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Outcomes of Bicruciate Ligament Reconstruction: A systematic review

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Introduction

- Bicruciate (ACL & PCL) injuries are rare
- Often occur in context of knee dislocation
- Knee dislocations as a whole account for less than 0.02% of all orthopaedic injuries[1]
- Isolated bicruciate ligament injuries are reported in as little as 5.3% of all knee dislocations[2]

Objective

To perform a systematic review on the outcomes of isolated bicruciate ligament reconstruction

Methods

- Systematic review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines
- PubMed, MEBASE, and MEDLINE searched from inception to February 2024
- “**anterior cruciate ligament**”, “**posterior cruciate ligament**”, “**treatment outcome**”, and “**bicruciate ligament reconstruction**”
- Study characteristics, surgical techniques, and clinical outcomes were collected
- Weighted averages of commonly reported outcomes using a random-effects model due to the small number of studies, small sample sizes, and heterogeneity across studies

Methods

Inclusion criteria:

- English publications
- Clinical outcomes of isolated bicruciate ligament reconstruction without associated collateral ligament, posterolateral, or posteromedial repair or reconstruction

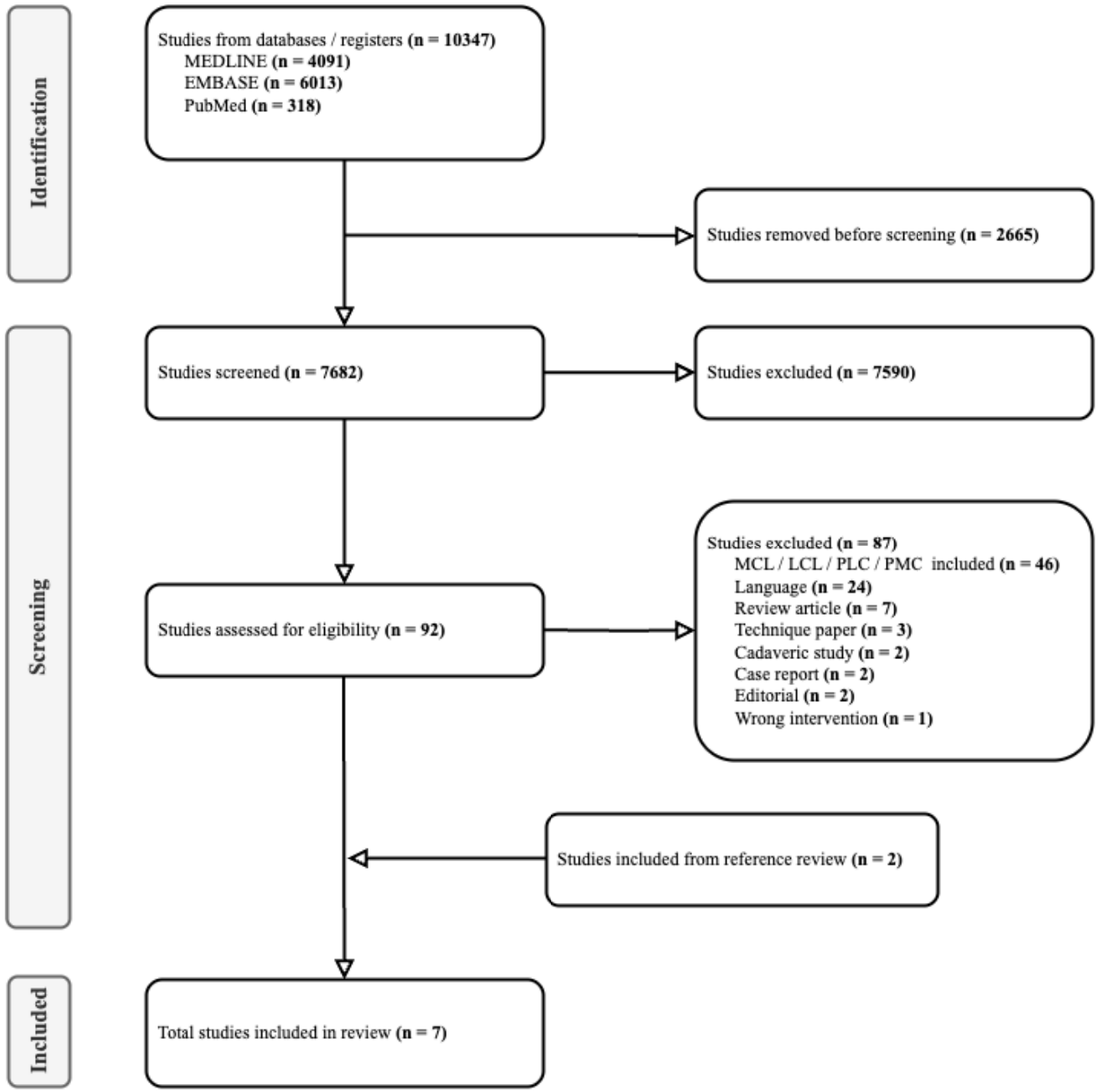

Figure 1 PRISMA search strategy

MCL medial collateral ligament, *LCL* lateral collateral ligament, *PLC* posterolateral corner, *PMC* posteromedial corner

Results

Table 1 Study Characteristics and Patient Demographics

Author (year)	Type of Study, LOE	Sample size	Male:Female	Age, mean (years)	Acute Injuries (n)	Chronic Injuries (n)	MINORS score, comparative	MINORS score, non-comparative
