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Anterior cruciate ligament reconstruction: An overview

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Abstract: Background: Anterior cruciate ligament (ACL) reconstruction is one of the most common procedures in sports medicine. Several areas of controversy exist in ACL tear management which have engaged surgeons and researchers in debates towards identifying an ideal approach for these patients. This instructional review discusses the principles of ACL reconstruction in an attempt to provide guidelines and initiate a critical thinking approach on the most common areas of controversy regarding ACL reconstruction.

Keywords: *Anterior cruciate ligament reconstruction*

Introduction

Among the many orthopaedic procedures done on a global scale, anterior cruciate ligament (ACL) reconstruction ranks high. The number of ACL injuries is on the rise, going from about 33 per 100,000 in 1994 to 40–60 per 100,000 in 2014. Those that take part in organized sports will feel the effects the most.1- 4The estimated annual number of anterior cruciate ligament (ACL) reconstructions performed in the United States alone is above 200,000, and this figure is projected to rise even higher due to the growing athletic participation among teenagers and young people.one, two, five

Finding out what happens in the long run once an ACL injury happens is crucial. Approximately 15% to 20% of knees develop osteoarthritis (OA) following an ACL tear; this is a tenfold increase from the baseline.6It is estimated that over half of people who experience an ACL damage will develop symptoms of osteoarthritis within the next ten to twenty years.7The incidence of osteoarthritis (OA) can be magnified when a meniscectomy is performed alongside an ACL injury.6In particular, the existence of intact menisci was linked

to normal radiographic findings in around 88% of patients in a cohort study with a ten-year mean follow-up, compared to only 63% when meniscectomy was done. Evidence suggests that ACL tears are more significant than meniscal tears alone because they produce radiographic abnormalities at a younger age.8

One of the key concerns is whether ACL repair can reduce the likelihood of osteoarthritis formation, even if OA development after an ACL damage is common. In fact, at seven years' follow-up, the reported incidence of osteoarthritis following ACL repair ranges from 39% to 47%. After 13 to 15 years, the prevalence looks to rise to between 74% and 80%.12, 13Forty percent of people with degenerative arthritis did not have any symptoms at all.12, 13Radiographic knee OA was found to be more likely to occur in men, those with a higher body mass index (BMI), those who waited longer after injuries to undergo reconstruction, those who had undergone meniscectomy before, and those whose surgeries revealed medial compartment cartilage deterioration.11

Additionally, several investigations have shown that osteoarthritic alterations are associated with more knee laxity.13So, it turns out that knee OA after an ACL tear is a lot more complicated than it first seemed. Restoring knee function to the level of an intact knee is more challenging after ACL surgery, although it does appear to slow the course of OA. We need more studies to determine if ACL restoration improves prognosis and slows or reverses the natural history of cartilage deterioration, and to shed light on the early events that occur following knee injuries.

In an effort to lay down some ground rules and kick off a critical thinking process about the most contentious aspects of ACL repair, this review goes over the fundamentals of the procedure. The fundamentals of graft selection and ideal graft positioning, when surgery should be performed, and how long patients should wait before and after the procedure are covered in this instructional overview that draws on data from meta-analyses and systematic reviews.

Treatment options: conservative and surgery

The "gold standard" for treating an ACL tear in young adults who want to go back to their pre-injury activities is surgery. In the past, non-operative treatment of ACL-deficient knees was suggested as a possible alternative; however, this approach has been linked to subpar functional results.14-18As an example, subsequent ACL and meniscus surgeries were more common after non-operative treatment, and most patients were unable to return to their pre-injury activities due to poor and fair functional outcome scores.16-20Surgery is now the gold standard for treating ACL deficiencies in active people due to the superior results of ACL reconstruction.

