THE ROLE OF PLAIN FILM RADIOGRAPHY IN THE DIAGNOSIS AND MANAGEMENT OF KNEE PAIN

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, Chantelle Ann Damon, do hereby 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 parents, Norma and Raymond Damon. Thank you for all the love and support you have given me. Thank you for providing me with all I ever wanted or needed. I love you and appreciate everything you have done.

My brother, Darren and sister, Theresa, even though you have been so far away, you are always close to my heart. Thank you for your support and love.

My boyfriend, Leroy Ryan, for being there all these years. For lifting me up in my lowest moments and loving me when I know I was impossible to love. I love you.

My friends, Marencia and Laken, you guys always believed in me. Thank you for always being around when I needed you to make me laugh and thank you for your support, love and care. I couldn’t ask for better people to walk with me on my journey of life.

ACKNOWLEDGEMENTS

It is with sincere gratitude and appreciation that I would like to thank the following individuals:

1. My supervisor, Dr. J. Shaik, of the Department of Chiropractic, Faculty of Health Sciences, Durban University of Technology, for his guidance and advice during the entire process of my research project. This time and knowledge was greatly appreciated.

2. Mrs. Tonya Esterhuizen for her assistance with the statistical analyses used in this study.

3. Funding for this study was provided by the Durban University of Technology's Research Fund.

ABSTRACT

Background:

Attempts to determine the association between the radiographic and clinical findings of knee pathology have produced conflicting results. It is also not yet known how knee radiographs influence the conservative management of patients with knee pain.

Objectives:

1. To determine the association between the clinical and radiographic diagnoses of knee pain.
2. To record the consultation at which a radiograph of the knee was requested by the student or clinician and the reasons thereof.
3. To record the suspected clinical diagnoses and management of the patients prior to referral for radiographs of the knee.
4. To determine the number of incidental radiographic findings in the selected radiographs.
5. To determine any change in the clinical diagnoses and management following radiographic reporting of the selected radiographs.

Method:

Radiographic and clinical data from 1 January 1997 to 31 December 2010 were retrospectively collected from knee radiographs and corresponding patient files from the archives of the Chiropractic Day Clinic (CDC). Statistical analysis included the use of percentages, mean, standard deviation, range and frequency counts for the descriptive objectives. Diagnoses were categorized into specific groups and to construct two-by-two tables of absence or presence of radiographic vs. clinical diagnosis for each specific diagnosis to determine the association indicator variables were used.

Results:

The overall agreement between the clinical and radiographic diagnoses was 85.5%. For degenerative joint disease there was a 97.8% agreement while in Osgood Schlatter's disease the agreement was 100%, and in chondromalacia patella the agreement was 50%. However, there was no agreement between the clinical and radiographic diagnoses for each of the other specific conditions. Degenerative changes were the most common radiographic findings. The

majority of the knee radiographs were requested at the initial consultation and as the length of treatment increased, the frequency of radiograph requests decreased. The most common reasons for referral for radiographs were to identify degenerative changes (47.5%) and to assess for unspecified pathology (37.4%). Of the 146 patients in this study, 125 patients did not have a change in diagnosis after radiographs were obtained which means that 85.6% of the diagnoses remained the same after radiographic examination. There was a wide range of treatment modalities utilized in the management of patients with knee pain, including soft tissue therapy, electrotherapeutic modalities and manual therapy (manipulation and mobilization). The use of manual therapy increased from 67.8% prior to radiographs being taken to 82.9% after radiographs were obtained.

Conclusion:

Knee radiographs were over-utilized at the CDC and the findings on radiography did not have much influence on the diagnosis and the management of the patient presenting with knee pain. The majority of the clinical diagnoses were degenerative causes of knee pain.

LIST OF SYMBOLS AND ABBREVIATIONS

>:	Greater than
<:	Less than
ACL:	Anterior cruciate ligament
AP:	Antero-posterior view
AVN:	Avascular necrosis
CDC:	Chiropractic Day Clinic
CRP:	C-reactive protein
CT:	Computed tomography
DJD:	Degenerative joint disease
DUT:	Durban University of Technology
ESR:	Erythrocyte sedimentation rate
FBC:	Full blood count
IFC:	Interferential current
ITBS:	Iliotibial band syndrome
LCL:	Lateral collateral ligament
MCL:	Medial collateral ligament
MRI:	Magnetic resonance imaging
***n*:**	Sample size/count
NAD:	No abnormality detected
NSAIDs:	Non-steroidal anti-inflammatory drugs
OCD:	Osteochondritis dessicans
ON:	Osteonecrosis
PCL:	Posterior cruciate ligament
PFPS:	Patello-femoral pain syndrome
PNF:	Proprioceptive neuromuscular facilitation
RA:	Rheumatoid arthritis
Rx:	Treatment
SD:	Standard deviation
SLE:	Systemic lupus erythematosus
SOAPE:	Subjective, objective, assessment, plan, education

TENS:	Transcutaneous electric nerve stimulation
Yrs*:*	years

LIST OF TABLES

CHAPTER TWO

CHAPTER THREE

CHAPTER FOUR

LIST OF FIGURES

CHAPTER TWO

CHAPTER FOUR

LIST OF APPENDICES

TABLE OF CONTENTS

CHAPTER ONE

INTRODUCTION

1.1. INTRODUCTION TO THE STUDY

Low back pain and knee pain are the two most common musculoskeletal complaints seen in private practice (Antonopoulou *et al.*, 2009). Knee pain occurs in approximately 20% of the general population (Levy and Dickey-White, 2009) and this incidence is thought to be increasing due to the rise in the activity levels of individuals (Calmbach and Hutchens, 2003). Since the differential diagnoses of knee pain are considerable, the exact cause of the pain may be difficult to isolate. A clinical history and physical examination are required to identify possible causes of knee pain, and to determine whether the use of diagnostic testing is warranted (Calmbach and Hutchens, 2003). Following the clinical examination, a treatment program may be initiated depending on the suspected diagnosis (Levy and Dickey-White, 2009). A thorough clinical examination may lead to the detection of certain features termed “red flags” which indicate serious underlying pathologies. These “red flags” which include a history of direct trauma, inability to move the joint, and no response to appropriate treatment may warrant secondary investigations such as radiographs and magnetic resonance imaging (MRI) (Fagan and Davies, 2000; Levy and Dickey-White, 2009).

Chiropractors’ utilization of radiographs began soon after the discovery of ionizing radiation in 1895 (Cooperstein and Gleberzon, 2004). Besides being important to the chiropractor in aiding in the clinical diagnosis, radiographs also provide information regarding biomechanical anomalies, recognizing contra-indications to manipulative therapy, and to follow the course of degenerative processes. The evidence provided by radiographs is then utilized for formulating or changing a treatment plan and identifying the need for referral for further management (Cooperstein and Gleberzon, 2004).

Chiropractors have been criticized for overuse of radiographs (Ammendolia *et al.*, 2008), but this is not unique to this profession as general practitioners are also known for radiograph overuse (Phillips, 1992; Morgan *et al.*, 1997). The overuse of knee radiographs is particularly related to medico-legal considerations, and in identifying degenerative changes that were

previously expected (Morgan *et al.*, 1997), despite exposing patients to unnecessary ionizing radiation which may have adverse effects such as the risk of developing cancer, or genetic abnormalities (Shapiro, 2002).

In conclusion, the reported overuse of radiographs by chiropractors and observations of Morgan *et al.* (1997) emphasise the need to determine the correlation between the radiographic diagnoses and clinical diagnoses of knee pain. It is also important to not only investigate the role of knee radiographs in determining the treatment protocol, but also how the radiographic findings may result in alterations to the treatment or management protocol. Therefore, the aim of this research was to determine the correlation between clinical and radiographic diagnosis and to determine if or how the radiographic diagnosis influenced a change in the management of the patient with knee pain.

1.2. AIMS AND OBJECTIVES

1.2.1. THE AIMS OF THE STUDY

The aims of this study were to:

1. Determine whether there was an association between the clinical and the radiographic diagnoses of patients who presented with knee pain at a chiropractic teaching clinic and;
2. Whether radiographs of the knee influenced a change in the diagnosis or management of these patients.

1.2.2. THE OBJECTIVES OF THE STUDY

Specific objectives were identified and these included:

1. To determine the association between the clinical and the radiographic diagnoses of knee pain.

2. To record the consultation at which a radiograph of the knee was requested by the student or clinician and the reasons thereof.

3. To record the suspected clinical diagnoses[#] and management of the patients prior to referral for radiographs of the knee.

4. To determine the number of incidental radiographic findings* in the selected radiographs.

5. To determine any change in the clinical diagnoses[#] and management following radiographic reporting of the selected radiographs.

*** Definition of an incidental finding: "any abnormality not related to the illness or causes that prompted the diagnostic imaging test" (Lumbreras *et al.*, 2010).**

[#] **This refers to the clinical suspicion as it appeared either on the SOAPE note or the radiographic request form at the point of referral for radiographs.**

1.3. HYPOTHESES

The Alternate Hypothesis (Ha) was set for the first objective which stated that there would be a significant association between the clinical and the radiographic diagnoses of patients with knee pain.

The Alternate Hypotheses (Ha) was set for the fifth objective which stated that the radiographic diagnosis would significantly influence a change in the clinical diagnosis and management of the patient.

1.4. SCOPE OF THE STUDY

The results of 146 radiographs of the knee and the corresponding patient files that met the inclusion and exclusion criteria are discussed in this dissertation. All radiographs and patient files were obtained from the Chiropractic Day Clinic (CDC) archives at the Durban University of Technology (DUT). Informed consent for the use of clinical and radiographic information was obtained from patients at their initial consultation. Codes were assigned to each patient's name to maintain patient confidentiality and these were used instead of patients' names in the data sheets. Access to the patient files and knee radiographs were restricted to the researcher and supervisor.

1.5. LIMITATIONS OF THE STUDY

The study was limited to including only the plain film radiographs of the knee and the corresponding patients' files within the CDC archives. Knee radiographs in this study were required to be taken during the patient's management at the CDC. Therefore, this study excluded patients with knee pain who presented at the initial consultation with knee radiographs. This was due to the fact that it could not be determined if there would be an influence in the diagnosis or management of the patient by the radiographic findings if patient presented at the initial consultation at the CDC with the knee radiographs.

Since this study was retrospective, there was no way to verify the clinical findings as the details were already recorded in the patient's files. This study may not be representative of all knee pain patients at the CDC, as there was probability of some radiographs being removed from the archives for teaching purposes and others being taken home by patients.

CHAPTER TWO

LITERATURE REVIEW

2.1. INTRODUCTION TO KNEE PAIN

The knee joint is the largest and one of the most complex joints in the body (Calmbach and Hutchens, 2003). The structure of the knee joint and its location subject it to many stresses, diseases and trauma. This causes the knee joint to be the most injured joint in the body (Smillie, 1978; Calliet, 1992; Calmbach and Hutchens, 2003). Knee pain is second to low back pain as the most common musculoskeletal conditions seen in private practice (Antonopoulou *et al.*, 2009; Levy and Dickey-White, 2009).

The incidence of knee pain is increasing rapidly as there is a rise in the activity levels of individuals in today's society (Calmbach and Hutchens, 2003). The majority of patients with knee pain present to medical doctors for their assessment and treatment. However, with the growth of the alternate health care sector, more patients are presenting to chiropractors for the management of their knee pain and other musculoskeletal complaints (Goldstein, 1999).

2.2. THE AETIOLOGY AND DIAGNOSIS OF KNEE PAIN

Musculoskeletal conditions are generally difficult to diagnose. This is true for the causes of knee pain due to the extensive differential diagnosis (Calmbach and Hutchens, 2003). The knee is one of the most complex joints of the body and is subjected to multiple stresses and pathological factors making it difficult to reach a definitive diagnosis (Smillie, 1978; Calliet, 1992; Calmbach and Hutchens, 2003), although a thorough clinical history and physical examination can narrow the list of differential diagnoses (Calmbach and Hutchens, 2003).

