Wallace S . (2024) ADVANCES IN ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION: A REVIEW OF SURGICAL TECHNIQUES AND REHABILITATION. Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte vol. 24 (98) pp. 377-391.
DOI: https://doi.org/10.15366/rimcafd2024.98.025

ORIGINAL

ADVANCES IN ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION: A REVIEW OF SURGICAL TECHNIQUES AND REHABILITATION

Simon Wallace

University of Leeds, UK.

Recibido 25 de enero de 2024 **Received** January 25, 2024
Aceptado 24 de septiembre de 2024 **Accepted** September 24, 2024

ABSTRACT

Anterior cruciate ligament injuries are frequent. Reconstruction through surgery is more common than ever. The patient's care after anterior cruciate ligament repair surgery is covered in this review article. Early recovery of passive motion, early weight bearing, bracing, kinetic chain exercises, neuromuscular electrical stimulation, and rapid rehabilitation are emphasized, among other aspects of therapy. While evidence supports the therapy of surgically repaired cruciate ligaments, further research is required to more precisely define the timeframes for progression. There is proof that many of these adolescents are not fully resuming unrestricted high-level activities. To assist the busy clinician in comprehending and connecting scientific and clinical research to rehabilitating a patient after reconstruction, this review paper provides some of the most recent findings about anterior cruciate ligament rehabilitation. In summary, although a great deal of research has been done and is continuously being added to the literature every day, more work must be done to understand the pathology associated with ACL tears to potentially improve the prognosis of people who have had ACL tears.

KEYWORDS Anterior Cruciate (AC); Ligament Reconstruction (LR); Surgical Techniques (ST); Rehabilitation

1. INTRODUCTION

The word anterior cruciate ligament reconstruction refers to a kind of surgical treatment for replacing the anterior cruciate ligament back to its place in the knee joint. The anterior cruciate ligament has various important functions in knee joints. These important functions are restoring the stability of the knee

joint, improving the function of the joint, the aspect of relief of pain in the knee joint, the aspect of preventing injury, and the aspect of the ability to move joints easily. In this introduction, we are going to discuss the important advances in anterior cruciate ligament reconstruction related to surgical techniques. Various important surgical techniques are preferred in anterior cruciate ligament reconstruction, such as arthroscopic assisted surgery, anatomical single bundle reconstruction, double bundle reconstruction, all inside technique, outside in technique, anteromedial portal technique, and transtibial technique(Budny et al., 2017). We are going to describe each of these surgical techniques one by one. The first and foremost surgical technique for anterior cruciate ligament reconstruction is arthroscopic assisted surgery. This surgery is especially minimally invasive surgery, in which arthroscopy is utilized to visualize the internal parts of a joint for the sake of repair and reconstruction. There are a variety of benefits of this surgery, such as in this surgery, there is less trauma to surrounding tissues of joints. The other benefit is much less post-operative pain in this case. The other benefit is a fast recovery in the Case of arthroscopic-assisted surgery(Wilk et al., 2003). The important techniques useful in arthroscopic assisted surgery are portal technique, all inside technique, outside in technique, and others. In the case of the portal technique, there is a small incision for the arthroscope and instruments. In the case of all inside techniques, there is only one incision for both the arthroscope and instruments. The outside technique has two incisions for the arthroscope and instruments. Fewer important steps are included in arthroscopic assisted surgery. The first step in this surgery is preparation for surgery and anesthesia. The second step of arthroscopic assisted surgery is the arthroscopic examination. The third step for arthroscopic assisted surgery is inserting an instrument, the fourth step is the surgical repair of the anterior cruciate ligament. The final step of arthroscopic assisted surgery is the aspect of closure and rehabilitation. This surgical technique has applications not only for anterior cruciate ligament reconstruction andfor other knee joints such as meniscal repair, cartilage restoration, Ligament repair, and others(Wilk et al., 2003). Although there are a variety of applications of arthroscopic assisted surgery, there are some limitations to it. For example, the first limitation is that this surgical technique has a risk of infection. The other limitation is that it may cause nerve damage in fewer cases. The next limitation is that, in some cases, there is damage to blood vessels. Sometimes, there is a risk of instrument breakage and adhesives, which may act as limitations of arthroscopic assisted surgery. The next important surgical technique for anterior cruciate ligament reconstruction is an anatomical single-bundle reconstruction(Machotka et al., 2010). This is a special surgical technique for the anterior cruciate ligament, in which a single graft is placed is placed in the anatomical position of the anterior cruciate ligament. This surgical technique also consists of fewer important steps for anterior cruciate ligament reconstruction. The first step of this surgical technique is preoperative planning and accurate patient positioning. The next

