Profile of lumbar spine conditions requiring surgical intervention in the Orthopaedic Department at a specialist public hospital in Kwa-Zulu Natal

By

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Dissertation submitted in partial compliance with the requirements for the

Master's Degree in Technology: Chiropractic

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I, Jens Hillermann, do declare that this dissertation is representative of my own work in both conception and execution (except where acknowledgements indicate to the contrary)

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Dedication

I dedicate this dissertation to my Lord who gave me the knowledge, ability and perseverance to complete this study.

“Fear not, for I am with you; be not dismayed, for I am your God; I will strengthen you, I will help you, I will uphold you with my righteous right hand”

Isaiah 41:10

I dedicate this dissertation to my family: Ingbert, Elona, Kirsten and Rainer. Words cannot describe how grateful I am for having you in my life. Your endless support, guidance and constant encouragement and belief in me, not only during this dissertation, but also in life have been immense and I will be forever grateful. I could not have achieved this without you.

Acknowledgements

My supervisor, Dr Laura O'Connor: your guidance, patience and encouragement throughout this study have made it all possible. The hours you have sacrificed and the constant support you have given are indescribable and it is greatly appreciated.

Dr Charmaine Korporaal: thank you for the guidance, experience and knowledge you have shared over the past seven years. Your contribution to the Chiropractic programme is paramount to its success.

Linda, Pat and the rest of the clinic staff: thank you for what you do in order to maintain and run the clinic efficiently; it would not be the same without you.

Deepak Singh, thank you for the time taken assisting me with the statistics for this study, it is greatly appreciated.

Dr S. Maharaj, Professor Govender and the Orthopaedic Department at King Dinizulu Hospital (KDZH): thank you for allowing me to conduct my research at KDZH and with your fantastic team. The efficiency and care you take with each patient is truly inspirational.

Nicole Uhlmann: your support, enthusiasm and constant encouragement has helped me get through this dissertation. Your constant positive attitude has helped me get past the highs and lows in the past three years, and were instrumental in the completion of this dissertation. I am eternally grateful that I have you in my life.

Lindy Uhlmann: thank you for the constant support and guidance over the past eight years. The highs and lows that we got through in order to be where we are now was a real roller-coaster ride and I am grateful to have done it with you.

Abstract

Purpose: Low Back Pain (LBP) is a leading cause of activity limitation and absence from work globally, and the treatment is often complicated and multifactorial. There is little documentation about the types of conditions requiring lumbar spine surgery in the public health care sector in South Africa (SA). The aim of this study was to develop a profile of lumbar spine conditions requiring surgical intervention in the Orthopaedic Department at a specialist public hospital in KwaZulu-Natal (KZN).

Methods: This study utilised a descriptive, retrospective, clinical audit design. A total of 112 patient files meeting the study inclusion criteria were analysed and data was extracted and recorded on a data template. Permission to conduct the study was obtained from the KZN Department of Health, the Manager of the King Dinizulu Hospital and ethical approval was obtained from the Institutional Research Ethics committee. The data was analysed using the Statistical Package for the Social Sciences (SPSS) (IBM Corporation). The data was described using means, standard deviations, percentages and count. Inferential statistical analysis was utilised to draw conclusions about populations from sample data. Chi-square and Fischer's Exact test were used to compare categorical data with a statistical significance of p value ≤0.05.

Results: The mean age of the patients was 41.7 years of age (range 3-76 years of age), with more females (55.4%, n = 62) than males (44.6%, n = 50) requiring surgery. More than half of the patients were Black Africans (55.4%, n = 62), with the majority (58%, n = 65) of all the patients being unemployed. Mechanical low back pain (MLBP) was the condition most often requiring surgical intervention (41.1%, n = 46) with lumbar stenosis being the most common diagnosis (17%, n = 19). This was followed by infective spondylitis (33.9%, n = 38). Frankel grading for neurological deficit was most often reported in patients with non-mechanical or infective causes of low back pain. Infective co-morbidity was (39.3%, n = 44) with 19.6% (n = 22) patients suffering from both tuberculosis (TB) and human immunodeficiency virus (HIV), 14.3% (n = 16) from TB alone and 5.4% (n = 6) with HIV/Acquired immunodeficiency syndrome alone. Most patients (91.1%, n = 102) received pre-surgical management consisting of medication either alone or in combination with other therapies such as physiotherapy, back braces, crutches and dietary intervention. The most common surgical procedure utilised was posterior spinal fusion (PSF) (43.8%, n = 49) either alone or in combination with other surgical procedures such as: decompression, biopsy and abscess drainage. This procedure alone was the favoured for non-mechanical LBP (NMLBP) (12.5%, n = 14), while PSF in combination with decompression was favoured the treatment for LBP of infective origin (15.2%, n = 17).

Post-surgical management included medication (96.4%, n = 108) and physiotherapy (17%, n = 19); these were administered either individually or in combination. There were only six post-surgical complications; two were metal ware failure and four were infections. Of the four post-surgical infections, all of the patients had HIV/AIDS as a co-morbid condition.

The trends suggest that the MLBP patients were predominantly older i.e. 40-69 years (82.6%, n = 38) and from the Indian race group (25.9%, n = 29). This was in contrast to the other types of LBP which predominately affected younger populations (i.e. 10-39 years) and Blacks. There were no differences in gender distribution for both MLBP and NMLBP. However, with LBP of infective origin, females were twice as much affected than males.

Conclusion: The profile of lumbar spine conditions requiring surgical intervention at a public hospital is varied and there is a high prevalence of surgery for mechanical and infective cases of lumbar spine pain. Effective management of these conditions may reduce morbidity. Future studies should investigate the economic impact of lumbar spine surgery on health expenditure in South Africa.

Key indexing terms: low back pain, mechanical low back pain, lumbar spine surgery, pre- and post-surgical management, infection, post-surgical complications.

Table of Contents

Chapter Three

Chapter Four

Chapter Five

Chapter Six

List of Tables

List of Figures

List of Appendices

Definitions

Dermatome: the band of skin innervated by the sensory root (afferent nerve fibres) of a single spinal nerve (Bickley and Szilagyi 2009).

Epidural: is an injection administered to treat low back and/or lower extremity pain secondary to disc herniation, discogenic pain, spinal stenosis, sciatica and post lumbar surgery syndrome. The underlying action mechanism of epidural injections is not well understood, however it is believed that it causes neural blockade, alters or interrupts nociceptive input, reflex mechanism of the afferent fibres, self-sustaining activity of the neurons, and the pattern of central neuronal activities (Benyamin, Singh, Parr, Conn, Diwan and Abdi 2009; Conn, Buenaventura, Datta, Abdi and Diwan 2009). For the purpose of this study epidural injections were considered as a surgical intervention.

Frankel Grading: was the first report of a neurological scale to characterise patients with acute spinal cord injuries (Frankel *et al*., 1962). Frankel grading is a component of the neurological examination which is utilized in order to determine whether the patient‘s condition had improved or deteriorated post-surgery (Ho, Wuermser, Priebe, Chiodo, Scelza and Kirshblum 2007).

Low back pain: pain and discomfort that is localized below the costal margin, above the inferior gluteal folds and posteriorly between the two mid-axillary lines, with or without referred leg (Rubinstein, Terwee, Assendelft, de Boer and van Tulder 2012).

Mechanical low back pain: also known as non-specific LBP, is pain that is not associated with a known specific pathology, but comes from the spine and its surrounding structures (Balagué, Mannion, Pellisé and Cedraschi 2012).

Myotome: a group of muscles innervated from a single spinal segment (Block, Borer, Bruce, Christopher, Drake, Jangid, John, Pucci, Silver, Vogl and Whitman 2007).

Scoliosis: is defined as an abnormal structural curvature of the spine and is characterized by a side-to-side curvature of the spine greater than 10 degrees (Gorman, Julien and Moreau 2012; Konieczny, Senyurt and Krauspe 2013).

Spondylolisthesis: is described as the forward slippage of one vertebra on top of another vertebra (Weinstein, Lurie, Tosteson, Hanscom, Tosteson, Blood, Birkmeyer, Hilibrand, Herkowitz, Cammisa, Albert, Emery, Lenke, Abdu, Longley, Errico and Hu 2007).

Abbreviations

n:	Number of participants (total sample)
p:	Probability value of statistical significance
>:	Greater than
<:	Less than
AIDS:	Acquired immunodeficiency syndrome
ALL:	Anterior longitudinal ligament
CS:	Canal stenosis
DB:	Disc bulge
DC:	Decompression
DDD:	Degenerative disc disease
DDS:	Decreased disc space
DH:	Disc herniation
DJD:	Degenerative joint disease
DOH:	Department of Health
DVBH:	Decreased vertebral body height
e.g.	Example
HIV:	Human immunodeficiency virus
HLA-B27:	Human leukocyte antigen
IBM:	International Business Machines
IV:	Intravenous
IVD:	Intervertebral disc
KDZH:	King Dinizulu Hospital
KZN:	KwaZulu-Natal
LBP:	Low back pain

L/S:	Lumbar spine
Meds:	Medication
MLBP:	Mechanical low back pain
Mm:	Muscles
NHI:	National Health Insurance
NMLBP:	Non-mechanical low back pain
PA:	Psoas abscess
PLL:	Posterior longitudinal ligament
PSF:	Posterior spinal fusion
PSIS:	Posterior superior iliac spine
PT:	Physiotherapy
SA:	South Africa
SD:	Standard deviation
SPL:	Spondylolisthesis
TB:	Tuberculosis
TENS:	Transcutaneous electrical nerve stimulation
TVP:	Transverse process
US:	United States
VB:	Vertebral body
VC:	Vertebral collapse
Viz.:	“namely”, “as follows”

Chapter One

Introduction

1.1 Introduction

Low back pain (LBP) is defined as pain and discomfort that is localized below the costal margin, above the inferior gluteal folds and posteriorly between the two mid-axillary lines, with or without referred leg pain (Rubinstein *et al.* 2012). Pain in this region is known as the most widespread and disabling musculoskeletal condition in the United States (US) and around the world (Hurwitz and Shekelle 2006) and is the leading cause of limited activity and absence from work (Dagenais, Caro and Haldeman 2008). It is responsible for major economic burden on individuals, families, communities, industry and governments (Dagenais, Caro and Haldeman 2008; Hoy, Brooks, Blyth and Buchbinder 2010). In the US the total costs of LBP exceeds $100 million dollars per year, and it is ranked among the top 10 most expensive medical conditions, with costs similar to those of cancer, cardiovascular disease and diabetes (Katz 2006; Dagenais, Caro and Haldeman 2008). It was largely thought that LBP was predominant in the Western world until a decade ago when studies showed that it is also a major burden in low- and middle-income countries (Hoy *et al.* 2010).

The lifetime prevalence of LBP in community-based populations in Europe and the US range between 50% and 85% (Hurwitz and Shekelle 2006). The findings are similar to those reported in South African studies (prevalence ranging from 48% to 78.2%) (Docrat 1990; Van Der Meulen 1997; Dyer 2012).

LBP is commonly acute with the pain generally subsiding between four to six weeks. Recurrence of LBP is not uncommon (Koes, van Tulder, Lin, Macedo, McAuley and Maher 2010). The high prevalence of recurrent and chronic LBP and its associated costs provides motivation for the prioritising of interventions that prevent LBP becoming recurrent or chronic (Dellito, Whitman, van DIllen and Godges 2012). Linton *et al.* (1993) reported that patients who received early active physical therapy interventions for the first episode of LBP had a reduced incidence of developing chronic LBP. Studies have shown that socioeconomic (employment, education) and sociodemographic status (age, gender, race), physical appearance, spinal deformity (e.g. scoliosis and spondylolisthesis) and psychological and psychosocial factors (stress, depression, anxiety, fear avoidance) all contribute to an increased risk of LBP (Manchikanti 2000; Jarvik and Deyo 2002; Hurwitz and Shekelle 2006).

A treatment plan for a patient with LBP is dependent on whether the condition can be conservatively managed or whether surgery is required (Dagenais, Caro and Haldeman 2008;

Dagenais and Haldeman 2012). In the past decade several guidelines for the management of LBP have been produced with most of them recommending similar protocols for management of LBP (Dagenais, Caro and Haldeman 2008; Dagenais, Tricco and Haldeman 2010; Koes *et al.* 2010; Ladeira 2011). Spinal surgery is only recommended when there is deterioration of the neurological signs, the cause is non-mechanical or diagnostic tests reveal structural changes for which surgical intervention is required (Dagenais and Haldeman 2012). Selecting appropriate candidates for surgery can be challenging due to the variability in diagnosis, clinical and radiographic characteristics of LBP conditions. In addition, even in well-selected surgical candidates the clinical benefit may vary, and many patients may fair just as well long-term with more conservative treatment options (Friedly, Standaert and Chan 2010). Surgical intervention is associated with risks ranging from minor infections to major complications such as death (Carrean, Puno, Dimar, Glassman and Johnson 2003).

There is currently a lack of research regarding the conditions and treatment of LBP in developed and developing countries. The high systemic infection rate in SA (Pettifor, Rees, Kleinschmidt, Steffenson, MacPhail, Hlongwa-Madikizela, Vermaak and Padian 2005) may influence the conditions requiring surgical interventions. The aim of this study was to develop a profile of lumbar spine conditions requiring surgical intervention in the Orthopaedic Department at a specialist public hospital in Kwa-Zulu Natal (KZN).

1.2 Rationale of the Study

The South African Department of Health (DOH) and its National Development Plan focuses on six major areas in which they spend their limited resources. These are increasing life expectancy, reducing and maintaining HIV/AIDS, reducing other infectious diseases (communicable/non-communicable), reducing maternal and child mortality, addressing injury and violence and implementing the National Health Insurance (NHI) (Motsoaledi 2014). These reasons possibly contribute to the limited resource available for the management of musculoskeletal conditions which are a major burden on individuals, health care systems and social care systems (Woolf and Pfleger 2003; Dagenais, Caro and Haldeman 2008; Roffey, Wai, Bishop, Kwon and Dagenais 2010; Wai, Roffey, Bishop, Kwon and Dagenais 2010). Spinal surgical intervention, especially for non-specific low back pain, has increased over the past two decades in first world countries (Deyo, Gray, Kreuter, Mirza and Martin 2005). Little is known about the types of conditions requiring lumbar spine surgery in the public health care sector in South Africa (SA). The high prevalence of infectious diseases like tuberculosis (TB) and human immunodeficiency virus (HIV) and acquired immunodeficiency syndrome (AIDS) in SA (Pettifor *et al.* 2005) may result in a profile of surgeries which differs to those in other settings.

Conservative management of LBP is recommended prior to surgical intervention (Dagenais and Haldeman 2012). This is often done by chiropractors or physiotherapists (Dagenais, Tricco and Haldeman 2010; Dagenais and Haldeman 2012; Dellito *et al.* 2012). Currently, chiropractic is not part of mainstream public health care in SA, despite reports of it being effective for reducing levels of disability and pain in patients with LBP (Wilkey, Gregory, Byfield and McCarthy 2007). In order for chiropractic to validate its inclusion in the NHI, which aims to provide access to appropriate, efficient and quality health services to people regardless of their socio-economic status (Motsoaledi 2014), studies need to be conducted to show that it may have a role in public health care. This study, by describing the types of conditions requiring surgical intervention, will provide data on the types of orthopaedic-related lumbar spine conditions that require surgical intervention and their pre- and post-surgical management. This may provide insight on a potential role for the chiropractic profession in a public health care setting in SA.

1.3 King Dinizulu Hospital Complex

King Dinizulu Hospital Complex (KDZN) (formerly King George V hospital) is situated in Springfield in Ward 25 of the eThekwini Health District in the province of KwaZulu-Natal (KZN). The Spinal Unit at this hospital is the only tertiary care referral unit in the province providing a service to a spectrum of spinal pathologies. The hospitals vision and mission is to be a centre of excellence for the delivery of district, specialised and selected tertiary levels of health care service within the designated. In addition, the KDZH also focuses on utilising the Batho Pele Principles with a multi-disciplinary approach to ensure the total wellbeing of the people they serve. The specialised services offered by the hospital include (Hospital 2017):

- The management of multi drug resistant (MDR) and complicated TB
- Orthopaedic spinal surgery, psychiatric services, family planning (sterilisation)

The Spinal Unit has five to six orthopaedic registrars who are under the supervision of the Head of the Spinal Unit. Patients from surrounding public hospitals are referred to the Spinal Clinic which is held once a week on a Wednesday. The purpose of this clinic is to evaluate or re-evaluate the patients post-surgically, in order to assess if the patients require surgery and to also identify if the surgery was a success or failure. The patients remain in the system until their pain has subsided and have shown a favourable post-surgical outcome. The KDZH uses LBP treatment guidelines that meet international standards and are maintained at all times throughout the treatment of the patient (Govender 2016).

1.4 Aims and Objectives of the Study

1.4.1 The study's aim

The aim of this study were to develop a profile of lumbar spine conditions requiring surgical intervention in the Orthopaedic Department at a specialist public hospital in Kwa-Zulu Natal (KZN).

1.4.2 The study's objectives

1) To determine the lumbar spine (L/S) conditions that required surgical intervention, their clinical features and co-morbid pathologies of the patients.
2) To determine the pre-and post-surgical management of the patients and post-surgical complications.
3) To determine if there was any association between the age, race, occupation, gender, and the co-morbid conditions and post-surgical diagnosis.

1.5 Flow of the Dissertation

Chapter One: the introduction and rational for the study, and a brief background of the KDZH complex were described. The aims and objectives are also stated in this chapter.

Chapter Two: the literature review of the relevant anatomy of the lumbar spine are presented. This will be followed by a review of the epidemiology, diagnosis, classification and management of LBP.

Chapter Three: the study design, methods, data collecting tool, data analysis and ethical considerations utilised in this study are described.

Chapter Four: the results of the study are presented in this chapter. The demographic, conservative and surgical management of the patients as well as the clinical findings are shown using appropriate figures and tables.

Chapter Five: the findings of the study are discussed and explained in relation to the current literature.

Chapter Six: the conclusion, study limitations and recommendations for future studies are described.

Chapter Two

Literature Review

2.1 Introduction

Low back pain (LBP) is one of the most common musculoskeletal conditions, with a lifetime prevalence of 84% in the general adult population. The severity of LBP varies from patient to patient and from episode to episode. It has been reported that about 15% of sufferers have severe disability, and of these, about 20-25% will consult a health practitioner (Dagenais, Tricco and Haldeman 2010). LBP can be classified as mechanical, non-mechanical, infective, malignancy, inflammatory and other specific causes, such as scoliosis (Colledge, Walker and Ralston 2010; Decade 2016). The treatment of LBP is complicated as it is a multi-factorial disorder with many possible causes (Manchikanti 2000). A patient's treatment plan is dependent on whether the condition can be conservatively managed or whether surgery is required (Dagenais, Tricco and Haldeman 2010; Dagenais and Haldeman 2012).

This chapter presents an overview of the anatomy of the lumbar spine and the surrounding structures. This will be followed by the relevant literature related to lumbar spine conditions and classification and also the treatment of lumbar spine conditions, either conservative treatment as well as surgical treatment.

The following sources were searched for information for this chapter: Google Scholar, Ebscohost, Medline, PubMed, Summon, eMedicine and the Durban University of Technology Repository.

Key terms used included: "Low back pain", "epidemiology", "prevalence and incidence", "lumbar spine surgery", "lumbar spine conditions", "conditions affecting the lumbar spine", "mechanical low back pain", "non-mechanical low back pain", "anatomy of the lumbar spine", "neurology of the lumbar spine", "surgical management of the lumbar spine", "conservative management of the lumbar spine", "neurological examination of the spine", "spine surgery", "guidelines to manage low back pain", "infection", "spinal infection", "risk factors for spinal surgery", "post-surgical complications".

2.2 Review of the anatomy of the lumbar spine

The lumbosacral area consists of five lumbar, five fused sacral and four fused coccygeal vertebrae (Gosling, Harris, Humpherson, Whitmore and Willan 2008; Moore and Dalley 2010; Cramer and Darby 2017). The vertebrae gradually increase in size from the cervical to the lumbar vertebrae and then become smaller again towards the coccyx. The largest vertebrae

are found in the lumbar spine as this is the region where most of the weight bearing as well as weight distribution through the pelvic girdle occurs (Moore and Dalley 2010; Cramer and Darby 2017). A typical lumbar vertebra has the features identified in **Figure 2.1**.

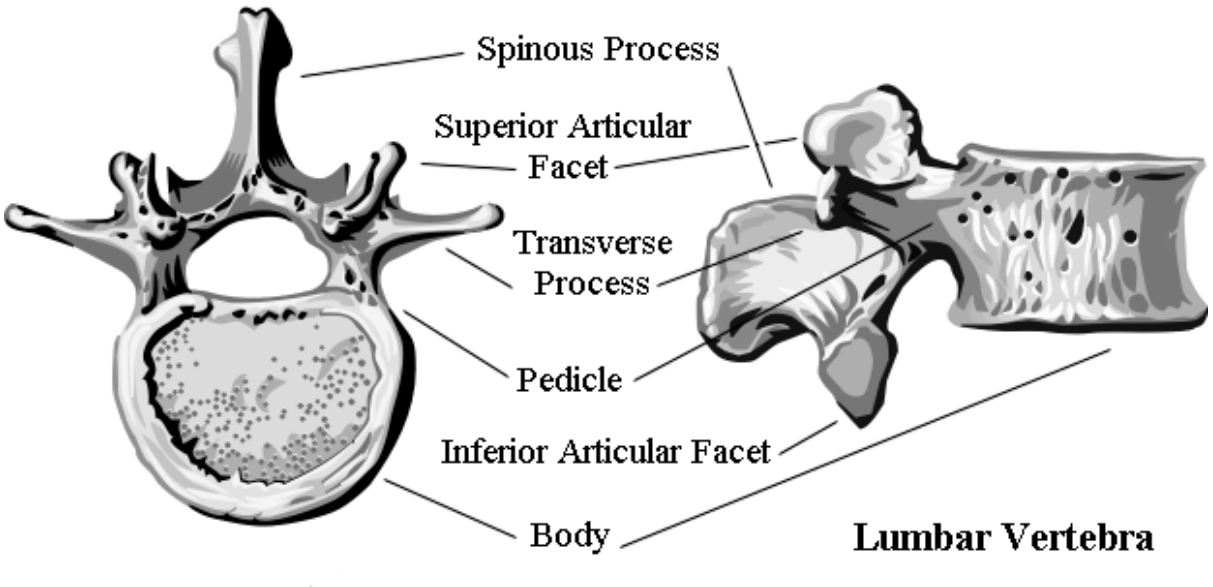

Figure 2.1 A typical lumbar vertebra

(Cramer and Darby 2017)

2.2.1 Intervertebral disc

The adjacent vertebrae are connected by the intervertebral discs (IVD), which account for 20-25% of the vertebral columns (VC) height. The IVDs get larger as the VC descends. The IVDs in the lumbar spine are thicker as they have to adapt to changes in weight bearing. The IVD consists of two parts viz. the annulus fibrosis (AF), which makes up the outer fibrous part. It consists of concentric lamellae of fibrocartilage and its blood supply decreases towards the centre with only the outer third receiving sensory innervation. The nucleus pulposus (NP) is the gelatinous central mass which gives the IVD its semifluid nature and is responsible for the flexibility and resilience of the IVD and VC. The NP is avascular and receives nutrients through diffusion(Moore and Dalley 2010; Cramer and Darby 2017).

