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CLINICAL AND FUNCTIONAL OUTCOMES OF AUGMENTED REPAIR VERSUS PRIMARY REPAIR IN ANTERIOR CRUCIATE LIGAMENT INJURY: A SYSTEMATIC REVIEW AND META-ANALYSIS

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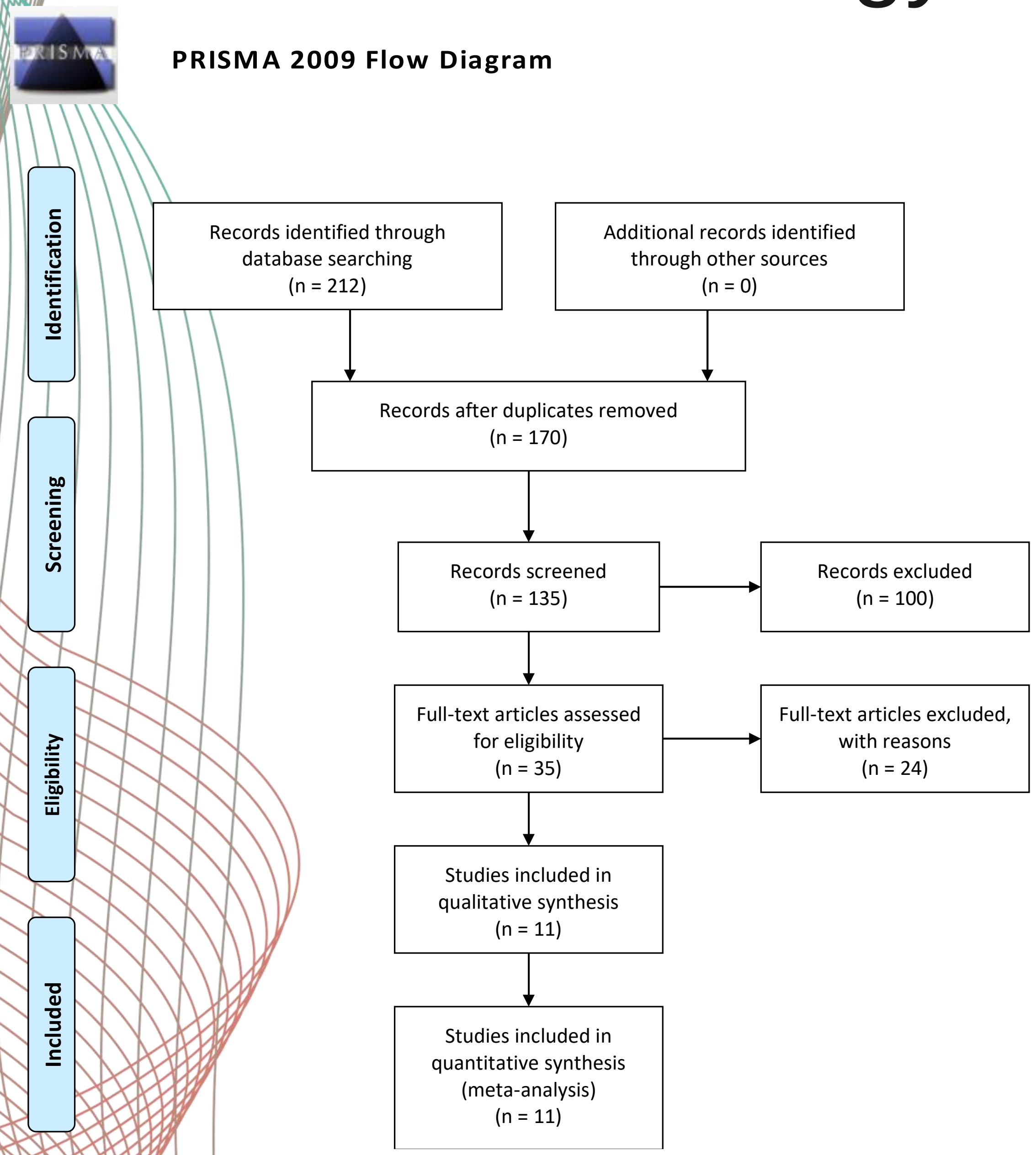
Disclosures: Nil

Background & Aims

"Orthopaedic surgeons have been seeking it for more than a century… Some call it the holy grail of orthopaedic sports medicine…primary repair of the anterior cruciate ligament."

