Ultrasound features of the Deep Infrapatellar Bursa

Dissertation submitted in fulfilment of the requirements for the degree Masters in Technology (M.Tech: Radiography) to the Department of Health Sciences in the Faculty of Science at the Bellville Campus of the Cape Peninsula University of Technology.

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Date of completion: February 2006

Dissertation Contents

Declaration

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I, Merle Neethling-du Toit, hereby declare that the work on which this dissertation is based is my original work (except where acknowledgements indicate otherwise), and that neither the whole work nor any part of it has been, is being or is submitted for another degree at this or any other University or Technikon.

February 2006

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Acknowledgements

I would like to extend my heart-felt gratitude to the following persons who have inspired and assited me during this research.

God, who gave me the ability and motivation to complete this project.

Mrs Maryna von Aulock, my internal supervisor who greatly assisted me with her expertise, caring, motivational and constructive influence.

Dr Richard de Villiers, my external supervisor who helped consistently throughout.

Melissa Dagnin, my colleague and friend at the Radiology department at the Sports Science Orthopaedic clinic, for her neverending understanding and assistance.

The Sports Science Orthopaedic Clinic for making this research possible.
Dr Willem van der Merwe for allowing me to perform the ultrasound examinations on his ultrasound machine.
The staff at the Sports Science Orthopaedic clinic for their wholehearted support.

Kathy McQuaide, from the research department of the Sports Science Institute of South Africa, for her unbelieveable assistance during recruiting and advertising of my project.

Lorenzo Himunchul, expert researcher and statistician at the Bellville campus, Cape Peninsula University of Technology, for his dedicated help and advise during data analysis and processing.

My loving husband, Charl, for all your understanding, love and support.

My parents, Dr & Mrs Neethling and Genl & Mrs du Toit, for their love and encouragement.

To those I have not personally mentioned thank you for the words of encouragement.

"No man is the lord of anything,
Though in and of him there be much consisting,
Till he communicates his parts to others."
-William Shakespeare

Abstract

The knee is one of the most complicated joints in the body. The deep infrapatellar bursa being only a small water-pocket and forming a small part of the knee. The deep infrapatellar bursa can get inflamed and cause great discomfort, especially to professional sportsmen and -women. If such a inflammation is present, a common treament option are to inject a cortisone solution into the bursa for quick relieve and healing.

This study was performed to investigate the specific ultrasound features of a normal deep infrapatellar bursa. Thus enableing more specific and accurate diagnosis of deep infrapatellar bursitis or not, which in turn leads to quicker recovery of the patients.

A total of 280 males and females from various population groups were recruited for the study. Subjects were categorized into different subgroups depending on their gender, ethnicity, competitiveness in sport, sport type practised and previous knee problems. These subgroups enabled a more individual specific DIB measurement.

A high frequency ultrasound examination of both knees of all recruits were performed. The deep infrapatellar bursa was located by slightly flexing the knee and applying not to much pressure with the probe whilst scanning. Three measurements, antero-posterio (AP), cranio-caudal (CC) and width measurements, were recorded of each individuals left and right deep infrapatellar bursa (DIB).

The results of the DIB measurements were compared to results from a ultrasound study performed in Germany and a favourable comparison could be made. MRI studies of the DIB performed in Turkey and Switzerland differed greatly from those of this study and Germany.

This study could serve as a valuable source of reference to sonographer, radiologist and orthopaedic surgeons when investigating the deep infrapatellar bursa. A statistical significant difference was shown for males having a larger DIB than female, for competitive sports people having a larger DIB than non-competitive sports people and also inactive people; and rugby players (as a sport type) have larger DIBs than cricketers, runners, soccer players and cyclists.

Another surprising factor was the amazing ultrasound detection rate of the deep infrapatellar bursa, which allows for future easy and confident assessing of the DIB by ultrasound.

Key words: deep infrapatellar bursa, competitive sport, gender, sport type.

List of Abbreviations

DIB	**Deep Infrapatellar Bursa**
AP	**Antero-posterior**
CC	**Cranio-caudal**
W	**Width**
mm	**millimetres**
vs	**versus**

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CHAPTER 1

INTRODUCTION

1.1 An Introduction to the 'Deep Infrapatellar Bursa'

The knee is a well studied joint and in the sport orientated practice that I work in, it constitutes for approximately 80% of the workload done. Therefore 80% of the radiographic examinations performed for patients visiting the radiology department involves the knee. By choosing the knee as my body part to research was thus an easy, almost logical decision to make.

The idea to have a closer look at the deep infrapatellar bursa originated from discussions between Dr Richard de Villiers, my external supervisor and radiologist on site, and myself.

After further investigation into the topic I found that there were a need for more detailed information about the deep infrapatellar bursa. The need specifically for more individualized patient information about the deep infrapatellar bursa. Any extra information about the deep infrapatellar bursa would help the orthopaedic knee surgeon, by minimizing the amount of cortisone injections given for a suspected deep infrapatellar bursitis. Thus predicting a more accurate bursa size could help differentiate between a normal or an abnormal bursa – adversely indicating a bursitis or not – concluding towards a cortisone injection or not. Thus if not a bursitis further investigation into the patient's problem can commence sooner.

The size of the deep infrapatellar bursa can give an indication if any pathologies are present. Depending on the clinical symptoms and suspected pathology, performing an ultrasound of the deep infrapatellar bursa of the knee, could determine possible treatment for the patient.

1.2 Definitions

bursa - a sac or saclike cavity filled with a viscid fluid and situated at places in the tissues at which friction would otherwise develop. (Dorlands Medical Dictionary, 2005)

tendon – Fibrous tissue that attaches muscles to bones. (Mark Lefers, 2004)
A cord or band of inelastic tissue connecting a muscle with its bony attachment. (www.biology-online.org/dictionary)

infrapatellar – inferior to the patella

deep infrapatellar bursa - The deep infrapatellar bursa is a small "water pocket" in the knee joint, which can become bigger if inflamed. This bursa is situated between the inferior edge of the patellar tendon and the anterior aspect of the tibia. The infrapatellar fat pad separates the deep infrapatellar bursa from the synovial cavity of the knee joint. (Carr et al, 2001:536)

competitive sportsman – Professional sport player/practitioner, training for competitions in a specific sport. Person competing for and striving to be the best in their specific sport type, either individually or as a team.

non-competitive sport – A sport type being exercised by a person who participate for the fun and love of the game or sport modality. The sport is usually practised as a recreational activity.

bursitis – Inflammation of a bursa, patient presenting with redness, swelling and discomfort.

Knee arthroscopy – An invasive procedure of the knee joint, using a small scope (camera) to confirm specific diagnosis.

knee pain - any pain perceived in the knee, anytime during activity or rest.

Antero-posterior – from the anatomical front (anterior) to the back (posterior).

Cranio-caudal - from head towards the feet.

Width measurement - maximum measurement from side to side/ left to right.

1.3 Aim of the study

The aim of this study is to determine the size of the deep infrapatellar bursa for each individual person, regardless of their characteristics. As many subjects as possible will be recruited for bilateral knee ultrasound examinations.

Anyone presenting with anterior knee pain, indicating suspected infrapatellar bursitis will benefit from this study. Ultrasound will be used as the radiographic examination tool to gather the relevant information/data. Ultrasound is an non-invasive examination, cheap to operate or use and painless for the patient with quick results.

Data collected will show either the size of the bursa or the absence of the bursa all together. Measuring three different diameters of the bursa will allow for the volume to be calculated, allowing for comparisons to be made. Thus testing the significance of the different comparisons.

1.4 Problem statement

The ultrasound size of the deep infrapatellar bursa differs depending on a normal or pathological bursa. The difference in size of the deep infrapatellar bursa for different variables are unknown. Therefore by individualising the size of a normal deep infrapatellar bursa, more accurate diagnosis can be made if a bursa is inflammed or whether a normal bigger variant of the infrapatellar bursa is present. The patient's treatment can thus be determined more accurately in a shorter timespan.

1.5 Sub-problems

1. The difference in the size of the deep infrapatellar bursa are unknown for:
    - Males and females,
    - Different population groups,
    - Opposing knees, and
    - People participating in different levels of and different types of sport.

2. The ultrasound detection rate of the deep infrapatellar bursa is currently unknown.

3. The effect on the size of the deep infrapatellar bursa for patients with previous knee injuries, previous knee operations and previous knee arthroscopies, and also patients with present knee pain and/or tendon inflammation are unknown.

1.6 Delimitations

A minimum of 200 adult males and females (400 knees), will be recruited for the study.

Inclusion criteria: Adults between 18 and 55 years.

Exclusion criteria: People aged <18 or >55 years.

People under 18 years of age are likely to have different values before epiphysial closer. (although this fact is not known, it has to be considered for a better result).
Older people over 55 years of age may have different values due to the increasing prevalence of osteoarthritis.

1.7 Assumptions

After collection of numerical data of at least 400 ultrasound examinations, standard reference values for the deep infrapatellar bursa will be calculated. The assumption is being made that for every subgroup identified above, there could be a statistical significant difference between the groups. The ultrasound detection rate of the deep infrapatellar bursa would be higher than suspected in current literature.

By individualising the diameters of the deep infrapatellar bursa for every person, better diagnosis and thus treatment can be offered to patients.

1.8 Research Objectives

1. To investigate the normal size, volume and characteristics of the deep infrapatellar bursa that are presently known.

2. To compare the size of a normal deep infrapatellar bursa of the left and right knees; male and female knees; different population groups' knees; people practising different sport types and competing at different levels of sports' knees.

3. To make the necessary recommendations on the size of the bursa for each individual person being examined.

4. To determine the ultrasound detection rate of the deep infrapatellar bursa.

5. To determine if previous knee injuries, operations and arthroscopy, and present knee pain and/or inflammation have any effect on the size of the deep infrapatellar bursa.

1.9 Hypothesis

The size of the deep infrapatellar bursa would differ depending on a normal or pathological bursa. The diameters of a normal deep infrapatellar bursa for males and females, different population groups, opposing lower limbs and people participating in different levels of and different types of sport would probably include different measurements.

1.10 Ethical considerations

All patients will stay anonymous and patient personal details will be kept private and confidential. Written consent will be obtained from each individual participant. For participants who do not speak or understand English and/or Afrikaans, a translator will be present to explain the questionnaire and ultrasound examination.

In medicine there are sometimes different values for different anatomical structures and the incidence for different pathologies for different population groups may vary. Therefore some pathologies or anomalies may be considered high risk for some population groups, while the same pathology/anomaly may be considered as low risk for another population group. In order to be more individual specific regarding the size of the deep infrapatellar bursa, - different population groups will be specified in this research study. This will enable the researcher to determine if there are indeed any statistical difference in the size of the deep infrapatellar bursa for different population groups in this instance. This discovery may lead to better diagnosis and treatment of each individual patient.

Please note that for this study approval was granted for the study by the Sports Science Orthopaedic Clinic. Please see Appendices 3 and 4 for appropriate letters.
All appropriate ethics approval forms were also submitted to the The Science Faculty Research Ethics Committee at Bellville Campus, Cape Peninsula University of Technology. The only response regarding approval from the university that I could

gather was, and I quote: "The ethics committee sort of stopped function due to a lack of interest/attendance...". Thus I rest my case in that regard.

1.11 Dissertation plan

Chapter 1 gave an overview of how the research topic came along, what the problem statement is, stated the planned objectives of the study and briefly what to expect from the study.

In Chapter 2 an indepth literature review follows – starting with an brief overview of the anatomy of the deep infrapatellar bursa, followed by the ultrasound examination technique for visualizing and measuring of the deep infraatellar bursa. Further the pathology of the deep infrapatellar bursa will be discussed, touching on different types of bursistis and treatmnt options for the physician. Concluding the chapter with a background literature review of the deep infrapatellar bursa.

In Chapter 3 the research design and methodology of the study will be explained. From the data measurement tools, sample design, sampling methods, data collection, data capturing and editing, data analysis to the shortcomings and source of error for the study.

In Chapter 4 the results will be discussed in detail. Stating the mean ultrasound size for the deep infrapatellar bursa. Comparing the DIB measurements of males and female, different population groups, different levels of sport participation (competitive , non-competitive or non-active), and different sport types. Also comparing the DIB volumes of subjects with knee pain, patellar tendonitis, history of previous knee operation and history of previous knee arthroscopy. Eliminated data for the study will be stated and reasons for elimination will be discussed.

Chapter 5 will conclude the dissertation and recommendations for future research will be named.

CHAPTER 2

LITERATURE REVIEW

In this chapter the anatomic and pathologic characteristics of the deep infrapatellar bursa will be discussed, with cross reference to past and present literature. The ultrasound examination technique for visualizing and measuring the deep infrapatellar bursa will also be mentioned.

2.1 Anatomy of the Deep Infrapatellar Bursa

The fact that the knee joint consists of tendons, ligaments, menisci, a capsule, cartilage and more, makes it one of the most complicated joints of the body. Ultrasound has its limitations with the examination of the knee, but by using a high frequency transducer, it is an ideal tool for examining the deep infrapatellar bursa. (Monetti et al., 1995)

The Greek meaning for the word *bursa* is "wine skin". The analogy of the wine skin is quite appropriate, as both bursae and wine skins have their greatest dimensions in length and width. These dimensions provide a large surface area occupying little volume under normal circumstances. (Codman, 1931). When a bursa is situated between two structures, the configuration mentioned above, allows movement and gliding of one structure over the other. Bursae can develop almost anywhere in the body, if unusual pressure and friction are persistently produced in a specified area. (van Holsbeeck & Introcaso, 2001)

Some authors, being anatomists and physicians who perform bursography and bursoscopy, claim that bursae are fluid-filled sacs. Bursae actually contain a lubricant which consist only of a thin film of viscous fluid. The walls of the bursae are thus separated by a thin film of fluid approximately 1mm thick, and bursae are potential spaces becoming only distended fluid-filled sacs when pathological. (van Holsbeeck & Introcaso, 1989)

Bursae can be divided into two groups: (1) communicating and (2) non-communicating. This depends on the bursa's relationship to a joint space. In humans non-communicating bursae are more common. Furthermore, bursae can be classified as subcutaneous or deep, depending on their location. (Canoso, 1981) Located between a bone and the overlying skin are subcutaneous bursae. While deep bursae are situated in different locations deep to the investing fascia; separating the joint capsule, tendons, ligaments and fascial planes. (van Holsbeeck & Introcaso, 2001)

Various bursae are located about the knee joint for purposes of decreasing friction over tendons and bones. See figure 2.1 below.

(1) The suprapatellar bursa is located between the deep surface of the quadriceps femoris muscle and the distal part of the femur. This bursa is in communication with the joint capsule of the knee.

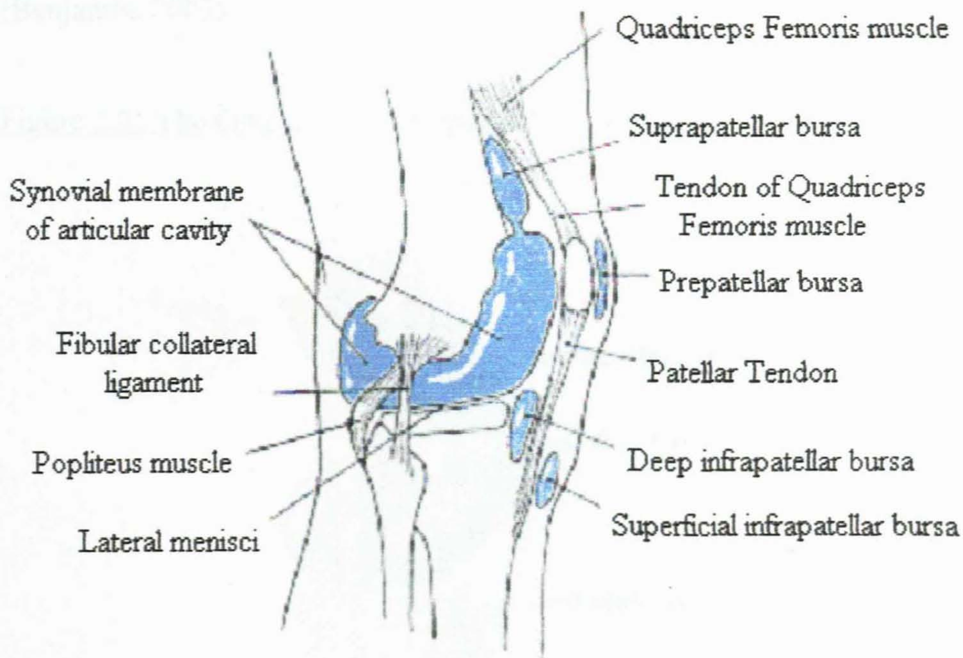
(2) The prepatellar bursa is located between the superficial surface of the patella and the skin.