step of this surgical technique is the arthroscopic examination and establishing a Portal. The next most important step of this surgical technique is graft harvesting. After graft harvesting, there is a step of tunnel creation(D'Ambrosi et al., 2023). The next step is the placement and fixation of the graft. The final step of anatomical single-bundle reconstruction is the final tightening and securing of the knee joint. There are a variety of graft options in this anatomical single-bundle reconstruction. These graft options are autografts, allografts, xenografts, and others. There are a few important advantages of this particular surgical technique. The first main advantage is that there is better restoration of the anterior cruciate ligament in this surgical technique. The next-door benefit is that the stability of the knee joint improves in this case. The other important advantage is that this surgical technique results in faster recovery. The other advantage is that this surgical technique has very little risk of complications (Piedade et al., 2023). There are a variety of applications of this surgical technique, but there are fewer limitations. The first limitation is that there is sometimes a technical difficulty in accurately placing this graft in the knee joint. The other limitation is that sometimes it is difficult to access a few areas of knee joints(Wilk et al., 2012). The other limitation of this surgical technique is the ambiguity in choosing a graft in this anatomical single-bundle reconstruction. The other important surgical technique for anterior cruciate ligament reconstruction is double-bundle reconstruction. As the name indicates, two separate bundles are used are used for anterior cruciate ligament reconstruction. These bundles are named anteromedial and posterolateral bundles. The main steps for this surgical technique are almost the same as those for anatomical single bundle reconstruction, but there are a few limitations. The first limitation of this surgical technique is the selection of patients (Musahl et al., 2022). This surgical technique is not suitable for all types of patients. The second limitation of this surgical technique is the aspect of rehabilitation time. In some cases, it has been seen that to reduce rehabilitation time, there is a need for particular rehabilitation protocols. The other limitation is the limited research on this surgical technique. The other important surgical technique for anterior cruciate ligament reconstruction is the transtibial technique, in which there is the drilling of the tunnel through the tibia to insert the graft at the accurate position in the knee joint(Vaishya et al., 2015). There are important advantages to this surgical technique, such as its traditional and well-established method. The other important advantage of this surgical technique is that it is easy to learn and perform. However, there are fewer limitations in this surgical technique as well(Manske et al., 2012; Rael et al., 2023). Over the past few decades, the knowledge on anterior cruciate ligament (ACL) reconstruction has expanded and become more sophisticated. Up until now, the main emphasis has been on comparing choices for transplantation, managing concurrent injuries such as meniscal rips and cartilage lesions, and treating damage to extra-articular ligaments. Even with the accumulation of information, a strategy for therapy specific to various types of ruptures remains

unclear. Ruptures were classified as (1) sub synovial ACL tears/stretch damage and proximal avulsion tears, (2) single-bundle tears (anteromedial/posterolateral), and (3) complete ACL rupture, each with distinct management approach implications. An overview of suggested surgical treatment plans for various ACL rupture types is given in this article. Over the last ten years, treatment choices have been notable improvements due to the combination of rigorous scientific study and breakthroughs in arthroscopy technology. ACL surgery and postoperative rehabilitation may and should be carried out in a way that is appropriate for each patient's particular circumstances, taking these changes into consideration. Additionally, recommendations for intra- and postoperative care include vancomycin graft coating. An expedited program of "Early Active Rehabilitation" is also suggested, which entails the use of extracorporeal shock-wave therapy after surgery and early active physiotherapy without the need for postoperative bracing.

1.1 Research Objective

The main objective of this research is to understand the advances in anterior cruciate ligament reconstruction related to surgical techniques that are useful nowadays for anterior cruciate ligament reconstruction.

2. Background and Review of Research

Studies contrast the benefits and weaknesses of various parts of everything-inwardly front cruciform tendon rehabilitation, involving joint determination & arrangement, ivory attachment remaking, obsession strategies, & careful strategy impacts & restrictions. It's been discovered that the everything-inwardly procedure succeeds the two physically & pathologically yet obliges additional turn of events (Yang et al., 2022). Researchers reveal that detached assessment & the executives of front cruciform tendon wounds are perhaps the more generally explored points in muscular games medication, providing suppliers more than adequate information on that to ground their exercises. The front cruciform tendon is additionally the greater normally tempered human Knee tendon. This research provides details regarding flow themes & examination in detached administration of front cruciform tendon wound, beginning along assessment, usable v/s non-surgical administration, & contemplations in exceptional populaces (Musahl et al., 2022). The target of this study was to approach & sum up the most recent proof toward post-surgical restoration conventions pursuing front cruciform tendon rehabilitation to assess normal periods, several stages, works out, also the duration of recovery convention. Based on the proof, trembling preparation might be securely integrated into the post-surgical recovery convention pursuing front cruciform tendon rehabilitation. Sped-up restoration might provide sufferers momentary practical advantages (Nelson et al., 2021). Studies suggest that front cruciform tendon inadequacy may be incapacitating, provide the material & athletics

