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# Knee Osteoarthritis after ACL injury- A Systematic Review

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## ABSTRACT

**Background:** The aim of this review to identify the prevalence and risk factors of knee osteoarthritis more than four years following anterior cruciate ligament tear.

**Methods:** Scanning of recent research articles was done through- Google scholar, Pedro and Pub-Med from 2010-2020. Knee pain, Physiotherapy, Clinical Practice, ACL, isolated anterior cruciate ligament injury or combined with other knee meniscal or ligaments injuries treated by operative or non- operative methods and assessed by radiological clinical evaluation tools and radiological classification systems like terms were used to search database. The primary search generated 50 possibly related publications, 5 articles out of 50 were finalized to include in this review depending on eligibility standards. These articles offer clear and valued perceptions into the direct and indirect effects of the physiotherapy several features of physiotherapy, together with clinical techniques, educational databases, and staffs primary forces.

**Results:** Five prospective, three of which were randomized controlled trail, and three retrospective studies were included. All studies were of good quality with Coleman modified score higher than 55. The mean score was 70 prevalence of knee OA following ACL injuries, varying between 0.2% and 61%. Meniscal injury and duration between injury and surgery were found to be the most common risk factors for knee OA following ACL injury.

**Conclusion:** Good quality studies suggest that the prevalence rates of knee osteoarthritis after anterior cruciate ligament reconstruction varies between 0.2 to 61% Patients with combined ACL and meniscal injury. There was wide variation in the reported knee OA prevalence. Overall, the modified Coleman methodology score was high for the included studies.

**Keywords:** anterior cruciate ligament injury; knee osteoarthritis; mid- to long-term follow- up

## INTRODUCTION

The ACL is a strong ligament connecting the femur to the tibia. Anatomically, it has two bundles, the Antero-medial, which originates from the proximal part of the femoral insertion to the antero-medial part of the tibial insertion. This bundle becomes loaded and stretched during knee flexion, and the poster-lateral bundle inserts into the postero-lateral part of the tibial plateau which gets loaded and stretched during knee extension1.The main function of the ACL is to support and stabilise the tibia from anterior displacement relative to the femur as well as stabilise internal and external rotation, valgus and varus movements of the tibia over the femur2 . ACL injury is one of the most common injuries to ligaments of the knee and accounts for approximately 30 injuries per 100,000 of the population3. However, there are more than 100,000 new ACL injuries that happen each year4. ACL is a common injury for those playing sport and among the general public. It is more common in the 15-25 age group4, particularly those involved in pivoting sports like football, tennis. Seventy percent of ACL injuries happen in non-contact situations when the player lands with external rotation of the tibia in relation to the femur with the knee fully extended5. Research shows that women are at higher risk than men4-6.

In people with ACL injuries, knee function impairment might be demonstrated in the form of limited ROM, muscle weakness and pain leading to limitation of daily living or sports activities7. One of the most reported consequences of an ACL injury is lack of dynamic knee stability, where stability of the joint is not held during fast changes of position during open and closed chain activities8.Quadriceps are some of the most affected muscles following an ACL injury and reconstruction9.

ACL Reconstruction has a range detrimental effect on joint function such as: reduced muscle function, reduced ROM and neuromuscular deficits10. Joint effusion is found to be associated with reduced knee function as well11 The long term effect of ACL reconstruction and rehabilitation on knee function has been discussed extensively in the literature12. Deehan conducted a case series study, which demonstrated the 15 year outcome of ACL reconstruction with emphasis on knee functions for 90 patients who had isolated ACL injury. The study used a good range of outcome measures including ROM, Lachman and pivot shift tests, single leg hop test, lysholm knee score, radiographic assessment and International Knee Documentation Committee evaluation. Study results indicated good ligament stability, ROM and subjective outcome measures at 15 years after surgery with kneeling pain as a common persistent problem. The radiological assessment has indicated signs of OA, although the severity of these signs was not associated with the level of joint stability.

Daniel conducted a prospective study to investigate the fate of 292 patients who had ACL injuries. These patients were treated either surgically or non-surgically13. The study results indicated that in the five-year follow-up all the participants who were treated by non-surgical approaches returned to normal sports activities, and those who underwent reconstruction developed a higher level of OA compared with the non-operated patients. .

