



Evolution of Lateral Extra-Articular Tenodesis: Current Perspectives in Primary Anterior Cruciate Ligament Surgery

Evolución de la tenodesis extraarticular lateral: Perspectivas actuales en cirugía primaria de ligamento cruzado anterior

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Abstract

Introduction Surgical reconstruction is the gold standard treatment for anterior cruciate ligament (ACL) rupture, aiming to restore normal anatomy, re-establish knee stability, and prevent the development of both meniscal and cartilage pathologies. This surgery has a graft re-rupture failure rate of up to 6-10%, which is why various associated techniques have been described over the last decade to reduce this failure rate. Lateral extra-articular tenodesis (LEAT) is a surgical procedure associated with ACLR, which has been reported to significantly decrease failure rates following primary anterior cruciate ligament (ACL) reconstruction.

Objectives To describe the trend and factors associated with the use of extra-articular tenodesis in ACL reconstruction surgery over the last 5 years in a high-volume national clinical center.

Methods Retrospective cohort study. An anonymized database consisting of all primary ACL surgeries performed between 2018 and 2023 at our institution was studied. Patients older than 14 years who underwent primary ACL surgery were included, and those who underwent revision surgeries, patients with multi-ligament injuries, or associated fractures were excluded. Descriptive statistics were performed for the variables age, sex, type of graft used, and LEAT performed during surgery. The Prais-Winsten test was used for trend analysis. The Chi-square test was used to analyze

Keywords

- ▶ reconstruction
- ▶ anterior cruciate ligament
- ▶ lateral extra-articular tenodesis
- ▶ failure

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the association between sex, type of graft, year, and LEAT. A logistic regression model was constructed with the obtained information.

Results A total of 922 patients were analyzed, with a mean age of 30.2 years, 687 of whom were male (74.6%). The most used graft in the sample was hamstring tendons (75.1%). During the study period, LEAT was performed in 14.21% of the participants. The yearly percentage indications were 5%, 8%, 10%, 27%, 17%, and 30% for the period 2018-2023, respectively. The Prais-Winsten test with $p < 0.05$ showed a significant increase in the use of LEAT over the years. A significant association was found between younger age and LEAT ($p < 0.01$). No significant association was found between sex and LEAT ($p = 0.360$), nor between the type of graft and LEAT ($p = 0.235$).

Conclusions In our setting, there is a significant upward trend in the use of LEAT in patients undergoing primary ACL reconstruction surgery. Patients undergoing LEAT are significantly younger, more hyperlax, and participate in contact sports.

Resumen

Introducción La reconstrucción quirúrgica es el estándar de oro en el tratamiento de rotura de ligamento cruzado anterior (LCA) y tiene como objetivo restablecer la anatomía normal, restaurar la estabilidad de la rodilla, y prevenir el desarrollo tanto de patologías meniscales como las de cartílago. Esta cirugía cuenta con una tasa de fallo por re-rotura del injerto de hasta un 6-10%, razón por la que en la última década se han descrito diversas técnicas asociadas para disminuir dicha tasa de fracaso. La tenodesis extraarticular lateral (TEA) es un procedimiento quirúrgico asociado a la RLCA con el que se ha reportado una disminución de importante en las tasas de fracaso posterior a una reconstrucción primaria de LCA.

Objetivos Describir la tendencia y factores asociados a la utilización de tenodesis extraarticular en cirugía de RLCA durante los últimos 5 años en un centro clínico nacional de alto volumen.

Métodos Estudio de cohorte retrospectivo. Se estudió una base de datos anonimizada consistente de todas las cirugías primarias de LCA realizadas entre el 2018 y el 2023 en nuestra institución. Se incluyeron pacientes mayores de 14 años sometidos a cirugía primaria de LCA, y se excluyeron aquellos sometidos a cirugías de revisión, pacientes con lesiones multiligamentarias, o con fracturas asociadas. Se realizó estadística descriptiva para las variables edad, sexo, tipo de injerto utilizado, y realización de TEA durante la cirugía. Para el análisis de tendencia se utilizó la prueba de Prais-Winsten. Para el análisis de asociación entre sexo, tipo de injerto, año y TEA, se utilizó prueba de Chi2. Se construyó un modelo de regresión logística con la información obtenida.

