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“Examination of Knee Functions After an Anterior Cruciate Ligament Injury in Saudi Arabia 2021”

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Abstract
Introduction: The anterior cruciate ligament (ACL) is one of the most important supporters and stabilizers of the knee joint. The injury of ACL leads to negative consequences that affect the functional status of the knee joint. Patients with an ACL injury are treated either by ACL-R or conservatively.
Purpose: To examine and measure the functions and ability of the knee-joint injured after a one-year anterior cruciate ligament injury for two groups: ACL reconstruction patients and ACL patients with non-surgery.
Methods: This cross-sectional study included 168 patients with an ACL injury. Patients-reported knee function as recorded on the Knee Injury and Osteoarthritis Outcome Score (KOOS), International Knee Documentation Committee (IKDC), and Lower Extremity Function Scale (LEFS) with use of online activity survey. T test was used to find out the significance of the differences between two independent groups to find out whether there are differences between the study sample individuals on the study variables by using p-value <0.05.
Result: The ACL-R group patients (n=107, 63.69%) with a mean age 32.01± 5.13 and the non-surgery group patients (n=61, 36.31%) with a mean age 28.8 ± 6.3. Only the knee-related quality of life in KOOS reported preference to ACL-R group (P=0.05). While in IKDC scale, the result of this study shows a significant difference between groups (ACL-R/ ACL- non-surgery) preference to ACL-R group (P=0. 001). However, the LEFS doesn't report any difference between the groups (ACL-R/ ACL- non-surgery).
Conclusion: The results of KOOS and LEFS indicated no differences after both treatment approaches with the use of progressive criterion-based rehabilitation. While, the IKDC showed a preference for ACL-R treatment.

Key words: Anterior cruciate ligament injury. ACL. reconstruction. ACL-R. knee function. non-surgery.

i. INTRODUCTION:

The anterior cruciate ligament (ACL) is one of the most important supporters and stabilizers of the knee joint. It is the bands-like structure of dense connective tissues that connects the shin bone (tibia) and the thigh bone (femur) and runs from femoral attachment to the tibia bone anteriorly, medially, and distally (Markatos, Kaseta, Lallos, Korres, and Efstathopoulos, 2013). The length of this band ranges between 22 to 41 mm (mean=32 mm) while its width ranges between 7 to 24 mm (Duthon et al., 2018). According to Butler and Noyes (1980), the main function of the ACL is the restraint of anterior tibial translation and internal tibial rotation. It provides 87% of the total restraining force at 30° of knee flexion and 85% at 90° of flexion (Noyes, 2009). The medial collateral ligament, iliotibial band, mid medial capsule, mid-lateral capsule, and fibular collateral ligament all combine to provide a secondary restraint to anterior tibial translation (Noyes and Grood, 1987). Moreover, it prevents knee hyperextension, limits valgus and varus stress, and promotes the screw–home mechanism of the knee (Ellison and Berg, 1985).

Despite being the main structure in the knee joint, ACL is identified as the center for ligament injuries caused by several reasons (Shen, Jin, Dong, and Li, 2018). The incident of ACL injuries is common worldwide. For example, in the United States, the number of people diagnosed with ACL injury ranges from 100,000 to 200,000 cases every year. This rate is high and has serious health and economic consequences (Singh, 2018). In Saudi Arabia, a study conducted in the city of Makkah has shown a high prevalence of non-contact anterior cruciate ligament injuries compared with contact ones (Alrubayyi et al., 2018). Such type of injury (ACL injury) is defined as a sprain or a tear in which the ligament stretches beyond its normal limit. It may occur during different sporting maneuvers such as sudden stop, change of direction, and landing that lead to extreme hyperextension. These knee movements are common in football, soccer, skiing, rugby, and gymnastic sport. However, athletes who practice these sports are at a high risk of ACL injury (Health Harvard, 2020).

Moreover, the ACL injury leads to negative consequences that affect the functional status of the knee joint. Some of the consequences or effects are immediate while others are long-term (Wetters, Weber, Wuerz, Schub, and Mandelbaum, 2016). An example of a common long-term consequence after an ACL injury shows that injured individuals might have a) a significantly lower self-reported knee function because physical capacity will differ in effect, particularly in jumping actions, and b) a reduced strength in the injured leg compared to the non-injured one (Tengman, 2014). Knee effusion is also an example associated with a limited function of the knee after an ACL injury (Lentz et al., 2009). Also, osteoarthritis in injured knee joints is a common yet annoying condition that often occurs lately with a difference in the percent of risk factor, regardless of whether the patient is treated (Tengman, 2014).

Another important factor in an ACL injury is the intensity of pain. Pain makes it difficult for patients and therapists to start treatment and diagnosis. Besides, the intensity of pain largely contributes to self-report of function and is a critical factor to address following ACL reconstruction (Lentz et al., 2009). Likewise, Kinesiophobia or fear of movement is another psychological factor that can obstruct or prevent patients from resuming sport activities after an ACL injury, particularly post reconstruction surgery. This explains why kinesiophobia impacts one’s self-reported function and performance following the injury.

