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PATTERNS AND OUTCOMES OF SURGICALLY TREATED LUMBAR DISC HERNIATION AMONG PATIENTS AT MOI TEACHING AND REFERRAL HOSPITAL, ELDORET - KENYA

BY

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A Thesis submitted in partial fulfilment for the requirements of the degree of Master of Medicine in Neurosurgery of University of Nairobi

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Declaration

I hereby declare this study is my original work and it has not been presented in any other university for an award of a degree or any academic merit

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Dedication

I dedicate this work to all patients who are struggling with Lumbar Disc Herniation and to all clinicians who have dedicated their lives to improve the quality of life of their patients.

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LIST OF ABBREVIATIONS

CES	- CaudaEquina Syndrome
CSF	- Cerebrospinal Fluid
CT	- Computed Tomography
DVT	- Deep Vein Thrombosis
ESI	- Epidural Steroid Injection
FE	- Full Endoscopic
FST	- Femoral Stretch Test
HLD	- Herniated Lumbar Disc
IQR	- Inter-Quartile Range
IVD	- Intervertebral Disc
KNH	- Kenyatta National Hospital
LDH	- Lumbar Disc Herniation
LE	- Lower Extremity
MD	- Microdiscectomy
MED	- Micro-endoscopic Discectomy
MRI	- Magnetic Resonance Imaging
MTRH	- Moi Teaching and Referral Hospital
NSAIDS	- Non-Steroidal Anti-Inflammatory Drugs
SD	- Standard Discectomy
sd	-standard deviation
VAS	- Visual Analogue Scale
SLR	- Straight Leg Raising Test

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SUMMARY

Herniated lumbar disc (HLD) is a common condition that frequently affects the spine in young and middle-aged patients.There is limited local data on the epidemiology, clinical and radiological patterns and outcomes after surgery for lumbar disc herniation.
The aim of this study was to assess the patterns and outcomes of surgically treated lumbar disc herniation among patients at MoiTeaching and Referral Hospital.
This was a longitudinal study that involved follow up of patients post operatively for upto 4 weeks. Data was collected consecutively till sample size attained.

Forty eight patients were studied. Males were more affected than females. The mean age was 47±9 years. Clerical work (42%) was the main occupation. The most common risk factor was heavy weight lifting (68.8%). Diminished ankle jerk (75%) was the most common reflex change noted. Foot drop (weakness in ankle dorsiflexion) was seen equally in 34% of patients with L4/L5 and L5/S1 disc herniations. SLR test was positive in 98%, Braggard's (50%), crossed SLR and FST were positive in 15% and 4.2%, respectively. Seventy nine percent of the participants had HLD at L5/S1 while those with HLD at L4/L5 and L3/L4 were 73% and 21%, respectively. Extrusion (79%), sequestration (15%) and protrusion (12.5%) were the types of HLD seen. Postero-lateral (92%), central (12.5%) and extreme lateral (4.2%) were the locations of HLDs. Intra-operative complications were noted in 14.6%. Post-operatively, one participant developed DVT and one had failure of pain relief. The median post-operative VAS was 1 (IQR 0-2) from the median pre-operative VAS of 8(IQR 7-9). Marked improvement in VAS was noted across all types and level of disc herniation. At 2 weeks post-operatively, 45.8% equally reported excellent andgood outcome according to the MacNab's criteria while at 4 weeks, 66.7% reported an excellent outcome while 29.2% reported a good outcome.

Low back pain (LBP) and leg pain were the main presentations. Diminished ankle jerk reflex showed a clear prediction for lower lumbar disc herniation. Sensory examination revealed a considerable overlap of dermatomes, inconsistent with expected dermatomal distributions. SLR test showed a high diagnostic performance for lumbar disc herniation, especially for lower lumbar levels. The most common level of lumbar disc herniation was L5/S1 while the most frequent type of disc herniation was extrusion. Postero-lateral location was the most common location for disc herniation. The type and level of disc herniation did not affect the outcome following microdiscectomy. Intra-operative and post operative complications were not common findings. Microdiscectomy, as demonstrated by the outcome scores (VAS and MacNab's), has a high success rate for patientswith HLDs who have failed a period of conservative management.

INTRODUCTION

Lumbar disc herniation is one of the most common diagnoses encountered in clinical spine practice. It is among the leading causes of chronic disability and functional incapacity in the working years. Over 200,000 lumbar discectomies are performed annually in the United States (13). Lumbar disc herniation is also believed to be a major contributor to the 60 – 80% lifetime incidence of low back pain in the general population (9, 81).

Symptomatic lumbar disc herniation occurs in upto 2% of the general population at some point in life (82). Men are affected more than women, with a peak incidence in the fourth and fifth decade of life (16, 17, 18, and 83).

The intervertebral disc (IVD) primarily serves to distribute the forces exerted during axial loading of the spinal column; yet allowing motion in the otherwise rigid column. The IVD consists of the gelatinous nucleus pulposus surrounded by the fibrous annulus fibrosus and the cartilaginous plates. The normal aging process results in reduced water content in the IVD, reducing its capability to cope with mechanical forces (84). Eventually, with repeated episodes of high stress, annular fissures occur; with resultant protrusion (contained), extrusion (non – contained), or sequestration of the nucleus pulposus.

Most herniations are located postero – laterally, and when this occurs, the ipsilateral nerve root is compressed at its exit from the dural sac; giving rise to radiculopathy along the distribution of that nerve. More dramatically but rarely, when the herniation is central, the cauda-equina is compressed resulting in the cauda-equina syndrome.

Atlas et al carried out a 10 year outcome study (The Maine Lumbar Spine Study), assessing the long-term outcomes of surgical and nonsurgical management of lumbar spinal stenosis. They noted that 71% of the patients who underwent surgery were satisfied with their outcome, while only 56% of the patients who were managed non-surgically were satisfied with their outcome (48).

Discectomy for lumbar disc herniation is the most commonly performed spinal surgery. The basic principle of the various techniques is to relieve the nerve root compression induced by the herniation (93).

Historically, in 1934, Mixter and Barr describedthe first surgical lumbar disc herniation technique, using a wide posterior trans-dural approach (8). In 1939, Love described an approach inclining the dural sac and releasing the nerve root with disc resection. These basic procedures are still employed today, although the technique has been refined, with a smaller standard unilateral 5 cm incision. This is the standard discectomy (SD).

Over the years, many technical improvements have decreased operative trauma by reducing incision size, thereby reducing postoperative pain and hospital stay and time off work, while improving clinical outcome. Magnification and illumination systems by microscope and endoscope have been introduced to enable minimally invasive techniques.

In 1977, Yasargil (94) and Caspar (95) described a surgical microdiscectomy (MD) technique. The muscular approach was reduced to 3 cm, using a speculum or distractor to distract the muscles and a microscope for illumination.

Kahanovitz et al. (96) found no difference in results between the two techniques, except for shorter hospital stay with MD (2 vs.7 days). Gibson et al’s meta-analysis (97) found no benefit of MD over SD. Katayama et al’s prospective study (52) found no difference except in hospital stay and bleeding, which were lower in MD. Veresciagina et al.’s prospective study (98) reported no significant difference between the techniques.

Ongeti and Gakuu conducted a 10 year retrospective study at Kenyatta National hospital, reviewing 603 cases for treatment and outcome after lumbar disk herniation. The study showed a female preponderance of 56% compared to the males figure of 44%. 35% of the patients underwent surgery. Various surgical methods were applied, of which standard laminectomy was the most popular, with microdiscectomy becoming more popular later on in the study. Ninety six percent of the patients reported improvement. They observed that the outcome was dependent on the level of herniation. They also observed that there was no relationship between complication and the surgical method used (87).

The aim of this study is to assess the clinical and radiological patterns and to determine the outcomes of surgically treated lumbar disc herniation among patients at Moi Teaching and Referral Hospital (MTRH).This study also aims to determine the socio-demographic characteristics and the outcome in form of pain relief and functional improvement and to correlate these findings with the type of surgery performed.

LITERATURE REVIEW

HISTORICAL PERSPECTIVE

Man has been plagued by lower back pain for as long as history has been recorded. In 1930, Breasted (1) translated the Edwin Smith papyri which reported cases of back pain as rendered by the ancient Egyptians.

In the Bible, there seems to be a citation of radicular pain in the lower limb. An episode is described in Genesis 32:23-33, where a fight with Jacob and an angel caused in the former to develop a sharp pain along the "big nerve". It has been hypothesized that the radicular like pain might have been produced by a herniated disc caused by a physical strain (2).

Hippocrates (460-357 B.C.) first used the term "Sciatica" in the "Treatise of Diseases" and described a pain in the joint of the femur extending to the buttocks, the thigh and the leg (3). Galen (131-201 A.D) discussed the usefulness of bleeding in the management of sciatica. The bleeding was aimed at removing the noxious "humors" described by Hippocrates in his "Treatise of Remedies" (3).

The Greek and the Latin physicians were, however, far from understanding the real aetiology of sciatica. In the 1764, Contugno attributed the pain to the sciatic nerve (4).

Several manoeuvres were devised to isolate the problem of sciatica. These include Lase´gue sign by Forst in 1881 but attributed to his teacher, Lase´gue (5). Goldthwait in 1911 attributed back pain to posterior displacement of the disc (6).

Oppenheim and Krause in 1909 performed the first successful surgical excision of a herniated lumbar disc. However, they interpreted it as an Enchondroma (7).

Definitive association with the intervertebral disc was established by the breakthrough work of Mixter and Barr in 1934(8). They publisheda small study describing symptoms that they postulated were caused by degenerative changes in the intervertebral disc that might be relieved by surgical intervention.

The German pathologists, Schmorl and Andrea (1927-1929) are to be credited for their contribution to the pathology of the intervertebral disc; recognizing the frequency and degenerative (Not Neoplastic) nature of nucleus pulposus herniation.

In 1977, Yasargil (94) and Caspar (95) described a surgical microdiscectomy technique (MD). The muscular approach was reduced to 3 cm, using a speculum or distractor to distract the muscles and a microscope for illumination.

In 1988, Kambin and Sampson (99) described a purely endoscopic technique (full endoscopy [FE]) on an extra-foraminal approach, for non-sequestrated intracanaldiscal hernia.

Ten years later, with a view to managing all kinds of herniation, Foley and Smith (100) described a video-assisted technique using a tubular work canal (micro endoscopic discectomy: MED) or speculum with a 2-cm incision on a transmuscular approach without multifidus release.

In 2002, Yeung and Tsou (101) described a Full Endoscopic (FE) technique able to ablate all forms of discal herniation on a transforaminal approach.

EPIDEMIOLOGY

Back pain is a major health issue worldwide. A study by Hult in 1954, estimated that 60 - 80% of people are affected by back pain at some time in their lives (9). The National Center For Health Statistics in USA, ranks impairment of the back and spine as the most frequent cause of limitation of activity in people younger than 45 years.

Bono et al, in 2006, estimated the incidence of lumbar disc herniation within certain populations to be greater than 50 %(10). Anderson noted the incidence of low back pain to be 61% and the prevalence to be 31% in a random sample of 40-47 year old men. In women between ages 38-64 years, the incidence of low back pain was 66% with a prevalence of 35%. 40% of those with back pain also had sciatica (77).

In a Finish population study of 57,000 subjects followed over 11years, 1537(2.6%) developed spinal related complaints. Disc herniation was documented radiographically or surgically in 30% of the subjects and diagnosed clinically in 24% (11, 12).

The prevalence does not seem to vary significantly in different populations: atleast in the developed countries. In U.S.A., the prevalence was found to be 1.6%; in England 2.2% and in Finland 1.2 %(13).

Back-related conditions including symptomatic lumbar disc herniation are a common cause of disability. It is estimated that the US health care system spends over 1 billion dollars to address these issues.

The highest prevalence of disc herniation is found in subjects in the age range of 30-50 years (13). The average age of patients undergoing surgery for disc herniation is about 40 years (11).

In children and adolescents, disc herniation is rare but the exact prevalence is unknown. A study done in Japan by Kurihara in 1980, noted a figure of 8%-15% of 70 operated cases being children (15).

As regards to gender, the prevalence of disc herniation is higher in males, with the male: female ratio being 2:1 (17, 18and 21). In a large series of 21,424 patients who underwent surgery for disc herniation, 61% of the patients were male (21).

Regarding the incidence of the vertebral level involved, L4-5 and L5-S1 herniated lumbar discs account for 90% of the cases of lumbar disc herniation (22). Upper lumbar disc herniations (L1/L2 or L2/L3 level) have been known to be no more than 5% of all lumbar disc herniations (24).

RISK FACTORS

a) Lifting Objects

Physical activities overloading the functional spinal unit in flexion may cause repetitive tensile stresses which may eventually lead to failure of the posterior annulus fibrosus. A study by Mundt et al, in 1993, noted that certain weights (25 pounds or more) and certain positions during lifting (trunk twisting or trunk bent forward with knees straight), increases the risk of herniation by nearly fourfold (25).

b) Age and Gender

It has been shown that there is a clear association between increasing age and progressive disc degeneration. Heine (26), in his study of 1000 autopsies showed that disc degeneration increases linearly from 0% to 72% between the ages of 39 years and 70 years.Miller et al (27) reported that male lumbar discs were significantly more degenerative than female discs across most age groups, and suggested that this could be due to higher mechanical stress on the male intervertebral disc.

c) Smoking

It has been hypothesized that the increased risk of disc herniation in smokers may be due to the chronic bronchitis and persistent cough leading to increased intra-discal pressure and facilitating disc failure. Another hypothesis suggests that nicotine causes vasoconstriction leading to decreased blood supply to the vertebral bodies and reduced nutrient supply to the disc, leading to disc failure. Animal studies have ascertained this hypothesis. According to Kelsey J's study, cigarette smoking increases the risk of lumbar disc herniation by 20% (16).

d) Genetic Factors

The importance of familial predisposition is now being recognized as a contributing factor in disc degeneration. More than half a dozen loci have been associated with disc degeneration, mostly from chromosomes 2, 4, 6, 7 and 11 (30).

e) Driving Motor Vehicles

The risk of disc herniation is increased in car and truck drivers and is related to the time spent behind the wheel. Kelsey J et al reported in her study that driving motor vehicles for more than half the working day could increase the risk of disc herniation by three fold (16, 31).Vibrations transmitted to the spine may increase mechanical stress on the disc and predispose to disc failure.

f) Pregnancy

An increased incidence of disc herniation has been noted in pregnant women. Pregnancy may contribute to deterioration of pre-existing sciatica, or cause sciatica in an asymptomatic disc prolapse (32).