Despite the fact that conservative therapy of ACL-deficient knees has been out of favor for the past 10-15 years owing to bad results, a new randomised controlled trial (RCT) shown that certain patients with specific traits can be successfully handled without surgery.21,22Proposal: ACL reconstruction at a later time, if necessary, might be part of an organized rehabilitation program that yields similar results as early ACL reconstruction.21The flawed methodology and interpretation of the results led to criticism of this study.23In the optional surgery group, ACL restoration was performed on 23 out of 59 patients, or 39% of the total.21In addition, the proportion of patients reporting instability and meniscal problems was higher in the group that underwent mandatory ACL repair (32% vs. 3% and 2%, respectively) than in the group that underwent voluntary ACL reconstruction.21According to previous research, conservative treatment increases the likelihood of symptomatic instability and late meniscus tears.the number ofIn young, active patients who want to go back to their pre-injury levels of activity, the risks and morbidity of late knee injuries seem to outweigh the possible advantages of a conservative approach.

Skeletally immature patients with ACL deficiencies are more likely to experience recurrent meniscal and chondral injuries. Early research in skeletally immature patients found a correlation between medial meniscal tears and the amount of time it took to reconstruct the anterior cruciate ligament (ACL), which raises the possibility that a delay in treatment is the underlying cause of these meniscal injuries.24Consistent with the aforementioned correlation, comparable research has shown that medial meniscal tears are associated with an elevated risk of chondral injuries.24, 26An estimated 20% of individuals with skeletally immature ACL deficiencies would experience a new meniscal injury in the next four years, according to prospectively-collected

MRI data.27Because of the increased likelihood of subsequent knee injuries and their long-term repercussions, the decision to operate or not on a child with an ACL injury should therefore take this into account.

Designing a new anterior cruciate ligament

The best way to rebuild an ACL has been the subject of heated controversy among orthopaedic surgeons and academics. Disagreement has arisen over several points, including the optimal time for repair and rehabilitation and the graft kind.28Another contentious issue is the relative merits of allograft and autograft. Concerning the intervention type, there is debate over whether or not the description of the double-bundle technique actually leads to a more anatomical technique.29

Scheduling maintenance and recovery

whether deciding whether to do ACL reconstruction, it's important to keep three things in mind and strike a balance between them. Delayed ACL reconstruction is associated with a greater risk of meniscus and chondral injuries, early ACL restoration is associated with an increased risk of arthrofibrosis, and post-operative muscle weakness from inactivity is a real concern.

Ten percent to fifty percent of patients will rupture their meniscus, even though their meniscus was previously intact when they tore their ACL.30-32The average duration between the first injury and meniscus tear in a study of 205 patients ranged from 11 months for injuries to one meniscus and 32 months for injuries to both menisci.33As mentioned before, chondral lesions greatly enhance the likelihood of cartilage degeneration after an ACL rupture. According to most statistics, 20% of chondral lesions happen during the ACL injury, and another 20% to 30% develop later on as a result of ACL shortage.31,34

Restoring full range of motion, especially after a 5°to full extension loss, might be challenging due to arthrofibrosis, a condition caused by joint stiffness, which has been linked to early ACL replacement. A significant proportion of patients who underwent surgery within the first week after their injury experienced a loss of 5o extension (52% vs. 17% for patients operated on between days 8 and 21), according to a comprehensive retrospective investigation. Extension loss did not occur in any of the subjects treated beyond the third week.35There was a correlation between a reduced incidence of joint stiffness in knees that had ACL reconstructions and a post-operative rehabilitation program that included early mobility, full passive extension, and immediate weight-bearing.35,36It is worth noting that ACL reconstructions carried out six months after the original injury also resulted in a loss of extension.37About 8% of kids and teens who had ACLs repaired also developed arthrofibrosis.38Arthrofibrosis has been called into doubt as a clinical entity due to studies that found an exceptionally low incidence when rehabilitation was utilized.31, 35, 40Arthrofibrosis is a real risk, thus orthopaedic surgeons should know not to reconstruct in the weeks following an injury and instead implement a well-thought-out rehabilitation program.

