect if they are being compressed from lumbar spinal stenosis.(Drake R et al. 2009)

1.3 Statement of problem:

There is a need for consensus on well-defined, unambiguous radiological criteria to define lumbar spinal stenosis in order to improve diagnostic accuracy and to formulate reliable inclusion criteria for clinical studies.

1.4 Objectives

The general objectives of this study To determine normal range of lumbar spinal canal.

Specific objectives

- To develop criteria for Sudanese population.
- To determine the mean values of normal lumbar spinal canal diameter in Sudanese population.
- To determine the mean values that defines lumbar spinal stenosis in Sudanese population.
- To determine the effect of age in lumbar spinal canal measurement.
- To improve diagnostic accuracy.

1.5 Overview of the study:

The research contains five chapters: Chapter one include introduction, statement of problem, objectives, significant of the study and overview.

Chapter two include lumbar spine anatomy, lumbar spine stenosis, diagnosis of lumbar spinal stenosis and literature review , Chapter three material and methodology ,Chapter four include results of the study and Chapter five include discussion ,conclusion, recommendation, references and appendix.

Chapter Two

CHAPTER TWO

Literature review

Theoretical background

2.1Anatomy

The lumbar spine consists of 5 moveable vertebrae numbered L1-L5. The complex anatomy of the lumbar spine is a remarkable combination of these strong vertebrae, multiple bony elements linked by joint capsules, and flexible ligaments/tendons, large muscles, and highly sensitive nerves. It also has a complicated innervation and vascular supply.(Drake R et al. 2009)

The lumbar spine is designed to be incredibly strong, protecting the highly sensitive spinal cord and spinal nerve roots. At the same time, it is highly flexible, providing for mobility in many different planes including flexion, extension, side bending, and rotation. (Kirkaldy-Willis WH& Bernard TN Jr.1999)

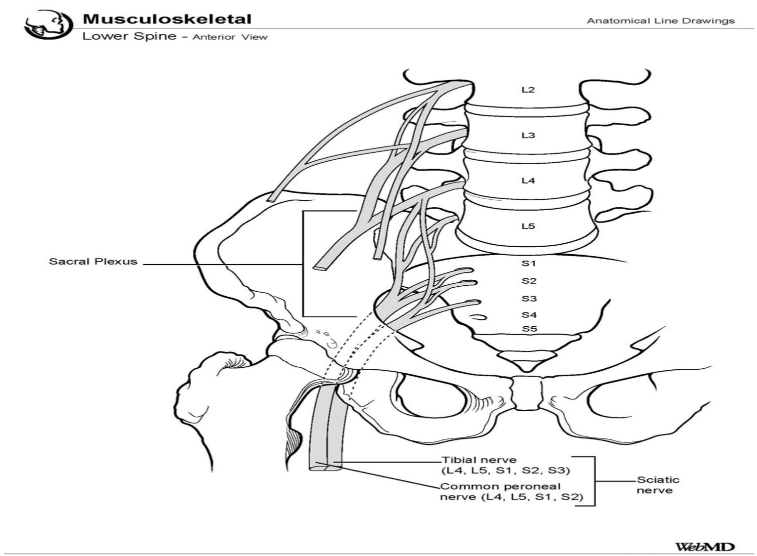


Figure 2:1 image show lower lumbar spine.

2.1.1Bones

The lumbar vertebrae, numbered L1-L5, have a vertical height that is less than their horizontal diameter. They are composed of the following 3 functional parts:

- The vertebral body, designed to bear weight
- The vertebral (neural) arch, designed to protect the neural elements
- The bony processes (spinous and transverse), which function to increase the efficiency of muscle action

The lumbar vertebral bodies are distinguished from the thoracic bodies by the absence of rib facets. The lumbar vertebral bodies (vertebrae) are the heaviest components, connected together by the intervertebral discs. The size of the vertebral body increases from L1 to L5, indicative of the increasing loads that each lower lumbar vertebra absorbs. Of note, the L5 vertebra has the heaviest body, smallest spinous process, and thickest transverse process . (Wong DA& Transfeldt E. 2007)

The intervertebral discal surface of an adult vertebra contains a ring of cortical bone peripherally termed the epiphysial ring. This ring acts as a growth zone in the young while anchoring the attachment of the annular fibers in adults. A hyaline cartilage plate lies within the confines of this epiphysial ring(Wong DA& Transfeldt E. 2007)

Each vertebral arch is composed of 2 pedicles, 2 laminae, and 7 different bony processes (1 spinous, 4 articular, 2 transverse) (see the following image), joined together by facet joints and ligaments. (Wong DA& Transfeldt E. 2007)

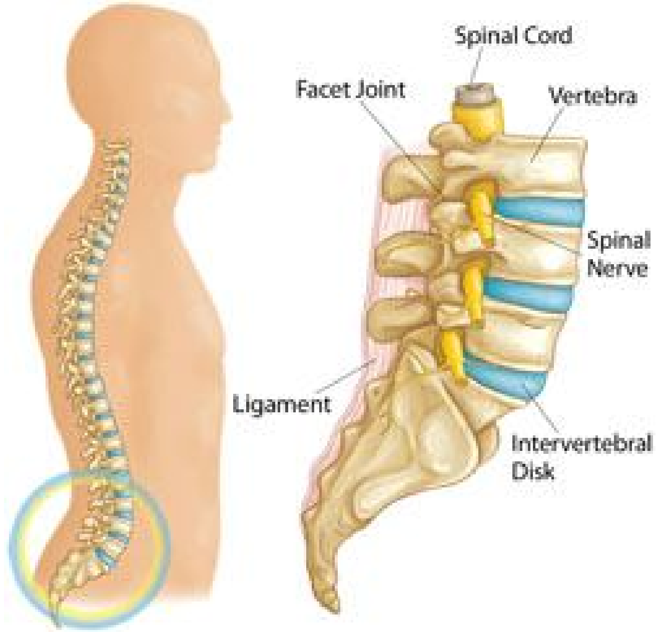


Figure 2.2 image shows of lumbar spine.(AAOS)

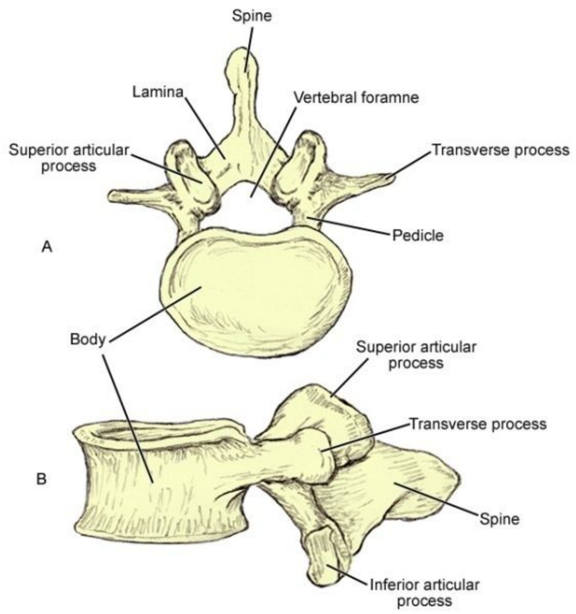


Figure 2.3 image show anatomical structure of lumbar vertebra (emedicine)

