OUTCOME OF ACL RECONSTRUCTION: A COMPARISON BETWEEN BIOTRANSFIX SCREW AND ALL-INSIDE TECHNIQUE

BY

NIK ALYANI NIK ABDUL ADEL

A dissertation submitted in fulfillment of the requirement for the degree of Master of Orthopaedic Surgery

Kulliyyah of Medicine
International Islamic University Malaysia

MAY 2017

ABSTRACT

This is a cross sectional study of 40 patients with Anterior Cruciate Ligament (ACL) injury treated with ACL reconstruction surgery in Hospital Sultanah Nur Zahirah, Kuala Terengganu and Hospital Kemaman, Kemaman, Terengganu. The aim of this study is to compare outcomes of patient after an ACL reconstruction between two techniques: biotransfix screw or all inside technique. 20 patients in each group of technique were selected and agreed to participate in this study. They were evaluated for the functional outcome with IKDC score, quality of life SF-36 questionnaire and time taken to return to normal activities at 18-24 months post-operative. There were 32 patients from HSNZ and another 8 from Hospital Kemaman. 37 patients were male and all of them were Malay. Mean age was 25.03 years old, range from 17 to 41 years old. 25 of them were working as office worker and the rest were a field worker. 37.5% were smoker at the time of surgery, while another 62.5% were nonsmoker. Right knee involved in 27 patients. Patients in biotransfix screw operated at mean of 21.3 months after the injury while in all inside technique was at mean of 17.65 months. Mean BMI was 24.58 with 42.5% of them were normal, 40% were overweight, 10% were underweight and 7.5% were obese. The biotransfix screw technique scored slightly better in all categories except for physical function, body pain and role emotional in SF 36 questionnaires compare to all inside technique but they were not statistically significant. Both groups have mean IKDC score of 82.99. Time taken to return to normal activity level was at mean of 46.3 weeks which was about similar in both groups. Re rupture rate were 10% in biotransfix screw technique and 5% in all inside technique. None of them has any form of infection. There were also no correlation in between outcome with age, tobacco use, BMI, duration of injury until operation and occupation of the patient in both techniques. As a conclusion, the functional outcome, quality of life and time return to normal activity were not statistically has a significant difference between biotransfix screw and all inside technique. There were also no correlations between factors study with outcome in both groups.

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Orthopaedic Surgery

…….

Mohd Shukrimi bin Awang
Supervisor

…….

Mohd Ariff Bin Sharifudin
Co-Supervisor

This dissertation was submitted to the Department of Orthopaedic and is accepted as a fulfillment of the requirements for the degree of Master of Orthopaedic Surgery

……...

Mohd Shukrimi bin Awang
Head, Department of
Orthopaedics, Traumatology
and Rehabilitation

This dissertation was submitted to the Kulliyyah of Medicine and is accepted as a fulfillment of the requirements for the degree of Master of Orthopaedic Surgery

……

Azmi bin Md Nor
Dean, Kulliyyah of Medicine

DECLARATION

I hereby declare that this thesis is the result of my own investigation, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

Nik Alyani Nik Abdul Adel

Signature……. Date ….....

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

DECLARATION OF COPYRIGHT AND AFFIRMATION OF FAIR USE OF UNPUBLISHED RESEARCH

OUTCOME OF ACL RECONSTRUCTION: A COMPARISON BETWEEN BIOTRANSFIX SCREW AND ALL-INSIDE TECHNIQUE

I declare that the copyright holders of this dissertation are jointly owned by the student and IIUM.

By signing this form, I acknowledged that I have read and understand the IIUM Intellectual Property Right and Commercialization policy.

Affirmed by Nik Alyani Nik Abdul Adel

……..……..…… ……..

Signature Date

ACKNOWLEDGEMENTS

First of all, Alhamdulillah I was able to complete the thesis. I am deeply grateful to my supervisor, Assoc. Prof. Dr. Mohd Shukrimi bin Awang who had always guide me from the beginning of this research until completion of the report. I am heartily thankful to Dr Atikah Amirah Suzanna bt Abdullah, Dr Suzanah bt Kamaluddin and Dr Isnoni bt Ismail from Hospital Sultanah Nur Zahirah for all the support given throughout the completion of the thesis. My appreciation also to all patient who participated in this study.

Special thanks to my husband, siblings and collegues for their continuous support and help throughout my study and completion of this thesis.