(3) A superficial infrapatellar bursa is located between the patellar ligament and the skin.

(4) The deep infrapatellar bursa is situated between the proximal tibia and the patellar ligament.

Other bursae about the knee joint decrease friction at the attachment sites of the gastrocnemius, gracilis, sartorius, semitendinosus, and semimembranosus muscles. (Jenkins, 1991)

Figure 2.1: The synovial membrane of the knee joint and the associated synovial bursae.

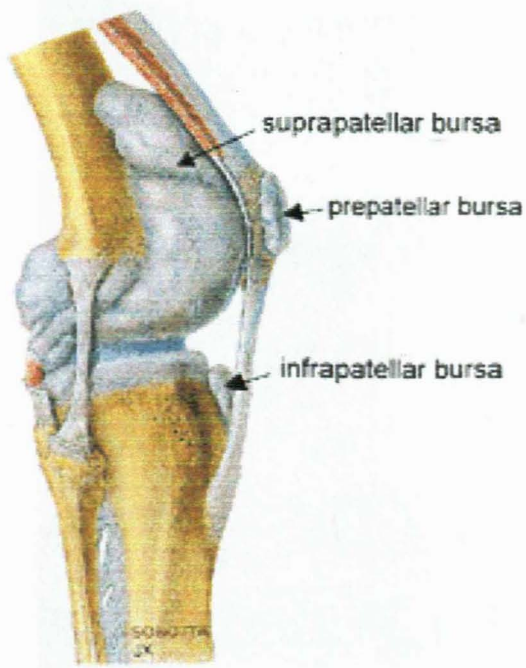


(Jenkins, 1991)

The infrapatellar bursa is located inferior to the patella of the knee, posterior to the patella ligament. It acts as a cushion between the patella ligament and the tibia. When swollen and inflamed, it is painful when kneeled upon and difficult to bend the knee fully. Although it does not limit extension of the knee. This bursa is often injured in conjunction with the quadriceps mechanism, above or below the patella. (Benjamin, 2003)

The causes for an inflamed and swollen bursa could range from subtle malalignments of the knee to impact trauma. Very little is known about why bursitis develops. Excessive movement, due to injured or torn medial and lateral collateral ligaments and anterior and posterior cruciate ligaments, could cause an irritated and inflamed bursa. (Benjamin, 2003)

Figure 2.2: The three anatomic bursae related to the anterior aspect of the knee..



(Benjamin, 2003)

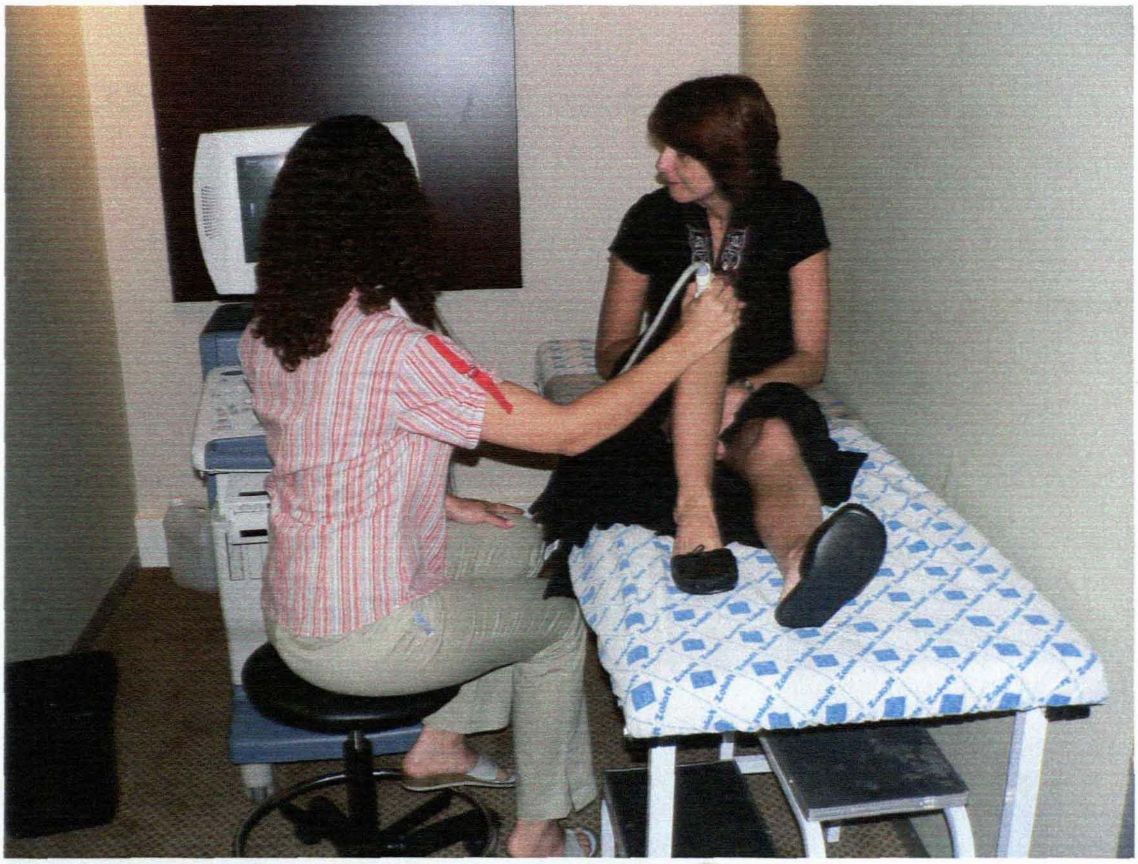
2.2 Ultrasound Examination Technique

As the deep infrapatellar is located in the anterior aspect of the knee, it is easily located and accessible via ultrasound. The location enables the user to use a high frequency linear transducer with ease. For this study a 14MHz frequency was selected on a multi-frequency transducer on a *Nemio 2* ultrasound machine from Toshiba. Even for the slightly more obese patients it was not necessary to select a lower frequency, as the deep infrapatellar bursa were easily seen in its fairly superficial location.

Figure 2.3 : The *Nemio 2* ultrasound machine from Toshiba.

The subject/patient was scanned while sitting on the examination bed with legs straightened. The knee that was being scanned was positioned in slight flexion of approximately 20° to 30°, with the appropriate foot flat on the bed.

Figure 2.4 : Patient demonstrating position.



This slight flexion caused the patellar tendon to be extended and thus given an overall better image of the deep infrapatellar bursa. Care was taken not to apply to much pressure with the transducer head on the area of scanning, as this could cause any small bursa to be flattened and thus not visualised. The right knee was always scanned first – by correctly identifying the deep infrapatellar bursa and taking three different measurements of the bursa. The antero-posterior-(AP), cranio-caudal-(CC) and width (left-to-right) measurements. The measurements were taken at the point where the bursa was maximally visualized – were it slightly inferior, superior, lateral or medial from where expected. The left knee deep infrapatellar bursa was identified and measured, in the same manner as the right side, next.

Figure 2.5: Slight flexion of the knee for measuring the DIB's AP and CC measurements.

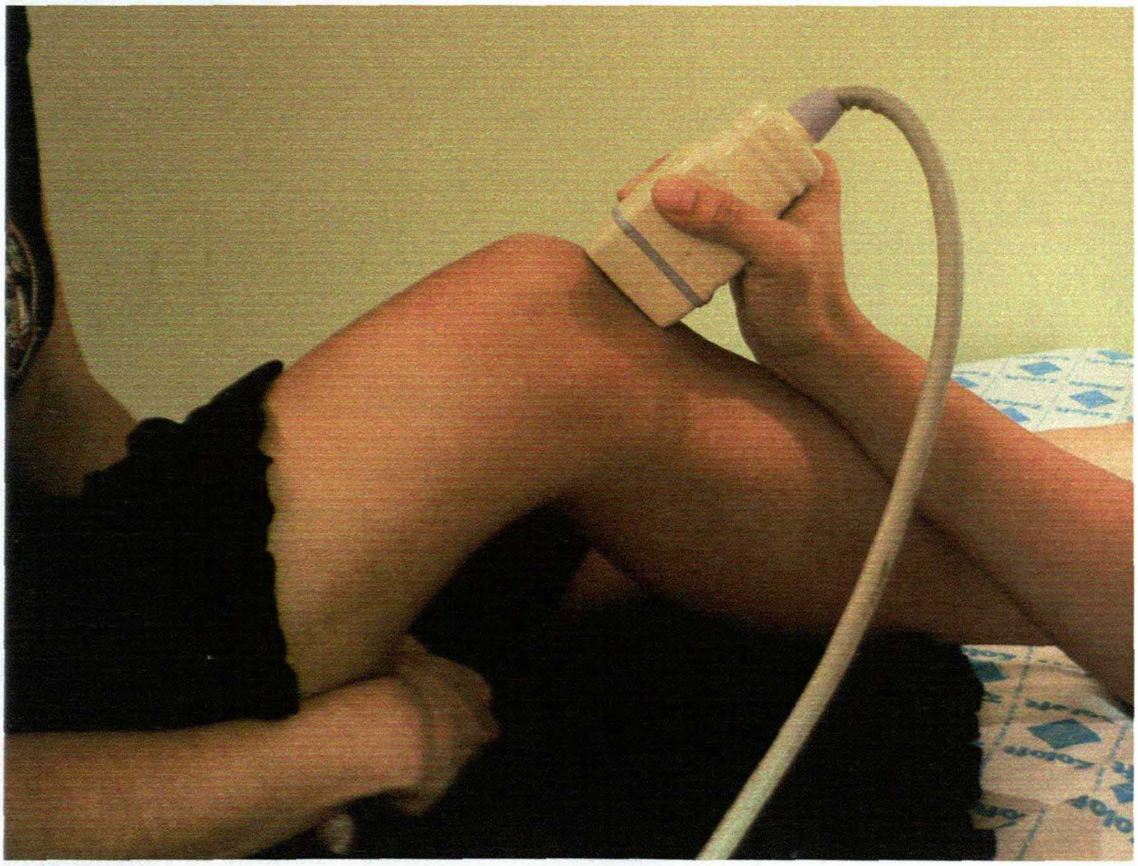
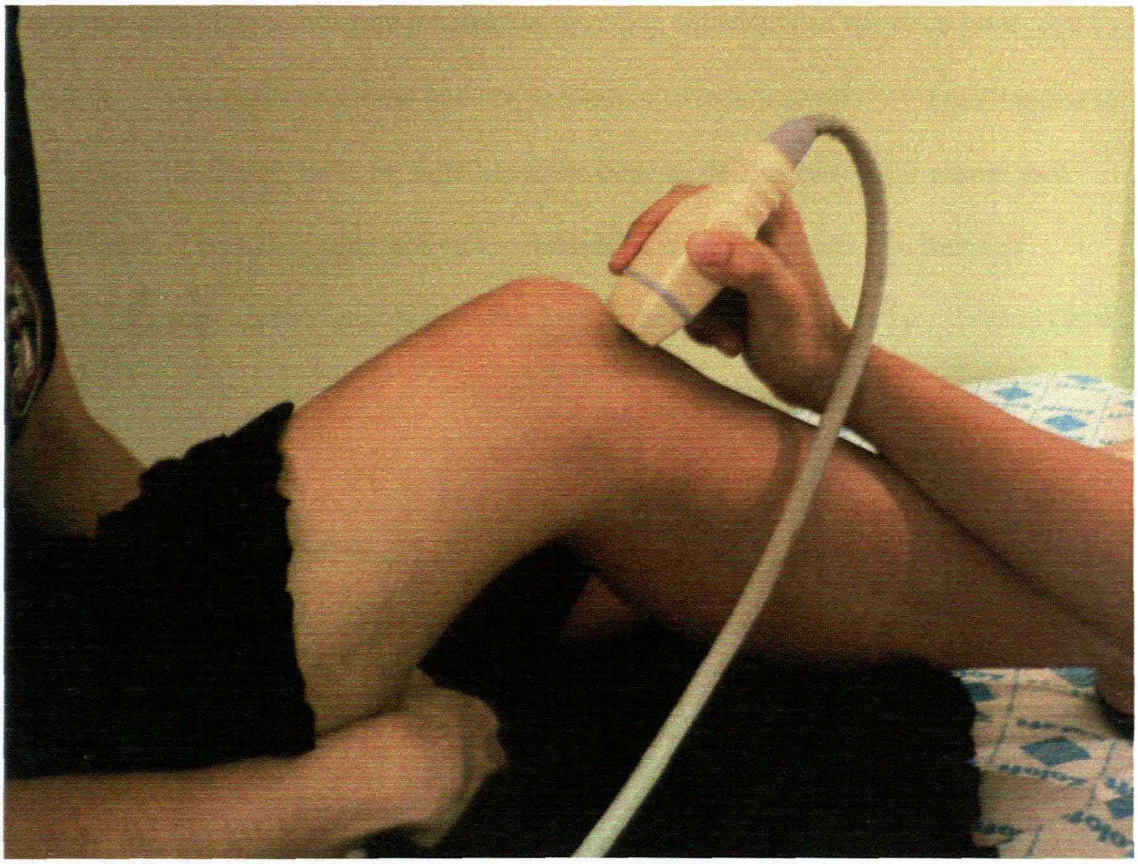


Figure 2.6: Demonstrating the same position, but for the Width measurement.