The pedicle, strong and directed posteriorly, joins the arch to the posterolateral body. It is anchored to the cephalad portion of the body and function as a protective cover for the cauda equina contents. The concavities in the cephalad and caudal surfaces of the pedicle are termed vertebral notches. (Rosse C& Gaddum-Rosse P. 1997)

Beneath each lumbar vertebra, a pair of intervertebral (neural) foramina with the same number designations can be found, such that the L1 neural foramina are located just below the L1 vertebra. Each foramen is bounded superiorly and inferiorly by the pedicle, anteriorly by the intervertebral disc and vertebral body, and posteriorly by facet joints. The same numbered spinal nerve root, recurrent meningeal nerves, and radicular blood vessels pass through each foramen. Five lumbar spinal nerve roots are found on each side. (Rosse C& Gaddum-Rosse P. 1997)

The broad and strong laminae are the plates that extend posteromedially from the pedicle. The oblong shaped spinous processes are directed posteriorly from the union of the laminae . (Rosse C& Gaddum-Rosse P. 1997)

The 2 superior (directed posteromedially) and inferior (directed anterolaterally) articular processes, labeled SAP and IAP, respectively, extend cranially and caudally from the point where the pedicles and laminae join. The facet or zygapophyseal joints are in a parasagittal plane. When viewed in an oblique projection, the outline of the facets and the pars interarticularis appear like the neck of a Scottie dog. (Rosse C& Gaddum-Rosse P. 1997)

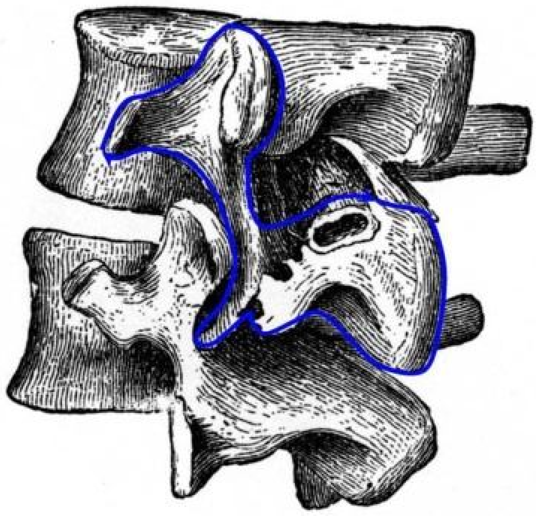


Figure 2.4 image shows outline of Scottie dog in an oblique projection.

Between the superior and inferior articular processes, 2 transverse processes are projected laterally that are long, slender, and strong. They have an upper tubercle at the junction with the superior articular process (mammillary process) and an inferior tubercle at the base of the process (accessory process). These bony protuberances are sites of attachments of deep back muscles.(Pansky B. 1996)

2.1.2Vertebral canal

The tubular vertebral canal contains the spinal cord, its meninges, spinal nerve roots, and blood vessels supplying the cord, meninges, vertebrae, joints, muscles, and ligaments. Both potential and real spaces intervene between the spinal cord, meninges, and osseoligamentous canal walls. The canal is enclosed within its column and formed by the juxtaposition of the vertebral foramen, lined up with one another in series. The vertebral bodies and discs make up the anterior wall (with the PLL draped over it), whereas the laminae and ligamentum flavum border the canal posteriorly. Laterally, spinal nerves and vessels travel through the intervertebral foramen. .(Pansky B. 1996)

2.1.3Meninges and related spaces

The meninges consist of 3 layers: the pia, arachnoid, and dura mater. Together, they enhance the protection of the spinal cord and roots. The dura is the most superficial but resilient layer. The pia and arachnoid, together termed the leptomeninges, are frail. The spinal cord, roots, and nerve rootlets are closely invested by the pia. The dura and arachnoid together form a loose sheath (termed dural/thecal sac) around these structures, separated from the canal walls by the epidural space .(Pansky B. 1996)

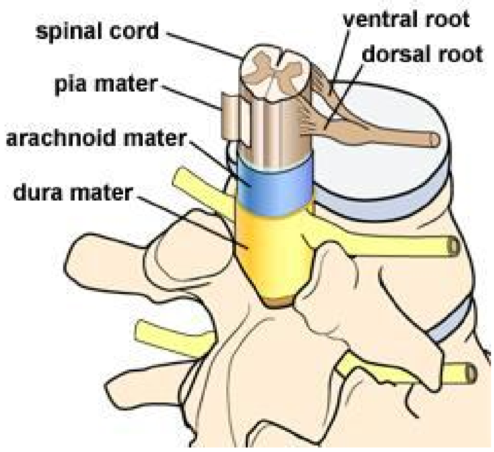


Figure 2.5 image shows meninges layers.(spinesurgery)

2.1.4Spinal cord

Other than the brain, the spinal cord is one of the 2 anatomic components of the central nervous system (CNS). It is the major reflex center and conduction pathway between the brain and the body. As noted earlier, the spinal cord normally terminates as the conus medullaris within the lumbar spinal canal at the lower margin of the L2 vertebra, although variability of the most caudal extension exists (see the following image) .(Pansky B. 1996)

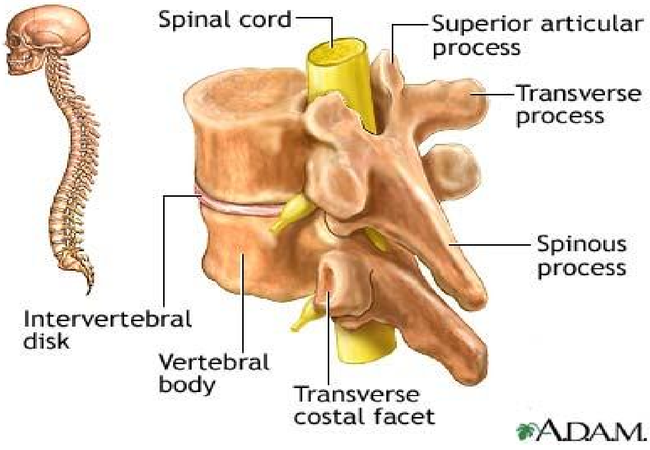


Figure 2.6 Image shows spine cord .

