

**PATTERN OF FINDINGS OF CERVICAL
SPINE DISEASE ON MRI AND THEIR
CLINICAL CORRELATION AS SEEN AT
KENYATTA NATIONAL HOSPITAL.**

**A DISSERTATION SUBMITTED IN PART FULFILMENT FOR
THE DEGREE OF MASTER OF MEDICINE IN DIAGNOSTIC
RADIOLOGY, UNIVERSITY OF NAIROBI.**

BY:

**DR. LEONARD GIKERA
MBCMB (NAIROBI).**

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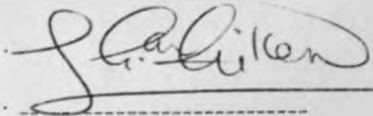


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DECLARATION

Author:

This dissertation is my original work and has not been presented for a degree in any other university.

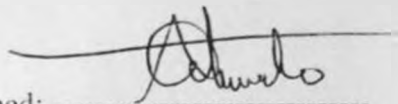
Signed:  _____

Dr. Leonard Gikera

MBChB (Nairobi)

Supervisor

This dissertation has been submitted for examination with my approval as the university supervisor.

Signed:  _____

Dr. Alfred Odhiambo

MBChB, MMED

Consultant Radiologist and senior lecturer,

Department of Imaging and Radiation Medicine,

University of Nairobi.

DEDICATION

To the late Joyce and Kaguchia Gikera.

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ABSTRACT

BACKGROUND

Cervical spine diseases especially neck pain and stiffness have so far been a common and neglected problem in our settings. These diseases compete with low back pain as leading causes of absence from work. The precise management protocol is still an open question. This study tries to account the pattern of cervical spine disease as seen at Kenyatta National Hospital.

METHOD:

Prospective study. Patients presenting with symptoms referable to cervical spine and were subsequently interrogated by MR examination of the cervical spine were recruited for the study.

RESULTS

A total of 100 patients were recruited. Age ranges from 7 months to 81 years. More males (65%) were recruited. Main symptom necessitating cervical spine MR was neck pain and stiffness followed by upper limb weakness and numbness. The commonest finding was disc disease accounting for 48% of the cases. Other findings included tumors and tumor like conditions, myelomalacia, cervical stenosis, spondylolisthesis and Chiari I malformation.

Only one patient representing 1% of the cases required further investigation after MR.

CONCLUSION

MR is a valuable investigation in patients presenting with cervical spine disease

ABBREVIATIONS

CT	Computed Tomography
CNR	Contrast to Noise Ratio
CSF	Cerebral Spinal Fluid
CECT	Contrast Enhanced Computed tomography
DTPA	Diethylene Triamine Penta-acetic Acid
DWI	Diffusion Weighted Imaging
GE	Gradient Echo
FSE	Fast Spin Echo
FLAIR	Fluid Attenuated Inversion Recovery
MITC	Medical Imaging and Therapeutic Centre
MRI	Magnetic Resonance Imaging
NECT	Non Enhanced Computed Tomography
NEX	Number of Excitations
KNH	Kenyatta National Hospital
MRS	Magnetic Resonance Spectroscopy
PD	Proton Density
STIR	Short Tau Inversion Recovery
T	Tesla
TE	Echo Time
TR	Repetition Time
T1W	T1 Weighted images
T2W	T2 Weighted images
FTP	Time To Peak
SE	Spin Echo
SNR	Signal to Noise Ratio

ETHICAL CONSIDERATIONS

The KNH Ethical and Research committee approved the research protocol.

Patients' names were not recorded during the study in order to maintain confidentiality and the information acquired was not used for any purposes other than for the research. For referral purposes only the patients' hospital numbers were recorded.

No examination was carried out on a patient apart from the one requested by the primary physician. Patients were asked to consent before being included in the study. This was in writing and only after the researcher has explained the nature of the research.

Patients who declined to give consent for any reason were excluded from the study.

LITERATURE REVIEW

Cervical spine disorders are common and may present with neck pain, neck stiffness, radiculopathy and/or myelopathy among other symptoms.

Neck pain

Transient episodes of acute neck pains and stiffness occur in 40-50% of all adults with increasing incidence in those over 45 years¹¹ Most sprain injuries will recover in 2-4 weeks with a conservative treatment plan and most cervical arthritis problems respond to medication and physical treatment measures.

Uncomplicated neck pain is defined as pain with a postural or mechanical basis, often called cervical spondylosis. It does not include pain associated with fibromyalgia.

Uncomplicated neck pain may include some people with a traumatic basis for their symptoms, but not people for whom pain is specifically stated to have followed sudden acceleration-deceleration injuries to the neck, that is, whiplash. Whiplash is commonly seen in road traffic accidents or sports injuries.

Neck pain often occurs in combination with limited movement and poorly defined neurological symptoms affecting the upper limbs. The pain can be severe and intractable, and can occur with radiculopathy or myelopathy.

About two thirds of people will experience neck pain at some time in their lives.¹²¹

Prevalence is highest in middle age. In the UK, about 15% of hospital based physiotherapy and in Canada 30% of chiropractic referrals are for neck pain.¹³¹¹⁴¹ In the

Netherlands, neck pain contributes up to 2% of general practitioner consultations.¹⁵¹

The aetiology of uncomplicated neck pain is unclear. Most uncomplicated neck pain is associated with poor posture, anxiety and depression, neck strain, occupational injuries, or sporting injuries¹²¹. With chronic pain, mechanical and degenerative factors (often referred to as cervical spondylosis) are more likely. Some neck pain results from soft tissue trauma, most typically seen in whiplash injuries.

Neck pain usually resolves within days or weeks but can recur or become chronic. In some industries, neck related disorders account for as much time off work as low back pain.¹⁷¹ The proportion of people in whom neck pain becomes chronic depends on the cause but is thought to be about 10%,¹²¹ similar to low back pain. Neck pain causes severe disability in 5% of affected people.¹³¹ Whiplash injuries are more likely to cause disability than neck pain because of other causes.¹⁸¹ Factors associated with a poorer outcome after whiplash are not well defined.¹⁹¹ The incidence of chronic disability after whiplash varies among countries, although reasons for this variation are unclear.¹¹⁰¹

Radiculopathy and myelopathy

Cervical radiculopathy may be defined as pain in the distribution of a specific cervical nerve root as a result of compressive pathology whether from disc herniation, spur formation or hypermobility states. Myelopathy is a general term denoting functional disturbances and/or pathological changes in the spinal cord. Symptoms of cervical radiculopathy are due to nerve root compression, while cervical myelopathy is usually

due to spinal cord compressive pathology.⁽¹⁵⁾

Rarely does a radiculopathy progress to a myelopathy,⁽¹⁶⁾ but the practitioner must be aware of the differentiation since early spinal cord compression may not be obvious. In the course of cervical spondylosis, while there may be no symptoms, occasionally neurological complications such as root or cord compression may result.¹⁶

MacNab¹⁷ discusses cervical spondylosis as a product of cervical disc degeneration which he divides into stages. He describes the first stage of cervical disc degeneration as an unstable segment and, therefore, vulnerable to trauma and involvement of injured ligaments or damaged joints. He states that the presenting symptom is just a pain in the neck with possible referral to the shoulder, suboccipital area, occipital headache, interscapular pain or pain down the arm or into the chest. The patient may also have blurring of vision, tinnitus or dysphagia. Early on, these symptoms are not necessarily due to nerve root irritation since they can be reproduced by injection into the supraspinous ligament. He feels that the later stages of disc degeneration with its associated bony outgrowths, especially from the joints of Lushka, will affect the nerve roots.

Progressive myelopathy may result if a diffusely bulging disc forms a transverse bar of bone and protrudes posteriorly, narrowing the AP diameter of the cervical spinal canal. This cord compression combined with possible vascular compromise of the radicular arteries creates the myelopathy.¹⁸

With regard to motor weakness, radiculopathy presents with, for example, a diminished triceps reflex, a weak triceps muscle, and numbness down the forearm into the middle finger (C7 radiculopathy), while the weakness of a myelopathy is typically more generalized and bilateral rather than unilateral.¹⁵

Clinical Diagnosis

There are no universally accepted criteria for the diagnosis of cervical radiculopathy.²⁰ In most cases, the patient's history and physical examination are sufficient to make the diagnosis.²¹ Typically, patients present with severe neck and arm pain. Although the sensory symptoms (including burning, tingling, or both) typically follow a dermatomal distribution, the pain is more commonly referred in a myotomal pattern.²²

Guidelines developed by the Agency for Health Care Policy and Research for the assessment of low back pain may be applied to the patient with neck pain and radiculopathy.²⁵

The presence of "**red flags**" in the patient's history (including fever, chills, unexplained weight loss, unremitting night pain, previous cancer, immunosuppression, or intravenous drug use) should alert clinicians to the possibility of more serious disease, such as tumor or infection. Clinicians should also inquire about symptoms of myelopathy. These may occasionally be subtle (e.g., diffuse hand numbness and clumsiness, which are often attributed to peripheral neuropathy or carpal tunnel syndrome; difficulty with balance; and sphincter disturbances presenting initially as urinary urgency or frequency rather than as retention or incontinence).

Findings on physical examination vary depending on the level of radiculopathy and on

whether there is myelopathy . In most series, the nerve root that is most frequently affected is the C7, followed by the C6.²¹ Many provocative tests have been proposed for the diagnosis of cervical radiculopathy, but the reliability and diagnostic accuracy of these tests are poor.^{20, 27}

Laboratory Studies

The erythrocyte sedimentation rate and C-reactive protein levels are elevated in many patients with spinal infection or cancer, but these tests are not sufficiently sensitive or specific to guide further evaluation.