2.3 Pathology of the Deep Infrapatellar Bursa

Pathology of the bursae around the knee can be a source of acute and chronic knee pain. Inflammation can result from chronic or acute trauma, haemorrhage, infection and inflammatory or infiltrative disorders. (Friedman&Chhem, 2005) The deep infrapatellar bursa do not communicate with the joint and thus any bursal effusion or swelling indicates a primary bursal process. (Chhem et al, 1999)

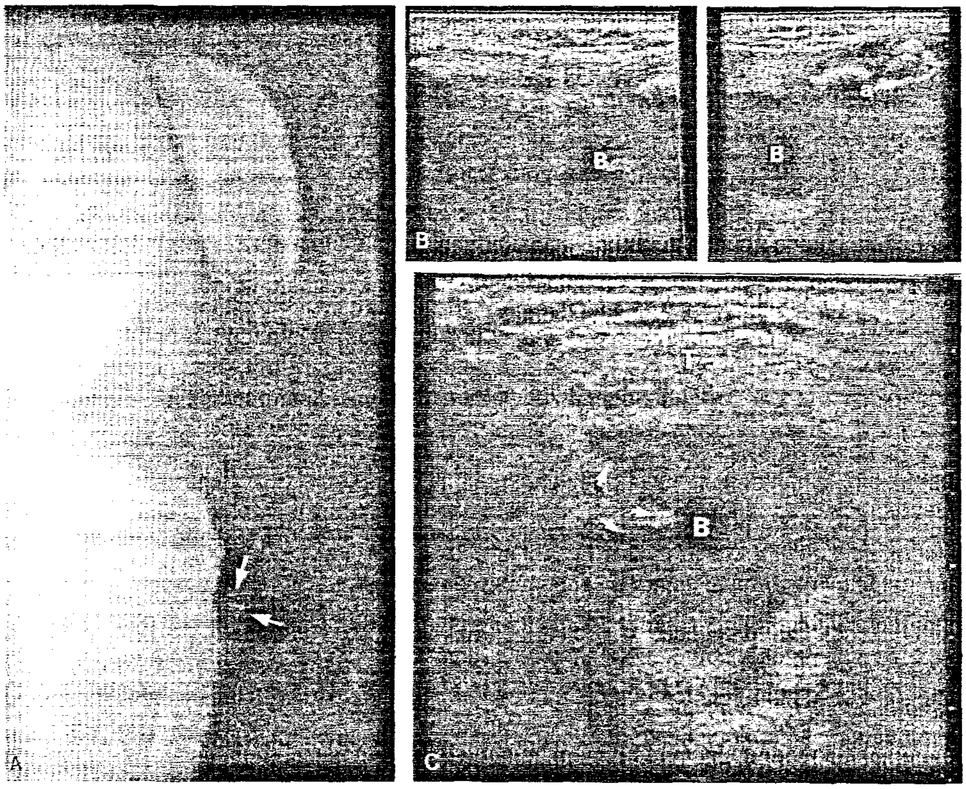
Bursitis of the knee can involve inflammation of one or more bursae about the knee. The causes for inflammation can vary from repetitive compression forces (created by the flexor and extensor muscle mechanism groups), instability of the knee joint (due to torn/injured ligaments about the knee or secondary to osteoarthritis) or direct trauma to the bursa. Bursitis of the knee, whether acute or chronic, can clinically appear as a cystic mass. The most important fact to determine is the anatomical location of this'cystic mass', to then enable the examiner to diagnose bursitis or not. (Chhem et al, 1999)

2.4 Deep Infrapatellar Bursitis

Deep Infrapatellar Bursitis can be the result of a direct blow to the bursa or especially in professional sportsman due to repetitive strain to the distal patellar tendon area – resulting in repetitive strain to the deep infrapatellar bursa, just posterior to the patellar tendon. Bleeding into the bursa may occur with inflammatory disease. By applying pressure to the probe, after the bursa was located and whilst scanning over this bursa, pain will be a positive sign for the diagnosis of bursitis. However, keep in mind that excessive pressure will result in flattening of the bursa and could lead to a false negative result of a potentially inflamed bursa. (Chhem et al, 1999)

Deep Infrapatellar bursitis should really only be considered if the effusion is large and the bursa symptomatic, as a small amount of fluid in the bursa is physiologically normal. As stated above – pain elicited from recurrent pressure applied to the bursa by

Figure 2.7: Frictional bursitis of the deep infrapatellar bursa.



A – A conventional lateral knee radiograph. An irregular apophysis with a separate ossification centre is noted at the distal patellar tendon insertion (*arrows*).

B – Longitudinal sonograms of the same patient. The left side of the split screen displays the patellar tendon stretched between the apex of the patella and the tibial tuberosity. A large, distended bursa (*B*) extends adjacent to the tuberosity and the tendon. The image on the right side of the split screen is a detail of the tibial tuberosity and the large bursa, which covers the bone just proximal to the fragmented apophysis(*a*). Fluid in frictional bursitis often appears anechoic.

C – Transverse sonogram of the same patient. Located deep to the patellar tendon (*T*), the anechoic fluid collection in the deep infrapatellar bursa (*B*)is indented by Hoffa's fat pad (*arrows*). (Van Holsbeeck & Introcaso, 2001)

This type of bursitis is very common in athletes whose sport requires repetitive motion, like runners, tennis players, and oarsmen. Bursae predisposed to the development of frictional bursitis are usually adjacent to joints with irregular edges and hypertrophic tendon insertions. Most common bursae of the knee to develop frictional bursitis are the prepatellar and deep infrapatellar bursae. (van Holsbeeck&Introcaso, 2001)

The pathophysiology is that of a typical acute inflammation. There is initially a short period of vasoconstriction followed by hyperaemia. The hyperaemia results from dilatation of arterioles, capillaries, and postcapillary venules. Transudation and exudation follows. (van Holsbeeck&Introcaso, 2001) The painful bursa becomes distended with a watery fluid, which is different from the fluid found within the bursa normally. It also differs from the thick gelatinous mucoid substance found in ganglia. (Nicholas &Hershman, 1986)

Ultrasound is a great way of examining the bursae and serves to primarily determine if the disease are limited to the bursa only. Surrounding structures can easily be examined, to determine if the bursitis developed secondary to pathology that originated from these surrounding tendons, ligaments or the joint space. (van Holsbeeck & Introcaso, 2001)

Frictional bursitis is easily identified by an increase in the volume of the bursa only. No other changes to the bursa structure is recognised. As always, comparison with the contra-lateral, asymptomatic side is of great value. The fluid within a bursa with acute traumatic bursitis, characteristically appears anechoic or markedly hypoechoic compared with normal bursal fluid. Posterior acoustic enhancement can be seen deep to the inflamed bursa. The walls of the bursa appears unchanged, which is an important factor to take into account when differentiation between acute and chronic traumatic bursitis are needed. (van Holsbeeck& Introcaso, 2001)

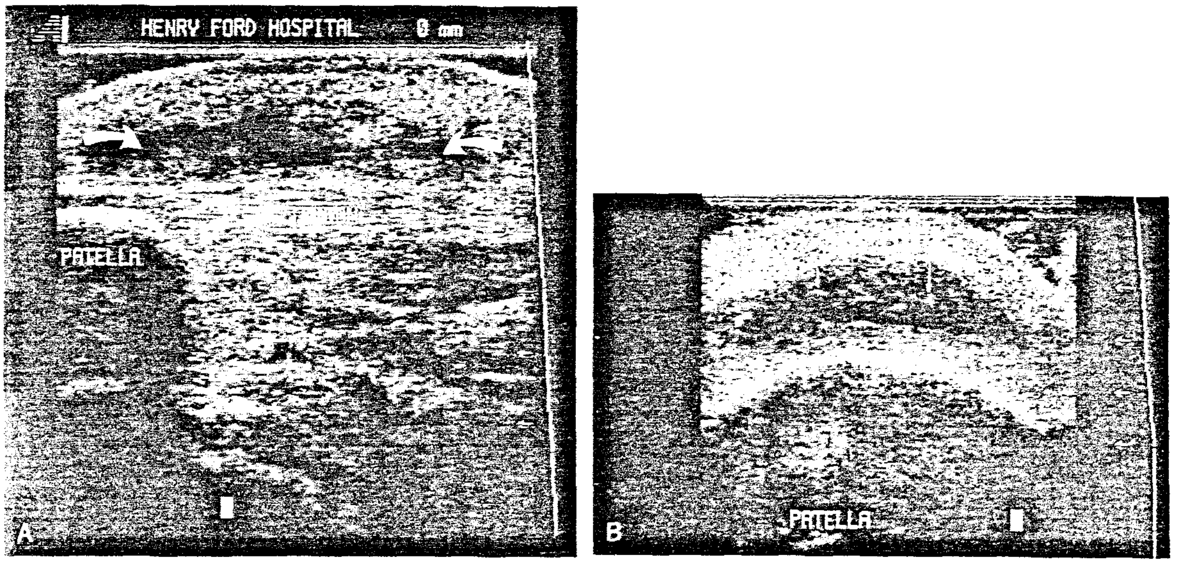
2.5.2 Chronic Traumatic Bursitis

Inevitably if acute traumatic bursitis persists, it may become chronic. The synovial bursa walls will become thickened and filled with a fibrinous exudate. Calcifications can sometimes be seen within or surrounding the chronically inflamed bursa. In an area exposed to chronic frictional irritation, an adventitious bursa can sometimes form as a subtype of chronic traumatic bursitis. If this happens, the surrounding connective tissue becomes inflamed and forms a area of fibrinoid necrosis. (Gardner, 1965 & van Holsbeeck&Introcaso, 2001) A cystic structure filled with cellular debris, extracellular fluid, altered ground substance and inflammatory exudate results (Nicholas& Hershman, 1986). This process is the formation of a bursa de novo(van Holsbeeck & Introcaso, 2001)

As in acute traumatic bursitis, the bursa is distended with fluid – but with definite echoes within the bursa. The outline of the bursa appears irregular and the synovial walls are thickened. Calcifications can sometimes be present, and appears as hyperechoic foci, with or without shadowing – depending on the size of the calcification and the frequency of the transducer. Surrounding bursae and tendons are frequently involved with chronic traumatic bursitis. The last to remember for chronic traumatic bursistis is that if the synovium of the effected bursa is adjacent to adipose tissue, local fatty hypertrophy can develop. (van Holsbeeck & Introcaso, 2001)

The sonographic features of chronic traumatic bursitis are demonstrated in the figures below.

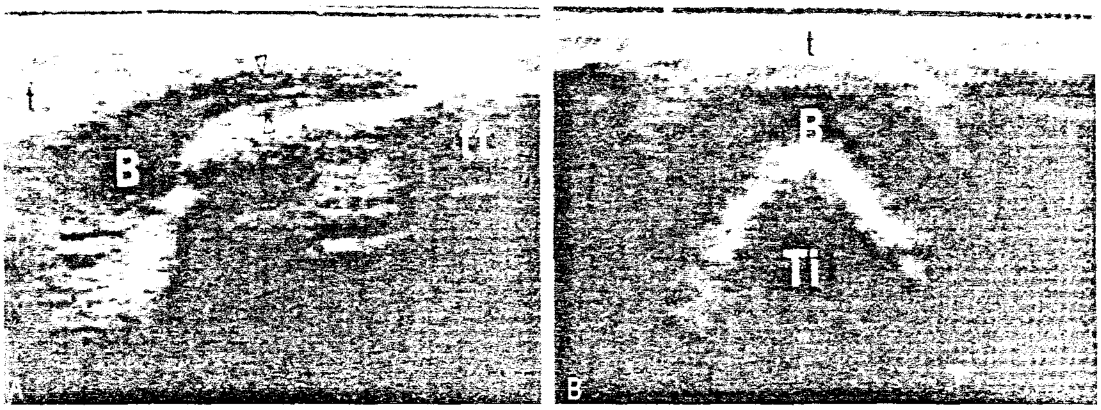
Figure 2.8 : An example of chronic prepatellar bursitis.



A – longitudinal sonogram. The bursa (*curved arrows*) appears hypoechoic, with distinct internal echos. The synovial lining of the bursa is irregular. **B** – transverse sonogram with similar patholgy than in **A**. The flat, sac-like structure filled with fluid and debris. The distinct internal echos (*arrows*) are often seen in chronic bursitis.

(van Holsbeeck & Introcaso, 2001)

Figure 2.9: Chronic bursitis of the deep infrapatellar bursa.



A – longitudinal sonogram. The inflamed bursa (B) measures approximately 5cm long. The bursa appears essentially anechoic, but synovial wall thickening is observed (*arrows*). Abbreviations: patellar tendon (*t*) and tibial tuberosity. **B** – transverse sonogram. Again the bursa is hypoechoic with a rim of synovial thickening around the bursa. Abbreviation: tibia (*Ti*). (van Holsbeeck & Introcaso, 2001)

2.6 Treatment Options

Treatment options for bursitis are limited. If several months of rest do not eliminate the pain, anti-inflammatory injections are usually indicated and effective. (Benjamin, 2003) Aspiration followed by injection of an appropriate steriod preparation is usually the procedure. At the Sports Science Orthopaedic clinic 2ml Marcaine together with 1ml Cortisone are usually injected under ultrasound guidance.

When an acute bursitis fail to respond to non-surgical treatment, incision and drainage are the next route to follow. Excision of chronically infected and thickened bursa are the next step if still unresolved. Last resort is to remove any underlying bony promineces. (Duke Othropaedics : Wheeless'Textbook of Orthopaedics, 2005)

2.7 Background Literature Review of the Deep Infrapatellar Bursa

According to Carr et al, from America, "the deep infrapatellar bursa may be normally visible as a flattened 2- to 3mm anechoic fluid containing structure" on ultrasound (2001). According to other literature, it may be found that this bursa contains some synovial fluid in asymptomatic knees, but may also be collapsed. (Jansen et al, 1994; LaPrade, 1998) In a study where cadaver specimens were dissected, it is described that the bursa is 20mm in length and contains less than 0.5ml of fluid. (Klein, 1996)

In a fairly recent study from Turkey the deep infrapatellar bursa on sagittal T2-weighted Magnetic Resonance Imaging (MRI) images were 2.1mm-2.7mm (antero-posterior diameter) and 7.3mm-9.1mm (cranio-caudal diameter) respectively. Taking into account that of all the knees scanned, the deep infrapatellar bursa could only be visualized in 68% of the subjects from this study. (Aydingoz et al, 2004)

Tschirch et al, from Switzerland, only visualized 42 deep infrapatellar bursae in 102 asymptomatic knees (41%) examined with MRI. Their mean measurement of the deep infrapatellar bursa being 6x3x5mm (2003). The low prevalence of the deep infrapatellar bursa with different MRI studies, may be due to different cut-off measurements used and also depends on the specific slice thickness used during the MRI examinations.

Joints with fluid-filled bursae are not uncommon ultrasound findings in healthy people. Schmidt et al (2004), from Germany, found the mean ultrasound value of the deep infrapatellar bursa to be 6.1x6.2x2.7mm. They could only detect 6% of the deep infrapatellar bursae in their study of 102 healthy volunteers. Stating that, it has to be said that they carried out their measurements at the same defined area and not necessarily at the area where the bursa appeared biggest or the area where the bursa could be visualised at all. There is thus a strong suspicion that the ultrasound detection rate of the deep infrapatellar bursae containing fluid are much higher than the 6% from Schmidt et al's study.

There has been no investigation of the possible difference in size of the deep infrapatellar bursa for different population groups as far as is known. Comparing different sexes, knees, sport types and different levels of competitiveness has been slightly reviewed, but not in depth. Schmidt et al found only a few relevant statistical significant correlations for different sexes, but do not state what anatomical area they were referring to. Taking into account that they were performing ultrasonography on 204 shoulders, elbows, hands, hips, knees and feet. Also due to there wide range of areas investigated they found several statistical significant values, unfortunately due to an α fault. (Schmidt et al, 2004)

No correlation was found for different sport activities by Schmidt et al (2004). Selected distances are different for athletes (Maffulli et al, 1987). The impact of different sport activities and different levels of sport competitiveness on the deep infrapatellar bursa has not been investigated before.

2.8 Summary of Conclusions of Literature Review

It is thus clear that the deep infrapatellar bursa as a structure on its own has not been investigated in depth with different comparisons between different variables before. I therefore aimed to try and investigate as much as possible about different variables specifically for this bursa.

The average measurement for the deep infrapatellar bursa differs between 2.1mm-2.7mm (antero-posterior diameter) and 7.3mm-9.1mm (cranio-caudal diameter); 6x3x5mm; to 6.1x6.2x2.7mm respectively, according to above mentioned authors.

Slight previous comparisons between men and women, different knees, different levels of and different types of sports and different population groups have not delivered very much information to date. Therefore an indepth study was conducted to try and determine more specific features or characteristics for the deep infrapatellar bursa.

CHAPTER 3

RESEARCH DESIGN & METHODOLOGY

In this chapter the design and methodology followed during my fieldwork will be discussed.

3.1 Hypothesis

The size of the deep infrapatellar bursa would differ depending on a normal or pathological bursa. The diameters of a normal deep infrapatellar bursa for males and females, different population groups, opposing lower limbs and people participating in different levels of and different types of sport would probably include different measurements.

