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Review article

Effectiveness of Thicker Hamstring or Patella Tendon Grafts to Reduce Graft Failure Rate in Anterior Cruciate Ligament Reconstruction: A Systematic Review

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Abstract

Introduction: In this systematic review, graft failure of two types of grafts (hamstring or patella tendon grafts) that are used for surgical reconstruction of the anterior cruciate ligament are reported and compared. ***Methods:*** This is a systematic review which is conducted in PubMed depending on preferred reporting item for systematic reviews and meta-analysis (PRISMA) criteria. We included a total of 19 studies which reported graft failure rates of at least one of the anterior cruciate ligament reconstruction methods mentioned above. To be able to compare studies with different follow-up periods, a yearly graft failure rate for each reconstruction group was calculated and then investigated for significant differences by using the Kruskal–Wallis test. ***Results:*** Overall, a total of 1366 patients treated with an anterior cruciate ligament reconstruction were included in the calculations. Comparison of graft types showed that hamstring tendon autografts had a yearly graft failure rate of 1.7 % in patients treated with Double-bundle hamstring autograft, 1.68 % among patients treated with single-bundle hamstring autograft and 1.6 % in patients with patellar tendon autograft. ***Conclusion:*** The results of this systematic revie showed that there is no significant difference in the graft failure rates per year among hamstring tendon autograft and bone–patellar tendon–bone autograft. Based on the results of this review, all graft options found to deliver comparable results in terms of graft failure rates and thus all graft type could be considered as reliable option for ACLR with superiority to hamstring tendon autograft.

Keywords: ***ACL reconstruction, Graft failure rate, Autograft, Allograft, Quadriceps, Bone-patellar tendon-bone Hamstring***

Introduction

Isolated tear of the anterior cruciate ligament (ACL) is one of the commonest orthopaedic injury with annual prevalence of 68.6 per 100,000 person among US population [1]. However, controversially management is one of the treatment options of torn ACL, superior outcomes of anterior cruciate ligament reconstruction (ACLR) compared to non-surgical treatment considering quality of life and function in sports [2]. In a previous systematic review, Krause et al., recommended that there is trend toward better functional outcomes and stability of knee after performing ACLR when compared with patients on non-surgical management [3]. There are many factors that affect the outcomes of ACLR and should be significantly considered when graft survival investigated including age which is considered as a significant risk factor for ACL graft rupture. For every yearly increase in age of the patients increase the odds of an ACL graft rupture decreases [4]. On the other hand, gender is not considered a risk factor of increased ACLR failure rate and not has any clinical difference in patients-reported outcomes [5].

There are several reconstructing techniques to treatment of ruptured ACL in recent traumatology surgery. In previous global perspective study, the most common grafts used in the reconstruction of the ACL are hamstring tendon autografts (HTA) and bone-patellar tendon bone autografts (BPTBA) [6]. Moreover, single-bundle reconstruction is used in more frequency than double bundle management [6].

The aim of this systematic review was to compare the graft failure rated of two of the most common graft options; hamstring tendon autografts (HTA) and bone-patellar tendon bone autografts (BPTBA) and investigated if these strategies have a positive impact on improving the rate of success of ACLR by taking the published studies in the last twenty years. Little previous studies had been conducted to investigate the purpose of this study including one study which found no significant difference between autograft subgroups in terms of graft failure rates [7]. Therefore, the main hypothesis of this study that there is no statistically significant difference between the failure rates of both grafts and better results than other techniques. The results of this study may have

contribution in better understanding and orientation in terms of graft choice and functional survival of different graft types.

Materials and methods

Literature search

This is a systematic review that was conducted in order to research about the common methods of ACLR using autografts in several known databases were included Ex: "Google Scholar, PubMed, The Cochrane Library, Web of Science" from 2000 to 2022depending on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria. Search was conducted during the last months of 2021 using several terms including "ACL reconstruction" in combination with "quadriceps tendon" OR "quadriceps graft" OR "hamstring" OR "bone tendon bone" OR "patellar tendon" OR "allograft" in <All Fields>.

Eligibility and study selection

All studies that were found during the research were investigated by titles and abstract and them relevant studies were collected and then assess for eligibility according to the following criteria.

