

Sport as a conditioning factor in the choice of the plasty to reconstruct the anterior cruciate ligament. Epidemiological survey and analysis of the current situation

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Summary

Objective: To know the surgeon's decision making on the choice of graft in anterior cruciate ligament (ACL) reconstruction surgery according to the sport practiced by the patient.

Material and method: An online survey was conducted through the Spanish Society of Sports Traumatology (SETRADE) and the European Society for Sports Traumatology, Knee Surgery and Arthroscopy (ESSKA). A descriptive analysis of the sample was performed, and an analysis of the main reason for the choice of plasty was carried out stratifying the sample into different groups.

Results: 83 surgeons responded to the survey, 71 members of SETRADE and 12 of ESSKA. The mean number of ACL reconstruction performed per year per respondent was 56 (1-220). For 86.7% of the respondents, sport influenced the decision on the type of graft to be used, the main reason being the biomechanical properties of the plasty (49.4%). The mean agreement in the type of graft to be used in each sport studied was 58.29% (71.1%-38.6%). The highest concordance in the plasty of choice occurred in cycling, with respondents using hamstrings in 71.1% of cases. The sports with the least concordance were wrestling and skiing. There were no statistically significant differences in the reason for choosing plasty.

Conclusions: The survey was conducted by a significant number of surgeons with experience in ACL surgery, with biomechanical properties being the main reason for choosing which graft to use. Most of them were influenced in this decision by the type of sport practiced. The authors recommend the handling of at least 2 plasties for primary ACL reconstructions and to individualize each case considering the type of sport in the selection of the graft.

Key words:

Anterior cruciate ligament.
Reconstruction. Graft selection.
Sport. Survey.

El deporte como condicionante en la elección del tipo de plastia en la reconstrucción del ligamento cruzado anterior. Encuesta epidemiológica y análisis de la situación actual

Resumen

Objetivos: Conocer la toma de decisiones del cirujano en la elección de la plastia en la cirugía de reconstrucción del ligamento cruzado anterior (LCA) en función al deporte practicado por el paciente.

Material y método: Se realizó una encuesta online, dirigida a través de la Sociedad Española de Traumatología del Deporte (SETRADE) y la European Society for Sports Traumatology, Knee Surgery and Arthroscopy (ESSKA). Se realizó un análisis descriptivo de la muestra, y un análisis del motivo principal de la elección de la plastia estratificando la muestra en distintos grupos.

Resultados: 83 cirujanos respondieron la encuesta, 71 miembros de SETRADE y 12 de ESSKA. La media de plastias realizadas al año por cada encuestado fue de 56 (1-220). Para el 86,7% de los encuestados el deporte influyó a la hora de tomar la decisión del tipo de injerto a utilizar, siendo la principal razón las propiedades biomecánicas de la plastia (49,4%). La coincidencia media en la plastia utilizar en cada deporte estudiado fue del 58,29% (71,1%-38,6%). Las mayores concordancias en la plastia de elección se produjeron en ciclismo, utilizando los encuestados isquiotibiales en el 71,1% de los casos. Los deportes con menos concordancia fueron la lucha y el esquí. No hubo diferencias estadísticamente significativas en la razón para elegir la plastia.

Conclusiones: La encuesta fue realizada por un número significativo de cirujanos con experiencia en plastias del LCA, siendo las propiedades biomecánicas el principal motivo a la hora de elegir el injerto a utilizar. A la mayor parte de ellos les influyó el tipo de deporte practicado en esta decisión. Los autores recomendamos el dominio de al menos 2 plastias para las reconstrucciones primarias del LCA e individualizar cada caso considerando el tipo de deporte en la selección del injerto.

Palabras clave:

Ligamento cruzado anterior.
Reconstrucción. Selección de injerto.
Deporte. Encuesta.