3.2 Data Measurement Tools

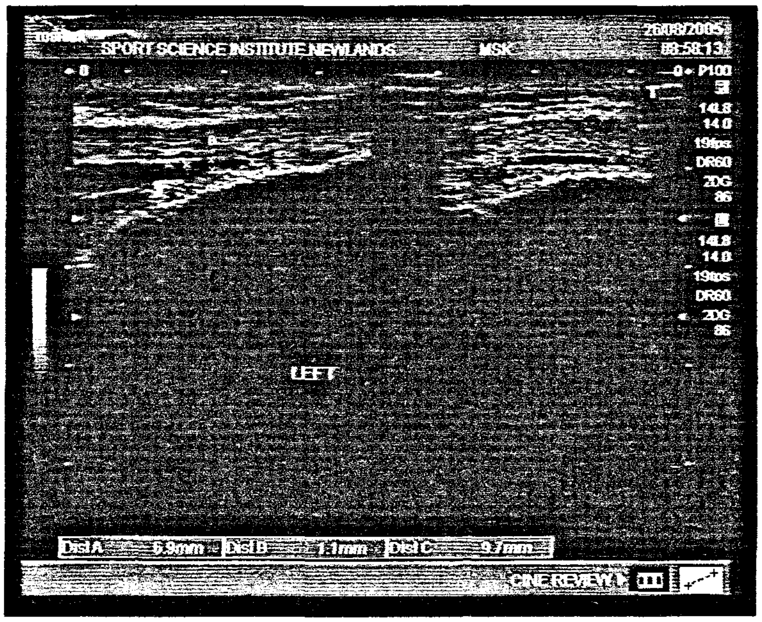
The subject filled in a questionnaire form, rendering information about previous and present knee problems, operations or examinations, sports activities, level of sport participation, sport type, gender, ethnicticity, age, height and weight. (Please see appendix 1 for example of the questionnaire and appendix 2 for an example of the consent form.)

Using a *Nemio2* Toshiba ultrasound machine with a multi-frequency (5-14MHz) linear transducer, the deep infrapatellar bursa was identified and different diameters of the bursa was measured in millimetres, using the callipers on the ultrasound machine. The measurements were recorded on thermal Mitshibushi ultrasound film paper and each individuals' measurements were filled in on their questionnaire form.

Figure 3.1 Picture of the Mitshibushi printer and thermal ultrasound paper brand.

Figure 3.2 Example of the measurements of the Right DIB taken.

Figure 3.3 Example of measurements of the Left DIB taken.



3.3 Sample Design & Sampling Methods

A prospective survey of a study population of people, randomly selected and between 18 and 55 years of age, were recruited. Numerical data were collected by measuring the different diameters of the deep infrapatellar bursa. Data collected shows either the size of the bursa or the absence of the bursa. No patient with possible and/or present deep infrapatellar bursitis were included in the study as this would obviously skew the average volume in a chosen group.

Measuring three different diameters of the bursa allowed for the volume to be calculated, which enabled me to statistically compare different variables. As there have not been any intensive research studies conducted on the deep infrapatellar bursa, no correction factor for the exact calculation of the volume of the deep infrapatellar bursa could be found in the literature. Hence the volume was calculated as mentioned above for comparing purposes of different entities of this research study.

A minimum of 200 adult males and females (400 knees), were to be recruited for the study. A total of 280 subjects (560 knees) were recruited for the study and included in the statistical analysis by the finishing date for data collection by 7 September 2005. The sample size had to be quite big to be able to make statistically significant comparisons.

Subjects aged <18 or >55 years were excluded from the study, as people under 18 years of age are likely to have different values before epiphysial closer and older people may have different values due to the increasing prevalence of osteoarthritis.

3.4 Data Collection

The idea of the study was to recruit as many subjects as possible to perform bilateral knee ultrasound examinations on. Subjects were recruited randomly by means of different internet websites (e.g. Health24 and vitality), local newspaper advertisements (*The Herold* from Newlands), asking people from the Sports Science Institute of South Africa's gym, staff members and students to participate, and like all good things via word of mouth the news spread that free knee ultrasounds were being performed at the

Orthopaedic Sports Science Clinic! All of this contributed to 280 people being recruited for the study!

The advertising on the websites, the local weekly Newlands' newspaper and the annoucement on local Cape Town Christian Radio was organised and orchestrated by a staff member of the Sports Science Institute of South Africa, Kathy McQuaide. She voluntarily orchestrated all this exposure to the study as she works in the research department of the Sports Science Institute of South Africa and does advertising/recruiting for research studies like this on a daily basis. She was an integral part of my subjects' recruitment!

Once the advertisement was read I usually received a phone call or email from an interested person concerning my study. The requirements and the examination to follow were explained and if the person was interested, an appointment was set up which suited the interested party's schedule and correlated with available time in the Sports Science Radiology department.

I was fortunate enough to have a lot of cooperation and support from my collegues at work, which enabled me to perform ultrasound examinations for my research on mostly Wednesday- and Friday afternoons at the Sports Science Othropaedic Clinic, but also on other days depending on the subjects' availability. Fifteen minutes were allowed for the actual examination to make sure enough time was allowed to complete each examination peacefully, to ensure optimal accuracy in finding and measuring the deep infrapatellar bursa on both knees for each individual.

As the interested voluntary person arrived for their ultrasound examination at the Sports Science Orthopaedic Clinic, they were given a questionnaire to complete and after carefull explaining by myself, about what to expect and what would happen next, a consent form was signed by the subject. Most participants were english speaking, but when required afrikaans were spoken. The Xhosa speaking participants mostly understood english and did not have any objections about the language being spoken. All participants had a very good understanding about the study, what the study entailed and what were being expected from them. All questionnaires were completed correctly.

The first ultrasound examination was performed on 8 June 2005 and the last one was finished on 7 September 2005. Most examinations were performed as explained above by recruiting subjects via email or advertisement, but most professional sportspeople were recruited by phoning, faxing and discussions with the various coaches, physiotherapists, team doctors and trainers. These subjects included the members of the Western Province men's rugby squad, the Western Province women's rugby squad and Ajax Cape Town Soccer Club. For these subjects certain specific pre-oraganised dates and times were organised to ensure no disruption with training or matches.

3.5 Data Capturing & Editing

Data was captured onto my computer manually by myself. This took quite a while, but various cross checks and spot checks via random selection was conducted to ensure minimal errors occured. Data that was captured included the date of the examination; the subject number; the subject's age, ethniticity, gender, date of birth, knee pathology history, knee injury history, rehabilitation time (if appliccable), sport activities, sport competitiveness, sport(s) practiced, how many hours a week trained/exercised, how many kilometres a week cycled or ran (where appliccable), height, weight, body mass index (BMI), respective right and left knee ultrasound measurements.

SPSS 13.0 for Windows was used for editing and post-coding of data. By doing random statistical tests and checking the data correspondence with other statistical tests errors were further minimised.

3.6 Data Analysis

Data analysis was done by using the SPSS 13.0 for windows program which was installed onto my computer. Mr Lorenzo Himunchul, expert statitician and researcher, from the Cape Peninsula University of Technology's research department assisted me with the analysing and performing of various statistical tests. He also assissted me with cross checking and final editing of my data and statistical results. Mr Lorenzo

Himunchul formed a very important link in enabling me to produce successful and accurate results.

The independent-samples T-test was used to compare means and check for statistical significance. Means were also calculated by using descriptive statistics and calculating frequency statistics.

The SPSS 13.0 program was chosen for data editing and analysis as it is a very useful, operator friendly program for producing optimal results.

3.7 Shortcomings & Sources of Error

It is never easy to admit that there were any shortcomings or errors within your data. In this study for certain variables the number of subjects were to little to produce a statistical significant result. Thus by enlarging the sample size for certain variables, beter results would be obtained. The specific variables referred to, will be listed and explained in more detail in chapter 4 where the results will be discussed in detail.

Eight subjects were excluded from the final data because either the right or left deep infrapatellar bursa ultrasound measurements were not taken for that subject. No data was noted as no bursa was visualized for either the left or right knees for these eight subjects. This resulted in the computer program listing some results as incomplete. These measurements could most probably still have been used as part as the final data used for analysis, but had to be excluded due to the computer program's limitations. These eight subjects' results will still be noted in chapter 4, as their would be looked into the reason(s) for not being able to see one of the bursae. Be the reason for this physiologically or pathologically.

The fact that I were the only person performing the ultrasound examinations could result in the measurements being slightly different for different operators. Every ultrasound operator has there own technique and thus resulting in different degrees of compressibility of the ultrasound probe onto the knees. This could result in the bursae being slightly compressed for some operators and thus appearing slightly smaller than for others. Also the fact that some bursae measurements were taken early morning and some late evening could possibly result in producing different results, but much more indepth research should be done to obtain answers to these biased questions.

All ultrasound examinations were done with the subjects being rested for at least an hour before the ultrasound examination, thus no fierce exercise or training was done before the ultrasound examination was performed. This concludes the third chapter stating the research design and methodology used in my study. In the next chapter we will look at the results obtained from all this data gathered.

CHAPTER 4

RESULTS

This chapter will document my results of my fieldwork. Altogether 280 subjects were recruited. Only 8 were eliminated due to incomplete data, thus 272 subjects' data were processed. The youngest subject was 18 years old and the oldest subject 52 years old. The average age for the study equally 30.67years.

The different sport types were rugby, soccer, running, cycling, cricket and various individual activities listed under 'other'. The subjects mainly had a coloured, black or white ethnicticiity, and were listed where appropriate under each ethnic group. 120 subjects were female and 152 were male.

The different results for the DIB size are discussed and shown below.

4.1 Mean ultrasound size of the Deep Infrapatellar Bursa(DIB)

The mean ultrasound measurements of the deep infrapatellar bursa for this study is as follow:

Table 4.1 - Mean DIB measurements for all subjects

		Right knee: AP	Right knee: CC	Right knee: Width	Left knee: AP	Left knee: CC	Left knee: Width
N	Valid	272	272	272	272	272	272
	Missing	0	0	0	0	0	0
Mean		**1.343mm**	**5.416mm**	**6.242mm**	**1.311mm**	**5.488mm**	**6.588mm**
Std. Error of Mean		.0266	.1236	.1606	.0282	.1154	.1662
Median		1.300	5.100	5.800	1.200	5.350	6.100
Std. Deviation		.4395	2.0382	2.6491	.4647	1.9038	2.7413
Minimum		.5	1.8	2.0	.4	1.5	2.0
Maximum		3.2	13.2	15.7	2.8	13.0	17.0

The mean measurements for the right knee are 1.3 x 5.4 x 6.2 mm. The mean measurements for the left knee are 1.3 x 5.5 x 6.6 mm. These measurements are normal measurements for the respective knees and the average for all participants of my study. Including all subjects with all the different variables for this study. The mean ultrasound measurements for different denominations or variables will be discussed later in this chapter.

4.2 Mean DIB measurements for All Male and Female subjects

The difference in measurements for males and females are showed in the next tables:

Table 4.2 – Mean knee volumes for comparing males and females

	Sex	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	male	152	64.3210	67.79190	5.49865
	female	120	43.4445	37.82347	3.45279
Left knee volume	male	152	65.0961	57.30023	4.64766
	female	120	46.0788	47.01618	4.29197

Table 4.3 – Independent Samples Test – Males vs Females

		t-test for Equality of Means								
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	12.394	.001	3.022	270	**.003***	20.87641	6.90872	7.27461	34.4782
	Equal variances not assumed			3.215	245.185	**.001***	20.87641	6.49284	8.08756	33.6652
Left knee volume	Equal variances assumed	1.094	.297	2.938	270	**.004***	19.01725	6.47386	6.27159	31.7629
	Equal variances not assumed			3.006	269.583	**.003***	19.01725	6.32628	6.56206	31.4724

*$p < 0.05$

There is a significant difference between the male and female measurements for the deep infrapatellar bursa. The men have a significantly bigger bursa. These results are including all subjects who participated in my study.

For comparisons to be made between different sub-groups, the deep infrapatellar bursa volume was calculated for each knee by simply multiplying the three ultrasound measurements obtained of each individual knee (AP x CC x Width = bursal volume). As no previous studies on the exact size and volume of the deep infrapatellar bursa has been done, no correction factor could be found in the literature for more accurate volume calculations. The mean knee volumes displayed in table 4.2(above) and all other tables to follow, thus include this simple calculation. This enabled me to compare the bursa size for different variables, by using one calculated variable only.

Table 4.4 – Mean DIB measurements for males

		Right knee: AP	Right knee: CC	Right knee: Width	Left knee: AP	Left knee: CC	Left knee: Width
N	Valid	152	152	152	152	152	152
	Missing	0	0	0	0	0	0
Mean		**1.361mm**	**5.813mm**	**6.608mm**	**1.389mm**	**5.791mm**	**7.083mm**
Std. Error of Mean		.0376	.1821	.2260	.0393	.1477	.2259
Median		1.300	5.400	6.300	1.300	5.700	6.700
Std. Deviation		.4637	2.2449	2.7863	.4847	1.8206	2.7849
Variance		.215	5.040	7.763	.235	3.314	7.756
Minimum		.5	1.8	2.0	.4	2.2	2.1
Maximum		3.2	13.2	15.7	2.8	13.0	17.0

The mean AP, CC and width measurements for men are as per table 4.4. The mean measurments for the right knee is AP - 1.4mm, CC – 5.8mm and Width – 6.6mm. The mean measurements for the left knee is AP – 1.4mm, CC – 5.8mm and Width – 7.1mm.

The mean DIB measurements for males thus are **1.4 x 5.8 x 6.9mm.**

Table 4.5 – Mean DIB measurements for females

		Right knee: AP	Right knee: CC	Right knee: Width	Left knee: AP	Left knee: CC	Left knee: Width
N	Valid	120	120	120	120	120	120
	Missing	0	0	0	0	0	0
Mean		**1.320mm**	**4.914mm**	**5.778mm**	**1.213mm**	**5.104mm**	**5.962mm**
Std. Error of Mean		.0372	.1475	.2188	.0383	.1775	.2339
Median		1.250	4.800	5.400	1.200	4.900	5.500
Std. Deviation		.4076	1.6157	2.3964	.4198	1.9448	2.5619
Minimum		.5	1.8	2.0	.4	1.5	2.0
Maximum		2.5	9.2	14.4	2.5	11.5	14.6

The mean AP, CC and width ultrasound measurements for women are as per table 4.5. The mean measurments fot the right female knee are AP – 1.3mm, CC – 4.9mm and Width – 5.8mm. The mean measurements for the left female knee are AP – 1.2mm, CC – 5.1mm and Width – 5.9mm.

The mean DIB measurements for females are **1.3 x 5.0 x 5.9mm.**

The difference for the mean ultrasound measurements of the deep infrapatellar bursa (DIB), between male and female thus are –

Right Knee : AP – 0.041mm

CC – 0.899mm

Width – 0.83mm

Left Knee : AP – 0.176mm

CC – 0.687mm

Width – 1.121mm

The males having the above specified, slightly bigger bursae than the female. These measurements include competitive, non-competitive and people participating in no sport. These are thus average measurements not incorporating any other characteristics or variables. Thus the average male has a slightly bigger DIB than the average female.

4.3 DIB measurement comparison between different population groups.

In the following table the differences between the different population groups will be showed. The main population groups participating in the study, being Black, Coloured or White, and mostly Cape Townian, South Africans.