- Gold-standard surgical treatment of anterior cruciate ligament (ACL) rupture is arthroscopic reconstruction.
- **Renewed interest** in primary repair, and in particular, augmented repairs of the ACL due to its perceived advantages of native ligament preservation with added biomechanical stability, minimized invasiveness, negated graft-donor site morbidity, decreased rates of secondary osteoarthritis, and earlier mobilization.
- Heterogeneity in both technique and form of augmentation.
- However, controversy remains over the exact benefits of augmentation in primary surgical repair, with a lack of clear evidence demonstrating its superiority over primary repair alone.
- The aim of this systematic review and meta-analysis is to compare the long-term clinical outcomes of ***augmented ACL repair*** against ***primary ACL repair without augmentation.***

Methodology



- PRISMA guidelines were utilized as a framework for this meta-analysis.
- An electronic search was performed in Cochrane, Embase, PubMed, Medline, & Scopus databases to identify all studies published up to July 2021 that fit the inclusion criteria.
- The same two search strings, (1) “ACL repair AND augmented” and (2) “Anterior Cruciate Ligament AND augmented”, were used in each of the five databases.
- Data extracted from 11 selected studies
- Specific outcomes identified included:

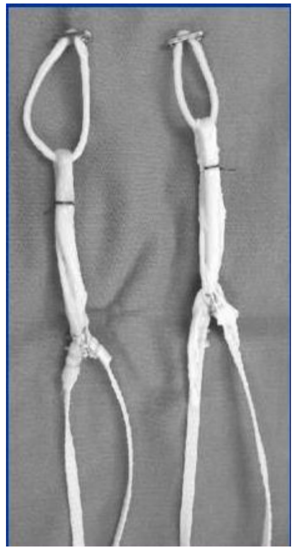
i) Revision rates (defined as graft rupture or revision ACL reconstruction)

ii) Incidence of osteoarthritis (defined as at least Grade 2 changes according to the Ahlbäck Classification)

iii) Clinical laxity on physical examination (pivot shift positive defined as 1+ or greater and Lachman test positive defined as 1+ or greater)

iv) Instrumented laxity using the KT-1000 arthrometer (MEDmetric, San Diego, California) (positive defined as $\geq$3 mm)

Results

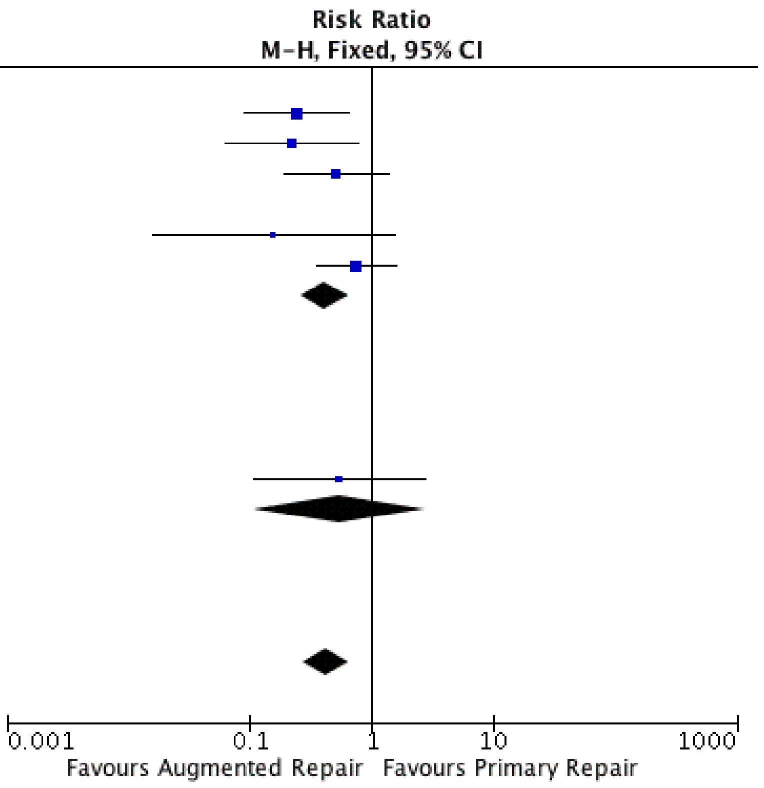


- Case control: 4; prospective RCTs: 7
- Level I studies: 7; Level II: 4
- Compare 2 interventions: 6; Compare 3 interventions (2 types of augmented repair vs primary repair): 5
- Augmented repairs
  - Kennedy Ligament Augmentation Device (6)
  - Bone Patellar Tendon Bone (BPTB) augmentation (5)
  - Others: Distal-based Iliotibial Strip, Semitendinosus Tendon, Carbon Fibres, Internal Bracing and Parapatellar Transcondylar Transposition Technique.
- Mean age for augmented repair versus primary repair was 33 ± 5 and 35 ± 5 respectively ($p<0.05$).
- Follow-up period= 1 year to 30 years; mean 7 years.