Imaging

Conventional radiographs of the cervical spine are often obtained, but their usefulness is limited³² This is due to the low sensitivity of radiography for the detection of tumors or infections, as well as its inability to detect disk herniation and the limited value of the finding of cervical intervertebral narrowing in predicting nerve-root or cord compression.³³

Magnetic resonance imaging (MRI) is the investigation of choice when imaging is pursued in patients with cervical radiculopathy but there are currently no clear guidelines regarding when such imaging is warranted. Reasonable indications include the presence of symptoms or signs of myelopathy, red flags suggestive of tumor or infection, or the presence of progressive neurologic deficits. For most other patients, it is appropriate to limit the use of MRI to those who remain symptomatic after four to six weeks of non surgical treatment, particularly given the high frequency of abnormalities detected in

asymptomatic adults, including disk herniation or bulging (57 percent of cases), spinal cord impingement (26 percent), and cord compression (7 percent).³⁵

Computed tomography (CT) alone is of limited value in assessing cervical radiculopathy,³⁶ but it can be useful in distinguishing the extent of bony spurs, foraminal encroachment, or the presence of ossification of the posterior longitudinal ligament. The combination of CT with the intrathecal administration of contrast material (CT myelography) provides accuracy similar to³⁸ and possibly superior to³⁸ that of MRI, but its invasive nature makes MRI preferable in most cases. Technetium and gallium bone scans are very seldom indicated, except in rare cases in which cancer or infection is suspected in multiple sites and MRI cannot be readily performed or is impractical.

ANATOMY OF THE CERVICAL SPINE

Cervical spine is made up of the cervical cord, subarachnoid space, epidural space and the cervical vertebral column.

SPINAL CORD

The cervical spinal cord is a nearly cylindrical structure almost centred in the subarachnoid space. The diameter of the cord enlarges slightly at the level of C5-6 level where the roots of the brachial plexus arise³⁰. The cord consists of gray and white matter.

Axial MR sections and some pulse sequence distinguish the pattern of gray and white matter in the cord.

SUB ARACHNOID SPACE

About half of the spinal canal is occupied by the subarachnoid space. The dentate ligament in the subarachnoid space connects the lateral margin of the cervical cord to the dural sac.

Cerebrospinal fluid in the subarachnoid space is optimally resolved from the spinal cord. T1 weighted images show the cord having a higher intensity signal than the CSF. With T2 -weighted images, the CSF has brighter signal intensity than the spinal cord. Rarely, the dentate ligament or vessels in the subarachnoid space are identified.

EPIDURAL SPACE

The narrow epidural space in the cervical spinal canal contains predominantly vascular tissue with small amounts of fat and connective tissue.

The meninges consisting of dura mater and arachnoid separate the epidural space from the subarachnoid space. These membranes are ordinarily obscured by bright signal from the CSF on T2 weighted spin - echo images or the bright signal from fat in T1 weighted images and are not usually resolved in conventional SE MR imaging. However, the dura may be seen on T2 - weighted gradient - echo images as a region of uniform low signal (40)

VERTEBRAL COLUMN

The MR appearance of the vertebral column depends mainly on the signal from bone marrow. Fat within the marrow of the vertebral bodies, neural arches and articular pillars has a moderately intense signal in T1 weighted SE images. Dense cortical bone surrounding these osseous structures has a negligible signal. In the T2 weighted images, the signal from the osseous structures is less intense and the image is noisier.

The intervertebral disc has a complicated structure of hyaline cartilage fibrocartilage, and gelatinous material. The central portion of the disc, the nucleus pulposus, contains the amorphous, gelatinous material which may contain notochordal cells.

The nucleus and medial portions of the annulus in T2 weighted images produce a relatively bright signal. The collagenous fibers in the periphery produce little signal in

either T1 - or T2 - weighted images. Some contrast is evident in T1 -weighted image sequences between the nearly absent signal from the collagenous fibers and the slight signal from the ground substance. In T2 weighted images, there is greater contrast, with a bright signal from the portions of the disc containing ground substance.

Some transversely oriented bands are evident in the MR images of the cervical intervertebral discs. One of these bands appears as a uniformly narrow signal void produced by the truncation effect and characteristically extends from the ventral to the dorsal surface of the disc in its mid portion. It is present variably depending on the spacing of the intervertebral discs, the number of times the signal is sampled, and the field of view. Other transverse streaks in the intervetebral discs represent degenerative changes.

The neural foramina are short canals through which the cervical nerves exit anterolaterally from the spinal canal. Borders of the neural foramina are formed by the facet joint posterolaterally, uncovertebral joint anteromedially and the pedicles superiorly and inferiorly.

PATHOLOGY:

DEGENERATIVE SPINE DISEASE

Pain secondary to degenerative changes of the spine is one for the leading causes of disability among adults. Most disorders of the spine result from degenerative changes that may arise in bone, ligaments or soft tissue components of bone.⁽⁴⁰⁾ The degenerative process involving the disc begins as early as late teens or early twenties⁽⁴¹⁾ Initially an increase in water content of the nucleus pulposus predisposes it to generalized bulges or focal herniations through the cartilaginous end plates of the adjacent vertebra (Schmorl's node). With time, the nucleus pulposus undergoes progressive dehydration with resulting loss of height of the disc space. With further loss of water and proteoglycans, the disc becomes brittle and fibrotic and is unable to provide the necessary elasticity for proper support of the vertebral column, a process known as disc desiccation.^(40, 41)

The triad that characterizes disc degeneration includes bulging, loss of height and loss of water seen as decreased signal intensity on MR imaging. As the disc degenerates it becomes hypo intense on T2 weighted sequences⁽⁴⁰⁾ The mechanism by which a degenerated disc produces pain is unclear, but is probably related to compression and repetitive firing of sensory nerve endings.⁽⁴¹⁾ The imaging features of progressive degenerative disease vary depending on the extent of the abnormality.

Computed tomography is unable to detect early disc desiccation; however it is useful for detecting late changes, such as disc space narrowing and sclerosis of the adjacent cartilaginous end plates. A reliable indicator of disc degeneration is the presence of intradiscal gas, which is referred to as vacuum phenomenon and may be visualized by plain radiographs or CT. The gas is predominantly nitrogen and is highly unusual in an infected disc space.⁽⁴²⁾

MR may show early degenerative changes that are not detected by CT. Early disc desiccation presents as loss of signal intensity on T2 weighted images. Sagittal images are helpful in determining the degree of disc space narrowing.

MR also detects marrow changes within end plates adjacent to the degenerative discs.

¹³ These changes are referred to as Modic changes. Modic changes take three main forms:

Type I

Shows decreased signal intensity on T1 and increased signal on T2W images. These changes are due to marrow oedema and are associated with an acute process. ¹³

Type II -the most common type

Shows increased signal on T1 and isointense or slightly hyper intense signal on T2. It represents fatty degeneration of subcondral marrow and is associated with a chronic process. Type I changes convert to type II changes with time while type II changes seem to remain stable. ¹³

Type III

Shows decreased signal on both T1 and T2. These changes correlate with extensive bone sclerosis on plain radiographs. ¹³

DISC HERNIATION

As the degeneration process progresses, small circumferential fissures develop in the annulus fibrosus which may later coalesce to form a radial tear⁴⁰.

Disc bulge refers to a smooth circumferential (global) extension of the disc margin beyond the boundary of the adjacent vertebral and plates. The annulus fibrosus is intact although weakened. There is usually loss of height of the involved disc space and desiccation of the nucleus pulposus. Patients rarely complain of nerve root compression unless there is coexisting spinal stenosis.⁴¹

Disc protrusion refers to a focal, incomplete extension of the contents of the nucleus pulposus through an incomplete tear of the annulus fibrosus. The posterior extent of the involved disc material is limited by some intact outer fibers of the annulus fibrosus and an intact posterior longitudinal ligament.⁴¹⁻⁴⁵

Disc herniation is an extension of disc contents through complete tears of annulus fibrosus and the posterior longitudinal ligament resulting in an anterior epidural mass. The herniated disc is often attached to the disc of origin. If the disc material migrates inferiorly, superiorly, laterally or posteriorly, it may be referred to as a **free fragment** or **sequestered disc**.

Disc herniations in the cervical spine, tend to produce symptoms involving the nerve root exiting at the same level. The herniations most commonly involve C5 - C6 and C6 - C7 spaces.^{44, 45}

The diagnosis of disc herniation can be made reliably with MR Imaging, CT or post myelography CT.⁴⁴ Although CT is more sensitive than MR for detection of intradiscal gas and calcification, MR is more widely used for evaluation of patients with radicular symptoms because of its multiplanar capabilities and superior tissue

characterization.

CERVICAL SPONDYLOSIS

Spondylosis results from disruption of the peripheral fibers of the annulus fibrosus, with minor degrees of displacement of the disc. This change predisposes to the formation of osteophytes at the sites of bony attachments of the ligamentous components of the annulus fibrosus. Spondylosis is usually seen in facet joint degeneration, and multilevel disease is the rule.⁴⁶

SPONDYLOLISTHESIS AND SPONDYLOLYSIS

Spondylolisthesis refers to displacement of a vertebra in relation to an adjacent vertebra, resulting in a malalignment of the spinal column. The term degenerative Spondylolisthesis is used to denote a malalignment that arise as a result of spinal instability due to degenerative changes involving the disc facet joints.

Spondylolisthesis may result from congenital defects or acquired fibrous defects in the pars interarticularis (spondylolysis) or from acute trauma. Spondylolysis is referred to as lytic Spondylolisthesis.

Spondylolysis occurs in approximately 5% of the population⁴⁵. It tends to be bilateral and most commonly involves the lower lumbar spine, but it may also be found in the cervical spine. Spondylolisthesis occurs in over 60% of patients with spondylolysis. Sagittal MR images show pars defects to be oriented perpendicular to the long axis of the adjacent facet joint. At times the anterior portion of the defective pars interarticularis may show high signal intensity on T1-weighted images. The Spondylolisthesis may impinge upon and stretch the nerve roots, producing a radiculopathy that tends to be bilateral.