Table 4.6 – Comparison between White and Coloured population groups

	white vs coloured	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	white	160	56.4262	62.42346	4.93501
	Coloured	71	48.2865	47.15411	5.59616
Left knee volume	white	160	55.3119	55.37542	4.37781
	Coloured	71	51.8444	52.84563	6.27162

Table 4.7 – Independent Samples Test – White vs Coloured

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	1.349	.247	.981	229	**.328***	8.13975	8.29681	-8.20811	24.48760
	Equal variances not assumed			1.091	174.695	**.277***	8.13975	7.46132	-6.58619	22.86569
Left knee volume	Equal variances assumed	.005	.942	.445	229	**.657***	3.46749	7.78799	-11.8777	18.81277
	Equal variances not assumed			.453	140.182	**.651***	3.46749	7.64843	-11.6536	18.58868

*p>0.05

The sample size of the White population group studied, was much bigger than the sample size of the Coloured population group. There were no statistical significant difference between the two gouprs, but it seems that there might be a tendency for the white population group to have a slightly bigger DIB volume than the coloured population group. (Table 4.6 above) More testing with a bigger sample volume is needed for further evaluation.

Table 4.8 – Mean DIB ultrasound measurements for White subjects

		Right knee: AP	Right knee: CC	Right knee: Width	Left knee: AP	Left knee: CC	Left knee: Width
N	Valid	161	161	161	161	161	161
	Missing	0	0	0	0	0	0
Mean		**1.340mm**	**5.447mm**	**6.186mm**	**1.307mm**	**5.306mm**	**6.592mm**
Std. Error of Mean		.0352	.1634	.2146	.0356	.1433	.2143
Median		1.200	5.100	5.700	1.200	5.000	6.200
Std. Deviation		.4466	2.0734	2.7224	.4521	1.8186	2.7195
Minimum		.5	1.8	2.4	.4	1.7	2.0
Maximum		2.5	13.2	15.7	2.8	11.5	15.8

The mean DIB ultrasound measurements for the right knee for the white population group are AP – 1.3mm, CC – 5.4mm and width – 6.2mm. The measurements for the left knee are AP – 1.3mm, CC – 5.3mm and width – 6.6mm.

The mean DIB measurements for White population group are **1.3 x 5.4 x 6.4mm.**

Table 4.9 – Mean DIB ultrasound measurements for Coloured subjects

		Right knee: AP	Right knee: CC	Right knee: Width	Left knee: AP	Left knee: CC	Left knee: Width
N	Valid	71	71	71	71	71	71
	Missing	0	0	0	0	0	0
Mean		**1.369mm**	**4.835mm**	**6.186mm**	**1.273mm**	**5.507mm**	**6.094mm**
Std. Error of Mean		.0544	.2168	.3050	.0544	.2397	.3197
Median		1.300	4.400	5.500	1.200	5.100	5.600
Std. Deviation		.4581	1.8266	2.5697	.4582	2.0194	2.6938
Minimum		.5	2.0	2.0	.6	2.2	2.1
Maximum		3.2	13.0	14.4	2.5	13.0	16.3

The mean DIB ultrasound measurements for the right knee of the Coloured population are: AP – 1.4mm, CC – 4.8mm and width 6.2mm. The measurements for the left knee are: AP – 1.3mm, CC – 5.5mm and width – 6.1mm.

The mean DIB measurements for the Coloured population group are **1.4 x 5.2 x 6.2mm.**

Table 4.10 – Comparison between Coloured and Black population groups

	Coloured vs Black	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	coloured	71	48.2865	47.15411	5.59616
	black	36	65.2065	54.76498	9.12750
Left knee volume	coloured	71	51.8444	52.84563	6.27162
	black	36	71.8738	47.84796	7.97466

Table 4.11 – Independent Samples Test – Coloured vs Black

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	.551	.460	-1.660	105	**.100***	-16.92001	10.19340	-37.1316	3.29161
	Equal variances not assumed			-1.580	61.887	**.119***	-16.92001	10.70646	-38.3226	4.48268
Left knee volume	Equal variances assumed	.039	.845	-1.911	105	**.059***	-20.02943	10.48260	-40.8144	.75564
	Equal variances not assumed			-1.974	76.963	**.052***	-20.02943	10.14537	-40.2315	.17273

*p>0.05

There seem to be a definite tendency for the Black population group to have a bigger DIB volume, than the Coloured population group. Again if the sample size of both these population groups were bigger, the significance could probably be shown.

Table 4.12 – Mean DIB ultrasound measurements for the Black population group

		Right knee: AP	Right knee: CC	Right knee: Width	Left knee: AP	Left knee: CC	Left knee: Width
N	Valid	36	36	36	36	36	36
	Missing	0	0	0	0	0	0
Mean		**1.300mm**	**6.461mm**	**6.636mm**	**1.403mm**	**6.311mm**	**7.308mm**
Std. Error of Mean		.0659	.3332	.4150	.0890	.3247	.3950
Median		1.200	6.500	6.500	1.400	6.250	7.450
Std. Deviation		.3957	1.9990	2.4902	.5337	1.9480	2.3697
Minimum		.6	2.0	2.0	.5	1.5	2.3
Maximum		2.2	9.7	12.9	2.7	10.9	12.0

The average mean DIB ultrasound measurements for the right knee of the Black population are: AP – 1.3mm, CC – 6.5mm and Width – 6.6mm. The average mean DIB ultrasound measurements for the left knee of the black population are : AP – 1.4mm, CC 6.3mm and Width – 7.3mm.

The mean DIB measurements for the Black population group are **1.4 x 6.4 x 7.0mm.**

Table 4.13 – Comparison between the Black and White population groups

	white vs black	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	white	161	56.1089	62.35822	4.91452
	black	36	65.2065	54.76498	9.12750
Left knee volume	white	161	55.2152	55.21573	4.35161
	black	36	71.8738	47.84796	7.97466

Table 4.14 – Independent Samples Test – Black vs White

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	.045	.832	-.808	195	**.420***	-9.09759	11.25798	-31.3006	13.105
	Equal variances not assumed			-.878	57.184	**.384***	-9.09759	10.36647	-29.8546	11.659
Left knee volume	Equal variances assumed	.026	.873	-1.674	195	**.096***	-16.65863	9.94949	-36.2810	2.9637
	Equal variances not assumed			-1.834	57.825	**.072***	-16.65863	9.08470	-34.8447	1.5275

*p>0.05

There seems to also be a tendency for the Black population group to have a slightly bigger DIB volume than the White population group. Unfortunately the Black population group sample size are most probably just to small to show the statistical significance.

Table 4.15 – Comparison between the White and Black Males only

	male white&black	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	white	79	66.9196	77.58078	8.72852
	black	24	76.2400	58.07065	11.85362
Left knee volume	white	79	64.7512	59.39892	6.68290
	black	24	74.2314	47.98229	9.79434

Table 4.16 – Independent Samples Test –White vs Black Males

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	.666	.416	-.543	101	**.588***	-9.32034	17.15309	-43.34746	24.70678
	Equal variances not assumed			-.633	50.340	**.530***	-9.32034	14.72058	-38.88254	20.24186
Left knee volume	Equal variances assumed	.043	.836	-.714	101	**.477***	-9.48016	13.28551	-35.83504	16.87472
	Equal variances not assumed			-.800	46.433	**.428***	-9.48016	11.85708	-33.34121	14.38089

*p>0.05

It seems that the Black males have a bigger DIB volume than the White males. However, due to the small sample size of the Black population the significance of this could not be shown.

Table 4.17 – Comparison between White and Coloured males

	male white&coloured	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	white	79	66.9196	77.58078	8.72852
	Coloured	47	55.0952	54.45471	7.94304
Left knee volume	white	79	64.7512	59.39892	6.68290
	Coloured	47	59.9661	58.65417	8.55559

Table 4.18 – Independent Samples Test – White vs Coloured Males

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	1.466	.228	.918	124	**.360***	11.82439	12.87660	-13.66202	37.31079
	Equal variances not assumed			1.002	120.525	**.318***	11.82439	11.80165	-11.54102	35.18979
Left knee volume	Equal variances assumed	.062	.804	.439	124	**.661***	4.78513	10.89142	-16.77205	26.34231
	Equal variances not assumed			.441	97.788	**.660***	4.78513	10.85630	-16.75943	26.32969

*p>0.05

It seems that there could be a small tendency for the White males to have a bigger DIB volume than the Coloured male population, but once again a bigger sample size is needed to determine the significance.

Table 4.19 – Comparison between Coloured and Black males

	male coloured&black	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	coloured	47	55.0952	54.45471	7.94304
	black	24	76.2400	58.07065	11.85362
Left knee volume	coloured	47	59.9661	58.65417	8.55559
	black	24	74.2314	47.98229	9.79434

Table 4.20 – Independent Samples Test – Coloured vs Black Males

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	.012	.912	-1.513	69	**.135***	-21.14472	13.97081	-49.01573	6.72628
	Equal variances not assumed			-1.482	43.870	**.146***	-21.14472	14.26885	-49.90412	7.61467
Left knee volume	Equal variances assumed	.175	.677	-1.028	69	**.308***	-14.26529	13.88048	-41.95609	13.42551
	Equal variances not assumed			-1.097	55.372	**.277***	-14.26529	13.00489	-40.32375	11.79317

*p>0.05

In the above tables it appears that the tendency is for the Black male population to have a bigger DIB volume than the Coloured male population.

Table 4.21 – Comparison between White and Black females

	female white&black	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	white	82	45.6937	40.76050	4.50124
	black	12	43.1395	41.17192	11.88531
Left knee volume	white	82	46.0280	49.50337	5.46673
	black	12	67.1587	49.33822	14.24272

Table 4.22 – Independent Samples Test –White vs Black Females

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	.007	.934	.202	92	**.840***	2.55416	12.61340	-22.49713	27.60545
	Equal variances not assumed			.201	14.342	**.844***	2.55416	12.70912	-24.64339	29.75170
Left knee volume	Equal variances assumed	.786	.378	-1.382	92	**.170***	-21.13064	15.29425	-51.50634	9.24505
	Equal variances not assumed			-1.385	14.437	**.187***	-21.13064	15.25582	-53.75839 *p>0.05	11.49711

No significant difference between the Black and White females' DIB volumes. This may be due to the small sample size of the Black female population.

Table 4.23 – Comparison between White and Coloured Females

	female white&coloured	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	white	82	45.6937	40.76050	4.50124
	Coloured	24	34.9526	23.58639	4.81455
Left knee volume	white	82	46.0280	49.50337	5.46673
	Coloured	24	35.9394	34.92878	7.12981

Table 4.24 – Independent Samples Test – White vs Coloured Females

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	2.598	.110	1.229	104	**.222***	10.74103	8.73632	-6.58342	28.06548
	Equal variances not assumed			1.630	66.380	**.108***	10.74103	6.59099	-2.41689	23.89896
Left knee volume	Equal variances assumed	2.089	.151	.931	104	**.354***	10.08865	10.83211	-11.3918	31.56913
	Equal variances not assumed			1.123	52.810	**.267***	10.08865	8.98439	-7.93328	28.11057

*p>0.05

In table 4.24 (above) there seem to be a difference in DIB volume for between the White and Coloured females' population. The White females tending to have a slightly bigger volume for both right and left knees. However, no statistical significance could be shown.

Table 4.25 – Comparison between Coloured and Black Females

	female coloured&black	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	coloured	24	34.9526	23.58639	4.81455
	black	12	43.1395	41.17192	11.88531
Left knee volume	coloured	24	35.9394	34.92878	7.12981
	black	12	67.1587	49.33822	14.24272

Table 4.26 – Independent Samples Test – Coloured vs Black Females

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	1.588	.216	-.761	34	**.452***	-8.18688	10.75149	-30.0365	13.66278
	Equal variances not assumed			-.638	14.717	**.533***	-8.18688	12.82343	-35.5652	19.19152
Left knee volume	Equal variances assumed	5.984	.020	-2.199	34	**.035***	-31.21929	14.19886	-60.0748	-2.36373
	Equal variances not assumed			-1.960	16.702	**.067***	-31.21929	15.92762	-64.8693	2.43075

*p>0.05

The samples size of the Coloured and Black females only amount to 24 Coloured and 12 Black ladies. Even so, there seem to be a significant difference for the left knee volume, with the Black females having a bigger DIB volume than the Coloured females. The right knee volume of the Black females appear much smaller than the left knee volume for some unknown reason, but there is still a tendency for the right knee volume to be bigger for Black females than for Coloured females. These big differences between right and left knee volumes can be as a result of the small sample size for these two female populations.

4.4 DIB measurement comparisons between different levels of sport participation.

The first comparisons are involving people involved in some sort of sport or recreational activity, be it competitive or non-competitive. The second set of comparisons will be between subjects practising some sort of sport (no matter the level of competitiveness) and subjects not involved in any type of sport or recreational activity – the no-sport subjects.

Table 4.27 – Comparison between subjects practising competitive vs non-competitive sport

	Competitive sport	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	no	69	45.5375	43.47318	5.23356
	yes	171	62.8672	64.22921	4.91173
Left knee volume	no	69	45.4351	36.51375	4.39574
	yes	171	64.6498	61.06568	4.66981

Table 4.28 – Independent Samples Test – Competitive vs Non-competitive Sport

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	3.756	.054	-2.058	238	**.041***	-17.32969	8.42150	-33.91988	-.73949
	Equal variances not assumed			-2.414	183.575	**.017***	-17.32969	7.17741	-31.49051	-3.16887
Left knee volume	Equal variances assumed	8.882	.003	-2.442	238	**.015***	-19.21469	7.86941	-34.71728	-3.71211
	Equal variances not assumed			-2.996	204.109	**.003***	-19.21469	6.41324	-31.85939	-6.57000

*P<0.05

These calculations show that there is a significant difference between the competitive sport and non-competitive sport groups. The competitive subjects had clearly bigger bursae than the non-competitive subjects.

Table 4.29 – Mean DIB measurements for competitive sport subjects

		Right knee: AP	Right knee: CC	Right knee: Width	Left knee: AP	Left knee: CC	Left knee: Width
N	Valid	171	171	171	171	171	171
	Missing	0	0	0	0	0	0
Mean		**1.391mm**	**5.624mm**	**6.658mm**	**1.351mm**	**5.670mm**	**6.996mm**
Std. Error of Mean		.0328	.1597	.2093	.0367	.1507	.2100
Median		1.300	5.400	6.200	1.200	5.400	6.600
Std. Deviation		.4284	2.0885	2.7375	.4804	1.9709	2.7461
Minimum		.5	1.8	2.0	.4	1.7	2.1
Maximum		2.5	13.2	15.7	2.8	13.0	16.3

The mean AP, CC and width ultrasound measurements for competitive sport subjects are as per table 4.29 (above). The mean measurements for the right knee for competitive subjects are AP - 1.4mm, CC – 5.6mm and Width – 6.7mm. The mean measurements for the left knee are AP – 1.4mm, CC – 5.7mm and Width – 7.0mm.

The mean DIB measurements for Competitive sport people are **1.4 x 5.7 x 6.9mm.**

Table 4.30 – Mean DIB measurements for non-competitive subjects

		Right knee: AP	Right knee: CC	Right knee: Width	Left knee: AP	Left knee: CC	Left knee: Width
N	Valid	69	69	69	69	69	69
	Missing	0	0	0	0	0	0
Mean		**1.306mm**	**5.165mm**	**5.830mm**	**1.255mm**	**5.259mm**	**5.974mm**
Std. Error of Mean		.0543	.2295	.2967	.0539	.2136	.3138
Median		1.200	4.900	5.300	1.200	5.000	5.500
Std. Deviation		.4508	1.9064	2.4644	.4480	1.7744	2.6069
Minimum		.7	2.0	2.3	.4	2.4	2.0
Maximum		3.2	11.3	13.6	2.5	10.9	17.0

The mean ultrasound measurements for the DIB for non-competitive sport or no-sport subjects are as per table 4.30 (above). The mean measurements for the right knee are AP – 1.3mm, CC – 5.2mm and Width – 5.8mm. The mean measurements for the left knee are AP – 1.3mm, CC – 5.3mm and Width – 6.0mm.