CLINICAL ASPECTS

The clinical presentation of a herniated disc varies from no symptoms to rapid paralysis: the severity of symptoms correlate with the degree of compression to the neural elements.

In a patient with a herniated lumbar disc, the chief complaint is commonly radicular leg or back pain. The onset may be acute, following a traumatic event. But often so, the patient cannot pinpoint exactly as to when the pain began.

The patient generally avoids prolonged standing or sitting. Straining manoeuvres like coughing and sneezing commonly increase the symptoms of disc herniation (33).

The patient may complain of difficulty in voiding, straining, or urinary retention. The incidence of voiding dysfunction is 1-18 % (34).

CaudaEquina Syndrome may arise from a massive herniated disc. The symptoms include: urinary retention, saddle anaesthesia, motor weakness, lower back pain/sciatica and sexual dysfunction.

The pain is presumed to result from both mechanical pressure and chemical inflammation of the nerve root by the herniated disc. Pain generation from disruption of the annulus fibrosus is thought to be mediated via branches of the sinu-vertebral nerves.

Physical Findings in Radiculopathy

Nerve root impingement gives rise to a set of signs and symptoms. Characteristic syndromes are described for the most common nerve roots involved.

Findings suggestive of nerve root impingement include the following:

1. Signs & Symptoms of radiculopathy:
    a. Pain radiating down LE
    b. Motor weakness
    c. Dermatomal sensory changes
    d. Reflex changes
2. Positive nerve root tension signs

A herniated lumbar disc usually spares the nerve root exiting at that interspace, and impinges on the nerve exiting from the neural foramen one level below (e.g. a L5-S1 HLD causes S1 radiculopathy). These findings are summarised in table 1.

Table 1: Physical findings in lower Lumbar Disc Herniation

	L3-4	L4-5	L5-S1
Root usually compressed	L4	L5	S1
% of lumbar discs	3 – 10%	40 – 45%	45 – 50%
Reflex diminished	Knee jerk	Medial hamstring	Ankle jerk
Motor weakness	Quadriceps femoris (knee extension)	Tibialis anterior (foot drop)	Gastrocnemius (plantar flexion)
Decreased sensation	Medial malleolus & medial foot	Large toe web & dorsum of foot	Lateral malleolus & lateral foot
Pain distribution	Anterior thigh	Posterior LE	Posterior LE, often to ankle

Nerve Root Tension Signs

1. **Lasègue's sign**: AKA Straight Leg Raising (SLR) test. With the patient supine, the symptomatic limb is raised by the ankle until pain is elicited (Should occur at < 60˚). A positive test consists of leg pain or paraesthesia in a dermatomal distribution correlating with the anatomic location of the herniated disc (Back pain alone does not qualify). The patient may also extend the hip (By lifting it off the table) to reduce the angle. SLR primarily tenses L5 and S1. Nerve root compression produces a positive SLR in ≈ 83% of cases (33). Vroomen et al, in 1999, conducted a systematic review of the diagnostic value of physical examination for the diagnosis of sciatica due to disc herniation. He concluded that the SLR was the only sign that was consistently sensitive for sciatica due to disc herniation (64).
2. **Braggard's test**: If the SLR test elicits pain when the patient's leg is passively elevated, then Braggard's test is included as an extra manoeuvre. The physician lowers the patient's leg about an inch from the position in which pain was elicited, and while holding it in that position, the physician dorsi-flexes the foot of the patient. It is an augmentation of the SLR.
3. **Crossed SLR**: SLR on the painless leg causes contralateral radicular pain in the opposite leg. It is more specific but less sensitive than SLR, as shown in Kostaljanetz's study (110).
4. **Sitting knee extension test**: AKA Tension test. With patient seated with both hips and knees flexed 90˚, one knee is slowly extended. During this test, the patient may feel the need to lean back and assume a tripod stance by balancing on his/her outstretched hands to relieve the pain.
5. **Naffziger's test**: Manual compression of the jugular veins bilaterally. An increase in pain over the distribution of the involved nerve root confirms the presence of a HLD.
6. **Femoral stretch test (37):** With the patient prone, the knee is maximally dorsiflexed. Positive in L2, L3, or L4 nerve root compression (in upper lumbar disc herniation).

A study carried out by Vroomen et al, in 1999; found that the SLR,crossed SLR, Bragard's sign and Naffziger's sign were the most consistent nerve root tension signs (64).

Herniated Upper Lumbar Discs

Disc herniation at the level of L1/L2 and L2/L3 typically results in compression of the L2 and L3 nerve roots, respectively. Patients may complain of pain along the anterior or antero-medial thigh. Lower extremity weakness is most commonly observed in the hip flexors. Patients complain of weakness when ascending stairs. Knee jerk reflex may be normal or slightly decreased.

RADIOLOGICAL FINDINGS

The main culprit in disc herniation is the nucleus pulposus, and it may herniate in any direction. However, most herniations occurpostero-laterally and this can be explained by the posterior location of the nucleuspulposus and by the central reinforcement of the annulus by the posterior longitudinalLigament (60, 85).

Nevertheless, 3 – 10% of disc herniations can occur in an extreme lateral position (61, 62). These include; herniation of a disc at the facet (foraminal disc herniation) or distal to the facet (extraforaminal disc herniation).The incidence of central lumbar disc herniation is low as compared to the more common occurrence of postero - lateral herniations (86).MRI has supplanted CT and myelography for diagnosing disc herniation. Specificity and sensitivity are similar to CT + myelography (90, 91).

Management Options

Non – Operative Management

Most cases of HLD respond well to conservative management. The natural history of the HLD is quite favourable regarding resolution of symptoms over time. Approximately 80% of the patients have full improvement of symptoms within 6 weeks of onset. Most HLDs diminish in size over time and ≈80% will decrease by atleast 50% or more (39).

The goals of non-operative management are to relieve pain, improve function, and to prevent chronicity of the problem. Non – operative treatments include:

a. **Bed rest**: Majority of patients do not require bed rest. De – activation from bed rest of more than 4 days appears to produce stiffness and worsened pain (41). The lowest pressure on nerve roots and intra – discal pressure is in the supine semi – Fowler position (42). Bed rest for 2 – 4 days may be an option for those with severe initial radicular symptoms.
b. **Education**: Educating the patient on proper posture and body mechanics is helpful in returning the patient to the useful level of daily life activity, after the acute exacerbation has eased.
c. **Epidural Steroid Injections**: The role of ESIs is to lessen radicular pain earlier than what would be seen with natural history alone. The mechanism of ESIs is to inhibit prostaglandin synthesis, impair cell – mediated and humoral responses, stabilize cell membranes, and suppress neuronal discharge. However, studies have shown contradicting results. Cuckler et al (43), in 1985, in his study of epidural steroid treatment of disc herniation, found no difference in the results at 6 months between placebo and epidural steroid injection. However, various clinical trials (44 and 45) have shown ESIs to be more effective than control for acute radiculopathy.
d. **Lifestyle/Activity Modification:** It is recommended to temporarily limit heavy lifting, strenuous exercise, bending or twisting of the back, and prolonged sitting. The goal is to achieve a tolerable level of discomfort while continuing daily activity (75).
e. **Analgesics:** In the short term period, acetaminophen and NSAIDs may be used. In severe pain, opioids may be used (75).
f. **Muscle relaxants:** Probably more effective than placebo, but have potential side effects (75).
g. **Exercise:** Extension based back exercises can be carried out as part of a physical therapy program. In the acute phase, low stress aerobics, walking or swimming, may minimize debility due to inactivity.
h. **Spinal manipulation therapy:** there is insufficient evidence to recommend SMT in patients with HLDs with radiculopathy.

i. **Physical Therapy:** In general has not been proven to be beneficial for patients with acute LBP, but it may be helpful for those with chronic LBP. The modalities include: TENS (transcutaneous electrical nerve stimulation), traction, lumbar corsets/braces, vertebral axial decompression (VAX-D), and ultrasound.

j. **Acupuncture:** Although anecdotal stories are rampant, there is little evidence suggesting its efficacy in treating HLD.

Surgical management

Indications

1. Failure of non – surgical management to control pain after 5 – 8 weeks. Most clinicians advocate waiting for 5 – 8 weeks, based on the natural history of HLD (75).
2. Patient choice.
3. Emergency surgery (before the 5 – 8 weeks lapse) is indicated for the following:
    a. Caudaequina syndrome(CES)
    b. For patients who cannot tolerate the pain despite the cocktail of analgesics.
    c. For patients with an acute development or progression of motor weakness.

Controversies abound regarding operative vs. non – operative modes. Hakelius (46), the Maine Lumbar Spine Study (48), and Saal (49), demonstrated that stable radicular weakness resolves equally well regardless of treatment. In 1983, Weber, in his classic work, found that those treated with surgery had a better result at one year post operatively (47). Recently, the Spine Patient Outcomes Research Trial (SPORT) reported a difference in favour of discectomy when compared with standard non – operative care (50).

Regardless of the method chosen to treat a disc herniation surgically, the patient should be aware that the procedure is predominantly for the symptomatic relief of leg pain. Patients with predominant back pain may not be relieved of their major complaint – back pain. After reviewing 2504 lumbar disc excisions, Sprangfort found that about 30% of the patients complained of back pain after surgery (51).

Surgical options

1. The standard "open" laminectomy and discectomy. The surgeon performs a hemi-laminectomy through a large skin and fascial incision to access the disc space without magnification.
2. The modern open discectomy "microdiscectomy" is typically performed using magnification emphasizing microsurgical techniques. A study by Katayama and colleagues prospectively compared the outcome between traditional open discectomy and microdiscectomy and demonstrated that the outcomes are similar (52). A study by Tulberg in 1993, demonstrated that the overall efficacy of microdiscectomy is similar to that of standard discectomy (53). However, numerous investigators such as Zahrawi (54), Lowell et al (55), and Moore et al (56), reported excellent results with low morbidity, shorter hospital stay, and early return to normal activity after microdiscectomy.
3. Sequestrectomy: Removal of only the herniated portion of the disc.
4. Endoscopic techniques: Are variations of the microdiscectomy technique using an endoscope rather than the microscope and different types of retractors. Thus far, the purported advantages have not been demonstrated.
5. Chemonucleolysis: Chymopapain is injected intradiscally. Acceptable treatment but less efficacious than discectomy.

DISABILITY, PAIN AND OUTCOME MEASUREMENTS

Some widely used measures include:

1. **Visual analogue scale (VAS):** Is a subjective scale for degenerative lumbar spine disorders in which '0' means 'no distress' and score '10' means 'agonizing pain'(63). It is a continuous scale comprised of a horizontal line, usually 10cm in length, anchored by verbal descriptors of the symptoms(92). Recall period varies but the respondents are asked to report 'current' pain intensity or pain intensity in the 'last 24 hours'. The respondent is asked to place a perpendicular line at the

point that represents their pain intensity. This provides a score range from 0 – 10 cm. A higher score indicates greater pain intensity.

Pain VAS is sensitive to changes in pain intensity associated with treatment or with time (92).

2. **Short form 36 (SF 36) (58):** Although the outcomes measured by the SF – 36 are not specific to the spine, it is useful for measuring the outcomes of spine surgery as spinal disorders impart a substantial negative effect on physical function.
3. **Oswestry disability index:** Is a commonly used assessment score in HLD. It is used to measure a patient's impairment and quality of life.
4. **MacNab'scriteria (102):** It is a commonly used scale used to assess the working capacity after spine surgery. It is graded into excellent, good, fair and poor.

   The patient is asked to rate his level of well-being, generally after surgery. With the same wording with the original (source) paper, the explanations of each grade are as follows:

   - Excellent: No pain; no restriction of activity.
   - Good: Occasional back or leg pain of sufficient severity to interfere with the patient's ability to do his normal work or his capacity to enjoy himself in his leisure hours.
   - Fair: Improved functional capacity, but handicapped by intermittent pain of sufficient severity to curtail or modify work or leisure activities.
   - Poor: No improvement or insufficient improvement to enable increase in activities; further operative intervention required.

COMPLICATIONS OF HLD SURGERY

Intra – Operative Complications

1. **Wrong site surgery:** A common intra – op complication is negative exploration or wrong level spine surgery. A self reporting survey indicated an incidence of 4.5 occurrences per 10,000 lumbar spine operations (65). Pre – operative communication with the patient, marking of the intended surgical site, and intra – operative verification radiographs have been identified as steps important in the prevention of wrong side or wrong level spine surgery (66).

2. **Incidental durotomy:** Inadvertent dural tear during spinal surgery has an incidence of 0 – 14 % (67). In a prospective study by Stolke et al (68), involving 412 primary and 69re – operations for HLDs, dura tear was reported in 1.8% of microdiscectomies and in 5.3% of standard open laminectomy plus discectomy. Dural lacerations can occur during the use of rongeur or kerrison punch, during dissection of the dura and the nerve root or it may tear while incising the ligamentumflavum. If a dural tear occurs, the herniated nerves should be carefully reduced and the tear sutured when possible. If the dural tear is in an inaccessible location, then a fascial or muscle graft can be placed over the tear and maintained in place by suture or tissue glue (71). Alexander et al reviewed patients who had sustained incidental dural tear at the time of disc surgery and found no peri–operative morbidity or compromise of results if the dura was repaired. They noted an incidence of 4% of this complication in 450 discectomies (74). Possible sequelae of dural tear include:
    a. External CSF leak which may require operative repair. A study by Ramires et al put the risk of a CSF fistula requiring operative repair at 10 per 10,000(69).
    b. Pseudomeningocele: The incidence is estimated at 0.7 – 2%(70)
3. **Iatrogenic vascular injury:** Although uncommon, may be rapidly fatal if not recognized and treated immediately (71). This occurs as a result of the ALL which exposes the great vessels to injury. The vessels prone to injury in surgery for HLDs include the aorta, the common iliac arteries, the venacava and the common iliac veins.
4. **Small bowel and ureteric injuries:** Rare but have been known to occur (73).
5. **Bleeding within the bony spinal canal or from the venous plexuses:** May necessitate transfusion. A study by stolke et al, noted that more bleeding was notable in the standard open laminectomy than in microdiscectomy (68).
6. **Nerve root injury:** It can occur during the use of rongeur, kerrison punch and cautery causing thermal injury (71).