FACET JOINT DISEASE

Degenerative changes of the facet joints may result from primary osteoarthritis or may be secondary to degenerative changes within the intervertebral discs. When facet joint and intervertebral changes are both present, it is impossible to ascertain which the primary cause is.

The imaging findings consist of joint space narrowing with associated subchondral sclerosis of the articular surfaces, sub chondral cyst formation and hypertrophic new bone formation.

SPINAL STENOSIS

Spinal stenosis refers to a reduction in the caliber of the spinal canal. Resultant symptoms depend on the level of involvement. If the cervical portion of the cord is involved, the patient may present with a radiculopathy, myelopathy, or neck or shoulder pain. Spinal stenosis may be either primary or acquired. The most common cause of acquired stenosis is degenerative change.

Although absolute measurements are not valuable in all cases, spinal canal stenosis should be considered if the AP diameter of the cervical and lumbar canals is less than 12 mm. In the thoracic region, an AP diameter of less than 10 mm is abnormal.⁽¹²⁾

INFECTIONS

MR imaging is 96% sensitive and 94% accurate in the detection of spinal infection.⁽¹²⁾ It is more sensitive than myelography and CT in the diagnosis of discitis, osteomyelitis and epidural abscesses. T1 - weighted MR images show low signal intensity of the involved intervertebral disc and the adjacent vertebral bodies. The cortical bone of the vertebral end plates may be indistinct. On T2 - weighted sequences, the disc space and

adjacent vertebrae are of increased signal intensity. Occasionally the intervertebral disc may appear less intense owing to the high signal intensity of the adjacent end plates. On T2 weighted images, the normal inter nuclear cleft is effaced.¹²⁾ Epidural infection which is bright on T2 - weighted images and dark on T1 -weighted images, may be iso intense with CSF and blend with it imperceptibly. Therefore, intravenous gadolinium administration is imperative. Separating the enhancing epidural abscess from the surrounding fat may necessitate the use of fat suppression techniques.

NEOPLASMS

Spinal cord neoplasms may present with myelopathy or radiculopathy. By the time the patient presents for imaging evaluation, the cord is almost always enlarged. The most common intramedullary tumor of the cervical spinal cord is astrocytoma. Less common spinal cord tumors include hemangioblastoma, lipomas and metastasis. Common extra axial tumours include meningiomas and nerve sheath tumors.

MR detection of a spinal cord tumor is accurate.⁴⁰⁾ MR typically shows the cord expanded by an intra medullary process. On T1 weighted images, most intramedullary neoplasms exhibit diminished signal intensity with respect to the normal cord. On T2 weighted images they usually have a brighter signal than cord. This is due to their increased fluid content. To distinguish various tumors, other techniques such as fat suppression, introduction of IV gadolinium and GE technique can be used.

Lipoma is an intra medullary neoplasm with high signal intensity on T1 weighted MR images. This tumor which has well defined margins and homogenous signal intensity rarely occurs in the cervical region. The differential diagnosis of lipoma in MR imaging includes sub acute hematoma. Fat suppression techniques are useful in

differentiating the two.

Meningiomas of the upper cervical spine are found most frequently in the foramen magnum. In T1 and T2 weighted sequences, meningiomas have little contrast with respect to cord tissue. Signal voids within the tumors represent calcification. With intravenous gadolinium in T1- weighted images, meningiomas enhance homogeneously and intensely.

Cervical neurofibromas are rare except in patients with neurofibromatosis⁽¹⁾. They tend to be lateral to the cord and may be dumbbell - shaped with intraspinal and extraspinal components connected in an enlarged neural foramen. They enhance avidly and the flecks of calcium, which occur rarely with neurofibromas, may produce regions of signal void in the MR image.

RHEUMATOID ARTHRITIS

For the most part, the spine is spared except for the cervical region. The most common site of involvement is the atlanto-axial joint where soft-tissue laxity permits subluxation . This subluxation is usually attributed to rupture of the transverse ligament and may be accompanied by erosion of the odontoid. Of the patients with subluxations, compression of the spinal cord and medulla occurs in 20 %.⁽¹⁾ MR imaging readily shows compression of the spinal cord and brain stem by pannus.

Finally, due to erosions and osteopenia the odontoid may fracture and, in the very late stages of rheumatoid arthritis, basilar invagination may occur.

Less commonly, the rheumatoid process may involve the apophyseal joints and disc

spaces . As in other synovial joints, synovitis of the apophyseal joints is manifest as malalignment (subluxation) and bone destruction. Occasionally, one or more apophyseal joints may fuse. In cervical intervertebral disc involvement, the disc spaces become eroded and may fuse.

SYRINGOMYELIA AND HYDROMYELIA

Cystic processes in the spinal cord are defined as syringomyelia if glial cells line the cavity and hydromyelia if ependymal cells line the cyst or neoplastic if they are associated with a tumour. MR is sensitive in the detection of these processes, but their differentiation may be difficult. ⁽⁴²⁾

In about 90% of syringomyelic and hydromyelic cysts, MR imaging demonstrates characteristic findings. In these cases, the cysts have discrete, smooth, well defined borders and uniform signal intensity, which is isointense with respect to cerebrospinal fluid. Cysts with proteinaceous fluid may be slightly hyperintense with respect to CSF.

BASIC PHYSICS OF MRI

Magnetic resonance imaging is a non invasive method of mapping the internal structures of the body. It employs radio frequency radiation in the presence of carefully controlled magnetic fields to produce high quality cross sectional images of the body in any plane. Nuclei suitable for MR are those which have an odd number of protons or neutrons and therefore possess a net charge and have angle momentum. These nuclei behave as magnetic dipoles. Hydrogen nucleus is particularly favorable to MRI because of its abundance through out the body. Protons can be regarded as small magnets. When placed in an external magnetic field, they align themselves in either the parallel or anti parallel direction.¹⁷

The direction of the static magnetic field conventionally defines the Z-axis which is generally along the longitudinal axis of the patient in atypical MRI machine. Resistive, permanent or superconductive magnets provide the strong, magnetic field, which must be homogenous over a volume large enough to contain to the human body in an MRI machine.

As the nuclei are spinning they respond to a magnetic couple like a gyroscope and their axes are tilted so that they come to rotate at exactly the same frequency about the magnetic field direction in a movement known as precession. The frequency of precession is directly proportional to the applied magnetic field for protons. This relationship is expressed as the Larmor equation ¹⁷.

$F = \gamma B$

whereas F is the resonant frequency

γ is the gyromagnetic ratio

B is the applied field

When the external radio frequency pulse and protons have the same frequency (precession frequency) the protons can pick up some energy from the radio wave, a phenomenon called resonance. This has two effects:

- 1) Longitudinal magnetization decreases
- 2) A new transverse magnetization is established.

The net magnetization along the Z-axis is deviated through an angle, which depends upon the strength and duration of the pulse of the radio frequency magnetic field.

This rotates the magnetization in the Z-direction through either 90° or 180° . After the applied radio frequency pulse is removed, the magnetization returns to its equilibrium position along the Z-axis in an exponential manner and as it does so, the changing magnetization induces a small voltage in a receiver coil. The electrical signal detected following a radio frequency pulse is known as free induction decay.

T1 or longitudinal relaxation time represents the time taken by the system of nuclei to return to thermal equilibrium after the radio frequency pulse. T2 or transverse relaxation time indicates the characteristic decay time of the free induction decay and is due to irreversible dephasing of the initially coherent precession of nuclei, which follows the radio frequency pulse.¹⁰

The principal pulse sequences are :

- a) Partial saturation which typically utilizes a 90° radiofrequency pulse

b) Spin echo which utilizes a 90° pulse followed at a time $TE/2$ by a 180° pulse.

c) Inversion recovery which utilizes a 180° pulse, followed at a time $T1$ later by a 90° pulse.

The contrast in short TR, short TE sequence is based primarily on differences in T1.

They are called T1 weighted sequences. The tissues with low values of T1 have the

highest signal intensity on T1W spin echo sequences (fat and met hemoglobin). Images

with long TR and TE are regarded as heavily T2 weighted images. Proton density

weighted images are obtained by minimizing the effect of T2 and T1 thus resulting in

long TR and short TE values.

In the inversion pulse sequence there is 180° pulse followed at a time T1 (inversion

time) later by a 90° pulse. If T1 is decreased to 100 - 150 milliseconds, it is possible to

null the signal from fat with a short T1 inversion recovery, STIR sequence. It is also

possible to increase T1 in order to null the signal for fluids (the fluid attenuated

inversion recovery or FLAIR sequences). This can be used to show subtle lesions. The

contrast medium commonly used for magnetic resonance imaging is gadolinium

DTPA. It crosses the abnormal blood brain barrier. Gadolinium causes a reduction of

T1 and T2, although the absolute effect on T1 is greater than T2^{10, 17}

CONTRAINDICATIONS AND PRECAUTIONS:

Acutely traumatized patients are not suitable candidates for MR because life support systems are not conveniently transported into the magnetic field and may be incompatible with the high magnetic field strength employed.

One of the greatest potential hazards around a magnet is the missile effect. Objects with iron (ferromagnetic) in them can be pulled into or toward a magnet and injure persons within or near the magnet. Hammers, screw drivers, vacuum cleaners, oxygen tanks and tool chests should not be brought in the MR room.

Hazards also exist for patients who have medical devices implanted in their bodies. Patients who should be excluded from a magnet include those with:

- Cardiac pacemakers
- Cerebral aneurysm clips
- Shrapnel or other metallic foreign bodies
- Implanted electrodes, such as neuro stimulators and bone growth stimulators
- Internal drug infusion pumps

Caution should be exercised with:

- Middle ear prostheses
- Metallic bio implants

Careful screening of anyone (workers, patients, visitors) having access to the magnet is required. The safety of MRI during pregnancy has not been established.

