What is the best hamstring graft configuration for ACL reconstruction?

Add an Anterolateral Ligament versus Increase Graft Diameter in Hamstring ACL reconstruction: A Prospective Multicenter Randomized Clinical Trial In High Risk Patients

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Head of Knee Group – EPM

Head of Regenerative Medicine Group – EPM

Head of EPO Group

Head of EPO Regen Group

Advisory Board – Brazilian School of Knee Surgery (BS Knee)

Executive Board – Brazilian Society Knee Surgery

ISAKOS member

Sociedade Brasileira de Cirurgia do Joelho

GRUPO DO JOELHO EPM-UNIFESP

BS Brazilian School of Knee

Conflicts of Interest

Boards:
EPO Group - Advisory and Executive Board
EPO Regen - Advisory and Executive Board
Brazilian School of Knee Surgery (BS Knee) - Advisory Board
VRX Tecnologia – Advisory Board
Brazilian Society Knee Surgery – Executive Board

Support for education:
BS Knee
Brazilian Society Knee Surgery
Smith & Nephew (ended at 2021)

Consulting:
Smith & Nephew (ended at 2021)

Research Grants:
FAPESP
ISAKOS

INTRODUCTION

ACL Hot Topics

INTRODUCTION

ACL Hot Topics

Ramp Lesions

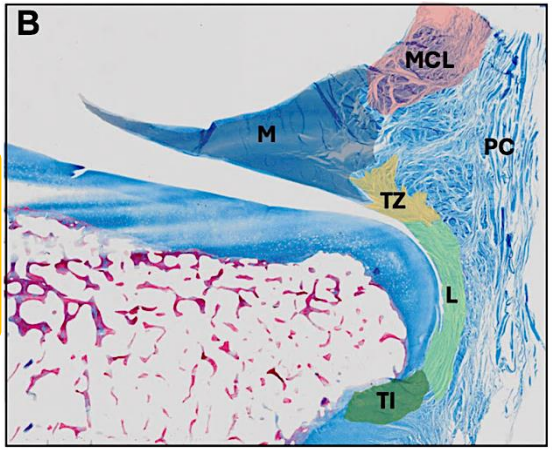
Characterizing the Transition Zone Between the Meniscotibial Ligament and the Medial Meniscus