2.2.2 Zygapophysial joints

Each vertebra articulates with the vertebra above and below by the zygapophysial joints, also known as the facet joints which are true synovial joints. They are innervated by the posterior rami of the spinal nerve, of which each branch supplies two adjacent joints. This results in two different nerves supplying one joint. The facet joints stabilise the motion between two vertebra.

Depending on their shape and orientation, they permit translation and torsion while allowing sagittal plane flexion and extension (Moore and Dalley 2010; Cramer and Darby 2017). The range of motion (ROM) of the lumbar spine is presented in **Table 2.1** and is determined by the size of the IVD in relation to the VB.

Table 2.1 Range of motion (in degrees) of the lumbar spine in males and females

(Troke, Moore, Maillardet and Cheek 2005)

Range of Motion	**Male (ages 16-91)**	**Female (ages 16-91)**
Flexion	73	68
Extension	29	28
Right and left lateral flexion	28	27-28
Right and left axial rotation	7	6-8

2.2.3 Lumbar spinal ligaments and muscles

There are numerous ligaments found within the lumbar spine but the two main ones are the anterior (ALL) and posterior longitudinal ligaments (PLL) preventing hyperextension and flexion respectively (Moore and Dalley 2010; Cramer and Darby 2017). They are accompanied by accessory ligaments shown in **Appendix A**, which help stabilise the movements of the lumbar spine.

There are three layers of muscles in the lumbar spine **(Appendix B)**. The main muscles responsible for spinal extension are the erector spinae muscles, while the abdominal muscles are responsible for spinal flexion (Moore and Dalley 2010; Cramer and Darby 2017). Muscular instability is an important risk factor for lumbar spine injury and the development of chronic LBP. The deep muscles of the lumbar spine provide stability to the spine and have been shown to have specific muscle fibre arrangements to accomplish this function (Ward, Kim, Eng, Gottschalk, Tomiya, Garfin and Lieber 2009). The multifidus muscle, in particular, has been identified as a major contributor to spinal stability. The specific architectural design of the multifidus muscle fibres allows them to withstand large forces in different directions (Ward *et al.* 2009).

2.2.4 Nervous supply to the lumbar spine

The spinal cord terminates at L1-L2 in adults and at L3 a in infants where it becomes the conus medullaris (Gosling *et al.* 2008; Moore and Dalley 2010; Cramer and Darby 2017). The cord

lies within the vertebral foramen (spinal canal) and is protected by the vertebrae, their associated ligaments and muscles, the spinal meninges and the cerebrospinal fluid (CSF).There are five lumbar, five sacral and one coccygeal spinal nerve that arise from the spinal cord as rootlets, viz. the dorsal and ventral nerve roots which converge to form mixed spinal nerves. The dorsal nerve roots carry afferent or sensory fibres from skin, subcutaneous tissue and viscera while the ventral roots carry efferent or motor fibres to skeletal muscle and contain presynaptic autonomic fibres (Moore and Dalley 2010; Cramer and Darby 2017). The lumbar and sacral plexuses of nerves are made up of the anterior rami of the spinal nerves which innervate the lower limbs. The graphical depiction of the nerve roots as they leave the spinal cord and form the spinal nerves is shown in **Figure 2.2**.

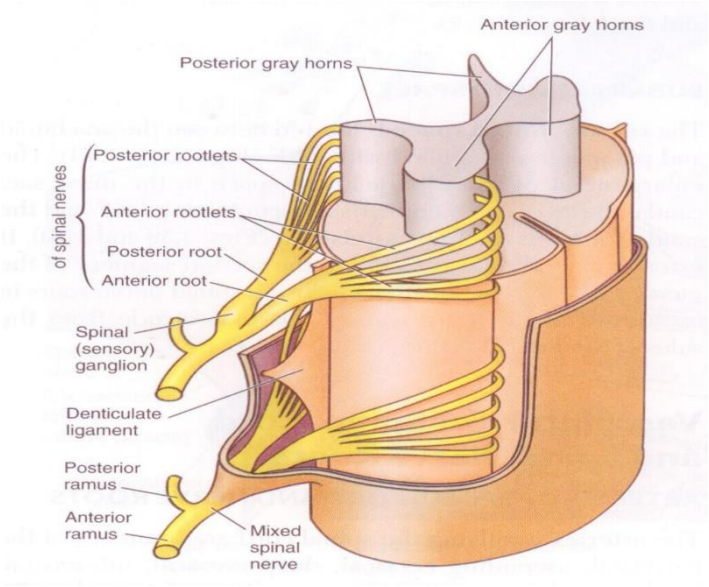

Figure 2.2 Nerve supply of the lumbar spine

(Moore and Dalley 2010)

2.2.5 Blood supply to the lumbar spine

The aorta and its branches are largely responsible for supplying the spinal cord **(Figure 2.3)**. The venous drainage has a similar distribution to that of the arterial supply of the spinal cord. There are usually three posterior and three anterior veins which are arranged longitudinally and are drained by up to 12 radicular, anterior and posterior medullary veins. These veins join the internal vertebral venous plexus which in turn also communicates with the external venous plexus on the external surface of the vertebra to drain the blood from the spinal cord (Moore and Dalley 2010; Griessenauer, Raborn, Foreman, Shoja, Loukas and Tubbs 2015; Cramer and Darby 2017).

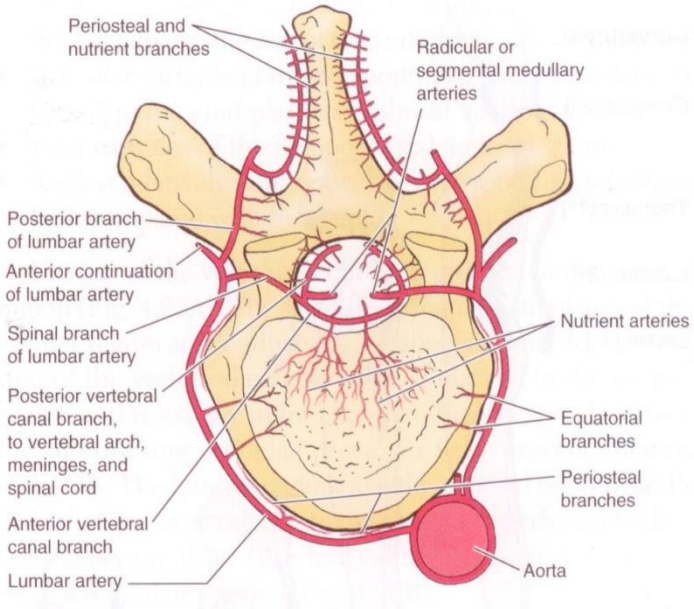

Figure 2.3 Blood supply of the lumbar vertebra

(Moore and Dalley 2010)

2.3 Low back pain

2.3.1 Epidemiology of low back pain

The Global Burden of Disease study emphasised the considerable worldwide burden of LBP identifying it as the leading cause of disability, ahead of 290 other conditions (Buchbinder, Blyth, March, Brooks, Woolf and Hoy 2013). LBP is known as the most widespread and disabling musculoskeletal condition in the US and around the world (Hurwitz and Shekelle 2006; Louw, Morris and Grimmer-Somers 2007) and is the leading cause of activity limitation and absenteeism from work worldwide (Dagenais, Caro and Haldeman 2008; Dagenais, Tricco and Haldeman 2010). It is responsible for significant economic burden on individuals, families, communities, industry and government (Dagenais, Tricco and Haldeman 2010; Hoy *et al.* 2010).

In the US the total costs of LBP exceeds $100 million dollars per year, and it is ranked among the ten most expensive medical conditions, with costs similar to those of cancer, cardiovascular disease and diabetes (Katz 2006; Dagenais, Caro and Haldeman 2008). Buchbinder *et al*. (2013) found that LBP ranked highest as a disease-causing disability and concluded that LBP causes more global disability than any other condition. LBP was estimated to be responsible for 83 million years lived with disability in 2010, compared to 58.2 million years in 1990 (Buchbinder *et al.* 2013).

The lifetime prevalence of LBP in Denmark, Sweden, United States, United Kingdom, Finland, Norway and Belgium has been estimated to be between 50% and 85% (Hurwitz and Shekelle 2006). Similar results were observed in SA, in different races, where the prevalence ranged from 48% to 78% (Docrat 1990; Van Der Meulen 1997; Dyer 2012).

LBP is the fifth most common reason for a patient to visit a physician's office in the US and is the most common musculoskeletal condition seen by physical therapists (Ladeira 2011) and chiropractors in the US (Schneider, Haas, Glick, Stevans and Landsittel 2015). Similarly, it is the most common musculoskeletal problem seen in Australia and in Italy, with it being the third most common reason for a medical visit (Ladeira 2011).

It was largely thought that LBP was a problem in Western countries, until about 10 years ago when several studies found that it is also a major burden in low- and middle-income countries (Hoy *et al.* 2010). There appears to be an assumption that the prevalence of LBP is lower in Africa than in developed countries. A systematic review by Walker (1999), who assessed the global prevalence of LBP, concluded that of the 56 studies reviewed, only 8% were conducted in developing countries, with only one study being conducted in Africa. During 2000-2006 numerous studies were conducted in African countries with regards to the epidemiology of LBP. Louw *et al.* (2007) found 27 studies pertaining to LBP epidemiology in Africa and reported little difference between the prevalence of LBP when compared to developed countries. The one-year prevalence of LBP in African countries ranged from 14% to 72%, while the one-year prevalence in developed countries ranging from 20% to 62%. Similarly the lifetime prevalence of LBP in African countries ranged from 28% to 74%, whilst that of developed countries ranged from 30% to 80%. the authors showed that from 1990 there was increased investigation into the prevalence of LBP in Africa yet emerging problem in African such as HIV/AIDS there is little resource available for research into less threatening causes of mobility (Louw, Morris and Grimmer-Somers 2007).

2.3.2 Risk factors for low back pain

LBP is a multi-factorial condition with many risk factors associated with its development. Studies have shown that socioeconomic status (e.g. employment and education), socio-demographic factors (e.g. age, gender and race), physical appearance, spinal deformity (e.g. scoliosis and spondylolisthesis) and psychological and psychosocial factors (e.g. stress, depression, anxiety and fear avoidance) all contribute to an increased risk of LBP (Manchikanti 2000; Jarvik and Deyo 2002; Hurwitz and Shekelle 2006). Females between the ages of 40-80 years of age were more at risk than their male counterparts in developing LBP (Hoy, Bain, Williams, March, Brooks, Blyth, Woolf, Vos and Buchbinder 2012). Borenstein (2013) reported that LBP increases with age, peaking between the third and fifth decades of life. Hoy *et al.*

(2012) observed that the prevalence of LBP was high among adolescence, then declined between the ages of 20-29 years, and then progressively increased to peak between 40-69 years of age.

Yang and Haldeman (2016) reported that a lack of physical activity was associated with an increased risk of LBP. This was contradictory to the findings of Chen et al. (2009) who found that a sedentary life did not increase the risk of LBP . Rivinoja *et al*. (2011) in a 28-year cohort study found that factors such as smoking, being overweight or obese and participating in sports at age 14 years could predict hospitalisations in adulthood for LBP and sciatica. The authors reported that 119 females and 254 males had been hospitalised at least once because of LBP or sciatica. Females who were overweight had an increased risk of second-time hospitalisation and surgery. Smoking in males was linked with an increased risk of first-time non-surgical hospitalisation and second-time hospitalisation for surgical treatment. Literature shows similar results that current or previous smoking, alcohol use, lack of sleep and obesity were associated with the development of LBP (Yang and Haldeman 2016).

The improvements with medical care in the western countries have not been achieved in the African countries (Louw, Morris and Grimmer-Somers 2007). The main reason for this is the recent HIV/AIDS epidemic, which has seen a shift in funding directions and health interventions in research (Louw, Morris and Grimmer-Somers 2007; Rehle, Hallett, Shisana, Pillay-van Wyk, Zuma, Carrara and Jooste 2010). A positive relationship between health and income is recognised internationally; a high income is thought to promote good health by creating sufficient access to clean water and sanitation, good nutrition and better quality health services (Louw, Morris and Grimmer-Somers 2007). South Africa is a developing country that suffers from poverty, unemployment and limited resources with regards to health care for individuals. These factors could predispose the population of SA to a greater prevalence of disease and disability (Louw, Morris and Grimmer-Somers 2007; Rehle *et al*., 2010).

The limited resources available in developing countries limit the possibility that every patient receives the required treatment or care they need to treat their conditions and things such as the effects of immunosuppression in HIV patients predisposes them to developing LBP of pathological origin (Rehle *et al.* 2010).

2.3.3 Diagnosis of low back pain

The clinical evaluation of LBP is very important in its diagnosis. The early identification of red flags or specific diseases is paramount. Red flags include significant trauma, suspicion of cancer, infection, weight loss, age of onset (< 20 or > 55 of age) and significant neurological changes (Koes *et al.* 2010; Ladeira 2011). Red flags are assessed through the patient's past medical history and a thorough physical examination (Chou, Qaseem, Snow, Casey, Cross

Jr, Shekelle and Owens 2007). The medical history will focus on character, type, location, onset, of pain aggravating or alleviating factors, past history of LBP, cancer, fever, fractures, bowel and bladder incontinence, medications and past surgery. The physical examination focuses on the patients' posture, range of motion, tenderness, muscle spasms, reflexes, sensory functions and motor functions (Henschke, Maher, Refshauge, Herbert, Cumming, Bleasel, York, Das and McAuley 2009; van der Windt, Simons, Riphagen, Ammendolia, Verhagen, Laslett, Devillé, Aertgeerts, Deyo, Bouter and de Vet 2009; Borenstein 2013). The neurological examination assists to identify individuals with systemic symptoms for back pain of pathological origin. Identifying these patients early in the diagnostic process is crucial in order to initiate the correct treatment protocol for the specific cause (Henschke *et al.* 2009). If red flags are identified then the patient would require specialist referral (Ladeira 2011).

Radiographs may show osteophytes or disc space narrowing, but these abnormalities can also be found in patients who have no LBP. Their usefulness in the diagnosis is, therefore, limited and have been recommended only when a serious underlying condition is clinically suspected (Borenstein, O'Mara, Boden and Lauerman 2001; Koes *et al.* 2010).

2.3.4 Spinal cord injury assessment

The Frankel Grading is a neurological scale which was the first to characterise patients with acute spinal cord injuries (Frankel, Hancock, Hyslop, Melzak, Michaelis, G.H, Vernon and Walsh 1962). Frankel Grading was a component of the neurological examination which was utilised in order to determine whether the patient's condition had improved or deteriorated post-surgery. The grading ranges from A-E as shown in **Table 2.2**.

Table 2.2 Frankel grading of spinal cord injury

Frankel grading	**Neurological status**	**Description**
A	Complete	No motor or sensory function is preserved in the sacral segments S4-S5.
B	Incomplete	Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-S5.
C	Incomplete	Motor function is preserved below the neurological level, and more than half of key muscles below the neurological level have a muscle grade less than 3.
D	Incomplete	Motor function is preserved below the neurological muscles below the neurological level have a muscle grade of 2 or more
E	Normal	Motor and sensory functions are normal.

In 1984 the American Spinal Injury Association developed guidelines on the neurological assessment and example of patient record using these guidelines is presented in **Figure 2.4**.

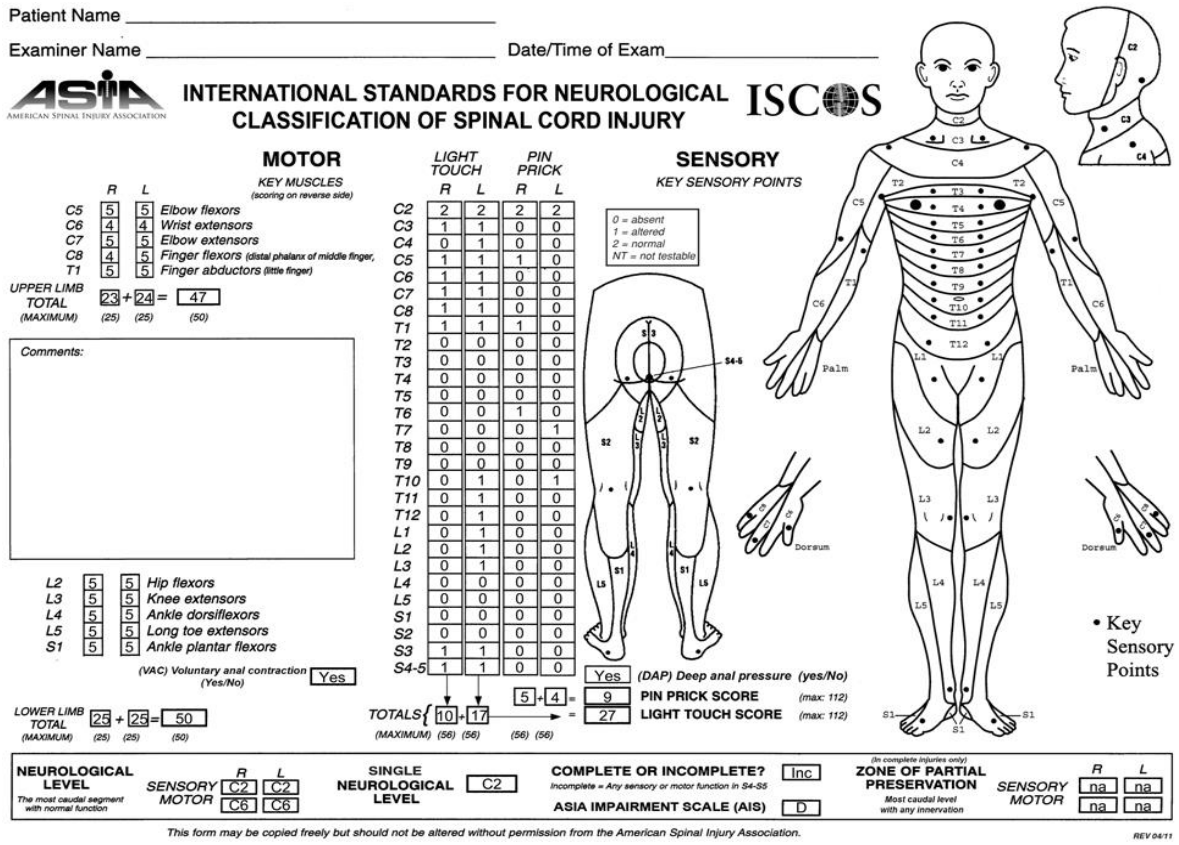

Figure 2.4 Standard neurological classification of spinal cord injury

(American Spine Injury Association , 2002; (Ho *et al.* 2007)

2.3.5 Classification of low back pain

Classification of LBP into sub-groups, with relevant clinical features, is necessary to help direct treatment and improve treatment outcomes (Henry, Van Dillen, Ouellette-Morton, Hitt, Lomond, DeSarno and Bunn 2014). For this study, a classification derived from the Bone and Joint Decade Task Force for LBP (Decade 2016) as well as Davidson's Principles and Practice of Medicine (Colledge, Walker and Ralston 2010) will be utilised.

2.3.5.1 Mechanical low back pain

Mechanical low back pain (MLBP), also known as non-specific LBP, refers to pain that is not associated with a known specific pathology, but originates from the spine and its surrounding structures (Balagué *et al.* 2012). This type of LBP can either be due to overuse in individuals with normal anatomical structures or it may be secondary to a deformity or injury (Borenstein

2013). A specific cause of MLBP can only be identified in about 20% of patients, but most people generally recover in a relatively short period of time with conservative treatment (Balagué *et al.* 2012).

Deyo *et al*. (2006) looked at the visit rates for non-specific LBP in the US. They found that the prevalence for non-specific LBP varied among different races. The prevalence was 27.4% for Whites, 23.9% for Blacks, and 20% for mixed race between white and blacks (Deyo, Mirza and Martin 2006). Freburger et al. (2009) looked at the prevalence of non-specific LBP in North Carolina. They compared the prevalence rates between 1992 and 2006 and found that the prevalence had increased over time. They also found that the prevalence for non-Hispanic Whites to be 10.5% and 9.8% for non-Hispanic Blacks (Freburger, Holmes, Agans, Jackman, Darter, Wallace, Castel, Kalsbeek and Carey 2009).

The most common MLBP disorders include lumbar strain, osteoarthritis (OA), spinal stenosis and herniated IVD (Borenstein 2013). Apart from degenerative factors causing LBP, it has long been thought that mechanical factors such as standing and walking, manual handling or assisting patients, awkward postures, pushing or pulling, bending and twisting, occupational sitting, lifting and carrying have been causative agents in the onset and perpetuation of MLBP. However, according to the Bradford Hill causation criteria these have been found unlikely to independently be responsible for resulting in LBP (Balagué *et al.* 2012). Other risk factors for MLBP include obesity, smoking and genetic factors (Battié, Videman, Levälahti, Gill and Kaprio 2007; Kalichman and Hunter 2008; Shiri, Karppinen, Leino-Arjas, Solovieva and Viikari-Juntura 2010).

The prognosis of MLBP depends on whether the patient has acute or chronic pain. Acute MLBP, which often results from muscular or ligamentous injury, may improve in two to four weeks of the initial onset. In 90% of the cases the LBP symptoms resolve within two months, but these patients have a higher risk of recurrence. Within the next six months, 40% of individuals are at risk of another episode of LBP, which may be greater in severity and duration than the initial episode. This suggests that MLBP can seldom be treated with a single treatment, but rather should be seen as a chronic illness that requires treatment over an extended period (Carey, Garrett, Jackman and Hadler 1999; Itz, Geurts, van Kleef and Nelemans 2013). It has been shown that a large portion of patients still have pain one year after the initial episode (Itz *et al.* 2013).

Chronic MLBP is described as LBP lasting longer than three months (Rubinstein, van Middelkoop, Assendelft, de Boer and van Tulder 2011). Apart from suffering from impaired function and pain, patients with chronic LBP often suffer from depression and anxiety, as well as altered social and work life (Rubinstein *et al.* 2011). Chronic MLBP requires a

multidisciplinary treatment protocol which includes physical, educational, psychosocial and work-related treatment needs. This requires a team of health care providers in specific fields (Rubinstein *et al.* 2011; Kamper, Apeldoorn, Chiarotto, Smeets, Ostelo, Guzman and van Tulder 2015). Exercises such as core strengthening and aquatic therapy have been identified to treat chronic MLBP (Ladeira 2011). Epidural injections are the most commonly used form of treatment for chronic LBP in the US. They cause local anaesthesia to the affected area resulting in alleviation of the pain (Conn *et al.* 2009).

2.3.5.2 Non-mechanical low back pain

Non-mechanical LBP (NMLBP) results from a known origin, such as a fracture, vertebral dislocation and/or spondylolisthesis.