ACL Injuries can be clinically treated by conservative rehabilitation or surgical repair followed by post-surgical rehabilitation. The clinical decision regarding which treatment pathway is usually made by the surgeon and the patient14. Conservative, on-surgical, rehabilitation aims to restore the joint dynamic stability and function, through strength and neuromuscular training2.

Quadriceps weakness is evident after anterior cruciate ligament (ACL) injury, which might affect the knee function post operatively15.

Knee osteoarthritis (KOA) is one of the major causes of pain and physical disability in older adults. This is a dynamic disease that is metabolically active and includes both destruction and construction mechanisms that could be activated by injuries from either biochemical or mechanical events1. No definitive treatment was found to be superior and the patho-mechanics are still not well understood1,16. There are a range of structural changes associated with knee OA, which include damage or loss of articular cartilage, remodelling and scelrosis of the subchondral bone, subchondral cysts formation and osteophyte formation17.

## MATERIALS AND METHODS

This review study is performed in accordance to PRISMA Preferred Reporting Items for Systematic Reviews and Meta Analyses. This review reported prevalence of knee OA after ACL injuries treated with conservative treatment or surgery with a follow-up more than four years.

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**Search strategy:**
The searching was done in PubMed, Google scholar and PEDro. Key words like knee pain, exercise, knee OA, physiotherapy management, and OA knee, ACL or combined with other knee meniscal or ligaments injuries treated by operative or non- operative methods and assessed by radiological clinical evaluation tools and radiological classification systems. We included past 10 years articles (mainly RCTs Randomized controlled trial) published in English language only from 2010 to 2020. This research was carried out from February 2024 to July 2024. The title and abstracts of all articles in the searches were screened in accordance with the inclusion and exclusion criteria to identify potentially eligible articles. Full texts of potential articles were read and assessed independently by the two reviewers.

**Inclusion Criteria:**
Studies might include male or female adult subjects with ACL injury and treated surgically by any type of technique or using any type of graft or treated non- surgically by rehabilitation programme. The follow-up time was more than four years.

**Exclusion criteria:**
The exclusion criteria were not prospective or retrospective case studies, and articles that reported individuals with ACL injury associated with fractures. These exclusion criteria were established to minimize the clinical heterogeneity of the review outcomes.

**Quality assessment:**

Methodological quality of selected articles was assessed using PEDro Scale consisting of 11 questions in two aspects. Criteria 2–9 assess internal validity and criteria 10–11 assess statistical information required to make a study interpretable. Scoring of each question is done in accordance to its existence or nonexistence in the assessed study. The final scoring is done by the addition of all positive answers. Studies considered of high quality scoring ≥5 (5/10) as stated by Moseley et al18 Therefore in our review all included studies scoring ≥5 were found to be of high in methodological quality. The studies were analyzed in PEDro scale by two independent investigators.

**Data analysis:**

The screening of included articles was done by two independent investigators. The selected articles were analyzed in an organized manner including parameters given: author year, study design, subjects age, interventions, study duration, outcome measures, and results. Differences between the investigators were solved by conversation to reach agreement and settled using Cohen's kappa statistics.

