Effect of Post-Operative Apprehension and J-Sign on Outcomes following Medial Patellofemoral Ligament Reconstruction for Recurrent Patellar Instability: Data from the JUPITER Cohort

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INTRODUCTION:

The most suitable treatment of recurrent patellofemoral instability (PFI) poses a challenge due to the multifactorial nature of patient characteristics. Identification of patients in need of bony realignment in addition to soft tissue stabilization is of the utmost importance in the comprehensive treatment of patellofemoral instability. The presence of a J-sign on physical exam has been associated with failure of isolated medial patellofemoral ligament (MPFL) reconstruction. The purpose of this study is to investigate whether persistence of J-sign and apprehension sign post-operatively indicate sub-optimal outcomes after isolated MPFL reconstruction to identify patients who might benefit from additional bony realignment.

METHODS:

All patients were enrolled from the prospectively collected multi-center Justifying Patellar Instability by Results (JUPITER) cohort study. Twenty-seven surgeons from twelve academic centers throughout the United States enrolled patients with a primary complaint of patellar instability and performed procedures as guided by their specific training and clinical indications. Inclusion criteria were patients who underwent a primary, single-stage, isolated MPFL reconstruction without concomitant bony procedure from January 2017 through July 2022. Pre-operative variables of interest included age, sex, BMI, Beighton score, presence of ≥ 10° knee hyperextension, Caton-Deschamps Index (CDI), tibial tubercle-trochlear groove distance (TT-TG), axial width of the patellar tendon beyond the lateral trochlear ridge (PT-LTR), pre-operative J-sign (none, mild, or severe (jumping)), and trochlear dysplasia (Trochlear Depth Index (TDI) < 3 mm). Post-operative variables included recurrent instability (subluxation or dislocation), persistent J-sign, positive apprehension sign, and return to sport data. Collected patient-reported outcome measures (PROM) include KOOS Pain, KOOS Symptoms, KOOS ADL, KOOS Sport/Rec, KOOS QOL, KOOS JR, Pedi-FABS, Pedi-IKDC, BPII 2.0, and Kujala at baseline, 1 and 2 years. Continuous variables were summarized using means and standard deviation and analyzed using independent 2 sample t-test. Categorical variables were summarized using frequencies and percentages and analyzed using chi-square test.

RESULTS:

975 patients (mean age 21 ± 3.95 years, 59.3% female) underwent isolated MPFL reconstruction from January 2017-July 2022. Mean Beighton score was 3.9 ± 2.9 and. 400 (56.9%) patients had a pre-operative J-sign, with 329 patients having a mild J-sign and 71 having a jumping J-sign. 208 (43.7%) patients had pre-operative knee hyperextension ≥10°. At 2 years, 50 patients (5.1%) reported recurrent instability. 94 patients (9.6%) had a persistent J-sign, 70 patients (7.2%) had positive apprehension sign, and 22 (2.3%) patients had both - persistent J-sign and positive apprehension sign. A greater percentage of patients with post-operative recurrent instability had a persistent J-sign, (24% vs 8.9%, p=0.0017), positive apprehension sign (34.2% vs 12.75%, p=0.011), a combination of positive apprehension sign and persistent J-sign (12% vs 1.7%, p=0.005), or a combination of persistent J-sign and knee hyperextension ≥10° (11.63% vs 1.9%, p=0.0022). At 2 years, 81.2% of patients were able to return to sport (RTS), and there were no differences in RTS rates between groups with post-operative J-sign, positive apprehension sign or both. Those with a mild post-operative J-sign tended to be more female (p=0.02) and had a higher CDI (1.33 ± 0.3 vs 1.17 ± 0.25, p<.001). Those with post-operative J-sign had a lower increase in PROs at 2 years than those without a post-operative J-sign in KOOS ADL (p=0.015), KOOS sports/rec (p=0.012), and IKDC (p=0.021).

DISCUSSION AND CONCLUSION:

In this multi-center prospective study for patients undergoing isolated MPFL reconstruction for PFI, patients with a post-operative J-sign showed worse improvement in PROs at 2 years post-operatively, but similar return to sports rates as those without a post-operative J-sign. Taken together, these findings emphasize the importance of further investigation of post-operative J-sign and positive apprehension sign, following MPFL reconstruction for patellofemoral instability as a marker of poor outcomes, possibly helping to identify which patients might benefit from an additional bony realignment procedure. Furthermore, these findings underscore the need to establish a minimal clinically important difference (MCID) threshold specific to patellofemoral instability.