The mean DIB measurements for Non-competitive sport people are **1.3 x 5.3 x 5.9mm.**

These measurements clearly show that the competitive sport subjects have bigger DIB ultrasound measurements than the subjects practising non-competitive- or no sport. The competitive sport group's measurements are on average bigger as follow:

Right Knee : AP – 0.085mm

CC – 0.459mm

Width – 0.828mm

Left Knee : AP – 0.096mm

CC – 0.411mm

Width – 1.022mm

Table 4.31 – Comparison between active and non-active subjects

	Active vs Non-active in sport	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	non-active	32	34.3046	32.69158	5.77911
	active	239	58.0885	59.48727	3.84791
Left knee volume	non-active	32	38.5604	30.26664	5.35044
	active	239	59.2569	55.82667	3.61113

In table 4.31 (above) there is a definite difference between the active and non-active subgroups' DIB volumes. The non-active subjects being people not practising any type of sport or physical activity. The active subjects being the people who practice or participate in some sort of sport type or physical activity – be it competitively or for pleasure/recreation.

In table 4.32 (below) the statistical difference are shown, with $p<0.05$. Therefor the active subjects had a definite bigger DIB volume than the non-active subjects. This is most probably due to the result of very little friction between tendon and tibia of the non-active subjects. Vice versa the active subjects' knees were exposed to more friction between the tendon and bone and thus resulting in a bigger DIB to minimize the direct friction between the distal patellar tendon and the proximal tibia.

Table 4.32 – Independent Samples Test – Active vs Non-active

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	3.984	.047	-2.215	269	**.028***	-23.78384	10.73805	-44.92515	-2.64253
	Equal variances not assumed			-3.426	62.967	**.001***	-23.78384	6.94295	-37.65835	-9.90932
Left knee volume	Equal variances assumed	7.568	.006	-2.055	269	**.041***	-20.69657	10.07217	-40.52688	-.86626
	Equal variances not assumed			-3.206	63.946	**.002***	-20.69657	6.45503	-33.59218	-7.80096

*p<0.05

Table 4.33 – Mean DIB measurements for Active subjects (Competitive&Non-Competitve)

		Right knee: AP	Right knee: CC	Right knee: Width	Left knee: AP	Left knee: CC	Left knee: Width
N	Valid	240	240	240	240	240	240
	Missing	0	0	0	0	0	0
Mean		**1.366mm**	**5.492mm**	**6.420mm**	**1.323mm**	**5.552mm**	**6.702mm**
Std. Error of Mean		.0281	.1320	.1732	.0305	.1241	.1769
Median		1.300	5.300	5.900	1.200	5.400	6.200
Std. Deviation		.4357	2.0445	2.6831	.4724	1.9219	2.7409
Minimum		.5	1.8	2.0	.4	1.7	2.0
Maximum		3.2	13.2	15.7	2.8	13.0	17.0

The mean DIB measurements for active subjects are as follow: Right Knee – AP – 1.4mm, CC – 5.5mm and Width – 6.4mm. Left Knee – AP – 1.3mm, CC – 5.6mm and Width – 6.7mm.

The DIB measurements for active people are **1.4 x 5.6 x 6.6mm.**

Table 4.34 – Mean DIB measurements for Non-active subjects

		Right knee: AP	Right knee: CC	Right knee: Width	Left knee: AP	Left knee: CC	Left knee: Width
N	Valid	32	32	32	32	32	32
	Missing	0	0	0	0	0	0
Mean		**1.169mm**	**4.847mm**	**4.906mm**	**1.219mm**	**5.009mm**	**5.734mm**
Std. Error of Mean		.0769	.3405	.3427	.0702	.3032	.4650
Median		1.200	4.500	4.900	1.200	5.100	5.350
Std. Deviation		.4351	1.9262	1.9386	.3971	1.7149	2.6305
Minimum		.5	2.0	2.0	.6	1.5	2.0
Maximum		2.5	10.3	8.7	2.8	8.2	15.0

When looking at table 4.34(above) it is clear to see the smaller values for the DIB for non-active subjects. The mean DIB measurements for non-active people are as follow:

Right Knee – AP – 1.2mm, CC – 4.8mm and Width – 4.9mm;

Left Knee – AP – 1.2mm, CC – 5.0mm and Width – 5.7mm.

The mean DIB measurements for non-active people are **1.2 x 4.9 x 5.3mm.**

4.5 DIB Measurement comparisons between different types of sport.

The different sport types were classified under the following headings: 1-rugby, 2-soccer, 3-running, 4-cycling, 5-cricket and 6-other. The other category include a whole list of different sport types listed below.

Table 4.35 – "Other"-category for Competitive Sport Activities.

ACTIVITY	N
Swimming	8
Squash	3
Clay pigeon shooting	1
Aerobics-gymnastics	1
Netball	2
Hockey	6
Volleyball	3
Adventure racing	3
Dancing	1
Waterpolo	2
Fencing	1
Capoeira	1
Tennis	2
Canoeing	1
Karate	1
Softball	4

On average the subjects in table 4.35 (above) train or practice 6.3hours a week.

Table 4.36 – "Other"-category for Non-Competitive Sport Activities.

ACTIVITY	N
Gym	38
Volleyball	2
Netball	2
Tae kwando	1
Tennis	6
Golf	11
Hiking	2
Squash	11
Belly dancing	1
Swimming	17
Rock climbing	2
Palates	1
Horseriding	2
Walking	5
Surfing	3
Lifesaving	1
Frisbee	1
Waveski	1
Motorcross	1
Aikido	1
Short circuit motorcycle racing	1
Yoga	2
Cricket	1
Basketball	2
Dancing	1
Weight training	2

On average the subjects in table 4.36 (above) train or practice 3.15hours a week.

Gym was not taken as a sport type by itself, even though 38 subjects were listed under this heading, as gymming consists of too many different aspects to determine if the type of action or sport type would make a difference on the DIB measurements.
Cricket was listed under the "other" category for the non-competitive sport activities, as there was only one subject playing recreational cricket.

Following next will be the comparison between the different sport types to determine any effect it will have on the DIB measurement.

4.5.1 Rugby vs Soccer

Table 4.37 – Comparison between Rugby and Soccer players' DIB volumes

	Rugby vs Soccer	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	rugby	37	105.6822	100.03012	16.44485
	soccer	31	46.7220	39.25470	7.05035
Left knee volume	rugby	37	98.4500	78.52956	12.91018
	soccer	31	52.7878	36.57905	6.56979

Table 4.38 – Independent Samples Test – Rugby vs Soccer

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	8.486	.005	3.086	66	**.003***	58.96016	19.10740	20.81100	97.10931
	Equal variances not assumed			3.295	48.485	**.002***	58.96016	17.89247	22.99422	94.92610
Left knee volume	Equal variances assumed	10.285	.002	2.976	66	**.004***	45.66219	15.34528	15.02435	76.30003
	Equal variances not assumed			3.152	52.810	**.003***	45.66219	14.48568	16.60515	74.71923

*$p<0.05$

In table 4.35 and table 4.36 (above) the comparison between rugby and soccer players' DIB's are shown. There is a distinct difference between the two subgroups, with the rugby players showing a statistically significant larger bursa volume than the soccer players.

Table 4.39 – Mean DIB measurements for Rugby players

		Right knee: AP	Right knee: CC	Right knee: Width	Left knee: AP	Left knee: CC	Left knee: Width
N	Valid	40	40	40	40	40	40
	Missing	0	0	0	0	0	0
Mean		**1.475mm**	**6.883mm**	**8.113mm**	**1.468mm**	**6.718mm**	**7.745mm**
Std. Error of Mean		.0619	.3621	.5523	.0745	.3678	.4803
Median		1.450	6.700	7.200	1.400	6.750	7.650
Std. Deviation		.3914	2.2902	3.4928	.4714	2.3259	3.0375
Minimum		.7	2.7	2.0	.6	2.2	2.9
Maximum		2.3	13.2	15.7	2.8	13.0	14.6

The mean DIB measurements for rugby playing subjects are as follow:

Right Knee – AP – 1.5mm, CC – 6.9mm and Width – 8.1mm.

Left Knee – Ap – 1.5mm, CC – 6.7mm and Width – 7.8mm.

The mean DIB measurements for rugby players are **1.5 x 6.8 x 8.0mm.**

Table 4.40 – Mean DIB measurements for Soccer players

		Right knee: AP	Right knee: CC	Right knee: Width	Left knee: AP	Left knee: CC	Left knee: Width
N	Valid	36	36	36	36	36	36
	Missing	0	0	0	0	0	0
Mean		**1.344mm**	**5.617mm**	**6.375mm**	**1.353mm**	**5.489mm**	**6.539mm**
Std. Error of Mean		.0792	.3038	.3459	.0730	.2560	.3786
Median		1.200	5.400	6.200	1.200	5.450	6.200
Std. Deviation		.4754	1.8229	2.0755	.4378	1.5362	2.2717
Minimum		.7	3.2	3.7	.7	2.9	2.1
Maximum		3.2	9.6	11.7	2.7	9.4	10.9

The mean DIB measurements for soccer playing subjects are as follow:

Right Knee – AP – 1.3mm, CC – 5.6mm and Width – 6.4mm.

Left Knee – AP – 1.4mm, CC – 5.5mm and Width – 6.5mm.

The mean DIB measurements for soccer players are **1.4 x 5.6 x 6.5mm.**

On average the rugby playing subjects train 9.95 hours a week. The soccer playing subjects train on average 4 hours a week. The big difference in training time for rugby and soccer playing subjects could have an effect on the outcome of DIB's size for the two subgroups. The training time reflects the time spent exercising and thus the indirect time of impact on the knee – patellar tendon – deep infrapatellar bursa.

Of the 36 soccer playing subjects, only 4 plays non-competitively. The remaining 32 soccer players are professional sportspeople. Of the 40 rugby playing subjects, only 2 plays non-competitive rugby for recreation. There are thus 38 professional rugby players amongst the subjects. Its seems as if professional rugby players train slightly harder on the field than professional soccer players. Time spent on the field can thus have a direct relation to the size of the deep infrapatellar bursa. Quite interesting!

Rugby is also considered as a more intense, high impact sport and the biomechanics of the subjects' knees are mostly different and can thus either contribute to a bigger DIB or not, depending on the sport type. This fact could also be explained by taking into account that rugby players do more strength training, while the soccer players concentrate more on fitness and suppleness. This however is quite a generilisation of professional sportspeoples' training, as both these sport types obviously concentrate on strength and fitness, but could it be that the one concentrate just slightly more on the one aspect than the other.

Another important factor to consider which could also propably influence the DIB size, is the difference in sheer size of an average rugby player compared to the average other speciality sport type in this study.

Table 4.41 - The average height, weight and BMI for this study are shown:

	Average Height	Average Weight	Average BMI	Average Age
Rugby players	1.76m	83.33kg	26.7	26.5years
Runners	1.73m	72.14kg	23.8	34.1years
Cricketers	1.82m	80.17kg	23.9	22.8years
Cyclists	1.77m	77.08kg	24.6	33.8years
Soccer players	1.70m	66.69kg	23.1	22.8years

It appears that the rugby players are slightly heavier than the other sports people. The runners and soccer players are slightly lighter again. It has to be taken into account that the study included men and women in all the different sport types, which could influence the weight especially. The average age for different sport types differed, with the soccer players and cricketers being the youngest. These differences in height, weight and age do not seem to be that significantly different and further studies with bigger sample volumes are needed to compare these characteristics more accurately.

4.5.2 Rugby vs Running

Table 4.42 – Comparison between Rugby players and Runners

	Rugby vs Running	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	rugby	37	105.6822	100.03012	16.44485
	running	82	50.8668	41.39052	4.57082
Left knee volume	rugby	37	98.4500	78.52956	12.91018
	running	82	59.1202	59.50211	6.57091

Table 4.43 – Independent Samples Test – Rugby vs Running

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	16.487	.000	4.238	117	**.000***	54.81537	12.93350	29.20125	80.42949
	Equal variances not assumed			3.212	41.667	**.003***	54.81537	17.06826	20.36206	89.26868
Left knee volume	Equal variances assumed	3.979	.048	3.011	117	**.003***	39.32977	13.05995	13.46522	65.19431
	Equal variances not assumed			2.715	55.415	**.009***	39.32977	14.48619	10.30369	68.35585

*p<0.05

There is a statistically significant difference between the rugby players' and runners' DIB volumes. The rugby players' DIB's being bigger than the runners'.

Table 4..44 – Mean DIB measurements for Running subjects

		Right knee: AP	Right knee: CC	Right knee: Width	Left knee: AP	Left knee: CC	Left knee: Width
N	Valid	85	85	85	85	85	85
	Missing	0	0	0	0	0	0
Mean		**1.366mm**	**5.304mm**	**6.126mm**	**1.321mm**	**5.334mm**	**6.795mm**
Std. Error of Mean		.0488	.1930	.2582	.0550	.1930	.3411
Median		1.300	5.000	5.700	1.200	5.300	6.200
Std. Deviation		.4497	1.7793	2.3808	.5071	1.7796	3.1448
Minimum		.7	1.8	2.6	.4	1.7	2.8
Maximum		2.5	10.3	14.4	2.5	10.5	17.0

The mean DIB measurements for the running subjects are as follow:

Right Knee – AP – 1.4mm, CC – 5.3mm and Width – 6.1mm.

Left Knee – AP – 1.3mm, CC – 5.3mm and Width – 6.8mm.

The mean DIB measurements for runners are **1.4 x 5.3 x 6.5mm.**

If compared to the rugby subjects' mean measurements (1.5 x 6.8 x 8.0mm) the difference in measurements between the two subgroups can be seen.

The biomechanics of runners' knees are also different from the rugby playing subjects' and can result in some of the difference noted. Runners have a more consistent repetitive impact on the knee – patellar tendon – deep infrapatellar bursa. Rugby players are more manoevreable in the sense that they perform different actions causing different impacts of varying degrees/stresses on the knee. The more 'complex' actions performed by rugby players compared to runners, can thus also result in the difference in size of the DIB as indicated in above tables.

On average the running subjects run 46.4km per week in 4.5hours, at a speed of approximately 10.3km/h. Of the 85 runners, 59 run competitively and 26 run for fun. If we devide them into there two subgroups: Competitive and Non-competitive runners, the 59 competitive runners run on average 56.5km per week in 5.4hours, at an approximate speed of 10.5km/h. The 26 non-competitive runners run 23.3km per week in 2.6h, at an approximate speed of 9km/h. Although there are quite a distinct difference between the two running subgroups, on average the runners as one group still train less hours a week, compared to the average of 9.95hours a week of the rugby players.

4.5.3 Rugby vs Cycling

Table 4.45 – Comparison between Rugby players and Cyclists

	Rugby vs Cycling	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	rugby	33	109.1395	104.09325	18.12031
	cycling	38	52.3453	43.02265	6.97919
Left knee volume	rugby	33	100.9009	79.65316	13.86584
	cycling	38	61.4088	50.61137	8.21025

Tabe 4.46 – Independent Samples Test – Rugby vs Cycling

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	9.104	.004	3.077	69	**.003***	56.79422	18.45840	19.97073	93.61771
	Equal variances not assumed			2.925	41.410	**.006***	56.79422	19.41790	17.59078	95.99766
Left knee volume	Equal variances assumed	4.613	.035	2.526	69	**.014***	39.49210	15.63223	8.30664	70.67755
	Equal variances not assumed			2.451	52.763	**.018***	39.49210	16.11427	7.16758	71.81661

*p<0.05

Again there are a statistically significant difference between the DIB's of the rugby players and the cyclists. The rugby players again having a bigger bursa.