STUDY OBJECTIVES

Main objective

To show the pattern of lesions detected by MRI examination of the cervical spine as seen at the Kenyatta National Hospital.

Specific objectives

1. To determine the age and sex distribution of patients referred for MRI of the cervical spine.
2. To determine the pattern of lesions /pathologies encountered on MRI of the cervical spine
3. To establish the common symptoms for which MRI of the cervical spine is requested and how these symptoms relate to MR imaging findings.
4. To correlate MR findings with the clinical presentation.

JUSTIFICATION

Symptoms relating to the cervical spine e.g. neck pain and stiffness, limb numbness, hand atrophy and upper extremity paraesthesia are frequently encountered in clinical practice. Transient episodes of acute neck pains and stiffness occur in 40-50% of all adults with increasing incidence in those over 45 years.⁽¹⁾ Imaging plays an important role in the diagnosis and management of these patients.

Conventional radiography, CT and CT myelogram have in the past been used to study the spine. MRI is however superior to these older modalities due to its multi planar capabilities and excellent tissue characterization. It is a highly sensitive imaging modality for the spine.

Kenyatta National Hospital has recently (2006) acquired an MR unit. There is therefore a need to establish the applicability of MR in the cervical spine which is one of the most commonly imaged regions in the body.

This study attempts to review the findings of MR examination of the cervical spine at Kenyatta National Hospital. A study of this nature has not been undertaken in the past in Kenya. The study reviews findings of the MRI of the cervical spine, the different patterns and presentations, and correlation with clinical symptoms. It is expected that the results of this study will enhance the understanding of different cervical spine pathologies and their varying appearances as shown by MRI.

The effective and efficient use of MRI in our setting will benefit the patient in terms of safer and cost effective diagnostic imaging, leading to earlier diagnosis and improved management of cervical spine pathologies.

STUDY DESIGN AND METHODOLOGY

Study design: A prospective descriptive study of 100 patients who presented with varied symptoms referable to the cervical spine and were asked to have cervical spine MR. The patients were seen by doctors of different specialties. These included general practitioners, physicians, general surgeons, orthopedic surgeons and neuro surgeons.

The study covered a period of six months between September, 2006 and February 2007. The cases included 65 males and 35 females.

Study area: The study was carried out at Kenyatta National Hospital's imaging department.

Study Population:

Patients referred for MRI of the cervical spine with various complaints relating to the cervical spine. The age of patients studied ranged from seven months to 81 years.

TECHNIQUE

After ascertaining that there were no contraindications to the examination, the patient was ushered into the changing room.

Once changed, he/she was placed on MR machine's table and positioned for the examination. A cervical spine coil was chosen.

At KNH, the standard protocols (sequences) for cervical spine are T1W sagittal, T2W sagittal, T1W axial, T2W axial and fat suppression. These sequences were done on all the patients. Additional sequences e.g. GRE, DWI and FRAIR were carried out on some

patients depending on clinical question to be answered and on whether a lesion required further characterization.

Intravenous contrast was given on selected patients after reviewing the standard sequences

The MR machine in KNH which was used on all the patients is a 1.5T Intera Model Philips unit.

SAMPLE SIZE CALCULATION

Required information:

- Primary outcome variable = Estimated proportion of patients undergoing cervical spine MRI examination.
- Best guess of expected percentage (proportion) = 10% (0.10)
- Desired width of 95% confidence interval = 10% (i.e. +/- 5%)

(Fisher & Vanbelle) formula for the sample size calculation. The formula for the estimation of a single proportion was as follows at 80% power:

$$n = 8 * p * (1-p) / W^2$$

n = required sample size.

P = the expected proportion.

In this situation 0.10 W = width of confidence interval = 0.10.

Inserting the required information into the formula gives:

$$n = (8 * 0.15 * 0.85) / (0.10)^2 = 102$$

Since the target population is less than 10,000 the following formula will then be used to adjust for the above sample size.

Suggested description of the sample size calculation: -

A sample of 288 respondents was required to obtain a 95% confidence interval of +/- 5%.

$$nf = \frac{n}{1 + n/N}$$

Where nf = the desired sample size when population is less than 10,000
 n = the desired sample size when the population is more than 10,000

N = the estimate of the population size undergoing MRI = 1500 patients per year

Substituting values in the formula, a sample size of 96 patients undergoing cervical spinal will be recruited for the study. 100 patients were studied.

Sampling method

Purposive sampling technique was used to obtain patients with symptoms referable to the cervical spine and were subsequently referred for MR examination of the cervical spine.

Exclusive criteria

Patients who declined to give a written consent for any reason were excluded from the study.

Patients who did not have adequate clinical information from their primary physicians were excluded from the study. Patients who did not undergo a complete examination either due to technical factors or due to unforeseen patient factors were also excluded from the study.

Limitation of the study

1. Delay in data collection/retrieval due to lack of computerization.

DATA MANAGEMENT

Data collection

At the time of getting consent, the patients (subjects) who met the inclusion criteria were interviewed by the researcher so as to verify the clinical information in their request forms.

The Researcher then directed the examination by advising the radiographer on the need for additional pulse sequences and the need or otherwise for the administration of intravenous contrast media depending on the clinical question to be answered.

After the patients were subjected to the MR examination, the researcher reviewed the images and formed an opinion. The images were then be presented to the qualified

radiologist specialized in MR for her opinion. The consensus opinion was taken as the diagnosis. Images seen and reported by other radiologists were subjected to the same criteria i.e. will be reviewed independently by the researcher and the MR specialist. When no consensus was achieved, they were excluded from the study. In this way the validity and reliability of the data was maximized as intra-and inter-examiner variability was minimized.

The consensus opinion formed the MR findings and diagnosis filled in the pre tested questionnaire by the Researcher. A sample of the questionnaire used for this purpose is given in appendix 11.

Data processing, analysis and presentation

After data collection all the raw data was coded by the researcher giving numbers to those questions which were open ended for example MRI diagnosis was answered differently according to the report and so all similar diagnosis was given same number. After coding the data was entered into a computer. SPSS computer program was used for data analysis and the results are given below.

RESULTS

About 120 cervical spine MR examinations were done between September 2006 through February 2007 .Out of these 100 of them were recruited for this study. A review of these one hundred cases is done and results are presented in the form of tables and graphs below.

Table 1 (age distribution)

Age group (years)	No of patients	%
0-10	4	4
11 - 20	6	6
21- 30	13	13
31 - 40	28	28
41 - 50	24	24
51 - 60	11	11
61 - 70	9	9
71-80	4	4
>81	1	1
Total	100	100%

Fig.1

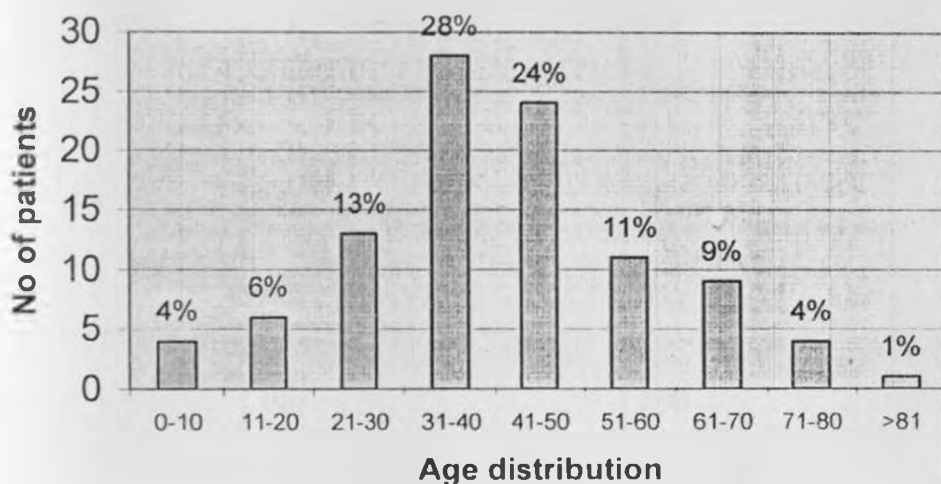


Table 1 and fig 1 show the age distribution of patients who had cervical spine MR. The age group between 31-40 years had the largest number of patients (28%). The least was above 81 years, one patient (1%).

Table 2

Sex distribution of patients who had cervical spine MR.

Sex	No of patients	Percentage
Male	65	65
Female	35	35
Total	100	100

FIG 2

Sex distribution of patients who had cervical spine MR.