Number of Revisions

- Patients undergoing augmented repair were less likely to undergo subsequent revision surgery, as compared to primary repair.
- RR for revisions was 0.42, favoring augmented repair (95% CI: 0.27-0.65, $p<0.05$) over primary repair.

Study or Subgroup	Augmented Repair Events	Augmented Repair Total	Primary Repair Events	Primary Repair Total	Weight	Risk Ratio M-H, Fixed, 95% CI
1.1.1 Randomised Controlled Trials						
Drogset 2006	5	84	11	45	27.7%	0.24 [0.09, 0.66]
Grøntvedt 1995	3	49	7	25	17.9%	0.22 [0.06, 0.77]
Grøntvedt 1996	7	97	7	50	17.9%	0.52 [0.19, 1.39]
Harilainen 1987	0	24	0	29		Not estimable
Meunier 2006	1	32	2	10	5.9%	0.16 [0.02, 1.55]
Sporsheim 2019	9	39	12	39	23.2%	0.75 [0.36, 1.57]
Subtotal (95% CI)		**325**		**198**	**92.5%**	**0.41 [0.26, 0.65]**
Total events	25		39			
Heterogeneity: $Chi^2 = 5.43$, df = 4 (P = 0.25); $I^2 = 26\%$						
Test for overall effect: Z = 3.88 (P = 0.0001)						
1.1.2 Observational Studies						
Jonkergouw 2018	2	27	4	29	7.5%	0.54 [0.11, 2.70]
Subtotal (95% CI)		**27**		**29**	**7.5%**	**0.54 [0.11, 2.70]**
Total events	2		4			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.75 (P = 0.45)						
Total (95% CI)		**352**		**227**	**100.0%**	**0.42 [0.27, 0.65]**
Total events	27		43			
Heterogeneity: $Chi^2 = 5.49$, df = 5 (P = 0.36); $I^2 = 9\%$						
Test for overall effect: Z = 3.92 (P < 0.0001)						
Test for subgroup differences: $Chi^2 = 0.10$, df = 1 (P = 0.76), $I^2 = 0\%$						

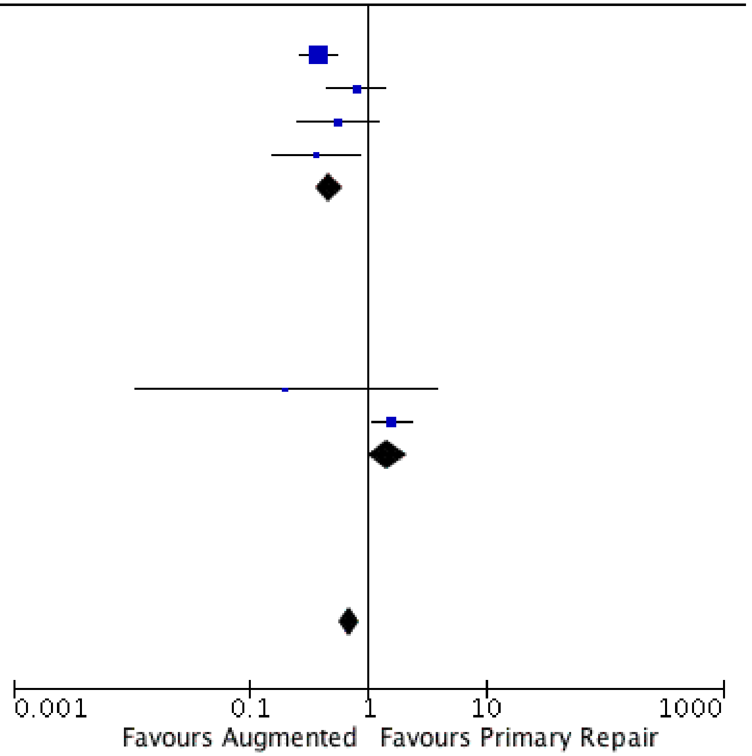


Grade + Pivot Shift Test

- A positive Pivot shift test was less likely to be found in augmented repair versus primary repair (RR 0.69, 95% CI: 0.56-0.85, $p<0.05$).