Table 4.47 – DIB measurements for Cyclists

		Right knee: AP	Right knee: CC	Right knee: Width	Left knee: AP	Left knee: CC	Left knee: Width
N	Valid	38	38	38	38	38	38
	Missing	0	0	0	0	0	0
Mean		**1.345m**	**5.295mm**	**6.311mm**	**1.350mm**	**5.545mm**	**7.203mm**
Std. Error of Mean		.0657	.2895	.3854	.0821	.2519	.3945
Median		1.300	5.250	6.150	1.200	5.400	7.000
Std. Deviation		.4052	1.7848	2.3759	.5060	1.5526	2.4317
Minimum		.7	2.3	2.9	.4	2.5	3.3
Maximum		2.5	10.3	13.0	2.4	9.5	13.2

The mean DIB volume for the cyclists are as follow:

Right knee: AP – 1.3mm, CC – 5.3mm and Width – 6.3mm.

Left Knee: AP – 1.4mm, CC – 5.5mm and Width – 7.2mm.

The mean DIB measurements of the cyclists are **1.4 x 5.4 x 6.8mm.**

If compared to the rugby subjects' mean measurements (1.5 x 6.8 x 8.0mm) the difference in measurements between the two subgroups can again be seen.

Comparing cyclists to rugby players are similar than comparing the runners to the rugby players. The biomechanics of the knees differ greatly as cyclists mostly relay on their quadriceps and hamstrings to perform the right amount of strenght needed for cycling. Also the cycling action are a repetitive action rather than a compilation of varied actions like rugby players, and this could have an effect on the volume of the DIB.

On average the cyclists cycle 142.5km per week in 5hours, at an average speed of 28.5km/h. Of the 38 cyclists, 22 cycles competitively and 16 cycle for fun. The competitive cyclists cycle on average 211.4km per week in 6.9hours, at an avergae speed of 30.8km/h. The non-competitive cyclists cycle 47.8km per week in 2.4hours, at an average speed of 19.62km/h. The big difference in parameters between the two subgroups are obviously a determining factor, but on average the amount of training per week even for the competitive group are still less than the training hours for rugby players per week.

It also have to be taken into account that cycling as an activity, includes road cycling as well as mountain biking or off-road cycling. This could also play a contributing factor in the size of the DIB volume for cyclists. If a big enough sample group between the two subgroups can be recruited an interesting result could follow. May be something to keep in mind for the future.

4.5.4 Rugby vs Cricket

Table 4.48 – Comparison between Rugby players and Cricketers

	Rugby vs Cricket	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	rugby	33	109.1395	104.09325	18.12031
	cricket	18	64.3901	68.30433	16.09948
Left knee volume	rugby	33	100.9009	79.65316	13.86584
	Cricket	18	53.0949	44.30976	10.44391

Table 4.49 – Independent Samples Test – Rugby vs Cricket

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	1.575	.215	1.638	49	**.108'**	44.74943	27.32261	-10.15740	99.65626
	Equal variances not assumed			1.846	47.153	**.071'**	44.74943	24.23920	-4.00939	93.50825
Left knee volume	Equal variances assumed	4.055	.050	2.349	49	**.023***	47.80599	20.35271	6.90570	88.70629
	Equal variances not assumed			2.754	48.951	**.008***	47.80599	17.35905	12.92079	82.69120

*p<0.05 'p>0.05

In the comparison between the rugby players and the cricketers it shows that the rugby players have a bigger DIB volume than the cricketers, but most probably due to a too small cricketer sample size the significance of the difference between the two groups are questionable. The left DIB volume being statictically significant, but not the right DIB volume.

Table 4.50 – DIB measurements for Cricketers

		Right knee: AP	Right knee: CC	Right knee: Width	Left knee: AP	Left knee: CC	Left knee: Width
N	Valid	18	18	18	18	18	18
	Missing	0	0	0	0	0	0
Mean		**1.372mm**	**5.356mm**	**6.911mm**	**1.244mm**	**5.561mm**	**6.639mm**
Std. Error of Mean		.1084	.6505	.7274	.1164	.4213	.6185
Median		1.400	4.450	6.950	1.150	5.450	6.000
Std. Deviation		.4599	2.7596	3.0860	.4938	1.7873	2.6239
Minimum		.5	2.4	2.9	.7	3.1	3.4
Maximum		2.3	13.0	13.0	2.5	9.3	11.6

Comparing the mean DIB volume for the cricketers (Right – 1.4x5.4x7mm; Left – 1.2x5.7x6.6mm as in table 4.49 above) and the rubgy players (Right – 1.5x6.9x8.1mm; Left – 1.5x6.7x7.7mm as in table 4.39 above) the difference in measurements between the two subgroups can be seen. As explained above these results are most probably biased due to the small sample size.

The mean DIB measurements for cricketers are **1.3 x 5.6 x 6.8mm.**

The cricketers trained an average of 22.9hours per week. This is quite a bit more than even the rugby players, but it can be explained. The cricketers participate in 1-day and 5-day matches, which considerably increases the training or field time. Also the 18 cricketers included in the study are either South African- or Western Province representitives. The rugby players include players from the South African team, Western Province team and various clubs from Cape Town and surroundings. Further the cricketers are not envolved in any contact during training or matches, to the extreme that rugby players are exposed to.

4.5.5 Soccer vs Running

Table 4.51 – Comparison between Soccer players and Runners

	Soccer vs Running	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	soccer	31	46.7220	39.25470	7.05035
	running	81	51.2444	41.50603	4.61178
Left knee volume	soccer	31	52.7878	36.57905	6.56979
	running	81	59.3862	59.82379	6.64709

Table 4.52 – Independent Samples Test – Soccer vs Running

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	.278	.599	-.523	110	**.602***	-4.52240	8.63883	-21.6425	12.59773
	Equal variances not assumed			-.537	57.235	**.593***	-4.52240	8.42473	-21.3911	12.34632
Left knee volume	Equal variances assumed	3.097	.081	-.574	110	**.567***	-6.59835	11.50532	-29.3992	16.20249
	Equal variances not assumed			-.706	88.198	**.482***	-6.59835	9.34590	-25.1707	11.97409

*p>0.05

As seen in the above tables, the DIB volumes for the runners and soccer players are more or less the same. Thus no statistical difference noted.

4.5.6 Soccer vs Cycling

Table 4.53 – Comparison between Soccer players and Cyclists

	Soccer vs Cycling	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	soccer	31	46.7220	39.25470	7.05035
	cycling	38	52.3453	43.02265	6.97919
Left knee volume	soccer	31	52.7878	36.57905	6.56979
	cycling	38	61.4088	50.61137	8.21025

Table 4.54 – Independent Samples Test – Soccer vs Cycling

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	.164	.687	-.562	67	**.576***	-5.62323	10.01431	-25.6118	14.36541
	Equal variances not assumed			-.567	66.122	**.573***	-5.62323	9.92052	-25.4295	14.18304
Left knee volume	Equal variances assumed	1.623	.207	-.794	67	**.430***	-8.62104	10.86044	-30.2985	13.05649
	Equal variances not assumed			-.820	66.119	**.415***	-8.62104	10.51524	-29.6146	12.37262

*p>0.05

The DIB volumes for the soccer players and cyclists are almost the same and thus also no statistical signifance between these two groups.

4.5.7 Soccer vs Cricket

Table 4.55 – Comparison between Soccer players and Cricketers

	Soccer vs Cricket	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	soccer	30	47.8798	39.38373	7.19045
	cricket	17	66.5818	69.75099	16.91710
Left knee volume	soccer	30	54.0886	36.46784	6.65809
	cricket	17	54.9462	44.95022	10.90203

Table 4.56 – Independent Samples Test – Soccer vs Cricket

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	2.944	.093	-1.179	45	**.245***	-18.70199	15.85989	-50.6454	13.24146
	Equal variances not assumed			-1.017	21.909	**.320***	-18.70199	18.38181	-56.8327	19.42875
Left knee volume	Equal variances assumed	.376	.543	-.071	45	**.944***	-.85758	12.04945	-25.1264	23.41125
	Equal variances not assumed			-.067	28.011	**.947***	-.85758	12.77436	-27.0242	25.30905

*p≠ <0.05

As mentioned before the cricket sample size might be too small for accurate results.

4.5.8 Running vs Cycling

There were quite a few bi-athlone and triathlone athletes and thus trying to compare the runners and cyclists would not be very accurate as more than a third of the running subjects also cycle and the question is – do you include them in one or both the subgroups? Thus no accurate statistics could be produced.

4.5.9 Running vs Cricket

Table 4.57 – Comparison between Runners and Cricketers

	Running vs Cricket	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	running	81	50.5075	41.51952	4.61328
	cricket	18	64.3901	68.30433	16.09948
Left knee volume	running	81	57.3731	57.71757	6.41306
	cricket	18	53.0949	44.30976	10.44391

Table 4.58 – Independent Samples Test – Running vs Cricket

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	3.173	.078	-1.126	97	**.263***	-13.88255	12.33121	-38.3565	10.59149
	Equal variances not assumed			-.829	19.878	**.417***	-13.88255	16.74741	-48.8308	21.06570
Left knee volume	Equal variances assumed	.552	.459	.295	97	**.768***	4.27813	14.48867	-24.4778	33.03413
	Equal variances not assumed			.349	31.291	**.729***	4.27813	12.25572	-20.7081	29.26440

*p>0.05

Again the sample group of the cricket group are too small for accurate results. Although it does appear that the runners and cricketers has fairly the same size of DIB volume.

4.5.10 Cycling vs Cricket

Table 4.59 – Comparison between Cyclists and Cricketers

	Cycling vs Cricket	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	cycling	38	52.3453	43.02265	6.97919
	cricket	18	64.3901	68.30433	16.09948
Left knee volume	cycling	38	61.4088	50.61137	8.21025
	cricket	18	53.0949	44.30976	10.44391

Table 4.60 – Independent Samples Test – Cycling vs Cricket

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	2.059	.157	-.805	54	**.425***	-12.04479	14.96938	-42.0565	17.96700
	Equal variances not assumed			-.686	23.607	**.499***	-12.04479	17.54715	-48.2922	24.20270
Left knee volume	Equal variances assumed	.277	.601	.596	54	**.553***	8.31390	13.93906	-19.6322	36.26002
	Equal variances not assumed			.626	37.861	**.535***	8.31390	13.28471	-18.5828	35.21063

*p>0.05

No difference between the cyclists and cricketers noted, but again the small sample size of the cricketers could play a role in this fact.

4.6 DIB measurement comparisons between different previous knee history.

The different types of previous knee history that were listed included: knee pain, patellar tendinitis, knee arthroscopy and knee operation. All these were thought to have a possible effect on the DIB volume.

4.6.1 Knee pain vs No pain

Table 4.61 – Comparison between 'knee pain' and 'no pain'

	Knee pain	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	no	191	56.4196	60.55687	4.38174
	yes	81	52.0245	49.44338	5.49371
Left knee volume	no	191	53.4337	48.47868	3.50779
	yes	81	64.4225	64.19521	7.13280

Table 4.62 – Independent Samples Test – Knee pain vs No pain

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	.998	.319	.577	270	**.565***	4.39507	7.62264	-10.6123	19.40244
	Equal variances not assumed			.625	182.981	**.532***	4.39507	7.02713	-9.46955	18.25968
Left knee volume	Equal variances assumed	7.772	.006	-1.546	270	**.123***	-10.98872	7.10943	-24.9856	3.00825
	Equal variances not assumed			-1.382	120.410	**.169***	-10.98872	7.94868	-26.7260	4.74856

*p>0.05

There do not seem to be any comparison to be made between subjects with knee pain and subjects with no knee pain. Statistically there are no significant difference.

The knee pain which were included were infrapatellar knee pain, anterior knee pain and knee pain generilized to the DIB. Of the 81 subjects with knee pain the distribution between left knee pain and right knee pain were as follow: 23 with left knee pain, 22 with right knee pain and 36 with pain in both knees. Surprisingly a fairly good distribution between right – and left knee pain.

4.6.2 Patellar tendonitis vs No tendonitis

Table 4.63 – Comparison between 'patellar tendonitis' and 'no tendonitis'

	Patellar Tendonitis	N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	no	253	55.0934	56.90649	3.57768
	yes	19	55.3424	65.55790	15.04001
Left knee volume	no	253	56.6401	53.99608	3.39470
	yes	19	57.5854	51.82442	11.88934

Table 4.64 – Independent Samples Test – Patellar tendonitis vs No tendonitis

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	.566	.452	-.018	270	**.985***	-.24905	13.68342	-27.1888	26.69071
	Equal variances not assumed			-.016	20.090	**.987***	-.24905	15.45968	-32.4881	31.99002
Left knee volume	Equal variances assumed	.128	.721	-.074	270	**.941***	-.94529	12.81048	-26.1664	24.27585
	Equal variances not assumed			-.076	21.045	**.940***	-.94529	12.36448	-26.6553	24.76474

*p>0.05

No significant difference could be found between subjects with previous patellar tendonits and subjects with no previous patellar tendonitis. However, the patellar tendonitis subgroup's sample size are fairly small and comparison between these groups with a larger sample size could show different results.

The patellar tendonitis' left – and right knee distribution were as follow: 7 subjects with patellar tendonitis in the left knee, 6 subjects with patellar tendonitis in the right knee and 6 subjects with patellar tendonitis in both knees. The patellar tendonitis mentioned here includes infrapatellar tendonitis.

In the same breath it should be mentioned again that no subjects with deep infrapatellar bursitis were included in this study as this would obviously skew the average DIB volume in any chosen group.

4.6.3 Previous knee operation vs No knee operation

Table 4.65 – Comparison between 'previous knee operation' and 'no knee operation'

Previous knee operation		N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	no	246	55.2546	58.89811	3.75521
	yes	26	53.7498	41.69926	8.17790
Left knee volume	no	246	56.0368	53.86779	3.43449
	yes	26	63.0390	53.29386	10.45178

Table 4.66 – Independent Samples Test – Previous knee operation vs No operation

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	.535	.465	.127	270	**.899***	1.50481	11.86218	-21.8493	24.85895
	Equal variances not assumed			.167	36.489	**.868***	1.50481	8.99887	-16.7372	19.74687
Left knee volume	Equal variances assumed	.538	.464	-.631	270	**.529***	-7.00218	11.09770	-28.8512	14.84685
	Equal variances not assumed			-.636	30.654	**.529***	-7.00218	11.00161	-29.4503	15.44603

*p>0.05

No significant difference could be found between subjects with previous knee operation and subjects with no knee operation. Again a bigger sample size could most probably show different results.

The right- and left knee distribution for the previous knee operation subgroup were as follow: 11 subjects with previous left knee operation, 11 subjects with previous right knee operations and 4 subjects with bilateral previous knee operations. Again quite amazing to see the random selection of subjects having such a perfect distribution.

4.6.4 Previous knee arthroscopy vs No knee arthroscopy

Table 4.67 – Comparison between 'previous knee arthroscopy' and 'no knee arthroscopy'

Previous arthroscopy		N	Mean	Std. Deviation	Std. Error Mean
Right knee volume	no	251	54.4971	56.99744	3.59765
	yes	21	62.4454	63.25527	13.80343
Left knee volume	no	251	56.4815	53.57437	3.38158
	yes	21	59.3909	57.16977	12.47547

Table 4.68 – Independent Samples Test – Previous knee arthroscopy vs No arthroscopy

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right knee volume	Equal variances assumed	.819	.366	-.609	270	**.543***	-7.94826	13.05833	-33.6573	17.76083
	Equal variances not assumed			-.557	22.801	**.583***	-7.94826	14.26456	-37.4710	21.57449
Left knee volume	Equal variances assumed	.942	.333	-.238	270	**.812***	-2.90942	12.23249	-26.9926	21.17378
	Equal variances not assumed			-.225	23.037	**.824***	-2.90942	12.92565	-29.6457	23.82695

*p>0.05

No significant difference between these two subgroups, but there are a slight indication that the arthroscopy-subgroup have a larger DIB volume. Again with a larger sample group this could be proven statistically significant. However, in contrast in what was believed before the study commensed, there are a DIB visualised for patients following an arthroscopy.