Inclusion criteria

- Publication date within the last 20 years (2000–2020).
- A follow-up (FU) period of at least 1 years.
- Isolated ACL rupture as primary ligamentous injury with or without meniscal damage.
- Trials only conducted on human species (level of evidence I-IV).
- All tibial and femoral graft fixation techniques.
- Studies including transtibial or anteromedial tibial tunnel drilling.
- Study population with a minimum mean age of 18 years.
- All kinds of hamstring techniques (any number of strands).

Exclusion criteria

- Studies published in languages other than English.
- Revision ACLR.
- Studies investigating only highest-risk populations such as professional athletes or skeletally immature.
- No documentation of graft failure or re-rupture rate.
- Multiple ligamentous injuries of the knee joint.
- Follow-up duration unavailable or only available as median.

Data extraction

In order to have homogenous data about the characteristics and patient's demographic, information was collected by systematically extracting year of publication, authors, study design, number of subjects, mean age, mean follow-up time, cases of graft failure and used grafts technique.

Statistical analysis

For statistical calculation of the results, IBM SPSS Statistics 26 (IBM Corporation, Armonk, NY, USA) was utilized. In the beginning, descriptive statistics were conducted: the number of patients included, the average patients' age at surgery and overall mean follow-up was calculated per graft type and for the overall study population.

The follow-up period of 19 studies included in this systematic review ranged from 1 to 10.7 years. Annual graft failure rate is calculated for different follow-up studies for each type of grafting. This variable (annual graft failure rate) was tested for normal distribution using the Kolmogorov-Smirnov test. A Kruskal-Wallis test was performed to determine if there were any differences in the annual graft failure rates. In this test method, the hypothesis estimates that there is no significant difference in annual failures between reconstruction strategies. The significance level is determined by a value of p less than 0.05.

Results

1. Study selection

The electronic search strategy conducted in this review ended in 875 hits which after removing of duplicated reduced to 360 studies. These 360 studies were considered eligible for further evaluation, from which 346 studies were excluded for different reasons as 245 studies based on title and abstract, 86 studies do not relevant to the subject of this study or sitting of this review, 12 consider replies of authors, 2 books, and 25 were reviews. At end, 19 articles were included in the qualitative synthesis of the present review (**Figure 1**).

2. General results

Among the included studies, all studies were published during the period between 2000 and 2020. The pooled population of the review was 1366 patients 27.8 years old (SD=3.3). Thirteen studies discussed the using of Patellar tendon autograft and 18 studies including cases with Single-and double bundle hamstring autograft including three studies using double bundle hamstring autograft and 15 studies using single bundle hamstring autograft. The mean percentage of male among the pooled population was 75 % and mean follow-up period was 3.78 year ranged between one year and 10.7 year (**Table 1**).