Study or Subgroup	Augmented Repair Events	Augmented Repair Total	Primary Repair Events	Primary Repair Total	Weight	Risk Ratio M-H, Fixed, 95% CI
11.1.1 Randomised Controlled Trials						
Engebretson 1990	27	90	38	48	46.8%	0.38 [0.27, 0.54]
Grøntvedt 1995	15	34	10	18	12.4%	0.79 [0.45, 1.39]
Harilainen 1987	6	24	13	29	11.1%	0.56 [0.25, 1.24]
Meunier 2006	7	31	5	8	7.5%	0.36 [0.16, 0.84]
Subtotal (95% CI)		**179**		**103**	**77.8%**	**0.47 [0.36, 0.61]**
Total events	55		66			
Heterogeneity: Chi² = 5.39, df = 3 (P = 0.15); I² = 44%						
Test for overall effect: Z = 5.63 (P < 0.00001)						
11.1.2 Observational Studies						
Aho 1986	0	13	2	13	2.4%	0.20 [0.01, 3.80]
Zysk 2000	49	67	16	35	19.9%	1.60 [1.08, 2.36]
Subtotal (95% CI)		**80**		**48**	**22.2%**	**1.45 [0.99, 2.13]**
Total events	49		18			
Heterogeneity: Chi² = 1.98, df = 1 (P = 0.16); I² = 50%						
Test for overall effect: Z = 1.90 (P = 0.06)						
Total (95% CI)		**259**		**151**	**100.0%**	**0.69 [0.56, 0.85]**
Total events	104		84			
Heterogeneity: Chi² = 32.82, df = 5 (P < 0.00001); I² = 85%						
Test for overall effect: Z = 3.51 (P = 0.0004)						
Test for subgroup differences: Chi² = 22.68, df = 1 (P < 0.00001), I² = 95.6%						

Risk Ratio
M-H, Fixed, 95% CI



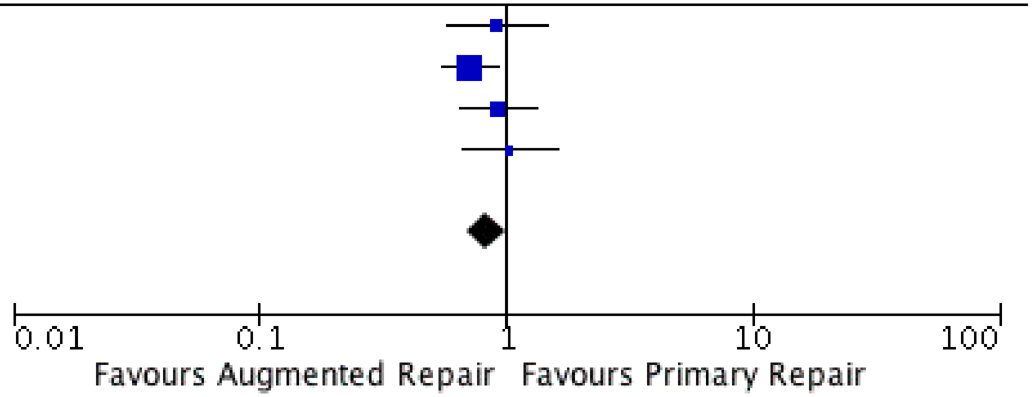
Grade + Lachman Test

- Grade 1+ Lachman test was also less likely to be found in augmented repair (RR 0.83, 95% CI, 0.69-1.00, p<0.05).

	Augmented Repair		Primary Repair			Risk Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% CI
Grøntvedt 1995	19	34	11	18	17.1%	0.91 [0.57, 1.47]
Grøntvedt 1996	47	90	30	41	49.0%	0.71 [0.54, 0.94]
Harilainen 1987	16	24	21	29	22.6%	0.92 [0.64, 1.32]
Meunier 2006	24	31	6	8	11.3%	1.03 [0.66, 1.61]
Total (95% CI)		**179**		**96**	**100.0%**	**0.83 [0.69, 1.00]**
Total events	106		68			

Heterogeneity: $Chi^2 = 2.60$, df = 3 (P = 0.46); $I^2 = 0\%$
Test for overall effect: Z = 2.00 (P = 0.05)