On initial evaluation of the patient, if ACL injury is suspected, it is recommended to visit a physical therapy center immediately as a first measure to maintain range of motion and develop quadriceps strength and knee immobilization (Cimino, Volk, and Setter, 2010). Some patients can function reasonably well even if the ACL is torn. That is, they can keep on with conservative management and find it necessary to change certain activities and to avoid high-risk sports such as basketball, soccer, and football (Dedham, 2018). By contrast, some patients with torn ACL might have additional injuries such as the tear of the menisci or fragments of articular cartilage that are knocked loose. These associated injuries usually cause symptoms or side effects such as swelling, locking, and giving way due to the torn ACL (Krause et al., 2018). Thus, an arthroscopic surgery to remove torn menisci or fragments or loose bodies is sometimes an appropriate (initial) solution for these cases (Krause et al., 2018; Dedham, 2018). Surgical reconstruction or anterior cruciate ligament reconstruction (ACL-R) is the last solution if conservative management has not achieved the required goals or if the patient prefers to have ACL-R (Dedham, 2018). 83% of athletes return to their preinjury level following surgery; however, many of studies argue that the knee functions better after anterior cruciate ligament reconstruction than conservative management (Krause et al., 2018). To elaborate more on this point, Kalinowska (2017) compared knee functions in people who underwent ACL reconstruction and those who did conservative management. He found out that conservative management was often effective for patients whose level of activity was low. As for patients who were treated reconstructively, they had significantly improved knee stability.

A systematic review and meta-analysis conducted by Smith, Postle, Penny, McNamara, & Mann (2014) addressed the question whether reconstruction was the best management strategy for anterior cruciate ligament rupture. The study concluded that there were limited differences in the clinical outcomes between patients treated with ACL reconstruction vs patients who managed non-operatively at longer-term follow-ups (10 years and more). Another study by Vyas, Semakula, Elson, & Chimes (2012) emphasized that many athletes with an ACL tear could not participate in high-level pivoting-jumping sports, adding that they showed activity-limiting knee instability, progressive articular cartilage damage, and a high risk of a meniscus tear. Consequently, ACL reconstruction with compliant rehabilitation can be the optimal solution to restore function, range of motion, and strength for athletic patients. Wittenberg, Oxfort, and Plafki (1998) reported satisfactory/good function outcomes after the conservative management of ACL rupture. However, knee instability during sport or normal activity reconstruction should be considered.

- Purpose of The Study:

❖ To examine the functions of the knee-joint injured after a one-year anterior cruciate ligament injury for two groups: ACL reconstruction patients and ACL patients without operation.

- Research Question:

❖ Are the functions of knee-joint affected after a one-year anterior cruciate ligament injury among the Saudi Arabia population?

ii. Literature Review

Anatomy of Anterior Cruciate Ligament

The anterior cruciate ligament (ACL) injury is one of the most common types of injury in the United States and other countries, compared with other ligaments in the knee joint. The number of ACL injuries increases in people who play sports such as football, basketball, and soccer; however, it is more frequent in football players. Besides, the ACL injury rates tend to be higher in women than men adding that it may lead to disability in non-athletes or a premature end of athletic careers (Siegel, Vandenakker-Albanese, & Siegel, 2012).

According to biomechanical behavior, the human anterior cruciate ligament consists of two distinct anatomic bundles: an anteromedial band that helps to taut in flexion movement, and posterolateral band that helps to taut in extension movement. Both bindles have similar diameters that range from 7 to 17 mm (McNeill Ingham, de Carvalho, Abdalla, Fu, & Lovejoy, 2017). The ACL originates from the medial surface of the lateral femoral condyle posteriorly in the intercondylar notch and heads toward the tibial insert anteriorly, distally, and medially (Markatos, Kaseta, Lallos, Korres, and Efstathopoulos, 2013). Both the femoral origin and tibial insertion differ in shape and size. For example, the femoral origin has an elliptical shape and an area/size that ranges from 83 mm2 to 197 mm2. The angle between the course of the ACL origin and the femoral shaft varies from 12 degrees to 37 ones. As for the tibial insertion, its size ranges from 114 mm2 to 229 mm2 while its length ranges from 14mm to 29.3mm (Kopf et al., 2009) (Markatos, Kaseta, Lallos, Korres, & Efstathopoulos, 2013).

According to a study conducted by Siebold, Ellert, Metz, and Metz, (2008), males, unlike females, have a bigger area and a longer length of the femoral origin and tibial insertion of ACL (anteromedial and posterolateral bundle) while the width was identical in both. The anterior cruciate ligament is intra-articular and extra synovial and is composed primarily of type I collagen. It gets blood supply primarily from the middle genicular artery which stems from the popliteal artery while inferomedial and inferolateral genicular arteries are secondary vascularized (Giuliani, Kilcoyne, & Rue, 2009). In a full extension of the knee joint, both anteromedial and posterolateral bundles become parallel in the sagittal plane. Yet, in the frontal plane, the anteromedial bundle is oriented vertically to the joint line more than a posterolateral bundle. If the knee flexes, the posterolateral bundle femoral insertion moves anteriorly, and the bundles become crossed. The anteromedial bundle tightens at ^60° of flexion while the posterolateral one is tight in extension and lax in flexion (Gabriel, Wong, Woo, Yagi, & Debski, 2004), (Giuliani, Kilcoyne, & Rue, 2009).