**Table 1: Description of the included studies**

| Authors | Study design | No. of Subjects | Description of Subjects | Additional Injuries | Follow-up, year | Initial Treatment of | Radiologic Findings | CMS score |
|---|---|---|---|---|---|---|---|---|
| Song et al., 2013[18] | RCT | 112 | 80 male 32 female; mean age=33.1y ACL injury confirmed on MRI or arthroscopically, with meniscus injury Or LCL or interchindroial injury | 58with meniscal injury 18 had meniscal repair Menisectomy | 4 | patients had either single bundled or double bundled reconstruction BTB graft single bundled n=60 double bundled n=52 | single bundled group: grade 0=80,gradeI=21,grade II=7,gradeIII=4,grade IV = 0; Non operative group: grade0=8,grade I=10, grade II=4,gradeIII=3, | 76 |
| Streich et al., 2013[19] | Retrospective | 40 | 12 Female 10 male Mean age 29 y isolated ACL injury | Excluded from study | 10 | Isolated ACL injury using quadrupled hamstring allograft | IKCD at 10 Y follow up 29 knees =normal Grade A 11 Knees=nearly normal Grade B | 67 |
| Soumalainen et al 2012[20] | Prospective | 90 | 61 Male 29 Female Mean age = 33 ACL Injury confirmed on arthroscopy with meniscal injury | excluded from study | 5 | Patient had either single bundled or double bundled reconstruction n=30 single bundled n=60 | KL Classification Grade 0= 25 Grade I =56 Grade II =9 Grade III and IV = 0 | 87 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Strewer et al., 2011 et al., 2012[21] | prospective | 73 | Median age=43y(range, 24-63y);46men, 27 women; isolated ACL injury at presentation with no articular surface damage or meniscus lesions | Excluded from study | 13 | Isolated ACL-R using BTB graft | K/L classification 13.5-y=4.1%grade 0, 41.1% grade I, 32.9% grade II,16.4% grade III, | 63 |
| Sharick Shamsi, Abdullah Al-Shehri et. al 2020[22] | RCT | 50 | 30 male 20female mean age 25.8 | excluded from study | 3 | isolated knee injury ACL reconstruction conservative treatment | IKDC at 3 y follow up 40 operative Grade B 42 non-operative Grade B 60 Operative Grade C 57 No-operative Grade C | 65 |

**DISCUSSION**

Five studies of good quality (Coleman Modified score CMS > 55) including a total of 365 subjects with ACL injury were included in this systematic review based on the inclusion criteria. Two of the studies were assessed to have a RCT, 2 as prospective study design and one study were assessed to have a retrospective study design. The studies achieved a mean Coleman Modified score (CMS) of 74.6 of a total score of 90. The prospective studies disclosed higher methodological quality than did the retrospective studies. Mean modified CMS for the prospective studies was 76 and 47 for the retrospective studies.

In this review two different radiological classifications were used by the studies: International Knee Documentation Committee and Kellgren-Lawrance classification. In studies which used International Knee Documentation Committee grade (A), there was no evidence of radiological degeneration and grade D indicated severe degeneration. In studies which used Kellgren and Lawrence classification, grade 0 indicated no evidence of radiologic classification and grade IV indicated severe degeneration. To maintain consistency, Grade B in the International Knee Documentation Committee and Grade II in the Kellgren and Lawrence classification were considered as the cut-off grade to indicate degeneration at the follow-up evaluation23.

The reported prevalence of knee OA in this review varied between 0% and 59%. Five of the studies included subjects with isolated knee injuries and showed prevalence of knee OA of 0% (Soumalainen CMS score of 87) to 49% (Streich – SMS score of 65). Studies with subjects combining ACL and meniscal injury showed prevalence of knee OA which varied between 0% ( CMS score of 67) and 42.3 % (Oiestad CMS score of 87).

The study which included subjects with isolated knee injury and achieved second highest SCM score reported knee OA prevalence of 0% 24. In comparison, the study with the highest CMS score and included subjects with combined ACL and meniscal injury reported a knee OA prevalence of 42.3%. In summary, the study results indicated that isolated ACL injury have low prevalence of radiologic knee OA compared with those with combined ACL and meniscal injury.

Only one study with CMS score of 65 compared subjects treated by operative and non-operative approaches. The study reported no significant difference between the two groups with regard to the prevalence of knee OA.

The review of these results shows a wide range of variations in the reported knee OA prevalence. These variations might be attributed to different factors such as study population, study design, participant's level of activity, reconstruction approaches, post-operative rehabilitation programme and radiological classification used. These factors were considered by previous review. However, this review included more prospective studies; three were randomised controlled trials and the mean CMS score was higher than that of the study by the CMS score for the included studies in this review was relatively higher than those included.

One prospective case control study with CMS of 6725 and one retrospective study with CMS score of 85% used regression analysis to identify risk factors for development of knee OA following ACL injury. Different risk factors were reported by these two studies; the strongest factors were concurrent meniscal injury, duration between injury and surgery and Body Mass Index (BMI). A previous review considered the same factors as strong predictors as well.