Resultados Se analizaron 922 pacientes con una media de edad de 30.2 años, 687 de sexo masculino (74.6%). El injerto más utilizado en la muestra fue el de tendones isquiotibiales (75.1%). En el periodo estudiado, se realizó una TEA en un 14.21% de los participantes. Los resultados porcentuales de indicación por año fueron 5%, 8%, 10%, 27%, 17%, 30% en el periodo 2018-2023, respectivamente. La prueba de Prais-Winsten con $p < 0.05$ mostró un aumento significativo en la utilización de la TEA a lo largo de los años. Se encontró una asociación significativa entre una menor edad y TEA ($p < 0.01$). No se encontró una asociación significativa entre el sexo y TEA ($p = 0.360$), ni entre el tipo de injerto y TEA ($p = 0.235$).

Conclusiones En nuestro medio, existe una tendencia importante al alza de la utilización de TEA en pacientes sometidos a cirugía primaria de RLCA. Los pacientes sometidos a TEA son significativamente más jóvenes, hiperlaxos y practican deportes de contacto.

Palabras clave

- ▶ reconstrucción
- ▶ ligamento cruzado anterior
- ▶ tenodesis extraarticular lateral
- ▶ falla

Introduction

Anterior cruciate ligament (ACL) injuries are high-frequency events with a reported overall incidence of 68.6 cases per 100,000 people per year.¹ The ACL plays a critical role in the mechanical stability of the knee. In situations where this noble ligament experiences a complete rupture of its fibers, it is usually recommended to perform a surgical reconstruction with the aim of restoring the stability of the joint, preventing secondary injuries to the meniscus, articular cartilage, and reducing the development of knee osteoarthritis.^{2,3}

ACL reconstruction surgery has made significant advances in recent decades,⁴ and although the results of ACL reconstruction with modern surgical techniques are extremely positive, 90% of patients report normal or near-normal knee function, 82% successfully return to sports, 63% regain their pre-injury level of participation, and 44% return to competitive sports, the development of the technique is far from perfect. To this day, specific groups of patients report high rates of graft rupture.^{5,6}

Due to the ever-growing need to improve clinical results and reduce surgical failure rates, a scenario of interest has been configured for the implementation of new techniques during ACLR.⁷ One of the most notable developments in this field has been in relation to the understanding of the anterolateral complex of the knee, a field in which multiple extra-articular surgical techniques have been described with the intention of providing better rotational stability to our ACLR.⁸⁻¹⁰

Lateral extra-articular tenodesis (LEAT) was initially described in the 1960s and 1970s as an isolated procedure aimed at controlling anterolateral rotational laxity in knees with ACL deficiency, in a period when intra-articular ACLRs were not performed.¹⁰ After having been partially abandoned, with the advent of intra-articular reconstructions, this technique regained prominence, especially in the group of young, athletically demanding patients, who have exponentially higher risks of post-ACLR failure.¹⁰

To date, multiple configurations have been described for this anterolateral reinforcement, one of the most used being the modified Lemaire technique, in which the central third of the iliotibial band is harvested with a length of approximately 8 - 10 centimeters, then passed under the lateral collateral ligament and is attached proximal and posterior to the lateral epicondyle.¹¹

The advantages of the LEAT have attracted the attention of the global community of orthopedic surgeons, with growing curiosity about the possible clinical applications, highlighting the aforementioned work of the STABILITY group, who found that by adding a LEAT in primary reconstructions with semitendinosus gracilis-autograft in patients younger than 25 years, there was a relative risk reduction for graft rupture of 0.67 (95% CI, 0.36-0.83; $P < 0.001$), with a number needed to treat to prevent a re-rupture at two years of 14.3 patients.¹²

Despite the advantages reported with the implementation of this technique, the frequency and magnitude of its application are not adequately described in the literature, and this knowledge gap deepens even further in our Latin American environment. We know that the balance has been tipping towards its indication frequently, but we do not know how big this change has been in the primary ACLR algorithm.