Maintaining muscular strength prior to surgery is crucial for successful reconstruction. Among the most significant indicators of poor clinical success was a 20% pre-operative quadriceps strength loss, which was related with a 15% drop at two years post-operatively.41among addition, the International Knee Documentation Committee (IKDC) functional score was lower (though not statistically significant) and hop test scores were lower (when compared with the contralateral side) among those whose quadriceps strength was less than 85%.42There was a marked improvement in the functional result of the knee for patients with ACL injuries who participated in a rehabilitation exercise program for five weeks.43

Curiously, the timing of ACL reconstruction and the type of autograft can also impact the method for rehabilitation. There is evidence that delays in quadriceps recovery have been associated with early ACL reconstruction. In particular, after two months, 80% of patients who had their ACLs repaired later (on average 40 days) had quadriceps strength of 65%, compared to 53% of patients who had their ACLs repaired earlier (on average 11 days).44Compared to patients whose ACLs were repaired early, 73% of individuals whose reconstructions were delayed (with a mean duration from injury of 40 days) achieved 80% muscle strength at six months.44Autograft harvesting for ACL reconstruction might potentially lead to muscle weakening. When BPTB and HST autografts were employed in ACL reconstructions, there was a tendency for a decrease in

strength in the flexor and extensor muscles, respectively.45Therefore, it appears that a strategically crucial step towards a successful outcome post-ACL reconstruction is carefully planned rehabilitation that is applied both before and after the operation. The goal is to preserve the quadriceps strength and knee range of motion.46

Sort of transplant

The two most commonly-used autografts for ACL reconstruction are the patellar tendon (PT) (also known as a BPTB graft) and the hamstring tendon (HT). The general notion, as indicated by most RCTs and meta-analyses, is that both grafts exhibit excellent results with no differences between them regarding functional outcome and activity level.[47] Strong advocators for each graft type exist, and certain advantages and disadvantages have been suggested in the literature for each graft.

Table 1.

Advantages and disadvantages of most commonly used autografts

	Patellar tendon	**Hamstrings**
Advantages	• Higher strength • Lower re-tear rate • Earlier graft remodeling and healing • Better knee stability	• Smaller incision/better cosmesis • Minor functional impairment from graft harvesting • Earlier regeneration of hamstrings
Disadvantages	• Higher incidence of anterior knee pain and kneeling pain • Increased incidence of OA post-ACL reconstruction • Higher rate knee extension deficit due to adhesions	• Higher incidence of tunnel widening • Electromechanical delay in knee flexors/weakness

Advantages of the patellar tendon graft

Biomechanical data comparing PT graft and HT with native ACL found that PT graft had a maximum load of With a strength of around 57 MPa, which translates to being around 160 to 170% stronger and 150% stiffer than native ACL, and a torque of 2730 N or 2900 N (respectively, depending on whether the middle or center part of BPTB was examined).48On the other hand, the semitendinosus and gracilis tendons, which are part of the HT, were determined to have maximal loads of 1220 N and 840 N, respectively, and stiffnesses of 89 MPa and 112 MPa. These values equate to 70% and 49% of the load and stiffness of native ACL, respectively.48Because the maximal load and stiffness for the semitendinosus and gracilis tendons were both doubled when using numerous stands, it is important to think about the precise technique in relation to the desired result.49To sum up, ACL restoration with either graft is a safe way to try to avoid graft tears because the biomechanical strength and stiffness of the grafts are higher than those of native ACL.28

The reduced re-tear rate observed with the PT graft compared to the hamstring graft is one of its primary benefits. According to a meta-analysis, the failure rate of a PT graft is 1.9%, while the failure rate of an HT transplant is 4.9%.50Another meta-analysis that included only level-I trials corroborated this, finding that PT had a failure rate of 7.2% and HT of 15.8%. While some meta-analyses found a decreased failure rate with HT (2.3% vs. 2.5 percent, RR 0.78, 95% CI 0.41 to 1.5)28, other studies found no significant difference between the groups when it came to failure rate.31,52 out of 28,

