

Biologic Advantages of ACL Reconstruction in Meniscal Repair: Evidence from Synovial Fluid Biomarkers

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INTRODUCTION:

Meniscal repairs performed with anterior cruciate ligament reconstruction (ACLR) have demonstrated superior healing compared to isolated repairs. This benefit may stem from growth factor release during bone tunnel drilling. This study compared postoperative synovial fluid (SF) biomarker profiles between patients undergoing isolated meniscal repair and those undergoing meniscal repair with concomitant ACLR.

METHODS:

Patients undergoing arthroscopic meniscal repair between 2014-2024 were included if they had SF samples collected intraoperatively and at a postoperative clinic visit. Fourteen patients undergoing isolated repair with microfracture were matched 1:2 by age, sex, BMI, and symptom duration to 28 patients undergoing meniscal repair with ACLR. SF samples from the operative knee were analyzed for nine biomarkers. Biomarker concentrations were log-transformed, and independent t-tests were used to compare between groups.

RESULTS:

Fourteen patients undergoing isolated meniscal repair (“isolated” cohort) were successfully matched 1:2 to 28 patients undergoing meniscus repair with ACLR (“+ACLR” cohort). There were no significant differences in age, sex, BMI, symptom duration, or time to postoperative aspiration between groups. Preoperative log-normalized biomarker levels were similar across all nine markers. Postoperatively, the +ACLR group demonstrated significantly higher log-normalized levels of the growth factor VEGF (7.93 ± 0.65 vs. 7.24 ± 1.45 , $p = 0.040$), along with increased concentrations of pro-inflammatory RANTES (4.82 ± 1.74 vs. 3.19 ± 3.20 , $p = 0.009$) and anti-inflammatory IL1-Ra (5.21 ± 3.10 vs. 2.06 ± 2.02 , $p = 0.021$).

DISCUSSION AND CONCLUSION:

Patients undergoing meniscal repair with concomitant ACLR exhibited elevated postoperative levels of VEGF, a growth factor involved in tissue healing, compared to those undergoing isolated repair with microfracture. RANTES and IL1-Ra were also significantly elevated, potentially altering the inflammatory milieu. These findings support the hypothesis that ACLR may enhance the intra-articular healing environment for meniscal tears through increased growth factor availability.

Table 1: Comparison of Baseline Demographic and Injury Characteristics Between Isolated Meniscus Repair and Meniscus Repair with ACLR Groups

	Isolated Meniscus Repair	ACLR and Meniscus Repair	P Value
Age	39.33 ± 13.53	33.00 ± 9.27	0.131
Sex (male)	11 (78.6)	21 (75.0)	0.798
BMI	26.91 ± 3.93	26.82 ± 3.76	0.945
Symptom Duration (months)	6.95 ± 7.70	6.05 ± 11.80	0.799
Laterality (right)	13 (92.9%)	9 (32.1%)	<.001
Aspiration post-surgery (weeks)	1.80 ± 1.52 (0.9-5.55)	1.89 ± 2.08 (0.45-8.7)	0.897

BMI, Body Mass Index; ACLR, anterior cruciate ligament reconstruction

Table 2: Comparison of Log-Normalized Preoperative Synovial Fluid Biomarkers Between Isolated Meniscus Repair and Meniscus Repair with ACLR Groups

	Isolated Meniscus Repair	ACLR and Meniscus Repair	P Value
RANTES	3.76 ± 1.76	5.14 ± 2.40	0.208
IL6	3.15 ± 3.26	2.23 ± 2.86	0.521
MCP-1	6.54 ± 0.98	5.83 ± 1.11	0.172
MIP	3.34 ± 1.99	3.76 ± 1.43	0.666
VEGF	5.72 ± 1.42	5.55 ± 1.14	0.787
TIMP1	11.89 ± 4.38	11.17 ± 3.85	0.706
IL1-Ra	4.60 ± 1.79	4.37 ± 1.81	0.797
MMP-3	13.19 ± 0.70	13.98 ± 2.16	0.436
bFGF	3.54 ± 1.49	2.87 ± 1.87	0.433

RANTES, Regulated on Activation Normal T Cell Expressed and Secreted; IL-6, Interleukin-6; MCP-1, Monocyte Chemoattractant Protein-1; MIP, Macrophage Inflammatory Protein; VEGF, Vascular Endothelial Growth Factor; TIMP-1, Tissue Inhibitor of Metalloproteinases-1; IL1-Ra, Interleukin-1 Receptor Antagonist; MMP-3, Matrix Metalloproteinase-3; bFGF, Basic Fibroblast Growth Factor

Table 3: Comparison of Log-Normalized Postoperative Synovial Fluid Biomarkers Between Isolated Meniscus Repair and Meniscus Repair with ACLR Groups

	Isolated Meniscus Repair	ACLR and Meniscus Repair	P Value
RANTES	3.19 ± 3.20	4.82 ± 1.74	0.009
IL6	4.22 ± 4.29	6.14 ± 3.38	0.148
MCP-1	7.63 ± 0.76	7.08 ± 1.32	0.225
MIP	5.06 ± 1.78	4.63 ± 1.45	0.466
VEGF	7.24 ± 1.45	7.93 ± 0.65	0.040
TIMP1	9.43 ± 4.55	11.61 ± 3.81	0.234
IL1-Ra	2.06 ± 2.02	5.21 ± 3.10	0.021
MMP-3	14.97 ± 2.09	15.45 ± 1.93	0.584
bFGF	1.69 ± 1.01	2.07 ± 1.26	0.347

RANTES, Regulated on Activation Normal T Cell Expressed and Secreted; IL-6, Interleukin-6; MCP-1, Monocyte Chemoattractant Protein-1; MIP, Macrophage Inflammatory Protein; VEGF, Vascular Endothelial Growth Factor; TIMP-1, Tissue Inhibitor of Metalloproteinases-1; IL1-Ra, Interleukin-1 Receptor Antagonist; MMP-3, Matrix Metalloproteinase-3; bFGF, Basic Fibroblast Growth Factor