action requirements that adversely influence the personal satisfaction. Although, latest innovations do include a distinct expectation to learn & adapt that might influence restoration projects & create conflicting outcomes. The improvement of restoration conventions can't be characterized unless a precise determination of the front cruciform tendon wound & taking into account the sufferer's actual requests & assumptions (Piedade et al., 2023). Scholars suggest that different reconstructive conditions pursuing front cruciform tendon reproduction are powerful in working on careful results & yield-to-athletic charges. Additional proof & further developed concentrate on the plan are expected to additionally approve conditions involving sped-up recovery, blood flow restriction preparation, utilitarian examination, & yield-to-athletic standards (Glattke et al., 2022). Studies elaborate that a wound toward the front cruciform tendon is among the best well-known muscular wounds, & reproduction of a cracked front cruciform tendon is a typical muscular system. As a rule, careful mediation is important to reestablish solidness toward the harmed human Knee, & to forestall meniscus harm. Further examination is expected to tackle how practice-founded recuperations should adjust to such imaginative fixed methods (Wu et al., 2022). The findings of this study show that the front cruciform tendon reproduction restoration program should to encounter the prerequisites of the expected games to advance the competitor's capacity to get back toward the normal degree & limit the danger of continued victimization. Behavioral-psychological & logical variables should as well be viewed as recovery caution to personalize & enhance every sufferer's scheme(Rambaud et al., 2022). This survey sums up the latest patterns, conclusions, & styles in front cruciform tendon restoration study, along with a particular spotlight on clever strategies to address the particular psycho-social desires of front cruciform tendon lacking sufferers. Exercise-based recuperation assumes a basic part in the fruitful recuperation of the two carefully & Non-precisely oversaw sufferers (Jenkins et al., 2022). This survey aims to give primers a concise foundation regarding front cruciform tendon wounds, an engaged audit of detached results concentrates afterwards front cruciform tendon remaking, & a refreshed structure with master-directed suggestions towards postsurgical recovery & yield to donning action. In view of detached encounters, a recharged center around the intention, measures founded achievements might expand the capacity of yield to before a wound degree of sport capability (Badawy et al., 2022). Studies claim that sufferers must to go through a total past & actual assessment along with a particular spotlight on past wound instruments & surgeries. Studies also show that a correction front cruciform tendon recreation is an requesting system, & the specialist should to be ready to tackle ivory passage Gorham-stout disease, simultaneous meniscus, tendinous, or ligament sores, & appendage misalignment (Miller et al., 2021). Scholars explain that front cruciform tendon fix has the best possible in instances of proximate front cruciform tendon crack. Alert is prompted in competitors & more youthful sufferers in light of greater disappointment estimates. At present, front

cruciform tendon fix stays dubious & should to be executed along alert due to restricted intermediate-& extended haul results (Gee et al., 2020). The point of this complete audit was to examine the various strategies utilized to remake the harmed front cruciform tendon. Irritable-mending of hinders has been made toward front cruciform tendon reproduction with expectations of further developing prospective issues connected with the impedance hump & knob obsession method (Gerami et al., 2022). Studies show that front cruciform tendon reproduction is a methodology regularly carried out in Muscular games medication. With propels in careful methods giving best situating & obsession of the transplant, ensuing transplant inability to a specific degree have to be reckoned by unfortunate transplant recuperating (Yao et al., 2021). Studies determined that with work on comprehension of the front cruciform tendon dissection & movement science & the development of the gastroscope and front cruciform tendon recreation advanced from frank methods to gastroscopic. Also, with the assistance of numerous specialist researchers who detailed sufferer results pursuing front cruciform tendon reproduction with different procedures, transplant decision advanced along the hinders & patella ligament joins, turning into the prevailing & favored decision of the two specialists & sufferers (Lind et al., 2023). Studies explain that front cruciform tendon wounds are among the most pervasive human Knee wounds, especially in competitors who participate in elevated-influence athletics. The audit examines the brief-& extended haul results involving utilitarian recuperation, yield to athletics, complexity estimates, & the effect of sufferer-explicit elements, for example, epoch, movement degree, & multimorbidity. Furthermore, the audit talks about the job of recovery conventions in streamlining careful results (Gharpinde et al., 2024). This research aims to give an outline of all distributed riffled restrained preliminaries in front of cruciform tendon reproduction, summing up the accessible proof. The proof shows that a conventional laparoscopic solo-or twofold pack front cruciform tendon reproduction along hinders/kneecap xenografts, transported method, & obsession strategies natural toward the specialist prompts tantamount outcomes (Matar et al., 2021). The findings of this study indicate that material & mental capability, as friendly help, may be impacted by suitable intercessions, showing prospective operation on restoration schemes toward yield prior to a wound should seriously mull over adopting the comprehensive strategy tending to that (Drole & Paravlic, 2022). This precise audit planned to contrast the viability of regulated recovery & with respect to human Knee capability along with that of locally established restoration in sufferers going through front cruciform tendon remaking. The restricted proof accessible doesn't recommend that supervised reconstruction brings about more predominant results than home-founded reconstruction in sufferers along front cruciform tendon remaking. Extra examinations are expected to explain either sufferer attributes & explore conventions with extended intercessions that impact the outcomes(Uchino et al., 2022). The motivation behind this survey was to sum up the ongoing writing in regard to late advancement & specialized