Patient Demographics Post-Op J-Sign

Variable	Overall		Post-Op J-Sign -		Post-Op J-Sign Mild		P-value
	N/Mean	%/SD	N/Mean	%/SD	N/Mean	%/SD	
Age	20.52	3.97	20.66	4.02	20.12	3.23	0.121
Sex							0.0165
Male	332.00	40.21	268.00	41.77	24.00	25.53	
Female	178.00	59.28	509.00	57.78	69.00	73.40	
Other	1.00	0.18	1.00	0.11	0.00	0.00	
Missingness	4.00	0.41	3.00	0.34	1.00	1.06	
BMI	24.24	5.98	24.09	5.95	23.57	5.81	
Beighton Score	3.83	2.84	3.83	2.87	3.76	2.96	0.7746
Beighton Score >3							0.6716
No	211.00	39.07	190.00	39.42	21.00	36.21	
Yes	329.00	60.93	292.00	60.58	37.00	63.79	
Hypermobile(on Passive ROM/ Beighton >13)							0.1044
No	268.00	56.38	244.00	55.71	24.00	63.16	
Yes	208.00	43.79	194.00	44.29	14.00	36.84	
TT-TG	13.22	4.23	13.21	4.33	13.44	3.41	0.731
CCI	1.19	0.26	1.17	0.25	1.33	0.29	0.0083
FT-LTA	7.84	6.56	7.85	6.43	7.84	6.56	0.6761
Preoperative J-Sign							<0.0001
None	323.00	61.18	288.00	46.23	15.00	18.75	
Mild	153.00	28.98	153.00	24.56	16.00	20.00	
Severe	73.00	10.18	56.00	8.99	10.00	18.75	
Preoperative J-Sign: Binary							<0.0001
No	323.00	61.18	288.00	46.23	15.00	18.75	
Yes	400.00	56.98	335.00	53.77	65.00	81.25	
Trochlear Dysplasia							0.491
No	185.00	18.95	170.00	19.27	11.00	11.96	
Yes	721.00	81.05	712.00	80.73	79.00	88.04	

Recurrent Instability at 2Yr Follow Up		
Variable	N	%
Recurrent Instability	50	5.12
Post Op Apprehension	70	14.43
Post Op J Sign	94	9.63
J Sign + Apprehension	22	2.26

Return to Sport 2Yr Follow Up		
Variable	N	%
Return to Sport		
No	62	18.84
Yes	267	81.16
Same or Higher Level		
No	63	27.88
Yes	163	72.12

Return to Sport with Apprehension, J Sign and Knee Hyperextension

Variable	Overall		No RTS		RTS		P Value
Post Op J Sign							0.8492
No	257	83.99	45	83.33	212	84.13	
Yes	49	16.01	9	16.67	40	15.87	
Post Op Apprehension							0.2673
No	169	82.44	33	78.74	136	83.95	
Yes	36	17.56	10	21.26	26	16.05	
J Sign + Apprehension							0.9393
No	297	95.81	52	91.23	245	96.84	
Yes	13	4.19	5	8.77	8	3.16	
J Sign + Hyperextension (Passive ROM/ Beighton >13)							>.9999
No	294	94.23	50	94.92	238	94.07	
Yes	18	5.77	3	5.08	15	5.93	
Apprehension + Hyperextension (Passive ROM/ Beighton >13)							0.921
No	216	96.86	43	95.56	173	97.19	
Yes	7	3.14	2	4.44	5	2.81	
J Sign + Apprehension + Hyperextension (Passive ROM/ Beighton >13)							
No	304	100	58	100	250	100	
Yes	0	0	0	0	0	0	
Recurrent Instability OR Apprehension							0.548
No	170	84.74	33	59.41	137	88.99	
Yes	33	16.26	9	27.27	24	72.73	