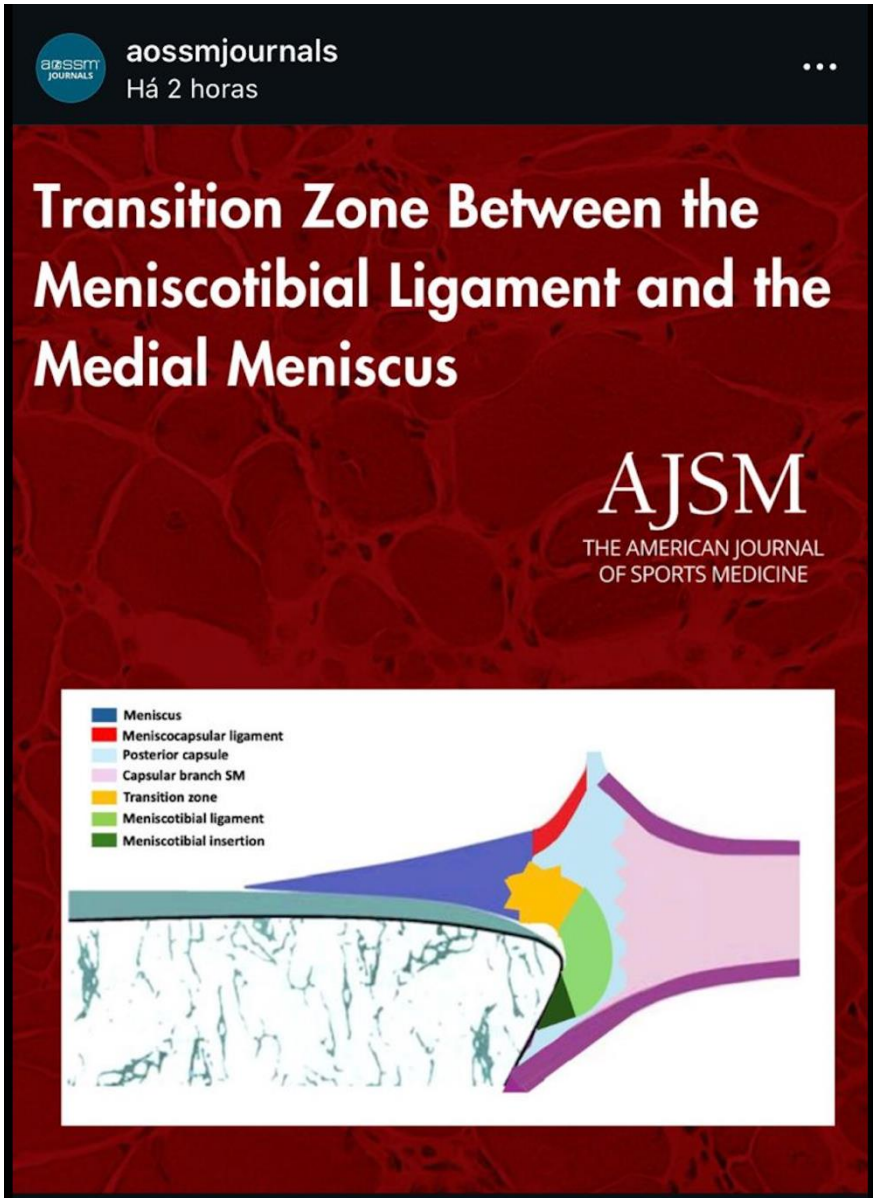
A Hidden Trigger for Ramp Lesions

Felipe Galvao Abreu,*† MD, PhD, Carlos Eduardo da Silveira Franciozi,† MD, PhD, Bertrand Sonnery-Cottet,‡ MD, PhD, Vitor Barion Castro de Padua,† MD, PhD, Thais Santana Gastardelo Bizotto,§ MD, PhD, Marcelo Seiji Kubota,† MD, PhD, and Marcus Vinicius Malheiros Luzo,† MD, PhD
Investigation performed at Sao Paulo Federal University–EPM/UNIFESP, Sao Paulo, Brazil

The American Journal of Sports Med
2026;54(1):52–62
DOI: 10.1177/03635465251393521

Transition Zone





INTRODUCTION

ACL Hot Topics

Ramp Lesions

Rectus Femoris

ORIGINAL PAPER

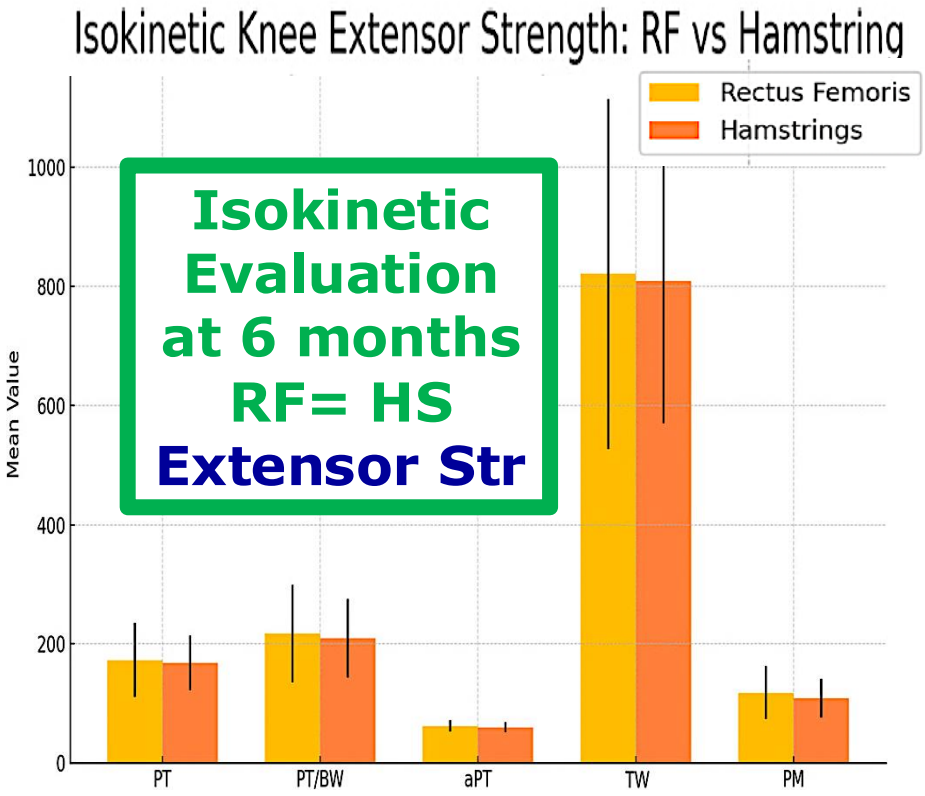
Journal of Experimental Orthopaedics WILEY