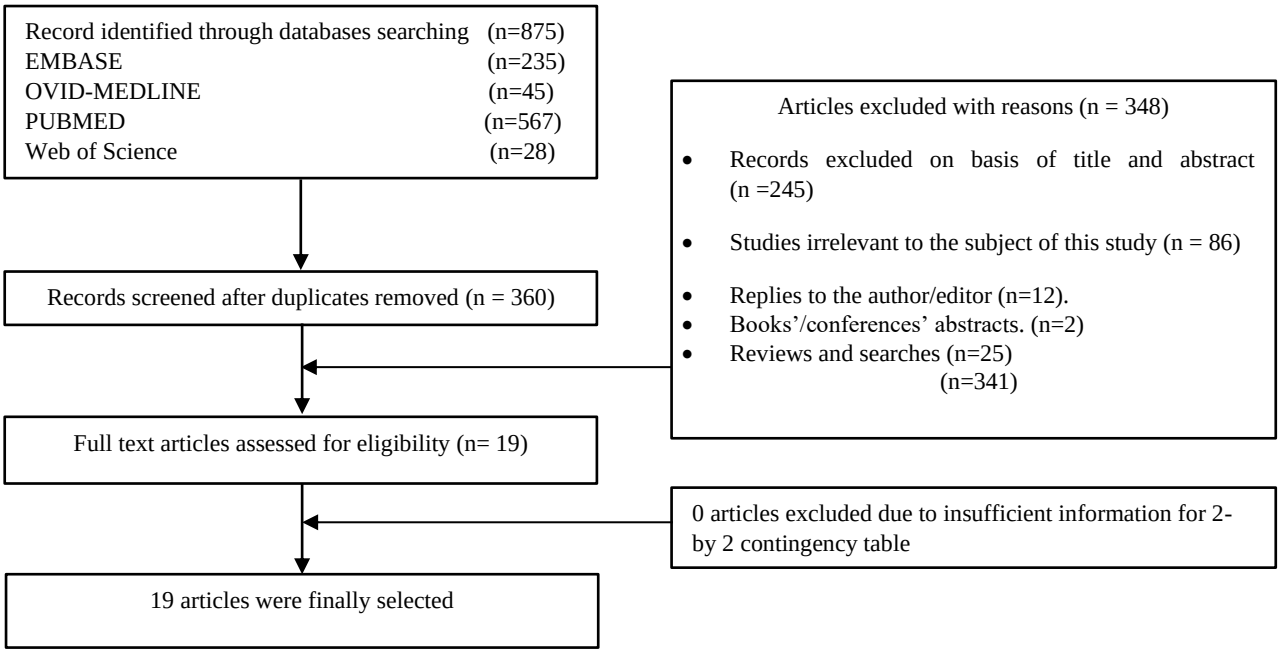

Figure 1: The PRISMA figures showing the steps to choose the studies for systematic review.

Table 1: The general characteristics of the studies included in this review (N=19)

	Study	Year	Graft type	Patients at follow-up (N)	Age	Gender (%male)	Follow-up
1	Johannes Leitgeb [8]	2014	Patellar tendon autograft	56	28.4	80.40%	5.2
			Single-bundle hamstring autograft	40	29.2	57.50%	5.4
2	Kang Sun [9]	2011	Single-bundle hamstring autograft	36	30.9	77.80%	3.5
3	Kang Sun [B] [10]	2009	Patellar tendon autograft	76	31.7	80.30%	5.6
4	Julian A. Feller [11]	2003	Single-bundle hamstring autograft	31	26.3	70.60%	3
			Patellar tendon autograft	26	25.8	74.20%	3
5	Mark D. Shaieb [12]	2002	Single-bundle hamstring autograft	37	30	56.80%	2.75
			Patellar tendon autograft	33	32	78.80%	2.75
6	Ran Sun [13]	2015	Double-bundle hamstring autograft	154	27.5	68.80%	3
7	Lars Peterson [14]	2014	Patellar tendon autograft	102	27	53.30%	2
8	Sahnghoon Lee [15]	2012	Single-bundle hamstring autograft	18	29.4	85.70%	1
			Double-bundle hamstring autograft	19	31.2	90.50%	1
9	Piia Suomalainen [16]	2011	Single-bundle hamstring autograft	60	32	69.20%	2.3
			Double-bundle hamstring autograft	61	32	74.70%	2.3
10	Jung Ho Noh [17]	2011	Single-bundle hamstring autograft	33	23	90.90%	2.3
11	Inger Holm [18]	2010	Single-bundle hamstring autograft	29	27	51.70%	10.7
			Patellar tendon autograft	28	25	64.30%	10.2
12	S.R.A. Ghalayini [19]	2010	Patellar tendon autograft	24	30.9	73.10%	5
13	Kang Sun[A] [20]	2009	Patellar tendon autograft	33	29.7	72.70%	2
14	Dean C. Taylor [21]	2009	Patellar tendon autograft	24	21.7	78.10%	2.7
			Single-bundle hamstring autograft	29	22.1	87.50%	3.2
15	Nikolaus A. Streich [22]	2008	Single-bundle hamstring autograft	25	29.2	100.00%	2
			Double-bundle hamstring autograft	24	30	100.00%	2
16	Stefano Zaffagnini [23]	2006	Patellar tendon autograft	25	30.5	64.00%	5
			Single-bundle hamstring autograft	25	31.3	60.00%	5
17	Gauti Laxdal [24]	2005	Patellar tendon autograft	40	28	72.80%	2.1
			Single-bundle hamstring autograft	39	26	71.80%	2.2
18	Samir AbdulRazik Ibrahim [25]	2005	Single-bundle hamstring autograft	45	22.3	100.00%	6.75
			Patellar tendon autograft	40	22.3	100.00%	6.75
19	K. Eriksson [26]	2001	Single-bundle hamstring autograft	74	25.7	58.50%	2.75
			Patellar tendon autograft	80	25.7	58.50%	2.75

From this dataset, the main patient demographics containing number of operated patients, the mean age and mean follow-up time were elaborated. These main patient demographics are displayed in Table 2.