2.3.5.2.1 Fractures of the lumbar spine

Spinal fractures typically affect only the minority of people with traumatic injuries (Leucht, Fischer, Muhr and Mueller 2009). In a study on German patients (n = 562) attending a trauma centre they found the ratio of male to female patients was 1.6:1, with a mean age of 43.8 years of age, with majority of the males being between the ages of 20-50 years of age, whereas the females had two peaks, one between 20-50 years and the other between 60-80 years of age. More than half the fractures occurred in the lumbar spine (50.4%), with the thoracolumbar area being the most likely site of compression fracture. The aetiology of the fractures were from high energy falls (39%), motor vehicle or pedestrian accidents (26.5%), simple fall (20%), sport related (5.2%) or blunt impact (3.9%) with 5.1% being from an unknown causes. Using the Frankel Grading **(Table 2.2)** they also found that 19.8% of the patients with lumbar spine fractures had neurological deficits with 11.4% of the patients with Type A fractures having neurological deficits, compared to 46.3% of those with Type B fractures and 51.9% of patients with Type C (Leucht *et al.* 2009).

The presentation of spinal fractures is variable Some patients may be in severe pain with radiating pain to the abdomen, while others may have limited back pain (Colledge, Walker and Ralston 2010). Diagnostic imaging techniques such radiographs, bone scans, computed tomography scan (CT) or magnetic resonance imaging (MRI) scans may be utilised to identify fractures. Magnetic resonance imaging can also help differentiate if the fracture has a pathological origin due to tumours, infection or from osteoporosis (Colledge, Walker and Ralston 2010).

The management of traumatic lumbar spinal fractures remains controversial, with many available options for treatment; there is no clear consensus on the appropriate treatment. Nonetheless, in general, all guidelines agree that surgery is necessary for fractures where the

biomechanical structure of the spine has changed and there is significant neurological deficit (Verlaan, Diekerhof, Buskens, van der Tweel, Verbout, Dhert and Oner 2004).

2.3.5.2.2 Spondylolisthesis of the lumbar spine

Spondylolisthesis is essentially described as the slippage of one vertebra on top of another vertebra (Weinstein *et al.* 2007). The epidemiology of this condition is not well-documented despite a high number of surgeries for these cases (Jacobsen, Sonne-Holm, Rovsing, Monrad and Gebuhr 2007).

Jacobsen *et al*. (2007) found that women were more likely to suffer from spondylolisthesis than men with a ratio of 5:1, and also found that Black females were about three times more affected than White females. The L4/5 segment was the most common area to slip, though rarely exceeding 30% and that females had a greater risk of L3/L4 slippage than men, with the ratio being 1:6.4. The mean age of the women was also significantly older than the men: 71 and 68 years respectively). There was no association found between the body mass index (BMI) and spondylolisthesis in men, yet overweight women were more likely to present with slippage at the L4/L5 levels. Increased pelvic inclination and lumbar lordosis were also found to be associated with increased slippage of L4/L5 in females. Smoking and occupational factors such as daily lifting were not associated with spondylolisthesis (Jacobsen *et al.* 2007).

In the US, posterior spinal fusion and decompression surgery is the treatment of choice for patients with spondylolisthesis (Weinstein, Lurie, Olson, Bronner and Fisher 2006). According to the Spine Patient Outcomes Research Trial (SPORT), patients who received surgical treatment for spondylolisthesis had greater pain relief and improved function after a two-year follow up than patients who were treated non-operatively (Birkmeyer, Weinstein, Tosteson, Tosteson, Skinner, Lurie, Deyo and Wennberg 2002; Weinstein *et al.* 2007; Weinstein, Tosteson, Lurie, Tosteson, Blood, Hanscom, Herkowitz, Cammisa, Albert, Boden, Hilibrand, Goldberg, Berven and An 2008). However, a later study by Weinstein *et al*. (2009) found that the benefits of surgery early on deteriorated over time and the gap narrowed between surgical treatment and non-surgical treatment for spondylolisthesis with spinal stenosis.

In a four-year observational study Weinstein *et al*. (2009) found that the re-surgical rate for spondylolisthesis was 15%. They also found that there were two deaths due to post-surgical complications; one was from respiratory distress post-surgically and the other was from sepsis. Non-surgical treatment included epidural injections, physical therapy, opioids and non-steroidal anti-inflammatory drugs. They concluded that there was no significant difference between non-surgical treatment and surgical treatment in patients with spondylolisthesis. However, they did state that patients who had spinal stenosis secondary to spondylolisthesis and had surgical treatment had greater improvement in scores of function, satisfaction, pain

and self-rated progress over a four-year period than those who were treated non-surgically . This study highlights the importance of conservative management of LBP prior to surgery for certain L/S conditions.

2.3.5.3 Infection

Infections of the spine can be non-pyogenic or pyogenic in nature and can affect any anatomical area surrounding the spine including the vertebral body, discs, paravertebral tissues and the epidural space. The most common infections are vertebral osteomyelitis, discitis, abscess (psoas, paravertebral and epidural) and spinal or vertebral osteomyelitis (pyogenic infection) which accounts for 2-4% of all bone and joints infections. The three ways that spinal infections can be spread are through haematogenous spread, which is most common, via direct introduction through iatrogenic sources and lastly, by spread from adjacent contamination (Quesnele, Dufton and Stern 2012).

The literature shows that there has been an increase in the incidence of pyogenic spinal infections in adults (Grammatico, Baron, Rusch, Lepage, Surer, Desenclos and Besnier 2008; Cheung and Luk 2012; Quesnele, Dufton and Stern 2012). This was not dissimilar to the findings of Nagashima *et al.* (2010), where they documented an increase in pyogenic and non-pyogenic spinal infections, with the diagnosis being approximately 6.8 times more common between 1996-2005 than from 1976-1985 (Nagashima, Yamane, Nishi, Nanjo and Teshima 2010). The advancement in diagnosing ability through MRI and CT guided biopsies was thought to be responsible for the increase. Other authors have suggested that the increasing rates of people with compromised immune systems and increased use of IV drugs is responsible for the increase in spinal infection (Luzzati, Giacomazzi, Danzi, Tacconi, Concia and Vento 2009; Quesnele, Dufton and Stern 2012).

The risk of spinal infection has been associated with increasing age. Several studies confirmed that the most at risk are those between the ages of 50-80 years of age (McHenry, Easley and Locker 2002; Gasbarrini, Bertoldi, Mazzetti, Fini, Terzi, Gonella, Mirabile, Barbanti Brodano, Furno, Gasbarrini and Boriani 2005; Mylona, Samarkos, Kakalou, Fanourgiakis and Skoutelis 2009; Quesnele, Dufton and Stern 2012). Males are more commonly affected than females (1.5-3:1) (McHenry, Easley and Locker 2002; Gasbarrini *et al.* 2005; Grammatico *et al.* 2008; Mylona *et al.* 2009; Cheung and Luk 2012) and it was suggested that this was due to males having more comorbidities than females (Grammatico *et al.* 2008). Co-morbidities such as cancer, renal failure requiring haemodialysis, diabetes or those who have had previous surgery are at a greater risk of acquiring a spinal infection (Butler, Shelly, Timlin, Powderly and O'Byrne 2006; Grammatico *et al.* 2008; Mylona *et al.* 2009; Cheung and Luk 2012; Quesnele, Dufton and Stern 2012). Other potential risk factors that could predispose a patient

to a spinal infection include immunosuppressive disorders (HIV infection), coronary heart disease, long-term steroid use, liver disease, IV drug users, advanced age and severe trauma (Butler *et al.* 2006; Grammatico *et al.* 2008; Mylona *et al.* 2009; Cheung and Luk 2012; Quesnele, Dufton and Stern 2012).

Spinal infections, such as vertebral osteomyelitis occur most commonly in the L/S. This may be due to the extensive anastomosing of arteries and veins in the L/S region, allowing for easy spread of infections via the haematogenous pathway. Typically, spinal infections are difficult to detect in the early stages as the symptoms are vague, making them difficult to distinguish from other diagnoses. Back pain and fever are often reported early, with 91-100% of the patients suffering back pain in the early stages (Quiñones-Hinojosa, Jun, Jacobs, Rosenberg and Weinstein 2004; Mylona *et al.* 2009; Quesnele, Dufton and Stern 2012). The back pain progressively gets worse forcing patients to become bedridden. The symptoms may be aggravated with activity and relieved with bed rest. These signs may mimic MLBP presentation, which often leads to a delay in the diagnosis of spinal infection (Quiñones-Hinojosa *et al.* 2004; Mylona *et al.* 2009; Quesnele, Dufton and Stern 2012). The prevalence of fever as a symptom with regards to spinal infections varies from 16.2% to 79.6% (Nolla, Ariza, Gómez-Vaquero, Fiter, Bermejo, Valverde, Escofet and Gudiol 2002; Quesnele, Dufton and Stern 2012). The large discrepancy in the prevalence of fever make it difficult to rule out spinal infection (Mylona *et al.* 2009). Similarly neurological impairment in spinal infections varies from 14.3% to 51.7% (Zarrouk, Feydy, Salles, Dufour, Guigui, Redondo and Fantin 2007; Quesnele, Dufton and Stern 2012).

South Africa has one of the highest infection rates for TB and HIV (Lawn, Myer, Bekker and Wood 2007; Karim, Churchyard, Karim and Lawn 2009). Although it has only 0.7% of the world's population, it is responsible for contributing 17% of the global burden of HIV infection. The escalating number of TB cases is largely due to the escalating HIV epidemic and emergence of drug resistant strains which have placed SA in a TB crisis (Karim *et al.* 2009).

Spondylitis due to TB and pyogenic spondylitis are an important aetiologies of infective spondylitis. They often result in severe complications such as spinal deformity and irreversible neurological deficits. In Korea, TB spondylitis is the more common form of infective spondylitis, as the rate of TB infection is high in the country. Recently there has been a decline in the cases of TB spondylitis due to improvements in treatment (Ahn and Lee 2007). Spondylitis due to TB often affects the thoraco-lumbar region of the spine, especially the vertebrae, spinous processes and posterior arches. The symptoms of TB spondylitis are back pain, night sweats and partial tenderness of the spine (Ahn and Lee 2007; Cheung and Luk 2012). The

predisposing factors include malnutrition, diabetes mellitus, HIV infection, long-term steroid use, illicit substance abuse, liver cirrhosis and chronic renal failure (Cheung and Luk 2012).

The treatment of spinal infections varies according to the type of spinal infection. For example, an epidural abscess causing neurological damage requires surgical intervention while an uncomplicated discitis causing no neurological damage can be treated with antibiotics (Mylona *et al.* 2009). The majority of patients with infective spondylitis are treated non-surgically. Patients are treated with antibiotics, which are determined according the strain of the culture of the infection. Patients are required to be followed-up in order to determine if the efficacy of the antibiotic treatment. The patient is also fitted with a cast or brace in order to limit movement of the specific area (Cheung and Luk 2012). Non-operative treatment leads to an approximate 75% clinical success rate; however 14% of the patients experience a relapse, with worsening of the symptoms, spread of infection, neurological deficit and spinal deformity (McHenry, Easley and Locker 2002; Cheung and Luk 2012).

Surgical treatment is indicated in patients with cauda equina and spinal cord compression with neurological deficit, failed conservative treatment and lack of improvement of clinical presentation following antibiotic treatment or progressive spinal deformity with biomechanical instability (Cheung and Luk 2012). Fang et al. (1994), reported on 39 patients who had infective spondylitis and underwent anterior spinal fusion, decompression and debridement surgery; 30 of these patients had improved symptoms after surgery and 93% achieved bone fusion, with the fusion taking between six and seven months to form (Fang, Cheung, Dos Remedios, Lee and Leong 1994). There was only one post-operative wound complication and one case of recurrent infection. This is supported by Cheung and Luk (2012) who state that traditionally, anterior decompression and debridement, followed by anterior fusion is the choice of surgery in treating infective spondylitis. Anterior spinal fusion allows for rapid bony healing with less vertebral collapse, quicker patient rehabilitation and a diminished reactivation of the infection compared to non-surgical treatment.

The mortality rate of spinal infections ranges from 6-20% (McHenry, Easley and Locker 2002; Quiñones-Hinojosa *et al.* 2004; Sendi, Bregenzer and Zimmerli 2008; Mylona *et al.* 2009). The early identification of causative agent, diagnosis and early initiation of specific treatments greatly reduce the mortality rate of patients (Quiñones-Hinojosa *et al.* 2004; Sendi, Bregenzer and Zimmerli 2008; Mylona *et al.* 2009). McHenry *et al*. (2002) followed 255 patients who were diagnosed with vertebral osteomyelitis. Of these 57% recovered fully, 31% had qualified recovery defined as improvement with persistent pain, motor weakness or paralysis, and/or bowel/bladder dysfunction. The remaining 11% of the patients died (McHenry, Easley and Locker 2002).

2.3.5.4 Malignancy

The spine is the most common site for early presentation of metastases and is responsible for 80% of bone metastatic lesions (Nielsen, Munro and Tannock 1991; Lote, Walløe and Bjersand 2009; Mabry, Ross and Tonarelli 2014). Cancer of the prostrate, breast and lung are most commonly associated with bony metastases, and 50% of patients with these types of malignancies may develop metastases (Nielsen, Munro and Tannock 1991; Mabry, Ross and Tonarelli 2014). Approximately 60% of these bony metastases are located in the axial skeleton (Qureshi, Shams, Akhter and Riaz 2012). The upper lumbar spine is commonly affected by gastric cancer metastases (Mabry, Ross and Tonarelli 2014); breast cancer metastasis commonly affects the L2 vertebra (Fornasier and Horne 1975) and lung cancer commonly metastasises to the T12 vertebrae (Mabry, Ross and Tonarelli 2014). Vertebral metastases may cause spinal cord compression, compression fractures, cauda equina syndrome and nerve root compression (Lee, Saylor and Smith 2011).

Intracranial and spinal cord tumours are the second most frequent cancers found in children (Stiller and Nectoux 1994). Stiller *et al.,* (1994) observed the international incidence of childhood cancer and found that the highest incidence of spinal cord tumours to be in Nordic countries, with White children being affected more than Black children. They also found that the incidence was lower in developing areas such as South Africa, South America and Asia. In a descriptive epidemiological study, Schellinger *et al*., (2008), observed the incidence of primary tumours being diagnosed affecting the lumbar spine between the years of 1998- 2002 in the US. They found that 69% of tumours were non-malignant, with the most common being meningioma's (29%), nerve sheath tumours (24%) and ependymomas (23%).

Although LBP due to a serious underlying pathology is rare, it still needs to be ruled out by the use of red flags (Mabry, Ross and Tonarelli 2014). Serious underlying pathologies may present as dull, constant pain that is not affected by body movements and may be worse at night. Metastatic lesions may, however, also mimic musculoskeletal pain, as symptoms are reproducible in certain movements through active or passive motion (Mabry, Ross and Tonarelli 2014). Lack of improvement with conservative treatment over a one-month period has been shown to be an indicator of a serious underlying pathology (Joines, McNutt, Carey, Deyo and Rouhani 2001).

Deyo *et al*. (1988) stated that cancer can be ruled out if the patient presents with LBP with no unexplained weight loss, is under 50 years old, does not have a history of cancer and is responding to conservative treatment. If the above criteria are not met, and the patient has signs of red flags, then laboratory testing and diagnostic imaging is the next step to confirm the cause of LBP (Mabry, Ross and Tonarelli 2014). Delays in diagnosis of cancers can be

significant as with most serious underlying pathologies (Mabry, Ross and Tonarelli 2014). Studies have shown that in lung cancer the symptoms-to-diagnosis delay can be approximately one to three months (Allgar and Neal 2005; Bjerager, Palshof, Dahl, Vedsted and Olesen 2006; Radzikowska, Roszkowski-Śliż and Głaz 2012). This delay not only contributes to the delay in the patient seeking care, but also to the misdiagnosis and misinterpretation of test results by the practitioner (Mitchell, Macdonald, Campbell, Weller and Macleod 2008; Radzikowska, Roszkowski-Śliż and Głaz 2012). Radiographs have poor sensitivity to detect metastatic bone lesions, and radiographic findings may only be seen if the bony lytic lesion has caused 30-50% destruction (Mabry, Ross and Tonarelli 2014).

The treatment for metastatic bone tumours aims to prevent the metastases from occurring. This is achieved by taking medication. For the prevention of bone metastases from prostate cancer, zoledronic acid and denosumab are taken in order to prevent the metastases of the cancer. Denosumab also prevents fractures from occurring and helps strengthen the bone as it raises the androgen levels. (Lee, Saylor and Smith 2011).

2.3.5.5 Inflammatory

Inflammatory causes of LBP are mostly caused by a group of disorders called spondyloarthritides (SpA). These comprise of reactive arthritis, ankylosing spondylitis (AS), Reiter's syndrome, enteropathic arthropathy, arthritis/spondylitis with psoriasis, arthritis/spondylitis with inflammatory bowel disease and undifferentiated spondyloarthritis (Rudwaleit, van der Heijde, Khan, Braun and Sieper 2004; Saraux, Guillemin, Guggenbuhl, Roux, Fardellone, Le Bihan, Cantagrel, Chary-Valckenaere, Euller-Ziegler, Flipo, Juvin, Behier, Fautrel, Masson and Coste 2005; Colledge, Walker and Ralston 2010). They share similar clinical features and are all associated with the HLA-B27 antigen (Rudwaleit *et al.* 2004; Colledge, Walker and Ralston 2010). The SpA group of inflammatory disorders affect the body when the immune system attacks specific tissues in the body (Sheeler, Arora and Chir 2013). They often cause inflammation of the sacroiliac joints (Sheeler, Arora and Chir 2013). They cause numerous signs and symptoms including painful joints, back pain, prolonged morning stiffness, back pain that's aggravated by activity, psoriatic skin lesions, mouth and skin ulcers s, features of inflammatory bowel disease and eye inflammation (uveitis) (Sheeler, Arora and Chir 2013).

The SpA's are one of the most common rheumatic diseases with a prevalence of 0.5-1.9%, with AS being the most common sub-group of the SpA (Rudwaleit *et al.* 2004). This finding, however, is not applicable to Africa (Saraux *et al.* 2005). Mijiyawa *et al*. (2000) found that HLA-B27 is virtually absent in most sub-Saharan populations and that AS is rare with cases being reported mainly in central and southern Africa. However, with the onset of the HIV epidemic

there has been a significant increase in SpA's, especially reactive arthritis, psoriatic arthritis and undifferentiated arthritis being the most common rheumatic disorders observed in some sub-Saharan African countries (Mijiyawa, Oniankitan and Khan 2000).

AS is a chronic inflammatory rheumatic disease that has a strong relationship with the HLA-B27 leucocyte antigen which predominantly affects the axial skeleton and sacroiliac joints (Belachew, Sandu, Schaller and Guta 2009). Due to the low HLA-B27 antigen found in the sub-Saharan populations the clinical presentation of AS is rare when compared to European and North American countries (Diaz-Pena, Ouedraogo, Lopez-Vazquez, Sawadogo and Lopez-Larrea 2012). It has, therefore, been suggested that the AS affecting the sub-Saharan populations forms a sub- group of the disease (Belachew *et al.* 2009). This disease has a similar clinical presentation when compared to North America and Europe. Most patients affected by AS are older, have no family history of the disease and many lack the extra articular manifestations (Belachew *et al.* 2009; Diaz-Pena *et al.* 2012).

The goal of treating SpA disorders is to relieve pain and inflammation and to delay complications and spinal deformity (Sheeler, Arora and Chir 2013). Apart from medications NSAIDs, corticosteroids, and disease-modifying anti-rheumatic drugs (DMARDs)), it is important to maintain range-of-motion and stretch the joints. Physical therapy and exercise is key to delaying the complications and allow the patient to continue with normal daily activities (Sheeler, Arora and Chir 2013). Patients that have large joint deformities may require surgery (such as joint replacement) to correct the deformity (Colledge, Walker and Ralston 2010).

2.3.5.6 Other specific causes

2.3.5.6.1 Scoliosis

Scoliosis is a term that comes from the Greek work "skolios" which means curved or crooked (Konieczny, Senyurt and Krauspe 2013). Scoliosis is defined as an abnormal structural curvature of the spine (Gorman, Julien and Moreau 2012). It is the most common spinal disorder in adolescents and children, and is characterized by a lateral curvature of the spine greater than 10° (Konieczny, Senyurt and Krauspe 2013).

There are two main groups of scoliosis viz. idiopathic scoliosis or non-idiopathic scoliosis. Non-idiopathic scoliosis is further divided into:

- Congenital scoliosis: this results from malformation of vertebrae (e.g. a block vertebra or hemi vertebra). This type of scoliosis may not be evident at birth but may develop as the child reaches adolescence.

- Neuromuscular scoliosis: this is the result of insufficient active stabilisers of the spine due to spinal muscular atrophy, muscular dystrophies, cerebral palsy, spina bifida and spinal cord injuries.
- Mesenchymal scoliosis: this results from insufficient passive stabilisers of the spine. This may be due to osteogenesis imperfecta, mucopolysaccharidosis, Marfan's syndrome, inflammatory diseases or after thoracic spine surgery (Konieczny, Senyurt and Krauspe 2013).

Idiopathic scoliosis is further divided into:

- Infantile scoliosis: this develops between the ages of zero to three years of age and has a prevalence of 1%. Infantile scoliosis has declined most probably being due to the recommendation of the prone position posture for infants.
- Juvenile scoliosis: this is responsible for 10-15% of all idiopathic scoliosis cases and develops between the ages of four and ten years of age. If these cases are left untreated they can result in curves exceeding 30° which will require surgical procedures to correct.
- Adolescent scoliosis: this accounts for about 90% of idiopathic cases in children and occurs between the ages of 11-18 years of age.
- Adult scoliosis: this is caused by degenerative changes to the aging spine and has a prevalence of 8% in adults over the age of 25 years of age and rises to 68% in adults over the age of 60 years of age. (Konieczny, Senyurt and Krauspe 2013).

Studies conducted in Germany, Korea, Singapore, Brazil, Turkey and Greece show that adolescent idiopathic scoliosis (AIS) has a prevalence ranging from 0.47%-5.2% (Cilli, Tezeren, Tas, Bulut, Ozturk, Oztemur and Unsaldi 2009; Nery, Halpern, Nery, Nehme and Stein 2010; Suh, Modi, Yang and Hong 2011; Konieczny, Senyurt and Krauspe 2013). Genetic factors do influence the progression and incidence of AIS as studies have shown that 97% of people with AIS are related to other family members with AIS (Ogilvie, Braun, Argyle, Nelson, Meade and Ward 2006; Ward, Ogilvie, Singleton, Chettier, Engler and Nelson 2010; Konieczny, Senyurt and Krauspe 2013). Some races may be more susceptible to scoliosis than others. Kamtsiuris et al (2007) reported that German children had a higher prevalence (5.5%) than immigrant children (3.5%) (Kamtsiuris, Atzpodien, Ellert, Schlack and Schlaud 2007).