In a cadaveric study of 129 cadaveric specimens, the spinal cord terminated at L2 in 60%, L1 in 30%, and L3 in 10% of specimens. Differential growth rates in the spinal cord and the vertebral canal are the cause of these disparities. Exceptions also include patients with congenital spinal deformities known as spina bifida. In such patients, the conus medullaris can be displaced downward to the middle or lower lumbar spine. (Lippincott Williams & Wilkins, 2007)

2.1.5 Lumbar spinal stenosis

Lumbar spinal stenosis is a condition whereby either the spinal canal (central stenosis) or one or more of the vertebral foramina (foraminal stenosis) becomes narrowed. If the narrowing is substantial, it causes compression of the spinal cord or spinal nerves, which causes the painful symptoms of lumbar spinal stenosis, including low back pain, buttock pain, and leg pain and numbness that is made worse with walking and relieved by resting. (Lippincott Williams & Wilkins, 2007)

Lumbar spinal stenosis can cause low back pain, weakness, numbness, pain, and loss of sensation in the legs.

In most situations, the symptoms improve when the patient is sitting or leaning forward. Typically, painful sensations shoot down the legs with continued walking and diminish with resting. This particular activity-related symptom is sometimes referred to as pseudoclaudication because it mimics the true claudication of poor circulation from peripheral vascular disease. Standing and bending backward can make the symptoms worse. This is because bending forward increases the space in the spinal canal and vertebral foramina, while bending backward decreases this space. It is therefore more comfortable for patients to sit or lean forward. Patients are frequently unable to walk for long distances and often state that their symptoms are improved when bending forward while walking with the support of a walker or shopping cart. (Lippincott Williams & Wilkins, 2007)

The symptoms commonly worsen with time. This is because degenerative arthritis is a progressive disease that gradually becomes more severe with time. If left untreated, the compression on the nerves from lumbar spinal stenosis can lead to increasing weakness and loss of function of the legs. It can also lead to loss of bowel and bladder control and loss of sexual function. (Lippincott Williams & Wilkins, 2007)

Many other disorders can cause similar symptoms that mimic lumbar spinal stenosis including :diabetic neuropathy,peripheral vascular disease, and vascular claudication.

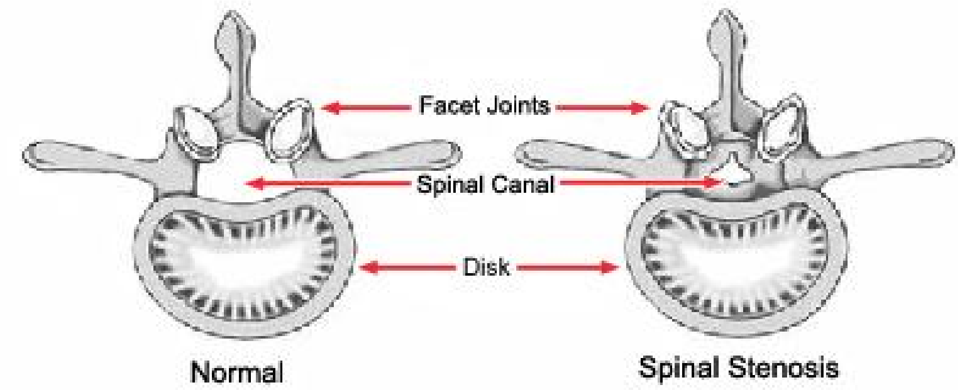


Figure 2.7 Image shows spinal stenosis.(AAOS)

2.1.5.1 Causes of lumbar spinal stenosis

The most common cause of lumbar spinal stenosis is degenerative arthritis and degenerative disc disease. As with other joints in the body, arthritis commonly occurs in the spine as part of the normal aging process and as a result of osteoarthritis. This can lead to loss of the cartilage between the bones at the joints, formation of bone spurs (osteophytes), loss of the normal height of the discs between the vertebrae of the spine (degenerative disc disease, also known as spondylosis), and overgrowth (hypertrophy) of the ligamentous structures. Further degeneration of the lumbar discs can lead to slippage of one vertebra on another, a process referred to as spondylolisthesis. Each of these processes can reduce the normal space available for the nerves in the spinal canal and result in direct pressure on nerve tissues to cause the symptoms of lumbar spinal stenosis.(Drake R et al. 2009)

Lumbar spinal stenosis can also be caused by other conditions that decrease the space of the spinal canal or vertebral foramen. These can include

- tumor of the local structures or metastatic tumors (tumors that originated in another part of the body and spread to this location),
- infection,
- various metabolic bone disorders that cause bone growth, such as Paget's disease of bone.

These causes, however, are much less common than degenerative arthritis.(Drake R et al. 2009)

2.1.5.2Diagnosis of lumbar spinal stenosis

The medical evaluation begins with a complete medical history and physical examination to get clues to the diagnosis of lumbar spinal stenosis. During the medical history, the patient will be asked questions regarding symptoms, including how long they have been present, what makes them better or worse, what prior treatment the patient has had, and what other medical conditions they have. These questions can also help the doctor distinguish lumbar spinal stenosis from other disorders that may produce similar symptoms (Drake R et al. 2009)

The physical examination often consists of testing the range of motion in the back and feeling for areas of tenderness in the back. The legs may be examined for range of motion, strength, sensation, reflexes, and pulses. The hips and knees may also be examined because problems with these joints can often causes symptoms similar to those of lumbar spinal stenosis.

After the examination, the physician may order imaging studies to detect anatomic signs of lumbar spinal stenosis. This often begins with plain X-rays of the spine. The doctors may also order an X-ray of the patient's pelvis and hips, depending on findings from the physical examination. The X-rays can show the doctor various signs associated with spinal stenosis, including loss of the normal intervertebral disc height, the presence of bone spurs (osteophytes), and spinal instability (abnormal motion between the vertebrae). The ultimate diagnosis of lumbar spinal stenosis is made by an MRI scan (magnetic resonance imagining scan) or CT scan (CAT scan or computerized axial tomography). These are more advanced tests that are used to visualize the nerves in the lower back and detect if they are being compressed from lumbar spinal stenosis.(Drake R et al. 2009)

In some cases, special nerve tests, including electromyogram (EMG) or nerve conduction studies, may be ordered. These tests can identify damage to or irritation of the nerves caused by long-term compression from lumbar spinal stenosis. These tests can also help determine exactly which nerves are involved.(Drake R et al. 2009)