Comparable isokinetic quadriceps performance six months after ACL reconstruction with rectus femoris versus hamstring tendon autografts

Márcio Cabral Fagundes Rêgo[1] | Alef Cavalcanti Matias de Barros[2] | Jamilson Simões Brasileiro[2] | Marcelo Cabral Fagundes Rêgo[1] | Camilo Partezani Helito[3] | Carlos Eduardo da Silveira Franciozi[4] | Diego Ariel de Lima[5]

Received: 30 September 2025 | Accepted: 12 November 2025

DOI: 10.1002/jeo2.70601



INTRODUCTION

ACL Hot Topics

Ramp Lesions

Rectus Femoris

BIOMECHANICAL ANALYSIS OF AUTOLOGOUS GRAFT CONFIGURATIONS FOR KNEE LIGAMENT RECONSTRUCTION: A CADAVERIC STUDY

Authors: Helito CP [1]; Lopes MBG [2]; Ariel de Lima D [3]; Neto JBA [2]; Clazzer R [4]; Canuto SMG [5] , Franciozi CES[4]

Submitted for publication

Table: Ultimate load to failure of different autologous graft configurations. N = Newtons

Graft	n	Mean (N)	Standard Deviation (N)	95% CI Lower (N)	95% CI Upper (N)
Quadriceps tendon	6	2302,92	79,68	2219,31	2386,53
Peroneus longus tendon	12	1991,33	160,29	1889,49	2093,18
Braided hamstrings	5	1821,80	11,67	1807,30	1836,30
Patellar tendon	12	1734,70	136,24	1648,13	1821,26
Rectus femoris tendon	6	1713,88	56,05	1655,06	1772,69
Parallel hamstrings	6	1683,76	80,50	1599,28	1768,24
Iliotibial tract	11	749,13	155,40	644,73	853,53

Rectus Femoris equivalent to Patellar and Hamstring

INTRODUCTION

ACL Hot Topics

- Ramp Lesions
- Rectus Femoris
- Hamstring Graft Configuration

INTRODUCTION

ACL Hamstring Graft

A Nationwide Profile of ACL Reconstruction in Brazil: Graft Choice, Extra-Articular Procedures, and Meniscal Management

Escudeiro D.; Baches P; Franciozi C; Padua V; Funchal LF; Helito C

Submitted for publication

Hamstring tendon	344	90.1%
Bone–patellar tendon–bone (BTB)	22	5.8%
Rectus femoris tendon	10	2.6%
Quadriceps tendon (soft tissue)	3	0.8%
Peroneus longus	1	0.3%
Synthetic graft	1	0.3%
Other	1	0.3%
—	—	—