Kebaish *et al*. (2011) examined 3185 x-rays of individual patients in the US between the ages of 40- 97 years of age. They found that patients between the ages of 40-50 years of age had a prevalence of 3.14% and patients who were 90 years or older had a prevalence of 50% for scoliosis, thus increasing age is a risk factor for scoliosis. Whites had a higher prevalence

(11.1%) compared to African Americans (6.5%) (Kebaish, Neubauer, Voros, Khoshnevisan and Skolasky 2011). There was no association between the prevalence of scoliosis and the sex of the individuals. In contrast, Zavatsky *et al*. (2015), who reported on findings in the US, observed that Blacks patients had a greater curve magnitude (>40˚) in the spine than Whites and had surgery as their first treatment option more often than the Whites (Zavatsky, Peters, Nahvi, Bharucha, Trobisch, Kean, Richard, Bucello, Valdevit and Lonner 2015).

The treatment of scoliosis may be complicated as the prognosis cannot be determined as it evolves differently in each individual. Various treatment protocols are proposed but these depend on the rib hump height, severity of the curve, age at diagnosis, skeletal maturity and spinal stiffness (Romano and Negrini 2008). In a retrospective study of 3937 patients with scoliosis, Negrini *et al*. (2009), observed that those treated conservatively with using bracing, exercise and mobilisation had reduced curvatures of the spine and an improvement in the scoliosis. In adult scoliosis the natural history of untreated spinal deformity is progression of the curve, unlike adolescent scoliosis in which bracing techniques prevent the progression of the curve. No such treatment has been found to be effective for a skeletal mature patient (Yadla, Maltenfort, Ratliff and Harrop 2010).

The advancements with operating techniques, instrumentation and better understanding of the biomechanics of the spine over the past few decades has led to many surgical treatment options for patients with scoliosis. In order to identify the best approach for surgery the clinicians must be familiar with the risk and benefits of each surgical procedure, and which will be most suitable for each individual patient. Surgery is generally indicated for progressive curves and significant deformity-related pain. The most common form of surgery involves instrumentation in order to correct the spinal curve. Instrumentation surgery for adult scoliosis has shown to improve the clinical outcomes of the patients after a two year follow-up period (Yadla *et al.* 2010).

2.3.6 Clinical management of low back pain

The treatment approach to LBP is complicated as it is a multi-factorial disorder with many possible origins (Manchikanti, 2000). A patient's treatment plan is dependent on whether the condition can be conservatively managed or whether surgery is required (Dagenais, Tricco and Haldeman 2010; Dagenais and Haldeman 2012). Patients who present with LBP and one of the following: red flags indicating suspicion of cancer, infection, cauda equina syndrome, spondyloarthritis, spinal fracture, visceral (gastrointestinal and genitourinary) referred pain, and abdominal aortic aneurism need to be sent to a specialist (Ladeira 2011). The high prevalence of recurrent and chronic LBP and its associated costs means that clinicians should prioritise interventions that prevent LBP becoming recurrent or chronic (Dellito *et al.* 2012).

2.3.6.1 Conservative management of low back pain

Ideally all health care providers involved in managing LBP should be guided by the best and latest available scientific evidence to minimise costly, ineffective and sometimes harmful procedures (Chou *et al.* 2007; Bronfort, Haas, Evans, Kawchuk and Dagenais 2008; Koes *et al.* 2010; Ladeira 2011). Clinical practice guidelines attempt to evaluate, locate and summarise the scientific literature on particular topics and are an important part in implementing evidence-based medicine (Dagenais, Tricco and Haldeman 2010). In the past decade many countries have developed guidelines for the management of LBP. Generally these guidelines are similar in terms of protocols for the management of LBP. The majority of the guidelines stress the importance of history- taking and a thorough practical examination of the patients (Haldeman and Dagenais 2008; Dagenais, Tricco and Haldeman 2010; Koes *et al.* 2010; Ladeira 2011). The guidelines aim to triage the patients into three categories viz. 1) patients who have a serious underlying pathology, 2) patients with LBP and radiculopathy, and 3) patients with non-specific LBP. The initial division helps to identify red flags and patients who may need further examination either through imaging techniques or specialist referral (Ladeira 2011).

Once red flags have been ruled out, conservative management can commence using the guidelines. The treatment approach varies according to the onset of LBP, and whether it is acute or chronic. With regards to non-specific acute LBP, the most common recommendation was patient education on LBP. The guidelines included recommendations for the patients to stay active, and includes spinal manipulation, NSAIDs, muscle relaxants and exercise (Koes, van Tulder and Thomas 2006; Dagenais, Tricco and Haldeman 2010; Ladeira 2011; Rubinstein *et al.* 2012).

The recommendations for the treatment of chronic LBP include education on LBP, staying active, back schools, spinal manipulation, NSAIDs and back exercises (Dagenais, Tricco and Haldeman 2010; Ladeira 2011). Secondary recommendations for chronic LBP management include multidisciplinary rehabilitation, behavioural therapy, adjunctive analgesics, fusion surgery, facet injection therapy, epidural steroid injection and soft tissue injections (Dagenais, Tricco and Haldeman 2010; Ladeira 2011).

The recommendation for LBP with neurological involvement focusses on educating the patient about LBP, staying active, NSAIDs, muscle relaxants, spinal manipulation, back exercises and back schools. Ultrasound, heat, cold packs and lumbar supports were not recommended. Secondary treatment options recommended were behavioural therapy, multidisciplinary rehabilitation, decompression surgery, strong opioid analgesics, facet injections and soft tissue injections (Dagenais, Tricco and Haldeman 2010).

The types of conservative treatment available for LBP is shown in **Appendix C**. The physician is required to identify the best treatment available for the specific patient, as all patients differ and respond individually to different types of treatment.

2.3.6.2 Surgical management of low back pain

The appropriate selection of patients for surgical intervention is a debated topic in literature. The high prevalence of recurrent and chronic LBP and its associated costs, means that clinicians should prioritise interventions that prevent LBP becoming recurrent or chronic (Dellito *et al.* 2012). Studies show that abnormal physical findings correlate with anatomical abnormalities seen in surgery, but the outcome of the patient is very dependent on the psychological health of the patient, which affects the effectiveness of the surgery. Increased mortality and morbidity are associated with older patients who undergo surgery (Borenstein, Wiesel and Boden 1995).

There are numerous different types of lumbar spine surgeries that can be performed. The different types of surgical procedures available and their risk factors, benefits and outcomes of the procedures are shown in **Appendix D**.

Spinal surgery should be recommended only when there is deterioration of the neurological signs, the cause is non-mechanical or diagnostic tests reveal significant structural changes (Dagenais, Caro and Haldeman 2008; Dagenais and Haldeman 2012). Selecting appropriate candidates for surgery can be challenging because of the variability in diagnosis and characterising clinical and radiographic characteristics of LBP conditions. In addition, even in well-selected surgical candidates, the clinical benefit can vary, and many patients may fair just as well long-term with the conservative treatment options (Friedly, Standaert and Chan 2010).

In the US more than 300 000 back surgeries are performed each year, and for about 10%-39% of patients, the pain may continue or worsen after surgery (Zhou and Irwin 2009). This condition is known as failed back surgery syndrome and about 80 000 new cases are reported in the US annually (Zhou and Irwin 2009). This suggests that conservative management plans should be exhausted first before surgery is considered.

In England spinal surgeons working in the public sector reported that they referred their patients for physiotherapy, for post-operative rehabilitation between two to eight treatments (mean 1.3 treatments) (McGregor, Dicken and Jamrozik 2006). Post-surgical rehabilitation traditionally consists of patient education, muscle facilitation, pain control and exercises. These techniques and approaches are taught to the chiropractic students at the Durban University of Technology (Technology 2014).

However, with spinal surgery there are always risk factors involved while the patient is in surgery, or after the patient has had surgery. In a review of hospital records of patients who were 65 years and older at the time of surgery (n = 98), Carrean *et al*., (2003), found that 80% of the patients had post-operative complications. In addition, 21% had at least one major complication, with the most common being infection, and 70% had at least one minor complication, with the most common being urinary tract infection. The complication rate increased with age, increased blood loss, longer operative time and the number of spinal levels operated on. This study supported the retrospective review completed by Faciszewski et al., (1995), where they reviewed the complications of anterior spinal fusion of 1223 cases in all Minnesota Spine Centre patients over 18 years of age (US). They found that the risk of a complication was increased for patients over age 60 years, for women and for patients with multiple pre-existing health conditions. They also found that serious complications such as death, paraplegia and deep wound infections were rare and concluded that anterior spinal fusion surgery is generally a safe procedure and suggested that complications are often approach-specific. This outcome was later supported in a critical review by Bono and Lee (2005) of 4454 patients in 78 reports of spinal fusions It was found that the average fusion was 85% successful and the average clinical success rate was 75%. They also found that a successful spinal fusion takes a relatively long time, an average of 15 months, to heal and predisposes to adverse effects on adjacent spinal levels (Bono and Lee 2005).

When comparing the international context to Africa and South Africa, it is noted that Africa and South Africa has the highest number of individuals with HIV and AIDS (Rehle *et al.* 2010). Jellis (1996) observed the complications of orthopaedic procedures in people with HIV infection in Lusaka and SA. They found that post-operative complications such as risk of sepsis after surgery, musculoskeletal infections (tropical pyomyositis, long bone osteomyelitis, and infection of implants) increased in patients with HIV infection (Jellis 1996). Similar findings were reported by Turgut (2001) in Turkey, where 694 patients with Pott's disease (mostly in the thoracic spine), were treated with decompression surgery together with anti-TB chemotherapy. The follow-up of these patients (414 of the 694 were available) revealed 10 deaths, one occurring during surgery and the other nine occurring from post-surgical complications (Turgut 2001). There is a paucity of literature describing conditions which require lumbar spine surgical intervention in South Africa and its complications.

2.4 Conclusion

Low back pain (LBP) is one of the most common musculoskeletal conditions with the severity of LBP varying between mild LBP to severe disability (Dagenais, Tricco and Haldeman 2010). LBP can be classified as mechanical, non-mechanical, infective, malignancy, inflammatory

and other specific causes, such as scoliosis (Colledge, Walker and Ralston 2010; Decade 2016). LBP was always thought to be a problem only affecting the Western countries (Hoy *et al.* 2010) until studies (Walker 1999; Louw, Morris and Grimmer-Somers 2007) showed that the lifetime prevalence of LBP in African countries ranged from 28% to 74%, whilst that of developed countries ranged from 30% to 80%.

The literature shows that socioeconomic status (e.g. employment and education), socio-demographic factors (e.g. age, gender and race), physical appearance, spinal deformity (e.g. scoliosis and spondylolisthesis) and psychological and psychosocial factors (e.g. stress, depression, anxiety and fear avoidance) all contribute to an increased risk of LBP (Manchikanti 2000; Jarvik and Deyo 2002; Hurwitz and Shekelle 2006), with older (40-80 years of age) female patients being most at risk (Hoy *et al.* 2012).

The improvements with medical care in the western countries have not been achieved in the African countries (Louw, Morris and Grimmer-Somers 2007). The main reason for this is the recent HIV/AIDS epidemic, which has seen a shift in funding directions and health interventions in research (Louw, Morris and Grimmer-Somers 2007; Rehle *et al.* 2010). South Africa is a developing country that suffers from poverty, unemployment and limited resources with regards to health care for individuals. These factors could predispose the population of SA to a greater prevalence of disease and disability (Louw, Morris and Grimmer-Somers 2007; Rehle *et al*., 2010).

The treatment approach to LBP is complicated as it is a multi-factorial disorder with many possible origins (Manchikanti, 2000). Ideally all health care providers involved in managing LBP should be guided by the best and latest available scientific evidence to minimise costly, ineffective and sometimes harmful procedures (Chou *et al.* 2007; Bronfort *et al.* 2008; Koes *et al.* 2010; Ladeira 2011). The appropriate selection of patients for surgical intervention is a debated topic in literature (Dellito *et al.* 2012). Spinal surgery should be recommended only when there is deterioration of the neurological signs, the cause is non-mechanical or diagnostic tests reveal significant structural changes (Dagenais, Caro and Haldeman 2008; Dagenais and Haldeman 2012).

There is a paucity of literature describing conditions which require lumbar spine surgical intervention in South Africa and its complications. Therefore this study aimed to profile the lumbar spine conditions requiring surgical intervention, in order to contribute to the knowledge of LBP and its treatment.

Chapter Three

Materials and Methods

3.1 Introduction

This chapter describes the methodology utilised in this study and state the ethical considerations.

3.2 Study Design

This study utilised a descriptive retrospective clinical audit design. This allowed for data that was obtained from the clinical records of patients receiving spinal surgery at KDZH to be statistically analysed and inferences made. A clinical audit study design is utilised in order to improve the quality of patient care (Johnston, Crombie, Davies, Alder and Millard 2000).

3.3 Location of and necessary permission to conduct the study

The study was conducted at the Orthopaedic Department of KDZH. Permission to conduct this study was obtained from the KwaZulu-Natal Provincial Health Department **(Appendix E)**, the KDZH manager **(Appendix F)** and the Durban University of Technology Institutional Research and Ethics Committee (IREC) (Ethical Clearance Certificate No. IREC 016/16 – **Appendix G**).

3.4 Study population

Clinical records of patients requiring L/S surgery at the KDZH starting on the 30th of November 2016 working retrospectively until the minimum of 112 patient files that met the inclusion criteria were assessed.

3.5 Sampling

3.5.1 Sample size

Prior to approval of the study protocol the researcher visited the KDZH and found that on average ten L/S surgeries were conducted per month. The G-Power Program (Version 3.1.9.2; Franz Faul, Universität Kiel, Germany) was utilised to conduct a power analysis using the Goodness-of-Fit tests to determine the minimum number of patient files needed to show a medium effect size. A power of 80% and an alpha of 0.05 was utilised in the calculation resulting in a minimum of 112 patient files needing to be included in the study **(Appendix H).** The Goodness-of-fit test requires four assumptions to be met. One, that the variables are categorical, two, that they have independence of observation, three, that they are mutually

exclusive and four that there are at least five expected frequencies in each group (Lund and Lund 2018).

3.5.2 Sampling method

A non-probability purposive sampling method was utilised to obtain the sample required commencing on 30th November 2016, then going through the orthopaedic surgical slates to select files that met the study inclusion and exclusion criteria until a total of 112 files were included.

3.5.3 Sample characteristics

The following criteria were required to be met for inclusion in the study:

3.5.3.1 Inclusion Criteria

- Files of patients who must have received lumbar spine surgery at the KDZH prior to the 30th of November 2016.

3.5.3.2 Exclusion Criteria

- Patient files that were incomplete. This meant that if the files had any of the following information missing it was excluded: no diagnosis, surgical management strategy or insufficient information available within the clinical record to complete the data collection tool designed by the researcher.

3.6 Measurement Tool

A data collection tool **(Appendix I)** was designed by the researcher following the review of the patient clinical records of the patients who had received lumbar spine surgery at KDZH. The collecting tool was adapted keeping the current literature in mind with regards to LBP and what information is needed to be collected in order to answer the aims and objectives of this study. The tool was further revised following discussions with the supervisor of this study. Once ethical approval was obtained from IREC and the Department of Health (DOH), the data collecting tool was pilot-tested. A pilot study is defined as a small study for helping to design a further confirmatory study and is useful to test study procedures and to assess the validity of a collecting tool (Arain, Campbell, Cooper and Lancaster 2010).

This entailed that the researcher selected ten clinical records of patients that had undergone L/S surgery at KDZH Orthopaedic Department outside of the data collection period for this study. This allowed for the data collection tool to be evaluated to ensure that it was feasible, contained all the necessary information and was relatively easy to use.

Following pilot testing, the data collection tool **(Appendix I)** was amended to include the following categories that were not previously included: occupation, Frankel Grading and MRI findings. The amended measurement tool **(Appendix J)** was then used to collect data for this study.

3.7 Research procedure

Once approval for the study was obtained, the researcher consulted the surgical slates which were located in the Orthopaedic Department to identify those patients who had undergone lumbar spine surgery. Their KG number (the number allocated to the patient when they are admitted to the hospital and is specific to each patient) was recorded. This was done until a minimum of 112 KG numbers were identified. The researcher then located the patient files in the filing room using their KG numbers. The KG numbers are all located in the filing room, and are in chronological order within the filing cabinets, which allowed the files to be located with relative ease.

The filing room is only accessible by using a key card and only people with permission from the Orthopaedic Department have access to the filing room. The researcher had an assistant assigned to him by KDZH in order to gain access to the filing room. The files were examined within the filing room and were not allowed to be removed from the room under any circumstances in order to keep the records confidential. Once the file was assessed for eligibility the inclusion criteria the researcher extracted the relevant information from the patient file. When a file did not meet the inclusion criteria the file was not included in the study and the KG number was marked as a default on the researchers KG numbers list. For every patient file that did not meet the inclusion criteria, the researcher selected a new KG number from the surgical slates in the orthopaedic wards. This procedure was repeated until the minimum of 112 patient files met the inclusion criteria.

Once the researcher had extracted all the required data from the patient file, the file was replaced in the same chronological order where it was initially located. This allowed the KG numbers to remain in order. The data that was captured onto the data collection tool **(Appendix J)** in the filing room was then later captured on the researcher's computer on an Excel spread sheet. The patients' names were coded which allowed for confidentiality and the researcher's computer has an access code known only to the researcher.

3.8 Data analysis

The Excel spread sheet was imported into Version 23 of IBM Statistical Package for the Social Sciences (SPSS) (IBM Corporation) and analysed by a statistician.

Descriptive statistics were used to describe the data in terms of means, standard deviations, percentages and count. Inferential statistical analysis was utilised to determine relationships between variables and allowed the researcher to draw conclusions about populations from sample data. Chi-square and Fischer's exact test were used to compare categorical data with a statistical significance of *p* value less than 0.05.

3.9 Ethical Consideration

The patient files were selected according to the study inclusion criteria and no files were excluded based on sex, race, age, nationality and religion which is keeping with the ethical principle of justice.

Non-maleficence and autonomy: the welfare of the participants was protected as the clinical records did not leave the filing room in the KDZH and were only accessible by a key card from the Orthopaedic Department. This study procedure caused no harm to the patients as only their clinical records were utilised for this research. The patients' files were only used for data collection and no patients were in contact with the researcher. Due to sensitivity of the information gathered from the patient files confidentiality was maintained at all times. Prior to commencing with the study the researcher gained permission to conduct this study from the KwaZulu-Natal Provincial Health Department **(Appendix E)** and the King Dinizulu Hospital Manager **(Appendix F**) who act as the gatekeepers of the patient's medical information at the KDZH. The researcher signed the KDZH indemnity form and the patient confidentiality form ensuring patient confidentiality **(Appendix K)**. Permission to conduct this was also obtained from the Durban University of Technology Faculty of Health Sciences Institutional Research and Ethics Committee **(Ethical Clearance Certificate No. IREC 016/16 – Appendix G)**, which aligns itself with the Declaration of Helsinki. Patient confidentiality was ensured by using the allocation of codes to the participants, ensuring that no participant names appeared in the dissertation or publication arising from this study. In additional all research data will be stored in the chiropractic programme for five years thereafter it will be shredded.

The ethical principle of beneficence was maintained in this study as researching the types of L/S surgeries conducted at a public hospital in South Africa provides information to medical personnel on how low back pain is managed in the public sector in an orthopaedic department. This is useful to manual therapists, orthopaedic surgeons and the hospital management.

Chapter Four

Results

4.1 Introduction

This chapter presents the results of the data that was analysed. The demographic characteristics of the patients receiving spinal surgery are presented followed by the results for each objective. The results are illustrated in the form of tables, graphs and cross tabulations.

4.2 Sample size

A total of 187 patient files were examined for this study of which 112 met the inclusion criteria. The other 75 files were excluded for the following reasons: they were either misplaced and could not be found (patients may have left with the file and did not return it or the file may have got lost while the patients moved between the different hospital departments) or the file had insufficient data required to meet the inclusion criteria.

4.3 Demographic characteristics

4.3.1 Age

The mean age of the patients was 41.7 (±SD 17.1) years of age, ranging from three to 76.

4.3.2 Sex

The sex distribution showed more females (55.4%, n = 62) having L/S surgery than males (44.6%, n = 50).

4.3.3 Race distribution

The majority of the patients receiving L/S surgery were black Africans (55.4%, n = 62).

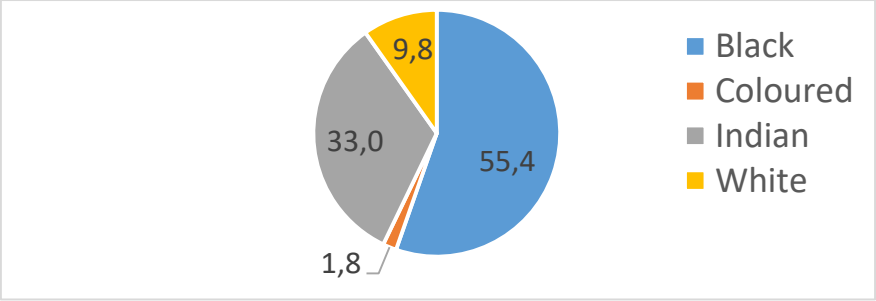

Figure 4.1 Race distribution of the patients having lumbar spine surgery at King Dinizulu hospital (n =112)

4.3.4 Occupation

There was a high unemployment rate (58%, n = 65) amongst the patients with 10.7% (n = 12) of the participants being under the age of 18 years with one child (0.9%) requiring surgery **(Table 4.1)**.

Table 4.1 Occupation of the patients (n=112)

Occupation	n (%)
Unemployed	65 (58)
Scholar	12 (10.7)
Pensioner	9 (8.0)
Driver	3 (2.7)
Technician	2 (1.8)
Clerk	2 (1.8)
Cleaner	2 (1.8)
Customer Care	2 (1.8)
Machinist	2 (1.8)
Admin Assistant	1 (0.9)
Fitter	1 (0.9)
Shop Assistant	1 (0.9)
Material Co-Ordinator	1 (0.9)
Teacher	1 (0.9)
Baker	1 (0.9)
Trade Worker	1 (0.9)
Nurse	1 (0.9)
Student	1 (0.9)
Supervisor	1 (0.9)
Factory Worker	1 (0.9)
General Worker	1 (0.9)
Missing	1 (0.9)
Total	112 (100)

4.3.5 Medical history

The medical conditions that the patients suffered from is tabulated in **Table 4.2**. A total 198 conditions were observed in the patient files (n =112). Some patients presented with more than one medical condition. The percentages for each condition were calculated out of the total number of patient files included in the study (112). More than half of the patients receiving L/S surgery (58.9%, n = 66) reported a history of LBP.

Table 4.2 Medical history of the patients

Condition	n (%)
Low back pain	66 (58.9)
Infection	46 (41.1)
Trauma	33 (29.5)
Epidural	25 (22.3)
Posterior spinal fusion	6 (5.4)
Laminectomy	4 (3.6)
Smoking	4 (3.6)
Disc herniation	3 (2.7)
Cancer	2 (1.8)
Spinal stenosis	1 (0.9)
Scoliosis	1 (0.9)
Radiculopathy	1 (0.9)
Discectomy	1 (0.9)
Decompression	1 (0.9)
Renal failure	1 (0.9)
Hip replacement	1 (0.9)
Epilepsy	1 (0.9)
Koolen de Vries syndrome	1 (0.9)
Total	198 (100)

4.4 Objective 1: To determine the lumbar spine conditions that required surgical intervention, their clinical features and co-morbid pathologies of the patients

4.4.1 Lumbar spine conditions requiring surgical intervention

4.4.1.1 Pre- and post-surgical diagnoses

In certain instances patients may have had more than one diagnosis, thus the sample exceeds 112 in order to allow for multiple diagnoses. In most instances the pre-operative diagnoses did not change post-operatively except in three instances, as seen in **Table 4.3.** One case of IS changed to a burst fracture and sciatica with disc herniation, and two cases of lumbar disc disease changed to lumbar spinal stenosis post-operatively. The most common diagnosis was infective spondylitis (33.9 %, n = 38) with mechanical or degenerative LBP making up 50.1% (n = 57) of the diagnoses.