A study by Girgis, Marshall, and Monajem (1975) collected twenty cadaver knees and twenty-four fresh knees to perform anatomical, functional, and experimental analysis of anterior cruciate ligament for the knees. The researchers identified the presence of a wide and strong tibial attachment compared with femoral one. That is, the ACL appeared in a flat position as if the knee were extended in the first attachment while it became twisted on itself if the knee was flexed in the second. This signaled the relationship between the tibial attachment of anterior cruciate ligament and posterior cruciate ligament, i.e., the tibial attachment of the ACL was nearly vertically to the line of the tibial attachment of PCL and discrete from it by space. In the sagittal plane, the cruciate ligaments were separated from each other. These findings conclude that the anteromedial band of ACL is responsible for the

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increase in the anteroposterior drawer with flexion. Moreover, a study by Amis and Dawkins (1991) has reported that the fibers of the anterior cruciate ligament are twisted on themselves as the knee flexes due to the relative rotations of the attachments. Hence, the main changes of the fiber bundles are lengthening of the anteromedial and shortening of the posterolateral through flexion. As for the alteration in fiber length, it is associated with their changing involvement in the total anterior cruciate ligament action as the knee flexes.

Functions of Anterior Cruciate Ligament

Brantigan and Voshell (1941) conducted a study of 100 knees to observe the functional roles of the ligaments of the knee joint. They concluded that the anterior cruciate ligament was restricted and controlled the forward gliding of the tibia bone on the femur bone because the force was directed at the ACL attachment line. When the anterior cruciate ligaments and the posterior cruciate ligaments are tense in all positions of flexion and extension, they help to preserve the accurate normal anatomical relationship between the femoral and tibial condyles. By twisting on themselves, both ligaments prevent the abnormal medial rotation of the tibia on the femur. Furthermore, hyperextension is controlled first by the anterior cruciate ligament and then by both collateral ligaments, both menisci, and the posterior cruciate ligament.

A study conducted by Thore Zantop, Mirko Herbort, Michael J. Raschke, Freddie H. Fu, & Wolf Petersen (2007) used ten fresh-frozen cadaveric knees to evaluate the role of the ACL anteromedial and posterolateral bundles in anterior tibial translation and internal rotation. The study concluded that the anterior cruciate ligament was the most important stabilizer of the knee joint and that it was the primary constrain to anterior tibial translation and the secondary one to internal tibial translation. When the knee joint is close to extension, the posterolateral bundle plays a basic role in response to a combined rotatory load. On the other hand, the anterolateral bundle plays a minor role in restraining combined rotatory loads because its insertion points are close to the central axis of the knee joint. Accordingly, the knee that is deficient in the anteromedial bundle showed a significant increase in anterior tibial translation under anterior tibial loads at 60° and 90°of flexion.

From another perspective, it is argued that the extension of the tibia bone requires tension in the anterior cruciate ligament. This hypothesis is supported by studies that demonstrate how the anterior cruciate ligament recruits knee angles from approximately 0°- 50° through open chain knee extension (Cleather, Southgate, & Bull, 2014). In addition, ligaments in the knee joint (collateral ligaments, menisci, and cruciate ligaments) are classified as providing a primary or secondary restraint against anterior tibial translation. For example, the anterior cruciate ligament is a primary restraint that provides stability during an overwrought performance which subjects the knee to large functional forces ((Butler & Noyes, 1980). The role of the ACL is ideally determined by its impact on limiting the combined movements of internal tibial rotation and anterior translation as well as on the resulting anterior subluxation of the medial and lateral tibiofemoral compartments which clinically represents the pivot-shift phenomena (Noyes, 2009).

Mechanism of Anterior Cruciate Ligament Injury

Understanding the mechanism of anterior cruciate ligament injury is the first step to learn how to prevent it. The mechanism of ACL injury is either contact or non-contact. A non-contact mechanism is the most common ACL ruptures (approximately75%). However, multiple vectors on the knee joint or multiplanar loading can be the main feature of the non-contact ACL injury. Subsequently, sport-related activities at the time of non-contact ACL injury could differ depending on the kind of sport. However, the most common ones include a change in velocity or multidirectional force generation through the knee while bearing weight. On the other hand, the contact injury mechanism often results from a higher energy mechanism of injury. This may involve traumatic knee dislocations or high-energy injuries on-field (Wetters, Weber, Wuerz, Thomas H., MD, MSc, Schub, & Mandelbaum, 2015). Another retrospective epidemiological study recruited 1000 male and female participants to explore the mechanism of ACL injury among high school athletes within each sport on a large scale (Takahashi, Nagano, Ito, Kido, & Okuwaki, 2019). The study concluded that the ratio of indirect injury was higher than the direct one in ACL contact injury among female soccer players. On the other hand, in male soccer players, the ratio was higher in non-contact compared with contact injury related to ACL injury. In basketball players, the number of non-contact injuries of anterior cruciate ligament was higher than the number of contact ones among both female and male players. The same findings apply for basketball players, volleyball players and handball players.

A systematic review conducted by Peterson, Peterson & Krabak, Brian J., MD, MBA (2014) examined the mechanism of anterior cruciate ligament injury and the strategy for prevention. The review concluded that the anterior cruciate ligament injury related to sport usually occurred in non-contact related forces on the knee. Contact led to less ACL tear than cutting maneuvers or speed decelerations. Another systematic review reviewed the three planes (sagittal, frontal, and transverse) that related to anterior cruciate ligament injury mechanism (Quatman, Quatman-Yates, & Hewett, 2010). The study emphasized that the knee joint might be exposed to high loading statuses in any plane, particularly in sporting maneuvers such as cutting, landing, and jumping, where high loading statuses can occur. During the injury event, the knee joint moved in multiple planes, in particular in a

valgus action combined with external or internal tibial rotation at low angles of knee flexion. As a result, anterior cruciate ligament injuries do not happen through solely plane mechanism; rather, they are more likely to happen via multiplanes mechanism.