It was suggested that graft fixation is also a significant factor in surgical failure as a result of this. It is recommended that the type of fixation be modified based on the graft that is employed.pages 53–57When it comes to PT grafts, interference screws provide the most similarity to native ACL in terms of stiffness and maximal load capacity.56Given the importance of PT graft in promoting graft remodeling and healing, this is of the utmost importance. It has been suggested that PT grafts may experience ligamentization and revascularization quicker, allowing for an earlier return to activity, compared to flexor tendon transplants, based on an animal study that found a higher maximum failure load at three weeks for PT grafts.from 58 to 60Although there is growing interest in biological techniques that could improve graft healing, more study is required to draw firm conclusions regarding their efficacy.pages 61–63

Lastly, PT graft has demonstrated a greater ability to restore knee stability in certain studies. In fact, 73.8% of patients in a meta-analysis showed a KT-1000 arthrometer side-to-side difference of less than 3 mm, compared to 79% in hamstring patients ($p < 0.05$).50A reduced incidence of positive pivot shift was seen in another meta-analysis of 22 trials involving almost 2000 patients (95% CI, 0.53 to 0.93; $p = 0.01$).52A meta-analysis of eight trials including 550 patients found that physical therapy increased the likelihood of returning to the same level of activity as before the accident (OR = 1.48, 95% CI, 1.03 to 2.12; $p = 0.03$).52A similar pattern was observed in a recent long-term RCT with a 15-year follow-up, indicating that a greater proportion of patients who underwent PT graft reconstruction engaged in athletic pursuits ($p = 0.05$). This result agreed with previous studies that found the patellar graft to be more effective in Lachman and pivot shift tests.28,51

Disadvantages of patellar tendon graft

Anterior knee pain and kneeling pain are more common in patients with patellar tendonitis. Relative risk (RR) = 1.71 (95% CI, 1.35 to 2.16; $p < 0.01$) of anterior knee pain was shown to be considerably greater in PT grafts in a recent meta-analysis of 12 studies including data from almost 850 individuals.52Patients undergoing physical therapy also experienced more severe knee discomfort (RR = 2.05, 95% CI, 1.51 to 2.77; $p < 0.01$).52Another meta-analysis found that although 11.5% of those in the hamstrings group experienced anterior knee pain, 17.4% of people in the patellar tendon group did.50Several studies have found that PT graft harvest morbidity includes an increased incidence of anterior knee pain and kneeling pain.51

In addition to the discomfort felt when kneeling, a significant concern with PT grafts is the higher incidence of osteoarthritis (OA) reported in 45% of patients compared to 14% in hamstring grafts ($p = 0.002$).10Patellar graft was linked to an increased risk of radiographic osteoarthritis, as validated in a meta-analysis of trials with follow-ups of more than five years.64In particular, degenerative arthritis was more common in four trials including 290 patients who had patellar tendon grafts. (95% CI, 1.08 to 2.4; $p = 0.02$), with a relative risk of 1.61.64Although not all studies were randomised, there was an increased incidence of meniscus surgery in the patellar tendon group.64The greater laxity observed in the PT group after seven years compared to two-year follow-up may be related to this finding, which has not been verified by other long-term reports28,65,67.10To clarify whether this link exists, further study with long-term follow-up studies is recommended.

Finally, a greater rate of adhesions requiring anesthesia for manipulation was discovered to be connected with patellar grafts.50The high prevalence of extension deficits in individuals undergoing patellar tendon grafts likely contributes to this side effect. In particular, a sub-group of over a thousand patients included in the meta-analysis had a higher risk of patellar tendon patients with an extension deficit more than 3° (1.71, 95% CI 1.25 to 2.33; $p < 0.01$). Not only is there a significant rate of morbidity linked to all of the aforementioned drawbacks, but there is also a risk that high-performance athletes who have undergone PT graft restoration may experience diminished performance and activity levels.49The lower re-tear rate may, therefore, be due to less athletic activity following surgery.