Having said the above, the present work aims to address this gap, focusing on the trend and frequency of LEAT indication in primary RLCA and how this procedure has been gaining space during the last 5 years in our institution.

Materials and methods

The institution's ethics committee approved the registration and use of clinical scores and demographic information in a prospective longitudinal database (REDCap, Vanderbilt University). Patients signed an informed consent during pre-surgical evaluations for the potential use of their information in an anonymized manner in future reports and retrospective studies.

The database was analyzed to identify those patients who underwent primary ACL reconstruction surgery between 2018 and 2023. Cases of patients over 14 years of age who underwent primary ACL reconstruction surgery were included. All patients undergoing revision surgeries, multiligamentous injuries, and those with associated fractures were excluded.

The technique used as LEAT was the modified Lemaire technique (→ Fig. 1), which consists of passing the central third of the iliotibial band under the lateral collateral ligament, to then be fixed posteriorly and cephalad to the lateral epicondyle.

The general indications used as a working group for recommending LEAT in primary ACL reconstructions are patients under 25 years old, hyperlax patients, those participating in pivoting sports such as soccer or skiing, high-performance athletes, and those with a high-grade pivot shift test (≥ 2).

Descriptive statistics were performed for variables including age, sex, graft type, and the performance of LEAT during surgery. The Prais-Winsten test was used to analyze the trend of the procedure over time. For the bivariate analysis of the association between sex, graft type, year, and LEAT, the Chi-square test was applied.² For the bivariate analysis between age and LEAT, the Student "t" test was used. With the information obtained, a multiple logistic regression model was built. Statistical significance was established with $p < 0.05$ and $\alpha = 5\%$. STATA statistical software version 17.0 (StataCorp, TX) was used.

Results

922 patients who met both the inclusion and exclusion criteria were included, of which 235 (25.4%) were women and 687 (74.6%) men with a mean age of 30.2 years. 48% of

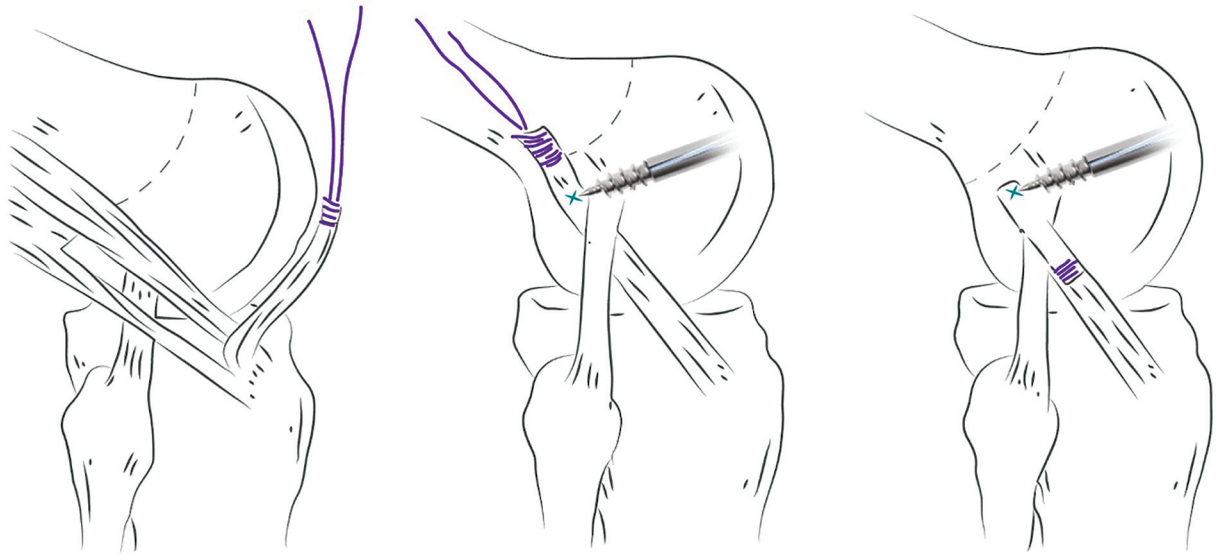


Fig. 1 Scheme illustrating the modified Lemaire technique, the central third of the iliotibial band is harvested, then passed under the lateral collateral ligament and fixed posteriorly and proximally to the lateral epicondyle with an anchor.

the patients presented a pivot shift of at least second degree, within the other 52% who presented a low-grade pivot shift test, the indication was related to the age of the patients, laxity, and sports activities performed.