A useful classification of the causes of knee pain proposed by Wallace and Staats (2004) is presented in **Table 2.1**.

Table 2.1 Classification of the causes of knee pain

Extra-articular causes	Intra-articular causes
• Iliotibial band syndrome	• Meniscal lesions
• Patellar tendonitis	• Ligament injuries (ACL and PCL)
• Pes anserine bursitis	• Plica syndrome
• Ligament injuries (MCL and LCL)	• Patello-femoral pain syndrome
• Pain referred from the lumbar spine or hip joints	• Degeneration
	• Inflammatory arthritis
	• Infection
	• Fractures
	• Osteonecrosis
	• Osteochondritis dessicans
	• Tumours

*__Table adapted from Wallace and Staats (2004)__

ACL= anterior cruciate ligament; LCL= lateral collateral ligament; MCL= medial collateral ligament; PCL= posterior cruciate ligament

Several extra-articular or intra-articular causes may be responsible for knee pain (**Table 2.1**). The intra-articular causes include lesions affecting the structures directly related to the knee joint such as the bones (femur, tibia, fibula and patella), cartilage, ligaments and soft tissue surrounding and within the knee joint (Wallace and Staats, 2004).

The extra-articular causes include lesions involving joints proximal to the knee joint (hip joint and lumbar spine pathologies referring to the knee joint), tendons and soft tissues that cross or surround the knee joint and refer pain to the joint (pes anserine bursa, Iliotibial band, patella tendon, medial collateral ligament (MCL) and lateral collateral ligament (LCL).

The common extra-articular causes can be divided into three categories: referred pain, overuse syndromes and ligament injuries (Wallace and Staats, 2004). The most common of these are the overuse syndromes which affect the tendinous insertions around the knee and are caused by repetitive movements of the knee which result in inflammation of the tendons e.g. repetitive flexion and extension of the knee results in the iliotibial band friction syndrome (ITBS). The region of knee which is affected is specific to the tendon structure involved. (Anterior knee pain is caused by patellar tendonitis and lateral knee pain is caused by ITBS). Although the diagnosis of overuse syndromes are not difficult to reach, the clinical history must be thorough to identify the mechanism of injury and the physical examination must include movements of the knee which will reproduce the pain and palpation to identify which structures are affected. Further investigations are not usually necessary although they may be used to confirm the diagnosis. These investigations may include radiographs, ultrasound,

computed tomography (CT) scanning or magnetic resonance imaging (MRI) (Calmbach and Hutchens, 2003; Martinez, 2009). Pes anserine bursitis is usually diagnosed on clinical grounds and further investigations are usually not necessary (Glencross, 2009). However, in certain cases, investigations such as ultrasonography may aid the clinician in the diagnosis (Glencross, 2009).

Two extra-articular knee ligaments commonly injured are the MCL and LCL (DeBerardino, 2010). The MCL is the most commonly injured ligament of the knee due to either direct or indirect trauma to the lateral knee or overuse injury which may occur as a result of repetitive valgus loading at the knee joint (DeBerardino, 2010). The LCL is less commonly injured as the opposite leg acts as a guard to the medial aspect of the knee. However, direct trauma to the medial aspect of the knee may take place while the knee is in extension and placed in front of the body. These ligament injuries can be diagnosed on clinical history and examination as they are often sports-related and will present with a specific mechanism of injury (DeBerardino, 2010; Ho, 2010).

Referred pain to the knee from the hip or the lumbar spine is difficult to identify as all other possible causes of knee pain need to be excluded (diagnosis of exclusion) (Hollis, 2010). Pain referred from the lumbar spine is most commonly due to nerve root entrapment especially at L4. Pain referred to the knee from the hip may result from specific conditions (e.g. slipped capital femoral epiphysis) or may be due to active myofascial trigger points of muscles of the hip region (e.g. hamstrings and adductors). Nerves exiting the hip (e.g. femoral nerve) may become entrapped and refer pain to the knee and cause other symptoms in the knee (e.g. weakness). Once the region is identified as the primary cause, investigations may be required to evaluate the region to reach a definitive diagnosis (Calmbach and Hutchens, 2003; Hollis, 2010).

Intra-articular structures, including the menisci (medial and lateral) and anterior and posterior cruciate ligaments (ACL and PCL) (**Table 2.1**) may also be injured (Aiello, 2008; Allen, 2010). Meniscal tears may be due to either traumatic injury or degenerative processes. Traumatic injuries are more commonly observed in athletes whereas degeneration is more likely in the elderly. Traumatic meniscal injuries are often associated with ACL and MCL injuries resulting in the “unhappy triad” syndrome (Freitas, 2011). The PCL is injured most commonly in the hyperextended position whereas the ACL in the partially flexed position (Aiello, 2008; Allen, 2010). The ACL is the most commonly injured ligament of the knee and injury occurs in both athletes and non-athletes, either with or without contact to the knee. Ligament injuries are graded depending on the severity, from partial to complete tears (Allen, 2010).

The plica syndrome results from a remnant of foetal tissue in the knee which usually decreases in size in the second trimester of pregnancy (Dupont, 1997). However, in some individuals this process does not happen and the tissue continues into adult life. It is then referred to as plica and can be injured as a result of direct trauma or an overuse injury when the knee is flexed (Dupont, 1997).

Although patello-femoral pain syndrome (PFPS) is one of the most common of all musculo-skeletal complaints, the evaluation, diagnosis and treatment of this condition are often difficult due to the multifactorial aetiology (Servi, 2009). Aggravating factors include joint malalignment, unbalanced muscle pull, excessive knee valgus deformity and excessive loading, all of which need to be evaluated in order to reach the definitive diagnosis of PFPS. These factors also lead to the development of degenerative joint disease (DJD) (Potter, 2009). A common cause of knee pain in the middle-aged and elderly individuals is DJD which is a non-inflammatory arthritide as opposed to the majority of the other arthritic causes of knee pain. The inflammatory causes (which also may be referred to as systemic causes) of knee pain include rheumatoid arthritis (RA), septic arthritis and gout. These inflammatory causes always have symptoms that warrant further investigation as the clinical features will suggest the underlying pathology. These features include severe knee pain, swelling, fever, exquisite tenderness and redness of the joint (Brusch, 2010; Patel, 2011). It should be noted that several of these features may also be observed in infections or tumours around the knee and even in post-traumatic states.

Infections of the knee (including bone infections) may be seen in individuals of any age, but are most common in immuno-compromised individuals as in cases of alcoholism, prolonged corticosteroid therapy and acquired immunodeficiency syndrome (AIDS) (Calmbach and Hutchens, 2003). The onset of pain and swelling is sudden with no history of trauma. Physical examination reveals a warm, swollen and tender joint with intense pain on any movement (Calmbach and Hutchens, 2003).

There are many different fractures of the knee such as stress fractures, pathological fractures, open and closed fractures. Closed fractures and stress fractures can be treated conservatively with rest and immobilisation (Handoll and Parker, 2008). More severe fractures that are open and displaced require surgical reduction. These, therefore, require immediate referral for surgical intervention (Handoll and Parker, 2008; Steele, 2011).

Osteonecrosis (ON) or avascular necrosis (AVN) is a condition characterised by necrosis of osseous tissue as a result of derangement of circulation (Rajadhyaksha, 2008). Often the cause is not found as the condition occurs spontaneously, but in some cases the clinician is able to identify a cause, such as trauma. Imaging studies such as plain film radiography and

MRI may be used to diagnose ON (Rajadhyaksha, 2008). Osteochondritis dessicans (OCD) is a disorder of the calcification centres characterised by avasular necrosis and recalcification. The aetiology is multifactorial and includes trauma, ischaemia and genetic predisposition. This disorder may be diagnosed on plain film radiography, radioisotope bone scan or MRI (Jacobs, 2011).

The knee joint is the most common location for primary bone tumours which occur as either benign or malignant. Osteochondromas (exostoses), the most common of the benign tumours, are composed of cortical and medullary bone with an overlying hyaline cartilaginous cap. They may be solitary or multiple resulting in deformity of the knee joint, and malignant change may occur in less than 5% of cases (Murphey *et al.*, 2000; Yochum and Rowe, 2005; Breitenseher and Dominkus, 2006). Malignant tumours are one of the most important of all pathological conditions affecting the knee (Dickinson *et al.*, 1997). The most common of all tumours are metastatic bone tumours. Malignant tumours account for 70% of all metastatic tumours and those affecting bone have a primary extra-skeletal site (Yochum and Rowe, 2005). Primary malignant bone tumours include multiple myeloma and osteosarcoma. Osteosarcomas are often located in the long bones of the extremities and most commonly affect the knee and shoulder joints. A clinician should be aware of the appearance of this tumour on radiographs as it is similar to that of myositis ossificans (Yochum and Rowe, 2005). Even though a clinician may suspect a tumour on clinical grounds, radiographic confirmation may not be possible due to the latent period. This is the time interval between the onset of clinical symptoms and the appearance of the radiographic features. Further diagnostic testing and imaging may be required e.g. erythrocyte sedimentation rate (ESR) and alkaline phosphatase enzyme, ultrasound MRI and bone biopsy to identify the specific tumour (Longmore *et al.,* 2007; Cameron and Howard, 2010).

As there are several causes of knee pain, a definitive diagnosis may be difficult to reach. However, with a thorough clinical history and a complete physical examination, clinical findings may suggest a specific diagnosis or a list of differential diagnoses (Calmbach and Hutchens, 2003). Depending on the suggested list of differential diagnoses there may be the need to request for special investigations such as radiographs to guide the clinician to the diagnosis or to exclude other diagnoses.

2.2.1. FACTORS ASSOCIATED WITH THE DIAGNOSIS OF KNEE PAIN

The differential diagnosis of knee pain is considerable which makes it difficult to reach an exact diagnosis (Calmbach and Hutchens, 2003). Clinicians should focus on the clinical history as this leads to the identification of symptoms which are characteristic to a specific condition. Once these symptoms are identified, the physical examination is easier and is used as a confirmation in the diagnosis of the condition suggested by the symptoms (Calmbach and Hutchens, 2003). If the history is not thorough and specific, the physical examination may be confusing making it difficult to reach a clear diagnosis. Once the clinical history and physical examination is complete, a suspected diagnosis is reached and a management plan is initiated (Levy and Dickey-White, 2009). The suspected diagnosis is a working diagnosis which allows the clinician to assess the response of the condition to the management. If there is no response to treatment or the response is insignificant, further investigations may be necessary to identify any underlying causes (Fagan and Davies, 2000; Levy and Dickey-White, 2009).

During the clinical assessment (history and physical examination) there may be certain features which indicate serious underlying pathologies (**Table 2.2**). These features are termed 'red flags' and require a thorough evaluation to determine the exact pathology (Fagan and Davies, 2000; Levy and Dickey-White, 2009). Red flags may present at any time during the natural development of a condition. Therefore, a careful assessment of the patient's status is important to identify the development of any red flags during patient management. Serious pathologies indicated by red flags include infections, neoplasms, inflammatory arthritides and fractures (Steele, 2011).