enhancement of front cruciform tendon remaking. Front cruciform tendon rehabilitation has advanced after some time regarding method, unite choice, & extra techniques. Although, there's a quiet opportunity to get better(Kataoka et al., 2023). Studies give an understanding of the reconstructive conventions & procedures used toward front cruciform tendon rehabilitation by muscular specialists practically speaking beyond the US. Furthermore, scholar's discoveries demonstrate that whilst numerous specialists accept that quantifiable appraisal innovation might be valuable in determination-production toward reverting sufferers to athletic, there are as yet numerous boundaries that substitute the method of its execution toward detached procedure (Glattke et al., 2023). Scholar studies reveal that suitable restoration following front cruciform tendon remaking may concede typically great results, along with yield to past degrees of movement & elevated human Knee capability. A front cruciform tendon wound should not be considered a "straightforward" outer muscle bacteriology, along with neighborhood automatic or engine anomalies(Kakavas et al., 2021). Scholars reveal that anatomical front cruciform tendon rehabilitation has arisen at the highest quality level, fully intent on reestablishing the sufferer's local life structures & human Knee kinetics. This study will sum up the pertinent life structures, present-day anatomical front cruciform tendon recreation strategies, & writing encouraging anatomical front cruciform tendon remaking like the latest worldview(Fox et al., 2023). Researchers suggest that contemporary postsurgical recovery methodologies in front cruciform tendon rehabilitation with quadriceps tendon present an entanglement contour tantamount to such detailed with different united forms. In light of the recovery routine, such conventions should concentrate on a former range of motion, explicitly on accomplishing the entire expansion, close by isobaric fortifying(Zhang et al., 2022). This exploration aims to contrast the viability of essentially postoperative v/s fundamentally reconstructive administration toward front cruciform tendon crack. The results show that there's miserable to extremely miserable conviction of proof that essential restoration with discretionary postoperative reproduction brings about comparable result estimates as former postoperative recreation for front cruciform tendon break. The discoveries contradict a verifiable worldview that anatomical flimsiness should be considered with essential postoperative adjustment to give ideal results(Saueressig et al., 2022). This survey intends to inspect the ongoing information concerning front cruciform tendon fix. A few front cruciform tendon fix surgeries have created gratitude toward the progression of the latest obsession gadgets. The ongoing writing demonstrated that the front cruciform tendon fix prompts good results when executed on a reasonable sufferer along the suitable injury form, relating toward the proximate 3rd with great fabric peculiarity(Bosco et al., 2024). More than 100,000 ACL procedures are done annually in the United States, making ACL tears one of the most common diseases seen by orthopedic surgeons. Furthermore, it has been noted that the prevalence of ACL tears has been rising over time,

particularly impacting children and teenagers. This finding suggests that the injury prevention initiatives that have been put in place up to this point have failed to meet their objectives. In the athletic community, ACL reconstruction remains the gold standard for treating this injury; nonetheless, failure rates have been recorded as high as 24%, and only 50% to 65% of recreational players can resume their pre-injury level of play. We need to improve. We must enhance our outcomes by injury avoidance, better treatment plans, rehabilitation, or a mix of these. With this concept in mind, this Special Issue has since published, expanding our c have been published sinceurrent understanding of ACL and related fields. Orthopedic surgeons have focused a lot of effort on enhancing outcomes by modifying surgical methods including choosing grafts, fixing them, placing tunnels, and using single-versus double-bundle approaches. It's interesting to note that the authors discovered no appreciable variations in clinical outcomes with posterior interference screw insertion, despite reduced tunnel expansion at the tibial tunnel close to the articular surface of the tibia. Still, the authors suggested posterior screw insertion to improve the environment for graft healing and revision (Fig 1).