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Introduction

The anterior cruciate ligament (ACL) injury of the knee is currently one of the most limiting pathologies for athletes¹. The instability that it causes in the knee means that sport is out of the question in most cases and so it requires reconstruction surgery with a tissue graft to replace it.

The type of reconstruction has varied over the last century. Firstly, attempts were made to repair the ACL, although this was not particularly successful, so this is now not recommended for athletes². Nevertheless, some work groups are currently performing repair techniques with comparable results to reconstruction techniques³. Even so, reconstruction is the most recommended treatment among elite athletes nowadays.

Different types of grafts are available to replace ACL. Within these types, there are different classes of grafts and multiple factors to consider when choosing one or the other: the type of sport, the patient's sporting level and job, their availability, the presence of multiple injuries, the presence of previous surgeries, the surgeon's philosophy and experience, patient preference, aesthetics and economic means^{4,5}. The main issues of these grafts initially revolve around the donor zone, the area where they are extracted, where residual pain is the most frequent⁶.

The success of this ACL surgery is based on the capacity to get patients back playing sport and to work by recovering the sporting or working level prior to their injury.

The general objective of the study is to reveal specific indications for each graft in our medium when choosing the plasty for primary reconstruction of ACL in older professional athletes depending on the sport the patients play, the reasons for this choice and observe whether our results match the recommendations obtained in the bibliography which was consulted.

Material and method

An online, anonymous, unpublished survey was carried out, comprising 5 questions: 3 open questions and 2 multiple choice questions (Annex 1). The survey was sent out via the *Sociedad Española de Traumatología del Deporte* (SETRADE) (Spanish Sports Traumatology Society) and the European Society for Sports Traumatology, Knee Surgery and Arthroscopy (ESSKA) to all Spanish and European orthopaedic surgeons who perform ACL reconstruction as part of their usual clinical practice.

All the questions refer to the context of a mature professional athlete who has completely torn their ACL with no previous history, injuries or surgeries.

Firstly, information was compiled on the quantity of ACL reconstruction surgeries that they carried out every year, the number and type of plasties that they had mastered for this reconstruction, choosing from among the most frequently used (BTB autograft, hamstring, QT, allograft, ACL reconstruction + extra-articular plasty or other), where it was possible to pick more than one option.

Subsequently, they were asked for the surgeon's main reason when choosing the plasty to be used (complications in the donor zone,

greater plasty stability/rigidity, faster osteointegration, biomechanical properties, re-tear rate, etc.) and if they consider the patient's sport when picking one plasty over another.

Finally, various scenarios were raised to see how the chosen graft preferences changed according to the sport and the level of activity and functional needs of the patient: the participants were asked to pick one type of graft for each scenario and the results were analysed.

All the data obtained were recorded in a database designed for this study.

A descriptive analysis was made for the sample. The "reason for choice of plasty" variable was analysed by stratifying the sample into different groups, analysing them separately: surgeons that carried out more than or less than 40 plasties a year, surgeons who belong to SETRADE and ESSKA and any influenced by the sport when choosing one plasty over another.

Statistical analysis

The statistical analysis used the SPSS computer program, version 18.0 (SPSS Inc., Chicago, USA). The Kolmogorov-Smirnov test was used to determine whether the data fitted the normal distribution. The quantitative variables are presented as means and standard deviation and the qualitative variables as percentages. To compare the characteristics between the groups, 2x2 tables were constructed for the categoric variables. For the qualitative variables, the chi square test was used with Yates's correction depending on the Mantel-Haenszel parametric.

Results

The survey was answered by 83 surgeons (n=83) who are members of SETRADE (n=71) and ESSKA (n=12).

The mean number of plasties performed per year for each survey respondent was 55.93 (1-220 range typical deviation 47.82) and the median was 40. In this range, the 25th percentile was 20, the 50th percentile was 40 and the 75th percentile was 100. 26.5% of survey respondents performed more than 100 ACL reconstruction surgeries a year.