7. **Complications of positioning (75):** These include:
    a. Compression neuropathies with injury to ulnar nerves.
    b. Anterior compartment syndrome due to pressure on the anterior compartment of the leg.
    c. Pressure on the eye resulting in corneal abrasions.
    d. Cervical spine injuries during manipulation of the neck while the patient is under anaesthesia.

Post – operative complications

1) **Wound infections:** According to a study by Shektmanetal, laminectomy wound infection occurs in 0.9 – 5% of cases(76).Spangfort's series of 2503 open disc excisions provided an incidence of 3.2% for wound infection (77).
2) **Post – operative discitis:** the incidence after lumbar discectomy is 0.2 – 4 % (77, 78). Patients may present with back, groin and/or abdominal pain, fever and paravertebral muscle spasms with limited range of motion of the spine.
3) **Deep vein thrombosis with risk of pulmonary embolism:** The incidence of thromboembolism ranges from 0.1–1% (69, 77). Ongetiet al, in a retrospective study of 603 patients, of which 213 patients underwent disc surgery, found an incidence of pulmonary embolism of 0.9% (87). Stolke in his prospective study of 481 patients operated on for HLD, found an incidence of 0.5% of pulmonary embolism as a post – operative complication.
4) **CSF leak asasequelae of unintended durotomy (69).**
5) **Increased motor deficit: 1 – 8%. May be transient (75).**
6) **Failure of pain relief.**
7) **Caudaequina syndrome:** An incidence of 0.21% - 0.14% was noted in two large studies (88, 89). It is mainly attributed to post – operative spinal epidural hematoma (89).
8) **Recurrence of HLD:** Is defined as herniation and pain at the same level after 6 asymptomatic months.

PROBLEM STATEMENT

The clinical and radiological patterns and outcomes of HLD’s are not well known in our set-up. Lumbar disc herniation continues to be one of the major causes of morbidity in the Kenyan population. It significantly reduces the quality adjusted life years. Understanding the patterns of surgically treated HLD’s will help in patient management.

STUDY JUSTIFICATION

Lumbar disc herniation remains among the most common diagnosis encountered in clinical practise. Lower back pain lifetime prevalence is estimated to range from 60 – 90%. Of these, upto 3% have a lumbar disc herniation (59).

There is a knowledge gap in terms of clinical patterns and socio demographics in our set-up. Describing the burden of disease and related patient variables in our set up will aid in providing useful data that can generate other entry points into studying this condition.

The relationship between the age, risk factors, presentation, treatment and outcome for HLDs, will help in improving the care of these patients inMTRH and other health institutions.

OBJECTIVES

Broad Objective

To assess the patterns and outcomes of surgically treated lumbar disc herniation among patients at Moi Teaching and Referral Hospital (MTRH).

Specific Objectives

The specific objectives assessed the following:

1. To describe the socio – demographic patterns of patients with HLDs at MTRH.
2. To determine the clinical presentation and radiological patterns of patients with HLDs at MTRH.
3. To determine the outcome using the pre-operative and post-operative visual analogue scale as a measure of pain intensity.
4. To determine the functional outcome after surgery, using the MacNab’s Criteria.

METHODOLOGY

Study Design:

This study was a longitudinal study involving observation of the same patients for a period of four weeks post operatively following HLD surgery at MTRH.

Study Setting

The study was conducted atMoi Teaching and Referral Hospital (MTRH), Eldoret-Kenya. MTRH isa 1,000 bed capacity hospital and is situated in the north rift region of Kenya. It has several clinical departments including surgerywhich houses a neurosurgical division.

Study Population.

The study population comprised of all patients with a confirmed radiological diagnosis of lumbar disc herniation presenting at MoiTeaching and Referral Hospital.

Inclusion criteria

a) Patients who were diagnosed with HLDs at MTRH and who had failed a conservative treatment period of at least 6 weeks
b) Patients who chosesurgery, or those who presented with indications for surgical management
c) MRI evidence of HLD

Exclusion Criteria

a) Patients who declined to give consent for their participation in the study.
b) Very sick patients or those in coma were excluded from the study

Sample Size Determination

In order to have a 95% confidence level that the proportion of the patients with L4-5 and L5-S1 herniated lumbar discs among all the patients with herniated lumbar discs is within plus or minus 5% of the population proportion of 95%, the number to study was determined using the following formula (Cochran, 1963).

$$n = \left(\frac{Z_{1-\alpha/2}}{\delta} \right)^2 P(1-P)$$

Where P is the population proportion of those who have L4-5 and L5-S1 herniated lumbar discs, among those patients who will present with herniated lumbar disc, taken to be 95% in this study, δ is the margin of error equal to the 5% and $Z_{1-\alpha/2}$ is the $(1-\alpha/2)\times 100\%$ quantile of the standard normal distribution which is equal to 1.96.

This gave us a total of 73 patients.

In Moi Teaching and Referral Hospital (MTRH) an average of 10 patients present withlumbar disc herniation per month, giving a total of 120 patients per annum. Thus adjusting our sample size for a finite population of 120 cases that are seen per year in the hospital resulted in $n/(1+n/N) = 73/(1+73/120) = 46$ valid number of patients to be studied. The notation N is the population size per year in MTRH.

Recruitment and Methods

Inpatients scheduled for lumbar disc herniation surgeryand who met the inclusion criteria werephysically approached by the investigator and the nature and purpose of the study explained to them. Thereafter, they were requested to sign consent forms. This continued consecutively until the desired sample size wasattained.

The socio – demographic and clinical data was collected by means of a structured questionnaire. MRI findings were reviewed and the type, location, level and side of HLD were noted and recorded into the questionnaire.

The surgical options under study includedone case of standard open laminectomy and discectomy and the rest were microdiscectomy procedures. The outcomes of the procedureswere recorded.

The visual analogue scale was used to measure the pre-operative and post-operative pain intensity. The post-operative VAS was recorded on the first post-operative follow up visit (2 weeks after surgery for those subsequently discharged) at the neurosurgical clinic at MTRH. Patients who were not discharged for whatever reason (after 2 weeks), were assessed within the ward. This period allowed adequate healing and ruled out any pain that could be attributed to soreness due the surgery.The MacNab's Criteria was used to determine the functional outcome after surgery (during the follow up visits at 2 weeks after surgery and 4 weeks after surgery).

To avoid any bias, the same neurosurgeon performed all the surgeries during the study period. Intra-operative and post-operative complications were recorded into a questionnaire.

Data Management and Analysis

Data Collection

A structured close ended questionnaire was used to collect the data. The data was captured using the questionnaire by the principal investigator. The completed questionnaires were stored in locked cabinets with restricted access. The data was entered and analyzed using the STATA version 13.

Data analysis

Data analysis was performed using STATA version 13 special edition. Categorical variables were summarized as frequencies and the corresponding percentages. Continuous variables that assumed normal distribution were summarized as mean and the corresponding standard deviation (SD) while the continuous variables that were skewed were summarized as median and the corresponding inter quartile range (IQR). The test for normality assumption was done using Kolmogorov-Smirnov test.

Some participants had multiple risk factors. The frequency of these risk factors was assessed individually by tallying the individuals who reported the risk. This means that a participant was counted more than once if that individual had more than one risk factor. The same approach was also used when we were assessing the levels of herniated lumbar disc (HLD). Some participants had more than one level of HLD.

The test for association between the categorical variables was conducted using Pearson's Chi Square test while the association between continuous variables and the categorical variables was assessed using the two-sample Wilcoxon ranks sum test. The test for differences in the visual analogue (VAS) scale scores was conducted using the sign rank test. The results were presented in form of tables and graphs.

Ethical Clearance and Informed Consent

The approval to conduct the study was obtained from Institutional Research Ethics Committee (IREC) of Moi Teaching and Referal Hospital /Moi University before the study commenced. Permission to conduct the study was also sought from MTRH. The autonomy of the patient was respected and privacy was taken into consideration. Confidentiality was maintained strictly by limiting access to study information and data.

Patients were not compelled to enrol into the study. Those that declined to give consent were not discriminated against in provision of the standard medical care.

An informed written consent was obtained from each participant before recruitment. The purpose and nature of the study was fully explained to the participants in a language they could fully understand.

This was a minimal risk study and involved no more harm of any nature to the participants/patients concerned other than what the patient could have incurred before and after the medical procedure. The participating patients were free to leave the study at any time they changed their minds without any consequences.

While compiling the research report, no misconduct (fabrication or falsification) took place. There was no financial conflict of interest in this study.

Limitations of the study

Being a hospital based study, the results cannot be generalised to the population. Likewise, other outcome measures cannot be used in this study because of the stipulated time frame and limited resources. This study also needs a longer period to allow an evaluation of a larger sample and extend the functional outcome evaluation in patients with HLDs.

RESULTS

Demographic characteristics

Data for a total of 48 participants was analyzed. The mean age was 47(SD: 9) years. The minimum and maximum age limits were 27 and 74 years respectively. The participants aged below 40 years were 10(21%), while those aged 40-50 years were 21(44%). Those aged above 50 years were 17(35%). This is as shown in Figure 1.

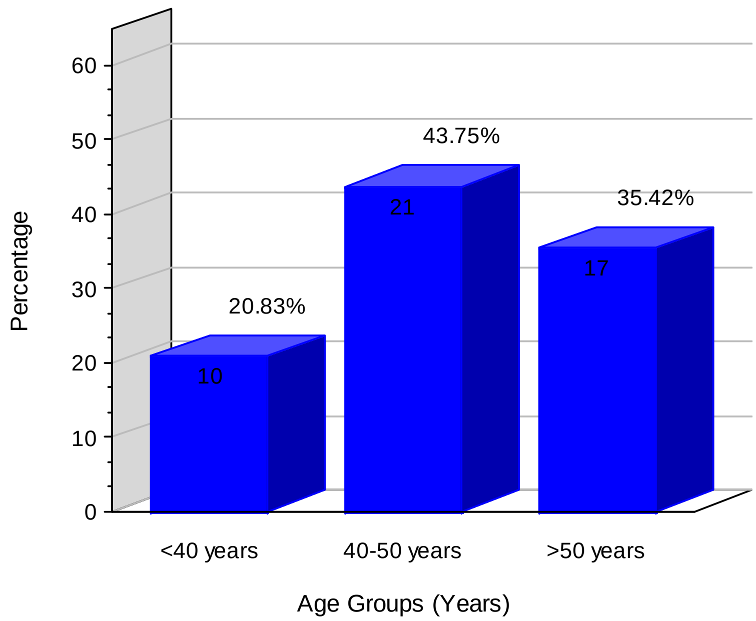

Figure 1: Age distribution

Slightly over 50% were male participants (Figure 2) giving a female to male ratio of 1:1.2. The average age for male was 46 (SD: 11) years and for females was 48(SD: 8) years. The test for difference was not statistically significant (P=0.325).The age distribution by gender was as presented in Table 2.

Table 2: Age distribution by gender

		Female	Male	Total	P
Age groups	<40	2(9%)	8(31%)	10(21%)	0.183
	40-50	11(50%)	10(38%)	21(44%)	
	>50	9(41%)	8(31%)	17(35%)	
	Total	22(100%)	26(100%)	48(100%)	

Male and female participants in the age group of 40-50 years were highly represented (44%); (Table 2). The test for differences in the proportions of male and female participants was not statistically significant. This implies that the males and the females were equally represented (Figure 2).

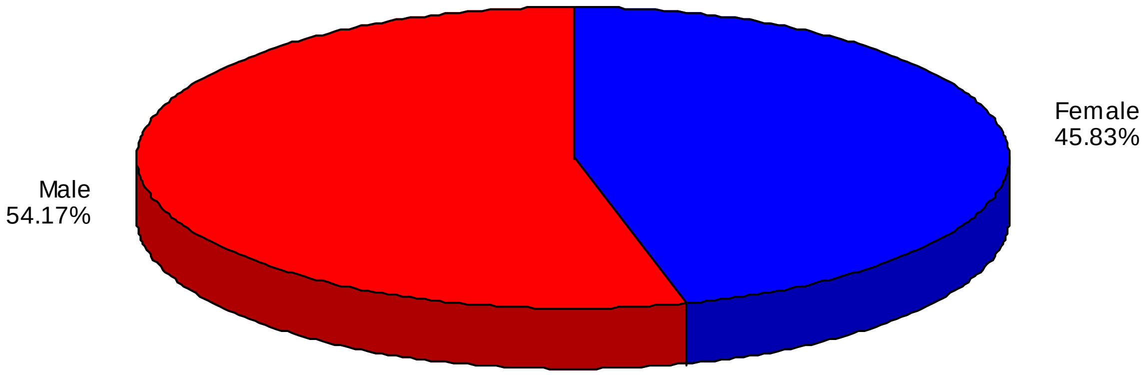

Figure 2: Distribution by gender

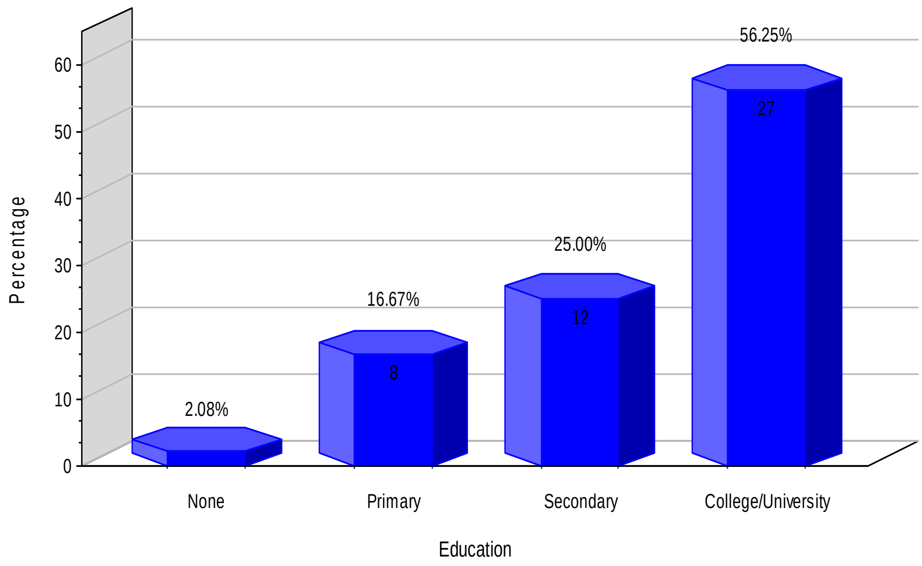

Figure 3: Distribution of the participants by level of education

The study participants had mainly college or university qualifications (56.25%). Only one participant had no formal education. Evidently, as the level of education rose, the number of participants also went up (Figure 3). .