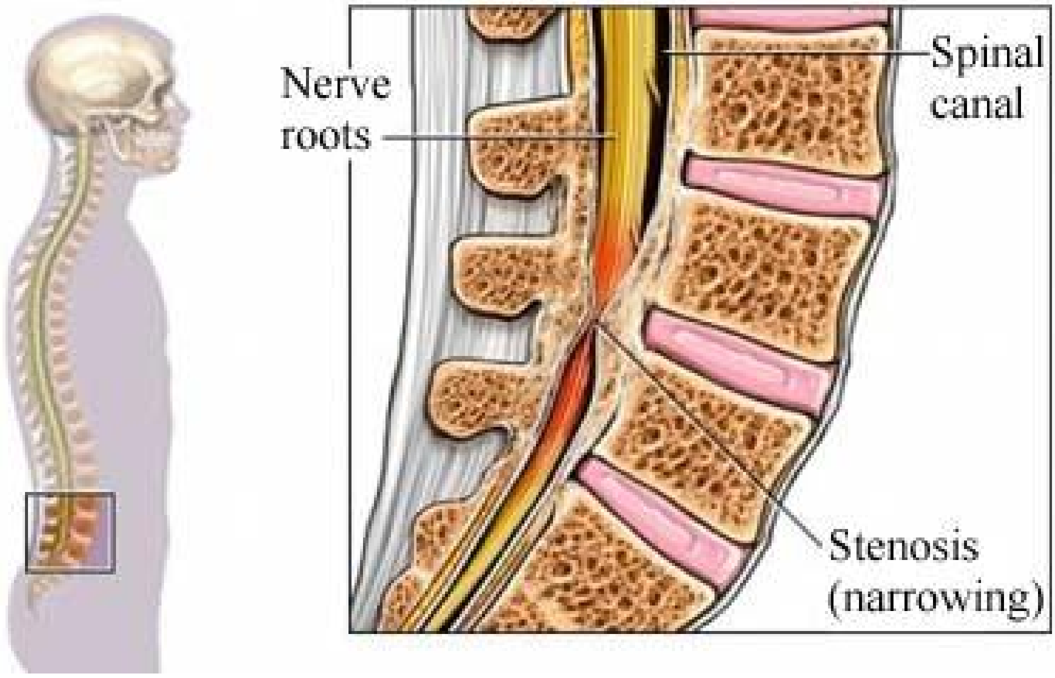


Figure 2.8 Image shows spinal stenosis. (nucleusinc)

2.2 Previous study

2.2.1Radiologic Criteria for the Diagnosis of Spinal Stenosis: Results of a Delphi Survey By Nadja Mamisch , Martin Brumann and Juerg Hodler , For the Lumbar Spinal Stenosis Outcome Study Working Group ZurichFrom the Department of Diagnostic and Interventional Radiology found that anterioposterior length of the spinal canal in millimeters from the posterior edge of the intervertebral disk edge to the most posterior point in the bony canal in the axial plane(< 15 mm and 17 mm) .in ct anterioposterior length of the spinal canal in millimeters from the posterior edge of the intervertebral disk edge to the most posterior point in the bony canal in the axial plane (13mm).Transver diameter of osseous spinal canal in MRI <15 mm .

2.2.2Quantitative Radiologic Criteria for the Diagnosis of Lumbar Spinal Stenosis By Johann Steurer, Simon Roner, Ralph Gnannt, Juerg Hodler and On behalf of the LumbSten Research Collaboration, Zurich, Switzerland Beside symptoms and clinical signs radiological findings are crucial in the diagnosis of lumbar spinal stenosis (LSS). We investigate which quantitative radiological signs are described in the literature and which radilogical criteria are used to establish inclusion criteria in clincical studies evaluating different treatments in patients with lumbar spinal stenosis.

Results: 25 studies reporting on radiological signs of LSS and four systematic reviews related to the evaluation of different treatments were found. Ten different parameters were identified to quantify lumbar spinal stenosis. Most often reported measures for central stenosis were antero-posterior diameter (< 10 mm) and cross-sectional area (< 70 mm^2) of spinal canal.

Discussion:The result of this literature review documents a remarkable list of various quantitative radiologic criteria applied to describe lumbar spinal stenosis. Measurement of antero-posterior diameter and the cross sectional area of spinal canal with varying cut-off levels are the most often applied criteria for central stenosis.

Lumbar spinal stenosis is a common disorder and the most frequent indication for lumbar spine surgery in the elderly. Due to the demographic changes the number of patients with this disorder will increase. There is a need for a consensus among experts on well defined, unambiguous radiological and clinical criteria to define lumbar spinal stenosis. The criteria, reported in this paper, can be used as a source for the development of radiological criteria.

Conclusions: There is a need for consensus on well-defined, unambiguous radiological criteria to define lumbar spinal stenosis in order to improve diagnostic accuracy and to formulate reliable inclusion criteria for clinical studies.

2.2.3 Evaluation of Lumbar Canal Diameter and Areas by Computed Tomography by Zinat Miabi and Omid Mashrabi in (2011) aimed to Determining normal ranges of spinal canal diameters, we can make initial diagnosis in persons who have lower diameters of spinal canal. These persons are predisposed to spinal canal stenosis that is a major cause of spinal radiculopathies. In different studies performed in several countries, minimum and maximum ranges of spinal canal diameters were different for each population. In this study, we tried to determine the mean values of normal spinal canal diameters and areas Â in Tabriz and its suburb. Thirty nine healthy, young to mid-age cases were selected. Our study was focused on L3-L4 and L4-L5. The following parameters were measured: the area of cross-section of the vertebral body, the area of cross-section of the dural sac, interarticular diameter, interligamentous diameter, antero-posterior diameter of the lumbar canal, inter-pedicular diameter and the area of cross-section of the vertebral canal. A correlation between the parameters studied and the height of subjects was significant for interligamentous diameter (for L3/L4 and L4/L5) and interarticular diameter (only at L3/L4), cross-section area of the vertebrae (both L3 and L4), cross-section area of vertebral canal (only at L5 level), area of dural sac (at L3/L4 and L4). It was suggested that these diameters and areas should be interpreted as unction of height of the subject. Most of diameters studied had smaller means than those in previous studies. This can be attributed to differences between populations and it can be interpreted as predisposition to spinal canal stenosis in our population.

Materials And Methods: This study was performed on 39 subjects (16 males and 23 female) with age ranging from 18-40. Study cases were selected from patients referred to perform CT scan of other parts of the body and had no low back pain or other problem attributable to lumbar spine.