89.1% (n=74) mastered at least 2 plasties when performing this surgery. From the total, 60 of them (72.2%) were familiar with the BTB graft technique and 75 (90%) mastered the STG technique. Only 21 surgeons were aware of the QT tendon technique (25.3%) while 55 (66.2%) were able to use the allograft technique. The extra-articular plasty was used by 50.6% of the responding surgeons (n=42) (Figure 1).

For 86.7% of the survey respondents, the sport influences the decision on the type of graft to be used, where the main reason is the biomechanical properties of the plasty (49.4%), followed by complications in the donor zone (19.3%) and thirdly, the type of sport that the patient plays (12%) (Figure 2).

When different scenarios were suggested, their graft choices varied as follows: More detailed information is available in Table 1:

Figure 1. Knowledge of the plasties by the survey respondents.

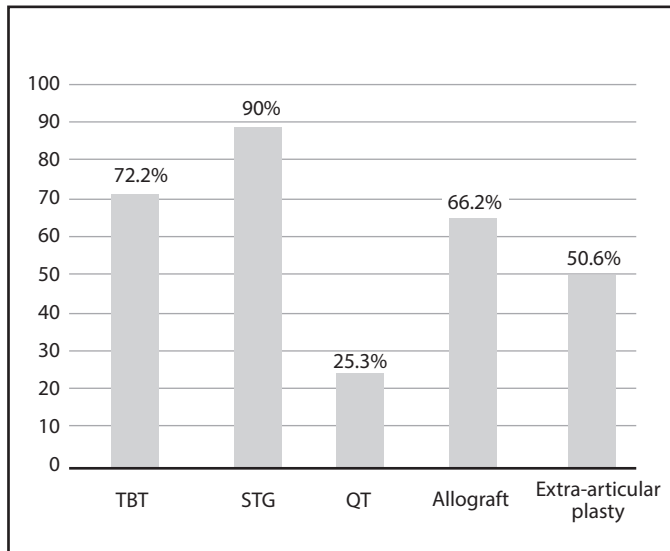


Figure 2. Reasons for choosing the plasty.

