Six-week KOOS Sports Score After Knee Chondroplasty Correlates with Future Cartilage Transplantation

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Introduction: Certain biomarkers have been found to correlate with outcomes in anterior cruciate ligament reconstructions and other arthroscopic procedures, however, the correlation of baseline cytokines and outcomes after chondroplasty have not been elucidated. The purpose of this study was to investigate the correlations between intraoperative inflammatory cytokines, early patient reported outcome scores (PROs), and minimum one-year outcomes in patients undergoing arthroscopic chondroplasty for cartilage defects of the knee.

Methods: Forty-four patients were included. All patients had preoperative MRI and completed preoperative Knee injury and Osteoarthritis Outcome Score (KOOS) and International Knee International Knee Documentation Committee (IKDC) Subjective Knee Forms. Sterile aspiration of synovial fluid of the operative knee was performed prior to initiation of diagnostic arthroscopy and chondroplasty. Patients also had follow-up PRO scores available at a minimum of one year postoperatively or had record of a repeat surgery on the operative knee for cartilage etiology at any timepoint. Multiplex ELISA was run on intraoperative synovial fluid aspirations for PDGF, CCL-5, MMP-3, MMP-1, EGF, VEGF, IL-1a, FGF, CCL-2, BMP-2, and aggrecan.

Patients were assigned to a Failure or Non-Failure cohort. Failure was defined as requiring subsequent surgical treatment for cartilage etiology of the ipsilateral knee. Subsequent surgeries included conversion to osteochondral allograft (OCA) transplantation, subchondral stabilization, and total knee arthroplasty (TKA).

Akaike Information Criterion (AIC) was utilized to select the best-fit multivariate regression model using the PRO, defect characteristic, and cytokine concentration most significantly different between failure and non-failure groups on univariate analysis. Multivariate probit regression modeling was used to determine the independent variables most significantly correlated with a binary outcome of chondroplasty failure. All testing was two-sided and significance was set at p<0.05.

Results: The failure group (n=16 patients; 13 OCA, 1 subchondral stabilization, 2 TKA) had a mean time to failure of 5.08 ± 10.30 months (1.29 ± 1.23 months for conversion to OCA). Groups were equivalent in sex, age, number of defects treated, and occurrence of concomitant procedure. The failure group had larger defect areas (482.97 ± 404.83 vs. 272.06 ± 228.00 mm^2, p=0.026), and concentrations of MMP-1 (p=0.002), VEGF (p=0.024), IL-1a (p=0.012), and CCL-2 (p=0.019) **(Table 1)**. The failure group had significantly worse PRO scores (IKDC and all KOOS subscores) at both 2 weeks and 6 weeks postoperatively. In addition, the failure cohort had worse preoperative KOOS quality of life (QOL) and KOOS Jr scores compared to the non-failure group. We used AIC model selection to distinguish among a set of possible multivariate models describing the relationship between outcome, defect area, MMP-1 concentration, and six-week KOOS Sports. The best-fit model found six-week KOOS Sports scores to be independently correlated with future chondroplasty failure (p= 0.004) **(Figure 1)**.

Discussion: Our study found significantly higher intraoperative synovial fluid concentrations of inflammatory cytokines in chondroplasty patients who later required subsequent surgery related to their chondral defects compared to a cohort of non-failure patients. Multivariate analysis found six-week KOOS Sports scores are independently correlated with failure.

Clinical Relevance: Synovial fluid concentrations of inflammatory cytokines can aid surgeons in predicting patients who will require cartilage restoration procedures after a chondroplasty.