Table 2.2 Red flags associated with knee pain

Category	History findings	Physical findings
General	Innocuous symptoms	Inability to bear weight
	Nocturnal pain[1]	Locking of knee
	Knee pain with or without referral[2]	Neurological deficit
	Failure to improve	Joint deformity*
	No response to treatment	
Malignancy	Constitutional symptoms[1]	Severe knee pain
	Night pain[1]	Neurological deficits[1]

	Age <18 years[1]	Immobility
		Deformity*
Infection	Constitutional symptoms[1]	Constitutional symptoms[1]
	History of infection[1]	Pain, warmth and swelling[1]
Nerve root entrapment in the lumbar spine; nerve entrapment in hip region	History of neurological symptoms[2]	Generalised knee pain[2]
		Neurological deficits[2]
Fracture	History of trauma[1]	Knee pain[1]
	Age > 60 years*	Swelling and ecchymosis[1]
		Point tenderness[1]
Inflammatory arthritides	Constitutional symptoms	Pain and swelling[1]
	Age > 40 years*	Constitutional symptoms*

[1]Adapted from Cameron and Howard *(*2010); [2]adapted from Wallace and Staats *et al.* (2004); *adapted from Yochum and Rowe (2005)

There are symptoms that are not considered red flags when they present alone (innocuous symptoms). These include localised knee pain, swelling, morning stiffness, pain worse on walking and on weight-bearing. However, if these symptoms present with other red flag symptoms, they may indicate serious underlying pathologies. For example, localised knee pain and swelling may not be red flags if they present alone, but if they present with a history of trauma or with constitutional symptoms (e.g. fever, night sweats or weight loss of unknown cause), these may indicate fractures or malignancy (Cameron and Howard, 2010). Red flags may also be related to the duration of symptoms which may occur in several ways; symptoms may occur acutely (e.g. with a fracture, severe pain and swelling after trauma), or they may be present over a longer period of time (e.g. neurological deficit) (Levy and Dickey-White, 2009).

The patients' age may provide a clue to the potential diagnosis. Knee pain caused by malignancy usually occurs in individuals younger than 18 years and Osgood Schlatter's disease (tibial apophysitis) is most commonly observed in boys aged 13 or 14 years and girls aged 10 or 11 years. Patients over the age of 60 years are more at risk of fractures which may be as a result of repetitive stress on the area or due to osteoporosis. Rheumatoid arthritis is most commonly observed in young to middle-aged adults whereas crystal induced

inflammatory arthropathies such as gout most commonly present in the elderly. Infection of the knee is suspected by clues such as recurrent respiratory or urinary infections, drug abuse or in individuals who are immuno-compromised (Calmbach and Hutchens, 2003; Doherty *et al.,* 2010).

The duration of a patient's symptoms is an important clue because a condition lasting for more than six weeks may be due to a serious underlying pathology, but a clinician should be aware that benign conditions such as DJD may also be symptomatic for several weeks or months. Patients whose symptoms persist for more than six weeks should undergo a thorough re-evaluation to determine the nature of the condition and clinicians should request further investigations to rule out serious pathologies. An example of a condition that may be misdiagnosed resulting in chronicity of symptoms is malignancy. Symptoms such as pain and swelling may be mistaken for degeneration, but if the symptoms persist and increase in severity over time, malignancy should be considered (Cameron and Howard, 2010). With a thorough re-evaluation and further investigation the correct diagnosis may be reached. A red flag which is also very important to consider is non-responsiveness to treatment. This is important because the clinician may have diagnosed the patient incorrectly, and therefore, instituted the incorrect management protocol or, there may have been an underlying cause which was missed during the evaluation of the patient. However, not all conditions that don't respond to treatment are red flags. Degenerative conditions are notorious for not responding to treatment (Stauffer *et al.*, 2011). Another factor which affects the response to treatment is patient (non-) compliance. Patients are educated with regards to their management and taught home-exercises and stretches to supplement the management program. If patients do not perform these activities, the management program may be partially effective or only be effective over a longer period of time. However, with the help of the patient in being involved with his or her treatment, the response to treatment would be much quicker (Schenk, 2005).

Clinical features such as temperature above 38°C, night sweats, unexplained weight loss of and generalised lymphadenopathy are suggestive of malignancy or infection (Cameron and Howard, 2010; Doherty *et al.,* 2010). A previous or current medical history of cancer and nocturnal pain may indicate metastatic spread to the knee. Deformity of any nature should be considered as red flags as these require further investigation to determine the cause (Stevens, 2010). The deformities may be either valgus (knock-knees) or varus (bow-leg) and causes range from physiological, genetic disorders or metabolic bone disease such as Charcot's (neuropathic) arthropathy (Stevens, 2007; Shah, 2011). If, at any point during the clinical history the main complaint is not determined for any reason, the clinician should suspect a more serious cause of knee pain as a matter of precaution. Examples of cases in

which this occurs are patients with mental illness or unconscious patients and the inability to communicate (e.g. language barriers).

Neurological symptoms may present as dermatome, myotome or reflex deficits (Bradley, 2004). Dermatomes affected present as diminished sensation including, light touch, crude touch, vibration, temperature and pain (e.g. as seen in diabetes mellitus). Myotome deficits present as weakness or atrophy in the musculature surrounding the knee joint (e.g. quadriceps weakness seen in L4 lumbar nerve root entrapment). Reflexes affected may include the knee jerk or the ankle reflexes which may be either decreased or absent. It is important for a clinician such as a chiropractor to be aware that non-musculoskeletal conditions such as hypothyroidism may also cause neurological deficits (Longmore *et al*., 2007). Sometimes, even with a history that provides clues to a condition, the physical examination may not provide any useful information to the clinician. This may be a result of the timing of the natural history of the condition i.e. the condition may not have reached the clinical phase in which features are present on physical examination. A Baker's cyst may present with constitutional symptoms whereas with internal knee derangement there may be some degree of deformity e.g. a mild varus deformity. Vascular symptoms may be produced by popliteal artery calcification or aneurysm and cause the leg, distal to the knee to lose warmth and colour (Bradley, 2004; Longmore *et al.*, 2007).

2.2.2. THE ASSOCIATION BETWEEN THE HISTORY AND EXAMINATION FINDINGS AND THE DIAGNOSIS OF KNEE PAIN

Several clinicians have attempted to link findings from the clinical history and physical examination (Oberholder *et al*., 1993; O'Shea *et al.*, 1996; Wagemakers *et al.,* 2008) but have been unsuccessful. It has been reported that the history has more of a diagnostic value than the physical examination (Wagemakers *et al.,* 2008). The relationship between knee pain and knee joint abnormality is controversial as there are cases in which there is knee abnormality (e.g. valgus deformity seen in DJD), but the patient presents with no pain or other symptoms besides pain (Yochum and Rowe, 2005). Furthermore, many patients present with knee pain and other symptoms characteristic of a condition, but the patient does not have a confirmatory diagnosis. It is, therefore, difficult to reach a diagnosis in these cases as the association between the presenting symptoms and the pathology present is poor (Claessens *et al.*, 1990; Bedson and Croft, 2008).

Conflicting information has been reported by authors highlighting the controversy around the diagnosis of knee pain. Bedson and Croft (2008) reported that knee pain is not a precise marker for knee osteoarthritis and that radiographic evidence of osteoarthritis is not a

precise guide to the likelihood that knee disability or pain will be present. Neogie *et al.* (2008), on the other hand, reported that radiographic evidence of osteoarthritis is strongly associated with knee pain.

Chronic knee pain in the elderly and children or adolescents is commonly diagnosed as degenerative joint disease or patella-femoral pain syndrome respectively (McAlindon, 1999; Calmbach and Hutchens, 2003). The severity of the knee pain and the degree of disability in any age has been reported to correlate poorly to the pathological findings of these conditions (McAlindon, 1999).

2.3. THE ROLE OF PLAIN FILM RADIOGRAPHY IN THE DIAGNOSIS OF KNEE PAIN

2.3.1. UTILIZATION OF RADIOGRAPHS IN CLINICAL PRACTICE

Plain film radiography is utilised in clinical practice to identify pathological changes and to aid the clinical diagnosis of patients **(Table 2.2)**. Occasionally, radiographs are utilised in circumstances where the clinical diagnosis is not known (Cooperstein and Gleberzon, 2004). Radiography is a relatively inexpensive and readily available as a diagnostic tool compared to other diagnostic imaging tests (Koplas and Schils, 2008). Radiographic imaging is relatively quick and the films produced are easy to evaluate (Yochum and Rowe, 2005). Soon after the discovery of ionizing radiation in 1895, chiropractors began utilising radiographs to aid in the diagnosis of their patients (Cooperstein and Gleberzon, 2004). Radiographic imaging is an important diagnostic tool for the chiropractor as it aids in formulating a clinical diagnosis, provides information regarding biomechanical anomalies and the course of degenerative processes, identifies red flags and contra-indications to manipulative therapy and for protection against medico-legal challenges.

Yochum and Rowe (2005) provide a list of general indications for skeletal diagnostic imaging, but some of these indications are applicable to patients presenting with knee pain. These are shown in **Table 2.3**.

Table 2.3 Indications for radiographing the knee

Probable indications	Possible indications	Non-indications
Trauma	Age > 50 years	Routine screening
History of cancer	Research purposes	Biomechanical assessment
Constitutional symptoms	Systemic diseases	Physical limitation of patient
Neurological deficit	Alternate imaging unavailable	Patient education
Inflammatory arthritis	Response to treatment	
No response to treatment	Therapeutic risk assessment	
Deformity		
Medico-legal considerations		

Adapted from Yochum and Rowe (2005)

The indications for radiographing the knee shown in **Table 2.3**, are general to all causes of knee pain. There are also specific indications to identify clinically important fractures and these are referred to as the Ottawa Knee Rules (Koplas and Schils, 2008; **Table 2.4**).

Table 2.4 Ottawa Knee Rules for requesting knee radiographs

Criteria
Age ≥ 55 years
Fibula head tenderness
Patella tenderness
Inability to flex the knee to 90°
Inability to bear weight

Adapted from Koplas and Schils (2008)

The guidelines of the Royal College of Radiologists for the request of radiographs of the knee include indications such as locking and signs of restricted movement of the knee joint (Morgan *et al.,* 1997). Plain film imaging in the acute phase may not provide information that is useful to the clinician unless there are red flags present (Morgan *et al.,* 1997). The most important red flags in the acute phase are those represented by the Ottawa Knee Rules (Koplas and Schils, 2008; **Table 2.4**). Other important indications for radiographic imaging when managing knee pain include no response to conservative treatment over a suggested period, or aggravation of pain or other symptoms (Morgan *et al.*, 1997).

Lumbreras *et al.* (2010) state that incidental findings on radiographs include any abnormalities that are not related to the condition for which the imaging test was requested i.e. they are not expected to be seen on the radiograph. The difficulty arises when the clinician needs to determine whether the incidental finding is significant or not. An incidental finding may be clinically important as it may lead to a diagnosis that was not suspected and may warrant further investigations or changes in management. The majority of incidental findings are found in the elderly, specifically in those who have co-morbid pathologies such as diabetes mellitus where there may be radiographic suggestions of atheroma in the arteries (Lumbreras *et al.*, 2010). The most common incidental findings observed on radiographs of the knee are those of degenerative joint disease, congenital patella abnormalities (e.g. bipartite or tripartite patella) and soft tissue abnormalities (e.g. calcification of the popliteal artery) (Yochum and Rowe, 2005; Frier and Fisher, 2010). Lumbreras *et al.* (2010) conducted a study to determine the frequency of incidental findings and observed that incidental findings are present in 15% of all diagnostic imaging.

A minimum of two perpendicular views are required to evaluate plain radiographs. Therefore, to investigate knee conditions, a minimum of an antero-posterior (AP) and a lateral view are required (Yochum and Rowe, 2005). These views show the alignment of the knee joint including the tibio-femoral joints and the patella-femoral joints, bony anatomy and joint spaces (Yochum and Rowe, 2005). The AP and lateral views are taken for every patient who is referred for radiographic imaging, but there are other views (e.g. skyline view) which may be ordered depending on the cause of the knee pain and the structure that needs to be evaluated (Yochum and Rowe, 2005).