Advantages of hamstring tendon

One major benefit of hamstring tendon grafts is the reduced risk of donor site morbidity during the harvesting process. Although hamstring harvesting is technically difficult, it can be worth it for young female patients because it reduces the size of the incision, which improves the wound's aesthetics. As mentioned earlier, it also

reduces the occurrence of kneeling pain and anterior knee pain greatly.28,50,52 €There is no evidence that the very small complications linked with hamstring graft—such as electromechanical delay in knee flexors and weakness—cause a functional impairment.sixty-eight, 69Curiously, while patellar tendon reconstitution could take longer, hamstring regeneration is typically reported to occur within two years of surgery.number of pages 68–72

Disadvantages of hamstring tendon

It is more common for tunnel widening to occur with hamstring grafts. This went against the initial assumption that there would be less tunnel widening with hamstring transplant since it completely fills the drilled tunnels. More specifically, in comparison to patellar tendon transplant, the tibial tunnel increase was over double (~20% versus ~10% and 25% versus 15% for anteroposterior and lateral views, respectively, p = 0.003 and 0.01, respectively). An animal study shown that the development of tunnel widening is influenced by graft stiffness and graft hypertrophy as a result of remodeling.73Although one study found significantly greater knee laxity in the hamstring group, three randomised controlled trials indicated that patients treated with hamstring graft had a larger percentage of femoral tunnel widening14,47,74.47After one to two years post-operatively, almost 90% of patients were able to avoid tunnel extension by compacting an autologous bone dowel into the tibial tunnel, thereby reducing the cross-sectional area of the tunnel.75

Allograft *versus* autograft

One can choose from patellar, Achilles, or tibialis tendon allografts for reconstructing an ACL. Allografts have a number of benefits, the most important of which are the assurance of sufficient graft tissue, a reduced surgery time, and the absence of donor site morbidity. However, there are a number of concerns regarding allografts, including the potential for delayed integration and immunological response, an increased likelihood of disease transmission, and an increase in cost.

Table 2.

Advantages and disadvantages of allografts

	Allografts
Advantages	• No donor site morbidity • Shorter surgical time • Ensure adequate graft length and diameter
Disadvantages	• Higher failure rate • Higher cost • Worse knee stability measured in some studies • Potential disease transmission and higher infection rate

Advantages of allografts

Given that up to 40% of patients experience anterior knee pain after autografts, the lack of donor site morbidity in allografts is a significant drawback of these transplants.47.76 percentOne meta-analysis compared hamstring allograft to soft-tissue allograft and found that the former required 59 minutes of surgery compared to 77 minutes for autograft (p = 0.008). Furthermore, autograft tissue dimensions may vary in length and diameter, making it unsuitable for some reconstructions.77Allografts are used to solve these problems. Clinical assessment analysis tends to overlook the significance of these factors, but they must all be taken into account. Donor morbidity, for example, can have a negative impact on patient subjective outcomes and the doctor-patient relationship, while shorter surgical times usually mean that surgeons can repair more ACLs per day.

Allografts' Drawbacks

Allografts continue to have a higher failure rate than expected. The failure rate of ACL restorations with allografts was shown to be up to four times higher than those utilizing autografts, according to a prospective cohort design.78The re-rupture rate was shown to be three times higher after allograft in a meta-analysis included over 5,000 individuals who had patellar tendon allograft/autograft. The risk of re-rupture was higher for PT allografts than for PT autografts, according to a meta-analysis that included over 500 patients (OR = 5.03, p = 0.01). Autograft had a reduced risk of clinical failure (RR, 0.47; p = 0.0007), according to a recent meta-analysis that included nine randomized controlled trials and 10 systematic reviews.79There was no difference in the rates of clinical failure and re-operation between allografts and autografts in two separate meta-analyses.80,81 It is worth noting that this difference was eliminated when grafts that had been treated with chemicals or irradiation were not included,82 indicating that these factors play a crucial role in the failure of grafts. When comparing BPTB non-irradiated allograft with autograft, the graft failure rates were 8.8% and 6.1%, respectively, when examined independently.No. 83To settle the current disputes between allografts and autografts, more randomised controlled trials are necessary, even though the tendency points to autograft having greater performance.