Of the total sample size, 14.21% of patients underwent LEAT in the context of primary ACLR, while 85.79% did not perform any lateral extra-articular gesture. The frequency of this indication varied annually, initially being 4% in 2018, to finally reach a maximum of 29.3% during 2023 (► **Fig. 2**). Regarding the type of graft, hamstring autograft was used mostly in 692 cases (75.05%), autologous bone-tendon-bone graft in 209 cases (22.56%) and allograft in 21 cases (2.28%).

In the bivariate analysis, a significant difference was found according to age and LEAT performance ($p < 0.001$) (► **Fig. 3**), on the other hand, no significant association was found between sex and LEAT indication ($p = 0.36$). The association between the type of graft used and performance of LEAT was significant ($p = 0.004$), being mostly indicated in the context of reconstructions with bone tendon bone (BTB) graft.

In the multiple logistic regression model, only age showed a significant association with LEAT, with a decrease of 8.8% in the indication per incremental point ($p < 0.001$).

According to the Prais-Winsten test, there is an upward trend in the indication of LEAT in the period studied with an

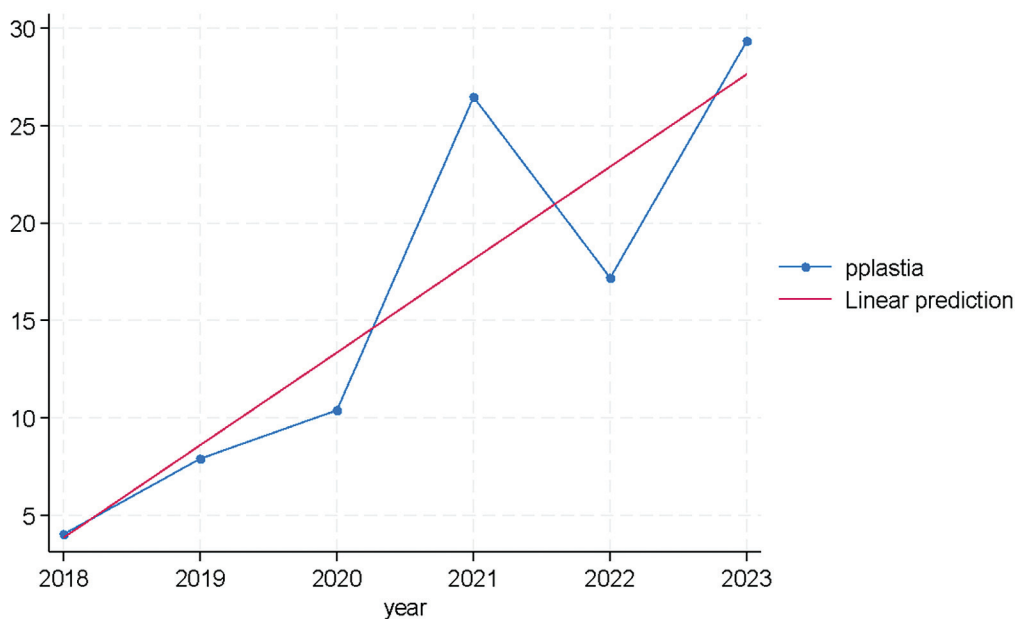


Fig. 2 Graph illustrating the trend of indication for lateral extra-articular plasty in patients undergoing first ACL reconstruction. The breakdown is made year by year, and linear growth is observed, whereas in the last year (2023) there is almost a 30% indication of the procedure in question.