Lastly, I would like to send my regard and blessings to all of those who supported me in any aspect during the completion of the project.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF STUDY

Anterior cruciate ligament (ACL) reconstruction is a common procedure done to treat an ACL tear. Since it first arthroscopic technique is introduced in 1920's, surgical technique for arthroscopic ACL reconstruction continuously progressing to improve the result of the procedure. It has become less invasive, with fewer and smaller incisions, more bone stock preservation, preservation of tendon at its donor site, better graft positioning and better fixation technique to bone (Benea et al., 2014).

Hence all-inside technique is introduced in the aim to fulfill the criteria of better ACL reconstruction technique. The drilling technique in all inside is the creation of a half tunnel both on tibia and femur side, where bone are drilled in two diameters, bigger diameter inside for graft positioned and another smaller diameter just to pass the fixation to outer cortex. The drilling of the double half tunnel involved usage of retrograde flipcutter (L & Anderson, 2013; R.Buda et al., 2013). This method will preserve the external cortical bone. The way which the tunnel is created, it will increase bone to graft contact area, to improve graft-bone incorporation (R.Buda et al., 2013).

Using this method, shorter graft is needed where it allows use of single tendon that can be triplicated or quadruplicated. Only one donor tendon is needed (usually semitendinosus) in comparison to previous technique that needs at least 2 hamstrings tendons in case autologous hamstring tendon are used. Because of this, the hamstring knee biomechanics is more restored in all inside technique (L & Anderson, 2013).

Biotransfix screw fixation of graft in femoral and tibia tunnel has served as classical method of fixation for ACL reconstruction. An all-inside technique using adjustable loop cortical button suspensory fixation in both bone sockets (Smith et al., 2016).

With this new all inside technique, the goal is minimizing surgical trauma. It has also affected clinical outcomes by reducing pain and morbidity, shorter time for recovery, earlier returning to activities, better cosmetic results, better stability and overall knee function. By reducing the postoperative pain, it will improve quality of life of patients, enables early rehabilitation and mobilisation following the surgery (Benea et al., 2014).

1.2 OBJECTIVES AND HYPOTHESIS

1.2.1 General Objective

General objective of this study is to observe and compare outcomes of patient after an ACL reconstruction surgery between two techniques; All-Inside and Biotransfix Screw technique.

1.2.2 Specific Objectives

Specific objectives of this study are:

1. To compare quality of life between all-inside-technique and biotransfix-screw-technique group through SF 36 questionnaire.

2. To compare functional outcome between all-inside-technique and biotransfix-screw-technique group through International Knee Documentation Committee (IKDC) scores.
3. To compare time of return to normal activity level after an ACL Reconstruction surgery in between all-inside technique group and biotransfix-screw technique group.

1.2.3 Hypothesis

Quality of life, functional outcome and time to return to normal activity are better in All-inside technique group compare to biotransfix screw technique group.

CHAPTER TWO

LITERATURE REVIEW

2.1 HISTORY AND EMBRYOLOGY OF ACL

Anterior Cruciate Ligament (ACL) is among the most frequent topic that has been reviewed and been studied due to its special anatomy and important function. Dated back in 3000 BC, first anatomical description of the ACL was found on an Egypt papyrus scroll. Later in 460-370 BC, description ACL injury causing subluxation of human knee was described by Hippocrates. 'Ligamenta genu cruciate' is the named applied by Claudius Galen of Pergamon in 129-199 BC (Zantop, Peterson, & Fu, 2005; Zantop, Peterson, K.Sekiya, Musahl, & Fu, 2006). First human knee joint and cruciate ligament biomechnical investigation was first described by Weber in 1836 (Zantop et al., 2006) followed by Bonnet in 1850, who presented the mechanism of ACL injury. He also described the ACL was commonly ruptured at insertion site at femoral condyle.

Embryologically, formation of knee joint started in fourth week of gestation from vascular mesenchyme between femur and tibia, between blastoma of femur and tibia. At eighth week of gestation, there is the appearance of ACL fibers in a distinct amount. At this time, alignment of the fibroblasts within the ligaments is according to the axis of ACL strain. By 9 week of gestation, the compositions of cruciate ligaments are of numerous immature scanty neoplasm fibroblasts and the nucleus is in fusiform shape (Dye & Cannon, 1988).

.