2.3.2. ADVANTAGES OF RADIOGRAPHS IN DIAGNOSING KNEE PAIN

Plain film radiography is the most readily available diagnostic imaging test and it is non-invasive, relatively quick and inexpensive and is, therefore, often the first diagnostic imaging investigation to be requested for skeletal disorders or abnormalities (Yochum and Rowe, 2005; Koplas and Schils, 2008). Furthermore, plain film radiographs are easy to evaluate, and the films show all the necessary bony landmarks and to a much lesser extent, the surrounding soft tissue structures that need to be evaluated (Yochum and Rowe, 2005). The information provided may lead to a list of differential diagnoses or lead to an exact diagnosis being made.

2.3.3. LIMITATIONS OF RADIOGRAPHS IN DIAGNOSING KNEE PAIN

Despite its benefits, plain film imaging does have a few limitations. The most important of these is the exposure of patients to ionizing radiation which may have adverse effects such as the development of cancer or genetic abnormalities (Shapiro, 2002; Yochum and Rowe, 2005). Other limitations of plain film radiography include (Yochum and Rowe, 2005):

- Lack of soft tissue discrimination
- Decreased sensitivity in identifying bone density changes
- Difficulty in identifying small lesions
- Radiographic latent periods
- Exposure differences effect

The soft tissue seen is determined mainly by fat and this is limited on radiographs. Radiographs have diminished sensitivity in identifying bone density changes. For a lesion to be visible on a radiograph, 30-50% bone density loss needs to have taken place and the size of the lesion should be between 1cm and 5cm. There is a time interval between the onset of clinical symptoms and the appearance of radiographic features which is referred to as the radiographic latent period. The patient may have a radiograph taken during this period and there would be no evidence of the condition on the radiograph. An example of this is osteomyelitis in the peripheral bone which has a latent period of 10-14 days before it is visible on radiography (Yochum and Rowe, 2005). To the clinician who is unaware of the radiographic latent period, it would appear that there is no pathology. If exposure factors are not optimal there may be an overexposed or an underexposed film resulting in the clinician missing a radiographic diagnosis. It may appear that there is no disease process as there is no evidence on radiography, but there may be a histologic disease present. For these

reasons tumours and infection may be missed in the early phases (Yochum and Rowe, 2005).

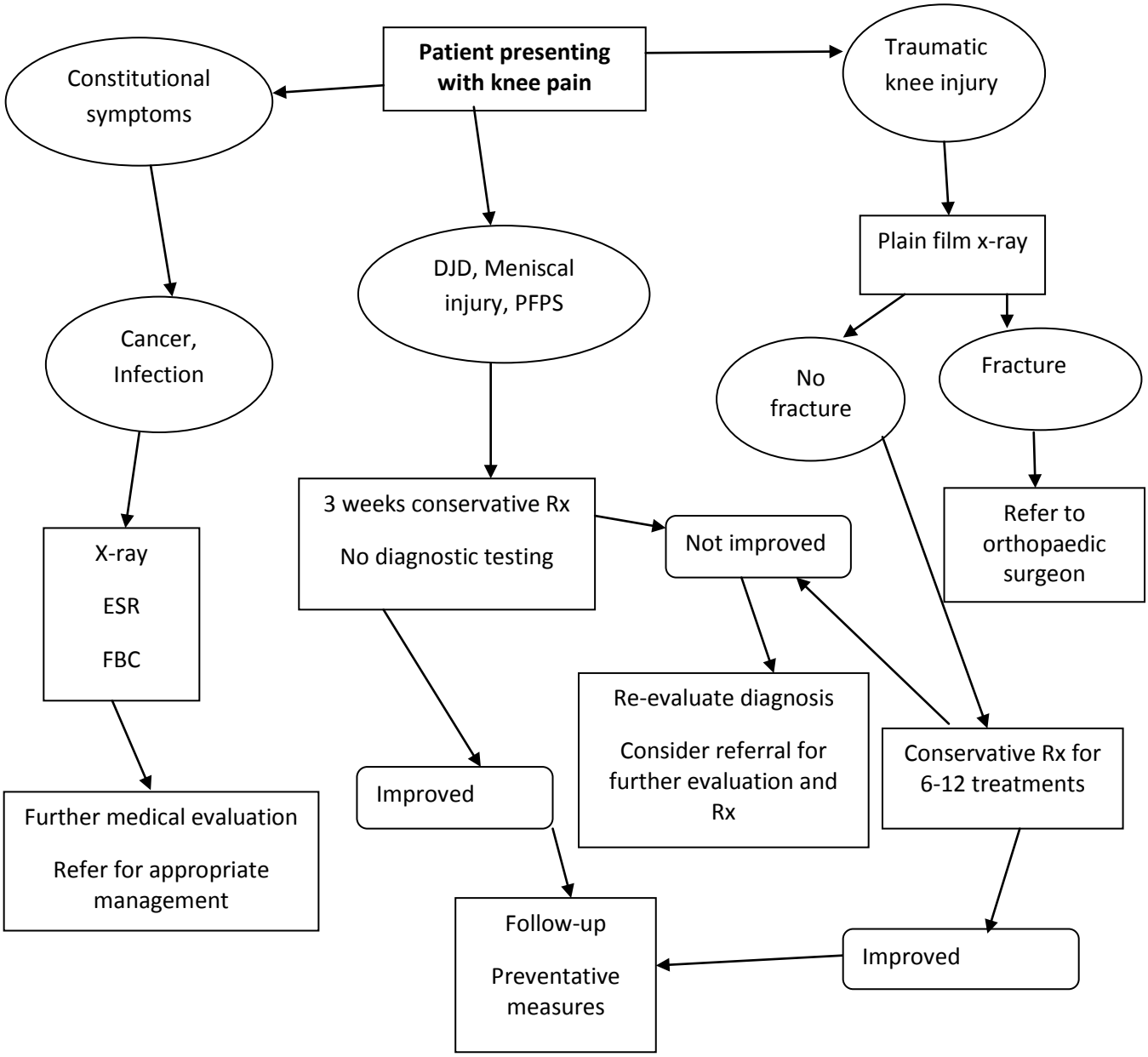
2.4. THE CORRELATION BETWEEN THE CLINICAL AND RADIOGRAPHIC FINDINGS

Radiographic findings may be non-specific and correlate poorly to the clinical findings. Plain film imaging may not be sensitive in identifying soft tissue causes of knee pain which may, therefore, be missed by the clinician (Morgan *et al.*, 1997).

Many asymptomatic individuals may also have abnormal radiographic findings (Morgan *et al.*, 1997). This leads to doubt whether an abnormal structure appearing on radiography is the actual cause of the presenting symptoms in symptomatic individuals. Asymptomatic individuals have been observed to have abnormalities such as degenerative changes of the knee joint visible on plain film radiographs (Morgan *et al.*, 1997). Researchers at a college of radiologists evaluated the use of knee radiographs by general practitioners (Morgan *et al.,* 1997). They correlated the patients' history and physical examination findings with the radiographic findings. It was observed that 90% of the knee radiographs were diagnosed as normal or had features of degenerative changes that were previously clinically suspected. The majority of the knee radiographs taken at the college, therefore, had no evidence of pathology or incidental findings supporting the view that many radiographs of the knee are unnecessarily taken (Morgan *et al.*, 1997).

2.5. AN OVERVIEW OF THE MANAGEMENT OF KNEE PAIN

The management of a patient with knee pain depends on the presenting condition and the health care professional in charge. Chiropractors will utilise manual therapy most often, whereas medical doctors will utilise pharmacological interventions and orthopaedic surgeons will proceed with surgical intervention. A general algorithm for the management of knee pain adapted from Palmer and Toombs (2004) and Hertling and Kessler (2006) is presented in **Figure 2.1**.



Key: Rx = treatment; PFPS = patello-femoral pain syndrome; ESR = erythrocyte sedimentation rate; FBC = full blood count; DJD = degenerative joint disease

Figure 2.1 Suggested algorithm for the management of knee pain

(Adapted from Palmer and Toombs (2004); Hertling and Kessler (2006)

When managing any musculoskeletal disorder, including knee pain, the initial protocol is to exclude any serious underlying pathology (Main and de C Williams, 2002). The more serious causes of knee pain need to be identified early and the patient must be referred for the most appropriate management. The management may include both imaging and diagnostic tests. Diagnostic tests may include blood tests such as ESR, FBC and C-reactive protein (CRP) whereas the imaging tests may include plain film radiographs, ultrasound, MRI and CT scans. The results of these investigations will inform the clinician whether the patient

requires referral for conservative, medical or surgical management. The main goal of treatment when managing knee pain is to reduce pain and inflammation and to maintain or restore range of motion and function.

After the initial evaluation of a patient and there is no evidence of underlying serious pathology, the initial treatment should be conservative management for six weeks (Hertling and Kessler, 2006). Conservative management of knee pain may include exercise, stretching and strengthening, heat and cryotherapy, other soft tissue techniques (e.g. massage, dry needling, acupuncture, soft tissue manipulation), patient education and modification of activity. If it is necessary, the patient may be advised to take medication such as non-steroidal anti-inflammatory drugs (NSAIDs) and, if required manual therapy may be utilized to maintain or increase range of motion (Palmer and Toombs, 2004).

An important aspect of patient management is patient education. It is important that the patient understands the cause of the knee pain, the role of the investigations performed and how they relate to the patient's condition and the recommended management protocol. Although a patient may be advised to limit bed rest and increase mobility, the clinician should advise activities that are not strenuous or exacerbate pain. Activities such as stretching in the pain free range of motion and strengthening of specific muscle groups are suggested to the patient and the patient is instructed to return to normal activity when there has been a significant response to treatment (Palmer and Toombs, 2004; Hertling and Kessler, 2006).

After the initial period of conservative management of approximately six weeks, the patient should be re-evaluated to determine if there has been any improvement. If there has been no improvement, the patient should be sent for radiographic imaging of the knee in anticipation of identifying anatomical changes, biomechanical anomalies, degenerative changes and the development of possible red flags. These radiographic findings will guide the clinician on the next step of patient management. Fractures, infections or malignancies, are classified as medical emergencies and require immediate referral for medical or surgical management (Cooperstein and Gleberzon, 2004; Palmer and Toombs, 2004).

2.5.1. CHIROPRACTIC MANAGEMENT OF KNEE PAIN

The initial approach of a chiropractor to the management of knee pain is to evaluate the patient and determine if the patient has any red flags. If these are present the patients should be referred for medical evaluation and management. If there is no evidence of serious pathology, the condition may be managed conservatively for at least six weeks. However, if there is no response to the management after this period, the patient should be re-evaluated, referred for further investigations or to another clinician for a second opinion (Palmer and Toombs, 2004).

During the assessment of the patient, the clinician should assess for the presence of indications and contra-indications to manipulative therapy. Indications for manipulative therapy include knee joint (patella-femoral, tibio-femoral, tibio-fibular joints) dysfunction and myofascial pain syndromes (Wieting, 2008). However, there are relative and absolute contra-indications to manipulation. Relative contra-indications refer to the conditions such as osteoporosis and inflammatory arthritis which require modification of technique during manipulation. Absolute contra-indications to manipulation include malignancy, infection and joint instability or ligament laxity (Wieting, 2008).

There are many management options available to the chiropractor. These include manual therapies (including manipulation or mobilisation), soft tissue techniques (including massage, dry needling, ischaemic compression and soft tissue manipulation), electrotherapy (IFC, ultrasound, TENS) and patient education (Palmer and Toombs, 2004). Patient education involves advice on lifestyle modification as well as the teaching of stretches and specific exercises (Palmer and Toombs, 2004).

There are several treatment modalities available to the chiropractic students at the Chiropractic Day Clinic (CDC) at the Durban University of Technology (DUT) for the treatment of patients (Chiropractic Clinic Manual, 2010). Manual therapy is the primary modality utilised by the student at the CDC. The manual therapy techniques are often utilised in combination with soft tissue techniques, electrotherapy, stretching and strengthening exercises and other techniques such as heat and cryotherapy. Soft tissue techniques include dry needling, massage, ischaemic compression and soft tissue manipulation techniques and electrotherapeutic modalities available include ultrasound, IFC and TENS. Proprioceptive neuromuscular facilitation (PNF), static stretches and strengthening exercises are included when appropriate.