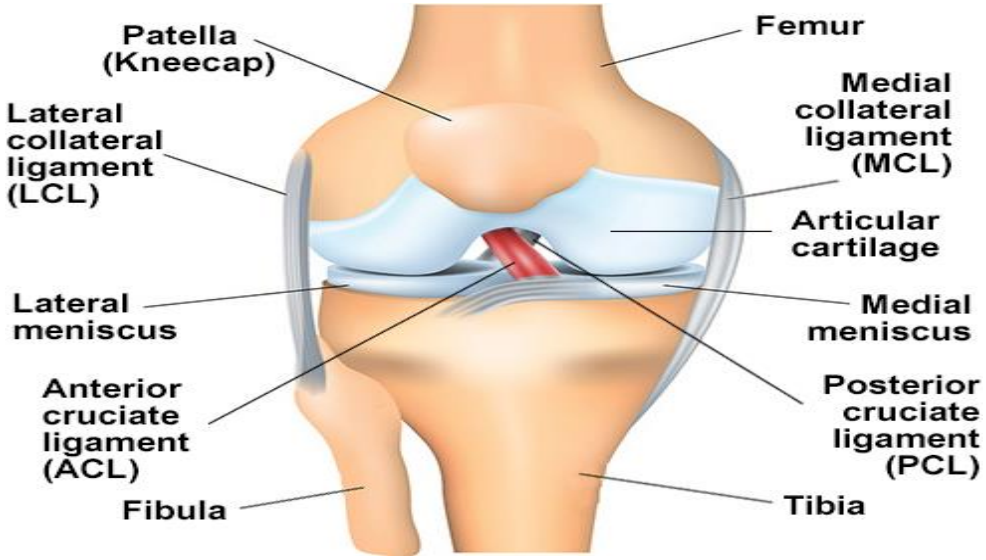

Figure 1: ACL Reconstruction Surgery:

3. Implications

- Reconstruction of knee ligaments using ACL surgery-based procedure helps in the rehabilitation of knee injury. The injury between the two major bones of the leg results in knee dysfunction. The anterior cruciate injury occurs mostly due to high physical activity. Most people who indulge in high-intensity workouts feel pain in their knees. This pain may be due to some injury or ligament damage. The best way to overcome knee pain is to avoid the cause of the pain. For example, for people who indulge in physical activity, extreme exercise causes knee pain. These people can overcome their knee pain by avoiding extreme or heavy physical training sessions.

- If the pain worsens after following the precautions, it indicates that the knee has undergone ACL injury.to treat ligament injury patients undergo a surgery procedure, a low dose of anesthesia is given to ACL injury patients. Anesthesia is given to make the surge process painless for the patient. The surgery procedure is carried out with all the medical protocols to overcome the chances of any mischief during the surgery procedure. After all the primary protocols are followed, the next step after amnesties is to carry out the surgery process using a grafting procedure. The autographing methodology is used to graft healthy ligaments instead of damaged ones. Auto grafting involves using a patient's healthy ligaments to replace the abnormal or damaged ones.

- For ligament surgery, advanced methods are used, like auto grafting. These methods are involved in reconstructing the bone. The process of auto-grafting is carried out by taking tissue from a healthy donor or by taking tissue from the patient's own healthy tissue. The healthy tissues thus obtained are used to replace the damaged tissues. Auto grafting is carried out through arthroscopy. This process involves the insertion of cameras from the cut into the injury site. The cameras provide image-based data about the injury site (Fig 2).

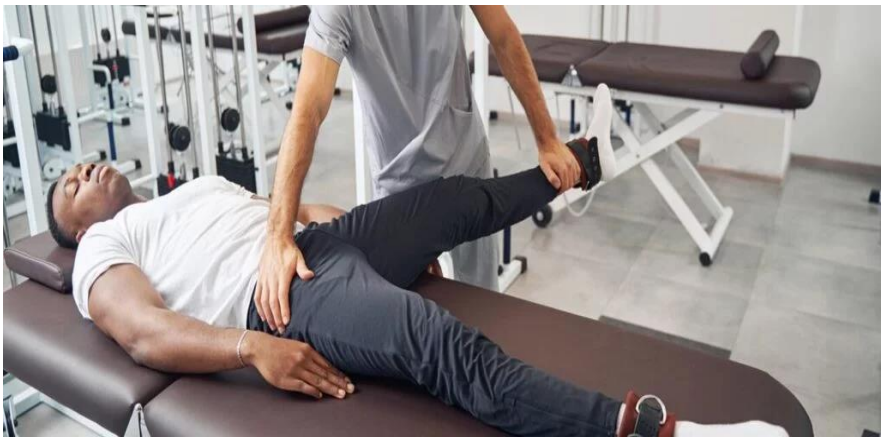

Figure 2: Post Surgical Techniques and Rehabilitation

- The process of surgery is carried out in three significant steps. The first step is when the surgeon decides whether to use a person's cells for grafting or to replace them with donor cells or tissue. The second step in making a decision is to place an autograft at the site of injured tissue. In the second step, the injured ligament is removed, and the new ligament is implanted. In the third step, the surgeon screws the bone and ligament together and then seals the cut with stitches. After surgery is completed, the dressing of the patient is changed after a few days until the wound is fully healed.

- Surgery of ACL-based injury is performed for many reasons. The first reason is knee pain, people who feel extreme knee pain are advised by professionals to undergo surgery. The second reason is the unstable knee. The

third cause of surgery is injured or damaged ligaments due to an accident. These reasons cause a person to go for knee surgery to reconstruct their damaged knee ligaments. But before the surgery is performed the patient is kept under observation of health professionals for three to four months. After surgery, the rehabilitation period starts and lasts for almost six months. After the rehabilitation period, a person fully recovers and becomes capable of performing his daily life activities as usual.