There is a great deal of debate in the literature concerning knee stability. There was a larger percentage of unstable knee measures related with allografts (14% vs. 5.3% respectively) compared to autografts.84The percentage of patients with a side-to-side difference less than 3 mm for autograft was 75.3% and for allograft it was 60.2%, according to a meta-analysis of 38 studies that incorporated data for over 2500 patients.85 It is worth noting that autograft also had better functional outcomes, with better Lachman test and Tegner score.79A meta-analysis of hamstring autograft versus soft-tissue allograft showed a modest favoritism for allograft for KT arthrometer laxity < 3 mm (RR = 1.1, 95% CI 0.89 to 1.39), and Lachman negative (RR = 1.37, 95% CI 0.88 to 2.14) (81). On the other hand, other publications did not find any change. Furthermore, there was no discernible difference when 650 patients were pooled from six trials to form a meta-analysis (RR = 1.19, CI 95% 0.63 to 2.24; p = 0.59, preferring allograft).80

There is a higher infection rate and higher expenditures related with ACL transplant. The PT allograft was found to be statistically more expensive than the PT autograft, with a total mean cost per case of $4147 compared to $3154 (p < 0.001).86The allograft was shown to be roughly $1,000 more expensive than the hamstring autograft (US$5195 vs. US$4072, p < 0.001) in another study that compared the two procedures.No. 87Nevertheless, there are findings that indicate the likelihood of overnight hospitalization due to autograft donor site morbidity and greater surgical time could lead to an increase in the cost of hospital stays.No. 87Allografts were shown to be the more expensive alternative in a cost-effectiveness analysis.88There is a higher documented risk of infection with allografts, which should be considered while calculating cost.89There was no elevated risk of infection with transplanted tissue, however, in other studies that found the opposite.88,90 percent

IDEAL position characteristics

For the ACL graft to last as long as possible, it must be positioned correctly. Roof impingement was linked to ACL graft malposition, such as anterior tibial tunnel implantation.91It was quickly recognized that roof impingement of the repaired ACL graft is a major cause of graft failure.pages 91–94Additionally, after two-year follow-up, the likelihood of ACL graft failure was 100% in cases of severe impingement and 29% in cases of moderate impingement.91Hence, it is logical to assume that the ACL graft should be carefully placed to prevent any possibility of malposition.

Over the past few decades, researchers have studied the native ACL in great detail in an effort to replicate its anatomical features during ACL restoration, after realizing how crucial it is to position the graft correctly. Although the tibial and femoral osseous attachments of the ACL have often taken on an oval and crescent-like shape, respectively, there have been suggestions of possible variances in their shape based on extensive research.95,96Operative techniques such total footprint restoration—the painstaking positioning of the ACL

graft within the tibial and femoral footprints—were born out of the attachments' anatomical features and the need to avoid impingement.97

A double-bundle graft was suggested as a way to mimic the natural ACL's anteromedial and posterolateral bundles, in keeping with the same idea of osseous attachment-based ACL repair.98.99 percentThe biomechanical results indicated improved rotational knee stability; however, this method failed to provide clinical confirmation of these findings.a hundredKnee extension also poses the risk of early graft rupture or attenuation because to the high tension at the PL bundle.101Reconstruction with two bundles is uncommon at the moment.between 5,102 and 2,104

A growing body of research is focusing on the anatomy and form of the ACL mid-substance, in addition to the attachments. In particular, it was noted that the ACL's mid-substance cross-sectional area is smaller than its attachments'.105Along its length, the ACL resembles a band; however, near its tibial attachment, it expands like a trumpet to secure itself to the tibia.106Given that the posterior cruciate ligament takes up the majority of the notch's space, leaving only a 5-mm opening for the ACL graft, it is critical to acknowledge the surgical consequences arising from these findings.106Thus, in order to try to include the aforementioned anatomical, histological, isometric, and biomechanical characteristics into the decisions made during ACL repair, a more intricate procedure is required for ACL graft placement.