It is stated in the CDC Radiographic Guidelines and Procedures that radiographs should not be used as a tool for general screening and should only be requested if they will contribute

significantly to patient diagnosis or management. The radiographs should be used to confirm or refute a clinical diagnosis that was suggested by the clinical history or physical examination. The intention of these guidelines is to decrease the amount of ionizing radiation the patients are exposed to when undergoing radiographic imaging and avoiding the taking of unnecessary radiographs (Chiropractic Clinic Manual, 2010).

2.6. CONCLUSION

Knee pain is the second most common presenting musculoskeletal complaint. There are many different causes of knee pain ranging from benign to serious causes. There have been attempts by several researchers to link specific features in the clinical history and physical examination, but the results are conflicting. Radiographs have been utilised to identify serious pathologies and have been utilised by chiropractors to aid in the diagnosis of knee pain. However, it has been observed that clinical findings poorly correlate with radiographic findings (Morgan *et* al., 1997). Although guidelines for the use of radiographs have been provided to eliminate the overuse of radiographs, researchers have observed that often there is overuse of radiographs in clinical practice (Morgan *et al*., 1997).

Radiographs of the knee are used to provide information when formulating a diagnosis, identifying contra-indications to manipulative therapy, following degenerative processes and identifying red flag conditions that require referral for the necessary assessment and management. Therefore, the aim of this study is to determine whether there is an association between the clinical and the radiographic diagnoses of patients who present with knee pain at a chiropractic teaching clinic and whether radiographs of the knee influence a change in the diagnosis or management of these patients.

CHAPTER THREE

MATERIALS AND METHODS

3.1. STUDY DESIGN

This research was designed as a retrospective, non-experimental study. Data was obtained from knee radiographs and the corresponding patient files of patients who presented to the Chiropractic Day Clinic (CDC) at the Durban University of Technology (DUT) with knee pain from 1 January 1997 to 31 December 2010. Ethical clearance for this study was obtained from the Faculty of Health Sciences Research Committee at DUT (**Ethical clearance certificate number: 006/11**).

3.2. PATIENT CONFIDENTIALITY

Throughout the process of this study, steps were taken to maintain the confidentiality of the patients. Before any examination or treatment at the CDC all patients are required to sign an informed consent form. By signing the informed consent form, they provided written consent to the use of their clinical and radiographic records for the purpose of research and strict guidelines (according to DUT policy) were followed to maintain the confidentiality of the patients. Codes were assigned to all patient names and recorded on a data sheet (**Appendix 2**). These codes were then used instead of patient names in all documentation that followed. Patient names were not recorded in this dissertation or any publication likely to follow from this research. Access to patient files and radiographs was restricted to the researcher and the supervisor.

3.3. SAMPLING METHOD AND SAMPLE SIZE

In this study, purposive sampling was used. Data sheets (**Appendix 1**) were used to record all information. Knee radiographs of patients who presented to the CDC with knee pain taken during the management at the CDC from 1 January 1997 to 31 December 2010 were included in this sample. A total of 176 knee radiographs were found in the archives at the CDC at the end of December 2010. Patient files and radiographs which did not meet the inclusion and exclusion criteria were excluded. Therefore, the final sample size in this study was 146.

3.4. INCLUSION AND EXCLUSION CRITERIA

3.4.1. INCLUSION CRITERIA

1. Clinical files of patients who presented to the CDC for treatment of knee pain.
2. Radiographs of the knee must have been taken during or prior to the selected patient's treatment at the CDC.
3. A minimum of an antero-posterior (AP) and lateral knee views were required.

3.4.2. EXCLUSION CRITERIA

1. Radiographs of the knee taken prior to the first consultation at the CDC.
2. Any patient files with no patient history, physical examination, knee orthopaedic examination and a SOAPE (Subjective, Objective, Assessment, Plan and Education) note corresponding to the date of the radiographic examination.
3. Any radiographs which were not reported by a radiologist or if the radiology report was missing.

3.5. RESEARCH PROCEDURE

This study took place in three phases:

Phase 1

Radiographs from the CDC archives were sorted and all knee radiographs were placed aside. The patients' names and date of birth were recorded on a data sheet (**Appendix 2**). This was done to locate the corresponding patient files using the CDC computer archive system. A code was then assigned to each patient's name. The data sheets with patients' names were destroyed using a shredder once a code had been assigned to each patient. These codes were used on all other data sheets.

Phase 2

All radiographs and patient files were briefly inspected and evaluated in order to determine if they met the inclusion criteria.

Phase 3

Knee radiographs and the corresponding patient files were evaluated and the following data was recorded (**Appendix 1**) as shown in **Table 1:**

Table 3.1 Data collected and the source of the data

Data collected	Source
Code and basic demographic information: code, age, gender, ethnicity	Patient confidentiality coding sheet (Appendix 2) and case history form
Date of the initial consultation	Case history form and SOAPE note
Main complaint (knee pain with/without radiation)	Case history form
Outline of treatment before radiographs*	SOAPE note
Reason for radiograph referral/ suspected clinical diagnosis	SOAPE note and/or radiology request form
Date of radiographs	Radiology report and/or identification marker on radiographic films
Radiographic diagnosis	Radiology report
Radiographic incidental findings	Radiology report and/or findings of the researcher (and confirmed by supervisor/radiologist)
Clinical diagnosis after radiographs	SOAPE note
Any change (or no change) in treatment outlines after radiographs	SOAPE note

*** Radiographs refer to the radiographs of the knee**

Table adapted from the approved PG4a proposal of McPhail (2010)

3.6. STATISTICAL ANALYSIS

Version 15.0 of the Statistical Package for the Social Sciences (SPSS Inc, Chicago, Illinois, USA) was used in the analyses of the data in this study.

Method of data analysis:

The association between the radiographic diagnosis and the clinical diagnosis was determined. Diagnoses were categorised into specific groups and indicator variables were used to construct two-by-two tables of absence or presence of radiographic *vs.* clinical diagnosis for each specific diagnosis. This way, the associations between radiographic and clinical diagnoses were assessed for each condition separately. The other objectives were purely descriptive and were analysed and the outcomes reported using frequency tables and bar charts in the case of categorical variables, or summary statistics such as mean, standard deviation and range in the case of quantitative variables (Esterhuizen, 2010).

CHAPTER FOUR

RESULTS

4.1. AGE AND GENDER

One hundred and forty-six patient files and the corresponding knee radiographs were evaluated in this study. The mean (± SD) and range of the age of patients whose clinical files and knee radiographs records were examined are shown in **Table 4.1**. The data of 72 male and 74 female subjects were obtained in this study as shown in **Figure 4.1**.

Table 4.1 **The mean, standard deviation and the range of patients whose clinical files and radiographs were examined**

Age (years)		
N	Valid	146.0
	Missing	0.0
Mean		52.7
Stdev		18.1
Minimum		13.0
Maximum		88.0

Stdev = standard deviation

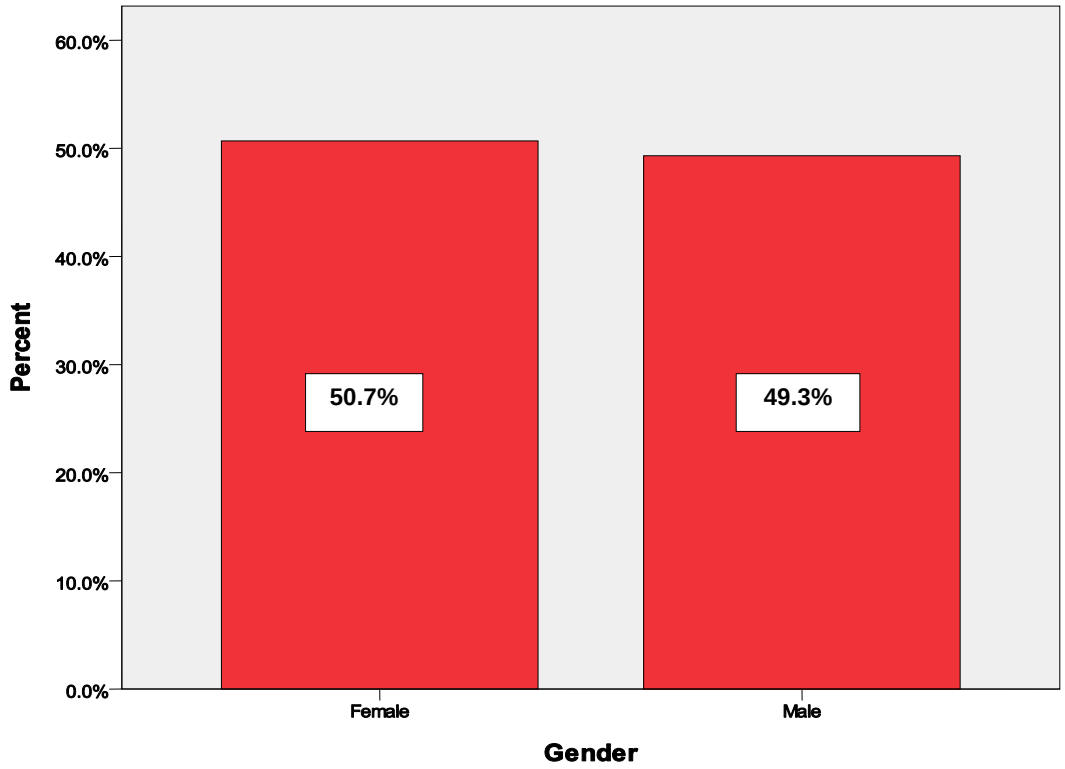


Figure 4.1 Gender distribution

4.2. THE ASSOCIATION BETWEEN THE CLINICAL AND THE RADIOGRAPHIC DIAGNOSES OF PATIENTS WITH KNEE PAIN

The radiographic diagnosis within each type of clinical diagnosis is shown in **Table 4.2.** For degenerative joint disease there was a 97.6% agreement between the radiographic and clinical diagnoses while in Osgood Schlatter's disease the agreement was 100%, and in chondromalacia patella the agreement was 50%. However, there was no agreement between the clinical and radiographic diagnoses for each of the other specific conditions. The other specific conditions refer to those which affect soft tissue structures around the knee, but are not visible on radiographs. These include ligament pathology e.g. ACL tear and LCL sprain, and medial meniscal pathology. Overall, there was a 55.5% agreement between the clinical and radiographic diagnoses as shown in **Table 4.3**.