Table 2: The patients' characteristics according to the used graft

Graft type	Patients (n)	Mean age (years)	Mean FU (year)
Patellar tendon autograft	587	27.59	4.2
Double-bundle hamstring autograft	258	30.17	2.1
Single-bundle hamstring autograft	521	27.45	3.8

3. Comparison of graft failure rates of all graft types

The Kruskal–Wallis test of failure rates per year for the three main graft groups resulted in a p value of 0.089 which is considered as not significant ($p > 0.05$). Therefore, the yearly graft failure rate of the three investigated ACLR groups did not differ significantly, and the null hypothesis was retained.

In table 3, we showed the mean of the yearly failure rate for each graft types where the mean yearly graft failure rate were 1.7 % in patients treated with Double-bundle hamstring autograft, 1.68 % among patients treated with single-bundle hamstring autograft and 1.6 % in patients with patellar tendon autograft.

Table 3: Yearly graft failure rates of all graft types

Graft type	Mean (%)	Std. deviation	Median	Range
Patellar tendon autograft	1.60	1.38	0.76	8.96
Double-bundle hamstring autograft	1.7	1.98	1.07	11.11
Single-bundle hamstring autograft	1.68	1.88	1.01	11.15

Discussion

The most significant finding of this systematic review is that two types of grafts analyzed and commonly used for ACLR did not differ significantly in term of graft failure rates by year. These results mimic the results of recent metaanalysis by Mourabes et al, in which both types were compared together and both compared with quadriceps tendon autograft and no significant differences in graft failure rate could be found [7]. Moreover, systematic review conducted by Hayback G et.al., showed similar results where no significant difference was found among four grafts of hamstring tendon autograft, bone–patellar tendon–bone autograft, quadriceps tendon autograft and allograft [27].

Moreover, another study conducted by Nyland et al., reported that quadriceps tendon autograft showed better results considering graft failure rates than other common grafts [28]. However, these results could not be confirmed by most of the recent studies including study of Lind et al who focused on comparing the graft failure rates of quadriceps tendon autograft to other grafts and found that failure rate for quadriceps tendon autograft was 4.7 % during the first two years in 531 cases which is significantly higher than failure rates of hamstring and patellar tendon grafts reported in their study and our systematic review [29]. Another study conducted by Galan et al., during a five year follow up found that failure rate of quadriceps tendon autograft was 10.7 % among 291 patients which is also higher than failure rates of hamstring and patellar tendon grafts reported in this study [30]. These results showed that using of hamstring and patellar tendon grafts could decrease the failure rate with longer follow-up duration. However, most of studies that assessed the failure rate in quadriceps tendon autograft were investigating the failure rate during short term follow up because the fact that frequent use of quadriceps tendon autograft in ACL reconstruction surgery was pushed during the past few years. Therefore, these results could be changed dermatically after conducting high-quality studies investigating long-term (10 years and more) failure rates and functional outcomes of the quadriceps tendon autograft [29,30].

Graft failure is considered the most important indicator that used to measure to assess the success rate of ACLR however there are other factors including harvest site pain and functional results that could be assessed and affect the success rate of ACLR. One of the important facts of bone-patellar tendon–bone autograft is that anterior knee pain and kneeling pain often happened because of harvest site defect [31]. These important factors could prevent bone–patellar tendon–bone autograft from being superior to hamstring tendon autograft however, in some previous studies showed that failure rates were lower than hamstring tendon autograft and functional outcomes were better [32-34].

There are several limitations to this study including that the studies that were included in the present systematic review contained different graft fixation methods such as suspensory fixation methods, fixation with interference screws or a combination of both methods. Furthermore, the definition of graft failure was inconsistent as some studies defined the need for ACL revision as graft failure, while others considered pathological magnetic resonance imaging (MRI) or clinical deficits as graft failure.

Conclusion

The results of this systematic revie showed that there is no significant difference in the graft failure rates per year among hamstring tendon autograft and bone-patellar tendon–bone autograft. Based on the results of this review, all graft options found to deliver comparable results in terms of graft failure rates and thus all graft type could be considered as reliable option for ACLR with superiority to hamstring tendon autograft.

Conflicts of Interest

None

Funding Statement

None

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