Risk factors

The main occupation was clerical, 20(42%), followed by manual labor, 16(33%). This is evident from Figure 4.

Eight participants had more than one occupation. Precisely, they had two occupations. Three of those who were doing clerical work were also doing business. Of the sixteen participants who were doing manual work, five had other occupations. These include: one doing business, one doing clerical work, two who were housewives, and one who was a police officer.

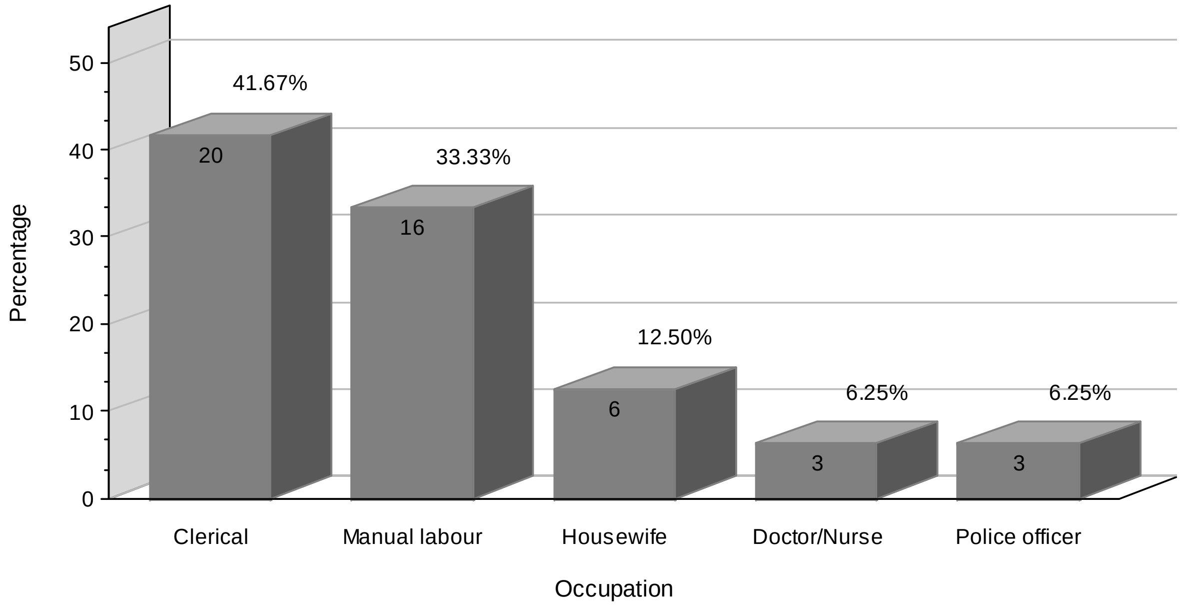

Figure 4: Distribution of the participants by occupation.

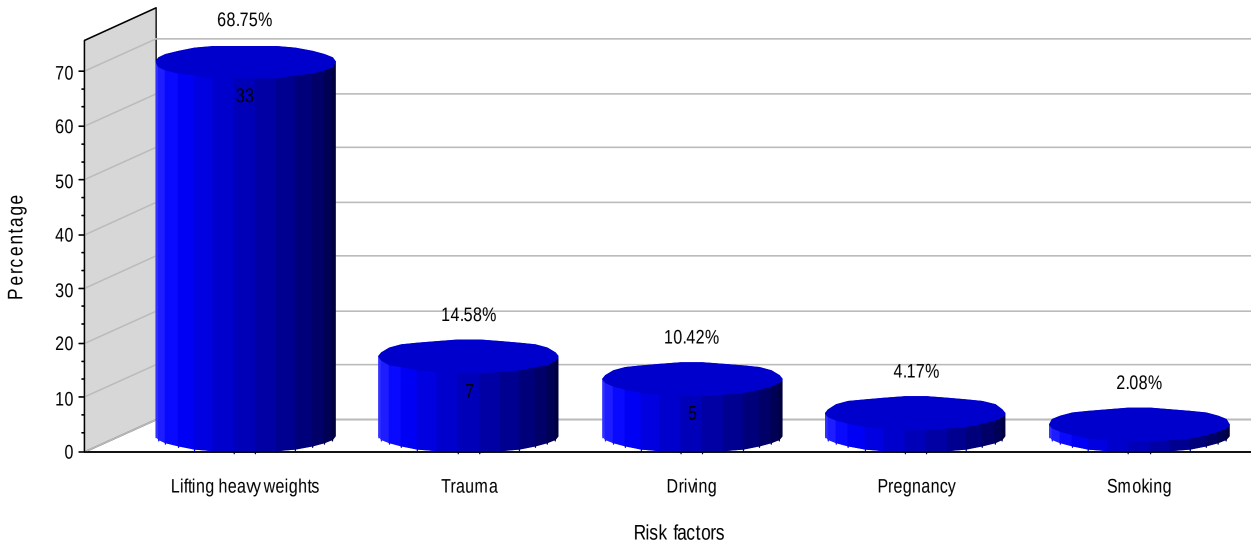

Figure 5: Distribution of the participants with multiple risk factors

The main risk factor was heavy weight lifting (Figure 5). However, this main risk factor came in combination with other risk factors. Of the 33 participants who had heavy weight lifting as a risk factor, 8(24%) had one other risk factor while 6(18%) had two other risk factors. Of those who had one risk factor, three were driving, three were pregnant, one had a family history of HLD, and another one had trauma. Among those who had two other risk factors, three mentioned driving and smoking, three each mentioned driving, or pregnancy, or smoking in combination with trauma. Therefore, in total five participants (10.4%) had smoking as a risk factor.

Four of those who had heavy weight lifting as the risk factor mentioned pregnancy as another risk factor. This gives a total of six participants who mentioned pregnancy as the possible risk factor. All of them said that the symptoms occurred after pregnancy.Table 3 presents the number of participants who mentioned a specific risk factor.

Table 3: Risk factors of lumbar disc herniation

Risk factor	n(%)
Driving	12(25.0%)
Lifting heavy weights	33(68.8%)
Smoking	5(10.4%)
Family history of HLD	1(2.1%)
Trauma	11(22.9%)
Pregnancy	6(12.5%)

Eight out of the 11 who had trauma reported the history of a possible cause of trauma. Four said that they had fallen from a high place; one reported that possible cause was participating in sports, and three reported accident as the possible cause. Of those who had accidents, one was due to a road traffic accident while two were due to motor bike accidents. Of these two who had accidents due to motor bike, one was a passenger while the other was a rider.

Clinical and Radiological characteristics

The main presenting symptom was LBP and leg pain. LBP was present in 45(94%) participants while a combination of LBP and leg pain was present in 42(87.5%) of the participants. Leg pain was also present in a bigger proportion of the participants, 44(91.6%). Motor deficits, sensory deficits, and bladder symptoms were present in 13(27%), 6(12.5%), and 1(2.1%) participants, respectively. This is shown in table 4.

Table 4: Main presenting symptoms

Main presenting symptoms (n=48)	**n(%)**
LBP	2(4.2%)
Leg pain	1(2.1%)
LBP + Leg pain	28(58%)
Motor deficits	0
Sensory deficits	0
Bladder symptoms	0
LBP, and motor deficits	1(2.1%)
LBP, and Bladder symptoms	1(2.1%)
Leg pain, and motor deficits	1(2.1%)
LBP + Leg pain, and motor deficits	8(16.7%)
LBP + Leg pain, and sensory deficits	3(6.3%)
LBP + Leg pain, and motor deficits, and sensory deficits	3(6.3%)

Table 5 presents the clinical signs noted on examination. Majority of the participants, 36(75%) had a diminished ankle jerk. Seven, (15%), of the participants had a diminished knee jerk while 2(4.2%) had a diminished medial hamstring reflex. One fifth of the participants did not have any diminished reflex.

Foot drop (weak ankle dorsiflexion) was noted in 13(27%) participants. Plantar flexion was weak in 4(8.3%), while knee extension was weak in one participant. Over half of the participants did not have any motor weakness.

Close to one third of the participants had decreased sensation. Decreased sensation over the large toe web & dorsum of foot (L4/L5) was noted in 5(10.4%) participants while decreased sensation over the lateral malleolus & lateral foot was noted in 10 (20.8%) participants.

Table 5: Clinical signs noted on examination

Characteristic	**n(%)**
Diminished reflex (n=48)	
Knee jerk(L3-4)	2(4.2%)
Medial hamstring (L4-5)	0
Ankle jerk(L5-S1)	29(60.4%)
Ankle jerk(L5-S1), and medial hamstring(L4-5)	2(4.2%)
Ankle jerk(L5-S1), and knee Jerk (L3-4)	5(10.4%)
None	10(20.8%)
Motor weaknesses (n=48)	
Knee extension (L3-4)	0
Foot drop(L4-5)	10(20.8%)
Plantar flexion(L5-S1)	5(10.4%)
Knee extension(L3-4), and plantar flexion(L5-S1)	1(2.1%)
Foot drop(L4-5), and plantar flexion(L5-S1)	3(6.3%)
None	29(60.4%)
Decreased sensation (n=48)	
Medial malleolus & medial foot (L3-4)	-
Large toe web & dorsum of foot(L4-5)	4(8.3%)
Lateral malleolus & Lateral foot(L5-S1)	8(16.7%)
Large toe web & dorsum of foot(L4-5) plus Lateral malleolus & Lateral foot(L5-S1)	1(2.1%)
None	35(72.9%)
Pain distribution(n=48)	
Anterior thigh(L3-4)	1(2.1%)
Posterior LE(L4-5)	12(25.0%)
Posterior LE, often to ankle(L5-S1)	31(64.6%)
Posterior LE(L4-5), and Posterior LE, often to ankle(L5-S1)	4(8.3%)

One participant had radicular pain distribution over the anterior thigh (L3/L4). Thirty five participants(73%), had pain distribution over the posterior lower extremity often to ankle correlating to L5-S1 level while 16(33%) participants had pain distribution over the posterior lower extremity correlating to L4-5 level of HLD.

Table 6: Nerve root tension signs

Nerve root tension signs (n=48)	**n(%)**
Straight leg raising	21(43.8%)
Braggard's test	1(2.1%)
Crossed SLR	0
Femoral stretch test	0
Braggard's test, crossed SLR, straight leg raising	5(10.4%)
Braggard's test, Femoral stretch test, straight leg raising	1(2.1%)
Braggard's test, straight leg raising	17(35.4%)
Crossed SLR, straight leg raising	2(4.2%)
Femoral stretch test, straight leg raising	1(2.1%)

Braggard's test was positive in 24(50%) participants and straight leg raising (SLR) nerve root tension sign was positive in 47(98%) participants. Crossed SLR was positive in 7(15%) participants, and 2(4.2%) participants had a positive femoral stretch test. This is shown in table 6.

The types of herniated lumbar discs noted were extrusion, sequestration, and protrusion. Extrusion was noted in 38(79%) participants. However, it was noted in combination with sequestration in three participants. Protrusion was present in 6(12.5%) participants. Sequestration was noted in 7(15%) participants.

The main location of herniated lumbar disc was postero-lateral. This was seen in 44(92%) participants. It was noted to be central in location for 6(12.5%) participants, and to the extreme lateral in 2(4.2%) participants.

The HLD was to the left in 20(42%) participants and to the right in slightly more than half of the participants. Only two had the disc herniated to both the right and left sides. All these are summarised in table 7.

Table 7: Radiological findings on MRI

Characteristic	**n(%)**
Types of HLD (n=48)	
Protrusion	6(12.5%)
Extrusion	35(72.9%)
Sequestration	4(8.3%)
Extrusion and sequestration	3(6.3%)
Location of the HLD (n=48)	
Central	2(4.2%)
Postero-lateral	40(83.3%)
Extreme lateral	2(4.2%)
Central, Postero-lateral	4(8.3%)
Side of the HLD (n=48)	
Right	26(54.2%)
Left	20(41.7%)
Left & right	2(4.2%)
Level of HLD (n=48)	
L1-2	0
L2-3	0
L3-4	0
L4-5	6(12.5%)
L5-S1	12(25%)
L2-3, L3-4	1(2.1%)
L3-4, L4-5	3(6.3%)
L3-4, L4-5, L5-S1	6(12.5%)
L4-5, L5-S1	20(41.7%)

The patterns of the levels of the herniated lumbar disc were studied and the results were as presented in Figure 6.