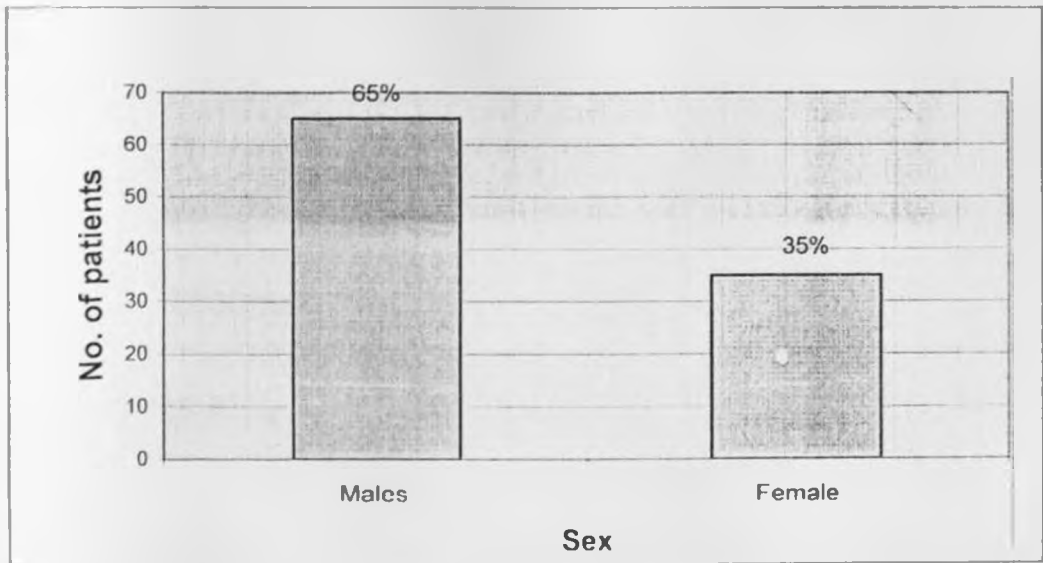


Table 2 and figure 2 shows distribution of patients according to their sexes. Males were more common accounting for 65% while females accounted for 35%. Male female ration 13: 7

Table 3: Distribution of symptoms necessitating Cervical spine MR

	Symptom	Frequency	Percentage
1.	Neck pain and stiffness	31	31
2.	Upper extremity weakness and numbness	21	21
3.	Quadripareisis	10	10
4.	Paraparesis	10	10
5.	Radioculopathy	15	15
6.	Myelopathy	9	9
7.	Gait difficulties	7	7
8.	Hand muscle wasting	3	3
9.	Short neck	1	1
10.	Post surgical assessment	2	2
11.	Ascending paralysis	1	1
12.	Spinal mass	1	1
13.	Sphincter disturbances	1	1

Fig.3: Distribution of symptoms.

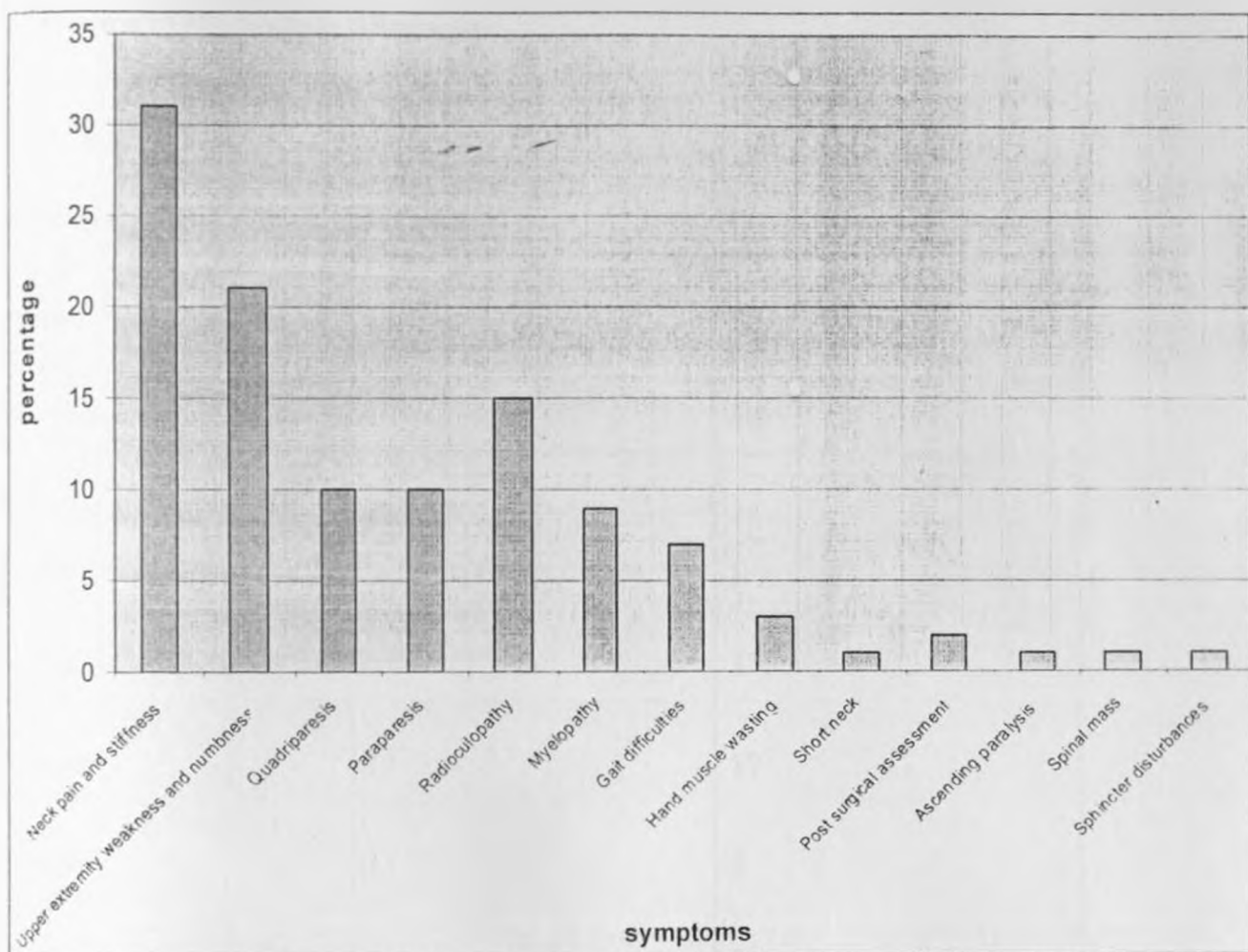


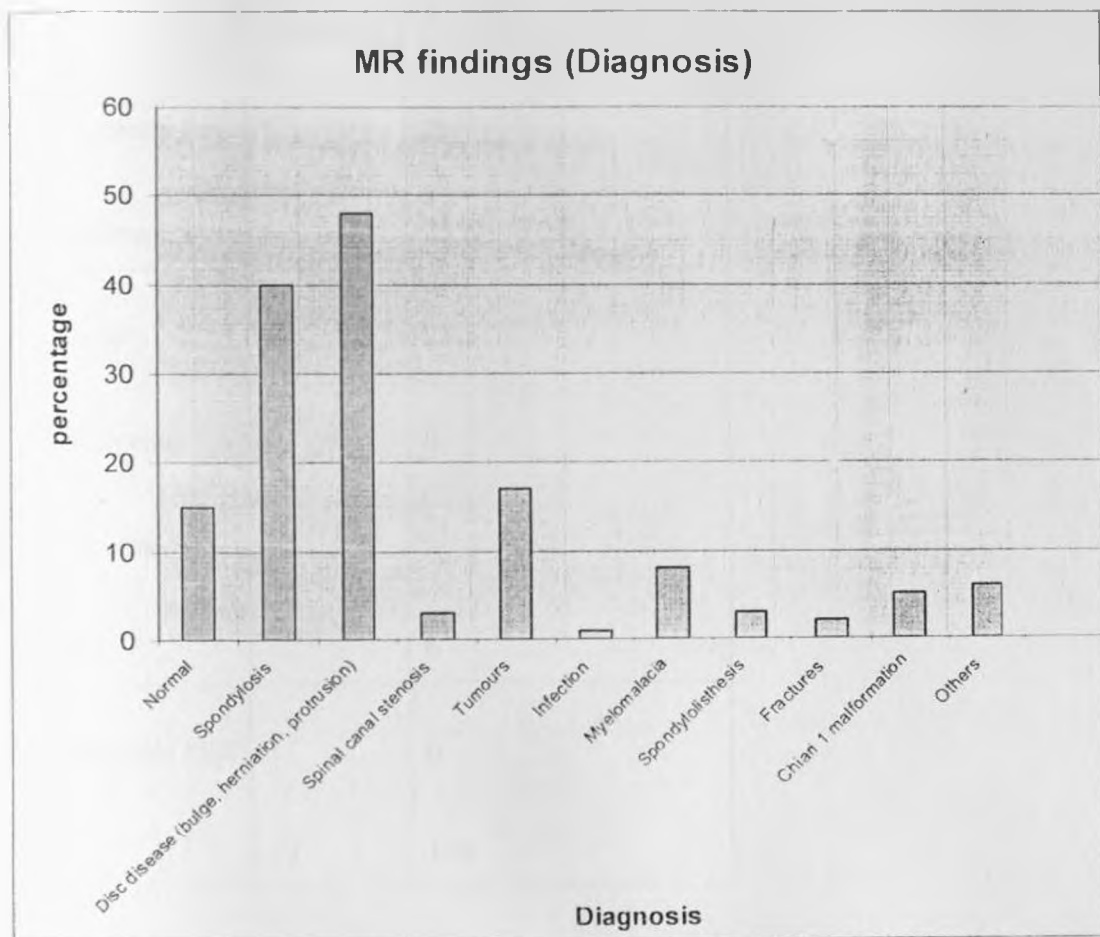
Table 3 and figures 3 show the distribution of symptoms that patients who presented for cervical spine MR complained of. Most patient had neck pain and stiffness followed by upper extremity weakness and numbness. Short neck, sphincter disturbances, spinal mass and ascending paralysis were the least common symptoms.

Table 4.

Distribution of MR findings (Diagnosis)

Diagnosis	Frequency	Percentage
Normal	15	15
Spondylosis	40	40
Disc disease (bulge, herniation, protrusion)	48	48
Spinal canal stenosis	3	3
Tumours	17	17
Infection	1	1
Myelomalacia	8	8
Spondylolisthesis	3	3
Fractures	2	2
Chiari 1 malformation	5	5
Others	6	6

Fig.4: MR findings.