A recent systematic review conducted by Zhang, Hacke, Garrett, Liu, & Yu (2019) examined all the movements of the tibia bone relative to the femur bone during ACL injuries. The study cited relevant systematic review articles that examined bone bruises following anterior cruciate ligament injuries. It concluded that a substantial anterior translation of the tibia relative to the femur occurred with a slight knee flexion angle when bone bruises occurred in ACL injury cases. This occurs as the primary mechanism of both contact and non-contact ACL injury. Besides, the valgus of the knee joint may occur through the injury. Nonetheless, the maximal knee valgus, that occurs after a substantial anterior translation of the tibia bone, can lead to ACL injury.

Consequences of Anterior Cruciate Ligament Injury

Riordan, Frobell, Roemer, and Hunter (2013) discussed key issues regarding the health and structural consequence of acute ACL injury. They concluded that injuries of the knee joint resulting in anterior cruciate ligament tear were often associated with a wide range of additional structural joint damage. Examples of damage include meniscal damage (observed in about 65% to 70% of ACL-ruptured knees during arthroscopy), posttraumatic bone lesions, and collateral ligament injuries. These types of damage are common and associated with long-term damage to the synovial joint.

Another review study examined the long-term consequences of the anterior cruciate ligament injury and menisci (Lohmander, Englund, Dahl, & Roos, 2007). According to the review findings, the anterior cruciate ligament tear seldom happened in isolation. Rather, it was associated with other meniscus tears, ligament sprains, bone bruises, and sometimes intra-articular fractures in at least 50% of the acute conditions. Moreover, intra-articular bleeding is common after ACL tear which in turn can activate the inflammatory pathways of the knee joint with long-term consequences. The review authors argued that the rates of osteoarthritis (OA) after an ACL injury ranged from around 10 % and 90 % at 10–20 years after the injury. This is expected because the injured knee, whether or not it is reconstructed, will be exposed to abnormal loading patterns in daily tasks, particularly sports activities.

A retrospective cohort study conducted by Lohmander, Östenberg, Englund, and Roos (2004) recruited 103 female soccer players who sustained ACL injury to examine the long-term consequences after the injury in connection with the development of radiographic knee osteoarthritis, subjective symptoms, and levels of activity. The authors reported that more than 50% of participants had radiographic osteoarthritis in their injured knee. Besides, the injury of the meniscus requiring surgery had the potential to impact long-term symptoms and the prevalence of osteoarthritis. Thus, the injury, regardless of the management offered to patients, resulted in knee-related symptoms that had a serious impact on the quality of life of young people.

Another study conducted by Ageberg (2002) analyzed the consequences of ACL injury on neuromuscular function and its relevance to rehabilitation. Ageberg reported that the anterior cruciate ligament injury led to changes in neuromuscular function as well as to reduction in functional performance, where a general weakness of the quadriceps muscle occurred. The author also reported that the injured leg had a different movement and activation pattern, such as a change in muscle timing and recruitment order, a delayed muscle response, and an altered coordination pattern. After a unilateral injury, bilateral defects were reported in postural control, voluntary quadriceps muscle activation, proprioception, and functional performance.

Examination of Knee Functions after an Anterior Cruciate Ligament Injury

A recent cross-sectional study conducted by Ardern, Sonesson, Forssblad, & Kvist (2017) compared patient-reported knee function outcomes between two groups: one group preferred ACL reconstruction and another group chose non-surgical management for ACL injury. The authors used Knee Injury and Osteoarthritis Outcome Score (KOOS) and EuroQoL-5D instruments to evaluate the function of knee injured. As patient-reported, the 5-year patient-reported outcome measurements showed that both groups had good function, symptoms, and quality of life regardless of the management they selected.

Similarly, a recent cohort study was conducted by Wellsandt, Failla, Axe, and Snyder-Mackler (2018) to identify any differences in the 5-year radiological and functional outcomes between the non-operative group and the group completing operative treatment of ACL injury. Similar to Ardern, Sonesson, Forssblad, & Kvist study (2017), the study did not identify significant outcome differences between both groups. However, a prospective cohort study provided a somewhat different result (Grindem, Eitzen, Engebretsen, Snyder-Mackler, and Risberg, 2014). It highlighted the presence of few variations after a 2-year clinical course between patients who preferred surgical treatment of an ACL injury and those who preferred a nonsurgical one. While both groups showed significant improvements in patient-reported knee function through IKDC score, ACL reconstruction group patients had a significantly higher risk of knee reinjury. That is, 1/5 of the patients reported knee reinjuries while 1/3 of them reported a weakness in muscle strength.

Another cohort study examined both knee function and physical activity level in patients with a unilateral ACL injury that occurred more than 20 years ago. Using patient-reported scales (KOOS, Lysholm, and Tegner), the study compared patients who were treated by physical therapy in combination with surgical reconstruction or by physical therapy alone and then compared the outcome measures with a healthy control group. The study findings showed that ACL injured patients had a decreased knee physical activity level compared with the control group. Furthermore, regardless of treatment, there occurred negative long-term consequences related to the functions of the injured knee, such as osteoarthritis, weight gain as a result of a decrease in physical activity level, fear of reinjury that influenced the jump capacity, etc. (Tengman, E. et al., 2014).