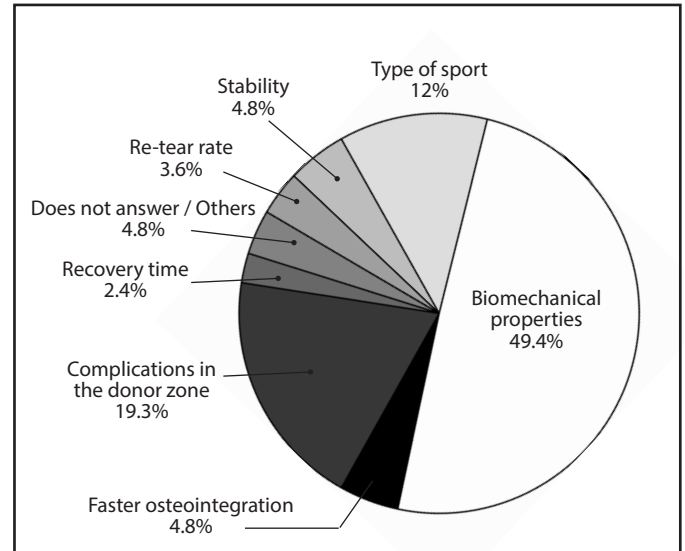
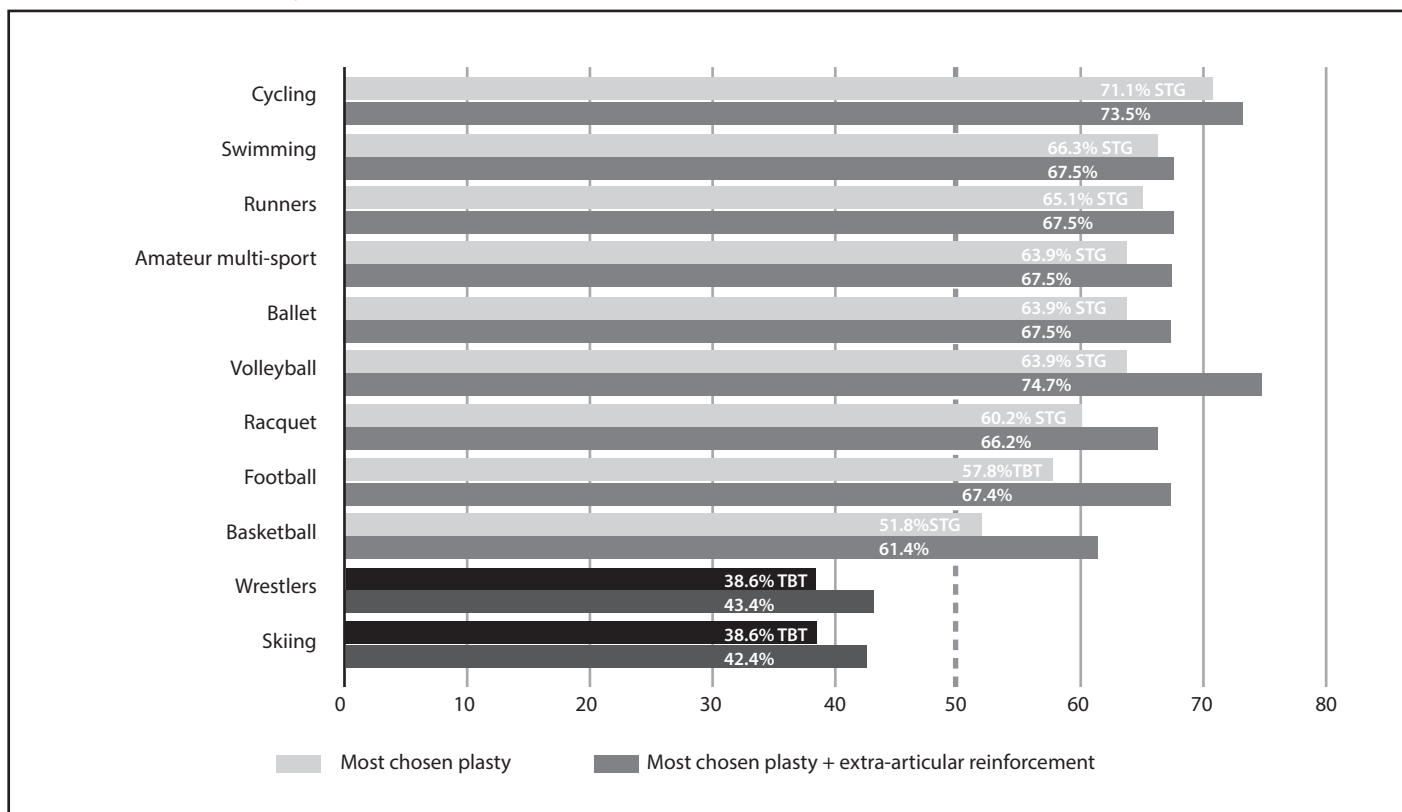


Table 1. Distribution of choice of plasty by sport.

Sport	BTB (%)	STG (%)	QT (%)	BTB + Plasty extra-articular (%)	STG + Plasty extra-articular (%)	Allograft (%)	No answer (%)
Football	57.8	21.7	4.8	9.6	2.4	3.6	-
Basketball - jumping events	27.7	51.8	2.4	-	9.6	7.2	1.2
Racquet	22.9	60.2	2.4	-	6	6	2.4
Wrestlers	38.6	38.6	4.8	4.8	2.4	7.2	3.6
Volleyball	18.1	63.9	1.2	-	10.8	3.6	2.4
Cycling	14.5	71.1	1.2	-	2.4	8.4	2.4
Skiing	38.6	37.3	4.8	3.6	3.6	8.4	3.6
Ballet	15.7	63.9	2.4	-	3.6	10.8	3.6
Runners	14.5	65.1	2.4	-	2.4	12	3.6
Swimming	18.1	66.3	-	-	1.2	10.8	3.6
Multi-sport	24.1	63.9	-	-	3.6	7.2	1.2