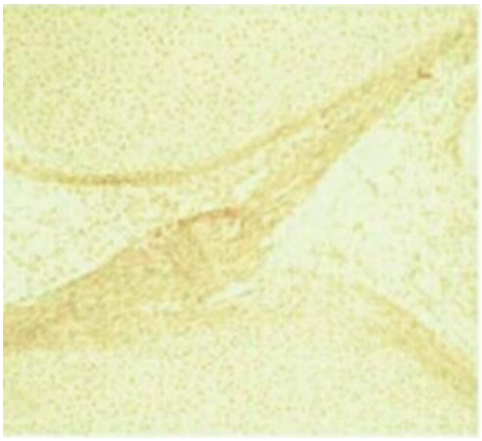

Figure 2.1 Histology slide on early organization of ACL between femur and tibia at 10^{th} week gestation.

Figure 2.2 Magnified view of ACL of a fetus at tenth week of gestation showing fibroblasts in the ligament is aligned to its axis.

Over the next few gestational weeks, there are additional changes to growth and major changes in increment of the vascularity. At this time, the fibroblast that is in fusiform shaped express high titres of vascular endothelial growth factor (VEGF) which promotes angiogenesis. The VEGF expression is largely downregulated after birth, but it is strongly expressed back during the remodelling process after the ACL

reconstruction surgery using autologous tendon grafts. Then after week twenty of gestation, there is little change in the form and marked growth development.

As fetal knee joint at twenty-four to forty gestational week were arthroscoped by Tena-Arregui, ACL appearance is similar to adult except the different at ACL femoral attachment which appears more ribbon like compared to adult ACL. Although both main bundles are detectable, but the orientation are parallel which is different compare to adult ACL. It is due to the knee of a fetus did not exposed yet to motion like loading and twisting hence it differ in term of position and orientation to adult. It is also assumed that the cruciate ligament interact with the shape of the femoral condyle and tibia plateau, as they already present at early gestational age (Tena-Arregui, C, F, J, & J, 2003; Zantop et al., 2005).

2.2 ANATOMY OF ACL

Osteoarthritis The ACL is a band of dense connective tissue that connects the femur and the tibia. The ligament is covered with the synovial membrane of the knee joint, hence it is by definition located intraarticularly but extrasynovial (Miller & Azar, 2013; Zantop et al., 2005). The ligament originates from medial surface of lateral femoral condyle and runs an oblique course through the intercondylar fossa distal-anterior-medial to its insertion at medial tibial eminence. Femoral attachment of ACL has been described in several studies. It is a segment with its anterior side straight (Zantop et al., 2005) or concave (Zantop et al., 2006) and posterior side convex to complement the condyle's articular surface curvature. Its projection is oval, semicircular or circular. The ACL has 2 bundles, the anteromedial (AM) bundle and posterolateral (PL) bundle. It is named after its insertion at tibia. The AM bundle

located more proximal and comprised about 49% of the femoral foot print, whereas the remaining is the attachment of PL bundle which is more distal (Beasley et al., 2005).

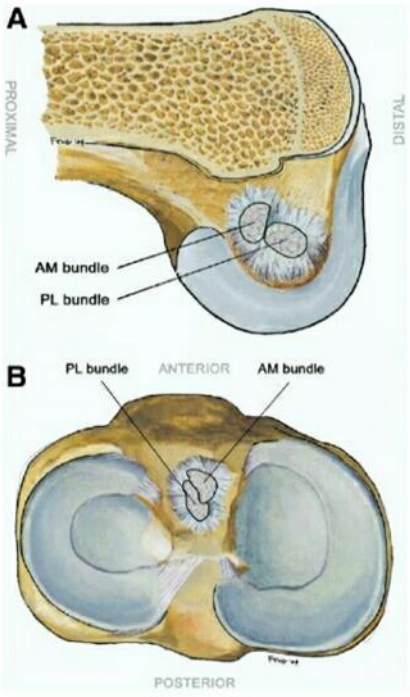

Figure 2.3 The ACL's AM and PL bundle origin and insertion.

The ligaments narrowest part is at midsubstance area. The insertion at femur and tibia is 3.5 times than the ligament's midsubstance. During its course from the origin to the insertion, it twists in a lateral spiral fashion in the knee joint. This external rotation twist is approximately 90 degrees as the fibres reaching the tibial surface. The twisting of the fibres of the ACL is a result of its bony attachment. The femoral attachment is oriented primarily in the longitudinal axis of the femur whereas the tibial attachment is in anteroposterior axis of the tibia. The intraarticular length of

the ligament is ranging from 22-41mm (with mean of 32mm) and the width ranges from 7-12mm (Zantop et al., 2005, 2006).