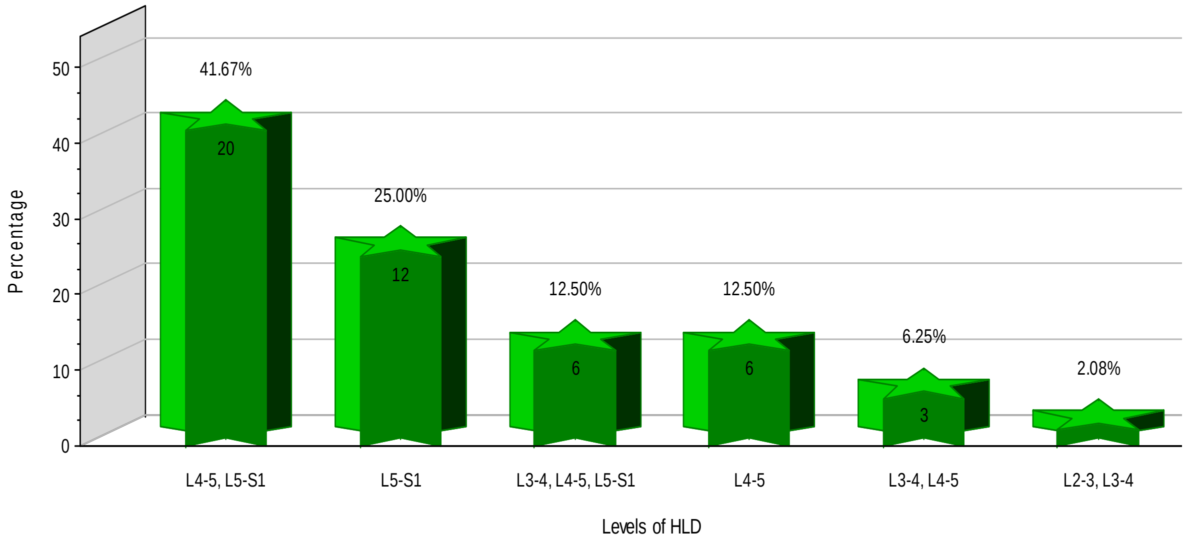

Figure 6: Patterns of herniated lumbar discs

Among the 48 participants, 47(98%) had a disc herniation at the level of either L4-5 or L5-S1 or both. The other findings were as tabulated in Table 7. There were 30(63%) participants with multiple levels of HLD. Among all the participants studied, one participant had a herniated lumbar disc at the level of L2-3. There were 10(21%), 35(73%), and 38(79%) participants who had HLD involving L3/L4, L4/L5, and L5/S1 respectively (Table 8).

Table 8: Level of HLD

Level	n(%)
L1-2	0
L2-3	1(2%)
L3-4	10(21%)
L4-5	35(73%)
L5-S1	38(79%)

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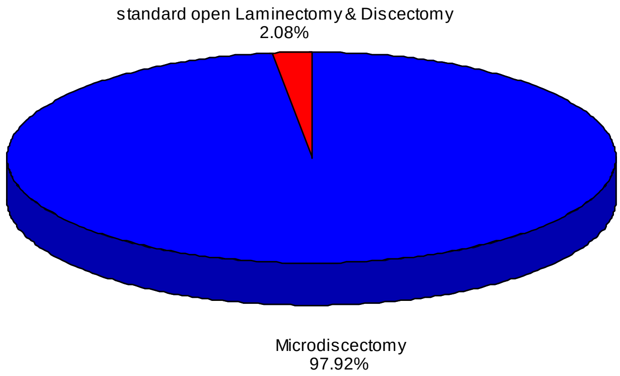

Figure 7: Surgical option

The major surgical option that was used was microdiscectomy (Figure 7). The levels of microdiscectomy performed were documented and it emerged that 18(38%) had a 1 level microdiscectomy, 25(52%) had a 2 level microdiscectomy, and 5(10%) had a 3 level microdiscectomy.

Table 9: Complications

Intra operative complications (n=48)	**n(%)**
Wrong site surgery	0
Incidental dural tear	5(10.4%)
Great vessel injury	0
Visceral injury	0
Excessive bleeding requiring transfusion	1(2.1%)
Nerve root injury	0
Others	1(2.1%)
None	41(85.4%)
Post operative complications (n=48)	
Wound infection	0
Post operativediscitis	0
DVT/Pulmonary embolism	1(2.1%)
Failure of pain relief	1(2.1%)
CaudaEquina syndrome	0
None	46(95.8%)

Intra operative complications occurred in seven participants. Five (10.4%) of them had an incidental dural tear, one had excessive bleeding requiring transfusion, and another one had excessive bleeding but did not require transfusion. Post operative complications occurred in two (4.2%) participants. One had DVT of the leg while the other had failure of pain relief. Only one participant had both post and intra operative complications. The participant had excessive bleeding (but did not require transfusion) and also had failure of pain relief post operatively. These are as shown in table 9.

Table 10: Test for improvement in Visual analogue scale scores

<table>
<tr><th>VAS scores</th><th>Sample size</th><th>Median(IQR)</th></tr>
<tr><td>Pre operative</td><td>48</td><td>8(7-9)</td></tr>
<tr><td>Post operative</td><td>48</td><td>1(0-2)</td></tr>
<tr><td>Change in VAS</td><td>48</td><td>7(6-8)</td></tr>
<tr><td colspan="3">Sign rank test
n = 48
Z = -6.02
P <0.0001</td></tr>
</table>

The median score for pre-operative VAS was 8(IQR: 7-9) while the median score for post operative VAS was 1(IQR: 0-2) resulting in a median change of 7(IQR: 6-8). The test for significant drop (change) in the visual analogue scale was done using the Sign Rank test. The test showed that the post operative VAS was significantly lower than pre operative VAS (P<0.0001). This is a strong indication that surgery was effective in lowering the pain. These are as shown in table 10.

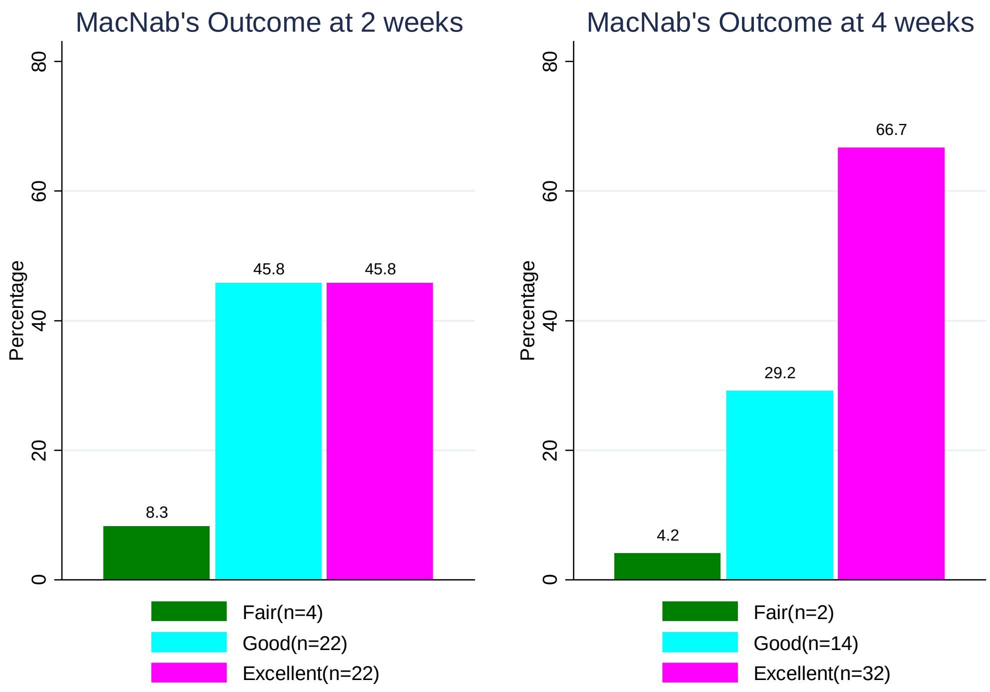

Figure 8: MacNab's Outcome

The MacNab's outcome at 2 weeks and at 4 weeks has been presented in Figure 8. Less than half of the participants had a MacNab's outcome of excellent at 2 weeks. Equal proportion had a good outcome. After four weeks the MacNab's outcome for two thirds of the participants was excellent. This is a marked improvement. The statistical test for improvement was performed using sign rank test since the two measurements are paired and ordinal. The scoring was 0 for poor, 1 for fair, 2 for good and 3 for excellent. The results showed that there was a significant improvement in the outcome (P=0.003) by the fourth week. That is most participants were more likely to score excellent at the fourth week compared to the second week.

Table 11 presents the association between the level of HLD and the clinical signs noted on examinationwere counted twice. This is also true for other characteristics that exhibited multiple responses. The detached responses were then related separately.

From the results, 27(77%) among the participants who had L4-5 level of HLD had a diminished ankle jerk. Compared to those who did not suffer L4-5, this risk was high, though not statistically significant. Among the 38 participants with L5-S1, 31(82%) had a diminished ankle jerk. Similarly, among those participants who had L3-4 level of HLD, 9(90%) had a diminished ankle jerk. This proportion is high, though not statistically significant, compared to those who had other levels of HLD.

Table 11: Association between clinical signs noted on examination and the level of HLD

Characteristic	**L2-L3**			**L3-L4**		
	Yes	**No**	**P**	**Yes**	**No**	**P**
Sample size (n)	**1**	**47**		**10**	**38**	
	n(%)	**n(%)**		**n(%)**	**n(%)**	
Diminished reflex (n=48)						
Knee jerk(L3-L4)	1(100)	6(13)	0.146[f]	5(50)	2(5)	0.003[f]
Medial hamstring (L4-L5)	0	2(4)	1.000[f]	0	2(5)	0.094[f]
Ankle jerk(L5-S1)	0	36(77)	0.250[f]	9(90)	27(71)	0.414[f]
None	0	10(21)	1.000[f]	0	10(26)	1.000[f]
Motor weaknesses (n=48)						
Knee extension(L3-L4)	0	1(2)	1.000[f]	0	1(3)	1.000[f]
Foot drop(L4-L5)	0	13(28)	1.000[f]	4(40)	9(24)	0.425[f]
Plantar flexion(L5-S1)	0	9(19)	1.000[f]	3(30)	6(16)	0.370[f]
None	1(100)	28(60)	1.000[f]	6(60)	23(61)	1.000[f]
Decreased sensation (n=48)						
Medial malleolus & medial foot (L3-L4)	-			-		
Large toe web & dorsum of foot(L4-L5)	0	5(11)	1.000[f]	3(30)	2(5)	0.054[f]
Lateral malleolus & Lateral foot(L5-S1)	0	9(19)	1.000[f]	3(30)	6(16)	0.370[f]
None	1(100)	34(72)	1.000[f]	5(50)	30(79)	0.108[f]
Pain distribution(n=48)						
Anterior thigh(L3-L4)	1(100)	0	0.021[f]	1(10)	0	0.208[f]
Posterior LE(L4-L5)	0	16(34)	1.000[f]	4(40)	12(32)	0.615[f]
Posterior LE, often to ankle(L5-S1)	0	35(74)	0.271[f]	5(50)	30(79)	0.108[f]

“f” – Fisher’s exact P. This P was reported when the expected cell counts in at least one cell was less than 5.

Though the results are not statistically significant, these results demonstrate a clear prediction of a HLD at L5-S1 when a participant has diminished ankle jerk reflex.

Table 11 Continued

Characteristic	L4-L5			L5-S1		
	Yes	**No**	**P**	**Yes**	**No**	**P**
Sample size (n)	**35**	**13**		**38**	**10**	
	n(%)	**n(%)**		**n(%)**	**n(%)**	
Diminished reflex (n=48)						
Knee jerk(L3-L4)	6(17)	1(8)	0.656[f]	3(8)	4(40)	0.027[f]
Medial hamstring (L4-L5)	2(6)	0	1.000[f]	2(5)	0	1.000[f]
Ankle jerk(L5-S1)	27(77)	9(69)	0.710[f]	31(82)	5(50)	0.094[f]
None	7(20)	3(23)	1.000[f]	7(18)	3(30)	0.414[f]
Motor weaknesses (n=48)						
Knee extension(L3-L4)	1(3)	0	1.000[f]	1(3)	0	1.000[f]
Foot drop(L4-L5)	12(34)	1(8)	0.064[f]	13(34)	0	0.028[f]
Plantar flexion(L5-S1)	6(17)	3(23)	0.687[f]	9(24)	0	0.172[f]
None	20(57)	9(69)	0.522[f]	19(50)	10(100)	0.003[f]
Decreased sensation (n=48)						
Medial malleolus & medial foot (L3-L4)	-			-		
Large toe web & dorsum of foot(L4-L5)	5(14)	0	0.304[f]	3(8)	2(20)	0.276[f]
Lateral malleolus & Lateral foot(L5-S1)	9(26)	0	0.090[f]	8(21)	1(10)	0.661[f]
None	22(63)	13(100)	0.010[f]	28(74)	7(70)	1.000[f]
Pain distribution(n=48)						
Anterior thigh(L3-L4)	0	1(8)	0.271[f]	0	1(10)	0.208[f]
Posterior LE(L4-L5)	14(40)	2(15)	0.170[f]	9(24)	7(70)	0.010[f]
Posterior LE, often to ankle(L5-S1)	24(69)	11(85)	0.466[f]	33(87)	2(20)	<.0001[f]

"f" – Fisher's exact P. This P was reported when the expected cell counts in at least one cell was less than 5.

There was one participant with L2-3 level of HLD who had no motor weakness. Among those who did not have L2-3 level of HLD, 1(2%) had weak knee extension, 13(28%) had foot drop (weak ankle dorsiflexion), and 9(19%) had weak plantar flexion. There were 28(60%) among those without L2-3 level of HLD who did not have any motor weakness.

Of the 10 with L3-4 level of HLD none had a weak knee extension, 4(40%) had foot drop (weak ankle dorsiflexion), 3(30%) had weak plantar flexion, and 6(60%) did not have motor weakness. Among those who did not have L3-4 level of HLD, 1(3%), 9(24%), and 6(16%) had a weak knee extension, foot drop (weak ankle dorsiflexion), and weak plantar flexion, respectively. There were 23(61%) who did not have motor weakness.