Table 4.2 The frequencies of each radiographic diagnosis by clinical diagnosis

Clinical diagnosis	Radiographic diagnosis	Frequency	Percent
ACL tear	NAD	1	100.0
Adductor tendonitis	NAD	1	100.0
Avulsion fracture of tibia	NAD	1	100.0
Chondromalacia patella	Chondromalacia patella	1	50.0
	NAD	1	50.0
	Total	2	100.0
Degenerative joint disease	Degenerative joint disease	80	97.6
	NAD	2	2.4
	Total	82	100.0
Fracture of lateral femoral condyle	NAD	1	100.0
Fracture of patella	NAD	1	100.0
Iliotibial band syndrome	Degenerative joint disease	1	50.0
	NAD	1	50.0
	Total	2	100.0
Infrapatellar bursitis	NAD	1	100.0
Tibio-femoral joint dysfunction	NAD	1	100.0
LCL sprain	Degenerative joint disease	1	50.0
	NAD	1	50.0
	Total	2	100.0
MCL sprain	NAD	2	100.0
Medial meniscal pathology	Degenerative joint disease	3	60.0
	NAD	2	40.0
	Total	5	100.0
None	Degenerative joint disease	5	83.3

	Osteochondritis dessicans	1	16.7
	Total	6	100.0
Osgood Schlatter's disease	Osgood Schlatter's disease	1	100.0
Patella tendonitis	Degenerative joint disease	1	25.0
	Medial meniscal damage	1	25.0
	NAD	2	50.0
	Total	4	100.0
Patello-femoral pain syndrome	Chondromalacia patella	3	12.5
	Degenerative joint disease	14	58.3
	NAD	7	29.2
	Total	24	100.0
Piriformis syndrome-referral to the knee	NAD	1	100.0
Popliteus muscle spasm	Degenerative joint disease	1	100.0
Postero-medial instability	NAD	1	100.0
Prepatellar bursitis	NAD	2	100.0
Rheumatoid arthritis	Degenerative joint disease	1	100.0

ACL= anterior cruciate ligament; LCL= lateral collateral ligament; MCL= medial collateral ligament; NAD = no abnormality detected

Table 4.3 The agreement between the clinical and radiographic diagnoses

Agreement		Frequency	Percent
Valid	No	65	44.5
	Yes	81	55.5
	Total	**146**	**100.0**

4.3. THE CONSULTATION WHEN A RADIOGRAPH WAS REQUESTED AND THE REASONS THEREOF

The consultation at which knee radiographs were requested by the student or clinician and the reason(s) for referral are shown in **Table 4.4.** The majority of the knee radiographs were requested at the initial consultation and as the length of treatment increased, the frequency of radiograph requests decreased. It is interesting to note that no knee radiographs were requested at treatment 9 and after treatment 10, only one radiograph was requested at treatments 16 and 19.

The most common reasons for the referral for radiographs were to identify degenerative changes and to evaluate unspecified pathology (**Table 4.4**). The term 'unspecified pathology' refers to any pathology that the student or clinician suspected on consultation, but did not state on the referral form which pathology was suspected. This was a common observation in this study group, with 33.6% (*n* = 49) of knee radiographs being requested without providing a specific pathology that was suspected. It was also noted that eight radiographs were requested to evaluate the reason why the patient was not responding to treatment **(Table 4.4)**. Surprisingly, this was the reason provided for requesting a few radiographs at treatments 1 and 2.

There were circumstances where the student or clinician referred patients for radiographs as there were red flags present. The conditions suspected included avascular necrosis (AVN) of the knee, tumours and fractures. These radiographs were requested at treatment 1. Interestingly, a radiograph was ordered at treatment 16 to determine calcification of the patella tendon.

Table 4.4 A summary of the consultation at which knee radiographs were requested and the reasons thereof

Treatment number	Frequency	Percent	Reason for radiographic referral
1	99	67.8	• Degeneration (47.5%) • Unspecified pathology (37.4%) • Fracture (5.1%) • No response to treatment, instability or pathology, degeneration or pain progression, AVN or fracture, rule out OCD, rule out OCD or degeneration, OCD or tumour, degeneration or tumour, degeneration or fracture, degeneration or pathology (1.0% each)
2	16	11.0	• Degeneration (62.5%) • Unspecified pathology (25.0%) • No response to treatment, fracture (6.2% each)
3	6	4.1	• Degeneration (50.0%) • Unspecified pathology (33.3%) • Suspected arthropathy (16.7%)
4	4	2.7	• Degeneration (50.0%) • Unspecified pathology, trauma (25.0% each)
5	4	2.7	• Unspecified pathology (50.0%) • Degeneration, meniscal pathology (25.0% each)
6	4	2.7	• Degeneration (75.0%) • No response to treatment (25.0%)
7	4	2.7	• Degeneration (75.0%) • Unspecified pathology (25.0%)
8	4	2.7	• No response to treatment (50.0%) • Degeneration, unspecified pathology (25.0% each)
10	3	2.1	• No response to treatment (66.7%) • Unspecified pathology (33.3%)
16	1	0.7	• Calcification of patella tendon
19	1	0.7	• No response to treatment
Total	**146**	**100.0**	

OCD = osteochondritis dessicans; AVN = avascular necrosis

4.4. SUSPECTED CLINICAL DIAGNOSES AND MANAGEMENT PRIOR TO REFERRAL FOR KNEE RADIOGRAPHS

The management options for each of the clinical diagnoses are summarized in **Table 4.5** and show that many treatment approaches were utilized for these conditions. Manual therapy included knee joint manipulation, knee joint mobilisation or patella mobilisation. Modalities such as ischaemic compression, dry needling and massage of myofascial trigger points are referred to as soft tissue techniques. Electrotherapy modalities refer to treatments such as interferential current therapy (IFC), ultrasound and transcutaneous electrical nerve stimulation (TENS) which were used in the treatment of patients presenting with knee pain. Stretching and strengthening included static stretches, proprioceptive neuromuscular facilitative (PNF) stretches or strengthening exercises. The category 'other' included treatments such as heat, ice or strapping (**Table 4.5; Figure 4.2**).

The most frequently utilized modalities in the management of patients with knee pain prior to the request of radiographs included manual therapy, electrotherapy and soft tissue techniques (**Figure 4.2**).

Table 4.5 Suspected clinical diagnosis and management prior to radiographic referral

	Manual therapy	Soft tissue techniques	Electrotherapy	Stretching or strengthening	No treatment, pending x-ray results	Other
ACL tear	✓	×	×	×	×	×
Adductor tendonitis	✓	×	×	✓	×	×
Avulsion fracture of tibia	×	×	×	×	✓	×
Chondromalacia patella	✓	✓	✓	×	×	×
Degenerative joint disease	✓	✓	✓	✓	✓	×
Diagnosis pending x-ray results	×	×	×	×	✓	×
Fracture of lateral femoral	✓	✓	×	×	×	✓

condyle						
Fracture patella	×	×	×	×	✓	×
Iliotibial band syndrome	✓	✓	×	✓	×	×
Infrapatellar bursitis	✓	✓	✓	✓	×	×
Tibio-femoral joint dysfunction	×	✓	✓	×	×	×
LCL sprain	✓	×	✓	✓	×	✓
MCL sprain	✓	✓	✓	✓	×	×
Medial meniscal pathology	✓	✓	✓	×	✓	×
Osgood Schlatter's disease	✓	✓	✓	×	×	×
Patella tendonitis	✓	✓	✓	×	×	×
Patello-femoral pain syndrome	✓	✓	✓	✓	×	×
Pes anserine bursitis	✓	✓	×	✓	×	×
Piriformis syndrome-referral to the knee	✓	✓	✓	✓	×	×
Popliteal muscle spasm	×	✓	×	✓	×	×
Postero-medial instability	✓	×	✓	✓	×	×
Prepatellar bursitis	×	✓	✓	✓	×	×
Rheumatoid arthritis	✓	×	×	×	×	×

✓= yes; ×= no; ACL= anterior cruciate ligament; LCL= lateral collateral ligament; MCL= medial collateral ligament

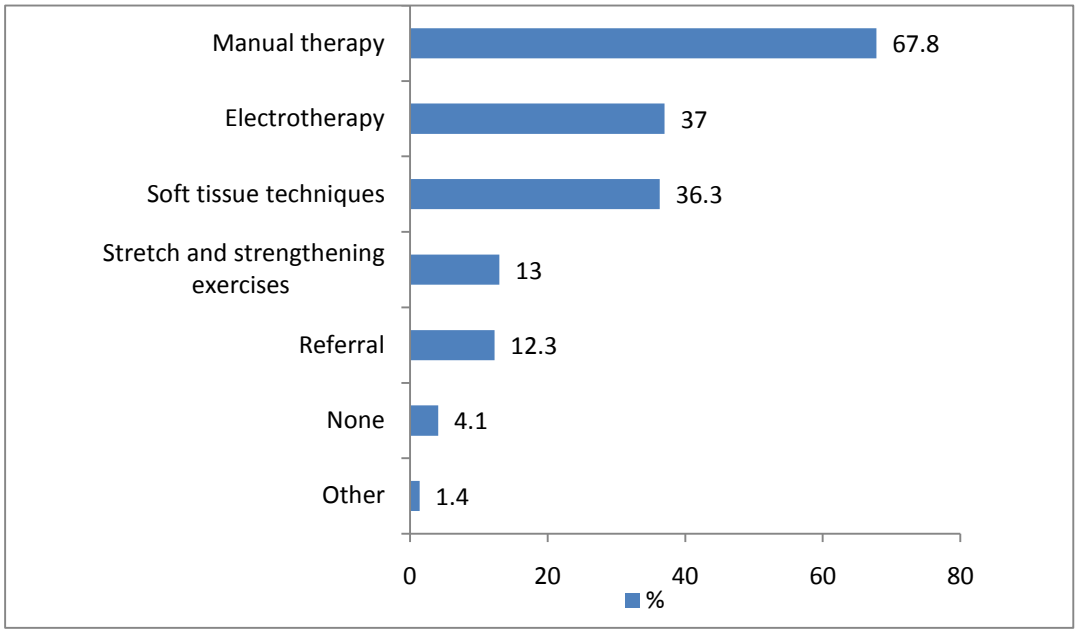


Figure 4.2 Management prior to requests for radiographs

4.5. CHANGES IN CLINICAL DIAGNOSIS AND MANAGEMENT AFTER RADIOGRAPHS

Of the 146 patients whose data is included in the study, 125 did not have a change in diagnosis. This means that 85.6% of the diagnoses remained the same after radiographic examination. There were 21 patients (14.4%) who had a change in the clinical diagnosis following radiographic examination **(Table 4.6)**. There were 33 patients (22.6%) who had a change in management after radiographic examination. After radiographic examination, the most common suspected clinical diagnoses changed to degenerative joint disease, chondromalacia patella and osteochondritis dessicans.

The change in patient management after the student or clinician had received the radiographic report is shown in **Figure 4.3**. Manual therapy was utilised more often after radiographs were obtained (82.9%), than before the radiographs were taken (67.8%). Across the spectrum of all treatment modalities, all of the modalities were used more often after radiographs were obtained. The percentage of patients being referred after the radiographs were obtained was 6.8% which was a significant decrease from 12.3% of patients being

referred before radiographs were taken. This is evident when comparing **Figures 4.2** and **4.3.**

Table 4.6 Details of change of diagnosis

Suspected clinical diagnosis	Radiographic diagnosis	New clinical diagnosis
Patello-femoral pain syndrome	• Degenerative joint disease (75.0%) • Chondromalacia patella (25.0%)	• Degenerative joint disease (75.0%) • Chondromalacia patella (25.0%)
Diagnosis pending x-ray results	• Degenerative joint disease (83.3%) • Osteochondritis dessicans (16.7%)	• Degenerative joint disease (83.3%) • Osteochondritis dessicans (16.7%)
MCL sprain	• Degenerative joint disease	• Degenerative joint disease
Patella tendonitis	• Normal	• Medial meniscal pathology
Pes anserine bursitis	• Degenerative joint disease	• Degenerative joint disease
Fracture	• Normal	• Prepatellar bursitis
Iliotibial band syndrome	• Degenerative joint disease	• Degenerative joint disease
Medial meniscal pathology	• Degenerative joint disease	• Degenerative joint disease

MCL= medial collateral ligament

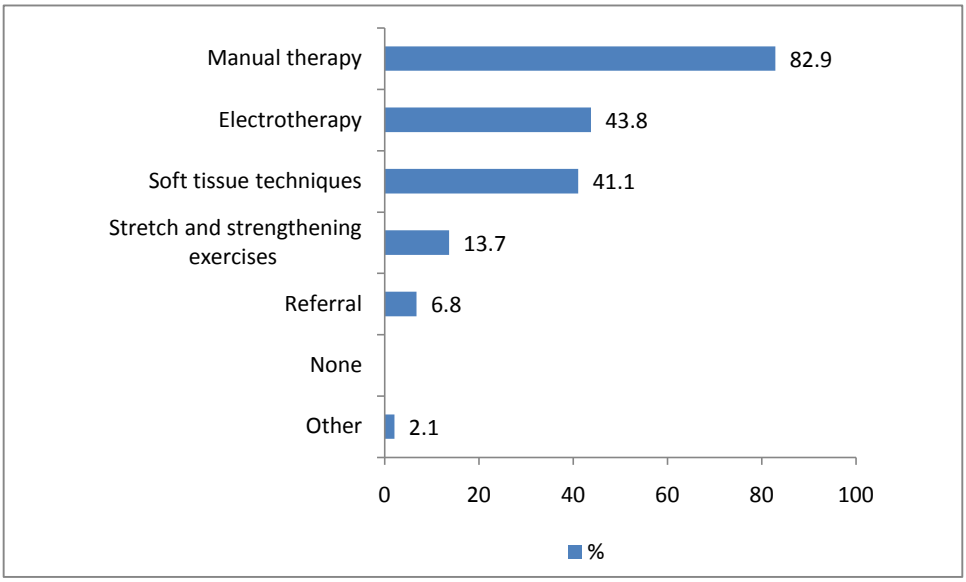


Figure 4.3 Management of the patients after knee radiographs were obtained

4.6. INCIDENTAL RADIOGRAPHIC FINDINGS

There were 41 (28.2%) incidental findings observed in the 146 knee radiographs of which 15.1% (*n* = 22) were fabellae and 9.6% (*n* = 14) had evidence of calcification of the popliteal artery. Congenital anomalies in the knee joint were rare with only one case of bipartite patella observed. The incidental findings were most commonly seen in patients diagnosed with degenerative joint disease and patello-femoral pain syndrome (**Table 4.7**).