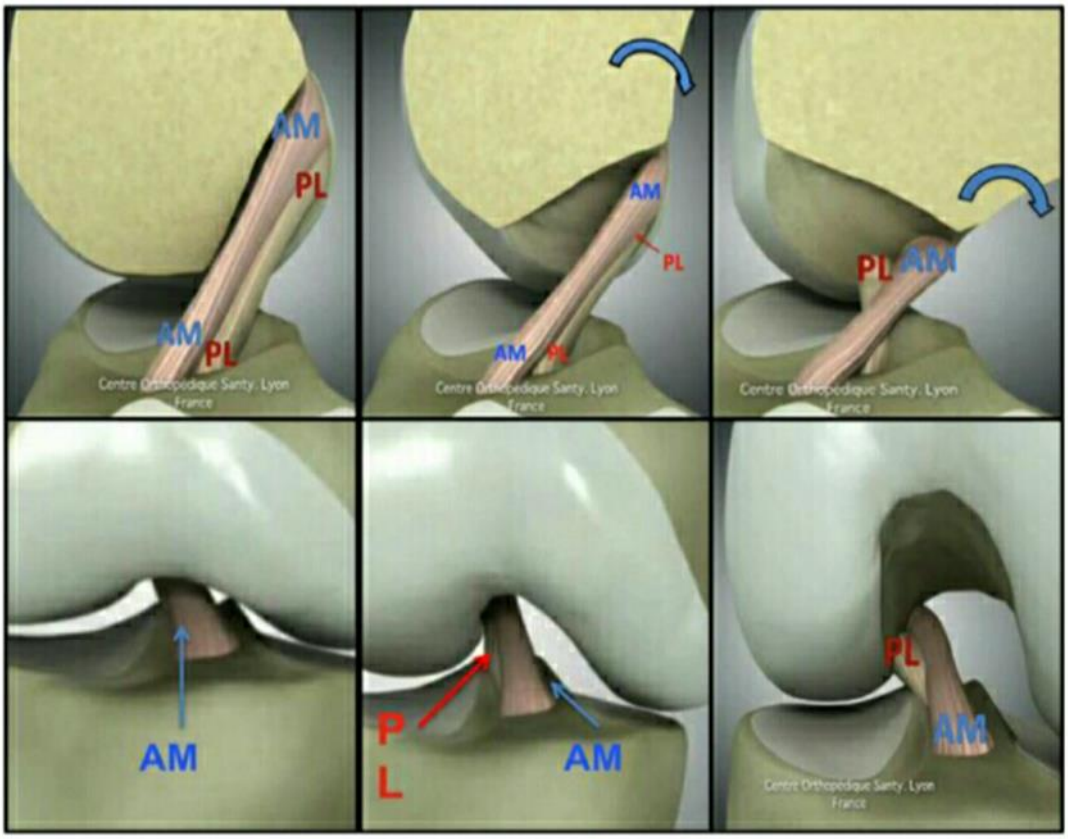

Figure 0.1The position of AM and PL bundle during knee extension and flexion. The AM bundle will always be anterior in all position of the knee

The tibia insertion of the ACL is medial to lateral meniscus anterior horn insertion at depressed area at antero lateral to the anterior tibial spine (Miller & Azar, 2013). Its insertion is fan shaped which is wide oval fossa that is larger and more secure if compare with femoral attachment site. The diameter is about 11mm in coronal plane and 17mm in sagittal plane.

The posterior part to anterior part of the intercondylar notch is wider and converging anteriorly. If there is formation of osteophyte or the anterior outlet of the intercondylar notch is stenosed which occur quiet early in knee with ACL deficiency, sometimes notchplasty is required for graft impingement avoidance. Notch index which is the ratio of epicondylar width to notch width has a negative correlation with the ACL rupture risk. It is confirmed by Shelbourne et al that measure the index during the operation and radiograhically, he concluded the notch width is narrower in ACL deficient knee that is similar in male and female. When he compares the notch index in between the gender, it is found that the index is wider in male than female. Shape of the intercondylar fossa is like gothic arch and its roof is known as 'Blumensaat line'. The Blumensaat line can be seen clearly on plain radiograph on lateral view. The notch roof angle which is the angle between the longitudinal axis of femur and the notch roof varies in between 23 to 60degrees. The 'unforgiving knee' is the knees with a small notch roof angle. It is very critical to position the tibial tunnel to avoid intercondylar notch anterior rim, impinge the graft (Zantop et al., 2005, 2006).