There were 35 participants with L4-5 level of HLD. Of this number, 1(3%), 12(34%), and 6(17%) had weak knee extension, foot drop (weak ankle dorsiflexion), and weak plantar flexion. There were 20(57%) without motor weakness. This was compared to those without L4-5 level of HLD. The tests were not statistically significant (Table 11).

Among the participants with L5-S1, 1(3%), 13(34%), and 9(34%) had weak knee extension, foot drop (weak ankle dorsiflexion), and weak plantar flexion respectively. Comparison to those who did not have L5-S1 level of HLD but with similar motor weakness showed that the rate of those with foot drop(weak ankle dorsiflexion) among those who had L5-S1 was significantly higher compared to those without L5-S1 level of HLD (P=0.028).

The only participant who had L2-3 level of herniated lumbar disc had no decreased sensation on physical examination. Of the 47 who had other levels of HLD other than L2-3, 5(11%) had decreased sensation over the large toe web & dorsum of foot, 9(19%) had decreased sensation over the lateral malleolus and lateral foot, and 34(72%) did not have any decreased sensation.

Out of the 10 participants who had L3-4 level of HLD, 3(30%) had decreased sensation over the large toe web & dorsum of foot, 3(30%) had decreased sensation over the lateral malleolus and lateral foot, and 5(50%) did not have any decreased sensation. Of the 38 who did not have L3-4 level of HLD, 2(5%) had decreased sensation over the large toe web & dorsum of foot, 6(16%) had decreased sensation over the lateral malleolus and lateral foot. And 30(79%) did not have any decreased sensation. The test for association was not statistically significant (Table 11).

Of the 35 participants who had L4-5 level of HLD 5(14%) compared to none among those who did not have L4-5 level of HLD were not significantly different statistically. Similarly, of the 35 with L4-5 level of HLD, 9(26%) had decreased sensation over the lateral malleolus and lateral foot. This compared to none among those who did not have L4-5 level of HLD was not statistically significant. Twenty two, representing 63%, of the participants with L4-5 level of HLD did not report any decreased sensation. This, compared to 13(100%) who did not have L4-5 level of HLD, was statistically significant, P=0.010.

Three participants, representing 8%, among those who had L5-S1 level of HLD had decreased sensation over the large toe and dorsum of foot. Similarly, 8(21%) among the same group with L5-S1 level of HLD had decreased sensation over the lateral malleolus and lateral foot, Another 28(74%) did not have any decreased sensation. Among those who did not have L5-S1 level of HLD 2(10%), and 1(10%) had large toe web and dorsum of foot, and lateral malleolus and lateral foot decreased sensation respectively. Seven, representing 70%, did not have decreased sensation. The tests for differences were not statistically significant.

The participant who had a L2-3 level of HLD had pain distribution over the anterior thigh. Of the ten participants who had L3-4 level of HLD, 1(10%) had the pain distributed over the anterior thigh, 4(40%) had pain distribution over the posterior lower extremity, and 5(50%) had pain distribution over the posterior lower extremity often to the ankle.

Of the 35 participants who had L4-5 level of HLD, 14(40%) had pain distributed over the posterior lower extremity, and 24(69%) had pain distributed over the posterior lower extremity, often to the ankle. The test for differences in the rates of pain distribution over posterior lower extremity, and posterior lower extremity often to the ankle was not statistically significant when compared to those who did not have L4-5 (Table 11).

Of the 38 participants who had L5-S1 level of HLD, 9 (24%) had pain distributed over the posterior lower extremity. This rate was significantly lower compared to that of the participants who did not have L5-S1 level of HLD, P=0.010 (Table 9).

Similarly, 33(87%) of the participants who had L5-S1 level of HLD had pain distributed over the posterior lower extremity often to the ankle. This rate was significantly higher compared to that of the participants who did not have L5-S1 level of HLD, P<0.0001.

Table 12: Association between nerve root tension signs with level of HLD

Nerve root tension signs	**L2-L3**			**L3-L4**		
Sample size (n)	**1**	**47**		**10**	**38**	
	Yes	**No**	**P**	**Yes**	**No**	**P**
	n(%)	**n(%)**		**n(%)**	**n(%)**	
Straight leg raising	1(100)	46(99)	1.000[f]	10(100)	37(97)	1.000[f]
Braggard's test	0	24(51)	1.000[f]	6(60)	18(47)	0.724[f]
Crossed SLR	0	5(11)	1.000[f]	1(10)	4(11)	1.000[f]
Femoral stretch test	1(100)	1(2)	0.042[f]	2(20)	0	0.040[f]

"f" – Fisher's exact P. This P was reported when the expected cell counts in at least one cell was less than 5.

Table 12, Continued

Nerve root tension signs	**L4-L5**			**L5-S1**		
Sample size (n)	**35**	**13**		**38**	**10**	
	Yes	**No**	**P**	**Yes**	**No**	**P**
	n(%)	**n(%)**		**n(%)**	**n(%)**	
Straight leg raising	35(100)	12(92)	0.271[f]	37(97)	10(100)	1.000[f]
Braggard's test	19(54)	5(38)	0.517[f]	19(50)	5(50)	1.000[f]
Crossed SLR	5(14)	0	0.304[f]	5(13)	0	0.569[f]
Femoral stretch test	1(3)	1(8)	0.473[f]	0	2(20)	0.040[f]

"f" – Fisher's exact P. This P was reported when the expected cell counts in at least one cell was less than 5.

The participant who had L2-3 level of HLD had a positive straight leg raising (SLR) and femoral stretch test. There were 46(99%), 24(51%), 5(11%), (among those who did not have L2-3 level of HLD), who had had positive SLR, Braggard's test, and crossed SLR respectively. Only 1(2%) had a femoral stretch test.

All the ten participants who had L3-4 level HLD had positive SLR. Out of the ten participants with L3-4, 6(60%) were positive to Braggard's test, 1(10%) was noted to have crossed SLR, and 2(20%) had positive femoral stretch test. Of the 38 participants who did not have L3-4 level of HLD 37(97%) were positive to SLR, 18(47%) were positive to Braggard's test, and 4(11%) were positive to crossed SLR. None was had a positive femoral stretch test.

Thirty five participants had L4-5 level of HLD. All of these participants were noted to have a positive SLR. Nineteen, representing 54%, had positive Braggard's test, 5(14%) with positive crossed SLR, and 1(3%) with positive femoral stretch test. Of the 13 who did not have L4-5 level of HLD 12(92%), were noted to have a positive SLR, 5(38%) were positive to Braggard's test, and 1(8%) was noted to have a positive femoral stretch test. None had a positive crossed SLR. The tests for differences were not statistically significant (Table 12).

Thirty eight participants had L5-S1 level of HLD. Of this number, 37(97%) were positive to SLR, 19(50%) were positive to Braggard's test and 5(13%) were positive to crossed SLR. None had a positive femoral stretch test. All of the 10 who did not have L5-S1 level of HLD had a positive SLR. Similarly, of the same number who did not have L5-S1 level of HLD, 5(50%) had a positive Braggard's test, and 2(20%) were positive to femoral stretch test. None had a positive crossed SLR. The tests for differences were not statistically significant (Table 12).

Table 13: Comparison of pre and post operative VAS across the types of HLDs

Types of HLD	No. of participants	Pre-operative VAS, Median(IQR)	Post operative VAS, Median(IQR)
Protrusion	6	8(8-10)	1(1-1)
Extrusion	35	8(7-9)	1(0-2)
Sequestration	4	8(7.5-8.5)	0(0-0.5)
Extrusion and sequestration	3	9(6-10)	1(0-2)

The median pre-operative visual analogue scale (VAS) score among the participants who had a combination of extrusion and sequestration was 9(IQR: 6-10). Compared to the other types of HLDs these participants had the highest median post operative VAS score. The participants who had sequestration type of HLD had the least post operative median VAS score.

The results shows that the post operative VAS had lower scores compared to the pre operative VAS across all types of HLDs. This indicates that there was improvement among the participants across all types of HLDs. These are as shown in table 13.

Table 14: Comparison of pre and post operative VAS across the levels of HLDs

Types of HLD	No. of participants	Pre-operative VAS, Median(IQR)	Post operative VAS, Median(IQR)
L4-5	6	8(7-8)	1(0-8)
L5-S1	12	8(7-9)	0.5(0-2)
L2-3, L3-4	1	8(8-8)	1(1-1)
L3-4, L4-5	3	8(8-8)	2(1-4)
L3-4, L4-5, L5-S1	6	7(6-10)	2(1-2)
L4-5, L5-S1	20	9(7-10)	1(0-1)

The pre and post operative VAS scores were assessed for change across the levels of HLD that were observed. The participants with a combination L4-5 and L5-S1 herniated lumbar discs had the greatest median pre-operative VAS score compared to the other HLD levels reported. Those with a combination of L3-4, L4-5, and L5-S1 had the least median pre operative score but had an IQR that was within the IQR of the participants having L4-5 and L5-S1 HLD levels.

Participants with L5-S1 had the lowest post operative VAS score. It was noted that all the participants across all the reported observed levels of HLD showed a marked improvement in the post-operative VAS. These are as shown in table 14.

DISCUSSION

This study investigated patterns and outcomes of surgically treated lumbar disc herniation among patients seen at MTRH. The mean age of participants was 47±9 years. This is similar to Heliovaara et al (11) and Deyo et al's (13) studies which reported the mean age of patients undergoing surgery for HLD at 40 and 43 years, respectively. Majority of the patients were in the 40 – 50 years age group. This was in keeping with the study of Deyo et al (13), in which it was reported that the majority of HLDs occurred in the age group of 30 – 50 years.

In this study, HLD occurred slightly more commonly in males (54%) than in females (46%) with the male: female ratio being 1.2:1. This is in keeping with the study findings of Maring et al (18) and Jachia et al (21), who reported a male: female ratio of 2:1. However, this contradicts a retrospective Kenyan study conducted in Kenyatta National Hospital by Ongeti et al (87) which found a female predominance; females with HLD were 56% while males were 44%.

The main occupation was clerical (42%), followed by manual labour (33%). These findings contrast Heliovaara's (11) study which found the risk of disc herniation to be lowest among the professional and white collar occupation workers. Furthermore, an increased risk was found among the industrial workers of both gender, and mainly among the female nurses. We found 6% of the participants were in the nursing profession.

However, our findings are in keeping with and can be explained by Kelsey J.L's (16) study, in which she hypothesized that since physical activity is known to increase the diffusion of nutrients into the disc, sedentary occupations could be associated with an increased risk of disc degeneration and disc herniation.

Majority of the participants in this study had a college/university level of education (56%), while only one participant lacked formal education. This could explain the majority of participant holding professional and clerical occupation in this study.

Most of the participants in this study had multiple risk factors. The most common risk factor noted was heavy weight lifting which was noted in 68.8%. This finding is consistent with the study findings of Mund et al (25) and Frymoyer et al (19), both of whom noted a positive association of heavy and repetitive weight lifting and the risk of disc herniation.

Furthermore, Mundt et al (25) reported an increased risk of disc herniation with lifting of heavy weights starting and ending at the waist or floor level. This could be correlated to this study for patients with heavy weight lifting as a risk factor. Upon self assessment, majority reported being involved in farming activities that involved digging and lifting of farm equipment. The region where this study was conducted is an agricultural zone and most of the population is involved in commercial or subsistence farming.

According to Kelsey J. L's (16) study, driving a motor vehicle for half the working day or more and at frequent intervals increases the risk of disc herniation by three fold as compared to non – drivers. In this study, 25% of the participants reported driving as a risk factor. Contributing factors such as the type of vehicle, the type of seating, the distance travelled and the road surface, were not investigated.

Cigarette smoking as a risk factor was noted in 10.4% of the participants in this study. In Kelsey J. L's (16) study, cigarette smoking was noted to increase the risk of disc herniation by 20%. Cigarette smoking is known to cause chronic bronchitis and the persistent coughing may lead to increased intra – discal pressure and facilitate disc failure.

Trauma as a risk factor was reported by 22.9% of the participants. This contradicts the findings by Kelsey J.L et al (16) which showed that the onset of sciatica was related to a traumatic event in upto 7.4% of the cases. In this study, the mechanisms of trauma included fall from a height and motorcycle accidents. One participant mentioned sports as a contributing factor.

Pregnancy as a risk factor was mentioned by 12.5% of the participants. In all, the symptoms began soon after pregnancy. O'Connel (32), noted in his study, that it seemed more likely that pregnancy may contribute to a deterioration of pre – existing sciatica, or cause sciatica in women who had prior to pregnancy, an asymptomatic disc herniation. This correlates well in this study. However, Heliovaara et al, (11), noted that pregnancy could not be considered a risk factor for disc herniation, even after numerous deliveries!

Only one (2.1%) patient reported a family history of HLD. However, the patient also had a concomitant risk factor. The family history could not be confirmed using medical records. This contradicts Bahle et al findings which recognized familial predisposition to HLD (30).

The main presenting symptom was a combination of lower back pain (LBP) and leg pain. LBP was present in 94% of the participants while leg pain was present in 91.6%. In combination, as the major presenting symptom, LBP and leg pain was noted in 58% of the participants. According to Frymoyer J. W et al (19), LBP per se, is usually a minor component of sciatica (only 1% of patients with acute LBP have sciatica). These study findings contrast Frymoyer's (19) study findings.

Motor deficits and sensory deficits were reported by 27% and 12.5% of the participants, respectively. These findings were contrary to Blaauw G et al's study findings (38). In his study of patients with radicular pain, 12% reported motor deficits, while 53% of patients reported sensory deficits. No patient in our study presented with motor or sensory deficits only.

In Andrew J. Schoenfeld's study, (14), it was noted that there is a lack of consensus regarding what constitutes a symptomatic herniation (i.e. back pain alone versus radicular pain versus back pain and radicular pain).