To elaborate more, another cohort study focused on athletes who had ACL injury to examine how ACL injury affected the injured knee after 20 years by using patient-reported scales mentioned previously (Lysholm, IKDC, KOOS, and Tenger). The study concluded that no significant differences were reported between athlete patients who had an ACL reconstruction and those who had non-operative management regarding the functional outcomes and meniscectomies. However, the results of this study showed a decrease in knee stability of the non-operative group compared with the operative group that did not result in a reduction in functional outcomes or comorbidity. Also, they study showed that 80% of operative patients had radiological knee osteoarthritis and 68% of non-operative ones also had (Yperen, Reijman, Es, Bierma-Zeinstra, & Meuffels, 2018). Similarly, a retrospective study confirmed the results of the previous study, arguing that the conservatively treated group had unstable knees with increased anterior laxity comparing with the ACL reconstruction group. The study identified a higher rate of severe degenerative changes in patients who chose conservative treatment only (Mihelic, Jurdana, Jotanovic, Madjarevic, & Tudor, 2011).

A large cohort study was conducted on 4093 patients who underwent primary ACL-R to determine the percentage of patients attaining symmetrical knee function after six months of primary ACL-R. The most important result of the study was that only 19.6% of the participants attained symmetrical knee function six months after ACL-R. Interestingly, medial or lateral meniscus repair or resection reduced the odds of attaining symmetrical knee function. Moreover, the study results found out that the use of hamstring tendon (HT) autograft over bone-patellar tendon-bone (BPTB) autograft increased the odds of attaining symmetrical knee function after six months of ACL-R (Cristiani, Mikkelsen, Forssblad, Engström, & Stålman, 2019). Also, a recent cross-sectional study conducted on 433 patients with ACL rupture assessed the knee functions 2 years after ACL-R through physical examination (anterior drawer, Lachman, and pivot-shift evaluation) and patient-reported measures (IKDC and KOOS). The main finding of the study showed that controlling for surgical and patient factors mildly increased anterior or rotational laxity of knee injury, and that it was not correlated with a decrease in patient-reported outcomes scores in patients two years after ACL-R (Magnussen et al., 2019). On the other hand, a prospective cohort study was conducted on 67 patients with a complete rupture of the ACLs that were not reconstructed. The study examined the subjective knee function and activity level of these patients 15 years after the injury. However, the main outcome of this prospective study was that good knee function and satisfactory activity level could be attained in the majority of patients with a complete rupture of the ACL treated without reconstruction. Also, the study found out that early neuromuscular rehabilitation and activity modification resulted in good knee function and acceptable activity (Kostogiannis et al., 2007).

iii. Methods:

1. Study design:

An observational cross-sectional study design was used to examine the functions of knee injuries in people with anterior cruciate ligament injury after one year for two groups: ACL reconstruction patients and ACL patients without operation.

2. Participants:

The study sample included 168 participants. 107 patients with ACL-Reconstruction and 61 patients with a non-operative ACL injury in Saudi Arabia.

3. Inclusion / Exclusion Criteria:

Male patients with anterior cruciate ligament injury, aged between 18 and 40 years, whether full or partial torn of the ligament, having ACL reconstruction or without it, were injured since one year or longer and they live in Saudi Arabia. All of them are included in this study. While, patients with previous musculoskeletal injuries such as fracture, dislocation, or previous surgeries, or having any neurological disordered or any lower extremity injuries within the last six months in the same lower limb side were excluded.

4. Instrumentation:

A. Knee Injury and Osteoarthritis Outcome Score (KOOS) Questionnaire:

KOOS is patient-reported outcome measures (PROMs) that is prepared for young, middle-aged, and old adults with a knee injury or knee osteoarthritis. This score can be utilized to measure outcomes following surgical, pharmacological, and other types of intervention (Perruccio et al., 2008). KOOS score involves five subscales:

pain (9 items), symptoms (7 items), activities of daily living (17 items), sport and recreation function (5 items), and knee-related quality of life (4 items). Each subscale is recorded separately from zero (severe knee problem) to 100 (no knee problem). People are encouraged to use the KOOS questionnaire due to its content validity (Good), test-retest reliability (α=0.95), construct validity, and responsiveness for age and condition relevant subscales (Collins et al., 2016). The Arabic version of the scale is also valid (r= 0.51–0.65), reliable (α= 0.92–0.94) and can be used in all Arabic speaking countries (Alfadhel et al., 2018).

B. International Knee Documentation Committee Subjective Knee Evaluation Form (IKDC):

The IKDC questionnaire was created by a group of international knee experts from the European Society for Sports Traumatology, Knee Surgery and Arthroscopy (ESSKA) and the American Orthopedic Society for Sports Medicine (AOSSM). The groups formed the IKDC form to standardize the international documentation system for assessing patients' outcomes after knee injury or treatment (Irrgang et al., 2001). The IKDC instrument contains eighteen items that are designed to measure and assess symptoms such as pain, swelling, stiffness, joint locking, and joint instability. Other items are also designed to measure knee functions and assess the ability to perform ADL. The last items are designed to measure sports activity levels and assess the ability to jump, run and land, ascend and descend stairs, stop and start quickly, squat, etc. (Irrgang et al., 2001; Higgins et al., 2007).
The IKDC questionnaire is known for its adequate reliability (α=0.87) and validity (r=0.51). Besides, it has good content validity (Husam, Herrington, and Jones, 2017). Likewise, the Arabic version of IKDC has an excellent test-retest reliability with a high value for the intraclass correlation coefficient (r=0.95) and a strong internal consistency (α=0.91).