The primary blood supply to the ligament is from the middle geniculate artery, which pierce the posterior capsule and enters the intercondylar notch near the femoral attachment (Miller & Azar, 2013). The middle geniculate artery supply the proximal part if the ligamanets, while distally, additional supply comes from the retropatellar fat pad via the inferior medial and lateral geniculate arteries (Zantop et al., 2005). When there is injury to the ligament, the additional supply plays an important role. The osseous attachment of the ACL contribute little to its vascularity (Miller & Azar, 2013). Distal and proximal vessels forms a synovial plexus from which the small vessels enter into the ligament and align parallel to its collagen bundles. By using

immunochemistry technique, avascular area could be found at the insertion area as well as in the part of the ACL where chondrocyte-like cells can be found (Zantop et al., 2005).

Innervation of ACL comes from posterior articular nerve which is a branch of the tibial nerve. Size of the nerve fibers is most consistent with size of nerve fiber that transmits pain in the intrafascicular spaces. Golgi like tension receptors were found to be located near the ligament and along the surface of the ligament there is Golgi tendon organs. Role of ACL in proprioception of the knee is due to presence of mechanoreceptors within the deep substance of the ACL, where mainly at tibial half of the ligaments and having slow adapting Ruffini type of receptors. Other types of receptors which sense motion in any position are the rapidly-adapting Pacinian corpuslces. Within 5mm of femoral attachment there is infrequent presence of free nerve endings. Patient with ACL injury will not present with pain as there is near-absence pain fibers in the ligament. But they will experience pain due to capsule distension secondary to heamarthrosis due to the injury.

2.3 HISTOLOGY OF ACL

The ACL consists of collagen fibers that surround the soft connective tissues. They form multiple fascicles within the ACL. Type 1 collagen is the ACL's major collagen whereas type lll collagen is at the loose connective tissue. Fibroblast cell bodies are elongated. The difference in the cell morphology at anterior part of distal third of the ligaments is due to its direct contact with intercondylar fossa in full extension hence there is functional adaptation in response to the 'physiological impingement' where histologically, there is tenocytes and chondrocyte-like cells.

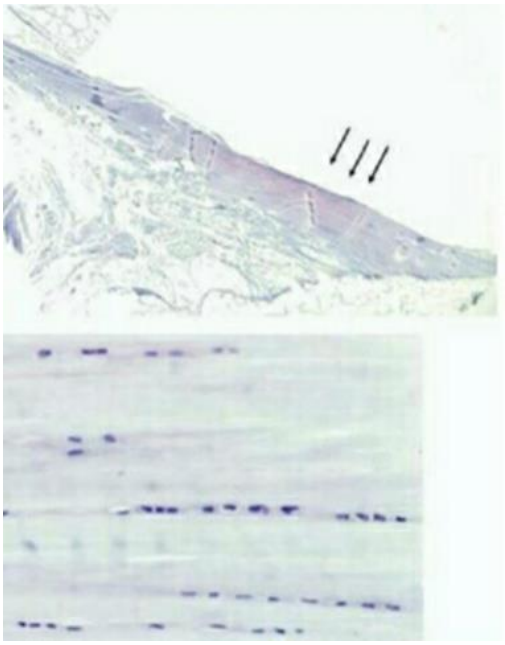

Figure 2.5 The histological section of ACL at physiological impingement site, where the below pictures shows larger view. Chondrocyte-like cells and tenocytes clearly seen (with metachromatic staining)

Microscopically, both of the attachments at femur and tibia have 4 layers of chondral apophyseal enthesis. First layer is consist of ligament fibers, second layer composed of fibrocartilagenous cells that aligned within the collagen bundles which is called the non-mineralised cartilage zone. The third layer consists of mineralised fibrocartilage and lastly it inserts at subchondral bone plate. Due to this specific layers, there is gradual transition from rigid bone to ligamentous tissue hence it allows gradual stiffness changes. This will prevent stress concentration at attachment site (Zantop et al., 2005)

2.4 BIOMECHANICS AND FUNCTIONS OF ACL

Normal function of the knee relies on a complex interplay between motion and stability. The knee possess interaction of bony structures which are femur, tibia and patella, with fibrous structure which are the ligaments and menisci to allow high forces to the knee joint especially during athletic activities. Any changes to any components of the knee will alter the biomechanics, increasing loads and functional demands to the intact structures (Dargel et al., 2007).