Table 4.7 Incidental findings and related suspected clinical diagnoses

Incidental finding	Frequency	Percent	Suspected clinical diagnosis
Fabella	22	15.1	• Degenerative joint disease (50.0%) • Patello-femoral pain syndrome (18.2%) • MCL sprain (9.1%) • Prepatellar bursitis, popliteal muscle spasm, avulsion fracture of the tibia, medial meniscal pathology, patella tendonitis (4.5% each)
Calcification of the popliteal artery	14	9.6	• Degenerative joint disease (78.6%) • Pes anserine bursitis, iliotibial band syndrome, MCL sprain (7.1%)
Tibial exostosis	2	1.4	• LCL sprain (50.0%) • Degenerative joint disease (50.0%)
Bipartite patella	1	0.7	• Patello-femoral pain syndrome
Fibula exostosis	1	0.7	• Degenerative joint disease
Myositis ossificans	1	0.7	• Degenerative joint disease
Total	**41**	**28.2**	

MCL= medial collateral ligament; LCL= lateral collateral ligament

CHAPTER FIVE

DISCUSSION OF RESULTS

5.1. AGE AND GENDER

The mean age and range of the patients whose clinical and radiographic records were examined **(Table 4.1)** were comparable to those of the participants of a study at the Royal College of Radiologists in which the mean age was 53 years and the range was 16-90 years (Morgan *et al.,* 1997). The age range observed in this study suggests that patients younger than 13 years and older than 88 years do not visit the Chiropractic Day Clinic (CDC) for treatment, but this conclusion would be erroneous as this study only included data of those patients who presented to the CDC with knee pain and had radiographs taken at some point during their management. There could have been patients who were treated for knee pain at the CDC, but their data was not included due to the exclusion criteria of this study. The number of males and female participants (**Figure 4.1**) were similar to the reports of Morgan *et al.* (1997).

5.2. THE ASSOCIATION BETWEEN THE CLINICAL AND THE RADIOGRAPHIC DIAGNOSES OF PATIENTS WITH KNEE PAIN

The overall agreement between the clinical and radiographic diagnoses is shown in **Table 4.3**. Degenerative joint disease was the most suspected clinical diagnosis and in 97.6% of these cases the radiographic diagnosis confirmed this. This percentage is more than twice the figure reported by Morgan *et al.* (1997) in which 42% of knee radiographs were requested to confirm degenerative changes that had been previously suspected. This indicates the overuse of radiographs ordered to diagnose degenerative joint disease as the majority of the cases were clinically correctly diagnosed since it is relatively easy to do so especially in the late stages due to cardinal features such as joint swelling and crepitus.

Six patients had no clinical diagnosis prior to radiographs being taken (**Table 4.2**). In the patient files and the radiograph request forms the students had recorded 'no diagnosis' or 'diagnosis pending x-ray results'. There was no clinical suspicion of what radiographic condition was suspected and the patient probably should not have been referred for radiographs as it is unethical to do so (Shapiro, 2002; Chiropractic Clinic Manual, 2010). Prior to radiographic examination there was no clinical diagnosis given to these patients which meant that no management protocol could be initiated. Once the radiographs were obtained, the patients were found to have degenerative changes and were diagnosed with degenerative joint disease and osteochondritis dessicans. Degenerative joint disease has specific clinical features and the student or clinician should, therefore, have provided a suspected clinical diagnosis when referring for the radiograph. Osteochondritis dessicans, on the other hand, is difficult to diagnose clinically due to the paucity of clinical features (Jacobs, 2011). One patient in this study was suspected of having Osgood Schlatter's disease which was confirmed radiographically. Osgood Schlatter's disease can be diagnosed clinically as the symptoms are typical and radiographs are ordered to identify the extent of the calcification or to confirm the clinical diagnosis (Chang, 2010).

For all the other specific clinical conditions (**Table 4.2**), there was no agreement between the clinical and radiographic diagnoses. Of all the other specific conditions in 27 cases the radiographs did not show any anatomical changes and, therefore, these were reported to have no abnormality detected (NAD). Another 20 cases were diagnosed with degenerative joint disease after the radiographs were obtained. Degenerative joint disease was the most common radiographic diagnosis in this study and this may be attributed to the higher average age of the patients. Three patients were referred for radiographs as a fracture was suspected in each case (**Table 4.2**). The referral was based on clinical suspicion of a fracture, but there was no evidence of fractures upon radiographic evaluation. It is, however, possible that hairline fractures which are often not visible or are difficult to visualise on radiographs, were missed in these cases (Drabicki *et al*., 2006). Nonetheless, the students in these cases identified red flags in the history and physical examinations and adhered to the Ottawa Knee Rules (**Table 2.4**) by referring the patients for radiographs.

It is evident that at the CDC there is overuse and overreliance on radiographs especially for diagnosing degenerative joint disease. In these cases, students requested radiographs unnecessarily, especially in cases where a clinical diagnosis could have been made. This probably highlights the lack of confidence in making clinical decisions which is further reflected in cases where the students did not provide a suspected clinical diagnosis when referring for radiographs, but only diagnosed their patients once radiographs were obtained. It is unethical to refer patients if no clinical condition is suspected as the patients are

exposed to unnecessary ionizing radiation which may have adverse effects such as the risk of developing cancer or genetic abnormalities (Shapiro, 2002). In the cases of OCD and fracture, the patients were referred for radiographs to confirm the clinical diagnosis which was the correct protocol for requesting radiographic imaging (Chiropractic Clinic Manual, 2010).

5.3. THE CONSULTATION WHEN A KNEE RADIOGRAPH WAS REQUESTED AND THE REASONS THEREOF

It was observed that the majority of radiographs were obtained at the initial consultation (**Table 4.4**) and more than a third were requested without a valid reason being provided as the request forms stated 'unspecified pathology'. Radiographs should not be requested unless there are red flags present or if the patient does not respond to conservative management over a period of six weeks (Palmer and Toombs, 2004; Hertling and Kessler, 2006). In keeping with the evidence-based guidelines for the requests of radiographs (Morgan *et al.*, 1997; Koplas and Schils, 2008), merely stating 'unspecified pathology' or not providing a reason on the radiograph request form is not a proper indication for radiographic evaluation (**Table 2.3**). Therefore, these requests for radiographic imaging were not in keeping with the evidence-based guidelines (Morgan *et al.*, 1997; Koplas and Schils, 2008).

At the CDC, the supervising clinicians are responsible for guiding the students, especially with respect to making accurate clinical diagnoses and decisions, and advising students on the appropriate diagnostic tests and reasons for referral. This also includes guidance on the request for plain film radiographs. After performing a thorough history and physical examination, the students provide a clinical diagnosis based on their findings. As stated in the Chiropractic Clinic Manual under the CDC Radiographic Guidelines and Procedures (Chiropractic Clinic Manual, 2010), the radiographs taken should be used to confirm or reject the clinical diagnosis made by the student. It is observed that a number of referrals for radiographic examination did not abide by these guidelines. This is an interesting observation as all radiographic request forms are signed-off by the clinician on duty before radiographs can be taken. It is recommended that the results of this study be presented to the clinicians at the CDC so that appropriate measures are taken to ensure that patients are not referred for unnecessary radiographs. Furthermore, students should be encouraged to have confidence in their suspected clinical diagnosis and only refer for radiographs in the presence of red flags or non-responsiveness to appropriate treatment.

Some radiographs were utilised to identify soft tissue structures including calcification of the patella tendon (**Table 4.4**). It is not recorded in the patient file why this was the suspected diagnosis. The patient did not respond to treatment and was eventually referred for radiographs at treatment 16. One of the limitations of plain film radiography is that soft tissue structures are poorly visualised except when there is calcification (Yochum and Rowe, 2005), but in this case, it was not evident on the radiograph nor was there evidence of any anatomical abnormalities. Other investigations such as MRI or diagnostic ultrasound or even referral to a medical practitioner are probably more appropriate in the management of patients with suspected soft tissue lesions.

Red flag conditions clinically suspected included fractures, tumours, osteochondritis dessicans, pain progression and no response to treatment **(Table 4.4)**. These patients were appropriately sent for plain film radiographs as the initial investigation. No treatment was given to these patients at the CDC until these red flag conditions were excluded as their presence could alter the management protocol of patients (Palmer and Toombs, 2004).

At treatment six, a radiograph was requested to determine pathology as the patient had not responded to treatment. The patient was diagnosed with degenerative joint disease and treated with manual therapy prior to radiographic examination which was appropriate in keeping with recommendations of Palmer and Toombs (2004). 'No response to treatment' (as in this case) is an accepted reason for the referral for radiographic imaging (Hertling and Kessler, 2006). However, it must be noted that patient response to treatment of degenerative joint disease varies considerably (Allen, 2007; Stauffer *et al.*, 2011) and non-responsiveness is not necessarily a red flag. In this case, the argument is supported by the radiographic examination findings of degenerative joint disease which did not have an influence on the management as this did not change. Perhaps the student could have explored alternative conservative treatment approaches and continued treatment for a little longer. Besides the possible lack of confidence by students in making clinical diagnoses, the overuse and overreliance may also be due to the free radiographic facilities available at the Radiographic Clinic to patients treated at the CDC. It is also possible that students requested radiographs in order for their patients to feel that "something important" was being done to identify their problem.

5.4. THE CLINICAL DIAGNOSIS AND MANAGEMENT OF PATIENTS PRESENTING WITH KNEE PAIN BEFORE AND AFTER RADIOGRAPHY

Of all the patients in this study the majority were diagnosed with degenerative joint disease. This is in agreement with the reported findings of Morgan *et al.* (1997) that 42% of knee patients will have degenerative causes of knee pain. There were six patients who were not diagnosed clinically. It was reported in these cases that the diagnosis was pending the radiographic results (**Table 4.1**). These patients were eventually diagnosed with degenerative joint disease and osteochondritis dessicans once the radiographs were obtained.