Technique: Examinations were made using a GE CT-MAX II scanner. Our study was focused on L3-L4 and L4-L5 levels because these levels are studied most frequently in CT-scan examinations. Meanwhile, examination of L5-S1 level is difficult because of technical limitations (angle of gantry in our scanner was limited to 20°). For each, we took a lateral scout view of lumbar spinal canal. Then cuts were made perpendicular to the posterior wall of the vertebral body at each level. About 2 mm thickness was used. For each level (L3-L4 and L4-L5) we acquired a cut through highest part of intervertebral foramen, a cut through the disc and a cut through the middle 3rd of the lower vertebral body. Images were reconstructed in high resolution and printed on film with a window for bony structures (level: 300, width: 1500) and a window for soft tissues (level: 80, width: 1000) and transferred to a PC using an HP transparent flatbed scanner. Measurements were made in adobe Photoshop and converted to actual sizes (mm) using the scale printed with each image.

Parameters studied: Cuts below the pedicles. These cuts were made through the highest part of the intervertebral foramina. The following parameters were measured: the area of cross-section of the vertebral body (SCV-L3 and SCV-L4); the area of cross-section of the dural sac (SF-L3 and SF-L4).

These cuts were made at the level of the middle of the disc and are concerned with the intervertebral articulation. The following parameters were measured: Interarticular diameter (DIA-L3/L4 and DIA-L4/L5); interligamentous diameter (DIL-L3/L4 and DIL-L4/L5); area of cross-section of the dural sac (SE-L3/L4 and SF-L4/L5). Measurements were made as greatest diameter between the internal limits of 2 articulations for DIA and the distance between internal borders of the soft parts of the articulations (capsules and ligament flavum) on the line joining the articulations for DIL.

These cuts were made through the third of the vertebral body and show a complete vertebral body ring. The following parameters were measured: antero-posterior diameter of the lumbar canal (DAP-L4 and DAP-L5); inter-pedicular diameter (DIP-L4 and DIP-L5); the area of cross-section of the vertebral canal (SC-L4 and SC-L5). Measurements were made as the distance from the mid-point of the posterior wall of the vertebral body to the anterior border of the point of union of the 2 laminae DAP and the greatest distance between the inner borders of the 2 pedicles for DIP. Measurements of SCV, DAP, DIP, SC and DIA were made on images printed using bony structures window and level, whereas those for SF and DIL were made on images with soft tissue window.

Statistical method: The presence of any significant correlation between the parameters that were measured and the height of the subjects was sought. Coefficients of correlation and p-values corresponding to these coefficients were calculated using SPSS Windows software. A coefficient of correlation was considered significant (not occurring by chance) when the corresponding $p \leq 0.050$ (5%).

Results:Mean age and height of patients were 30±6 year and 167±9.15 cm, respectively. Mean area of vertebral body of L3 and L4 was 1515±254.6 mm^2 and 1470±255.4 mm^2, respectively. Mean area of dural sac of L3 and L4 was 142±30.7 mm^2 and 128±36.4 mm^2, respectively .

Mean of interarticular diameter (DIA), interlig-amentous diameter (DIL), antero-posterior diameter (DSP), interpedicular ciameter (DIP).

Significant liner correlation was found between height and area of vertebral body of L3 (p = 0.008) and L4 (p = 0.007), area of spinal canal of L5 (p = 0.012), interarticular diameter of L3/L4 (p = 0.011), area of dural sac of L3/L4 (p = 0.033), interligamentous diameter of L3/L4 (p = 0.001) and L4/L5 (p = 0.046), respectively

Conclusion :A study of lumbar spinal canal at L3-5 level was performed on 39 cases. A significant correlation was found between height of subjects and cross-sectional areas of vertebral body, spinal canal and dural sac and interligamentous and interarticular diameters.

Some diameters that are important in examination of spinal canal stenosis were not significantly correlated with height of subjects (DAP-L4 and DAP-L5). It is important to note that in our study antero-posterior diameter of spinal canal had a mean value slightly lesser than previous studies in other populations (Gouzien et al., 1990). Meanwhile (and may be more important) in our series we had a considerable number of subjects with DAP value lesser than accepted minimum value in other populations. This can be attributed to differences between populations and it can be interpreted as predisposition to spinal canal stenosis in our population. Most of the other parameters had a lesser mean value than other population. This can also be attributed to differences between populations. It is suggested that there can be significant correlation between diameters and areas of spinal canal at upper levels and height of subjects.

Chapter Three

Chapter Three

Materials and Methods

3.1Material

3.1.1Study Population:

This study was performed on 100 subjects (52 males and 48 female). Study cases were selected from patients age range (30-70) referred for MRI scan of lumbar spine and had low back.

3.1.2 Machine used:

TOSHIBA MRI (1.5 tesla) scanner spine array coil used in alzaytona specialized hospital.

3. 2 Methods

3.2.1 Technique used:

For all patient sagittal T1 (TR=660,TE=30) , axial T2 (TR=3690,TE=120) are obtained using slice thickness 5mm for all planes.

3.2.2 Images interpretation:

The transverse diameter of osseous spinal canal was measured from inner border of the pedicles in axial image figure (3.1) and the antero-posterior diameter was measured posterior from the junction of lamina and anterior from border of body of vertebra in axial image figure(3.3).The antero-posterior diameter of osseous diameter also measured from the posterior border of vertebra to the pedicles in the mid sagittal image figure (3.2).

3.2.3 Statistical method:

All calculations were made by using SPSS windows software.

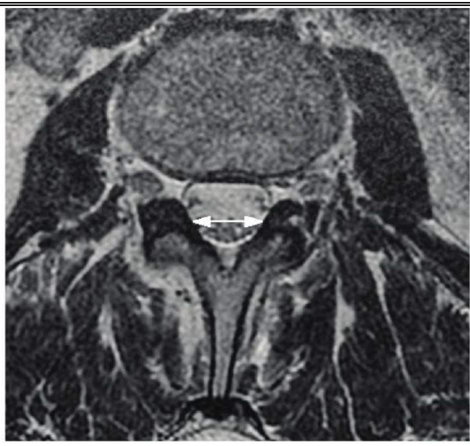


Figure 3.1 T2 weighted transaxial fast spin echo MR image of the lumbar spine at the level of L3. The white arrow indicates the transverse diameter of the osseous spinal canal.

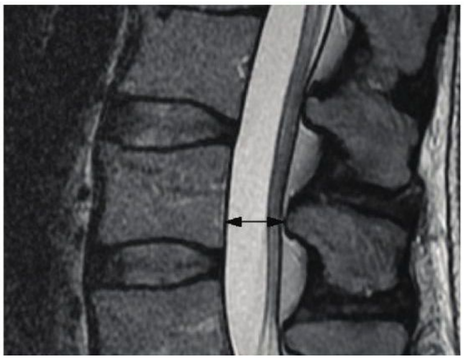


Figure 3.2 T2 weighted sagittal fast spin echo MR image of the middle lumbar spine. The black arrow indicates the antero-posterior diameter of the osseous spinal canal.