Table 4.3 Pre- and post-surgical diagnoses of patients

Category	Pre-surgical diagnosis	n (%)	Post-surgical diagnosis	n (%)
Mechanical low back pain	Lumbar spinal stenosis	21 (18.8)	Lumbar spinal stenosis	25 (22.3)
	Sciatica	15 (13.4)	Sciatica	14 (12.5)
	Disc herniation	14 (12.5)	Disc herniation	13 (11.6)
	Lumbar disc disease	5 (4.5)	Lumbar disc disease	3 (2.7)
	Lumbar disc extrusion	1 (0.9)	Lumbar disc extrusion	1 (0.9)
	Radiculopathy	1 (0.9)	Radiculopathy	1 (0.9)
	Total	**57 (50.1)**	**Total**	**57 (50.1)**
Non-mechanical low back pain	Fracture	17 (15.2)	Fracture	17 (15.2)
	Spondylolisthesis	4 (3.6)	Spondylolisthesis	4 (3.6)
	Vertebral dislocation	1 (0.9)	Vertebral dislocation	1 (0.9)
	Retrolisthesis*	1 (0.9)	Retrolisthesis*	1 (0.9)
	Total	**23 (20.5)**	**Total**	**23 (20.5)**
Infection	Infective spondylitis	39 (34.8)	Infective spondylitis	38 (33.9)
	Infection - iatrogenic	2 (1.8)	Infection - iatrogenic	2 (1.8)
	Total	**41 (36.6)**	**Total**	**40 (35.7)**
Malignancy	Cancer (plasmacytoma)	1 (0.9)	Cancer (plasmacytoma)	1 (0.9)
	Total	**1 (0.9)**	**Total**	**1 (0.9)**
Other	Metal ware failure	1 (0.9)	Metal ware failure	1 (0.9)
	Scoliosis	1 (0.9)	Scoliosis	1 (0.9)
	Total	**2 (1.8)**	**Total**	**2 (1.8)**

*Retrolisthesis although considered a spondylolisthesis has been reported separately in this study

4.4.2 Clinical Features

4.4.2.1 Red flags

Of the patients requiring lumbar spine surgery for MLBP only nine (8.0%) presented with red flags, whereas those with other categories of LBP had a high reporting of red flags **(Figure 4.2)**.

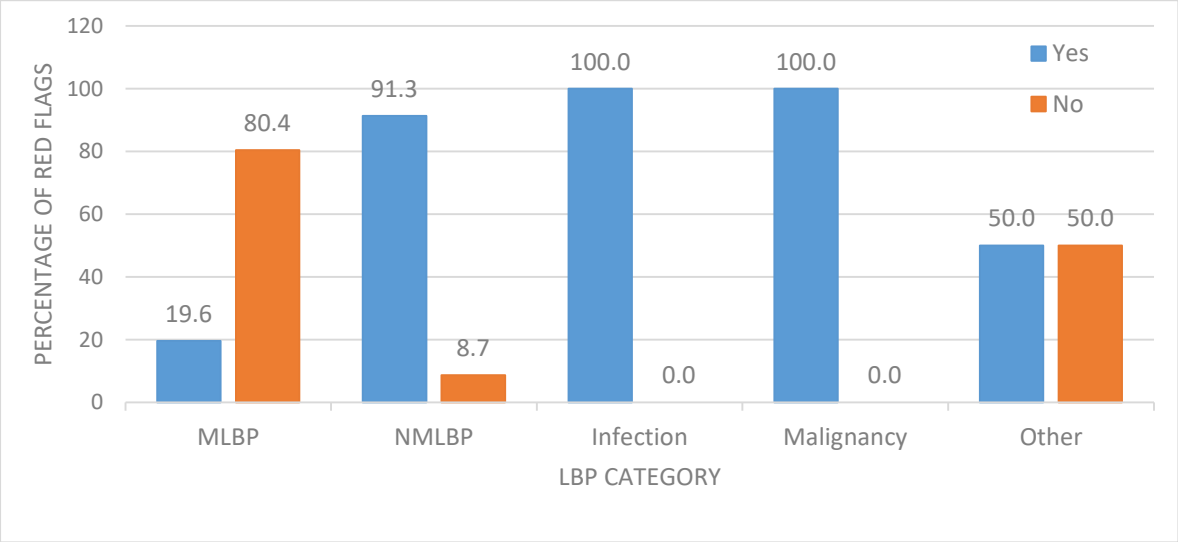

Figure 4.2 Red flags of patients

The number of red flags present in MLBP compared to the sum of the other LBP categories is depicted graphically in **Figure 4.3**. Odds ratio found that being diagnosed with LBP of a non-mechanical, infective or malignant origin, a patient was 8.95 times (CI 3.51- 22.80, *p* <0.001, Fishers Exact test) more likely to have red flags than those with MLBP.

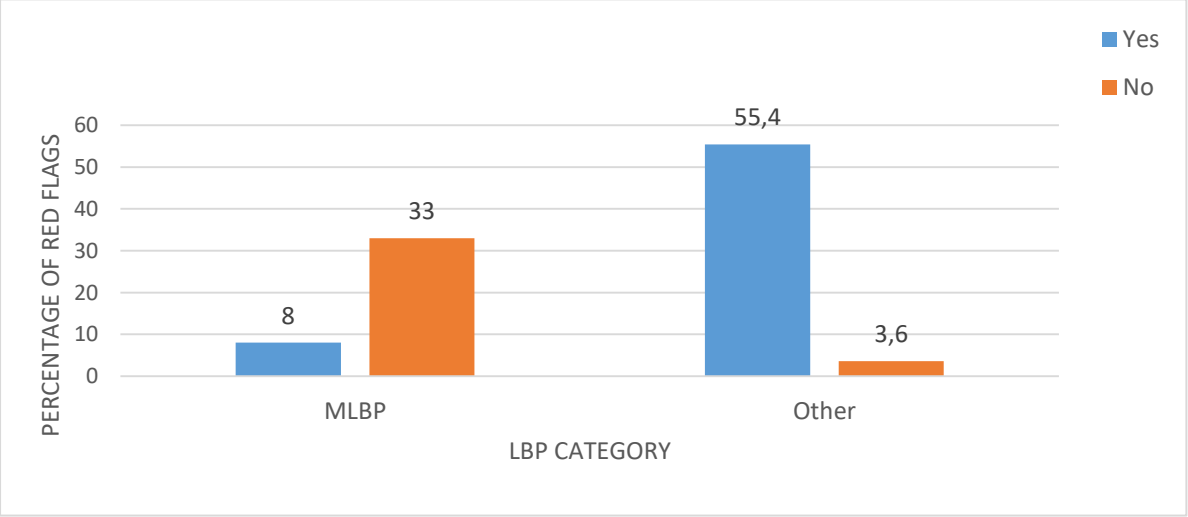

Figure 4.3 The presence of red flags in those with mechanical low back pain compared to the sum of the other categories

4.4.2.2 Frankel Grading

The trends show that patients with MLBP had few serious neurological signs in contrast to those with NMLBP and infection where the patients presented with a no motor or sensory dysfunction to severe motor or sensory function **(Table 4.4)**.

Table 4.4 Frankel Grading of patients

Frankel Grading	Total n (%)	MLBP n (%)	NMLBP n (%)	Infection n (%)	Malignancy n (%)	Other n (%)
A	4 (3.6)	-	2 (1.8)	2 (1.8)	-	-
B	3 (2.6)	-	2 (1.8)	1 (0.9)	-	-
C	13 (11.6)	-	6 (5.4)	6 (5.4)	-	1 (0.9)
D	12 (10.7)	2 (1.8)	2 (1.8)	8 (7.1)	-	-
E	37 (32.7)	15 (13.4)	7 (6.3)	14 (12.5)	1 (0.9)	-
Missing	43 (38.3)	29 (25.9)	4 (3.6)	7 (6.3)	-	3 (2.7)
Total	112 (100)	46 (41.1)	23 (20.5)	38 (33.9)	1 (0.9)	4 (3.6)

(Invalid Chi square test)

4.4.2.3 Dermatomes

The majority of the patients had normal dermatomes during neurological testing (90.2%, n = 101) as seen in **Table 4.5**. The most common nerve root resulting in dermatome abnormality was L5/S1 (3.6%, n = 4). Trends suggest that those patients with MLBP were more likely to have altered dermatomal presentation.

Table 4.5 Dermatomes of the patients

Dermatome	n (%)	MLBP n (%)	NMLBP n (%)	Infection n (%)	Malignancy n (%)	Other n (%)
L2	1 (0.9)	1 (0.9)	-	-	-	-
L3-L5	1 (0.9)	1 (0.9)	-	-	-	-
L4/L5	2 (1.8)	1 (0.9)	-	1 (0.9)	-	-
L5/S1	4 (3.6)	4 (3.6)	-	-	-	-
Whole lower limb	3 (2.7)	2 (1.8)	1 (0.9)	-	-	-
Normal	101 (90.2)	37 (33.0)	22 (19.6)	37 (33.0)	1 (0.9)	4 (3.6)
Total	112 (100)	46 (41.1)	23 (20.5)	38 (33.9)	1 (0.9)	4 (3.6)

(Invalid Chi square test)

4.4.2.4 Myotomes

The majority of the patients (87.5%, n = 98) had normal myotome results. Trends showed that an abnormal myotome distribution was not specific to the classification of LBP as seen in **Table 4.6.**

Table 4.6 Myotomes of the patients

Myotomes	Total n (%)	MLBP n (%)	NMLBP n (%)	Infection n (%)	Malignancy n (%)	Other n (%)
L1-L3	1 (0.9)	-	-	1 (0.9)	-	-
L1-L5	1 (0.9)	-	-	1 (0.9)	-	-
L4-S1	1 (0.9)	1 (0.9)	-	-	-	-
L5	1 (0.9)	1 (0.9)	-	-	-	-
S1	1 (0.9)	1 (0.9)	-	-	-	-
Whole lower limb	9 (8.1)	2 (1.8)	4 (3.6)	3 (2.7)	-	-
Normal	98 (87.5)	41 (36.6)	19 (17.0)	33 (29.5)	1 (0.9)	4 (3.6)
Total	112 (100)	46 (41.1)	23 (20.5)	38 (33.9)	1 (0.9)	4 (3.6)

(Invalid Chi square test)

4.4.2.5 Imaging findings

4.4.2.5.1 Radiographic findings

More than half (53.6%, n = 60) of the patients had no significant radiographic findings. This was followed by 10.7% (n = 12) having a gibbus deformity either alone (6.3%, n = 7) or associated with infection (1.8%, n = 2), decreased vertebral body height (0.9%, n = 1) or disc narrowing (0.9%, n = 1). Trends show that those with infection as a LBP classification were likely to have a gibbus presentation on radiographic analysis as seen in **Table 4.7**.

Table 4.7 Radiographic findings of patients and their origin of low back pain (n = 112)

Radiographic findings:		Total n (%)	MLBP n (%)	NMLBP n (%)	Infection n (%)	Malignancy n (%)	Other n (%)
Fracture		11 (9.9)	-	11 (9.9)	-	-	-
Infection	Infection alone	9 (8.1)	-	-	9 (8.1)	-	-
	+ disc narrowing	1 (0.9)	-	-	1 (0.9)	-	-
	+ DVBH	1 (0.9)	-	-	1 (0.9)	-	-
Disc narrowing		6 (5.4)	4 (3.6)	1 (0.9)	1 (0.9)	-	-
DDD		1 (0.9)	1 (0.9)	-	-	-	-
Vertebral dislocation		1 (0.9)	-	1 (0.9)	-	-	-
Scoliosis		1 (0.9)	-	-	-	-	1 (0.9)
Corpectomy		1 (0.9)	-	-	-	1 (0.9)	-
Gibbus	Gibbus alone	7 (6.3)	-	-	7 (6.3)	-	-
	+ platyspondyly	1 (0.9)	-	-	1 (0.9)	-	-
	+ infection	2 (1.8)	-	-	2 (1.8)	-	-
	+ DVBH	1 (0.9)	-	-	1 (0.9)	-	-
	+ disc narrowing + DVBH	1 (0.9)	-	-	1 (0.9)	-	-
Lytic lesion		1 (0.9)	-	-	1 (0.9)	-	-
Spondylolisthesis		2 (1.8)	-	2 (1.8)	-	-	-
Spondylosis		4 (3.6)	3 (2.7)	-	-	-	1 (0.9)
DDD + disc narrowing		1 (0.9)	1 (0.9)	-	-	-	-
None		60 (53.6)	37 (33.0)	8 (7.2)	13 (11.6)	-	2 (1.8)
Total		112 (100)	46 (41.1)	23 (20.5)	38 (33.9)	1 (0.9)	4 (3.6)

DDD = degenerative disc disease; DVBH= decreased vertebral body height Chi square test was invalid)

4.4.2.5.2 Magnetic resonance imaging findings

Less than half of the patients (42.8%, n = 48) had no significant MRI findings. The most common finding was disc herniation (16.1%, n = 18) either alone (14.3%, n = 16) or in conjunction with DJD (0.9%, n = 1) or disc narrowing (0.9%, n = 1). Trends suggest that the classification of LBP is aligned with the MRI findings as those patients diagnosed with an infective cause of LBP had the presence of infection seen on MRI, similarly those with MLBP had mechanical changes to their spine such as spinal stenosis or DJD as seen in **Table 4.8**.

Table 4.8 Magnetic resonance imaging findings and origin of low back pain (n=112)

MRI Findings:		Total n (%)	MLBP n (%)	NMLBP n (%)	Infection n (%)	Malignancy n (%)	Other n (%)
Fracture	Fracture alone	4 (3.6)	-	4 (3.6)	-	-	-
	+ SPL	1 (0.9)	-	1 (0.9)	-	-	-
	+ CS	1 (0.9)	-	1 (0.9)	-	-	-
Infection		9 (8.0)	-	-	9 (8.0)	-	-
	+ PA	2 (1.8)	-	-	2 (1.8)	-	-
	+ PA + VC	1 (0.9)	-	-	1 (0.9)	-	-
	+ spondylodiscitis + DDS	1 (0.9)	-	-	1 (0.9)	-	-
	+ Spondylitis	1 (0.9)	-	-	-	-	1 (0.9)
DH	DH alone	16 (14.3)	16 (14.3)	-	-	-	-
	+ DJD + DDS	1 (0.9)	1 (0.9)	-	-	-	-
	+ DDS	1 (0.9)	1 (0.9)	-	-	-	-
DJD	DJD alone	3 (2.7)	3 (2.7)	-	-	-	-
	+ CS	1 (0.9)	1 (0.9)	-	-	-	-
	+ CS + spondylosis	1 (0.9)	1 (0.9)	-	-	-	-
	+ CS + spondylosis + DDS	1 (0.9)	1 (0.9)	-	-	-	-
	+ DB	1 (0.9)	1 (0.9)	-	-	-	-
CS		5 (4.5)	3 (2.7)	1 (0.9)	-	-	1 (0.9)
	+ retrolisthesis	1 (0.9)	-	1 (0.9)	-	-	-
	+ DB + SPL	1 (0.9)	-	1 (0.9)	-	-	-
	+ disc extrusion	1 (0.9)	1 (0.9)	-	-	-	-
	+ DB	1 (0.9)	-	1 (0.9)	-	-	-
DB		5 (4.5)	5 (4.5)	-	-	-	-
SPL		1 (0.9)	-	1 (0.9)	-	-	-
PA		1 (0.9)	-	-	1 (0.9)	-	-
VC + PA		1 (0.9)	1 (0.9)	-	-	-	-
VC + DDS		1 (0.9)	-	-	1 (0.9)	-	-
Retro-listhesis + PA		1 (0.9)	-	-	1 (0.9)	-	-
None		48 (42.8)	11 (9.8)	12 (10.7)	22 (19.6)	1 (0.9)	2 (1.8)
Total		112 (100)	46 (41.1)	23 (20.5)	38 (33.9)	1 (0.9)	4 (3.6)

DJD = degenerative joint disease; DDD = degenerative disc disease; VC = vertebral collapse; PA = psoas abscess; CS = canal stenosis; SPL= spondylolisthesis; DDS = decreased disc space; DB= disc bulge; DH= disc herniation Invalid Chi square test)

4.4.3 Co-morbid conditions

The majority of patients suffered with a concomitant infective disease (39.3%, n = 44), with a combination of TB and HIV/AIDS (19.6%, n = 22) or TB alone (14.3%, n = 16) being the most common infective diseases.

Table 4.9 Co-morbid conditions suffered by the low back pain patients

System	n (%)	Condition	n (%)
Cardiovascular	11 (9.8)	Hypertension	9 (8.0)
		Hypotension	1 (0.9)
		Ischaemic heart disease	1 (0.9)
Systemic infection	44 (39.3)	TB + HIV/AIDS	22 (19.6)
		TB	16 (14.3)
		HIV/AIDS	6 (5.4)
Endocrine	6 (5.4)	Diabetes	2 (1.8)
		Hypothyroid	3 (2.7)
		Dyslipidaemia	1 (0.9)
Respiratory	2 (1.8)	Asthma	2 (1.8)
Autoimmune	1 (0.9)	Rheumatoid arthritis	1 (0.9)
Neurological	1 (0.9)	Epilepsy	1 (0.9)
Malignancy	1 (0.9)	Cancer	1 (0.9)
Endocrine + CVS	4 (3.6)	Hypertension + diabetes	4 (3.6)
Other	2 (1.8)	Cyst	1 (0.9)
		Infertility	1 (0.9)
None	40 (35.7)		
Total	112 (100)		

4.5 Objective 2: To determine the pre-and post- surgical management of the patients and post-surgical complications.

4.5.1 Pre-surgical management of patients with low back pain

The majority of the patients (83.9%, n = 94) received medication, either alone or in combination with other treatment options for their LBP; 28 (25.0%) patients received physiotherapy either alone (1.8%, n = 2) or together with other treatments (23.2%, n = 26). Only 10 patients (9.1%) received no treatment prior to surgery **(Table 4.10)**. The trends suggest that irrespective of the classification of LBP, medication was often taken pre-surgically, whereas those with mechanical LBP were most likely to utilise physiotherapy and the various types of pre-surgical management listed shown in **Table 4.10**.

Table 4.10 Pre-surgical management of low back pain patients

Pre-surgical management		**Total n (%)**	**MLBP n (%)**	**NMLBP n (%)**	**Infection n (%)**	**Malignancy n (%)**	**Other n (%)**
PT	PT alone	2 (1.8)	-	-	-	-	2 (1.8)
	+ Back brace	2 (1.8)	1 (0.9)	1 (0.9)	-	-	-
	+ Meds + back Brace	11 (9.8)	8 (7.1)	2 (1.8)	1 (0.9)	-	-
	+ Meds + Crutches + back Brace	3 (2.7)	2 (1.8)	1 (0.9)	-	-	-
	+ Meds	8 (7.1)	8 (7.1)	-	-	-	-
	+ Back brace + dietician	1 (0.9)	1 (0.9)	-	-	-	-
	+ Psychologist	1 (0.9)	1 (0.9)	-	-	-	-
Meds	Meds alone	59 (52.6)	19 (17.0)	7 (6.3)	32 (28.6)	-	1 (0.9)
	+ Back brace	10 (8.9)	3 (2.7)	2 (1.8)	3 (2.7)	1 (0.9)	1 (0.9)
	+ Dietician	1 (0.9)	1 (0.9)	-	-	-	-
	+ Crutches + back brace	2 (1.8)	1 (0.9)	1 (0.9)	-	-	-
Back brace		2 (1.8)	-	2 (1.8)	-	-	-
None		10 (8.9)	1 (0.9)	7 (6.3)	2 (1.8)	-	-
Total		112 (100)	46 (41.1)	23 (20.5)	38 (33.9)	1 (0.9)	4 (3.6)

PT = physiotherapy; Meds = medication Invalid Chi square)

4.5.2 Proposed and actual surgical procedure performed

The trends suggest that the proposed surgical procedures were most often the actual procedures performed as seen in **Table 4.11**.

Table 4.11 Proposed pre-surgical and actual surgical procedure performed

Pre-surgical procedure	n (%)	Actual surgical procedure	n (%)
Posterior spinal fusion	50 (44.6)	Posterior spinal fusion	49 (43.8)
Epidural	46 (41.1)	Epidural	45 (40.2)
Decompression	34 (30.4)	Decompression	34 (30.4)
Biopsy	12 (10.7)	Biopsy	12 (10.7)
Abscess drainage	7 (6.3)	Abscess drainage	7 (6.3)
Removal of metalware	2 (1.8)	Removal of metalware	2 (1.8)
Rhizotomy	2 (1.8)	Rhizotomy	2 (1.8)
Discectomy	2 (1.8)	Discectomy	2 (1.8)
Lumbar stabilisation	1 (0.9)	Lumbar stabilisation	1 (0.9)
Corpectomy	1 (0.9)	Corpectomy	1 (0.9)
Wound debridement	1 (0.9)	Wound debridement	1 (0.9)

Patients who were diagnosed with MLBP were more likely to have an epidural whereas those with infection or non-mechanical causes of LBP were most likely to receive posterior spinal fusions as seen in **Table 4.12**, (p <0.001; Fisher's exact test).

Table 4.12 Actual surgical procedure done on patients and the origin of the low back pain

Actual surgical procedure		Total n (%)	MLBP n (%)	NMLBP n (%)	Infection n (%)	Malignancy n (%)	Other n (%)
PSF	PSF alone	18 (16.1)	1 (0.9)	14 (12.5)	2 (1.8)	-	1 (0.9)
	+ DC	22 (19.6)	-	5 (4.5)	17 (15.2)	-	-
	+ DC + biopsy	4 (3.6)	-	-	4 (3.6)	-	-
	+ DC + abscess drainage	2 (1.8)	-	-	2 (1.8)	-	-
	+ biopsy	2 (1.8)	-	-	2 (1.8)	-	-
	+ abscess drainage	1 (0.9)	-	-	1 (0.9)	-	-
Lumbar stabilisation		1 (0.9)	-	1 (0.9)	-	-	-
Discectomy		2 (1.8)	2 (1.8)	-	-	-	-
Rhizotomy		2 (1.8)	1 (0.9)	1 (0.9)	-	-	-
Removal of metal ware		2 (1.8)	-	-	-	-	2 (1.8)
Abscess drainage		1 (0.9)	-	-	1 (0.9)	-	-
Biopsy		4 (3.6)	-	-	3 (2.7)	-	1 (0.9)
Epidural		44 (39.3)	42 (37.5)	2 (1.8)	-	-	-
DC	+ biopsy	2 (1.8)	-	-	1 (0.9)	1 (0.9)	-
	+ corpectomy	1 (0.9)	-	-	1 (0.9)	-	-
	+ abscess drainage	3 (2.7)	-	-	3 (2.7)	-	-
Wound debridement + epidural		1 (0.9)	-	-	1 (0.9)	-	-
Total		112 (100)	46 (41.1)	23 (20.5)	38 (33.9)	1 (0.9)	4 (3.6)

PSF = posterior spinal fusion; DC = decompression

4.5.3 Post-surgical management

Most patients (80.4%, n = 90) received medication either alone (71.4%, n = 80) or in combination with other treatments (8.9%, n =10) as part of their post-surgical management. Only 17% (n = 19) patients were referred for physiotherapy where they received a combination of physiotherapy with other treatments.