Although previous studies have highlighted the positive impact of post-operative rehabilitation on the outcome of ACL reconstruction26, most of the included studies did not highlight the possible effect of lack of supervised rehabilitation on the long-term clinical outcome. Future studies need to provide participants with comprehensive rehabilitation exercise programme in order to confirm post-operative rehabilitation as a possible risk factor for development of knee OA.

**Implication of the study**

The results of this study, which indicate low to moderate prevalence of knee OA following ACL reconstruction, support the findings of previous reviews. In line with previous studies, this review reported meniscal injury and time between injury to surgery as strong predictors of knee OA following ACL injury. The implication of these results on the timing of surgical approach, surgery performed early after the incidence of ACL rupture, might prevent further damage to the meniscus and articular cartilage and, consequently, reduce the risk of arthritis and prevent reoccurrence of rupture. In addition, such immediate surgical interference will reduce the age at surgery and the risk of patello-femoral OA.

**Strengths of the study**

One of the key strengths of this review is the inclusion of five prospective studies, three of which are randomised controlled trials. All studies including the three retrospective cohort studies scored over 55 in the Coleman modified score, which indicates good quality. Inclusion of good quality studies is important to reduce the biased outcomes27.

**Limitations of the study**

The study has a few limitations that might affect its validity. The data search was conducted by the researcher; unfortunately, it was difficult due to time constraint to use an independent librarian to conduct the data search to ensure that all the relevant studies were included. Although the researcher took all the necessary measures to identify the relevant literature, as a novice researcher there is possibility of error or inaccuracy in the data search. The researcher expanded the electronic search to cover the period from the inception of the included databases to October 2013, in order to identify any literature not included in the previous reviews. The screening of this large number of abstracts and main articles was a time consuming process. The researcher felt at the time that this would be helpful to improve the validity of the study. The search results identified the same studies included in the previous review. The researcher considers this as a beneficial learning experience and good attempt to improve the validity of the review.

Due to time limitation, only one reviewer conducted the data extraction and quality scoring processes; this might affect the validity of the review due to increased risk of reviewer bias27. In this review a qualitative (narrative) analysis was conducted to analyse the findings of the studies and quality score. This method of analysis is considered to be subjective in nature as it reflects the reviewer's interpretation of the results, particularly in the absence of a peer reviewer, due to lack of statistical analysis. There were many variations among the studies which affected the data analysis process. Heterogeneity of the studies due to variable study design, assessment tools and population used in the trials made it difficult to conduct a quantitative analysis (meta-analysis) in addition to the narrative analysis in this review.These variations in age and other variables in individual studies might lead to statistically heterogeneous outcomes. Clinical and statistical heterogeneity are closely related to each other29.

Considering that ACL injury is more linked to sports related activities, patients with higher level of motivation and desire to return to sport early might be more willing to participate in such studies. Therefore, this might produce evidence of selection bias30.

**Recommendations for future study**

Based on the results of this study, it is recommended that further prospective studies are conducted using less variables such as outcome measures, previous level of activity and age. Existence of such good quality trials will produce good quality meta-analysis studies. Such high level evidence is essential to guide change in clinical practice.

Future studies might use regression analysis to investigate the risk factors for developing knee O following ACL rupture. Although risk factor was a common aim among the studies in this review, only two studies used regression analysis to produce valid results.

## CONCLUSION

In conclusion, based on the quality assessment of the included studies and narrative analysis, the prevalence of knee OA was found to vary between 0 and 58% in this review. The highest prevalence was 49% reported by a retrospective study with Coleman modified score of 87%. Lowest prevalence was 0 and achieved by a prospective study with Coleman modified score of 85%. Different risk factors were considered as predictors of knee OA following ACL injury. Among these factors, meniscal injury, time between injury and surgery and BMI were found to be the strongest predictors. This review supports the evidence that the prevalence of knee OA following ACL injury is under 50% as described by a mixture of good quality prospective and retrospective studies. Future research might need to be prospective and pay more attention to the importance of post- operative rehabilitation and other variables that could lead to heterogeneity of the studies such as population and level of activities.

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