Primary anterior posterior knee restraint is provided by the cruciate ligaments. ACL is functioned to prevent anterior translation of the tibia in relation to femur. ACL also resist internal rotation of tibia and resist valgus or varus stress of the tibia in the absence of collateral ligament function. The ACL fibers bundle act differently in term of tension pattern throughout a full knee range of motion.

Palmer was among the first to distinguish the fibres of ACL into anteromedial and posterolateral components. Brantigan and Voshell later refines it, and has accepted widely as a basis of understanding the ACL functions. PL bundle is tight when the knee is in extension and AM bundle is moderately lax. Femoral origin of the ACL become more horizontally orientated as the knee is increasing in flexion, causing the tightening of the AM bundle and the PL bundle to become lax. When the anterior tibial load is given, the forces taken up more by the PL bundle in lower degree of flexion degree compared to AM bundle. In higher degree of knee flexion, the anterior tibial force is taken up more by AM bundle. Strain also is higher in PL bundle than in AM bundle in less than 20 degree knee flexion (P.Chambat, 2013; Zantop et al., 2006).

The role of describing 2 bundles of ACL is important in understanding ACL role in rotational movements. It is said that ACL reconstructions were successful in limiting the anterior tibial translation under anterior tibial loads. However in response to a combined rotational load, reconstruction was not enough to reduce the tibia translation anteriorly. Significant role of PL bundle is demonstrated to stabilize the knee against combined rotatory load.

2.5 EPIDEMIOLOGY OF ACL INJURY

Notwithstanding the healthy influence of sporting activities on risk factors, in particular those of cardiovascular diseases; it is becoming increasingly apparent that sports can present a danger to health in the form of sports injuries. The increased availability of leisure time, the awareness of reducing cardiovascular risk factors and the awareness of enhancing general health by improving fitness, has increased the community interest in sporting activities. Injury from acute trauma or due to overuse has been increased dramatically with the resultant upsurge in sporting activities (Arendt & Randall, 1995). But the injuries related to the sports activities also causing the decreased in physical activity, loss of work time lost and added to substantial medical costs. World widely, the cost of treating sports injuries is estimated at $1 billion yearly. In United States alone, Kraus and Conroy estimated 3 to 5 million sports injuries either recreational or competitive occur yearly. According to injury surveillance by the National Collegiate Athletic Association in the year 2000 and 2001, the most common sites of injury were the ankle followed by the knee and lower leg in soccer, field hockey, basketball and lacrosse athletes. Looking at injury type,

muscle strains, ligament sprains and contusions were being the commonest (Murphy, Conolly, & Beynnon, 2003).

Jennifer et al in 2007 reported an epidemiology of college students injuries for fifteen types of sports over period of 1988-1989 through 2003-2004 published in Journal of atheletic training, player contact account for majority of injuries compared to non-contact injury mechanism. Among all reported injuries, 50% or more were injuries to the lower extremities, with the ankle and knee accounting for highest number of the lower extremity injuries. Specifically to ACL injuries, she reported approximately 5000 ACL injuries reported over 16 years, an average of 313 per year. Men's football and women's gymnastics had highest number of reported ACL knee injuries, others includes basketball and soccer. Overall, ACL injuries accounted about 3-5% of all injuries, but these injuries causing time loss of more than 10days (Hootman, Dick, & Agel, 2007). The pattern of injuries following sports activities is about similar findings in a report way long ago in 1983, where knee accounts for most of the sports injury, followed by ankle injuries. This paper also quoted that the knee injuries includes injuries involving collateral ligaments account for 43% of cases, followed by patella femoral 26%; meniscus injuries 18%, traumatic synovitis 7% and the cruciate ligaments injuries is about 6% (Devereaux & Sylvia, 1983).

Kiapour et al reported in United States, the prevalence of ACL injury is estimated to be 1 in 3000, which means more than 120 000 cases every year. ACL injury usually involved active young adults and 2 to 10 fold increased risk in female in comparison with male who play same sports. One of the reason there is a rapid increment in ACL injury in females is due to increase participation of female in sports activities for the recent decades with risk that female has higher risk of getting an