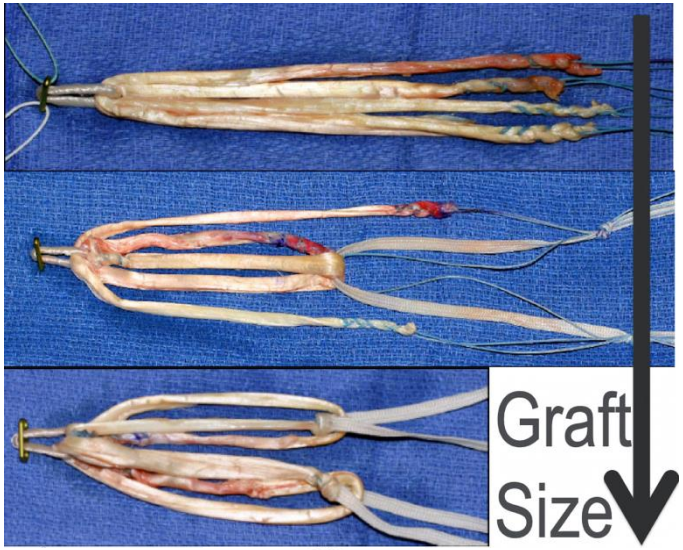
90% primary choice

INTRODUCTION

Graft Preparation

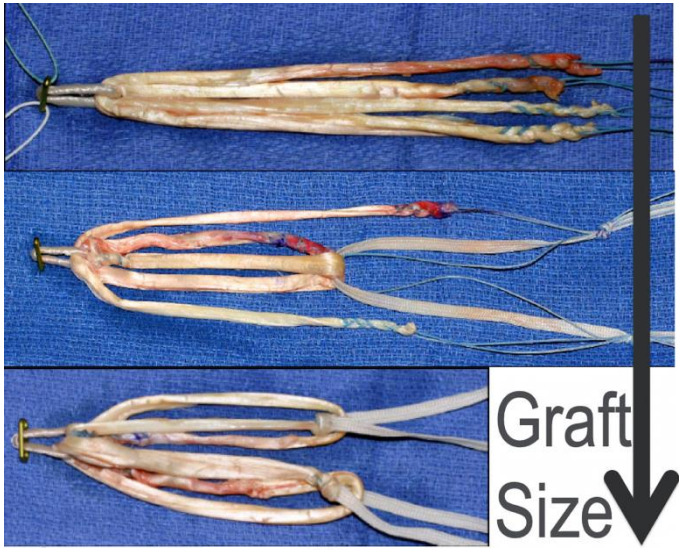
INTRODUCTION

Graft Preparation



INTRODUCTION

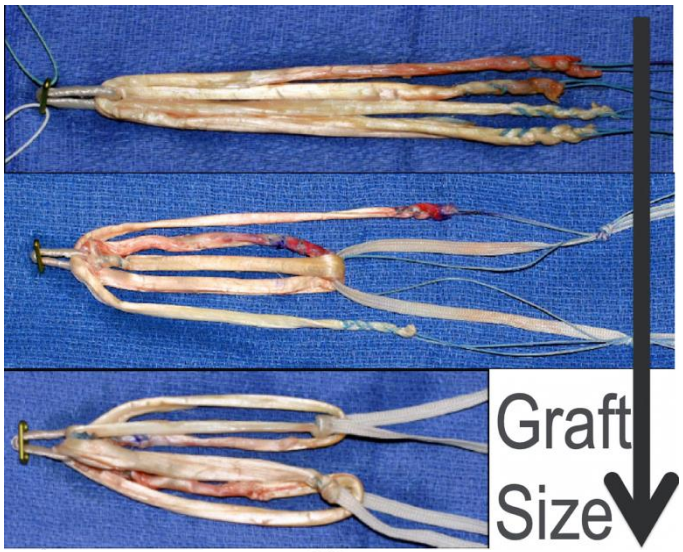
Graft Preparation



ALL

INTRODUCTION

What is the best hamstring graft configuration for ACL reconstruction?



ALL

OBJECTIVE

COMPARE ACL HS CONFIGURATION:

ACL + ALL

Versus

ACL Quintuple or Sextuple

METHODS

RANDOMIZED CONTROLLED TRIAL

Multicentric

ClinicalTrials.gov PRS
Protocol Registration and Results System

ClinicalTrials.gov Protocol Registration and Results System (PRS) Receipt

ClinicalTrials.gov ID: NCT06505525

Study Identification

Unique Protocol ID:	U1111-1297-1650
Brief Title:	Combined Intra- and Extra-articular ACL Reconstruction Versus Isolated Intra-articular ACL Reconstruction
Official Title:	Combined Intra- and Extra-articular ACL Reconstruction Versus Isolated Intra-articular ACL Reconstruction: Prospective Multicenter Randomized Clinical Trial With Hamstring Autograft

https://www.randomizer.org

Block Randomization

Population

Primary ACL injury
in high risk (for relesion) patients
from 14♀/16♂ – 40 years

Inclusion Criteria (ONE or more)