- For football, 57.8% of survey respondents preferred the BTB autograft, followed by STG (21.7%) and BTB + extra-articular plasty (9.6%). 4.8% of the survey respondents use QT as the first option, 3.6% autograft while 2.4% use the plasty with STG + extra-articular plasty.
- For basketball and jumping events, 51.8% of the survey respondents preferred the STG autograft, followed by BTB (27.7%) and STG + extra-articular plasty (9.6%). 7.2% of survey respondents use allograft in this type of athletes.
- For racquet sports, the most used plasty is STG (60.2%), followed by the BTB autograft (22.9%) and the STG + extra-articular plasty and allograft, both used as the primary option for 6% of surgeons who answered the survey.
- Among wrestlers, 38.6% of survey respondents chose both BTB and STG as their first option. In third place, 7.2% of surgeons use the allograft as the main option among these patients.
- For volleyball, 63.9% of survey respondents preferred the STG autograft, followed by BTB (18.1%) and STG + extra-articular plasty (10.8%).
- For cycling, 71.1% of survey respondents preferred the STG autograft, followed by BTB (14.5%) and allograft (8.4%).
- For skiing, 38.6% of survey respondents chose both BTB and 37.3% chose STG as their first option. In third place, 8.4% of surgeons use the allograft as the main option among these patients.
- For ballet, 63.9% of survey respondents preferred the STG autograft, followed by BTB (15.7%) and allograft (10.8%).
- For running, 65.1% of survey respondents preferred the STG autograft, followed by BTB (14.5%) and allograft (12%).
- For swimming, 66.3% of survey respondents preferred the STG autograft, followed by BTB (18.1%) and allograft (10.8%).
- For amateur multi-sport patients, 63.9% of the survey respondents preferred the STG autograft, followed by BTB (24.1%) and allograft (7.2%).

Figure 3. Choice of the plasty depending on the patient's chosen sport.



The most chosen plasty matched or was the same by 58.29% on average (range 71.1 - 38.6%) in each sport among the different sports studied (Figure 3).

When analysing the results, it was seen that 43 survey respondents (51.8%) performed 40 or more plasties a year, while 40 (48.2%) performed less than 40 plasties. When comparing these groups, there were no statistically significant differences in the reasons for choosing the plasty (Fisher Test $p=1$) (Table 2).

When comparing these groups of surgeons from the SETRADE and ESSKA societies, there were no statistically significant differences in the reasons for choosing the plasty (Fisher's Exact Test $p=0.22$) (Table 3).

When comparing surgeons influenced by the sport when choosing the plasty, there were no statistically significant differences in the reasons for choosing the plasty (Fisher's Test $p=0.734$) (Table 4).

Discussion

Our survey was completed by 83 surgeons or heads of surgical teams. In the light of the results, we observe that most of them are surgeons with wide-ranging experience, with an average number of plasties carried out per year for each surgeon or team of 55.93. Furthermore, the majority of these surgeons had mastered at least 2 plasties. These

findings show the suitability of the survey respondent for this work. The range of plasties performed every year was 1 to 220, where 220 was the number of plasties performed by one of the Spanish surgical teams. These figures are similar to other surveys published⁷. The best known plasty among surgeons filling in the survey were hamstring, handled by 90% of the survey respondents. These findings match those from Arnold and his team⁸ whose article presents the evolution of plasties for this surgery: In 1992, the most frequent choice of graft was BTB, accounting for almost 90%. Hamstring autografts have become more popular, and currently exceed 50%, followed by the BTB autograft with a little under 40%. The QT autograft has become more popular since 2014.