C. Lower Extremity Functional Scale (LEFS)

The LEFS consists of 20 items designed to test the functional status in the presence of lower extremity musculoskeletal issues. The scores of the 20 items range from 0 (unable to perform activity/extreme difficulty) to 4 (no difficulty). The total score can be obtained by summing the scores of each item, where 80 is the greatest score that indicates no difficulty or no functional limitation, while 0 indicates difficulty and extreme limitations (Mehta et al., 2016). The LEFS items are easy to score and complete and are workable to administer in most clinical settings (Yeung,Wessel, Stratford, and MacDermid, 2009). Moreover, the LEFS score is reliable (α=0.85 and 0.99) and valid (r>0.76) for evaluating the functional status in different populations with lower extremity musculoskeletal cases (Mehta et al., 2016). Likewise, the LEFS Arabic version has excellent internal consistency (alpha=0.95) and excellent test–retest reliability (ICC=0.96). The LEFS is a valid measure (r=0.59) to test the lower extremity musculoskeletal problem and is appropriate to use in the Saudi Arabia population (Alnahdi, Alrashid, Alkhaldi, and Aldali, 2016).

5. Data Collected Procedure:

Participants were recruited from various regions and cities in Saudi Arabia. The sampling was selected using a non-probability sampling design (Kothari, 2004). Thus, each participant who met the inclusion criteria, they included in this study. An online link was prepared carefully and specifically and adapted from the previous scales to collect the required data.

Various physiotherapy departments visited and met my colleagues to take permission and access samples with an ACL injury to give them the online link survey via WhatsApp application or e-mail according to the participant. The consent form was filled by participants also via WhatsApp or e-mail.

The online link was sent via all social media such as (WhatsApp, Telegram, Twitter, Facebook …etc) to reach other participants in overall Saudi Arabia. In general, online data collection increase the potential of accessing a large distributed population and wide regions, additionally to being time and cost-efficient for the (Lefever, Dal, & Matthiasdottir, 2007). .

6. Data Analysis:

To verify the validity of the study hypotheses, we made statistical analyzes using statistical analyzes, Excel and the Statistical Package For Social Sciences known as (SPSS 22;IBM Corp , New York, NY , USA). Mean, standard deviation, and 95% confidence intervals (CIs) around the mean were calculated for all continuous variables, while percentage and proportions were calculated for a categorical variables. Also, The independent-t test was used to find out the significance of the differences between two independent groups: to find out whether there are differences between the study sample individuals on the study variables by using p-value <0.05.

iv. Result:

i.

- **Demographic and baseline data of the participants:**

Of the 168 individuals who participated in the study, 107 ones (63.69%) underwent anterior cruciate ligament reconstruction (ACL-R) while 61 ones (36.31%) were treated non-surgically. Their average age, weight and height were shown as (30.4), (77.7), and (172.4), respectively. A sample of respondents who underwent ligament surgery (ACL-R) practiced different sport activities as follows: "walking and running" (13.08%), "basketball" (0.93%), "volleyball" (11.21%), and football (72.90%). The percentage of participants who did not practice any sport was (1.87%). On the other hand, the percentage of respondents who did not undergo ligament surgery but practiced sport was shown as "walking and running" (31.15%), "volleyball" (3.28%), football (54.10%). The percentage of those who did not exercise was 11.47% (See Table1).

Table 1 : Description of the sample according to the age, weight, height, and types of sports activity :

Variables	**ACLR (n=107)**	**ACL- No surgery (n=61)**
Age	32.01± 5.13	28.8 ± 6.3
Weight	76.7 ± 14.2	78.8 ± 17.9
Height	173.8 ± 6.89	171.09 ± 6.67
Types of sports activity:		
Walking and running	**14** (13.8%)	**19** (31.15%)
Basketball	**1** (0.93%)	**0** (0%)
Volleyball	**12** (11.21%)	**2** (3.28%)
football	**78** (72.90%)	**33** (54.10%)
Do not exercise	**2** (1.87%)	**7** (11.47%)

*Values are presented as mean ± SD. And as n , percent

Table 2: Description of the sample according to the dominant leg and injured knee:

	Dominant leg				Injured knee			
	Right foot		Left foot		Right knee		Left knee	
	count	percent	Count	percent	count	percent	count	percent
ACL-R	69	64.49 %	38	35.51 %	69	64.49 %	38	35.51 %
ACL-no surgery	46	75.41 %	15	24.59 %	34	55.74 %	27	44.26 %

Regarding the sample who underwent ACL-R, data in Table 2 show that the percentage of participants who depended on or used their right leg was (64.49%), while (35.51%) used the left one. As for those who did not undergo ACL-R, the percentage of depending on the right leg was (75.41%) and on the left one was (24.59%). Likewise, the study findings identified relevant information about the injured knee. In the sample of respondents who underwent ACL-R, (64.49%) of the participants had right knee injuries while (35.51%) had left knee ones. However, in the sample of participants who did not undergo knee surgery, the percentage of right knee injuries was (55.74%) while that of the left knee was (44.26%).