- ***Age (♀ 14 – 25 years; ♂ 16 - 25 years)***
- ***Explosive pivot-shift***
- ***Chronic ACL injury (>12 months)***
- ***Athlete (Tegner Scale ≥ 7)***
- ***Tibial slope > 12º***
- ***Recurvatum***
- ***Hypermobility (Beighton > 5)***

Non-Inclusion Criteria

- Age > 40years
- ACL revision
- Other ligament injury: PCLinjury (grade 2 and 3); MCLinjury (grade 2 and 3) or (grade 1 with valgus aligned axis); PLCinjury (grade 2 and 3 Fanelli classification)
- Recurrent patellar dislocation
- Chondral lesion ICRS grade 3 and 4>1cm^2
- Previous ipsilateral knee surgery
- Kellgren-Lawrence grade 3 o 4
- Inflammatory disease
- Contralateral knee ligament injury
- Malalignment: >5º of clinical asymmetry or symmetric >10º varus or valgus
- Final ACL graft diameter <=7mm (Final graft diameter HAD TO BE be >=8mm)
- BMI >35 or < 18
- Active malignant neoplasia
- Pregnancy
- Psychiatric-disorders

Data Collection

Physicians: in person visits

Maia Health

https://healthmaia.com

- **Remote and blinded**
- **HIPAA-compliant**
- **SMS, WhatsApp** (IKDC, Lysholm, Tegner, VAS)

REDCap

Research Electronic Data Capture

Outcomes

Primary

Clinical Failure

Pivot shift
- ≥ 1+ in more than one return
- ≥ 2+ at any return

Graft Rupture

(confirmed by MRI or arthroscopy in the presence of any clinical failure criteria)

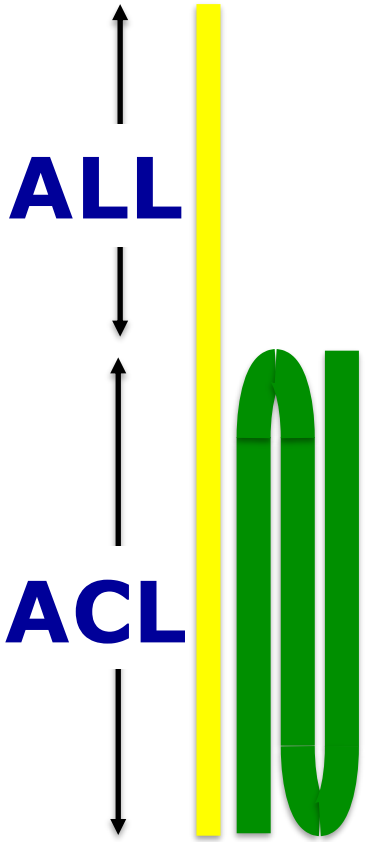
Outcomes

Secondary

- **IKDC**
- **Lysholm**
- **Tegner**
- **Objective IKDC**
- **Digital Rolimeter**
- Tampa Scale of Kinesiophobia
- Anxiety and Depression Scale