		Failures (n=16)	Non-Failures (n=28)	P-Value
	Age	34.89 ± 7.94	31.76 ± 7.96	0.289
	Male	9 (52.94%)	15 (53.57%)	0.876
	Female	7	13	
	Concomitant Procedure	8 (50%)	16 (57.14%)	0.661
	Number of defects treated	1.75 ± 1	1.32 ± 0.61	0.142
	Total defect area	482.97 ± 404.83	272.06 ± 228.00	*0.026
ICRS Grade	4	14 (87.5%)	16 (59.26%)	0.129
	3	1 (6.25%)	7 (25.93%)	
	2	1 (6.25%)	2 (7.41%)	
	AMADEUS	51.15 ± 16.60	51.30 ± 21.15	0.838
	PDGF-BB	147.07 ± 494.83	95.95 ± 328.13	0.120
	CCL-5	1192.16 ± 3755.18	1163.69 ± 3000.08	0.661
	MMP-3	76241.64 ± 54017.19	83804.22 ± 62349.28	0.759
	MMP-1	18395.97 ± 10936.41	7944.96 ± 11238.22	*0.002
	EGF	24.40 ± 69.73	19.03 ± 61.99	0.137
	VEGF	486.66 ± 390.87	284.95 ± 180.11	*0.024
	IL-1 alpha	57.79 ± 15.49	45.83 ± 20.76	*0.012
	FGF	1037.47 ± 710.44	1407.70 ± 770.87	0.073
	CCL-2	569.69 ± 247.42	394.69 ± 196.75	*0.019
	BMP-2	109.62 ± 118.21	63.35 ± 49.59	0.200
	Aggrecan	3175.22 ± 1357.89	2713.71 ± 1146.13	0.457
IKDC	PreOp	35.42 ± 13.70	44.44 ± 15.40	0.078
	6Wk	42.72 ± 12.97	60.63 ± 11.72	*0.024
KOOS Pain	PreOp	49.01 ± 14.06	56.94 ± 20.79	0.127
	2Wk	49.65 ± 19.89	71.37 ± 18.68	*0.038
	6Wk	58.12 ± 16.02	79.17 ± 11.59	*<0.001
KOOS Symptoms	PreOp	50.26 ± 14.92	54.21 ± 20.20	0.470
	2Wk	47.32 ± 15.94	66.48 ± 15.12	*0.022
	6Wk	56.59 ± 16.68	76.43 ± 13.23	*0.002
KOOS ADL	PreOp	59.24 ± 15.83	69.12 ± 21.93	0.115
	2Wk	58.09 ± 17.89	78.92 ± 19.98	*0.020
	6Wk	67.53 ± 17.25	87.06 ± 9.84	*0.001
KOOS Sport	PreOp	20.71 ± 18.90	33.75 ± 23.08	0.058
	2Wk	15.63 ± 19.72	49.23 ± 26.76	*0.006
	6Wk	21.15 ± 22.19	60.25 ± 25.57	*<0.0001
KOOS QOL	PreOp	15.18 ± 13.14	24.96 ± 12.56	*0.026
	2Wk	11.72 ± 22.27	41.35 ± 20.18	*0.012
	6Wk	21.15 ± 24.55	47.50 ± 21.40	*0.002
KOOS Jr	PreOp	50.25 ± 11.85	59.01 ± 15.60	*0.046
	2Wk	51.78 ± 12.80	66.17 ± 15.32	*0.047
	6Wk	59.72 ± 11.37	74.61 ± 12.31	*0.009

Table 1. Comparison of demographics, defect characteristics, synovial cytokines, and PRO's between chondroplasty failure and non-failure groups. Significance is set at p<0.05 and indicated by yellow highlight and *.
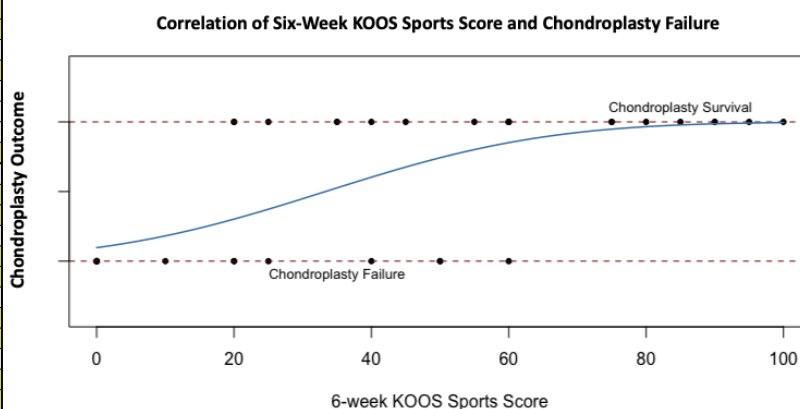

Figure 1. Probit regression graph demonstrating the nonlinear relationship between six-week KOOS Sports score and the probability of chondroplasty failure.