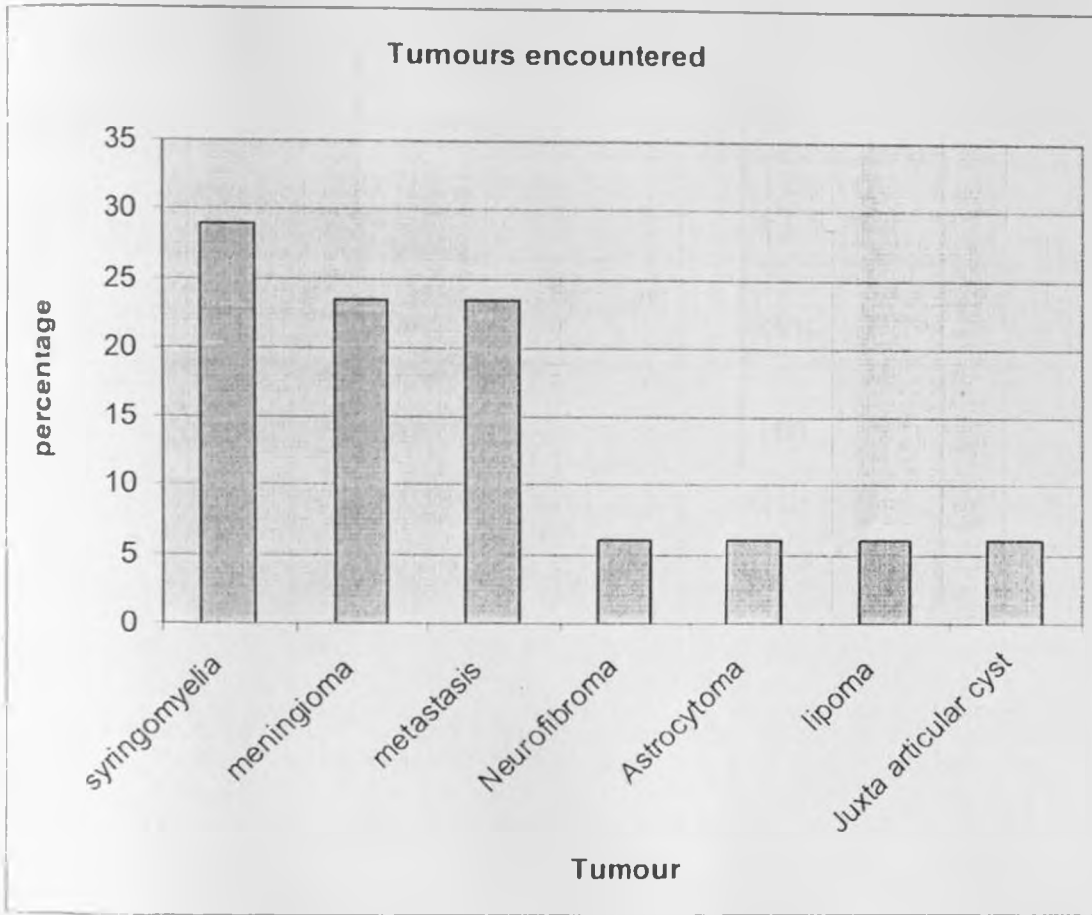
One patient may have more than one diagnosis.

Table 4 and figures 4 show the distribution of MR diagnosis in patients who had cervical spine MR. Disc disease was found to be the commonest finding (48%) followed by cervical spondylosis , 40%. The least common finding was infection (spinal arachnoiditis) which accounted for 1% of the cases.

Table 5: Tumours that were encountered.

tumour	frequency	Percentage (of tumors)
syringomyelia	5	29
meningioma	4	23.5
metastasis	4	23.5
Neurofibroma	1	6
Astrocytoma	1	6
lipoma	1	6
Juxta articular cyst	1	6
total	17	100

Fig 5: Distribution of tumours that were seen.



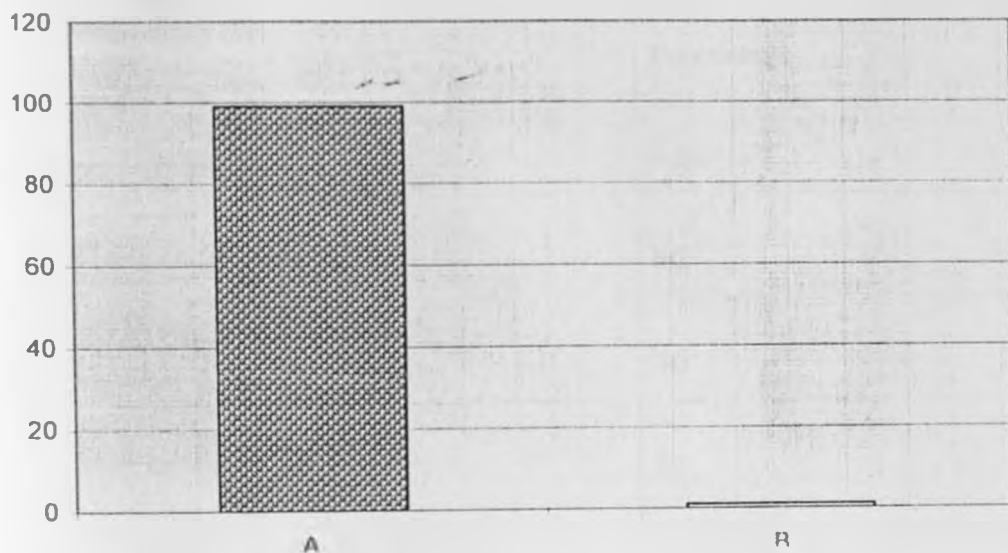
NB: One patient may have presented with more than one tumour.

Tumours accounted for 17% of the lesions seen. Syringomyelia was the commonest finding accounting for 29% of the tumours.

Table 6: Other investigations after MR.

Investigation	Frequency	%
Yes	1	1
No	99	99%
Total	100	100

Figure 6: Proportion of patients who required further radiological investigation.



Key:

A MRI only

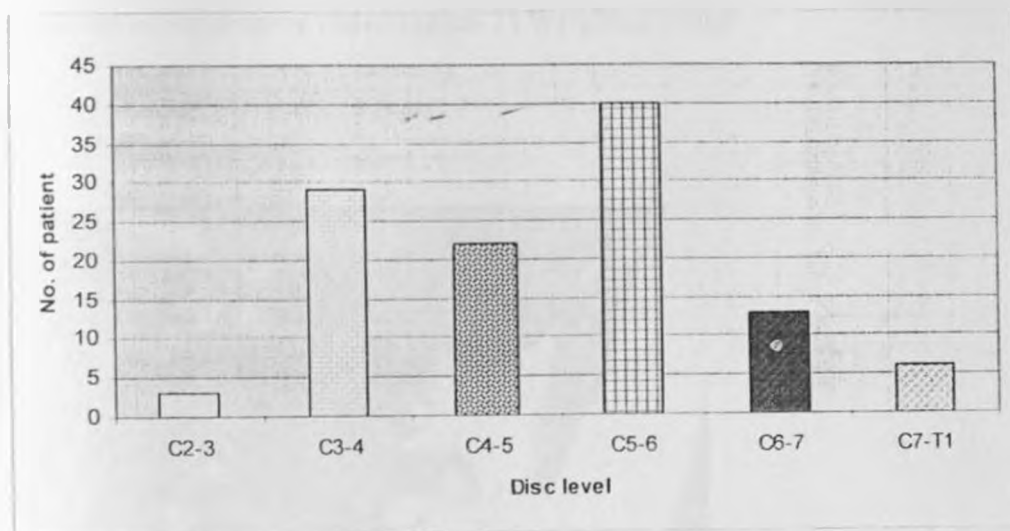
B other radiological investigation.

Table 6 and figure 6 show the proportion of cases that required further radiological investigation. Only one patient (1%) required further radiological investigation after MR of the cervical spine. This patient had metastasis suspected to have come from the breast and hence mammography was further requested.

Table 7: Involvement of disc levels.

Disc level	Frequency	Percentage
C2-3	3	1.06
C3-4	29	60
C4-5	22	46
C5-6	40	83
C6-C7	13	27
C7-T1	6	12.5

Figure 7: Distribution of disc level involvement



NB: One patient could have more than one disc involvement

Table 7 and figure 7 show the distribution of disc involvement. C 5-6 disc was the most frequently involved.

SELECTED IMAGES / ILLUSTRATIONS

Fig. 8 : Normal cervical spine . Mid sagittal T1 Weighted image.



Fig 10 : Axial GE T2W image of normal C5 vertebra. Arrow shows flow related enhancement from the vertebral artery. A-articular facet, B-vertebral body, P-pedicle, L-lamina, SP-spine.