- While performing surgery, some complications occur. These complications are related to anesthesia intake like a person getting an allergic reaction after the anesthesia intake. The chemicals in anesthesia can trigger the immune response of a person and show an allergic response. Some patients face problems in breathing after an anesthesia dose. This problem is caused by to side effects of anesthesia dosage in some patients with low immunity. The other risk factor associated with ACL surgery is bleeding. If the cut is too deep then it results in uncontrolled bleeding from the wounded side that can also result in the death of the patient use to blood loss. The other factor is infection. If the wounded cuts are not properly sterilized, it results in infection of the wounded site (Fig 3).

Figure 3: Surgical Rehabilitation

- In most cases, the ligament reconstruction surgery proves successful but, in some cases, serious problems arise like the ligament doesn't heal after the surgery. Knee pain after surgery and injury of vessels surrounding the ligament. bone stiffness as well and knee weakness are also some common problems that result after knee surgery. If these signs or problems appear in a patient after the surgery then it proves that the surgery has been unsuccessful against the injury.

- To avoid the complications caused after injury, the patients are provided with early intervention that guides them to follow a particular protocol before the surgery is done. The first protocol is to make sure that the patient doesn't take any education that makes the blood thin. Like aspirin makes blood

thin which results in uncontrollable blood flow during the surgery. So, the patients of ACL are advised to stop the use of such, medicines. The second protocol is if a person is diabetic, he has to ask his health care professional before undergoing ACL surgery. The third protocol is to tell the surgeon about the amount of alcohol your intake daily. If the patient intakes alcohol daily then he is advised to stop using it four months proper the surgery. The next protocol is to prohibit inured patients from smoking for six months before injury. Because the healing of wounds becomes slower in patients who smoke. All these protocols are maintained before surgery to ensure that no complications or side effects result.

- One more process that is of great significance after the surgery is the rehabilitation period of the patient. The rehabilitation period of the time of recovery of the wound after the surgery is performed. For some patients, the rehabilitation time is three months while for patients having slow immune systems the rehabilitation period ranges from six months to one year. Patients with ACL injuries undergoing surgery are provided with rehabilitation-based therapies after the surgical procedures. These therapies increase the time of recovery. The rehabilitation-based therapies provided to ACL-injured patients are of two types. The first is physical therapy, and the second is mental therapy. Both these therapies are provided to improve the physical as well as mental health of patients. In most cases, the patient undergoing surgery faces a lot of distress and mental health problems.to help such mentally disturbed patients to regain their mental peace they are provided with mental therapies along with physical rehabilitation therapies.

- The function of the lateral extra-articular tenodesis (LAT) and the anterolateral ligament (ALL) in enhancing the results of ACL reconstruction and original ACL repair have also been the subject of current research. The paper examining the prognosis of combined ACL and ALL repair that was published in this Special Issue is noteworthy. Patients who underwent combined ACL and ALL repair and had at least a two-year follow-up been retrospectively examined by the authors. According to their findings, individuals who underwent this combination treatment showed no signs of graft rip or poor functional knee instability. This is consistent with earlier research that demonstrates that adding a LAT technique lowers the re-tear rates of ACL restoration. When it comes to rehabilitation, physical therapy is widely acknowledged to be essential to the full recovery of people with ACL rupture who are treated medically or non-surgically. Current approaches provide a more customized approach to ACL injury patients' recovery, with protocols adaptable to each patient's unique requirements and rate of recovery.

4. Conclusion

ACL repair has a long history that dates back to the Egyptian era. This

field is rife with innovation and research, and clinical outcomes are always improving. Understanding the history of ACL reconstruction is crucial for those who work to enhance the procedure's results in order to build on previous successes and lower the possibility of making the same mistakes twice. For some forms of anterior cruciate ligament rupture, an ACL repair is a great alternative. Through this process, the natural ACL that has been torn is maintained, fixed, and given time to mend. Compared to the more typical ACL reconstruction operation, it is not the same. During an ACL reconstruction, the patient's or a cadaver's tendon graft is used to repair the knee's damaged and torn ACL. When ACL repair was initially done in the 1970s, the outcomes were not good. However, at the time, a large open incision was required for the procedure, all ACL tears—not just those in which the ACL pulled away from the femur—were repaired, suture material was weak, suture anchors had not yet been developed, and accelerated rehabilitation protocols had not yet been established. Back then, patients had to spend two months in a lower leg cast for rehabilitation, which left their knees severely damaged and rigid. Indications and current ACL repair methods have greatly improved. For ACL rips that occur high near the femur's attachment, ACL repair is a fantastic alternative. When an ACL rupture occurs in the center of the ligament, ACL repair is not recommended since these repairs do not heal effectively. These days, the process is arthroscopic and requires three tiny ½" incisions. High strength suture material and tiny, robust, non-metallic suture anchors are utilized to reattach the torn ACL to the end of the femur bone that it tore away from. Under the supervision of a skilled physical therapist, patients adhere to an expedited recovery regimen. Compared to following ACL repair surgery, the rehabilitation and return to sports period is substantially shorter. Ultimately, the original ACL surgery has shown excellent outcomes.