Risk Ratio
M-H, Fixed, 95% CI

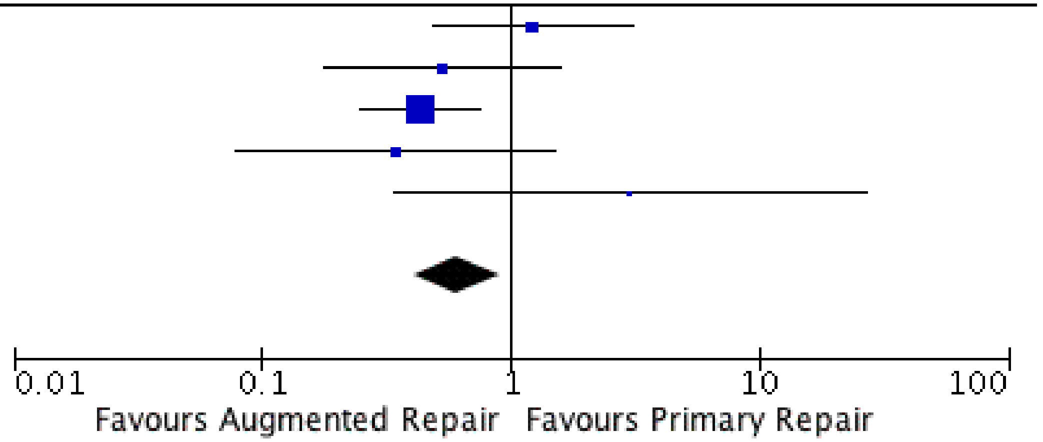


- Grade 2+ and 3+ Lachman's Test was less prevalent in augmented repair group (RR 0.61, 95% CI: 0.41-0.91, p<0.05), compared to primary repair.

	Augmented Repair		Primary Repair			Risk Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% CI
Drogset 2006	14	64	5	28	15.3%	1.23 [0.49, 3.07]
Grøntvedt 1995	5	34	5	18	14.3%	0.53 [0.18, 1.59]
Grøntvedt 1996	17	90	18	41	54.3%	0.43 [0.25, 0.75]
Harilainen 1987	2	24	7	29	13.9%	0.35 [0.08, 1.51]
Sporsheim 2019	3	23	1	23	2.2%	3.00 [0.34, 26.76]
Total (95% CI)		**235**		**139**	**100.0%**	**0.61 [0.41, 0.91]**
Total events	41		36			

Heterogeneity: $Chi^2 = 6.43$, df = 4 (P = 0.17); $I^2 = 38\%$
Test for overall effect: Z = 2.42 (P = 0.02)

Risk Ratio
M-H, Fixed, 95% CI

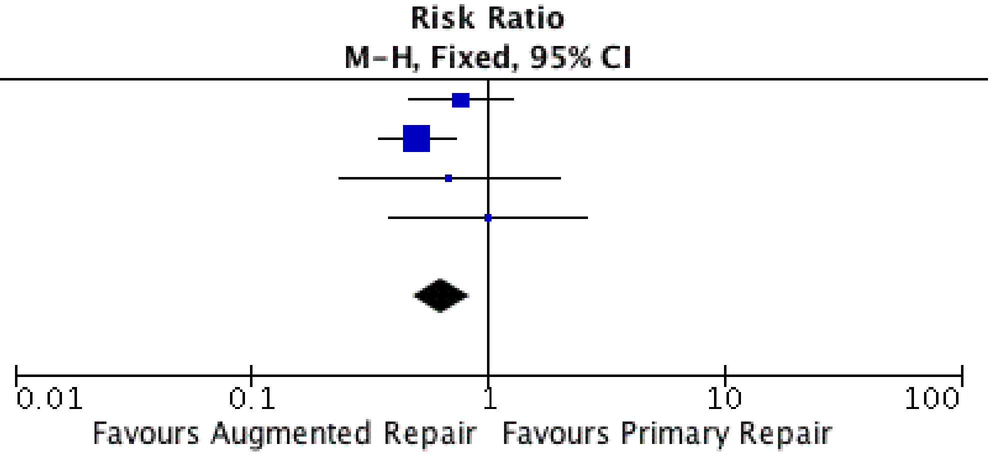


≥3mm KT-1000 Arthrometer

- Instrumented laxity testing via KT-1000 arthrometer also provided similar results for ligamentous stability, favoring the augmented group (RR 0.64, 95% CI: 0.48-0.84, $p<0.05$) over primary repair.