METHODS - Surgery

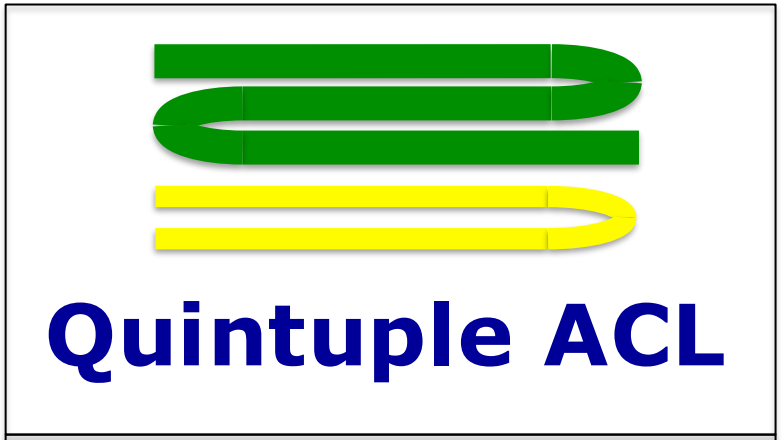
Group ACL + ALL



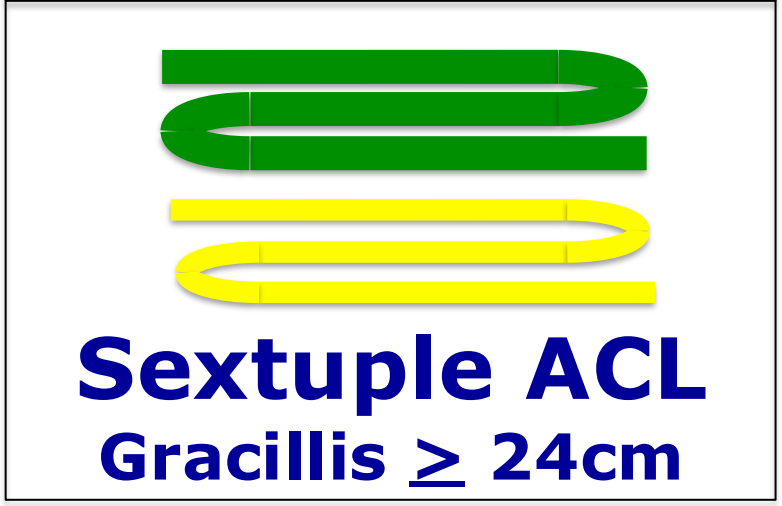
Semitendinosus

Gracilis

Group ACL



Quintuple ACL



Sextuple ACL

Gracillis ≥ 24cm

METHODS - Surgery

Group ACL + ALL

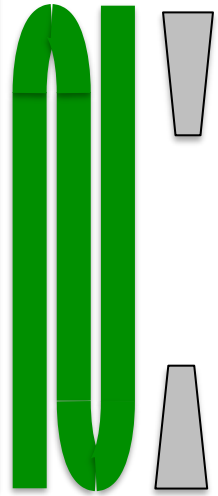
OUT-IN Femoral Technique

Group ACL

ALL

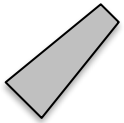
ACL

Camilo single bundle
Ethibond fixation

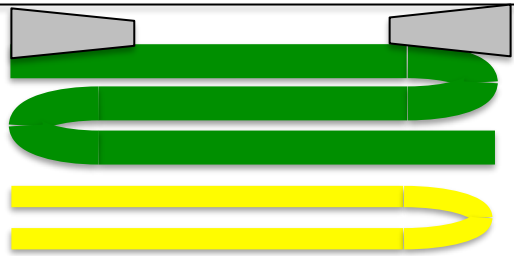


Semitendinosus

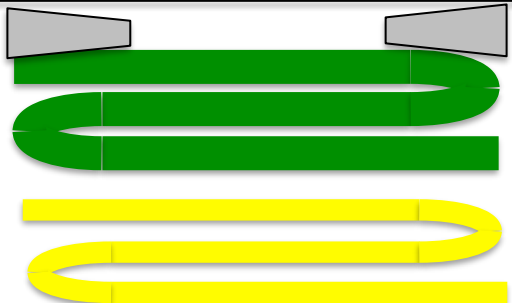
Gracilis



Interference Screw



Quintuple ACL



Sextuple ACL
Gracillis ≥ 24cm

Statistical Analysis

<u>Sample Size</u>
126 patients (Power 80%)
15% loss: 145 patients

Continuous numerical variables
Means, standard deviation, independent-samples t tests or Mann–Whitney U tests

Qualitative Variables
% in each group
chi-square or Fisher's exact tests

Results

Recruitment: 3 years and 5 months
(Started August 2022) (**Public Health System**)

112/129 **patients with at least 1y FU** (13% loss)
Follow-up: 29.72 ± 11.95 months (12 - 41.8)

Results

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(Started August 2022) (**Public Health System**)

112/129 **patients with at least 1y FU** (13% loss)
Follow-up: 29.72 ± 11.95 months (12 - 41.8)