Furthermore, the percentage of the 107 participants who underwent ACL-R was analyzed in terms of injury period as follows: injury between 1 to 5 years (49.53%), injury from 5 years to less than 10 years (29.91%), injury from 10 years to less than 15 years (11.21%), and injury from 15 years or more (9.35%). As for the percentage of the 61 participants who did not undergo knee surgery and were injured, it was (52.46%) for those who were injured during the period 1 year to less than 5 years, (27.87%) for injury from 5 years to less than 10 years, (11.47%) for injury from 10 years to less than 15 years, and (8.20%) for injury from 15 years or more (See Table 3 and 4).

Table 3:Description of the sample according to the duration of the injury:

period / sample	1-5 years		5-10 years		10-15 years		More than 15 years	
	count	percent	count	percent	count	percent	count	percent
ACL-R	53	49.53%	32	29.91%	12	11.21%	10	9.35%
ACL- no surgery	32	52.46%	17	27.87%	7	11.47%	5	8.20%

Table 4: 107 participants who underwent ACL-R, when was it?

percent / Duration	M	percent
1 - 3 years	41	38.32%
3 - 5 years	12	11.21%
5 years and over	24	22.43%
I do not know	30	28.04%

The proportion of the participants who performed the surgery and chose ligament compensation by "Patellar tendon ligament" was (27.10%). Those who made the compensation through the "Hamstring tendon grafts" reached the percentage of (28.97%) while those who chose “Quadriceps tendon grafts” were (6.54%). The percentage of the participants who showed lack of knowledge about the compensation method was (37.38%), as illustrated in Table 5.

Table5 : Description of ACL-R compensation

percent / Type of compensation	count	percent
Patellar tendon ligament	29	27.10%
Hamstring tendon grafts	31	28.97%
Quadriceps tendon grafts	7	6.54%
I don’t know	40	37.38%

- **Second Section: Descriptive statistics of the study Scale:**

Table 6: Differences between study groups (ACL-R/ ACL-non) on study scales :

Scales	ACL-R		ACL- No surgery		t. test	P value
	M ± S.D	95% CI	M ± S.D	95% CI		
KOOS subscale						
Symptoms	10.69 ± 1.99	10.31-11.07	10.00 ± 2.69	9.31-10.69	1.90	0.059
Stiffness	1.25 ± 1.45	0.97-1.53	1.15 ± 1.43	0.78-1.51	0.45	0.652
Pain	4.63 ± 5.43	3.59-5.68	6.39 ± 6.32	4.77-8.01	-1.89	0.059
Activities of daily living	6.50 ± 8.41	4.89-8.11	9.47 ± 11.28	6.59-12.36	-1.94	0.054
Sport and recreation unction	5.27 ± 4.51	4.40-6.14	6.51 ± 5.16	5.19-7.83	-1.62	0.107
Knee-related quality	6.43 ± 3.79	5.70-7.15	5.24 ± 3.64	4.31-6.17	1.98*	0.050*

Scales	ACL-R		ACL- No surgery		t. test	P value
	M ± S.D	95% CI	M ± S.D	95% CI		
of life						
IKDC scale						
Symptoms	15.68 ± 4.41	14.84-16.53	13.95 ± 4.71	12.74-15.16	2.387	0.018*
Sports Activities	33.36 ± 6.42	32.13-34.59	30.98 ± 6.37	29.35-32.61	2.318	0.022*
Function of Knee	16.38 ± 8.84	15.66-17.11	15.85 ± 4.08	14.81-16.89	0.849	0.397
Total scale	65.43 ± 8.84 8.84	63.8-67.1	60.79 ± 8.24	58.7-62.9	3.354	0.001*
LEFS						
Total	17.38± 17.38	13.40 - 21.36	23.1± 22.08	17.44 -28.75	-1.67	0.192

*Values are presented as mean ± SD. , 95% confidence intervals (CIs) , t test and p value >0.05
There are no differences between groups (ACL-R/ ACL-non surgery) in terms of subscales symptoms, stiffness, pain, daily activities, and sport and recreation function of the KOOS scale. Nevertheless, differences exist between the groups (ACL-R/ ACL- non-surgery) regarding the subscales knee-related quality of life (P >0.050) towards the ACL-R group. In the IKDC scale, the study results show a significant difference between groups (ACL-R/ ACL- non-surgery) for subscales symptoms (P >0. 018), sports activities (P >0. 022), and total scale (P >0. 001) towards the ACL-R group. By contrast, the results did not report any differences between groups (ACL-R/ ACL non-surgery) for subscale function of the knee. However, the LEFS does not report any difference between the groups (ACL-R/ ACL- non-surgery).

v. Discussion:

This cross-sectional study aimed to identify differences in the functional outcomes one year after the ACL injury in patients who were treated by ACL reconstruction on one hand and those who received conservative treatment on the other. All participants completed the questionnaire that contained three PROMs (KOOS, IKDC, and LEFS). The main findings of the study reported no significant differences between both groups in KOOS and LEFS. However, the IKDC scale findings reported better functional outcomes in the group who underwent ACL reconstruction than that who chose conservative management only.

- **Baseline Characteristics:**

The percentage of patients who were treated by ACL-R and participated in the study was (63.69%) compared with (36.31%) who were treated with non-surgery. This discrepancy might reflect the public perception in Saudi Arabia which prefers ACL-R more than conservative management. In terms of weight and height, no stoical significant differences were reported in both groups. However, some were identified in terms of age, where the average age in ACL-R group was 32.01 while that in non-surgery group was 28.8. Likewise, a Norwegian study conducted by Grindem, Eitzen, Engebretsen, Snyder-Mackler, and Risberg (2014) identified significant differences in the age of both groups toward the ACL-R sample. But for other studies, no demographic baseline statical difference existed between an ACL-R and non-surgical group including the age factor (Yperen, Reijman, Es, Bierma-Zeinstra, and Meuffels, 2018). The study findings also reported that football was the most preferrable/played sport activity for both groups in Saudi Arabia.