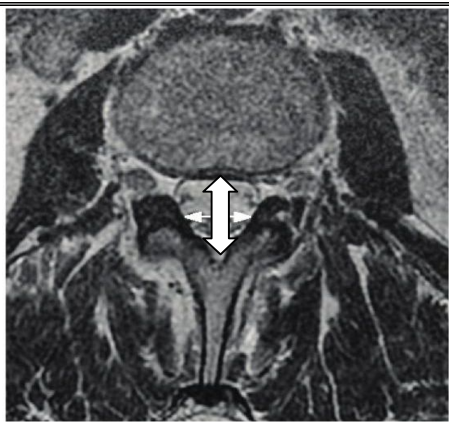


Figure 3.3 T2 weighted transaxial fast spin echo MR image of the lumbar spine at the level of L3. The white arrow indicates anterioposterior length of the spinal canal in millimeters from the posterior edge of the intervertebral disk edge to the most posterior point in the bony canal in the axial plane.

Chapter Four

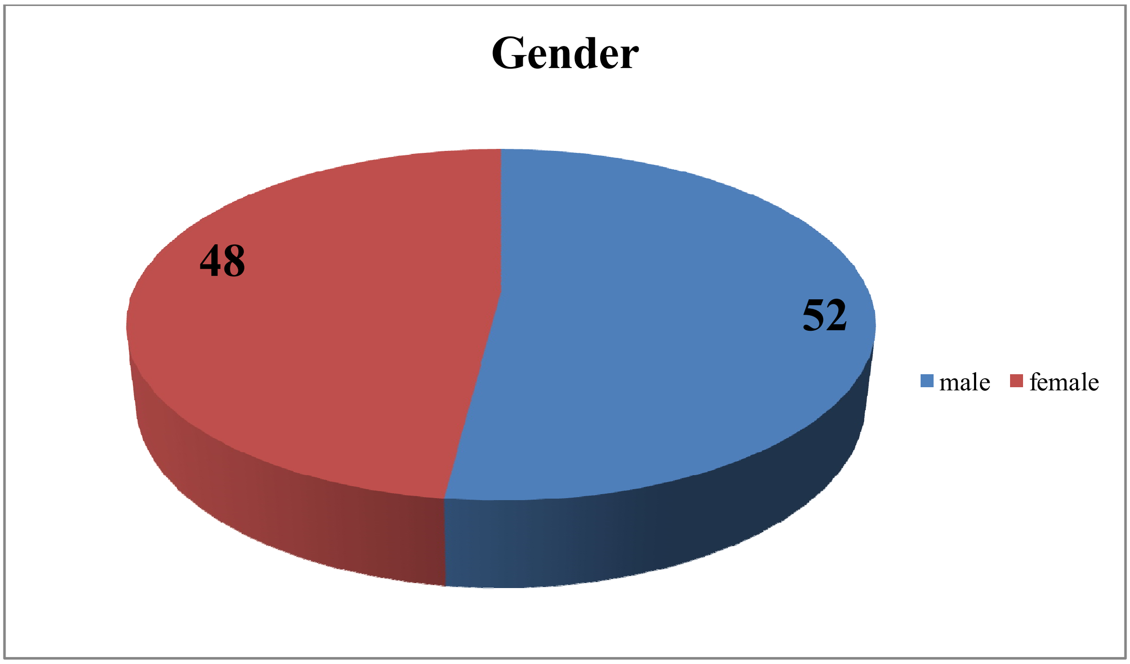
Chapter 4

Results

In the following pages prentation of collected data in tables and graphs

Table 4.1 :shows frequency of gender.

Gender	Frequency	Percent
Male	52	52.0
Female	48	48.0



Graph 4.1 shows frequency of gender.

Age

Table 4.2 : shows age distributions

	Age
Mean	46.39
Std. Deviation	12.503
Minimum	23
Maximum	71

Table 4.3 shows frequency of age group

Age group	**frequency**
30	15
31-40	19
41-50	28
51-60	25
61-70	13

Measurements

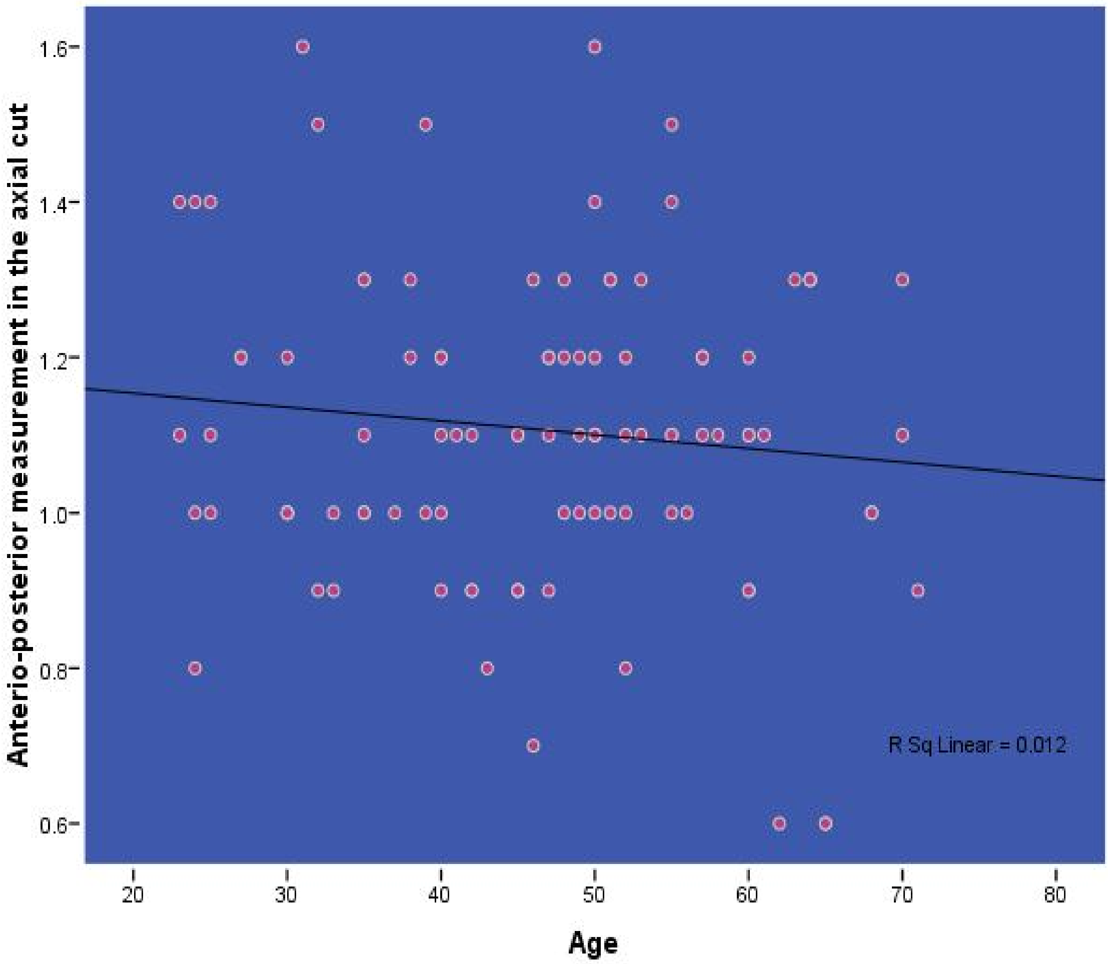
Table 4.4 : shows study group AP and transverse in axial image and AP in sagittal image .