63 ACL+ALL **X** **49 ACL** **(5/6xHamstring)**

75% Males

68.8% ACLs combined with meniscal injury

58.9% Meniscal injuries repaired

Results Pre-op

Baseline Characteristics & Group Homogeneity

Variable	ACL (n = 63)	ACL + ALL (n = 49)	P value	SMD
FOLLOW-UP TIME	29.94 ± 11.83 (3.91–41.46)	29.50 ± 12.07 (4.17–41.79)	0.849	0.04
SEX	Female 18 (28.6%) / Male 45 (71.4%)	Female 6 (12.2%) / Male 39 (79.6%)	**0.012**	—
AGE	31.12 ± 7.45 (18–44)	27.09 ± 6.05 (14–39)	**0.003**	0.59
BMI	25.95 ± 3.11 (19.9–33.0)	24.84 ± 2.75 (19.7–33.6)	0.090	0.38
PREOP FLEXION	126.54 ± 26.71 (0–140)	130.03 ± 24.26 (0–140)	0.522	-0.14
PREOP EXTENSION	1.62 ± 20.67 (-34–140)	3.85 ± 21.39 (-11–130)	0.622	-0.11
PREOP ROM	124.92 ± 41.75 (-140–142)	126.18 ± 44.08 (-130–151)	0.891	-0.03
PRE-INJURY TEGNER	6.26 ± 2.19 (1–10)	5.79 ± 1.75 (1–10)	0.245	0.24
PREOP IKDC	51.03 ± 18.58 (15–92)	49.30 ± 19.03 (16–86)	0.660	0.09
PREOP LYSHOLM	49.37 ± 19.00 (16.09–86.20)	54.85 ± 30.11 (0–94)	0.324	-0.22
PREOP VAS PAIN	3.19 ± 2.84 (0–9)	3.24 ± 3.10 (0–8)	0.922	-0.02
PREOP TAMPA	38.81 ± 9.36 (19–58)	44.08 ± 9.85 (21–65)	**0.011**	-0.55
PREOP ANXIETY	6.26 ± 4.00 (0–17)	5.68 ± 3.34 (0–14)	0.446	0.16
PREOP DEPRESSION	3.44 ± 3.21 (0–14)	3.46 ± 3.20 (0–12)	0.977	-0.01
MENISCAL INJURY	43 / 63 (68.3%)	34 / 49 (69.4%)	0.899	—
MENISCAL REPAIR	26 / 63 (41.3%)	20 / 49 (40.8%)	0.328	—
PARTIAL MENISCECTOMY	17 / 63 (27.0%)	13 / 49 (26.5%)	0.675	—

Primary Outcome

1 YEAR FAILURE

Outcome	ACL	ACL + ALL	Between-Group Comparison
Failure rate (%)	9.8%	18.2%	+8.4% absolute difference
Risk Ratio (ACL+ALL vs ACL)	—	1.85x	ACL + ALL higher risk
P value	—	—	0.33

Primary Outcome

1 YEAR FAILURE

Outcome	ACL	ACL + ALL	Between-Group Comparison
Failure rate (%)	**9.8%**	**18.2%**	+8.4% absolute difference
Pivot ≥ 1+ in more than one return	7.8% (95% CI: 2.5-18.9%)	15.2% (95% CI: 6.7-30.9%)	+7.4%
Pivot ≥ 2+ at any return	2% (95% CI: 0.3-10.4%)	3% (95% CI: 0.5-15.3%)	+1%

Most of the failures:
Persistent low-grade pivot 1+, rather than gross instability

Primary Outcome

1 YEAR FAILURE

Outcome	ACL	ACL + ALL	Between-Group Comparison
Failure rate (%)	**9.8%**	**18.2%**	+8.4% absolute difference
Pivot ≥ 1+ in more than one return	7.8% (95% CI: 2.5-18.9%)	15.2% (95% CI: 6.7-30.9%)	+7.4%
Pivot ≥ 2+ at any return	2% (95% CI: 0.3-10.4%)	3% (95% CI: 0.5-15.3%)	+1%
Graft Rupture (MRI or Arthro)	0	n=1 *new trauma at 8 months	n=1