Other findings worth mentioning include the influence of the sport when choosing the plasty for 86.7% of the survey respondents, and this was the 3rd most important reason for choosing the plasty in the survey. The biomechanical properties were the main reason for picking the graft. There were no statistically significant differences concerning the reason for choosing the plasty among surgeons from different societies, more or less experienced surgeons and surgeons who considered the sport in this choice, indicating a homogeneous sample.

Analysing each sport separately, we find that the most chosen plasty matched or was the same in an average of 58.29% (71.1 - 38.6% range) in each sport studied. From this data, it can be interpreted that

Table 2. Statistical analysis. Groups that perform more or less than 40 plasties a year.

			Reason for choosing the plasty		
			Properties	Others	Total
Number of plasties	≥40	Count	22	21	43
		% within the number of plasties	51.2%	48.8%	100%
	<40	Count	19	18	37
		% within the number of plasties	51.4%	48.6%	100%
Total		Count	41	39	80
		% within the number of plasties	51.3%	48.8%	100%

Chi-square tests

	Value	df	Asymptotic sig. (bilateral)	Exact sig. (bilateral)	Exact sig. (unilateral)
Pearson's chi-square	0.000*	1	0.000*		
Continuity correction**	0.000	1	0.000		
Authenticity reason	0.000	1	0.000		
Fisher's Exact statistic				1.000	0.582
Line by line association	0.000	1	0.987		
No. of valid cases	80				

*0 boxes (0.0%) have an expected frequency under 5. The minimal expected frequency is 18.04.

**Calculated only for a 2x2 table.

Table 3. Statistical analysis. Setrade and ESSKA groups.

			Reason for choosing the plasty		
			Properties	Others	Total
Origin	Setrade	Count	37	31	68
		% within the origin	54.4%	45.6%	100%
	ESSKA	Count	4	8	12
		% within the origin	33.3%	66.7%	100%
Total		Count	41	39	80
		% within the origin	51.3%	48.8%	100%

Chi-square tests

	Value	df	Asymptotic sig. (bilateral)	Exact sig. (bilateral)	Exact sig. (unilateral)
Pearson's chi-square	1.814*	1	0.178		
Continuity correction**	1.068	1	0.301		
Authenticity reason	1.839	1	0.175		
Fisher's Exact statistic				0.220	0.151
Line by line association	1.791	1	0.181		
No. of valid cases	80				

*0 boxes (0.0%) have an expected frequency under 5. The minimal expected frequency is 5.85.

**Calculated only for a 2x2 table.

the majority agree on the choice of the same plasty in most of the sports studied. Furthermore, in sports such as football or basketball, if we consider the sum of the main or most chosen plasty, plus the extra-articular reinforcement (the main plasty is the same, but an extra technique is

added), the plasty choice percentages would rise to 67.4% (adding isolated BTB and BTB with extra-articular plasty) in the case of football, and 61.4% in the case of basketball (adding hamstring and hamstring plus extra-articular reinforcement). In the case of volleyball, as the sport

Table 4. Statistical analysis. Groups where the sport may or may not influence the decision on the ACL reconstruction plasty.

			Reason for choosing the plasty		
			Properties	Others	Total
Does the sport influence your choice?	Yes	Count	37	34	71
		% within the sport, does the sport influence?	52.1%	47.9%	100%
	No	Count	4	5	9
		% within the sport, does the sport influence?	44.4%	55.6%	100%
Total		Count	41	39	80
		% within the sport, does the sport influence?	51.3%	48.8%	100%

Chi-square tests

	Value	df	Asymptotic sig. (bilateral)	Exact sig. (bilateral)	Exact sig. (unilateral)
Pearson's chi-square	0.188*	1	0.665		
Continuity correction**	0.006	1	0.937		
Authenticity reason	0.188	1	0.664		
Fisher's Exact statistic				0.734	0.468
Line by line association	0.186	1	0.667		
No. of valid cases	80				

*2 boxes (50%) have an expected frequency under 5. The minimal expected frequency is 4.39.