Gupta et al. (2021)[3]	Retrospective Cohort, III	21	3:1	27	NR	NR	15	NA
Huang et al. (2010)[4]	Case Series, IV	18	8:1	27.5	NR	NR	NA	8
Shi et al. (2008)[5]	Case Series, IV	15	2.8:1	24	3	12	NA	9
Winkler et al. (2022)[6]	Prospective Cohort, II	203	1.8:1	34 ± 12.9	NR	NR	17	NA
Xie et al. (2006)[7]	Case Series, IV	10	4:1	34	NR	NR	NA	8
Zhao et al. (2006)[8]	Case Series, IV	12	3:1	27	3	9	NA	10
Zhao et al. (2008)[9]	Case Series, IV	21	2.5:1	27	7	14	NA	10

LOE level of evidence; *NR* not reported; *NA* not applicable

- 7 studies included[3-9], 1 study excluded from analysis due to heterogeneity[6]
- 6 studies analyzed[3,4,5,7,8,9]
- 97 patients with mean age of 28.3 years and male:female ratio 3.85:1 included in final analysis

Results

Table 2 Graft Characteristics and Fixation

Author (year)	ACL Graft Harvest, Type	ACL Fixation	PCL Graft Harvest, Type	PCL Fixation
Gupta et al. (2021)[3]	BTB, Autograft	Aperture	Hamstrings Autograft	Aperture
Huang et al. (2010)[4]	LARS, Artificial	Aperture	LARS Artificial	Aperture
Shi et al. (2008)[5]	Achilles, Allograft	Aperture	Achilles Allograft	Aperture
Winkler et al. (2022)[6]	NR	NR	NR	NR
Xie et al. (2006)[7]	BTB, Allograft	Aperture	BTB Allograft	Aperture
Zhao et al. (2006)[8]	ST, Autograft	Suspensory	STG Autograft	Suspensory
Zhao et al. (2008)[9]	STG, Autograft	Suspensory	STG Autograft	Suspensory

ACL anterior cruciate ligament; *PCL* posterior cruciate ligament; *BTB* bone-patellar-tendon-bone; *LARS* Ligament Advanced Reinforcement System; *ST* semitendinosus; *STG* semitendinosus and gracilis; *NR* not recorded

- Hamstrings autograft was the most popular graft choice for both ACL and PCL reconstruction