Secondary Outcomes - 1 year

PROs & Change Scores

Outcome	ACL	ACL+ALL	P value	SMD
IKDC	63.3 ± 21.6	63.5 ± 19.9	0.958	−0.01
Lysholm	64.9 ± 27.9	59.3 ± 28.6	0.467	−0.20
Tegner	4.58 ± 2.72	3.81 ± 1.44	0.190	+0.35
IKDC Δ	+23.7 ± 19.8	+25.1 ± 17.3	0.809	−0.07
Lysholm Δ	+22.4 ± 25.4	+20.1 ± 22.8	0.792	+0.09
Tegner Δ	−1.36 ± 3.02	−1.58 ± 1.89	0.759	+0.09

No difference

Secondary Outcomes - 1 year

MCID Achievement (Distribution-Based)

*MCID definition: improvement ≥ 0.5 SD of pooled baseline score

Outcome	ACL	ACL+ALL	P value
IKDC MCID+	70.8%	89.5%	0.257
Lysholm MCID+	81.0%	70.6%	0.703

High rates of meaningful improvement in both cohorts
No difference

PASS Achievement

*IKDC PASS ≥ 75.9; Lysholm PASS ≥ 85

Outcome	ACL	ACL+ALL	P value
IKDC PASS+	60.0%	71.4%	0.553
Lysholm PASS+	71.0%	85.7%	0.318

Trends higher in ACL+ALL but without statistical support

Secondary Outcomes - 1 year

Objective IKDC

Test	Group	A%	B%	C%	D%	P value
Lachman	ACL	55.9	44.1	0	0	0.260
	ACL+ALL	39.1	56.5	4.3	0	
Anterior Drawer	ACL	32.4	64.7	2.9	0	0.858
	ACL+ALL	26.1	69.6	4.3	0	
Pivot Shift	ACL	64.7	35.3	0	0	0.658
	ACL+ALL	73.9	26.1	0	0	

Digital Rolimeter (mm)

Group	Mean ± SD	P value
ACL	−3.83 ± 31.31	
ACL+ALL	−3.72 ± 27.58	0.989

Secondary Outcomes - 1 year

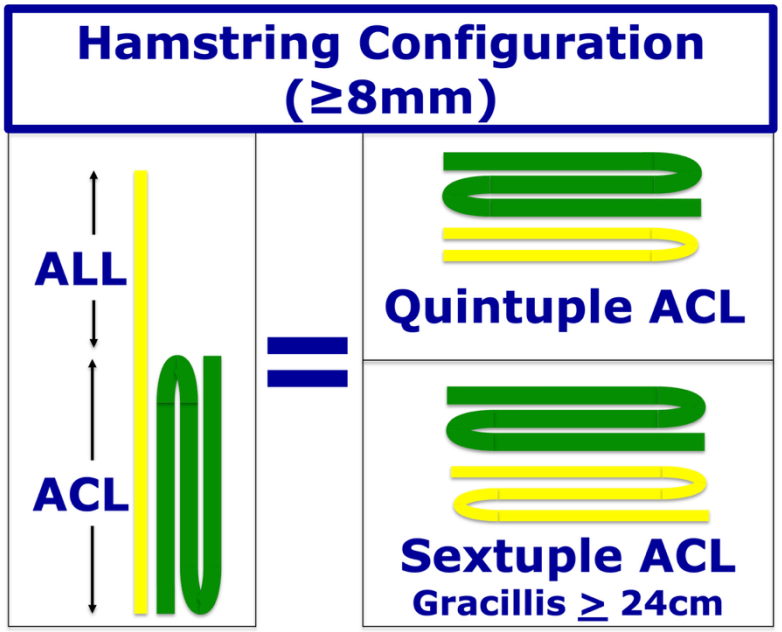
Complications & Reoperations

	ACL	ACL+ALL	P value
Complications	7.9%	6.1%	1.000
Reoperation	3.2% 2 MUA	6.1% New trauma at 8 months – GRAFT RUPTURE: Revision BTB + Lemaire MM Root: Reinsertion Stress fracture: Plate + Iliac graft	0.652

No difference

Conclusion

At 1 year, outcomes did not differ significantly between ACL+ALL versus hamstring quintuple or sextuple ACL reconstructions in high-risk patients, despite a numerically higher clinical failure rate with ACL+ALL (NS).



Study is still ongoing

Thank You