A study by A. Akbar in India (103), investigating lumbar disc prolapse, found 47% of patients reporting LBP plus leg pain and 18% of patients with leg pain only. These findings are consistent with these study findings.

Bladder symptoms were present in only one (2.1%) participant. Bladder symptoms occur mostly with upper HLD's or with central disc herniations. Furthermore, sacral roots are located centrally in the caudaequina and are the last to be compressed.

Majority of the participants, 75%, had diminished ankle jerk, while 15% had diminished knee jerk upon physical examination. Only 2 participants (4.2%) had a diminished medial hamstring reflex. In the participants who had a HLD at the level of L5/S1, 82% had a diminished ankle jerk reflex, while 77% of those who had a HLD at the level L4/L5 had a diminished ankle jerk reflex too. Among those participants who had a HLD at the level of L3/L4, 90% had a diminished ankle jerk reflex. This showed a clear prediction of lower lumbar disc herniation when a patient has a diminished ankle jerk reflex. In a Meta analysis of seven studies by Windt et al (36), it was found that impaired reflexes (mainly ankle jerk and knee jerk reflexes) had a poor diagnostic performance for the level of HLD, especially in terms of sensitivity. However, the diagnostic accuracy increased when used with other tests of physical examination.

One patient who had a HLD at the level L2/L3 had a diminished knee jerk. Of those participants who had a HLD at L3/L4, 50% had a diminished knee jerk reflex. Participants who had a HLD at the levels L4/L5 and at L5/S1 had diminished knee jerk at findings of 17% and 8% respectively. Aronson et al (59) showed that 50% of the patients with upper lumbar disc herniation had diminished knee jerk and 15% had a diminished ankle jerk. Our study findings are consistent with Aronson et al's findings. Though not statistically significant, the proportion of diminished knee and ankle jerk reflexes in upper lumbar herniated discs was considered high.

A diminished medial hamstring reflex was noted in only 2(4.2%) participants of whom, one of them also had a diminished ankle jerk. This contrasts the study findings of Ignatius et al (79), in which it was shown that the medial hamstring reflex is precise and accurate in predicting radiculopathy of L5 nerve root in HLD at L4/L5.

Foot drop/weakness in ankle dorsiflexion, often seen as result of paresis of Tibialis anterior and Extensor hallucislongus muscles (usually in L5 radiculopathy), was noted in 27% of the participants. Weakness in plantar flexion (which is an indicator of S1 radiculopathy), was noted in 8.3% of the participants. In an Indian study by Ali Akbar (103), 12.5% of participants had a foot drop upon examination. No correlation to the level of herniated disc, (Radiologically or surgically) was performed.

In our study, a correlation of motor weakness to the level of disc herniation was attempted. We found that among those participants who had a disc herniation at level L4/L5, 34% had a foot drop (weakness in ankle dorsiflexion), while in those who had a L5/S1 disc herniation, 34% also had foot drop (weakness in ankle dorsiflexion).

Twenty seven percent of the participants in this study had reported motor deficit. However, upon physical examination, 40% were found to have a motor deficit. Our findings were consistent with Blaauw et al's (38) study findings, in which motor deficit was reported by 12% of the patients, while upon physical examination, motor deficit was found in 28% of the patients. These findings could probably be explained by the fact that the patient's attention is concentrated mainly on the pain to which the disability caused by the muscle weakness is often attributed.

Windt et al's (36) Meta – analysis on physical examination in lumbar disc herniation demonstrated poor diagnostic performance of muscle weakness in identifying lumbar disc herniation.

In this study, plantar flexion was found to be weak in 24% of the participants who had a herniated disc at the level of L5/S1. The Gastrocnemius is electively supplied by the S1 nerve root. Weakness of this muscle is usually pathognomonic of impairment of S1 nerve root. Nevertheless, both Postachini (104) and Windt et al (36) recommended that the examination for motor weakness should be conducted and interpreted in the context of other physical examination findings. Our study findings re-affirm these recommendations.

A sensory deficit was reported as a symptom in 12.5% of the participants in this study. No participant reported a sensory loss as the only presenting complaint. Most patients referred to 'numbness' as sensory deficit. No participant reported paraesthesia. Upon physical examination, 27% of the participants were found to have decreased sensation. This was in contrast to Blaauw G et al's (38) study findings, which showed that 53% patients reported sensory phenomena (paraesthesia and decreased sensation), while upon examination, 45% were found to have decreased sensation.

An attempt was made to correlate the distribution of decreased sensation with the level of HLD. Of those participants who had a HLD at the level of L3/L4, none had decreased sensation over the medial malleolus (corresponds to L4 dermatome). Participants with HLD at the level of L4/L5, 14% had a decreased sensation that corresponded to the L5 dermatome. Similarly, of the participants who had a HLD at L5/S1, 21% had decreased sensation that corresponded to the S1 dermatome. There was considerable overlapping of the dermatomes in relation to the level of the HLD.

A study by Motoyuki et al (105), showed a preponderance of 72.6% of sensory disturbance. However, the study didn't reveal any significant difference in correlation of sensory disturbance with the level of disc herniation. This was consistent with our study findings.

The high variations, as reported, for sensory findings in patients with HLDs could be as a result of a number of reasons. Most importantly, sensory examination is a highly subjective part of the physical examination. As such, the sensory examination may provide findings of uncertain interpretation, especially when sensory impairment is mild. Moreover, the dermatomes of the lower limb show a certain degree of overlapping. There may also be anatomic variations in dermatomal topography within the population as shown in the study by Kortelainen P, et al (106).

Majority of the patients participants (73%) were found to have radicular pain distributed along the posterior lower extremity (LE) upto the ankle (often noted in S1 radiculopathy), while 33% of the participants had radicular pain down the posterior LE but not reaching the ankle (often noted in L5 radiculopathy). A statistically significant association was noted for those who had L5/S1 disc herniation. They presented mainly with radicular pain along the posterior LE down to the ankle, consistent with S1 radiculopathy.

Considerable overlapping of the L5/S1 dermatomal distribution was noted, since 69% of participants who had L4/L5 level disc herniation also reported a radicular pain distribution consistent with S1 dermatomal distribution. This overlapping distribution of radicular pain could have occurred because of the presence of the multiple level disc herniations that were noted in this study. However, the overlapping distribution of radicular pain is in keeping with the studies of Kortelainen (106) and Nitta et al (107). They showed that although majority of the patients seem to share the same nerve root dermatomal distribution, there exists a variation of some degree of the neural anatomy of the lumbar spine.

Straight leg raising (SLR) was positive in 98% of the participants, while Braggard's test was positive in 50%. Crossed SLR and Femoral stretch test (FST) were positive in 15% and 4.2% of the participants, respectively.

SLR was positive in 97% of the participants with a HLD at L5/S1, 100% in participants with a HLD at L4/L5 and in 100% of participants with a HLD at L3/L4. One participant with a HLD at L2/L3 had a positive SLR and a positive femoral stretch test (FST). These findings show that SLR was positive in a high proportion of patients with lower lumbar disc herniation (L3/L4, L4/L5 and L5/S1). This was consistent with Vroomen et al's (64) study, which showed that SLR was a consistently sensitive examination for sciatica due to disc herniation.

Windt et al (36) analyzed 15 studies; including Vroomen's (64) study, and showed a high sensitivity of SLR for lumbar disc herniation. Supik and Broom (109) showed SLR to be the most sensitive pre – operative physical diagnostic sign for lower lumbar disc herniation. However, this study did not establish the sensitivities of SLR but showed the trends of SLR being predictive of lumbar disc herniation.

Braggard's test is an extension of the SLR, in which the leg is lowered about an inch from the point of pain elicitation and the ipsilateral foot dorsiflexed. If pain occurs, then Braggard's test is positive. There have been few studies that have concentrated on this test's diagnostic accuracy. In this study, 50% of the participants with HLD at L5/S1 had a positive Braggard's test. 54% and 60% were positive for Braggard's test for HLDs at levels L4/L5 and L3/L4 respectively. From the findings, it is seen that Braggard's test may be helpful in the examination of lower lumbar nerve roots in combination with SLR, especially if the SLR is weakly positive. This study had a high proportion of strongly positive SLR and this could have led to the under estimation of the Braggard's test.

Crossed straight leg raising (SLR) test was positive in 7(15%) participants. thirteen and fourteen percent of the participants who had a positive Crossed SLR, had a HLD at level L4/L5 and L5/S1, respectively. A study by Kosteljanetz (110), showed a prevalence of 40% of crossed SLR. Older studies by Edga et al (111) and Peyton et al (23) have shown frequencies ranging from 17% to 44%.

Femoral stretch test (FST) was positive in 2(4.2%) participants. Only 1 of these two participants had a HLD at L2/L3. It is known to be a useful tool in examination upper lumbar disc herniation (L1/L2 and L2/L3). The main components of the femoral nerve are L2, L3 and L4 nerve roots. FST provokes pain by stretching of the femoral nerve. Hence, it can be inferred that upper lumbar disc herniations may show a positive FST. In this study, the low frequency of positive FST could be attributed to the low frequency of upper lumbar disc herniation. Thus, this study cannot clarify the importance of FST in testing for upper HLDs.

The majority of participants in this study had a HLD occurring at the level of L5/S1 (79%). Those participants who had a disc herniation at L4/L5 and at L3/L4 were 73% and 21%, respectively. Only 1 patient had a disc herniation at the level of L2/L3.

Those who had HLDs at multiple levels were 63%. A study by Mboka J, in Tanzania, 2010, (112), showed a majority of disc herniation occurring at the lower lumbar level, with the highest prevalence at L4/L5 at 47.3%, followed by L5/S1 at 30.9%. Ongeti's retrospective study (87) in Kenya showed similar figures, with the majority of patients having a lower lumbar disc herniation, most commonly at the L4/L5 level (156 patients), followed by L5/S1 (93 patients). Deyo et al (22) showed that L4/L5 and L5/S1 HLDs account for 90% of the cases of lumbar disc herniation. In our study, we found 98% of the participants had a HLD at the level of L4/5 or L5/S1 or both. Christopher B. et al (108), in 2008, showed in his study, a preponderance of L5/S1 HLD (53%), followed by L4/L5 HLD (44%). Our study findings are in keeping with the findings of Christopher B. et al's (108) findings. The increased frequency of HLD at lower lumbar levels as reflected in this study could be explained by the increased mobility and workload of lower segments, resulting in earlier disc degeneration and subsequent disc prolapse.

The commonest type of disc herniation found in this study was extrusion, which was seen in 79% of the participants. Protrusion was noted in 12.5% of the participants, while 15% had sequestration of the herniated disc. In Mboka J's study (112), no disc sequestration was seen, while 98% were protrusions, and only 2% were extruded discs. Our study findings contrasted Mboka's findings. Christopher B, (108) showed that 43% of the patients had an extruded type of disc herniation, while 35% had a sequestrated type of disc herniation.

The majority of the participants in this study had a postero-lateral disc herniation by location (92%). The herniated disc was located centrally in 12.5% and extreme lateral in 4.2% of the participants. These findings were in keeping with Mboka Jacob's study (112), in which he found the commonest location of disc herniation as postero-lateral (75%), followed by central and extreme lateral at 24% and 2%, respectively. However, the findings in this study were contrary to Bilut H's study (72), in Ethiopia, in which 61.2% of the disc herniations were central, 15.8% were postero-lateral, and 9.3% were extreme lateral. Most herniations occurring postero-laterally can be probably be explained by the central reinforcement of the annulus by the posterior longitudinal ligament. Thus, the postero-lateral margins of the disc are left weak, predisposing to disc herniation at this location.

In this study, it was noted that disc herniations occurred slightly more on the right side (54.2%) than on the left (41.7%). In 4.2%, the disc herniations were noted bilaterally. There's no study that we were aware of that described the side of the disc herniation and its significance.

The preferred method of surgery that was applied was microdiscectomy (98%). One level microdiscectomy was performed in 38% of the participants, while 2 level and 3 level microdiscectomy was performed in 52% and 10% of the participants, respectively.

Only 1 participant underwent standard 'open' laminectomy plus discectomy. This patient had concomitant lumbar spine degenerative changes, multiple lumbar disc herniation and cervical disc herniation, for which an anterior cervical discectomy and fusion was also performed in the same sitting.

Ninety eight participants underwent the procedure of microdiscectomy for herniated lumbar disc/s. For standardization purposes, the same consultant neurosurgeon performed all the operations in this study. Loupe magnification and headlight were used. The positioning was prone. Surface landmarks were used to identify the appropriate levels after correlating the clinical and radiological information. A 2cm posterior midline incision was made over the disc space of interest. Subperiosteal dissection carried down and lamina on involved side exposed. A keyhole laminotomy was made and the dural sac and nerve root retracted medially. A small annulotomy was done and the fragment of disc removed. The disc space was irrigated and the canal inspected. The nerve root was completely decompressed. Haemostasis was achieved and the incision was closed in layers.

Intra-operative complications were noted in seven (14.6%) participants. The most common was incidental dural tear which was noted in 10.4% of the participants. In stolke's study (68), incidental dural tears occurred in 1.8% of microdiscectomies. Alexander et al (74), noted incidental durotomy prevalence of 4%. Our findings were contrary to the findings of Stole and Alexander. However, in comparison, our sample size was much smaller. The incidental dural tears occurred during the process of excision of the LigamentumFlavum, which was noted to be adherent to the dural sac. The durotomies were repaired primarily with 6.0 absorbable suture and a fat graft applied over as a patch. The post-operative sequelae were uneventful.

One participant (2.1%) underwent blood transfusion because of excessive bleeding. The participant also had other co-morbid conditions (diabetes and hypertension) that could have been contributing factors. The bleeding was observed mainly from the epidural venous plexus. One other participant (2.1%) was noted to have excessive bleeding intra-operatively, but no blood transfusion was required in this case.