Table 4.13 Post-surgical management and their origin of low back pain

Post-surgical management		Total n (%)	MLBP n (%)	NMLBP n (%)	Infection n (%)	Malignancy n (%)	Other n (%)
Meds	Meds alone	80 (71.4)	35 (31.3)	15 (13.4)	27 (24.1)	1 (0.9)	2 (1.8)
	+ Back brace	8 (7.2)	-	2 (1.8)	6 (5.4)	-	-
	+ Dietician	1 (0.9)	-	-	-	-	1 (0.9)
	+ Crutches + back brace	1 (0.9)	-	1 (0.9)	-	-	-
PT	+ Back brace	1 (0.9)	1 (0.9)	-	-	-	-
	+ Meds	9 (8.1)	4 (3.6)	1 (0.9)	3 (2.7)	-	1 (0.9)
	+ Meds + back Brace	6 (5.4)	4 (3.6)	1 (0.9)	1 (0.9)	-	-
	+ Meds + occupational therapist	2 (1.8)	-	1 (0.9)	1 (0.9)	-	-
	+ Meds + crutches	1 (0.9)	-	1 (0.9)	-	-	-
Back brace		2 (1.8)	1 (0.9)	1 (0.9)	-	-	-
None		1 (0.9)	1 (0.9)	-	-	-	-
Total		**112 (100)**	**46 (41.1)**	**23 (20.5)**	**38 (33.9)**	**1 (0.9)**	**4 (3.6)**

PT = physiotherapy; Meds = medication

4.5.4 Post-surgical complications

Few post-surgical complications were reported **(Table 4.14)**. All the complications were as a result of posterior spinal fusion surgeries. The two failed surgeries resulted from screws that had become loose and needed to be tightened, while the four infections resulted from the metal ware causing infections. The patients were treated with medications and suffered no serious complications

Table 4.14 Post-surgical complications

Complication	n (%)
Failure of Surgery	2 (1.8)
Infection	4 (3.6)
Bleeding	-
Blood Clots	-
Stroke	-
Total	6 (5.4)

4.6 Objective three: To determine if there was any association between the age, race, occupation, sex, co-morbid conditions and post-surgical diagnosis

4.6.1 Age

The trends suggest that MLBP patients were mostly between 40- 69 years of age (82.6%, n = 38), whereas those with non-mechanical (91.3%, n = 21) and infectious causes of LBP were mostly younger being between 10- 49 years of age (89.5%, n = 34) **(Table 4.15)**.

Table 4.15 Age of the patients and diagnosis

Age (years)	Total n (%)	MLBP n (%)	NMLBP n (%)	Infection n (%)	Malignancy n (%)	Other n (%)
< 10	1 (0.9)	1 (0.9)	-	-	-	-
10 - 19	12 (10.7)	-	3 (3.7)	8 (7.1)	-	1 (0.9)
20 - 29	18 (16.1)	-	10 (8.9)	8 (7.1)	-	-
30 - 39	17 (15.2)	2 (1.8)	5 (4.5)	10 (8.9)	-	-
40 - 49	27 (24.1)	15 (13.4)	3 (2.7)	8 (7.1)	-	1 (0.9)
50- 59	20 (17.9)	14 (12.5)	2 (1.8)	4 (3.6)	-	-
60 - 69	10 (8.9)	9 (8.1)	-	-	1 (0.9)	-
70 - 79	7 (6.3)	5 (4.5)	-	-	-	2 (1.8)
Total	112 (100)	46 (41.1)	23 (20.5)	38 (33.9)	1 (0.9)	4 (3.6)

(Invalid chi squared test)

4.6.2 Race

Significant differences were observed between race and LBP classification with Blacks presenting with more with infection (32.1%, n = 36) as a cause of LBP. This was in contrast to

mechanical LBP which was more common in the Indians, Coloureds and Whites ($p < 0.001$, Fischer's exact test **Table 4.16**).

Table 4.16 Race of the patients and diagnosis

Race	Total n (%)	MLBP n (%)	NMLBP n (%)	Infection n (%)	Malignancy n (%)	Other n (%)
Black	62 (55.4)	8 (7.1)	17 (15.2)	36 (32.1)	-	1 (0.9)
Coloured	2 (1.8)	2 (1.8)	-	-	-	-
Indian	37 (33.0)	29 (25.9)	3 (2.7)	2 (1.8)	1 (0.9)	2 (1.8)
White	11 (9.8)	7 (6.3)	3 (2.7)	-	-	1 (0.9)
Total	112 (100)	46 (41.1)	23 (20.5)	38 (33.9)	1 (0.9)	4 (3.6)

4.6.3 Sex

Female patients accounted for more than half (55.4%, n = 62) of the number of patients receiving spinal surgery **(Table 4.17)**. Sex did not have a significant effect on the classification of LBP that the patient presented with, except for infection where females (22.3%, n = 25) were affected twice as often as males (11.6%, n = 13) patients ($p = 0.325$; Fischer's exact test).

Table 4.17 Sex of the patients and diagnosis

Sex	Total n (%)	MLBP n (%)	NMLBP n (%)	Infection n (%)	Malignancy n (%)	Other n (%)
Male	50 (44.6)	23 (20.5)	12 (10.7)	13 (11.6)	1 (0.9)	1 (0.9)
Female	62 (55.4)	23 (20.5)	11 (9.8)	25 (22.3)	-	3 (2.7)
Total	112 (100)	46 (41.1)	23 (20.5)	38 (33.9)	1 (0.9)	4 (3.6)

4.6.4 Occupation

Trends suggest that those with mechanical LBP were more likely to have manual jobs (i.e. occupations such as: heavy truck drivers, machine operators (not specified), janitors and cleaners, nursing aides, construction labourers, assemblers, retail sales workers and miscellaneous machine operators when compared to the other classifications of LBP **(Table 4.18)**. A high number of scholars presented with infection as a cause of LBP.

Table 4.18 Occupation of the patients and diagnosis

Occupation	Total n (%)	MLBP n (%)	NMLBP n (%)	Infection n (%)	Malignancy n (%)	Other n (%)
Unemployed	65 (58)	23 (20.5)	16 (14.3)	25 (22.3)	-	1 (0.9)
Scholar	11 (9.8)	-	2 (1.8)	8 (7.1)	-	1 (0.9)
Pensioner	9 (8.0)	8 (7.1)	-	-	-	1 (0.9)
Driver	3 (2.7)	2 (1.8)	-	-	1 (0.9)	-
Technician	2 (1.8)	1 (0.9)	-	1 (0.9)	-	-
Clerk	2 (1.8)	1 (0.9)	1 (0.9)	-	-	-
Cleaner	2 (1.8)	1 (0.9)	-	1 (0.9)	-	-
Customer care	2 (1.8)	-	1 (0.9)	1 (0.9)	-	-
Machinist	2 (1.8)	-	1 (0.9)	1 (0.9)	-	-
Admin assistant	1 (0.9)	1 (0.9)	-	-	-	-
Fitter	1 (0.9)	-	1 (0.9)	-	-	-
Shop assistant	1 (0.9)	1 (0.9)	-	-	-	-
Material co-ordinator	1 (0.9)	1 (0.9)	-	-	-	-
Teacher	1 (0.9)	1 (0.9)	-	-	-	-
Baker	1 (0.9)	-	-	-	-	1 (0.9)
Trade worker	1 (0.9)	-	-	1 (0.9)	-	-
Nurse	1 (0.9)	1 (0.9)	-	-	-	-
Child	1 (0.9)	1 (0.9)	-	-	-	-
Student	1 (0.9)	-	1 (0.9)	-	-	-
Supervisor	1 (0.9)	1 (0.9)	-	-	-	-
Factory worker	1 (0.9)	1 (0.9)	-	-	-	-
General worker	1 (0.9)	1 (0.9)	-	-	-	-
Total	111 (99.1)	45 (40.2)	23 (20.5)	38 (33.9)	1 (0.9)	4 (3.6)
Missing	1 (0.9)	-	-	-	-	-
Total	112 (100)	45 (40.2)	23 (20.5)	38 (33.9)	1 (0.9)	4 (3.6)

(Invalid Chi squared test)

4.6.5 Co-morbid conditions

There was a significant difference between comorbidity and the presenting LBP condition ($p < 0.001$; Fisher's exact test). The majority of patients with LBP of infective origin (31.1%, n = 35) had an infection as a co-morbid pathology. When examining the data of patients who presented with no co-morbid conditions, the majority of the patients (27.7%, n = 31) had LBP of a mechanical cause, and only one (0.9%, n = 1) patient who had no co-morbid conditions had LBP of an infectious origin.

Table 4.19 Co-morbid conditions and presenting low back pain

Co-morbid condition	Total n (%)	MLBP n (%)	NMLBP n (%)	Infection n (%)	Malignancy n (%)	Other n (%)
CVS	3 (2.7)	2 (1.8)	1 (0.9)	-	-	-
Systemic infection	42 (37.5)	3 (2.7)	3 (2.7)	35 (31.3)	-	1 (0.9)
Endocrine	2 (1.8)	2 (1.8)	-	-	-	-
Neurological	1 (0.9)	1 (0.9)	-	-	-	-
Oncology	1 (0.9)	-	-	-	1 (0.9)	-
Other	2 (1.8)	2 (1.8)	-	-	-	-
Endocrine + Respiratory	1 (0.9)	1 (0.9)	-	-	-	-
Infective + endocrine + CVS	1 (0.9)	-	-	1 (0.9)	-	-
Endocrine + CVS	3 (2.7)	2 (1.8)	1 (0.9)	-	-	-
CVS + infective	1 (0.9)	-	-	1 (0.9)	-	-
CVS + endocrine	2 (1.8)	1 (0.9)	-	-	-	1 (0.9)
CVS + autoimmune + Endocrine	1 (0.9)	1 (0.9)	-	-	-	-
None	52 (46.4)	31 (27.7)	18 (16.1)	1 (0.9)	-	2 (1.8)
Total	112 (100)	46 (41.1)	23 (20.5)	38 (33.9)	1 (0.9)	4 (3.6)

CVS = cardiovascular

4.6.6 Post-surgical complications

There were very few post-surgical complications recorded, with infection being most often reported as seen in **Table 4.20.** There was no statistically significant relationship between post-surgical complication and classification of LBP (p = 0.200; Fischer's Exact test).

Table 4.20 Post-surgical complications and presenting low back pain

Post-surgical complications	Total n (%)	MLBP n (%)	NMLBP n (%)	Infection n (%)	Malignancy n (%)	Other n (%)
Failure of surgery	2 (33.3)	-	1 (16.7)	-	-	1 (16.7)
Infection	4 (66.7)	-	-	3 (50.0)	-	1 (16.7)
Total	6 (100)	-	1 (16.7)		-	

Chapter Five

Discussion

5.1 Introduction

This chapter will discuss the results in the context of the current literature and the aim of the study.

5.2 Discussion of the demographic data of all the patients presenting for lumbar spine surgery at the King Dinizulu hospital Orthopaedic department

5.2.1 Age

Borenstein (2013) reported that LBP increases with age, peaking between the third and fifth decades of life. Due to the paucity in literature with regards to L/S conditions requiring surgery the findings of this study could not be compared to other studies. This study found the mean age of patients requiring surgery for LBP to be 41.7 years of age. Hoy *et al*. (2012) found that the prevalence of LBP was high among adolescence, then declined between the ages of 20-29 years, and then progressively increased to peak between 40-69 years of age. This study found that the youngest participant to have surgery was three years old while the oldest was 76 years of age. Age-related changes to the structure of the L/S have shown to cause LBP (DePalma, Ketchum and Saullo 2011). The most common of these age-related changes is lumbar disc degeneration (Livshits, Popham, Malkin, Sambrook, Macgregor, Spector and Williams 2011). Increasing age has been linked to conditions such as chronic LBP and osteoarthritis (Blagojevic, Jinks, Jeffery and Jordan 2010; DePalma, Ketchum and Saullo 2011). In this study trends suggest that those having spinal surgery for MLBP were 40 to 69 years of age whereas with non-mechanical and infectious causes were younger (10 to 49 years of age). In a systematic review, Louw *et al*. (2007) reported that the average lifetime prevalence of LBP in Africa was 36% among adolescents (11-19 years of age) and 62% among adults (20 years and older). The rate of spinal fusion surgery increases with increasing age of the patients (Rajaee, Bae, Kanim and Delamarter 2012). Spinal cord injury requiring surgical intervention was found to be highest in individuals less than 35.3 years of age (Sekhon and Fehlings 2001). When interrogating the results of the patients who presented with NMLBP and their Frankel Grading, it was found that 12 of the patients had neurological deficits. When this is compared with their age **(Table 4.15)**, it can be seen that 18 of the patients with NMLBP origin were less than 39 years of age. This supports the findings of Sekhon and Fehlings

(2001) who reported that spinal cord injury requiring surgery is highest in individuals who are less than 35 years of age.

5.2.2 Sex

Hoy *et al*. (2012) found that the prevalence of LBP was higher in female patients than in males. Similar results were found in this study where more females (55.4%) had LBP surgery than males (44.6%). Women are also significantly more affected by HIV than men. HIV has been shown to predispose a patient to spinal infections and an increase in LBP complaints (Pettifor *et al.* 2005). The findings of this study **(Table 4.17)** support this previous observation. However, with regards to LBP of mechanical or non-mechanical origin there was no sex difference observed (p = 0.325) which suggests that women and men are equally affected. This may be due to the low sample size used in this study and thus possibly not a true representation of the population.

5.2.3 Race

Deyo *et al*. (2006) conducted a survey to assess the prevalence of LBP in the US (n = 31044). They found that American Indians (35%) and Alaska natives (35%) had the highest prevalence for LBP, while Asian Americans (19%) had the lowest prevalence for LBP. The prevalence for the other races where: Blacks (23.9%), Hispanics (24.3%) and White (27.4%). van Der Meulen (1997), Docrat (1999) and Dyer (2012) found the lifetime prevalence of LBP to be higher in SA with 57.6% for Black, 78% for Indian and 48% for White South Africans respectively. The results in this study found that of the patients requiring L/S surgery at KDZH, 55.4% were Blacks, 33.0% were Indians and 9.8% were Whites. The differences in the races could be explained due to the demographics of the surrounding location. The census for Durban shows demographic data to be different to the total population in SA, with the population consisting of 51.12% Black African, 24.03% Indian, 15.33% White and 8.59% Coloured (Lehohla 2011). Race was associated with the classification of LBP where more Black Africans were diagnosed with an infective cause for their back pain in contrast to the Coloureds, Indians and Whites and who mostly presented in MLBP ($p < 0.001$).

5.2.4 Occupation

Low back pain remains the most common problem among the working population in high-income countries (Buchbinder *et al.* 2013), with its prevalence decreasing with greater levels of education. The prevalence fell consistently with increasing levels of family income (Deyo, Mirza and Martin 2006). The majority of patients having spinal surgery were unemployed (58%). Deyo *et al*. (2006) found that the prevalence of LBP to be highest in uneducated people (31.8%) and low income individuals (31.8%). They also found the prevalence in patients with

a bachelor's degree or more to be 22% (Deyo, Mirza and Martin 2006). SA has one of the highest unemployment rates in the world (Kingdon and Knight 2005; Banerjee, Galiani, Levinsohn, McLaren and Woolard 2006). In SA, the inequality in socio-economic status and access to basic social services between different racial groups has contributed to the inequalities in health care. The poor face more predisposing factors to ill health and often do not have the means to seek health care. The distribution of health service utilisation and the benefits from using services is skewed in favour of the wealthy for most public facilities, especially hospital (Ataguba, Akazili and McIntyre 2011). The Spinal Unit at KDZH is the only tertiary care referral unit in the province providing a service to patients presenting with a spectrum of spinal pathologies.

The relationship between LBP and occupational risk factors is difficult to determine as it is difficult to quantify the exposure. However, trends have been reported between high physical labour and the prevalence of LBP in the US (Manchikanti 2000). Manchikanti (2000) found the top ten worst affected occupations with LBP to be (in order of highest to lowest prevalence): heavy truck drivers, non-construction labourers, machine operators (not specified), occupations not classified, janitors and cleaners, nursing aides, orderlies and attendants, construction labourers, assemblers, retail sales workers and miscellaneous machine operators.

This study had nine pensioners presenting with LBP with eight of these presenting with MLBP. This is supported by Balague *et al*. (2012), who found the prevalence of LBP to be higher in older patients than in the adolescent patients. Trends from this study also showed that those with MLBP were likely to have manual labour type occupations which may predispose them to MLBP.

5.2.5 Medical history

South Africa ranks amongst the worst-affected countries in the world for both TB and HIV infection (Lawn *et al*., 2007; Karim *et al*., 2009). HIV-infected patients often have a loss of lean muscle mass. HIV-associated tissue wasting has been linked to increased morbidity and accelerated disease progression which may predisposes a patient to developing LBP (Dudgeon, Phillips, Carson, Brewer, Durstine and Hand 2006). The HIV infection rate in this study was 41.1%. Of the 35.7% of patients requiring lumbar spine surgery due to infection, 31.3% suffered from a systemic infection in contrast to less than 2.7% of patients who presented with either MLBP, NMLPB or malignancy ($p < 0.001$).

A history of smoking in male patients increased the risk of first-time non-surgical hospitalisation and second-time hospitalisation for surgical treatment of LBP (Rivinoja, Paananen, Taimela, Solovieva, Okuloff, Zitting, Jarvelin, Leino-Arjas and Karppinen 2011).

The prevalence of LBP increases in patients who smoke compared to non-smokers with a higher prevalence in adolescent smokers than adult smokers (Shiri *et al.* 2010). This study reported four participants who smoked - one female and three males. Rivinoja *et al*. (2011), stated that the prevalence of LBP was higher in male smokers.

The age ranged from 44-64 years of age which is in contrast to the findings of Shiri *et al*. (2010), who found the prevalence of LBP to be higher in adolescent smokers than in adult smokers. Due to the small sample size of this study (n = 112), the results may be skewed and not a true representation of the actual population. Interestingly, all four of the smokers had the same diagnosis and the same treatment. They all had lumbar spinal stenosis and all had an epidural as the form of treatment. Smoking has been shown to be a risk factor for lumbar disc disorders such as degeneration of the disc, which may lead to lumbar spinal stenosis (Katz 2006).

5.3 Lumbar spine conditions requiring surgical interventions, clinical features and co-morbid conditions

5.3.1 Lumbar spine conditions

5.3.1.1 Mechanical low back pain

Mechanical low back pain accounted for 41.1% of the LBP complaints of the patients receiving lumbar spine surgery. The most common form being lumbar spinal stenosis (22.3%, n=25). Borenstein *et al*. (2013) stated that the majority (> 95%) of LBP patients have LBP of mechanical origin. The difference in the findings between those of Borenstein *et al*. (2013) and this study, is that this study included only those patients who required surgery for their MLBP. These patients require surgery when there is a deterioration of the neurological signs or diagnostic tests reveal structural changes for which surgery is required (Dagenais, Tricco and Haldeman 2010). Epidural injections are the most commonly utilised form of treatment for chronic MLBP (Conn *et al.* 2009). This study supported the findings of Conn *et al*. (2009) as the majority (37.5%) of patients presenting with MLBP had surgical intervention in the form of an epidural.

Mechanical low back pain is uncommon in adolescents as its peak is in adults between 40-69 years of age (Balagué *et al.* 2012; Hoy *et al.* 2012). This is consistent with the findings of this study as 82.6% of MLBP sufferers were aged 40-69 years of age. Increasing age of patients results in degenerative changes within the spine which increases the risk of spinal injury. Age-related changes affect the intervertebral discs, the facet joints and the nerve roots as they exit the VC which may cause radicular pain radiating down the leg (Borenstein 2013).

This study found the highest prevalence of MLBP in Indians (25.9%), followed by the Blacks (7.1%), Whites (6.3%) and Coloureds (1.8%). The census for Durban shows the demographic profile to be different to the rest of SA, with the population consisting of 51.12% Black African, 24.0% Indian, 15.3% White and 8.6% Coloured (Lehohla 2011). There is a large Indian community in the eThekwini Municipality compared to other provinces (Lehohla 2011), and in this study more Indians had surgical intervention for their MLBP when compared to other race groups, reasons for this require further investigation.

There was a higher prevalence of MLBP in women than in men (Deyo, Mirza and Martin 2006; Hoy *et al.* 2010). In this study there were no sex differences observed for the MLBP sufferers. The small sample size may have skewed the sex differences in this study.

5.3.1.2 Non-mechanical low back pain

Non-mechanical low back pain accounted for 20.5% of the patients requiring surgical intervention. Spinal fractures accounted for majority (15.2%) of these while spondylolisthesis accounted for 4.5% of the surgeries for NMLBP. The surgical treatment option for spinal fractures is controversial, with no evidence-based guideline for the management of traumatic lumbar spinal fractures (Verlaan *et al.* 2004; Siebenga, Leferink, Segers, Elzinga, Bakker, Haarman, Rommens, ten Duis and Patka 2006). However, the specific surgical procedure aims to stabilise the spine, correct deformities, realign the spine and prevent complications or neurological deficits (Siebenga *et al.* 2006). The surgical treatment of choice for spondylolisthesis is PSF and decompression (Weinstein *et al.* 2006). This study supports the literature as the majority of NMLBP patients received PSF (17%) either alone (12.5%) or a combination of PSF and decompression (4.5%).

Traumatic spinal fractures in males receiving surgery was common between the ages of 20-50 years, and females had two peaks of 20-50 years of age and between the ages of 60-80 years of ages; the mean age of 45.7 years of age was reported for both sexes (Siebenga *et al.* 2006; Leucht *et al.* 2009). Vertebral fractures are common in older patients with osteoporosis, which is a condition where bone mineral density decreased making them prone to fracture even with minor trauma. The incidence for vertebral fractures increases for both male and female patients as age increases (Van Der Klift, De Laet, McCloskey, Hofman and Pols 2002). The mean age of spondylolisthesis in females is 71 years of age and in males it is 68 years of age (Jacobsen *et al.* 2007). This study found the mean age for spinal fractures to be 26.3 years of age (range of 12-48 years of age) and the mean age of female patients with spondylolisthesis to be 46.3 years of age, and 58.0 years of age in males. The data in this study may be skewed in respect to the age and NMLBP as the sample size was small, and only four patients presented with spondylolisthesis, of which only one was male.