4.6.5 Age related DIB measurements

Table 4.69 – Age group 18 – 29 years

		Right knee: AP	Right knee: CC	Right knee: Width	Left knee: AP	Left knee: CC	Left knee: Width
N	Valid	143	143	143	143	143	143
	Missing	273	273	273	273	273	273
Mean		**1.351mm**	**5.441mm**	**6.443mm**	**1.303mm**	**5.520mm**	**6.592mm**
Std. Error of Mean		.0372	.1742	.2413	.0384	.1609	.2268
Std. Deviation		.4450	2.0827	2.8850	.4598	1.9238	2.7120
Minimum		.5	2.0	2.0	.6	1.5	2.0
Maximum		3.2	13.2	15.7	2.8	13.0	17.0

Table 4.70 – Age group 30 – 39 years

		Right knee: AP	Right knee: CC	Right knee: Width	Left knee: AP	Left knee: CC	Left knee: Width
N	Valid	75	75	75	75	75	75
	Missing	273	273	273	273	273	273
Mean		**1.307mm**	**5.296mm**	**6.056mm**	**1.264mm**	**5.403mm**	**6.571mm**
Std. Error of Mean		.0482	.2280	.2663	.0514	.2241	.3015
Std. Deviation		.4173	1.9748	2.3059	.4450	1.9405	2.6109
Minimum		.6	1.8	2.4	.4	2.2	2.6
Maximum		2.5	12.7	13.0	2.8	11.5	14.6

Table 4.71 – Age group 40-52 years

		Right knee: AP	Right knee: CC	Right knee: Width	Left knee: AP	Left knee: CC	Left knee: Width
N	Valid	54	54	54	54	54	54
	Missing	272	272	272	272	272	272
Mean		**1.372mm**	**5.517mm**	**5.969mm**	**1.398mm**	**5.522mm**	**6.602mm**
Std. Deviation		.4595	2.0351	2.4341	.5004	1.8291	3.0330
Minimum		.5	1.8	2.6	.4	1.7	2.0
Maximum		2.5	11.3	14.4	2.5	10.5	16.3

The mean DIB measurements for the youngest age group (18-29years) are 1.4mm x 5.5mm x 6.5mm. The mean DIB measurements for the '30-39' years group are 1.3mm x 5.4mm x 6.4mm. The mean DIB measurements for the oldest age group (40-52years) are 1.4mm x 5.5mm x 6.3mm. It seems that the age of the subject has no effect on the size of the DIB. No statistical significance could be determined.

4.7 Eliminated data

Eight subjects' records were eliminated because of incomplete data. This meaning that either the right- or left deep infrapatellar bursa could not be visualised by ultrasound at the time of scanning. Thus from the 280 subjects recruited for the study only 8 subjects' DIBs could not be detected by ultrasound. The ultrasound detection rate for this study equals an amazing 97.14%.

Of the eliminated subjects 5 had no readings for the right DIB and 3 had no left DIB detected:

1. Eliminated subject number 1 had previous right knee surgery, including an ACL reconstruction, cartilage debridement and arthroscopy. This subject also showed small osteophytes on ultrasound.
2. Eliminated subject number 2 had previous right knee surgery, including maltraction correction, screw removal and arthroscopy.
3. Eliminated subject number 3 had no right knee DIB measurement and were envolved in a previous quite serious motor vehicle accident, involving extensive operations to espescially her ankles and tibias&fibulas.
4. Eliminated subject number 4 showed clear signs of Osgood Schlatters' disease on the right knee.
5. Eliminated subject number 5 had a fairly recent right ACL reconstruction in 2004.
6. Eliminated subject number 6 had a previous glass cutting injury to the left infrapatellar tendon. Very little could be visualised through the scar tissue formed directly in the DIB vicinity.
7. Eliminated subject number 7 had extensive left knee operations, including 4 cartilage operations, 2 debridements and one complicated 'raised knee' operation. Also small osteophytes could be visualised with the ultrasound.
8. Eliminated subject number 8 had previous bilateral patellar tendinosis, is a South African cricketer and had no DIB measurement for the left knee.

All the above mentioned clinical history of the subjects listed had all fairly explainable reasons for not having a DIB measurement. They either had some invasive operation, injury or pathology (eg Osgood Schlatters' disease) in the DIB area, which obviously curropted the DIB area and thus visualisation of the bursa. Only the last subject (no8) had no easy explaination for not having a visible DIB, as there are no invasive procedure or injury, thus no explaination for not being able to visualize the DIB.

4.8 Summary of Main Results

Such a large amount of data is difficult to interpret as it presents as a monotomous list of tables. I will discuss the main results in the following paragraphs.

The mean DIB measurements for all subjects are 1.3mm x 5.4mm x 6.2mm for the right knee and 1.3mm x 5.5mm x 6.6mm for the left knee. The average mean DIB measurement equalling 1.3mm x 5.5mm x 6.4mm.

There is a statistically significant difference between the DIB measurements for males and females, with the males having larger DIB measurements than woman.

Competitive sports people have statistically significant larger DIB measurements than non-competitive sports people. There are also a statistically significant difference between active and non-active people, with active people having slightly larger DIB measurements.

No statistically significant difference between the different population groups could be shown, but a definite tendency for the black population group to possibly have larger DIB measurements than the white or coloured groups were observed.

Rugby, as a sporttype, have bigger DIB's than the other sport types included in this study. The DIB measurements for rugby players averaging 1.5mm x 6.8mm x 8.0mm. No real statistical difference could be found between the other sporttypes.

Subjects with knee pain, patellar tendonitis, previous knee operation and previous knee arthroscopy seem to have no effect on the size of the DIB, but taking into account the 8 eliminated subjects there might be a degree of interruption of the DIB with knee operations, arthroscopies and patellar tendonitis. This resulting in not visualisation the DIB with ultrasound. Bigger sample sizes might show other results.

For this study the ultrasound detection rate was an amazing 97.14%. The average subject age equaling 30.67years. The age of the subjects did not seem to have an effect on the measurements of the DIB.

The above results answers all the research questions stated in chapter 1. The hypothesis was proven for the diameters of a normal DIB for males and females, people participating in different levels of and different types of sport having different DIB measurements. The hypothesis could not be proven for the DIB measurements for different population groups or opposing knees. In stating this, it has to be taken into account that the sample size for the different population groups need to be bigger for more accurate results. The fact that the hypothesis could not be proven for the opposing knees' DIB measurements, are most probably due to the fact that God created us symmetrical and thus the biomechanics of our knees must be mainly the same.

Table 4.72 – Following below are a table summarizing the mean DIB measurements:

	AP	**CC**	**Width**
Males	1.4mm	5.8mm	6.9mm
Females	1.3mm	5.0mm	5.9mm
White population	1.3mm	5.4mm	6.4mm
Coloured population	1.4mm	5.2mm	6.2mm
Black population	1.4mm	6.4mm	7.0mm
Competitive sport	1.4mm	5.7mm	6.9mm
Non-competitive sport	1.3mm	5.3mm	5.9mm
Active people	1.4mm	5.6mm	6.6mm
Non-Active people	1.2mm	4.9mm	5.3mm
Rugby players	1.5mm	6.8mm	8.0mm
Soccer players	1.4mm	5.6mm	6.5mm
Runners	1.4mm	5.3mm	6.5mm
Cyclists	1.4mm	5.4mm	6.8mm
Cricketers	1.3mm	5.6mm	6.8mm
18-29 years old	1.4mm	5.5mm	6.5mm
30-39 years old	1.3mm	5.4mm	6.4mm
40-52 years old	1.4mm	5.5mm	6.3mm
AVERAGE FOR ALL	**1.3mm**	**5.5mm**	**6.4mm**

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The fact is that the knee is one of the most complicated joints of the body. Ultrasound examination of the knee are limited, but by using a high frequency transducer, it is an ideal tool for examining the deep infrapatellar bursa. (Monetti et al., 1995) This statement was shown to be so unbelieveably true in my study with an ultrasound detection rate of 97.14% of the deep infrapatellar bursa.

Comparing my results with the MRI studies from Turkey (Aydingoz et al, 2004) and Switzerland (Tschirch et al, 2003), the mean DIB measurements differ. My study producing slightly smaller values, but with a definite higher detection rate. This could most probably be because it is MRI vs ultrasound and different factors could enfluence the results. MRI slice thickness , patient positioning and measurement methods are some of these factors.

Schmidt et al (2004), from Germany's mean DIB ultrasound measurements were 6.1mm x 6.2mm x 2.7mm. The similarity can be seen to my study were the mean DIB ultrasound measurements equaled 1.3mm x 5.5mm x 6.4mm. These two ultrasound studies thus compare favourably.

Males have a larger DIB than females. Competitive sportspeople have a larger DIB than non-competitive sports people. Active people have a larger DIB than non-active people. The left and right DIB's seem to be the same size generally. Rugby players seem to be the one sport were the DIB measurement are larger. Being larger than runners, cyclists, cricketers and soccer players DIB measurements.

It is important to note that the rugby players were training as a group and are exposed to the same amount of fitness, strength training and matches played. The runners, cyclists and soccer players include people training either by themselves or at various clubs, at an intensity suitable per individual or club, and this could lead to different results for the same sport type. Thus the statement, 'selected distances are different for different atheletes' (Maffulli et al, 1987), definetly has to be taken into account.

The outcome of the study provided more definite parameters to individualize the deep infrapatellar bursa. It ensures a better diagnosis and thus a better and faster treament plan for each patient. With all the modern technology at our exposure, it is advisable to ultrasound the deep infrapatellar bursa before final diagnosis are considered, to confirm deep infrapatellar bursitis or not. If cortisone injection is the choice of treatment, an ultrasound guided injection at the same time are advisable for optimum results and thus a better prognostic recovery.

5.2 Recommendations

On completion of this study it can be recommended that further such studies should be done to compare ultrasound and MRI measurements of the deep infrapatellar bursa.

Care was taken not to apply to much pressure with the ultrasound transducer to the infrapatellar region, during the ultrasound examination, to be able to locate the deep infrapatellar bursa easier. Also the knee was placed in slight flexion during examination to enable visualization of the DIB better. It was found that the deep infrapatellar bursa was not always visualised centrally and anterior in the knee. For future studies it would be interesting to note if the DIB was located centrally, medially or laterally and slightly inferior or superior. It would also be a good idea to correlate the position of the DIB with the specific biomechanics of the knee itself. The width, muscle circumference and fat measurement of the knee, may be even include the degree of the Q-angle of the patella to femur on flexion.

For further future studies in this field it is advisable to enlarge the sample size of the population groups and to then compare similar amounts of different population groups to each other, for optimum results. There seem to be a tendency for the black population group to have a bigger DIB than the white and coloured population group, but it could not be proven statistically significant due to the small sample size of the black population group.

If there are any means in which athletes' training could be standardised for a specific sport type, like for instance the WP rugby players, it would be advisable for future studies to compare these athletes (practising the same sport) with one another for better results.

Lastly, this study should be seen as a basis for further investigations where more samples are measured.

5.3 Summary

The study had five main objectives: (1) to investigate the size of the deep infrapatellar bursa, (2) to compare the size of the DIB of the left and right knees, male and female knees, different population groups' knees, people practising different sport types and competing at different levels of sports' knees; (3) to make recommendations on the size of the DIB for each individual, (4) to determine the ultrasound detection rate and (5) to determine if previous knee injuries, operations and arthroscopies, and present knee pain or inflammation have any effect on the size of the bursa.

All the objectives have been successfully met as documented in chapter 4. A specific technique for optimum ultrasound visualisation of the deep infrapatellar bursa has been mastered. With this study it was concluded that the deep infrapatellar bursa ultrasound measurements are in line with international standards, but could still be improved.

In conclusion the study confirms the hypothesis that the size of the deep infrapatellar bursa differs for male and female, competitive- and non-competitive sports people, active- and non-active people, and different sport types. Unfortuantely further studies are necessary to confirm the hypothesis that different population groups have different deep infrapatellar bursa measurements.

As a last thought, care should be taken not to overdiagnose deep infrapatellar bursitis in competitive sportpeople, males and rugby players specifically.

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APPENDICES

APPENDIX 1 – Questioniare

SPORTS SCIENCE
ORTHOPAEDIC
CLINIC

Ultrasound features of the deep infrapatellar bursa.

Questionnaire: (please fill in and tick the appropriate)

Name:.. Subject no:.......................................

Tel no:.. Date:.......................................

Address:...

Email:...

Ethnic origin :	Black	Coloured	Indian	White

Gender :	Female	Male

Date of birth : .... Nationality : ....

Do you have any knee pain?: .... Which knee:..

Do you have bursitis/tendonitis in the knee area: ....

Previous knee arthoscopy: ....

Previous knee operation: ....

Physio/Grucox/Strengthening exercises (hours/week): ....

Competitive Sport activities:..Hours/week:......Games/year: ....

Non-competitive sport activities: ....Hours/week: ....

Height: ....Weight: ....BMI: ....

For Office use only

Right knee : AP :	**Left knee : AP :**
CC :	**CC :**
Width:	**Width :**

APPENDIX 2 – Consent Form

SPORTS SCIENCE
ORTHOPAEDIC
CLINIC

CONSENT TO PROCEDURE

I, ……………………………………………………………………………

hereby consent to the performance of an ultrasound examination of my knees.

The above mentioned examination was explained to me by Merle Neethling – du Toit.

Signature …………………………………………………………………

Date ………………………………

APPENDIX 3 – Letter requesting approval for study at the Sport Science Orthopaedic Clinic.

March 2005

Dear Dr D O'Cuinneagain,

APPROVAL FOR PROPOSED RESEARCH STUDY

I, Merle Neethling-du Toit, would like to conduct a project at the Sports Science Orthopaedic clinic. The project will cover the following topic: **Ultrasound features of the Deep Infrapatellar Bursa.**

The objectives of the study are (1) to investigate the size of the deep infrapatellar bursa, (2) to compare the size of the DIB of the left and right knees, male and female knees, different population groups' knees, people practising different sport types and competing at different levels of sports' knees; (3) to make recommendations on the size of the DIB for each individual, (4) to determine the ultrasound detection rate and (5) to determine if previous knee injuries, operations and arthroscopies, and present knee pain or infalmmation have any effect on the size of the bursa.

I will recruit approximately 200 subjects and will need to perform an ultrasound examination at the Sports Science Orthpaedic Clinic on each individuals knees. The ultrasound examination will take 15 minutes per patient. As you are well aware, ultrasound examinations as not harmful or hazardous.

All subjects will stay anonymous and patient personal details will be kept private and confidential. Written consent will be obtained from each individual participant. For participants who do not speak or understand English or Afrikaans, a translator will be present to explain the questionniare and ultrasound examination.

I you have any questions regarding my proposed project please do not hesitate to contact me. (Cell phone: 0726110252, Email: merleneethling@yahoo.co.uk)

I am awaiting your approval for the proposed project.

Yours Sincerely

Merle Neethling-du Toit
Sonographer

APPENDIX 4 – Research Approval letter from Sports Science Orthopaedic Clinic.

March 2005

Dear Merle,

APPROVAL FOR PROPOSED RESEARCH PROJECT

This is to confirm approval for your proposed research study: Ultrasound features of the Deep Infrapatellar Bursa, at the Sports Science Orthopaedic Clinic.

Please be advised that ultrasound examinations need to be peformed during quieter times at the clinic and correspondence with the radiology department is essential. No patient/subject are allowed to participate without signing written consent.

We look forward to the results.

Kind Regards

Dr Dion O'Cuinneaggain
Manager – Sports Science Orthopaedic Clinic