Cuts / Statistics	Anterio-posterior measurement in the axial cut	Transverse measurement in the axial cut	Anterio-posterior measurement in the sagittal cut
Mean	1.107	1.694	1.397
Std. Deviation	.2001	.3038	.2363
Minimum	.6	1.0	.9
Maximum	1.6	2.5	2.0

The correlation coefficient

Table 4.5: shows the correlations coefficient between age and anterio-posterior measurement in axial cut

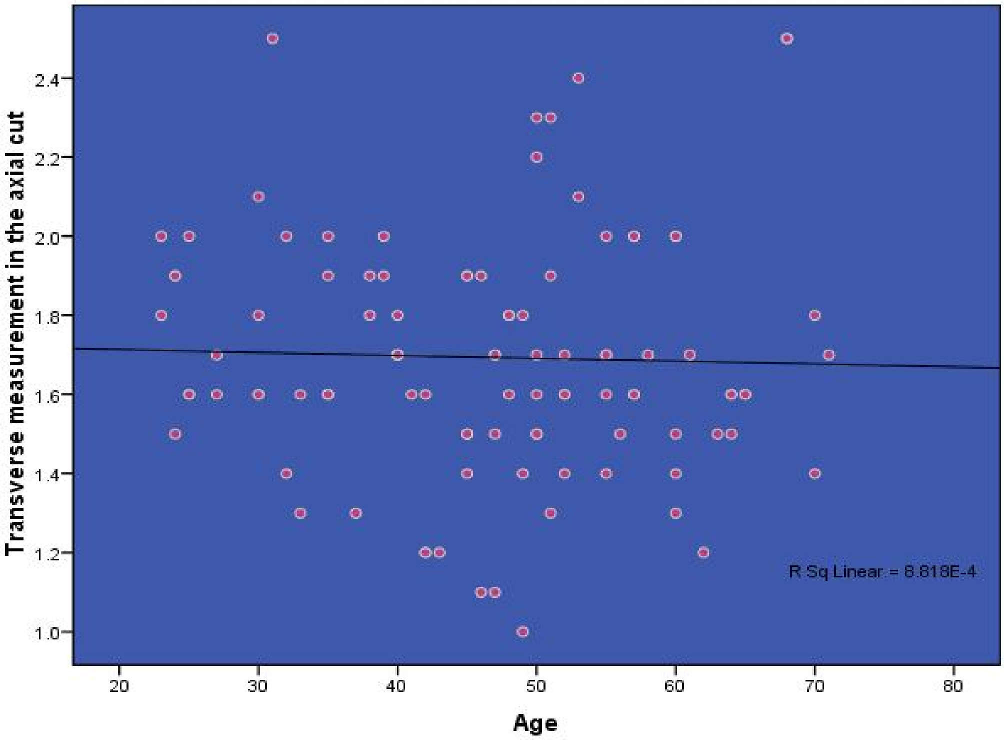
Correlations			
		Age	Anterio-posterior measurement in the axial cut
Age	Pearson Correlation	1	-.111
	Sig. (2-tailed)		.272
	N	100	100
Anterio-posterior measurement in the axial cut	Pearson Correlation	-.111	1
	Sig. (2-tailed)	.272	
	N	100	100



Graph 4.2: shows the relationship between age and anterio-posterior measurement in axial cut .

Table 4.6: shows the correlations coefficient between age and Transverse measurement in the axial cut

Correlations			
		Age	Transverse measurement in the axial cut
Age	Pearson Correlation	1	-.030
	Sig. (2-tailed)		.769
	N	100	100
Transverse measurement in the axial cut	Pearson Correlation	-.030	1
	Sig. (2-tailed)	.769	
	N	100	100



Graph 4.3: shows the relationship between age and Transverse measurement in axial cut .

Table 4.7: shows the correlations coefficient between age and Transverse measurement in the sagittal cut

Correlations			
		Age	Anterio-posterior measurement in the sagittal cut
Age	Pearson Correlation	1	-.056
	Sig. (2-tailed)		.582
	N	100	100
Anterio-posterior measurement in the sagittal cut	Pearson Correlation	-.056	1
	Sig. (2-tailed)	.582	
	N	100	100

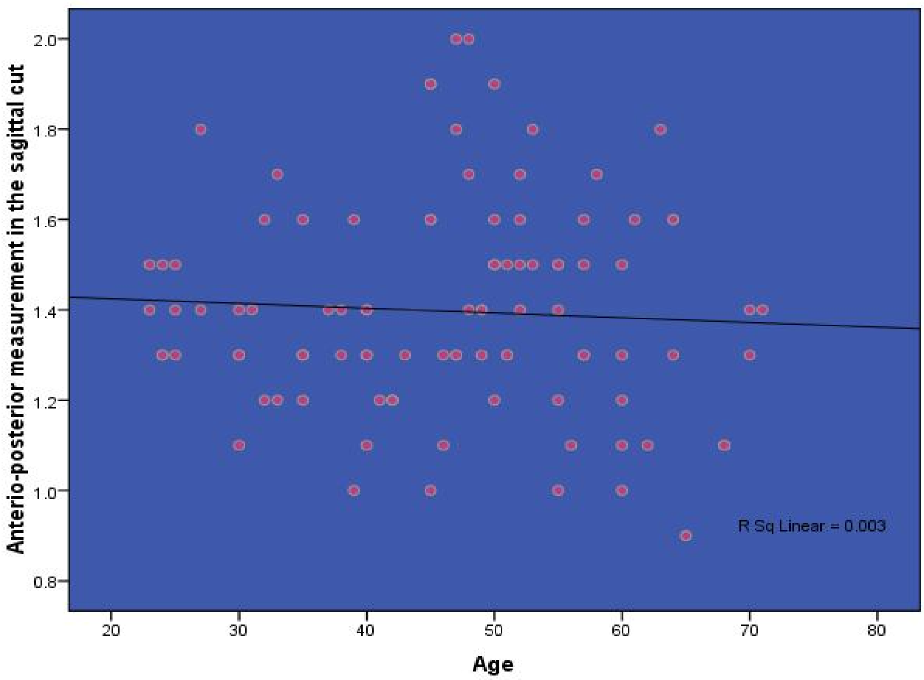


Figure 4.4: shows the relationship between age and anterio-posterior measurement in axial cut .