A number of treatment modalities were used to manage patients prior to requesting radiographs. Manual therapy which included manipulation and mobilisation was utilised more often than all the other modalities (**Table 4.5**; **Figure 4.2**). Chiropractors utilise manual therapy to decrease pain and increase range of motion and function which may explain why manual therapy was utilised the most. The majority of diagnoses did not influence a change in treatment protocols. Treatments were similar irrespective of the diagnosis. This raises an interesting question as to why a specific diagnosis is required for non-pathological knee pain if all the diagnoses are treated similarly. Another observation was that when the diagnoses were pending radiographic results, no treatment modalities were employed (**Table 4.5**) as these patients presented with red flags that were contra-indications to all modalities (Cooperstein and Gleberzon, 2004; Palmer and Toombs, 2004).

In the case of fractures, different management protocols were observed (**Table 4.5**). The patients suspected of having an avulsion fracture of the tibia or patella fracture were not treated prior to the request for radiographs. However, in the case of a suspected fracture of the lateral femoral condyle, the patient was initially managed with manual therapy and soft tissue therapy and then referred for radiographs. Although the pain was recorded as severe, the patient was ambulant and this could have influenced the student to proceed with conservative treatment, although the correct procedure would have been to rule out the suspected fracture and then initiate conservative treatment. In any case, the patient had no response to treatment and was referred for further medical assessment and management.

One hundred and twenty five patients (out of 146) did not have a change in diagnosis. This means that the radiographic examination did not offer any new diagnostic information in 85.6% of the cases which is comparable to the findings of Morgan *et al*. (1997) who

observed that 90% of knee radiographs yielded information that was insignificant or non-diagnostic. They believed that this high percentage indicates the unnecessary referral and the overuse of radiographs at the CDC.

Of the diagnoses that had changed after radiographic examination, 19 patients were diagnosed with degenerative joint disease, osteochondritis dessicans or chondromalacia patella. This observation was also in agreement with those of Morgan *et al.* (1997) who reported that the majority of patients with knee pain have degenerative changes. One patient was diagnosed with medial meniscal pathology and one was diagnosed with a prepatellar bursitis. It was observed that there were no red flag conditions in this group.

In the cases where a fracture was suspected, the radiographic examination showed no changes to the anatomical structures of the knee and was considered normal. The eventual clinical diagnosis was prepatellar bursitis. Prepatellar bursitis is easy to diagnose as it has specific features such as localised swelling over the patella, but there may be similarities with suspected fracture such as severe knee pain, swelling, redness, difficulty with ambulation and even a history of trauma (Drabicki *et al.*, 2006; Cameron and Howard, 2010; Steele, 2011). It is, therefore, likely that there may have been one or more of these features present that made the student suspect a fracture. The diagnosis of prepatellar bursitis also indicated that there was exclusion of the red flag condition (i.e. the fracture). In cases when the student or clinician were unsure of the diagnosis and stated 'diagnosis pending x-ray results' in the patient's clinical file, the patients were eventually diagnosed with degenerative joint disease and osteochondritis dessicans and there was no evidence of serious pathology.

When the diagnosis was changed, it was not always to a totally new diagnosis. For example, anterior knee pain was initially diagnosed as PFPS, but after the radiographic examination, the diagnosis changed to degenerative joint disease or chondromalacia patella. The results of this study show that radiographs were not influential in the diagnosis of patients as the diagnosis did not change in 85.6% of cases. This lends credence to the view that many patients are referred for radiographic examination unnecessarily. When assessing the management of the patients, there was a change in management after radiographs were obtained. All the modalities were used more frequently after radiographic examination (**Figure 4.3**). The most commonly used modality before and after radiographic imaging was manual therapy, an unsurprising finding as the primary treatment modality utilised by chiropractors is manual therapy (Dagenais and Haldeman, 2002). It is also possible that the students were more confident utilising manual therapies once the radiographic examination ruled out pathological conditions.

5.5. INCIDENTAL RADIOGRAPHIC FINDINGS

Incidental findings were observed in 28.2% of the knee radiographs which is greater than the figure of 16.2% reported by Lumbreras *et al.* (2010) for all musculoskeletal conditions. The most commonly observed incidental findings were fabellae followed by calcification of the popliteal artery (**Table 4.7**). The fabellae were evident in individuals of any age and gender and were not significant as they do not have any influence on the knee pain (Lumbreras *et al.*, 2010). Calcification of the popliteal artery was observed in patients above the age of 65 years. The majority of incidental findings are seen in the elderly, especially in those who present with comorbid pathologies (Frier and Fisher, 2010; Lumbreras *et al*., 2010). This was evident in this study as in the cases of calcification of the popliteal artery which was present in ten patients who had comorbid pathologies including hypertension, diabetes mellitus and hypercholesterolaemia, suggestive of peripheral vascular involvement associated with these conditions (Frier and Fisher, 2010).

Tibial and fibular exostoses (also called osteochondroma) were observed in three patients. They are usually asymptomatic, but may cause discomfort if close to the surface or when impinging on underlying structures such as a nerve (Yochum and Rowe, 2005). Sometimes they are covered with a cartilaginous cap which is invisible on a radiograph unless there is calcification (Yochum and Rowe, 2005). Although they are benign, there is a small likelihood of malignant change either in the bony exostosis (osteosarcoma) or in the cartilaginous cap (chondrosarcoma) (Murphey *et al.,* 2000; Yochum and Rowe, 2005; Breitenseher and Dominkus, 2006). Patients with bony exostosis should, therefore, be monitored for any changes suggestive of malignancy.

In the patient with myositis ossificans a history of trauma to the quadriceps muscle was noted. Myositis ossificans is a clinically important incidental finding as it may be a reason why the patient has pain and reduced range of motion in the affected knee and hip (Yochum and Rowe, 2005). The main radiographic differential diagnosis of myositis ossificans is osteosarcoma, but there are differences in the radiographic appearance. Myositis ossificans presents with a calcified peripheral shell and a radiolucent centre whereas the opposite is true for osteosarcoma (Yochum and Rowe, 2005). Nonetheless, it is possible for misdiagnosis. Therefore, it is important to note the history of the patient to identify if there was previous trauma, to examine for red flags and to be familiar with the radiographic appearances of bone diseases such as osteosarcoma.

5.6. PROPOSED RECOMMENDATIONS FOR THE CHIROPRACTIC DAY CLINIC

The following recommendations are proposed for the Chiropractic Day Clinic based on the results of this study:

- The supervising clinicians should encourage all students to base their clinical diagnosis on history and physical examination findings and to have confidence in their clinical approach.

- The guidelines for the referral for radiographs stated in the Chiropractic Clinic Manual should be adhered to. An improvement in the confidence in the clinical diagnosis together with adhering to the guidelines for radiograph referral will ensure that patients are not sent for unnecessary radiographs. The radiographic request form should never include 'unspecified pathology' or 'no diagnosis' as reasons for referral as it is unethical to do so. If radiographs are requested at the initial consultation, this should only be done if there are red flag conditions present.

- Patients presenting with suspected red flag conditions should not be treated conservatively at the CDC until these have been excluded.

- It should be noted by clinicians and students that not all red flag conditions (e.g. tumours) are visible on radiography. This may be due to early stages of a disease or the radiographic latent periods or the poor visualisation of soft tissue structures on plain film radiographs (Yochum and Rowe, 2005). Patients suspected of malignancy should be referred for another opinion and further assessments.

- All changes, to the clinical and radiographic diagnoses or management, should be recorded correctly in detail in the SOAPE note. This is important for new students or locum students who take over and in medico-legal cases.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

The association between the clinical and the radiographic diagnoses of knee pain were determined in this study. Diseases with strong agreements between clinical and radiographic diagnoses included DJD, Osgood Schlatter's disease and chondromalacia patella. However, there was no agreement for each of the other specific knee conditions. Of the knee radiographs taken at the CDC the majority were requested at the initial consultation and as the length of treatment increased, the frequency of radiograph requests decreased. The most common reasons for referral for radiographs were to identify degenerative changes (47.5%) and to evaluate unspecified pathology (37.4%). Of the 146 patients in this study, 125 patients did not have a change in diagnosis after radiographs were obtained which means that 85.6% of diagnoses remained the same after radiographic examination. There was a wide range of treatment modalities utilized in the management of patients with knee pain, including soft tissue therapy, electrotherapeutic modalities and manual therapy. The use of manual therapy increased from 67.8% prior to radiographs being taken to 82.9% after radiographs were obtained. This indicates that findings on radiography did influence the conservative management of patients presenting with knee pain at the CDC.

It was observed that radiographs are not requested following the evidence-based guidelines as in the case of 'unspecified pathology'. Knee radiographs were over-utilized at the CDC and the findings on radiography did not influence the diagnosis of the patients presenting with knee pain. This indicates the large amount of patients at the CDC who presented with knee pain who were sent for radiographs unnecessarily.

6.2 RECOMMENDATIONS

Recommendations for future studies include the following:

- To determine if these findings are similar to other teaching clinics in South Africa or if they are unique to the CDC at DUT. A similar study should be carried out at the University of Johannesburg Chiropractic Clinic or at another teaching clinic.
- A similar study could be conducted with a sample of private chiropractic practices to determine a comparison between an academic environment of a teaching clinic and the environment of private practice.

The findings of this study should be presented to the clinicians and the students at the CDC to provide information to improve clinical practices at the CDC.

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Appendix 1: Data Sheet

Age		**Gender**		**Ethnicity**		**Code**	

Main complaint **Date of Initial consultation: ____/____/____.**	
Clinical diagnosis/ differential diagnosis	

Treatment prior to x-rays					
Manual therapy	Soft tissue techniques	Electrotherapy	Stretching or strengthening	Referral	Other

Reason for x-ray referral (suspected diagnosis) **Treatment Number: _____.** **Date of x-ray: ____/____/____.**	
Radiological diagnosis	
Incidental findings on x-ray	

Change in clinical diagnosis after x-rays?	Yes	No
New diagnosis		
Change in treatment after x-rays?	Yes	No

Change of treatment after x-rays					
Manual therapy	Soft tissue techniques	Electrotherapy	Stretching or strengthening	Referral	Other

Appendix 2: Patient confidentiality coding sheet

File Number	Patient Name	Date of Birth	Code

DURBAN UNIVERSITY of TECHNOLOGY

Faculty of Health Sciences

ETHICS CLEARANCE CERTIFICATE

Student Name	Miss Chantelle Ann Damon	**Student No**	20602038
Ethics Reference	006/11	**Date of FRC Approval**	28.02.2011
Qualification	M. Tech. Chiropractic		
Research Title:	The role of plain film radiography in the diagnosis and management of knee pain.		

In terms of the ethical considerations for the conduct of research in the Faculty of Health Sciences, Durban University of Technology, this proposal meets with Institutional requirements and confirms the following ethical obligations:

1. The researcher has read and understood the research ethics policy and procedures as endorsed by the Durban University of Technology, has sufficiently answered all questions pertaining to ethics in the DUT 186 and agrees to comply with them.
2. The researcher will report any serious adverse events pertaining to the research to the Faculty of Health Sciences Research Ethics Committee.
3. The researcher will submit any major additions or changes to the research proposal after approval has been granted to the Faculty of Health Sciences Research Committee for consideration.
4. The researcher, with the supervisor and co-researchers will take full responsibility in ensuring that the protocol is adhered to.
5. ***The following section must be completed if the research involves human participants:***

	YES	NO	N/A
❖ Provision has been made to obtain informed consent of the participants	X		
❖ Potential psychological and physical risks have been considered and minimised			X
❖ Provision has been made to avoid undue intrusion with regard to participants and community	X		
❖ Rights of participants will be safe-guarded in relation to: - Measures for the protection of anonymity and the maintenance of Confidentiality.	X		
- Access to research information and findings.	X		
- Termination of involvement without compromise			X
- Misleading promises regarding benefits of the research			X

[redacted]

03-03-11
DATE

03-03-2011
DATE

7/3/2011
DATE

7:03: 2011
DATE