Post-Op Instability with Apprehension, J Sign and Knee Hyperextension

Variable	Overall		No Post-Op Instability		Post-Op Instability		P Value
Post-Op J Sign							0.6053
No	881	90.37	844	91.14	38	70	
Yes	94	9.63	82	8.86	12	24	
Post-Op Apprehension							0.0001
No	415	85.57	393	87.25	25	65.79	
Yes	70	14.43	57	12.75	13	34.21	
J Sign + Apprehension							0.0001
No	950	97.74	906	98.26	44	84	
Yes	22	2.26	16	1.74	6	12	
J Sign + Hyperextension (Passive ROM/ Beighton >13)							0.4002
No	881	97.67	844	98.14	38	88.37	
Yes	21	2.33	16	1.86	5	11.63	
Apprehension + Hyperextension (Passive ROM/ Beighton >13)							
No	415	100	393	100	25	100	
Yes	0	0	0	0	0	0	
J Sign + Apprehension + Hyperextension (Passive ROM/ Beighton >13)							
No	950	100	906	100	44	100	
Yes	0	0	0	0	0	0	

**All values presented as n, % unless stated otherwise.

Variable	Overall		Post-Op J-Sign -		Post-Op J-Sign Mild		P-value
	Mean	SD	Mean	SD	Mean	SD	
KOOS Pain							
Baseline	69.01	21.38	68.58	21.48	72.69	20.24	0.1397
1Y	91.78	11.32	91.55	11.43	93.12	10.67	0.303
2Y	90.94	13.42	90.66	13.41	92.51	13.49	0.3652
Baseline 2Y Delta	23.82	24.00	24.84	24.06	18.62	23.33	0.1395
KOOS Symptoms							
Baseline	67.13	18.95	66.73	19.29	70.52	15.47	0.068
1Y	87.43	13.11	87.13	13.15	89.06	12.86	0.2675
2Y	87.55	14.00	87.11	14.49	89.93	10.80	0.1064
Baseline 2Y Delta	22.32	21.00	23.30	21.35	17.54	18.74	0.1097
KOOS ADL							
Baseline	75.14	21.77	74.42	22.07	81.33	18.00	0.005
1Y	95.60	9.39	95.44	9.61	96.45	8.04	0.4224
2Y	94.87	10.72	94.66	10.66	96.08	11.08	0.3853
Baseline 2Y Delta	21.83	23.08	23.45	23.28	13.61	20.42	0.0147
KOOS Sport/Rec							
Baseline	41.56	31.83	40.17	31.43	52.79	32.98	0.0016
1Y	82.06	21.57	81.50	21.60	85.23	21.24	0.1959
2Y	82.97	22.26	82.49	22.68	85.58	19.87	0.359
Baseline 2Y Delta	42.94	38.86	45.82	37.83	29.58	41.20	0.0117
KOOS QOL							
Baseline	34.02	22.80	33.64	22.65	37.09	23.92	0.2298
1Y	71.58	23.59	71.76	23.41	70.55	24.71	0.7002
2Y	73.80	23.75	73.55	23.68	75.12	24.33	0.6626
Baseline 2Y Delta	39.08	30.41	39.58	29.36	36.70	35.20	0.5684
KOOS Jr							
Baseline	66.74	17.65	66.16	17.71	71.51	16.48	0.0182
1Y	88.42	13.08	88.18	13.28	89.75	11.89	0.3685
2Y	88.59	13.88	88.27	13.97	90.33	13.37	0.3301
Baseline 2Y Delta	22.79	20.50	23.94	20.26	17.10	20.99	0.0541
IKDC							
Baseline	50.56	20.99	49.73	20.99	57.40	19.78	0.0031
1Y	84.67	16.37	84.41	16.49	86.13	15.73	0.4194
2Y	84.95	16.76	84.64	17.19	86.53	14.33	0.4503
Baseline 2Y Delta	34.55	24.96	36.21	24.77	26.69	24.63	0.0213
Kujala							
Baseline	57.68	22.61	56.78	22.63	64.78	21.30	0.0046
1Y	89.59	13.23	89.30	13.44	91.11	12.00	0.2933
2Y	89.77	13.14	89.55	13.17	90.96	13.03	0.4784
Baseline 2Y Delta	32.97	24.85	34.34	24.86	26.60	24.04	0.0666
BANFF							
Baseline	42.38	18.08	42.25	18.26	43.53	16.56	0.5722
1Y	76.57	22.26	76.28	22.65	78.18	20.06	0.5233
2Y	78.01	22.62	77.89	22.79	78.59	21.94	0.8423
Baseline 2Y Delta	35.86	27.88	36.27	28.31	33.88	25.89	0.6168