Interestingly, the findings recorded the percentage between the dominant leg and the injured leg in ACL-R group, where 64.49% of the participants used their right leg that was injured. It is worthy to note that many ACL-R participants (37.38%) did not know how to compensate for the ligament, and this might indicate they had no interest in learning about details.

- **Patient-Reported Knee Function:**

This study depends on patients-reported information obtained by using three scales (KOOS, IKDC, and LEFS) to evaluate knee functions that are (not) affected one year after the ACL injury. In the current study, KOOS showed statical difference between participants who had ACL-R and those who did not have it in terms of the subscale knee-related quality of life (P=0.05) toward ACL-R group. In other subscales, no differences were reported between both groups. This might suggest that, in general, no differences existed between patients who did operative treatment or those who received conservative treatment. This is valid in case the patients with non-operative treatment managed to improve their lifestyles, as is shown in the daily living activities subscale in this study.

Furthermore, a study by Wellsandt, Failla, Axe, and Snyder-Mackler (2018) reported no differences in all the KOOS subscales between ACL reconstruction and non-surgery treatment approaches. This suggests that good outcomes can occur in both groups when they opt for progressive criterion-based rehabilitation. Nonetheless, a study conducted by Ardern, Sonesson, Forssblad, and Kvist (2017) reported that satisfactory functions, symptoms, and quality of life are indicative of an improved knee function, regardless of the treatment approaches chosen for ACL injury. On the other hand, a study conducted by Tengman et al. (2014) used KOOS and identified a general impairment in knee functions 20 years after the ACL injury for both groups.

The second scale used in this study is IKDC. It is a popular PROMs scale in many research studies that examine the knee functions following an ACL injury. The findings of the current IKDC refer to statical significance between patients who have ACL-R and those without surgery, i.e., more preference of the ACL-R group than the other (P=0.001). In other words, the symptoms subscale showed priority in ACL-R group (P=0.18) that may indicate reduced feelings of pain, swelling and stiffness in participants who did operation than those who chose the conservative management only. The same findings were reported in the sport activity subscale, where the ACL reconstruction is considered a priority or a prerequisite to restore special knee function and resume high-demand sport activities.

However, only one subscale in IKDC did not report significant differences between the two groups in terms of the knee function, where it compared general knee functions before and after an ACL injury (P=397). Some previous studies used the IKDC scale to examine general knee functions after an ACL tear. They support the hypothesis that the ACL reconstruction is the most appropriate option for knee stability and optimal knee functions after ACL compared with conservative management (Mihelic, Jurdana, Jotanovic, Madjarevic, and Tudor, 2011; Wellsandt, Failla, Axe, and Snyder-Mackler, 2018). Other studies used IKDC to evaluate long-term outcomes and knee functions after an ACL injury. They identified no significant differences in knee functions and osteoarthritis between operative versus nonoperative management. Although knee stability was better in ACL-R group, it did not result in better objective and subjective functional outcomes (Streich et al., 2011; Yperen, Reijman, Es, Bierma-Zeinstra, and Meuffels, 2018).

LEFS is the third scale used in this evaluation. Although the scale is commonly used in studies on ACL injuries, it helps to examine knee functions after an ACL injury (Alcock, Werstine, Robbins, and Stratford, 2012). The findings of the current study reported no differences between both groups (P=0.192). That is, knee functions were not significantly affected after an ACL injury in patients who did ACL-R or in those only with conservative treatment. The findings also identified two activities (jumping and making sharp turns during a fast run) in both groups that obtained the highest score for “extreme difficulty” or “inability to perform the activity”. This might signal worse or low knee confidence after the injury or the presence of a real function problem. This issue is examined in Van Wyngaarden et al.’s study (2020), where it argues that kinesiophobia and weakness of quadriceps muscle have significant implications for patient-reported outcome measurements after ACLR. However, a study by Alcock, Werstine, Robbins, and Stratford (2012) used the LEFS scale and recorded cases of optimal recovery in patients with self-reported lower extremity functional conditions after ACL-R. Another study argued that athletes after ACL-R could return to sporting activities in a normal situation without the risk of being reinjured (Damian and Damian 2018; Cupido, Peterson, Sutherland, Ayeni, and Stratford, 2014).

- **Limitations:**

There are some limitations to the findings of the study that need to be considered. Firstly, the age factor had little significance in both groups, and this might impact or lead to inaccurate results. Secondly, generalizing the results might be limited because the sample size was not equal between the two groups. Thirdly, this study was situated in the Saudi context, and focused only on the male population (rather than females and males) due to the difficulty of accessing female participants as well as the presence of a small number of female ACL injury in Saudi Arabia.

- **Conclusion:**

The study findings show that satisfactory outcomes can occur after both treatment approaches combined with the use of progressive criterion-based rehabilitation. No significant differences existed between ACL-R and non-surgery management for ACL injury in KOOS and LEFS scales. However, the IKDC scale identified differences between the two groups and recommended or prioritized the ACL-R group that underwent reconstruction as a treatment option.

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