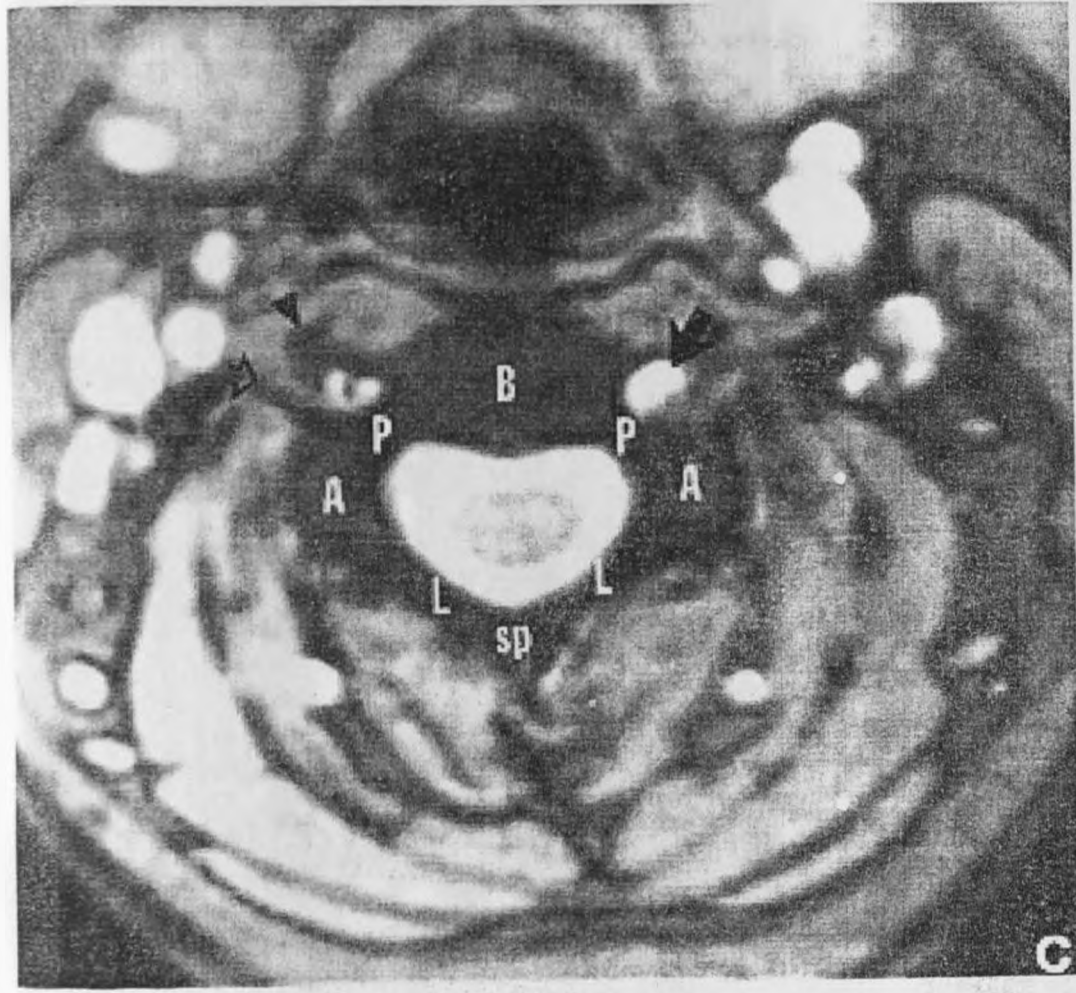


Fig. 11: Mid sagittal T1W image showing multiple Schmorl's nodes

(arrow heads).

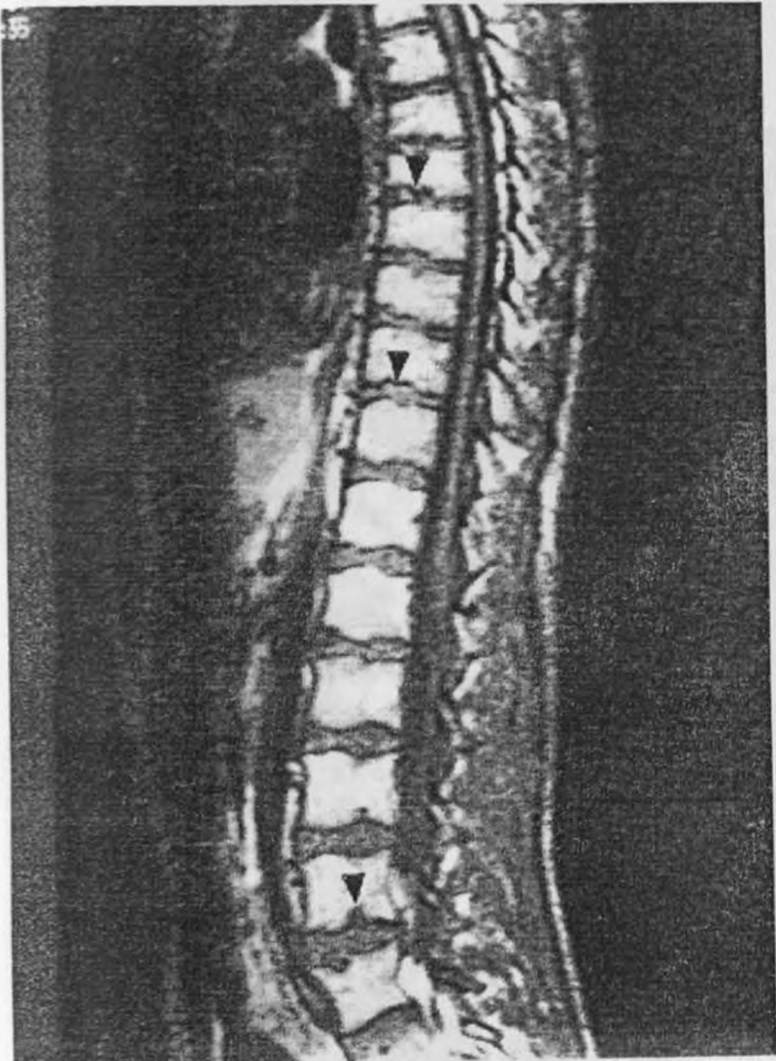


Fig. 12: mid sagittal T1w image shows a bright disc herniation at C5-C6 level. (arrow head).

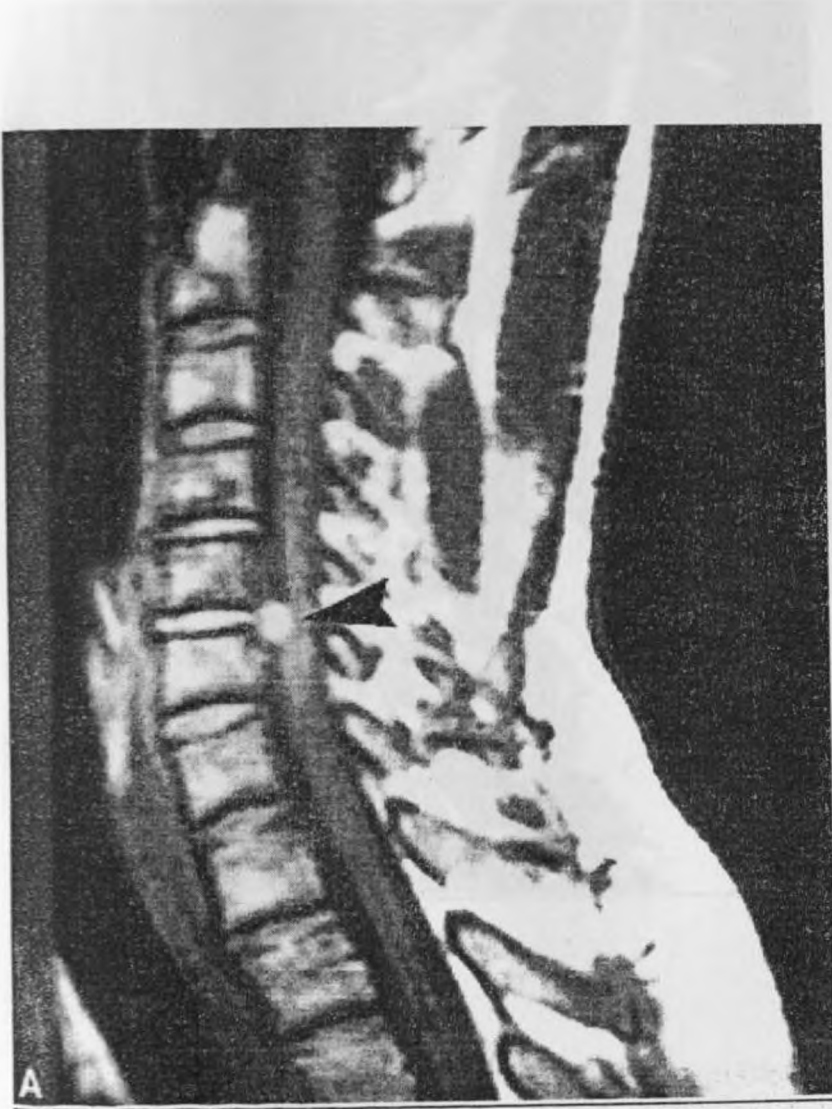


Fig. 13: mid sagittal PD weighted image shows the herniated disc fragment remains hyper intense.



Figure 14:

Syringomyelia and Chiari I malformation.

T1-weighted SE MR image showing cerebellar tonsils lying below the neural arch of C1, and a distended syrinx extending from C2 to T2.



DISCUSSION

Neck pain and stiffness was the commonest reason for referral for cervical spine MR. up to 31% of the patients seen had complained of neck pain and stiffness. Upper extremity weakness and numbness is also a common complaint accounting for 21% of the patients who had MR of the cervical spine.

Most studies elsewhere record neck pain as a common complain with some recording an occurrence of 40-50% in all patients⁽¹⁾

More men than women managed to have a cervical spine MR. Men comprised 65% of all the patients studied while women made up 35%

The age groups mostly investigated for cervical spine disease were the 31-40 and 41-50 age groups. The 31-40 age group accounted for 28% of the cases while the 41-50 age group accounted for 24% of the cases. These age groups can be described as young adults. This is unlike the high prevalence in middle age seen in the west⁽²⁾. This difference can partly be explained by the different demographic pattern between the population studied (Kenyan) and the western population with the former having a much younger population.

MR findings are discussed below under the following subheadings:

- ❖ Normal MRI of the cervical spine.
- ❖ Spondylosis
- ❖ Disc disease
- ❖ Tumours
- ❖ Fractures
- ❖ Infection
- ❖ Spinal stenosis
- ❖ Spondylolisthesis
- ❖ Myelomalacia

❖ Others

Normal MRI of the cervical spine

The normal anatomy of the cervical spine has been discussed previously. In this study 15 patients who had MR examination of the cervical spine due to various reasons had a normal scan. MR examination of the cervical spine was not able to explain the cause of their symptoms.

Cervical spondylosis

The primary pathologic finding in spondylosis is osteophytosis. Osteophytes are bony excrescences that originate near the margin of vertebral bodies or facet joints.

In this series 40 patients (40%) had spondylosis. Spondylosis increases with advancing age. The prevalence of spondylosis in patients of 50 years and above is estimated at between 60 and 80%. Majority of the patients in this study were between 31 and 50 years.

Disc disease- degeneration and prolapse.