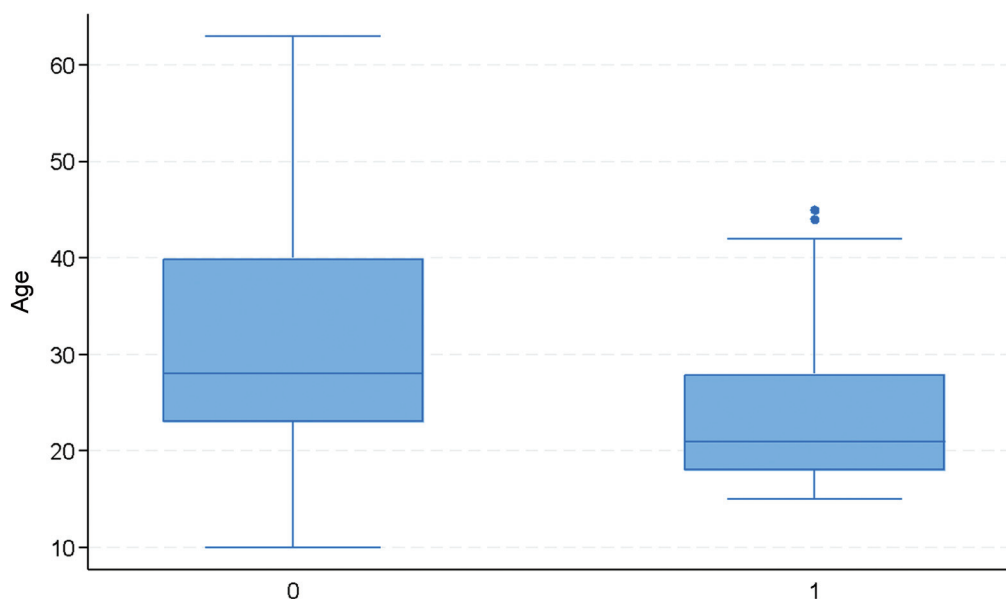


Fig. 3 Graph where we can see that the indication for LEAT occurs more frequently in young patients, with a statistically significant relationship in its indication ($P < 0.001$). On the ordinate axis we find the age, and on the abscissa, the number “1” represents the addition of LEAT.

annual growth of 4.75%; This data being statistically significant ($p = 0.02$).

Discussion

Evolution of the indication

The results presented in this study provide an illuminating view on the trend of increase in the indication for LEAT in primary LCAR surgeries, the most relevant element being the surprising growth rate of 4.75% per year.

The Latin American consensus published in 2022 by Barahona et al. showed that experienced knee surgeons indicate, on average, a lateral gesture in 24% of their primary LCAR,¹³ a number quite similar to the average obtained from the last two years (2022–2023) evaluated in our study (26.4%).

Initially, lateral procedures were indicated mainly in the context of ACL revisions and patients with a pivot shift test ≥ 2 , later including hypermobile patients and those who practiced sports involving pivot shifts such as soccer or basketball. Among the evidence that supports this procedure, a work consisting of ACL revisions with high-grade knee laxity (Pivot shift of ≥ 2 or a side-to-side difference greater than 6 mm) stands out, in which Alm et al reported that The addition of LEAT led to a decrease in failure rates from 21% to 5% ($p = 0.045$) when a lateral gesture was added, as well as an increase in postoperative functional scores.¹⁴

Recent cadaveric studies have given great importance to the addition of this lateral extra-articular gesture, demonstrating that adding a LEAT results in an anterior tibial translation and tibiofemoral kinematics closer to the native one, compared to isolated ACL reconstruction.^{15,16}

Over time, these lateral procedures have gained popularity, becoming more easily indicated, due to the clinical

benefits that have been demonstrated in multiple studies in recent years.

Changes in the trend

In this study, we found a significant increase in the indication of LEAT from 2018 to 2023, evolving from a relatively uncommon procedure to being performed in approximately one-third of primary reconstruction surgeries. This finding is of particular interest as it reflects a shift in the management of patients with ACL injuries, emphasizing the addition of new techniques to achieve better clinical outcomes. A possible explanation for this trend is the growing recognition of the importance of rotational and anterolateral stability in anterior cruciate ligament reconstruction.