Results

Table 3 Reported Study Outcomes

Author (year)	Sample size	CPM	Return to sport	Post-operative flexion degree ROM, degrees	KT-1000 at 25 degrees, mm	KT-1000 at 70 degrees, mm	KOOS score	Post-operative Lysholm score	Pre-injury Tegner score	Post-operative Tegner score	Post-operative IKDC Grades A:B:C	Complications, Type (n, patients)
Gupta et al. (2021)[3]	21	NR	NR	NR	NR	NR	NR	78.20 ± 7.62	6.72 ± 2.18	5.82 ± 1.90	4:12:5	Infection (1) ROM < 120 (3)
Huang et al. (2010)[4]	18	NR	10, cohort unspecified	NR	NR	NR	NR	85.5 ±2.3	NR	NR	6:10:2	NR
Shi et al. (2008)[5]	15	Pre-op & post-op	13	144	4.8, anterior-posterior laxity	4.2, anterior-posterior laxity	NR	90 ± 4	NR	NR	9:5:1	Effusion (1)
Winkler et al. (2022)[6]	203	NR	NR	NR	NR	NR	Reported	NR	NR	NR	NR	NR
Xie et al. (2006)[7]	10	Post-op only	8	128.38	<2 to 10, anterior laxity	2 to 10, difference in range of motion	NR	89.8 ± 3.4	6.9 ± 1.7	5.5 ± 1.6	4:5:1	NR
Zhao et al. (2006)[8]	12	NR	NR	143 ± 3.7	0 to 7, anterior laxity	0 to 7, anterior-posterior laxity 0-4, posterior sag	NR	92.3 ± 3.1	6.8 ± 0.6	6.6 ± 0.8	7:4:1	Arthrofibrosis (8) Cyst (1) Hematoma (2)
Zhao et al. (2008)[9]	21	Pre-op only	2	>120 in acute injuries	2.5±2.7, anterior-posterior laxity	2.1±1.7, anterior-posterior laxity	NR	91.9 ± 4.2	6.2 ± 1.8	5.0 ± 1.9	13:7:1	NR

CPM continuous passive motion; *ROM* range of motion; *KOOS* Knee injury and Osteoarthritis Outcome Score; *IKDC* International Knee Documentation Committee; *NR* not reported

- Winkler et al.[6] **excluded** due to heterogeneity
- 6 studies reported postoperative Lysholm and IKDC grades[3,4,5,7,8,9]
- 4 studies reported pre-injury and postoperative Tegner scores[3,7,8,9]

Results

Table 4 Weighted Means of Commonly Reported Outcomes

Post-operative outcome	Studies (n)	Random-effects Mean (95% CI)
Lysholm score	6	88.0 (83.9, 92.2)
IKDC Grade A	6	0.44 (0.28, 0.60)
IKDC Grade B	6	0.44 (0.34, 0.54)
IKDC Grade A or B (vs Grade C)	6	0.91 (0.86, 0.97)
Tegner score	4	5.8 (5.1, 6.5)
Change in pre-injury to postoperative Tegner score	4	-0.74 (1.38, -0.09)

IKDC International Knee Documentation Committee
Change in pre-injury to postoperative Tegner score p=0.025

- A Lysholm score of **88.0** indicates patients reported **good** ADLs postoperatively
- **91%** of patients had a IKDC **Grade A (normal)** or **Grade B (nearly normal)** knee postoperatively
- A Tegner score of **5.8** indicates patients were able to perform **some level of heavy labour with variance in sport**[10]
- There was a **0.74 decrease from pre-injury to postoperative** Tegner scores

Conclusion

- Isolated single-stage bicruciate ligament reconstruction without associated collateral ligament, posterolateral, or posteromedial repair or reconstruction have favourable postoperative Lysholm scores, Tegner activity scores, and IKDC grades

- Patients report lower postoperative Tegner scores compared to pre-injury scores suggesting that they do not return to the same level of activity as their pre-injury state

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