Vertebral fractures due to osteoporosis are more common in older female patients than in older male. The incidence of vertebral fractures was found to be higher in individuals who are older and are current smokers (Van Der Klift *et al.* 2002). However, in this study there were more males (9.8%, n = 11) affected with spinal fractures than females (5.4%, n = 6). The difference in the findings could be due to about one third of the vertebral fractures that occur due to osteoporosis coming to medical attention, whereas the majority are undiagnosed (Van Der Klift *et al.* 2002).

Jacobsen *et al*. (2007) found that women were more likely to suffer from spondylolisthesis than men with a ratio of 5:1. They also found that Black women were about three times more affected than White women. This study had four patients with spondylolisthesis, three females and one male. Of the female patients who complained of spondylolisthesis, not one was Black. The difference in this study compared to Jacobsen *et al*. (2007) could be explained due to the small sample size.

Interestingly in this study all the patients who presented with vertebral fractures except for one were Blacks. The mean age of the patients with spinal fractures was 26.3 years of age (range 12-48 years of age). The age of the patients is in keeping with the findings of Siebenga *et al*. (2006) and Leucht *et al*. (2009) who stated that traumatic spinal fractures have a peak for both sexes between the ages of 20-50 years of age. The younger mean age of the patients would suggest that the fractures were most likely due to trauma rather than osteoporosis which is increasingly seen in patients over the age of 50 years (Wright, Looker, Saag, Curtis, Delzell, Randall and Dawson-Hughes 2014).

5.3.1.3 Infection

South Africa (SA) is one of the worst plagued countries in the world for both TB and HIV infection (Lawn et al. 2007; Karim et al. 2009), contributing to 17% of the global burden of HIV infection. The escalating number of TB cases is largely due to escalating HIV epidemic and emergence of drug resistant strains of TB (Karim *et al*., 2009). In this study 33.9% (n = 38) of the patients had LBP infective spondylitis. TB is one of the most common causes of spinal infections and has been shown to affect all areas of the spine, especially the lumbar spine (45-50%) (Cheung and Luk 2012) reporting that those most at risk are between the ages of 50-80 years old (McHenry, Easley and Locker 2002; Gasbarrini *et al.* 2005; Mylona *et al.* 2009; Quesnele, Dufton and Stern 2012). The mean age of patients affected by TB of the spine has been found to be 36.5 years of age (Dharmalingam 2004). This is similar to this study where majority of the patients with spinal infections were aged 10-59 years of age with a mean age of 33.4 years of age. Karim *et al*. (2009), who found that the current TB rates in SA peak among women in their twenties and men in their thirties (Karim *et al*., 2009).

The majority of patients with LBP of infective origin (n=38) were Black Africans (94.7%, n = 36) all of whom had either HIV/AIDS, TB or co-infection with both. Pettifor *et al*. (2005), found in a survey in SA to determine the prevalence of HIV infection that 82% of the participants were Black Africans. These participants were from the following areas: urban formal (47%), rural informal (39%), urban informal (8%) and rural formal (6%).

Women are significantly more affected by HIV than men. The prevalence of HIV rose from 4% among 15 and 16-year-old females to 31% among women age 21 years. In males, HIV prevalence was relatively constant at 2-3% between the ages 15- 19 years and then steadily increased to 11-12% by ages 23–24 years (Pettifor *et al*., 2005). The results of this study support these reports with 22.3% (n = 25) of the patients with LBP of infectious origin being female and only 11.6% (n = 13) being male patients.

Govender (2005) stated that HIV infection predispose a patient to have spinal infections. Discitis, vertebral osteomyelitis and epidural abscess represent a range of indolent infections in the immunocompromised patient. This was supported by Cheung *et al*. (2012), who found that HIV infection predisposes a patient to pyogenic spinal infections and Dharmalingam (2004) and Quesnele, Dufton and Stern (2012) who stated HIV infection has caused a surge in TB spinal infections. In addition the literature found that HIV infected patients had significant loss of bone mineral density predisposing them to a range of LBP problems (Cazanave, Dupon, Lavignolle-Aurillac, Barthe, Lawson-Ayayi, Mehsen, Mercie, Morlat, Thiebaut and Dabis 2008).

ARV medications for patients with HIV/AIDS has been linked to numerous side effects. Toxicities are the major side effects from long-term use of ARV treatment. The toxicity has been found to cause myopathy, neuropathy and pancreatitis. The myopathy leads to muscle wasting, fatigue and weakness of the muscles, which can predispose a patient to LBP (Carr and Cooper 2000).

5.3.1.4 Malignancy

The spine is the region for 80% of bone metastatic lesions. Prostrate, breast and lung cancer are most commonly associated with bony metastases (Nielsen, Munro and Tannock 1991; Lote, Walløe and Bjersand 2009; Mabry, Ross and Tonarelli 2014). There is limited population-based data available on primary spinal cord tumours. The overall incidence rate for spinal tumours is 0.74/100000, and women are slightly more affected than men. The incidence rates were lower in children and peaked in patients between the ages of 75-84 years of age (Schellinger, Propp, Villano and McCarthy 2008).

The only bone tumour found in this study was a plasmacytoma but a minority (< 5%) of patients can present with a single bony lesion which most commonly affects the spine (Soutar, Lucraft, Jackson, Reece, Bird, Low and Samson 2004). The patient in this study presented with no other generalised disease, and only with a single bone lesion. Plasmacytomas affect males twice as often as females, and are commonly found in older patients (mean age: 55 years of age). The patient in this study was 61 years of age and was an Indian male.

5.3.1.5 Scoliosis

Scoliosis is the most common spinal disorder in adolescents and children (Konieczny, Senyurt and Krauspe 2013). Adolescent idiopathic scoliosis has a prevalence ranging from 0.47%-5.2% (Cilli *et al.* 2009; Suh *et al.* 2011; Konieczny, Senyurt and Krauspe 2013). Kebaish *et al*. (2011) reported that patients between the ages of 40-50 years of age had a prevalence of 3.14% and patients over the age of 90 years of age had a prevalence of 50% for scoliosis. They also reported that the Whites had a higher prevalence (11.1%) compared to African Americans (6.5%). This study only had one patient presenting with scoliosis. The patient was 15 years of age and was an Indian female patient.

5.3.2 Red flags

Red flags help to identify serious underlying pathology causing the LBP. Red flags include trauma, infection, symptoms of cancer, weight loss and wide neurological changes (Koes *et al.* 2010; Ladeira 2011). In this study 19.6% of the patients with MLBP had positive red flags. This finding is different from those patients who presented with LBP of infective origin where 100% of the patients had red flag findings. This study found that being diagnosed with LBP of a non-mechanical, infective or malignant origin, a patient was 8.95 times (CI 3.51- 22.80, p <0.001, Fishers Exact test) more likely to have red flags than those with MLBP. This finding is expected as infection, symptoms of cancer and trauma are all classified as red flags.

5.3.3 Frankel Grading

Frankel Grading is a component of the neurological examination used to determine whether the patient‘s condition had improved or deteriorated post-surgery (Frankel *et al*., 1962). The results of this study show that patients with LBP of non-mechanical or infectious in origin were likely to have serious neurological deficits. Butler *et al*. (2006) reported that 29% of patients with infective spondylitis presented with signs of neurological. In this study all of the patients with infective LBP had neurological deficits, with 44.7% having a Frankel Grading ranging from A-D; the majority (21.1%) had a grading of D, which is in agreement with the results of Butler *et al*. (2006).

Non-mechanical LBP cases included a vertebral dislocation with a Frankel Grading A and a spondylolisthesis with a Frankel Grading C. Traumatic spinal injuries can present with both neurological complications and no complications (Verlaan *et al.* 2004; Siebenga *et al.* 2006; Wright *et al.* 2014).

Patients with MLBP only two had positive neurological deficits findings, both Frankel D grading. Lumbar spinal stenosis was the diagnosis in both these cases. Spinal stenosis is usually a stable disorder with serious disability and neurological deficit usually developing over time (Haig and Tomkins 2010). The annual incidence of lumbar spinal stenosis is 5/100 000 individuals (Siebert, Pruss, Klingebiel, Failli, Einhaupl and Schwab 2009).

5.3.5 Radiographic findings

Diagnostic imaging studies should be reserved for patients with serious underlying pathologies or progressive neurological deficit. If these indications are not present, the imaging studies usually do not result in improvement of the clinical outcome (Balagué *et al.* 2012). Imaging techniques can show abnormalities like disc degeneration, which may lead to the patient being given an anatomical diagnosis, but this may not be the actual cause of pain. This is supported by Siebert *et al* (2009), which states that imaging of symptomatic patients is confusing due to degenerative changes in the lumbar spine being highly prevalent in the asymptomatic individuals. Therefore, imaging techniques could potentially lead to patients receiving unnecessary surgery as well as exposing them to harmful radiation (Balagué *et al.* 2012).

Plain film radiograph use in the initial evaluation of patients has been questioned. Many patients are sent for initial radiographs as it is easy to conduct and inexpensive. Radiographs are useful in assessing the bony anatomy and vertebral alignment. Radiographs are still the initial imaging technique used for traumatic spinal injuries (Van Goethem, Maes, Ozsarlak, van den Hauwe and Parizel 2005). When the radiographs findings in this study are examined, the following were found: fractures (9.9%, n = 11), gibbus formation (10.7%, n = 12) either alone (6.3%, n = 7) or in combination with other findings (4.5%, n = 5), disc space narrowing (5.4%, n = 6), spondylolisthesis (1.8%, n = 2) and scoliosis (0.9%, n = 1).

5.3.6 Magnetic resonance imaging findings

MRI is the preferred method of imaging when assessing the lumbar spine. MRI has multiplanar imaging capabilities, does not produce ionising radiation and provides superior soft-tissue contrast when compared to other diagnostic imaging techniques (Siebert *et al.* 2009). However, Modic et al (2005) (Modic, Obuchowski, Ross, Brant-Zawadzki, Grooff, Mazanec and Benzel 2005) found contradictory results regarding the clinical usefulness of the MRI. The

authors stated that the MRI changes observed added little or no clinically useful information to the clinical assessment alone in relation to predicting the outcome of surgery and prognosis.

In this study the MRI findings supported the literature in terms of having multiplanar imaging techniques and superior soft-tissue contrast compared to other imaging techniques, viz. x-rays. The multiplanar imaging of MRI showed more spinal canal stenosis findings either alone (4.5%, n = 5) or in combination with other findings (6.3%, n = 7) such as DJD and spondylolisthesis. The superior soft tissue imaging of MRI was also evident in this study as disc herniation's (16.1%, n = 18), infections (8.0%, n = 9) and psoas abscess (5.6%, n = 6) were findings only detected by MRI and not by x-ray imaging.

5.3.7 Co-morbid conditions

The MLBP patients reported few co-morbid conditions, with the majority having none (27.7%). Patients with MLBP were aged between 40-69 years where co-morbid conditions like CVS abnormalities or diabetes are more likely to occur (Ritzwoller, Crounse, Shetterly and Rublee 2006). Thus this finding was unexpected. The most common co-morbidities associated with LBP are hypertension, heart disease, depression, anxiety, asthma and gastrointestinal disease (Ritzwoller *et al.* 2006). These differences between the findings of this study and those of Ritzwoller *et al*. (2006) may be due to the small sample size of this study compared to Ritzwoller (2006) who looked at 16 567 patients presenting with LBP compared to 112 patients in this study.

An overview of co-morbid conditions that the patients presented with is shown in **Table 4.11**. This study found that majority of the patients had a concomitant infective disease (39.3%), TB and HIV/AIDS (19.6%) followed by TB alone (14.3%). Africa and SA has the highest number of individuals infected with HIV and AIDS worldwide (Rehle *et al.* 2010) South Africa accounts for just 0.7% of the world population, but is responsible for contributing 17% of the global burden of HIV infection (Karim *et al.* 2009). Predisposing factors such as TB spondylitis and pyogenic spondylitis are rare diseases, but they are major aetiologies of infective spondylitis, which can cause severe complications such as spinal deformity and irreversible neurological deficit (Ahn and Lee 2007). Those who presented with infection had a gibbus formation on x-ray findings.

This study had only one patient who presented with scoliosis. Interestingly, this patient had Koolen de-Vries syndrome as a co-morbid pathology. Koolen de-Vries syndrome is a genetic disorder with multisystem conditions characterised by intellectual disability, developmental delay, epilepsy, hypotonia, characteristic facial features and congenital malformations in multiple organ systems (Koolen, Pfundt, Linda, Beunders, Veenstra-Knol, Conta, Fortuna, Gillessen-Kaesbach, Dugan, Halbach, Abdul-Rahman, Winesett, Chung, Dalton, Dimova,

Mattina, Prescott, Zhang, Saal, Hehir-Kwa, Willemsen, Ockeloen, Jongmans, Van der Aa, Failla, Barone, Avola, Brooks, Kant, Gerkes, Firth, Ounap, Bird, Masser-Frye, Friedman, Sokunbi, Dixit, Splitt, Study, Kukolich, McGaughran, Coe, Florez, Nadif Kasri, Brunner, Thompson, Gecz, Romano, Eichler and de Vries 2016). Koolen de-Vries syndrome predisposes a patient to scoliosis and is a disorder that affects children and adolescents. In the study by Koolen *et al*. (2016), where they evaluated 45 patients with Koolen de-Vries syndrome, they found that 37.8% of these patients had scoliosis as a co-morbid pathology.

5.4 Pre- and post-surgical management of the patients and post-surgical complications

5.4.1 Pre-surgical management

Pre-surgical management should ideally be guided by the best and latest possible scientific evidence in managing LBP (Dagenais, Tricco and Haldeman 2010). The guidelines aim to triage the patients into three categories viz. 1) patients who likely have a serious underlying pathology, 2) patients with LBP and radiculopathy and 3) patients with non-specific LBP. The initial division helps to identify red flags and patients who may need further examination either through imaging techniques or specialist referral (Ladeira 2011).

These guidelines recommend staying active, back schools, spinal manipulation, back exercises and medication (Dagenais, Tricco and Haldeman 2010; Ladeira 2011). This study found that the pre-surgical management incorporated the majority of these recommendations for treatment guidelines for LBP. However, there were no clinical records suggesting that spinal manipulation was utilised as a pre-surgical treatment for the patients with LBP. Rubinstein *et al*. (2011) and Rubinstein *et al*. (2012) found that spinal manipulation to be as effective as other therapy options such as exercise, physiotherapy and standard medical therapy. Other studies (Bronfort *et al.* 2008; Cohen, Argoff and Carragee 2008) found spinal manipulation to be more effective than physical therapy and home exercises in the management of both acute and chronic LBP. This study found that of patients with LBP of mechanical origin (41.1%), 18.8% received physiotherapy in conjunction with other therapies.

In a systematic review by Dagenais and Haldeman (2008) which assessed the cost of illness studies in the US relative to health insurance claims for patients with LBP, it was found that 49% of the patients were claiming for chiropractic treatment; 20% after consulting a medical doctor and 11% following a visit to a physiotherapist (Dagenais, Caro and Haldeman 2008). Dagenais and Haldeman (2008) also found discrepancies among the literature with regards to consultations with chiropractors. In the US they found that 31% of patients with LBP will consult chiropractors, whereas in the UK only 2% of patients with LBP seek chiropractic care (Dagenais, Caro and Haldeman 2008). Although chiropractic and acupuncture therapies are often the non-pharmacological recommended treatment for LBP, they are often not utilised as

some health insurances do not reimburse their patients for these treatment options (Gore, Sadosky, Stacey, Tai and Leslie 2012). Currently, chiropractic is not part of mainstream health care in SA, despite it being effective for reducing levels of disability and pain in patients with LBP (Wilkey *et al.* 2007).

In a Swedish study done which looked at outpatients presenting to hospitals, it was found that of all pharmaceutical costs for musculoskeletal conditions, 25% of these were for the management of LBP (Ekman, Johnell and Lidgren 2009). In the US, prescription drugs for the treatment of LBP are estimated to cost $3.9 billion per annum (Dagenais, Caro and Haldeman 2008). Gore *et al*. (2012), found that the medication burden was significantly higher in patients with chronic LBP. Pain medications prescribed to patients with chronic LBP had costs that were more than twice those of patients who did not receive pain medication for their LBP (Gore *et al.* 2012). When looking at the pre-surgical treatment for patients presenting with LBP of infective origin, 36 of the 38 patients received medication as their treatment prior to surgery. Cheung and Luk (2012) stated that LBP of infective origin is generally treated non-surgically. Medication is administered according to the strain of infection causing the LBP, and surgery should only be considered in patients with cauda equina and spinal cord compression with neurological deficit, failed conservative treatment and lack of improvement of clinical presentation following a period of antibiotic treatment or progressive spinal deformity with biomechanical instability (Cheung and Luk 2012). This study found that 83.9% of the patients presenting with any form of LBP had medication as a pre-surgical treatment. The medication was administered either alone or in conjunction with other forms of treatment.

Ten patients received no pre-surgical management. Of these, seven had LBP of non-mechanical origin (fractures). This is understandable as surgery is necessary for fractures where the biomechanical structure of the spine has changed and is causing neurological deficits (Verlaan *et al.* 2004).

5.4.2 Surgical procedure

In patients receiving surgery for MLBP, 37.5% had an epidural as the form of treatment. This finding was in agreement with literature, which states that an epidural is the most common form of treatment for LBP (Conn *et al.* 2009). Epidural injections have minimal risks and may have a potential benefit in managing patients with LBP. Epidural injections may be administered prior to surgical consultation for a patient (Haig and Tomkins 2010). Epidural injections are used for radiculopathies, disc herniations, sciatica and spinal stenosis (Conn *et al.* 2009; Friedly, Standaert and Chan 2010; Parr, Manchikanti, Hameed, Conn, Manchikanti, Benyamin, Diwan, Singh and Abdi 2012). The findings in this support this as those patients presenting with MLBP were more likely to receive and epidural (39.3%, n = 44) as their form

of treatment compared to those who presented with non-mechanical (17.0%, n = 19) and infectious causes (25.0%, n = 28) who received PSF either alone or in conjunction with decompression, biopsy and abscess drainage ($p<0.001$; Fischer's exact test).

Spinal surgery should be recommended only when there is deterioration of the neurological signs, the cause is non-mechanical or diagnostic tests reveal structural changes for which surgical intervention is required (Dagenais, Caro and Haldeman 2008; Dagenais, Tricco and Haldeman 2010; Dagenais and Haldeman 2012). Surgery should also be considered when there are red flag signs (Koes *et al.* 2010; Ladeira 2011). However, according to guidelines outlined by Ladeira *et al*. (2011) and Dagenais *et al*. (2010) secondary treatment for chronic LBP should include fusion surgery, when conservative treatment has failed. When examining the medical history of the patients in this study, 22.3% had epidurals in the past as a form of treatment for their LBP. Only four patients with MLBP received surgery other than epidural injections, viz. PSF, discectomy or rhizotomy. King Dinizulu Hospital only utilize surgery for MLBP once conservative treatment has failed (Govender 2016). Balague *et al*. (2012) found that the place for surgery in the management of chronic LBP was very limited and that it had been overused in the past. They reported that the clinical outcome between intense conservative management and surgery was similar for both short- and long-term follow ups of the patients. Surgery had more complications and more expensive than conservative management.

This study found that majority of the patients presenting with non-MLBP had fractures or spondylolisthesis/retrolisthesis. In the US, PSF and decompression surgery is the treatment of choice for patients who have spondylolisthesis/retrolisthesis (Weinstein *et al.* 2006). The optimal surgical method to treat acute thoracolumbar spine injuries is controversial. There are no conclusive clinical studies available to assist the surgeon in determining the ideal method of treating thoracolumbar injuries (Vaccaro, Lim, Hurlbert, Lehman and Harrop 2006). However, PSF and decompression has been reported to be the safest and easiest way to treat these injuries which require urgent treatment due to neurological deficit (Vaccaro *et al.* 2006). Similarly, in this study 17% of the patients presenting with non-MLBP had PSF either alone or in conjunction with decompression surgery.

The most common form of surgical treatment for infective causes of LBP is fusion, decompression and debridement (Cheung and Luk 2012). This study supported the view of Cheung and Luk (2012) in that 76.3% of the patients presenting with LBP of infective origin had fusion surgery either alone or in conjunction with decompression, abscess drainage and debridement. When examining the data of the patients who presented with LBP of infective origin, 32.1% had medication prior to receiving surgery, 15.2% had neurological deficits with

regards to Frankel Grading and 22.3% had positive skeletal changes in the spine when looking at the radiographic imaging results of the patients.

5.4.3 Post-surgical complications

Jellis (1996) found that post-operative complications such as risk of sepsis after surgery, musculoskeletal infections (tropical pyomyositis, long bone osteomyelitis, and infection of implants) increased in patients with HIV/AIDS. This study supported the literature with four patients who had HIV/AIDS having infections as a post-surgical complication.

The complications from epidural injections are rare, and are generally due to two reasons: either from incorrect needle placement or incorrect drug administration. The complications and side effects included infection, intravascular injection, extra epidural placement, hematoma formation, abscess formation, subdural injection, nerve damage, headache, increased intracranial pressure, vascular injury, cerebral vascular or pulmonary embolus, and the effects of steroids (Conn *et al.* 2009; Parr *et al.* 2012). However there were no such complications observed in this study with regards to complications following an epidural injection.

Siebenga *et al*. (2006) looked at the treatment approach for traumatic spinal injuries. They assessed the complications of instrumentation and fusion surgery, and found that complications ranged from infection at the site where the bone graft was taken from for the fusion, to infection at the site of instrumentation, mechanical irritation of the screws without any infection, metal ware failure where the screws broke and superficial wound infection. These findings were supported in this study, with only two patients having metal ware failure where the screws had become loose and needed tightening, and four patients having infection at the site of instrumentation. The classification of LBP showed no association with post-surgical complications (p = 0.200).

Chapter Six

Conclusion, limitations and recommendations

6.1 Conclusion

The aim of this study was to develop a profile of lumbar spine conditions requiring surgical intervention (n=112) in the Orthopaedic Department at the KDZH complex, which is a specialist public hospital in KZN. The patients were mostly female (55.4%, n = 62), middle age (mean of 41.7 years) Black Africans (55.4%, n = 62) who were unemployed (58%, n = 65). The most common surgery was for MLBP (41.1%, n = 46), however this was mostly epidural injections (40.2%, n=45). Indicating that MLBP in this setting is being managed according to international guidelines for MLP, were only the most serve cases are managed with surgery. The second most common surgery was for infective causes (33.9%, n=38) with infective spondylitis (33.9%, n = 38) accounting for the majority of the cases and resulting in surgery, often with gibbus deformity (10.7%, n=12). Many of the patients suffered from TB/HIV (39.3%, n=44), either alone or in combination. Radiographic analysis in the form of plain x-ray and or MRI was routinely utilised. Pre-surgical management as well as post-surgical management was predominantly in the form of medication (83.9%, n = 94: 96.4%, n = 108), potential exists for professions like chiropractic to contribute to patient management at these points. The most common surgical procedure being PSF (43.8%, n = 49) either alone or in combination with other surgical procedures such as decompression, biopsy and abscess drainage.