We conducted a focused analysis of 2022 and 2023, the years in which the high trend of LEAT indication was sustained. Notably, LEAT was more frequently performed in cases using BPTB grafts: in 2022, 37.11% of patients operated with this graft underwent LEAT, compared to 12% of patients operated with hamstring grafts. In 2023, these figures were 42.86% for bone-patellar tendon-bone (BPTB) grafts versus 25% for hamstrings. Based on our experience, this finding may relate to the higher use of BPTB grafts in athletes at our center, particularly those practicing pivoting sports such as soccer, basketball, or skiing.

Another potential advantage of adding LEAT is highlighted by Lars Engebretsen's group, who reported a 43% reduction in forces exerted on the ACL graft when a lateral procedure is included, thereby reducing the risk of re-rupture.¹⁷

In relation to the technique used, it was created as an alternative approach in the effort to improve the rotational stability of ACL reconstruction. There are different types of modified LEAT.¹⁸ In our case, the technique we use is a modification of the one initially described by Lemaire in

the 1960s,¹¹ which consists of passing a central third of the iliotibial band, approximately 8 centimeters long by 1 centimeter wide, under the lateral collateral ligament, and then fix it posteriorly and proximally to the lateral epicondyle, in most cases with a 5.0 millimeter anchor with an orientation of 20° anteriorly and with a flexion of 30° knee, with neutral rotation, thereby avoiding possible over-constrictions and convergence of tunnels.

The relationship between the age of the patients and the indication for LEAT is also noteworthy. The data reveal that the probability of undergoing surgery decreases as the age of the patients increases. This suggests that TEA is considered more relevant and beneficial in younger patients (generally under 25 years of age, but this remains a debatable factor), which could be associated with sports practices or a certain laxity typical of early ages. Young ages have always been associated with a higher risk of failure in ACLR; the MOON group reported that the risk of rerupture increased by 9% for each year that the age of the subjects in their study decreased¹⁹. Furthermore, Schulemberg et al. demonstrated that patients under 25 years of age had a six-fold higher risk of ACL re-rupture than patients over 25 years of age²⁰. The average age of our sample was 23.7 years, a number that is within the parameters published in the current literature. Furthermore, the average age of patients who were indicated for LEAT was significantly younger than that of those who were not indicated for plasty (23.7 years versus 31.3 years), further supporting this observation. This difference in age could be related to the functional demand of the joint and the need for greater stability in younger, more active patients.

The choice of graft type is also an important aspect of the study. Hamstring tendon autograft stood out as the most common, used in approximately 75% of cases. This suggests that at least in our center it continues to be a preferred option in clinical practice, a trend that we believe could change in the future given the importance that the use of BTB autograft has regained. At the local level, there is a study by Dr. Tuca from 2020, where 103 Chilean knee surgeons were surveyed, highlighting 70% preference for the use of hamstring autograft in primary ACLR, and 27% by bone tendon bone autograft.²¹ In this study, from a few years ago, another particular fact stands out: only 7% of surgeons indicated a lateral procedure in primary reconstructions, which is similar to the percentages reported by us in 2018 where we found close to 4% of primary indications of ACL.

The annual growth trend in the indication for plasty is one of the most important findings, highlighting the evolution of clinical practice in this field. The 4.75% annual increase suggests that LEAT is becoming increasingly relevant in primary reconstruction surgery. It can be speculated that by 2027, we will be recommending LEAT procedures in approximately 50% of our primary reconstruction surgeries. Therefore, as a group, we suggest that new orthopedic surgeons start familiarizing themselves with this technique, which in most cases adds no more than 20 minutes to surgical time.

Finally, as a group, we would like to recommend considering the application of LEAT in patients under 25 years old,

ACL revisions, hyperlax patients, pivoting athletes, high-performance athletes, and patients with an explosive pivot shift (≥ 2).

Conclusion

The results of this study indicate a significant change in clinical practice related to the indication of LEAT in primary reconstruction surgeries. The trend towards greater use of anterolateral plasty, especially in younger patients and in combination with bone tendon bone autograft, suggests a response to the functional and sporting demands of patients. These findings are relevant to orthopedic surgeons and may influence decision-making when planning primary reconstruction surgeries in the future.

Ethical considerations

This work has approval from the ethics committee of Clínica Alemana, and all patients signed their respective informed consent.

Funding

There is no type of funding to carry out this study.

Conflicts of interest

None.

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