	Augmented Repair		Primary Repair			Risk Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% CI
Drogset 2006	23	62	13	27	27.5%	0.77 [0.46, 1.28]
Grøntvedt 1996	30	90	27	41	56.2%	0.51 [0.35, 0.73]
Meunier 2006	8	31	3	8	7.2%	0.69 [0.23, 2.02]
Sporsheim 2019	6	23	6	23	9.1%	1.00 [0.38, 2.65]
Total (95% CI)		**206**		**99**	**100.0%**	**0.64 [0.48, 0.84]**
Total events	67		49			

Heterogeneity: $Chi^2 = 2.90$, df = 3 (P = 0.41); $I^2 = 0\%$
Test for overall effect: Z = 3.21 (P = 0.001)



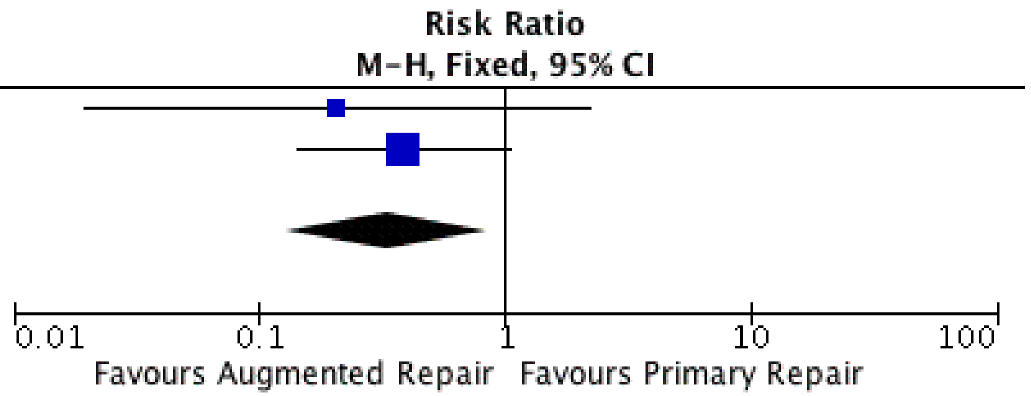
Osteoarthritis (Grade 2 Ahlbäck Classification)

- Amongst two studies that published the radiological grades of osteoarthritis during post-operative follow up of at least 15 years, the incidence of secondary osteoarthritis was found to be lower in the augmented repair group, as compared to primary repair (RR 0.33, 95% CI: 0.13-0.85, p<0.05).

	Augmented Repair		Primary Repair			Risk Ratio
Study or Subgroup	**Events**	**Total**	**Events**	**Total**	**Weight**	**M-H, Fixed, 95% CI**
Drogset 2006	1	80	2	33	30.8%	0.21 [0.02, 2.20]
Meunier 2006	6	31	4	8	69.2%	0.39 [0.14, 1.05]
Total (95% CI)		**111**		**41**	**100.0%**	**0.33 [0.13, 0.85]**
Total events	7		6			

Heterogeneity: $Chi^2 = 0.25$, df = 1 (P = 0.62); $I^2 = 0\%$

Test for overall effect: Z = 2.30 (P = 0.02)



Discussion

- ***Superior clinical outcomes for augmented repair*** of ACL tears compared to primary repair without augmentation.
- Patients who underwent ***augmented repair were less likely to have clinical laxity post operatively, and less likely to undergo subsequent revision surgery.***
- Vast majority of revision surgery were attributed to graft failure and/or chronic instability of the knee.
  - This has often been attributed to the poor tensile strength of the repaired construct, especially where absorbable sutures are used.
  - The location of tear has a significant bearing on the viability of the repair (potential confounding effect).
  - Future research to look into clinical long-term outcomes of Augmented ACL repairs against ACL reconstruction in proximal ACL tears?
- *Augmentation of ACL repairs with autogenous tissue (eg BPTB) appears to have the best clinical outcomes as compared to synthetic devices.*
- Newer techniques eg Internal brace ligament augmentation and dynamic intra-ligamentary stabilization have excellent short to mid-term clinical outcomes, but limited long term data.

Conclusion

- First such meta-analysis looking at augmented repairs versus primary repair without augmentation for ACL tears. However, there is heterogeneity in both technique and form of augmentation -> difficult to compare
- ***ACL repair with augmentation, compared to primary repair without augmentation, has favorable clinical outcomes in terms of lower revision rates, higher ligamentous stability, and lower incidence of secondary osteoarthritis.***

The quest for reliable primary ACL repair continues. Some of the reported results seem promising, while others are downright discouraging. In particular, younger patients

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