Chapter Five

Chapter five

5.1 Discussion

- The section images which obtained by CT or MRI made possible measurements of spinal canal to detect lumbar canal stenosisn, this study is an attempt to make lumbar canal measurement in sudanese population by using MRI .
- In this study the mean of antrio- posterior measurement in the axial cut (1.107 mm) with standard deviation (0.2001 mm) . the mean of transverse measurement in the axial cut (1.694 cm) with standard deviation (0.3038 cm). mean of anterio-posterior measurement in the sagittal cut (1.397 cm) with standard deviation (0.2363 cm) .
- In this study The relationship between the patient age and Anterio-posterior measurement in the axial cut was found to be a weak indirect relationship ,with person correlation coefficient (- 0.111), The relationship between the patient age and Transverse measurement in the axial cut was found to be a weak indirect relationship ,with person correlation coefficient (- 0.030)and The relationship between the patient age and Anterio-posterior measurement in the sagittal cut was found to be a weak indirect relationship ,with person correlation coefficient (- 0.056).
- All this measurements were said to be normal for the study group ,in comparison to other studies ,the different in population (body type) and sample size.
- So this measurements may taken as normal spinal canal diameter for Sudanese population.

5.2 Conclusion

- Lumbar canal measurements are important diagnostic information for many orthopedic and neurological disease.
- This study determined the normal diameter range of lumbar canal by using MRI in Sudanese population.
- In this study The relationship between the patient age and the three different measurements was found to be a weak indirect relationship.
- The relationships between age and measurement may change if the study applied in more than 100 patients.

5.3 Recommendations:

The study recommends the following:

- Further similar study using other patients information such as height and weight.
- Testing the suggested clinical diagnosis and patients with lumbar canal measurements.
- The technologist should know the normal range of lumbar canal measurements to correct image interpretation.

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Appendix

Data Collecting Sheet

NO.	M/F	Age	Measurements		
			AP(X) cm	Transverse(y) cm	AP in sagittal cm
1	F	55	1.5	1.7	1.0
2	F	31	1.6	2.5	1.4
3	F	40	1.1	1.7	1.1
4	F	64	1.3	1.5	1.3
5	M	24	1.4	1.9	1.5
6	F	60	1.1	1.4	1.3
7	M	35	1.0	1.6	1.2
8	M	60	1.2	2.0	1.5
9	F	50	1.1	1.5	1.5
10	F	45	1.1	1.9	1.9
11	F	48	1.0	1.8	1.4
12	F	53	1.1	2.4	1.5
13	M	45	0.9	1.4	1.0
14	M	71	0.9	1.7	1.4
15	F	70	1.3	1.8	1.4
16	M	35	1.3	2.0	1.3
17	F	27	1.2	1.7	1.4
18	F	50	1.6	2.3	1.5
19	F	46	1.3	1.9	1.3
20	M	57	1.2	2.0	1.3
21	M	24	1.0	1.9	1.3
22	F	60	1.1	2.0	1.2
23	M	38	1.3	1.9	1.4
24	M	33	0.9	1.6	1.2
25	F	40	0.9	1.7	1.3
26	F	39	1.0	1.9	1.0
27	F	30	1.0	1.6	1.3
28	M	60	0.9	1.5	1.0
29	F	49	1.2	1.8	1.4
30	M	68	1.0	2.5	1.1
31	M	30	1.0	1.8	1.3

32	F	39	1.5	2.0	1.6
33	F	30	1.0	1.6	1.1
34	F	25	1.0	1.6	1.3
35	M	25	1.4	2.0	1.4
36	M	55	1.4	2.0	1.5
37	M	23	1.4	2.0	1.4
38	M	51	1.3	2.3	1.3
39	F	30	1.2	2.1	1.4
40	F	65	0.6	1.6	0.9
41	M	62	0.6	1.2	1.1
42	F	51	1.3	1.9	1.5
43	F	47	1.1	1.5	2.0
44	M	48	1.2	1.6	2.0
45	F	32	0.9	1.4	1.2
46	M	55	1.1	1.6	1.2
47	F	63	1.3	1.5	1.8
48	M	53	1.3	2.1	1.8
49	F	27	1.2	1.6	1.8
50	F	64	1.3	1.6	1.6
51	F	47	0.9	1.1	1.8
52	M	52	1.1	1.6	1.6
53	M	32	1.5	2.0	1.6
54	M	24	0.8	1.5	1.3
55	F	48	1.3	1.8	1.7
56	M	43	0.8	1.2	1.3
57	M	50	1.4	2.2	1.9
58	M	23	1.1	1.8	1.5
59	M	33	1.0	1.3	1.7
60	M	45	0.9	1.5	1.6
61	F	35	1.1	1.6	1.6
62	M	61	1.1	1.7	1.6
63	F	58	1.1	1.7	1.7
64	M	50	1.1	1.7	1.6
65	M	52	1.2	1.6	1.7
66	F	57	1.2	1.6	1.6
67	M	49	1.0	1.0	1.4
68	M	55	1.0	1.4	1.5
69	M	50	1.2	1.5	1.5
70	F	40	1.2	1.7	1.4

71	M	18	1.0	1.3	1.4
72	M	55	1.1	1.7	1.4
73	F	47	1.2	1.7	1.3
74	M	35	1.0	1.6	1.3
75	M	42	1.1	1.6	1.2
76	M	52	0.8	1.7	1.4
77	M	49	1.1	1.4	1.3
78	F	70	1.1	1.4	1.3
79	M	46	0.7	1.1	1.1
80	F	42	0.9	1.2	1.2
81	F	38	1.2	1.8	1.3
82	F	52	1.0	1.4	1.5
83	F	60	0.9	1.3	1.1
84	M	50	1.0	1.6	1.2
85	M	57	1.1	1.6	1.5
86	M	25	1.1	1.6	1.5
87	F	35	1.3	1.9	1.3
88	M	56	1.0	1.5	1.1
89	M	40	1.2	1.8	1.4
90	M	41	1.1	1.6	1.2
91	M	47	1.2	1.7	1.3
92	F	51	1.0	1.3	1.3
93	F	40	1.0	1.7	1.3
94	F	45	1.1	1.9	1.9
95	M	57	1.2	2.0	1.3
96	M	68	1.0	2.5	1.1
97	F	65	0.6	1.6	0.9
98	F	64	1.3	1.6	1.6
99	M	45	0.9	1.5	1.6
100	F	42	0.9	1.2	1.2