Race was a significant factor when compared to the classification of LBP, with Indians mostly presenting with MLBP and Blacks with NMLBP and infectious causes of LBP. Patients with an infectious origin of LBP were almost twice as likely to be females, whereas for the other LBP classifications the sex differences were almost equitable. TB, HIV/AIDS infection was high especially in those with an infective origin of LBP. Post-surgical complications were low irrespective of the classification of LBP requiring surgery.

This study provided a profile of the L/S conditions requiring surgical intervention at an Orthopaedic Department at a specialist public hospital in KZN and adds to the body of knowledge of the management of LBP in a public health care setting. This information will be useful to public health care practitioners and managers to assist with planning, as well as to musculoskeletal health care practitioners working in the public and private health care sectors to gain further information on the profile of patients and their conditions requiring surgical intervention in SA. It also highlights potential roles for manual therapy professions, such as

chiropractic, to be further utilised in the pre- and post-surgical patient management, this requires further investigation. .

6.2 Limitations

An *a priori* sample size calculation indicated that 112 patient files should be able to result in generalisability. However due to the amount of data many of the statistical tests were invalid due to the sample size. Future studies should use a larger sample and would benefit from using a probability sampling technique like random sampling, as the current study could have suffer from selection bias..

This study used a retrospective design. This design was limited as the researcher only had access to what was available in the patient's clinical file, thus information like height and weight were not able to be collected. This limited the data that could be included in the study.

The site for data collection of this study was limited to a specialist referral hospital in KZN. Due to KZN having a unique demographic and disease profile the ability to generalise the results of this study to other provinces in SA may be limited.

6.3 Recommendations

The recommendations for future studies include:

- Similar studies should be conducted at other public health care settings, and utilise a larger sample, in SA to determine if the profile differs.
- Due to the high HIV/AIDS statistics a study should be conducted focusing on HIV/AIDS and LBP to further explore this relationship.
- A study into the economic impact of LBP should be conducted.
- Future studies should consider using a prospective design, this would allow for the researcher to obtain data from the patient like what additional treatment/management strategies they may have used prior to presenting for surgery. In addition other clinically relevant information not available in the patients file could be retrieved, like height and weight.
- Physiotherapy treatment was used on several patients both pre- and post-surgically. A study should be conducted with the physiotherapy department in order to assess what treatment they are utilising with the patients.
- A study should be conducted to assess why the Indians had the most MLBP surgery treatment compared to other groups.

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Appendix A: Ligaments of the lumbar spine

Ligaments of the Lumbar spine (Moore and Dalley, 2010; Cramer and Darby, 2017)

Ligament	Attachment	Function
Anterior longitudinal ligament (ALL)	Extends from the C1 vertebra and anterior aspect of the occiput longitudinally to the anterior aspect of the sacrum and pelvic floor, covering the anterior aspect of the IVD and VB.	Prevents hyperextension of the VC, maintaining stability of the VB's.
Posterior longitudinal ligament (PLL)	Attaches mainly to the posterior aspect of the IVD's within the vertebral canal, between the C2 and sacrum.	Resists hyperflexion and prevents posterior disc herniation as well as being rich with nociceptive nerve endings.
Ligament flava	Attach between the lamina of adjacent vertebra.	Limit abrupt flexion of the VC by resisting separation of the lamina and therefore prevent injury to the IVD's.
Interspinous ligaments	Connect adjoining SP's from the apex to the root of each SP	Stabilise with flexion and extension.
Supraspinous ligament	Attach to the tips of each SP from the sacrum to C7, and then merge with the nuchal ligament in the neck.	Stabilise with flexion and extension.
Intertransverse ligaments	Connect adjacent TVP's of adjacent vertebra.	Stabilise with lateral flexion.

VC = vertebral column; SP = spinous process; TVP = transverse process; IVD = intervertebral disc; VB = vertebral body

Appendix B: Muscles of the lumbar spine

Muscles of the lumbar spine (Moore and Dalley, 2010; Cramer and Darby, 2017)

Muscles	Proximal Attachment	Distal Attachment	Nerve Supply	Main Action
Intermediate layer of intrinsic L/S mm: ***Erector spinae:*** Iliocostalis Longissimus Spinalis	Arises from a broad tendon from the posterior surface of the sacrum, posterior part of the iliac crest, sacral and inferior lumbar spinous processes, sacroiliac ligaments and supraspinous ligament	*Iliocostalis*: lumborum, thoaracis, cervicis; fibres run superiorly to angles of lower ribs and cervical TVP. *Longissimus:* thoracis, cervicus, capitus; fibres run superiorly to ribs and TVP in thoracic and cervical region and to mastoid process of temporal bone. *Spinalis:* thoracis, cervicis, capitis; fibres run superiorly to SP in the upper thoracic region and to cranium.	Posterior rami of spinal nerves	Acting bilaterally: Extend VC Acting Unilaterally: Laterally flex VC
Deep layer of intrinsic L/S mm: ***Transversospinalis:*** Semispinalis Multifidus Rotatores- Longus and Brevis	TVP *Semispinalis:* arise from TVP C4-T12 *Multifidus:* arise from PSIS, posterior sacrum, aponeurosis of erector spinae, sacroiliac lihaments, mammillary processes of L/S, TVP of T1-T4 and articular processes of C4-C7. *Rotatores:* arise from TVP of vertebrae.	SP of more superior vertebra *Semispinalis:* thoracis, cervicis, capitis; fibres run superomedially to SP in cervical and thoracic region, spanning 4-6 segments. *Multifidus:* thickest in L/S; fibres pass obliquely superomedially to entire length of SP, spanning 2-4 segments. *Rotatores:* fibres pass superomedially to attach at junction of lamina and TVP/SP of vertebrae above, spanning 1-3 segments.	Posterior rami of spinal nerves.	Extension *Semispinalis:* Extend VC and rotates VC contralaterally *Multifidus:* Stabilize vertebra during movements *Rotatores:* Stabilize vertebra and assist in local extension and rotatory movements of VC
Minor deep layer of intrinsic L/S mm: Interspinales Intertransversarii Levatores costarum	*Interspinales:* Superior surface of SP in cervical and lumbar vertebra. *Intertransversarii:* TVP of cervical and lumbar vertebra *Levatores costarum:* Tips of TVP of C7 and T1-T11 vertebra	*Interspinales:* Inferior surface of SP of above vertebra. *Intertransversarii:* TVP of adjacent vertebra *Levatores costarum:* Pass inferolaterally and insert on rib between tubercle and angle	Posterior rami of spinal nerves	*Interspinales:* Extension and rotation of VC *Int*ertransversarii: Lateral flexion of VC and acting bilaterally stabilize the VC *Levatores costarum:* Elevate ribs and assist with lateral flexion of VC

Mm = muscles; L/S= lumbar spine; TVP = Transverse process; SP = Spinous process; PSIS= posterior superior iliac spine; VC = Vertebral column

Appendix C: Conservative management of low back pain

Conservative management procedures for LBP (Borenstein *et al*., 1995)

Conservative management procedure	**Action**
Controlled physical activity (bed rest)	Scientific evidence demonstrating the efficacy of bed rest for treatment of LBP is relatively insufficient
Traction	Unloading the spine by stretching ligaments, muscles and functional spinal units to decrease intradiscal pressure and alleviating LBP
Physical modalities: Ice Hot packs Diathermy Ultrasound	Reduce pain, swelling, muscle spasm,
Injection therapy: Soft tissue injections Sclerosant injection Epidural corticosteroid injection Facet joint injection Peripheral nerve blocks	Local or regional injection. Blocks the function of the nociceptive sensory fibres of the peripheral nerve supplying the "injured area" and blocks the reflex function of muscle fibres and so reduce pain as well.
Corsets and braces	Reduce the load on the spine/discs when patient is standing, and in doing so decrease the pain. Should only be worn for short periods of time in the recovery phase.
Manipulation	Correcting subluxations and mal-alignment of the spine in order to alleviate pain. This will bring back the normal biomechanics of movement within the spine allowing for normal anatomical movement.
Massage	Mechanical stimulation of muscles to relax contracted muscles and increase circulation to the area to decrease pain
Physical therapy and exercises: Physical therapy Flexion exercises Extension exercises Isometric flexion exercises Aerobic exercises	Strengthens surrounded weak muscles, lengthening short muscles, improve fitness, improve posture, improve mobility, stabilize hypermobile segments
Medications: NSAIDs Analgesics	Have analgesics properties and anti-inflammatory properties to reduce LBP Have analgesics properties only to reduce pain
Muscle relaxants	Relax muscles, but not always effective as there is not just one therapy effective for all forms of muscle spasms
Antidepressants	Used for treatment of chronic LBP, alterations in the central nervous system which is associated with chronic pain
Electrotherapy: Transcutaneous electrical nerve stimulation (TENS) High-voltage electric stimulation	Alleviate chronic LBP, the impulses activate larger afferent A-alpha fibres which block the pain stimulation carried by the smaller C-fibres, activation of the intra-neural system to decrease pain Same as TENS just uses high voltage which send pulses of short duration to stimulate the nerve fibres.
Back school	Non-surgical management of LBP. Helps to educate people about taking care of their back to manage their own back problems. Helps to educate patients on the aetiology, anatomic and biomechanical function of their back to help them better understand on how they can prevent LBP problems with their daily life.
Work-related educational/exercise	Helps with assessing the patients' job, functional capacity and work environment. Help to assess the ergonomics of the patient during a work day to prevent LBP
Miscellaneous therapy: Tryptophan Acupuncture	Helps to maintain the level of serotonin in the central nervous system in chronic LBP patients Using a needle to produce brief, moderate pain in specific locations to abolish severe, chronic pain. Counter irritation therapy.

Appendix D: Surgical procedures performed on the lumbar spine

Surgical procedures performed on the lumbar spine

Surgical Procedure	**Definition**	**Condition for which surgery is used**
Lumbar Decompression: 1) Laminectomy 2) Microdiscectomy 3) Foraminotomy	Decompression refers to any surgical technique which aims to free the space for the nerves in the spinal canal or foramina. Laminectomy occurs if there is pressure in the spinal canal. Microdiscectomy uses magnification to carefully remove small portions of the disc to relieve nerve pressure. Foraminotomy involves removal of bone/tissue within the foramen to relieve pressure to the nerve.	Lumbar herniated disc/lateral herniated disc, lumbar spinal stenosis, cauda equina syndrome, facet arthritis
Laminotomy	Removing portion of the lamina in order to free up space so that the spinal canal is widened and nerve compression is released.	Spinal stenosis, disc herniation
Lumbar Spinal Fusion/Multilevel lumbar fusion: 1) Posterior Lumbar Interbody Fusion (PLIF) 2) Anterior Lumbar Interbody Fusion (ALIF)	Fusion is a surgically created solid bone bridge between two or more adjacent, usually freely mobile bones. PLIF involves removing an IVD and creating a spinal fusion in the lumbar spine all through one small incision. ALIF approach, through the abdomen in order to remove the IVD, and to replace it by bone, similar to spinal fusion surgery.	Lumbar degenerative disc disease, spondylolisthesis. Multilevel fusion for cases of scoliosis, recurrent herniated disc, an instability of the spine, a chronic back problem related to disc rupture or disc related pain.
Discectomy	Removal of all/part of the IVD	Herniated disc
Endoscopic surgery	Has developed greatly in the past decade, using video and minimally invasive techniques to accomplish the same goals as traditional surgeries	Scoliosis, biopsies, anterior lumbar fusion
LASER surgery	LASER is used to deliver high levels of energy to local tissues. This method has been to found to not be as effective as traditional methods, so it is not indicated as the choice of surgery in a vast majority of surgeries.	

Appendix E: KwaZulu-Natal Department of Health approval

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

DIRECTORATE:
Health Research & Knowledge Management

Physical Address: 330 Langalibalele Street, Pietermaritburg
Postal Address: Private Bag X9051
Tel: 033 395 2805/ 3189/ 3123 Fax: 033 394 3782
Email: hrkm@kznhealth.gov.za
www.kznhealth.gov.za

HRKM Ref: 132/16
KZ_2015RP46_942

Date: 17 May 2016

Dear Mr J.L. Hillerman
Durban University of Technology

Approval of research

1. The research proposal titled **'Profile of lumbar spine conditions requiring surgical intervention in the Orthopaedic Department at a specialist public hospital in Kwa-Zulu Natal'** was reviewed by the KwaZulu-Natal Department of Health.

   The proposal is hereby **approved** for research to be undertaken at King Dinuzulu Hospital Complex.

2. You are requested to take note of the following:
   a. Make the necessary arrangement with the identified facility before commencing with your research project.
   b. Provide an interim progress report and final report (electronic and hard copies) when your research is complete.

3. Your final report must be posted to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za

For any additional information please contact Mr X. Xaba on 033-395 2805.

Yours Sincerely

[redacted]

Dr E Lutge
Chairperson, Health Research Committee
Date: 19/05/16

Fighting Disease, Fighting Poverty, Giving Hope

Appendix F: King Dinizulu Hospital approval

DEPARTMENT OF HEALTH
PROVINCE OF KWAZULU-NATAL

KING DINUZULU HOSPITAL COMPLEX

PO DORMERTON,4015
75 Dr R D NAIDU DRIVE, SYDENHAM, DURBAN 4015

Enquiries : Dr S B Maharaj	Telephone Number : (031) 2426000 Extension : 6101	Fax Number : (031) 2099586	
Email :shamin.maharaj@kznhealth.gov.za	Your Reference :	Date : 07 November 2014	

Ms Jens Hillerman
Chiropractic Student- fifth year
DUT
Durban

Dear Ms Jens Hillerman

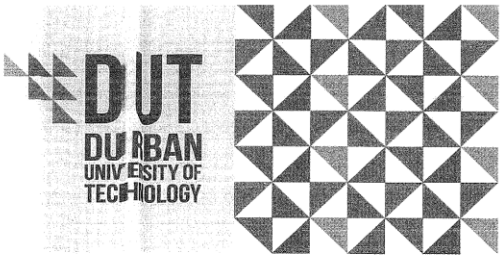
REQUEST FOR PERMISSION - TO CONDUCT RESEARCH AT KDHC SPINAL ORTHOPAEDICS DEPARTMENT: ACCESS TO PATIENT RECORDS

1. Your email dated 22/10 2014 refers.
2. Permission is granted for the above mentioned purpose, for you to begin with the data collection for the study. Please find attached copy of indemnity form for completion and submission by yourself prior to undertaking the study.
3. Your attention is once again drawn to the maintenance of confidentiality as discussed.
4. Arrangements should be made for you to work with the staff and patient records in the Spinal Orthopaedic Department.
5. The MEDITECH electronic system was implemented since 2012

[redacted]

Yours sincerely,
Dr S B Maharaj
Medical Manager KDHC

Appendix G: IREC approval



Institutional Research Ethics Committee
Faculty of Health Sciences
Room MS 49, Mansfield School Site
Gate 8, Ritson Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2900
Fax: 031 373 2407
Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

14 March 2016

IREC Reference Number: **REC 9/16**

Mr J K Hillermann
P O Box 55
Wartburg
3233

Dear Mr Hillermann

Profile of lumbar spine conditions requiring surgical intervention in the Orthopaedic Department at a specialist public hospital in Kwa-Zulu Natal

I am pleased to inform you that Provisional Approval has been granted to your proposal REC 9/16 subject to:

- Piloting of the data collection tool and
- Obtaining and submitting the necessary gatekeeper permission/s to the IREC.

Full approval is subject to meeting the above conditions.

The Proposal has been allocated the following Ethical Clearance number **IREC 016/16**. Please use this number in all communication with this office.

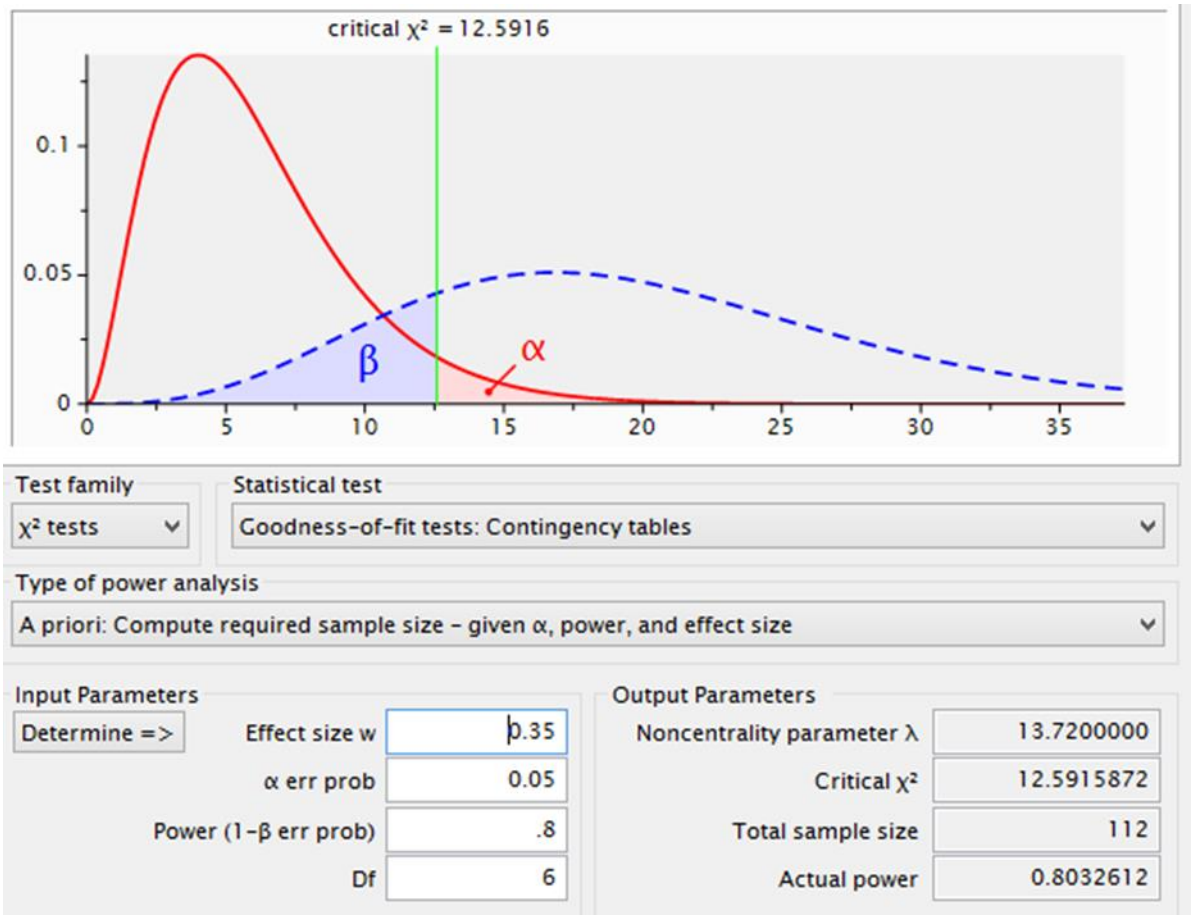
Approval has been granted for a period of two years, before the expiry of which you are required to apply for safety monitoring and annual recertification. Please use the Safety Monitoring and Annual Recertification Report form which can be found in the Standard Operating Procedures [SOP's] of the IREC. This form must be submitted to the IREC at least 3 months before the ethics approval for the study expires.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC SOP's.

Please note that any deviations from the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Please note that you may continue with validity testing and piloting of the data collection tool. Research on the proposed project may not proceed until IREC reviews and approves the final document. If there are no changes to the data collection tool, kindly notify the IREC in writing.

Appendix H: Goodness-of-fit test to show a medium effect size with 80% power



Appendix I: Initial data collecting form

Patient Code	

Demographics	Date of Birth	Age	Race	Gender
				M ☐ F ☐

Pre-Surgical Vitals	BP	PR	RR	Temperature

History	Cancer	Infection	Trauma	Insidious
	Mechanical Pathology		Other	

Red Flags	Cancer	Infection	Trauma	Other

Neurology	Dermatomes	Myotomes	Reflexes

Co-Morbid Conditions	Diabetes	Cancer	High BP	HIV/AIDS	TB
	Cholesterol		Other		

Pre-Surgical Diagnosis	Fracture	Infection	Dislocation
	Other		

Pre-Surgical Management	Physiotherapy	Medication	Chiropractic	Other

Suggested Pre-Surgical Surgery	Spinal Fusion	Decompression	Laminectomy	Other

X-Ray Findings	Fracture	Infection	DJD
	Incidental findings		

Pre-Surgical Vitals	*BP*	*PR*	*RR*	*Temperature*

Post-Surgical Diagnosis	Fracture	Infection	Dislocation
	Other		

Post-Surgical Management	Physiotherapy	Medication	Back Brace
	Other		

Post-Surgical Procedure Done	Fusion	Decompression	Laminectomy	Other

Post-Surgical Complications	Infection	Bleeding	Blood clots	Stroke	Failure of Surgery
	Other				

Appendix J: Final data collecting tool

Patient Code	

Demographics	Date of Birth	Age	Race	Occupation	Gender
					M ☐ F ☐

Pre-Surgical Vitals	BP	PR	RR	Temperature

History	Cancer	Infection	Trauma	Insidious
	Mechanical Pathology		Other	

Red Flags	Cancer	Infection	Trauma	Other

Neurology	Dermatomes	Myotomes	Reflexes	Frankel

Co-Morbid Conditions	Diabetes	Cancer	High BP	HIV/AIDS	TB
	Cholesterol		Other		

Pre-Surgical Diagnosis	Fracture	Infection	Dislocation
	Other		

Pre-Surgical Management	Physiotherapy	Medication	Chiropractic	Other

Suggested Pre-Surgical Surgery	**Spinal Fusion**	**Decompression**	**Laminectomy**	**Other**

X-Ray Findings	**Fracture**	**Infection**	**DJD**	**Incidental Findings**
	MRI			

Post-Surgical Diagnosis	**Fracture**	**Infection**	**Dislocation**
	Other		

Post-Surgical Management	**Physiotherapy**	**Medication**	**Back Brace**
	Other		

Post-Surgical Procedure Done	**Fusion**	**Decompression**	**Laminectomy**	**Other**

Post-Surgical Complications	**Infection**	**Bleeding**	**Blood clots**	**Stroke**	**Failure of Surgery**
	Other				

Appendix K: King Dinizulu Hospital indemnity form

HEALTH
KwaZulu-Natal

KING Dinuzulu hospital Complex
PO Dormerton, Sydenham, Durban
75 Stanley Copley Drive, Sydenham, Durban, 4091
Tel: 031 242 6000, Fax: 031 2099586
http://www.kznhealth.gov.za/kinggeorgevhospital.html
Email.thami.chizama@kznhealth.gov.za

Enquiries: PRO
Telephone: 031 242 6025

King Dinuzulu hospital Complex: Indemnity Form

I JENS HILLERMANN do hereby acknowledge and declare that in working at King George V Hospital and other Hospitals and Clinics under control of the Department of Health that I do so at my own risk. I further acknowledge that the Department of Health, its officials or employees shall not be held responsible for any ill effect or loss of health arising from my rendering services to the Department or visiting or working on the premises of the Department of Health.

I further declare that I, my executors and relatives do indemnify and absolve the Department of Health (King George V Hospital), its officials and employees from any such loss, costs or claims incurred.

Signed at Durban on the 25th day of FEBRUARY / 2015

Signature _____

Witness _____