Disc degeneration is defined as diminished signal intensity on T2W images combined with loss of inter vertebral disc space height. It is a common finding even in the asymptomatic.

Disc prolapse is the extrusion of nuclear pulposus into the spinal canal through a laceration of annulus fibrosus. In this study 48 patients out of 100 (48%) had disc disease of ranging severity (disc bulge, disc protrusion, disc herniation, disc extrusion and sequestration). Multilevel involvement was the rule.

C5 - C6 disc was the most common disc to be involved. It accounted for 40 out of the 48 patients who had disc disease (83% of the cases). Other authors also report this disc as the most commonly involved [44, 45]. C2-C3 was the second most commonly involved disc accounting for 29 of the 48 patients who had disc disease.

Tumours and tumour like conditions

Tumours of the cervical spine can be benign or malignant. Malignant tumours can be primary or secondary. Spinal tumours and tumour like conditions are classified by location into 3 categories:-

- a) Extradural lesions – lesions of the osseous spine, epidural space and paraspinous soft tissue.
- b) Intradural extramedullary lesions – these are inside the dura but outside the cord.
- c) Intramedullary lesions

In this study the tumours encountered were spinal meningiomas, syringohydromyelia, metastasis, neurofibromas, lipomas, astrocytoma and juxta articular cysts. Total number of tumours was seventeen patients. Syringohydromyelia were the commonest lesions seen in 5 patients. Meningiomas and metastasis followed closely and were seen in four patients. Neurofibromas, intradural lipoma, astrocytoma and juxta articular cyst were each seen in one patient.

Fractures

Only two patients were found to have fractures of the cervical spine. The low incidence of fractures is explained by the fact that MR was not used as primary imaging modality in most trauma cases.

Infection

Early diagnosis is crucial in the management of spine infections because delayed treatment can lead to increased morbidity.

In this study, only one patient had infection. He had spinal arachnoiditis

Spinal canal stenosis

Spinal canal stenosis can be congenital or acquired or result from a combination of congenital abnormality with superimposed degenerative changes. Congenital stenosis occurs with short pedicle syndrome. Minimal disc bulge or spondylotic changes superimposed on a congenitally small canal can produce severe neurogenic deficit. Other congenital spinal stenosis occurs with achondroplasia and inherited metabolic disorders such as morquio syndrome.

Spondylosis, disc bulges or herniation, ligamentous degeneration, spondylolisthesis or a combination of these disorders are typical causes of acquired spinal canal stenosis.

In this study spinal stenosis was found in three patients (3%). The precise incidence of spinal canal stenosis is not known, however the prevalence of spinal canal stenosis as shown by other authors is between 4% and 28%

Spondylolisthesis and spondylolysis

Spondylolysis is a fibrous defect within the pars interarticularis; spondylolisthesis is the slippage of one vertebral body in relation to an adjacent vertebral body. Spondylolisthesis often accompany spondylolysis but can also be caused by ligamentous laxity and acute trauma. Three patients accounting for 3% were found to

have spondylolisthesis with or without spondylolysis in this study. This is close to the value of 5% shown by other authors⁽⁴⁵⁾

Myelomalacia

Eight patients were found to have myelomalacia in this study. Most of these were caused by cord compression secondary to spinal canal stenosis

Others

Other MR findings included Chiari 1 malformation, block vertebra, intradural haematoma and ADEM.

Five patients had Chiari 1 malformation. Four patients had block vertebrae while one patient had intradural haematoma and ADEM each

CONCLUSION

- 1) Cervical spine diseases affects all age groups and follows normal distribution of a population with its peak at 31-50 years age group. Men are more affected.
- 2) The commonest pathology encountered in this series is disc disease and cervical spine spondylosis. The commonest disc space affected is C5 – 6 disc.
- 3) The commonest symptoms requiring cervical spine MR are neck pain and stiffness and upper extremity weakness and numbness.
- 4) In most situation (99% of cases), there was no need of further radiological evaluation following MR examination of the cervical spine. This makes MR of the cervical spine the best modality for evaluation of patients with neck pain and other cervical spine pathologies.
- 5) Most patients are adequately examined by the standard sequences. Fat suppression and gadolinium enhancement is necessary in cases of tumours and infections.

RECOMMENDATIONS

In the presence of qualified and experienced clinicians (neurosurgeons and orthopedic surgeons), patients presenting with cervical spine diseases will benefit from MR examination as this will save time for both patient and doctor, save patients from unnecessary surgery, reduce the period of hospital stay as well as reducing the risk of the disease progressing to incurable stages or developing severe complications.

As MR becomes more available in the country, further studies especially on effects of surgery will be required. A study of correlation of MR findings of tumours with histology is required to assess the accuracy of MR findings.

Patient consent form (English)

My name is Dr. Leonard Gikera , a master of medicine student in the department of Medical Imaging and Radiation Medicine at the university of Nairobi . I am doing a study on patterns of cervical spine disease as seen on MR.

I would like to recruit you in this study. The information obtained will be handled with utmost confidentiality. Your name will not be included, except the serial number. No additional examination will be carried out save for what your primary doctor will have requested.

The results of the study will be used to improve the diagnosis and management of cervical spine disease.

Please note that you are not obliged to participate and you have a right to decline or withdraw from the study.

If you accept please sign below.

Signature

Date

I certify that the patient has understood and consented participation in the study.

Dr. Leonard Gikera.

Signature

Date

APPENDIX 1b

Fomu ya mgonjwa kukubali (Patient consent form in Kiswahili)

Jina langu ni daktari Leonard Gikera . Mimi ni mwanafunzi wa masomo ya upigaji picha wa mwili katika chuo kikuu cha Nairobi.

Nafanya uchunguzi wa magonjwa ya shingo. Naomba ruhusa kwako ili nitumie majibu yako kwa uchunguzi wangu. Hayo majibu yatashughulikiwa kwa njia ya siri.

Jina lako halitawekwa kwenye uchunguzi wetu ila nambali ya fomu pekee. Matokeo ya huu uchunguzi yataboresha matibabu ya magonjwa ya shingo humu nchini.

Tafadhali jua kwamba sio lazima ukubali na hakuna uchunguzi utafanywa ila ule daktari wako aliagiza.

Kama umekubali , tafadhali weka sahihi hapa chini.

Sahihi

Tarehe

Nadhibitisha kuwa mgonjwa ameelezwa na kukubali uchunguzi.

Daktari Leonard Gikera

Sahihi

Tarehe

APPENDIX II

QUESTIONNAIRE

1. Serial No.....

2. Age in years.....

3. Sex Male (01) Female (02)

4. Symptoms

a) Neck pain

b) Neck stiffness

c) Radiculopathy

d) Myelopathy

e) Paraplegia

f) Gait difficulties

g) Upper extremity weakness and numbness

h) Difficulty in ambulation

i) Others (specify)

5. MRI findings and
diagnosis.....

.....
.....
.....

6. (i) Was there a need of doing another radiological examination after MRI?

Yes.....

No.....

(ii) If yes, what investigation was requested?

a) Plain x-ray

b) Plain myelogram

c) CT Myelogram

d) CT with or without IV contrast

e) Radionuclide scanning

f) Others (specify).....

APPENDIX III

BUDGET

NO	Requirement	Cost (Ksh)
1	Stationery, photocopying, typing	15000
2	Secretarial services	5000
3	Data analysis	20000
4	Computer printing	10000
5	Image scanning	20000
6	Binding	5000
7	Transport	10000
8	Contingency	10000
9	TOTAL	100000

Note:

The researcher met the above expenses.

The contingency allocation was to cater for any unforeseen expenditure.

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Signature

Date

APPENDIX 1b

Fomu ya mgonjwa kukubali (Patient consent form in Kiswahili)

Jina langu ni daktari Leonard Gikera . Mimi ni mwanafunzi wa masomo ya upigaji picha wa mwili katika chuo kikuu cha Nairobi.

Nafanya uchunguzi wa magonjwa ya shingo. Naomba ruhusa kwako ili nitumie majibu yako kwa uchunguzi wangu. Hlayo majibu yatashughulikiwa kwa njia ya siri.

Jina lako halitawekwa kwenye uchunguzi wetu ila nambali ya fomu pekee. Matokeo ya huu uchunguzi yataboresha matibabu ya magonjwa ya shingo humu nchini.

Tafadhali jua kwamba sio lazima ukubali na hakuna uchunguzi utafanywa ila ule daktari wako aliagiza.

Kama umekubali , tafadhali weka sahihi hapa chini.

Sahihi

Iarhe

Nadhibitisha kuwa mgonjwa ameelezwa na kukubali uchunguzi.

Daktari Leonard Gikera

Sahihi

Iarhe

APPENDIX II

QUESTIONNAIRE

1. Serial No.....

2. Age in years.....

3. Sex Male (01) Female (02)

4. Symptoms

a) Neck pain

b) Neck stiffness

c) Radiculopathy

d) Myelopathy

e) Paraplegia

f) Gait difficulties

g) Upper extremity weakness and numbness

h) Difficulty in ambulation

i) Others (specify)

5. MRI findings and

diagnosis.....

.....

.....

.....

6. (i) Was there a need of doing another radiological examination after MRI?

Yes.....

No.....

(ii) If yes, what investigation was requested?

- a) Plain x-ray
- b) Plain myelogram
- c) CT Myelogram
- d) CT with or without IV contrast
- e) Radionuclide scanning
- f) Others (specify).....

APPENDIX III

BUDGET

NO	Requirement	Cost (Ksh)
1	Stationery, photocopying, typing	15000
2	Secretarial services	5000
3	Data analysis	20000
4	Computer printing	10000
5	Image scanning	20000
6	Binding	5000
7	Transport	10000
8	Contingency	10000
9	TOTAL	100000

Note:

The researcher met the above expenses.

The contingency allocation was to cater for any unforeseen expenditure.

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