**Calculated only for a 2x2 table.

where surgeons chose the option of extra-articular reinforcement most often, this percentage would rise to 74.7% when adding hamstring and hamstring plus extra-articular reinforcement, providing the greatest percentage of coherence in the response chosen in our survey.

Our study found the most heterogeneity in sports such as wrestling and skiing, where no choice prevailed over 50%.

When reviewing the literature, we find that within the framework of a primary isolated reconstruction of ACL, most of the authors and reviews make recommendations concerning the type of plasty by dividing the patients into 3 groups⁹. Firstly, there are the elite, active athletes where the graft of choice is the BTB autograft, although the quadriceps tendon autograft can be an increasingly viable option in this population given that the hamstring autograft and the allograft have demonstrated greater failure rates and greater laxity, although they can be used if the patient must frequently kneel in their profession. Secondly, there are moderately active patients where the graft of choice is the hamstring autograft. It has a low failure and revision rate compared to allografts, and it also avoids the morbidity of donor zone associated with the BTB extraction. Although some residual laxity can remain, compared to a BTB graft, it is not clear whether this difference is clinically relevant. Finally, there are older patients who are less active for whom non-surgical treatment fails, where the graft of choice remains the hamstring autograft. However, the allograft

can be considered for patients who are prepared to accept a greater risk of graft failure.

Other BTB indications could be athletes with a patellar tendinopathy, to the extent that it can be treated concomitantly with taking the graft of the patellar tendon, and patients with medial laxity of the knee for chronic injuries, then the hamstring acts as a medial stabiliser and its resection would not be recommended for taking the graft⁵.

We thereby seen that BTB is the main option in the elite athletes' group and this is where we would like to step in. For us, one graft is no better than another, but a precise indication of its use. Not all sports are the same or have the same requirements.

Other revisions, such as Calvo and their group,¹⁰ go one step further regarding recommendations to select a graft according to the patient's characteristics and their sport: it is recommended to use a patellar tendon autograft in professional and top competition patients (football and rugby), patients who require an early return to their sport, patients who are susceptible to hamstring injury (sprinters, American football) and hyperlax patients; meanwhile, a hamstring graft is recommended for patients with open physes, women (aesthetic advantage), patients who have to kneel and sports which are susceptible to patellar tendon damage (basketball, volleyball, tennis). Finally, allograft is recommended in cases of multi-ligament injuries, patients over 40 years old with low demand, revisions.

This guide already made recommendations according to which sport is played and this is what we are trying to analyse.

Recent prospective studies of cohorts have identified risk factors for the failure of the ACL reconstruction graft failure, such as younger patients, greater levels of activity, fitting a non-anatomical tunnel and the use of allografts. Among these, the most easily modifiable risk factor is the choice of graft where the most suitable must be chosen for the patient, so Buerba and their team¹¹ also recommend considering these risk factors and the sport played, recommending BTB in sports or professions that do not involve kneeling; hamstring grafts in sports that do not depend to a great extent on the hamstring musculature; and QT in athletes that depend on their hamstring, and in athletes and workers who spend time on their knees (wrestlers, judo and carpenters).

Likewise, Arnold and Houck^{8,12} also concluded that the graft selection must be individualised for each patient and understanding the global trends in the choice of graft can help orthopaedic surgeons to discuss the graft options with their patients and determine the appropriate graft for each case. Therefore, the surgeon must be familiar with all ACL reconstruction options available to optimise the treatment and the results of each patient.

Some considerations on the possible limitations of this work could be due to only using data from 2 European societies as the selection bias. Many answers were received from the Spanish society (SETRADE) but not so many from the European society (ESSKA) and so these data may not be representative of the society. Furthermore, the range of plasties carried out every year by the surgeons is very high, and there are broad differences between groups with a lot of experience and surgeons with little experience.