Only 2 participants were noted to have post-operative complications. One participant (2.1%) developed deep venous thrombosis (DVT) of the leg, noted on follow-up. The incidence of thrombo-embolism ranges from 0.1% to 1%, according to the study by Ramirez (69). Ongeti et al's (87) study in Kenya, showed thrombo embolism in 0.9% of the patients. The other one participant (2.1%) reported failure of pain relief post-operatively. Upon repeat investigation, there was no recurrence of disc herniation or any attributable pathology to the operation. Ongeti et al (87) reported 1.9% of their patients with failure of pain relief post-operatively. This was similar to our study finding.

The median post-operative Visual Analogue scale (VAS) was 1(IQR: 0-2), from a median pre-operative VAS of 8(IQR:7-9). This change was statistically significant and a clear indicator of the good outcome after microdiscectomy surgery for HLD ($P<0.0001$). In correlating the type of disc herniation to the outcome after microdiscectomy (using VAS), showed that the type of disc herniation did not affect the outcome after microdiscectomy. The participants who had a sequestrated disc herniation had the least post-operative median VAS score. These findings were consistent with Christopher B. Dewing's (108), which showed that better surgical outcome was demonstrated (using VAS) for sequestrated discs than with extruded discs.

In correlating the level of disc herniation to the outcome after microdiscectomy (using VAS), showed that all the participants across all the reported levels of HLD, had a marked improvement after the procedure. Moreover, the participants with L5/S1 disc herniations had the lowest post-operative VAS. This was consistent with Christopher B. Dewing's (108) findings, which showed a better outcome after microdiscectomy for the L5/S1 disc herniations.

The MacNab's outcome assessment at 2 weeks showed that 45.8% of the participants reported an excellent outcome, while an equal proportion also reported a good outcome according to the criteria of MacNab.

After 4 weeks post-operatively, the MacNab's outcome findings showed that 66.7% of the participants reported an excellent outcome, while 29.2% reported a good outcome, according to the criteria of MacNab. This change was statistically significant. A study by Lagarrigue J (80) showed that 90% of both groups (undergoing microdiscectomy and open discectomy) had an excellent or good outcome according to the criteria of MacNab. In Ali Akbar's study (103), 50% of the patients of the patients showed an excellent outcome, while 40.6% had a good outcome according to MacNab's criteria. Our study findings were similar to these findings.

CONCLUSION

Lumbar disc herniation remains a common diagnosis encountered in neurosurgical practice. Majority of patients undergoing surgery for HLD were in the 40-50 years age group, with the mean age of 47±9 years. Males (54%) were more affected than females. Clerical work was the most common occupation (42%) followed by manual labor (33%). Heavy weight lifting was the most common (68.8%) risk factor seen followed by driving (25%) and trauma (22.9%). Majority of the patients presented with low back pain (LBP) and leg pain.

Diminished ankle jerk reflex showed a clear prediction for lower lumbar disc herniation. Sensory examination revealed a considerable overlap of dermatomes, inconsistent with expected dermatomal distributions. SLR test showed a high diagnostic performance for lumbar disc herniation, especially for lower lumbar levels. The most common level of lumbar disc herniation was L5/S1 (79%) while the most frequent type of disc herniation was extrusion (79%). Postero-lateral location was the most common location for disc herniation. The type and level of disc herniation did not affect the outcome following microdiscectomy.

Intra-operative complication occurred in 14.6% of the patients, with incidental durotomy being the most common. Majority of the patients (95.8%) did not have post-operative complications. Most patients (98%) underwent microdiscectomy for herniated lumbar disc ranging from 1 level to 3 levels of microdiscectomy. There was significant improvement in pain as evident from the pre and post-operative VAS scores.

Assessing the functional outcome using MacNab's criteria, an equal proportion of patients (45.8%) had a good and excellent grade at two weeks post-operatively. At four weeks, 66.7% of the patients had an excellent grade while 29.2% had a good grade.

Microdiscectomy, as demonstrated by the outcome scores, has a high success rate for patients with HLDs who have failed a period of conservative management.

RECOMMENDATIONS

1. Public health education should be carried out to emphasize on lifestyle modification in order to minimize the major risk factors associated with lumber disc herniation. For example, heavy weight lifting in abnormal postures, smoking, etc.

2. Physical examination including reflex changes, motor deficits patterns and nerve root tension signs provide high index of diagnostic clue for lumbar disc herniation and should be performed in joint combinations in all patients presenting with low back pain, leg pain and/or both.

3. We recommend that the following studies should be carried out:

    - Correlating the outcomes of surgically treated lumbar disc herniation with the type of surgery i.e. microdiscectomy versus standard open laminectomy with discectomy

    - Longitudinal studies on outcomes of surgically treated lumbar disc herniation by microdiscectomywith larger sample sizes.

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APPENDIX I: CONSENT FORM: PARTICIPANT'S STATEMENT

I ____having received adequate information regarding the study research, risks, benefits hereby AGREE / DISAGREE (Circle as appropriate) to participate in the study. I understand that my (our) participation is fully voluntary and that I (we) am/are free to withdraw at any time. I have been given adequate opportunity to ask questions and seek clarification on the study and these have been addressed satisfactorily.
Patient's/guardian's Signature/Thumb Print: ________________________

Date __________________

I ____ declare that I have adequately explained to the above participant, the study procedure, risks, and benefits and given him /her time to ask questions and seek clarification regarding the study. I have answered all the questions raised to the best of my ability.

Interviewers Signature ________________________ Date ______

PROBLEMS OR QUESTIONS:
If you ever have any questions about the study or about the use of the results you can contact the principal investigator, **Dr Abdul Wahid Kasmani** by calling **0722-700792.** If you have any questions on your rights as a research participant, you can contact the **Institutional Research Ethics Committee (IREC)** using contacts below:

The chairman, IREC
Moi University/MTRH
P.O BOX 4606 ELDORET

UNIVERSITY OF NAIROBI

APPENDIX II : QUESTIONNAIRE

Serial No... Date..

1.0 Demographics

1.1 Age ....(years)

1.2 Sex

a) Male
b) Female

1.3What is your highest education level?

a) College/University
b) Secondary
c) Primary
d) None

1.4 What is your occupation?

a) Clerical
b) Manual labour
c) House wife
d) Sports person
e) Driver
f) Doctor/Nurse

2.0 Risk factors

Are any of the following risk factors of Lumbar Disk Herniation involved?
(Tick where applicable)

i. Driving ☐
ii. Lifting of heavy weights ☐
iii. Smoking ☐
iv. Family history (genetics) of HLD ☐
v. Trauma ☐
vi. Pregnancy ☐

If pregnant, did the symptoms begin?

i. Before pregnancy ☐
ii. During pregnancy ☐
iii. After pregnancy ☐

2.0 Clinical Data *(tick where applicable)*

2.1 What are the main presenting symptoms?

i. LBP ☐
ii. Leg Pain ☐
iii. LBP + Leg pain ☐
iv. Motor deficits ☐
v. Sensory deficits ☐
vi. Bladder symptoms ☐

2.2. Clinical signs noted on examination *(tick where applicable)*

2.2.1 Diminished reflex

i. Knee jerk (L3-4) ☐
ii. Medial hamstring (L4-5) ☐
iii. Ankle jerk (L5-S1) ☐
iv. None ☐

2.2.2 Motor weakness

i. Knee extension (L3-4) ☐
ii. Foot drop (L4-5) ☐
iii. Plantar flexion (L5-S1) ☐
iv. None ☐

2.2.3 Decreased sensation

i. Medial malleolus & medial foot (L3-4 ☐

ii. Large toe web & dorsum of foot (L4-5) ☐

iii. Lateral malleolus & lateral foot(L5-S1) ☐

iv. None ☐

2.2.4 Pain distribution

i. Anterior thigh (L3-4) ☐

ii. Posterior LE (L4-5) ☐

iii. Posterior LE, often to ankle (L5-S1) ☐

2.3 Which of the following nerve root tension sign is present? *(Tick where applicable)*

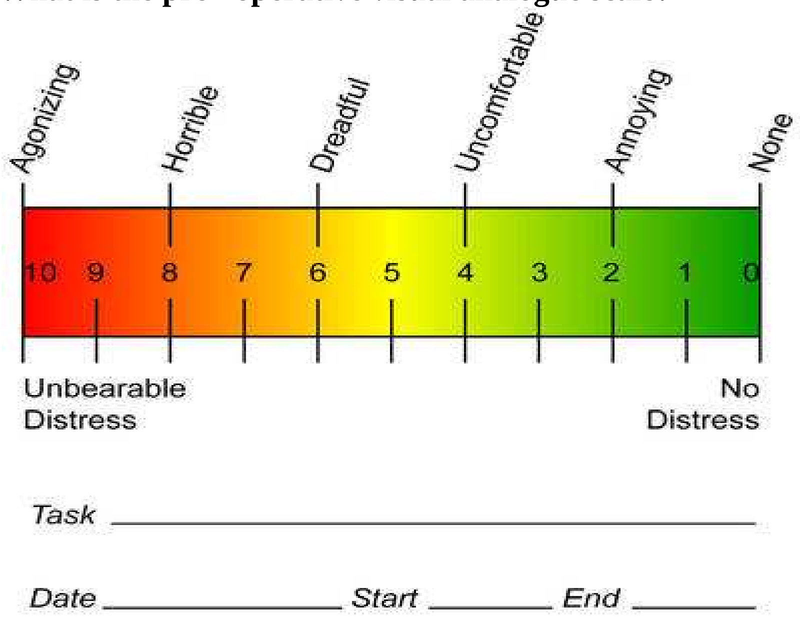
i. Straight leg raising ☐

ii. Bragard's test ☐

iii. Crossed SLR ☐

iv. Femoral stretch test ☐

2.4 What is the pre - operative visual analogue scale?



Indicate the mark here ☐

3.0Radiological Findings on MRI *(tick where applicable)*

3.1 Types of HLD

i. Protrusion ☐

ii. Extrusion ☐

iii. Sequestration ☐

3.2 Location of the HLD

i. Central ☐

ii. Postero-lateral ☐

iii. Extreme lateral ☐

3.3 Side of the HLD

i. Right ☐

ii. Left ☐

3.4 Level of the HLD

i. L1-2 ☐

ii. L2-3 ☐

iii. L3-4 ☐

iv. L4-5 ☐

v. L5-S1 ☐

3.5 Are there any other findings on the lumbar spine MRI? If so, state below:

____

4.0 Surgical option applied (*Tick where applicable)*

4.1 Standard 'Open' Laminectomy + Discectomy ☐

4.2 Microdiscectomy ☐

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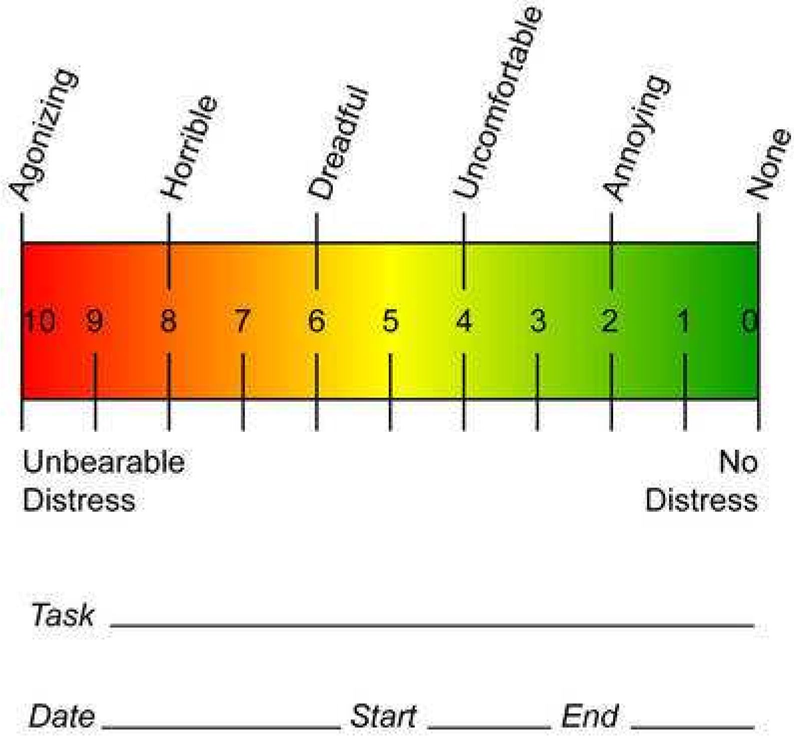
5.0 Outcome:

5.1 What is the post - operative visual analogue scale?



Indicate the mark here ☐

5.2 **Did any of the following intra - operative complications occur?** ***(tick where it applies)***

i.	Wrong site surgery	☐
ii.	Incidental dural tear	☐
iii.	Great vessel injury	☐
iv.	Visceral Injury	☐
v.	Excessive bleeding requiring transfusion	☐
vi.	Nerve root injury	☐
vii.	Others (specify)________________________________	

5.3 **Did any of the following post - operative complications occur?**

i.	Wound infection	☐
ii.	Postoperative discitis	☐
iii.	DVT/ Pulmonary Embolism	☐
iv.	Failure of pain relief	☐
v.	CaudaEquina syndrome	☐

5.4 What is the MacNab's outcome assessment of patient satisfaction at 2 weeks after surgery?

• Excellent: No pain; no restriction of activity.
• Good: Occasional back or leg pain of sufficient severity to interfere with the patient's ability to do his normal work or his capacity to enjoy himself in his leisure hours.
• Fair: Improved functional capacity, but handicapped by intermittent pain of sufficient severity to curtail or modify work or leisure activities.
• Poor: No improvement or insufficient improvement to enable increase in activities; further operative intervention required

Indicate Here:__________________

5.5 What is the MacNab's outcome assessment of patient satisfaction at 4 weeks after surgery?

• Excellent: No pain; no restriction of activity.
• Good: Occasional back or leg pain of sufficient severity to interfere with the patient's ability to do his normal work or his capacity to enjoy himself in his leisure hours.
• Fair: Improved functional capacity, but handicapped by intermittent pain of sufficient severity to curtail or modify work or leisure activities.
• Poor: No improvement or insufficient improvement to enable increase in activities; further operative intervention required

Indicate Here:__________________