Reference

Badawy, C. R., Jan, K., Beck, E. C., Fleet, N., Taylor, J., Ford, K., & Waterman, B. R. (2022). Contemporary principles for postoperative rehabilitation and return to sport for athletes undergoing anterior cruciate ligament reconstruction. *Arthroscopy, Sports Medicine, and Rehabilitation*, *4*(1), e103-e113.

Bosco, F., Rovere, G., Giustra, F., Masoni, V., Cassaro, S., Capella, M., Risitano, S., Sabatini, L., Lucenti, L., & Camarda, L. (2024). Advancements in Anterior Cruciate Ligament Repair—Current State of the Art. *Surgeries*, *5*(2), 234-247.

Budny, J., Fox, J., Rauh, M., & Fineberg, M. (2017). Emerging trends in anterior cruciate ligament reconstruction. *The Journal of knee surgery*, *30*(01), 63-69.

D'Ambrosi, R., Meena, A., Arora, E. S., Attri, M., Schäfer, L., & Migliorini, F. (2023). Reconstruction of the anterior cruciate ligament: a historical view. *Annals of Translational Medicine*, *11*(10).

Drole, K., & Paravlic, A. H. (2022). Interventions for increasing return to sport rates after an anterior cruciate ligament reconstruction surgery: A systematic review. *Frontiers in psychology*, *13*, 939209.

Fox, M. A., Engler, I. D., Zsidai, B. T., Hughes, J. D., & Musahl, V. (2023). Anatomic anterior cruciate ligament reconstruction: Freddie Fu's paradigm. *Journal of ISAKOS*, *8*(1), 15-22.

Gee, M. S. M., Peterson, C. D. R., Zhou, M. L., & Bottoni, C. R. (2020). Anterior cruciate ligament repair: historical perspective, indications, techniques, and outcomes. *JAAOS-Journal of the American Academy of Orthopaedic Surgeons*, *28*(23), 963-971.

Gerami, M. H., Haghi, F., Pelarak, F., & Mousavibaygei, S. R. (2022). Anterior cruciate ligament (ACL) injuries: A review on the newest reconstruction techniques. *Journal of Family Medicine and Primary Care*, *11*(3), 852-856.

Gharpinde, M. R., Jaiswal, A. M., & Dhanwani, Y. (2024). A Comprehensive Review of Graft Choices and Surgical Techniques in Primary Anterior Cruciate Ligament Reconstruction: An Outcome Analysis. *Cureus*, *16*(9).

Glattke, K. E., Tummala, S. V., & Chhabra, A. (2022). Anterior cruciate ligament reconstruction recovery and rehabilitation: a systematic review. *JBJS*, *104*(8), 739-754.

Glattke, K. E., Tummala, S. V., Goldberg, B., Menzer, H., & Chhabra, A. (2023). There is substantial variation in rehabilitation protocols following anterior cruciate ligament reconstruction: a survey of 46 American orthopaedic surgeons. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, *39*(3), 578-589. e520.

Jenkins, S. M., Guzman, A., Gardner, B. B., Bryant, S. A., Del Sol, S. R., McGahan, P., & Chen, J. (2022). Rehabilitation after anterior cruciate ligament injury: review of current literature and recommendations. *Current Reviews in Musculoskeletal Medicine*, *15*(3), 170-179.

Kakavas, G., Malliaropoulos, N., Bikos, G., Pruna, R., Valle, X., Tsaklis, P., & Maffulli, N. (2021). Periodization in anterior cruciate ligament rehabilitation: a novel framework. *Medical Principles and Practice*, *30*(2), 101-108.

Kataoka, K., Hoshino, Y., & Nukuto, K. (2023). Anterior cruciate ligament reconstruction: recent evolution and technical improvement. *Journal of Joint Surgery and Research*, *1*(1), 97-102.

Lind, D. R., Patil, R. S., Amunategui, M. A., & DePhillipo, N. N. (2023). Evolution of anterior cruciate ligament reconstruction & graft choice: a review. *Annals of Joint*, *8*.

Machotka, Z., Scarborough, I., Duncan, W., Kumar, S., & Perraton, L. (2010). Anterior cruciate ligament repair with LARS (ligament advanced reinforcement system): a systematic review. *BMC Sports Science, Medicine and Rehabilitation*, *2*, 1-10.