As aspects to be highlighted, surgeons and teams with broad experience completed the survey, both in terms of volume of surgeries per year and in plasties mastered by the survey respondents, which strengthens our results.

After evaluating the situation and making all the considerations, the following terms and consensus could be determined:

The performance of athletes in football, rugby, American football, weightlifting, sprinting, ballet dancers, taekwondo or karate, that compromise the hamstring, can be affected if we use them as a graft as this might considerably reduce the strength of the final flexion. There is also a greater incidence of muscle contractures and tears in the donor area and in female athletes if we use hamstring plasties; consequently, BTB would be the plasty of choice in these sports.

On the other hand, for sports where the extensor plays an important role, and kneeling is usual practice, as in martial arts, skiing, volleyball and basketball, we would choose hamstring plasties, so as not to injure the extensor.

In racquet sports, cycling, runners, swimming and amateur multi-sport patients, where hamstring power and the requirements are not as important, a hamstring plasty can be recommended given the advantages and disadvantages analysed above.

For athletes with open growth cartilage, only a hamstring graft is used, regardless of the sport, as the tunnel must always be filled with soft tissue to avoid damage to the epiphyseal growth.

We only recommend allografts in multi-ligament injuries, amateur athletes over 35 years old, as the inclusion and the strength of the graft requires double the time of the autografts, and the re-tear rate is higher. Patient preference should also be considered in the choice.

Currently we see that for almost 90% of the survey respondents, the sport influences the decision on the type of graft to use. If we analyse each sport separately, in general lines and the most popular sports, there is a coincidence in the plasty used, although for others there is not as much concordance as might be expected. With all this, the authors recommend mastering at least 2 plasties for primary reconstructions of ACL and individualising each case considering the type of sport when selecting the graft, considering what has been analysed in this work and in the literature.

Conclusions

Our survey was completed by a significant number of surgeons with experience in LCA plasties, where the biomechanical properties were the main reason when choosing the graft to be used. Most of them were influenced by the type of sport involved when making this choice.

The most chosen plasty was the same in 58.29% on average in each sport being studied, where most of them coincided with this same choice, although there are sports where no option prevails.

The authors recommend mastering at least 2 plasties for primary reconstructions of ACL and individualising each case by considering the type of sport when selecting the graft.

Appendix 1. Survey

All the questions refer to the context of complete rupture of the anterior cruciate ligament in a mature professional athlete with no previous history, injuries or surgeries.

1. How many ACL tear reconstruction surgeries do you perform per year?
2. Do you consider the type of sport that the patient plays when choosing the plasty in the ACL surgery?
3. What is the main reason that you consider when choosing the plasty to be used? (Complications in the donor zone, greater stability/rigidity of the plasty, faster osteointegration, biomechanical properties, re-break rate, etc.).
4. How many plasties for ACL reconstruction and which type have you mastered? Choose the options that consider patellar tendon autograft (BTB)?
 - a) BTB-Patellar tendon.
 - b) Hamstring autograft (STG).
 - c) Quadricipital tendon autograft (QT).
 - d) Allograft.
 - e) ACL reconstruction + extra-articular plasty.
 - f) Other.

5. Depending on the following type of activity, which ACL reconstruction plasty among the above do you think is the most appropriate? More than one answer is possible:

- a) Football player and impact sports – rugby, American football, handball.
- b) Basketball player /athletics – jumping events.
- c) Racquet sport or similar: tennis, paddle tennis, ping pong, badminton, squash, baseball, cricket.
- d) Wrestlers and martial arts.
- e) Volleyball.
- f) Cycling.
- g) Skiing / snowboard, ice or roller hockey.
- h) Ballet and other types of dancing.
- i) Long distance runners.
- j) Swimming.
- k) Amateur multi-sport patients.
- l) Low activity patients.

Conflicts of interest

The authors declare that there is no conflict of interest.

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