In order to summarize the key aspects of the ACL femoral tunnel position, recent guidelines have been outlined using the acronym IDEAL: The many patterns that occur throughout a whole cycle of knee motion are I-isometric, D-direct, E-eccentric, A-anatomical, and L-low tension/flexion.

While the knee bends and straightens, not every ACL fiber is taut during the whole range of motion.around 107,108This is because the AM bundle becomes loose (elongated) and the PL bundle becomes tight (shortened) when the knee bends, as a result of the length changes that occur during flexion.The number 108,109. According to popular belief, the AM bundle acts more like an isometric model since it is the ACL's center of rotation.109The most anterior and superior (proximal) part of the femoral footprint, at the confluence of the anteromedial and intermediate bundles, is the location that isometric tests have shown to be the most promising for ensuring isometry. 11,0, 10,8It was shown that this configuration may guarantee the replication of the native ACL's regular tension-flexion behavior.5

There are two types of collagen fibers at the femoral attachment: the direct fibers attached directly to the anterior part of the osseous ACL insertion along the lateral intercondylar ridge, and the indirect fibers attached to the posterior part of the ACL footprint; the latter are less dense and do not have the typical four-layered structure of the ligamentous-bone attachment.96It is recommended to position the femoral tunnel at the site of direct fiber insertion since, according to histological characteristics, indirect fibers are a weaker mechanical link than direct ones.

5,96Hence, the ideal location for the femoral tunnel is one that 1) is isometric, 2) is inside the footprint to prevent impingement, 3) returns the ACL pattern to its low flexion extension state, and 4) is at the site of direct fiber input.

Graft life depends on preventing impingement, as mentioned above. The likelihood of impingement increases and the likelihood of graft failure increases when it is positioned outside the anatomical limits of the footprints. Impingement of the posterior cruciate ligament (PCL) and roof impingement are two distinct conditions that call for distinct approaches to treatment. To avoid roof impingement, put the knee in its most passive hyperextended posture and ensure that the tibial tunnel entry is immediately behind the intercondylar roof. As a clinical issue, roof impingement manifests in extension and can lead to either a decrease in extension or an increase in laxity. The ACL graft rests above the PCL graft during knee flexion, which causes PCL impingement. To fix this, the surgeon needs to make sure the PCL's medial border is at least three triangles away from the graft's lateral edge. Post-110° knee flexion, the PCL impingement phenomena cannot occur if there is sufficient room. To minimize the danger of roof and PCL impingement and to guarantee proper location of the graft, it is recommended to place it inside the natural ACL footprints. In order to reduce graft stress, it

was discovered that situating the femoral tunnel at 60° in the coronal plane could help prevent the ACL graft from pressing on the PCL during terminal flexion.112If this is to be the case, the graft must be spaced such that the PCL and the lower margin of the femoral condyle notch are equally apart.

Lastly, a key feature linked to a high rate of ACL graft survival is minimizing the graft's exposure to high loading during knee flexion and extension. There is evidence that a posteriorly implanted graft undergoes significant loading forces during extension.101Also, a lot of stress in extension might result from graft placement low on the femoral condyle edge. The increased revision rate observed in registry data with the AM portal technique compared to the transtibial procedure can be explained by this.113Force patterns similar to the natural ACL were observed in anterior translation and internal torque application when the graft was positioned anteriorly.101So, to avoid subjecting the graft to forces that could surpass its strength and lead to its failure, it should be positioned in an area of low tension.

Every patient experiences the setback of an anterior cruciate ligament tear; proper therapy is critical for a speedy recovery and the avoidance of issues related to the knee injury in the long run. There have been a number of debates surrounding ACL reconstruction, but with to methodical study, we now know the answers to many crucial concerns. Restoring the patient's activity level to how it was before the injury seems to be the goal of surgical care of an ACL tear. For a successful result, the timing of the rehabilitation and restoration processes is crucial. It is crucial to carefully choose the graft for each patient because each type of graft has its own set of benefits and drawbacks. The proper placement of the graft and a positive clinical result depend on the surgical approach adhering to the fundamental principles of the anterior cruciate ligament (ACL) biomechanics and anatomy.

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