Manske, R. C., Prohaska, D., & Lucas, B. (2012). Recent advances following

anterior cruciate ligament reconstruction: rehabilitation perspectives: Critical reviews in rehabilitation medicine. *Current reviews in musculoskeletal medicine*, *5*, 59-71.

Matar, H. E., Platt, S. R., Bloch, B. V., James, P. J., & Cameron, H. U. (2021). A systematic review of randomized controlled trials in anterior cruciate ligament reconstruction: standard techniques are comparable (299 trials with 25,816 patients). *Arthroscopy, Sports Medicine, and Rehabilitation*, *3*(4), e1211-e1226.

Miller, M. D., Kew, M. E., & Quinn, C. A. (2021). Anterior cruciate ligament revision reconstruction. *JAAOS-Journal of the American Academy of Orthopaedic Surgeons*, *29*(17), 723-731.

Musahl, V., Engler, I. D., Nazzal, E. M., Dalton, J. F., Lucidi, G. A., Hughes, J. D., Zaffagnini, S., Della Villa, F., Irrgang, J. J., & Fu, F. H. (2022). Current trends in the anterior cruciate ligament part II: evaluation, surgical technique, prevention, and rehabilitation. *Knee Surgery, Sports Traumatology, Arthroscopy*, *30*(1), 34-51.

Nelson, C., Rajan, L., Day, J., Hinton, R., & Bodendorfer, B. M. (2021). Postoperative rehabilitation of anterior cruciate ligament reconstruction: a systematic review. *Sports Medicine and Arthroscopy Review*, *29*(2), 63-80.

Piedade, S. R., Arruda, B. P. L., de Vasconcelos, R. A., Parker, D. A., & Maffulli, N. (2023). Rehabilitation following surgical reconstruction for anterior cruciate ligament insufficiency: what has changed since the 1960s?—State of the art. *Journal of ISAKOS*, *8*(3), 153-162.

Rael, B., Alfaro-Magallanes, V., Romero-Parra, N., Barba-Moreno, L., Butragueño, J., Cupeiro, R., & Peinado, A. (2023). BODY COMPOSITION IN PREMENOPAUSAL AND POSTMENOPAUSAL WELL-TRAINED FEMALES. *rimcafd*, *23*(89).

Rambaud, A. J., Neri, T., Dingenen, B., Parker, D., Servien, E., Gokeler, A., & Edouard, P. (2022). The modifying factors that help improve anterior cruciate ligament reconstruction rehabilitation: a narrative review. *Annals of Physical and Rehabilitation Medicine*, *65*(4), 101601.

Saueressig, T., Braun, T., Steglich, N., Diemer, F., Zebisch, J., Herbst, M., Zinser, W., Owen, P. J., & Belavy, D. L. (2022). Primary surgery versus primary rehabilitation for treating anterior cruciate ligament injuries: a living systematic review and meta-analysis. *British journal of sports medicine*, *56*(21), 1241-1251.

Uchino, S., Saito, H., Okura, K., Kitagawa, T., & Sato, S. (2022). Effectiveness of a supervised rehabilitation compared with a home-based rehabilitation following anterior cruciate ligament reconstruction: A systematic review and meta-analysis. *Physical Therapy in Sport*, *55*, 296-304.

Vaishya, R., Agarwal, A. K., Ingole, S., & Vijay, V. (2015). Current trends in anterior cruciate ligament reconstruction: a review. *Cureus*, *7*(11).

Wilk, K. E., Macrina, L. C., Cain, E. L., Dugas, J. R., & Andrews, J. R. (2012).

Recent advances in the rehabilitation of anterior cruciate ligament injuries. *Journal of Orthopaedic & Sports Physical Therapy*, *42*(3), 153-171.

Wilk, K. E., Reinold, M. M., & Hooks, T. R. (2003). Recent advances in the rehabilitation of isolated and combined anterior cruciate ligament injuries. *Orthopedic Clinics*, *34*(1), 107-137.

Wu, J., Kator, J. L., Zarro, M., & Leong, N. L. (2022). Rehabilitation principles to consider for anterior cruciate ligament repair. *Sports Health*, *14*(3), 424-432.

Yang, Y.-t., Cai, Z.-j., He, M., Liu, D., Xie, W.-q., Li, Y.-s., & Xiao, W.-f. (2022). All-inside anterior cruciate ligament reconstruction: a review of advance and trends. *Frontiers in Bioscience-Landmark*, *27*(3), 91.

Yao, S., Fu, B. S.-C., & Yung, P. S.-H. (2021). Graft healing after anterior cruciate ligament reconstruction (ACLR). *Asia-Pacific journal of sports medicine, arthroscopy, rehabilitation and technology*, *25*, 8-15.

Zhang, K., Beshay, T., Murphy, B., & Sheean, A. (2022). Quadriceps tendon anterior cruciate ligament reconstruction: a systematic review of postoperative rehabilitation and complication profiles. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, *38*(6), 2062-2072. e2061.