Graft Survivorship and Reoperation After Patellofemoral Osteochondral Allograft Transplantation with and Without Concomitant Tibial Tubercle Osteotomy: A Retrospective Cohort Study

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INTRODUCTION:

Osteochondral allograft transplantation (OCA) is an effective surgical treatment for focal chondral defects of the patellofemoral (PF) joint with favorable mid- to long-term graft survivorship. Though it has been theorized that concomitant anteromedializing tibial tubercle osteotomy (TTO) may aid in PF OCA graft preservation by unloading the PF compartment, the true effect of TTO on PF OCA graft survivorship has not been described. This study aimed to compare graft survivorship and reoperation rates between patients undergoing PF OCA with and without concomitant TTO. The hypothesis is that patients who undergo concomitant TTO will demonstrate improved OCA graft survivorship.

METHODS:

This was a retrospective review of patients who underwent primary OCA transplantation for an osteochondral lesion of the patella and/or trochlea with (OCA + TTO) or without (OCA only) concomitant TTO at a single institution. Patients were excluded if they had undergone a prior cartilage procedure or TTO. Cases with concomitant medial patellofemoral ligament reconstruction (MPFLR), high tibial osteotomy (HTO), or distal femoral osteotomy (DFO) were also excluded. All clinical variables were queried from the electronic health record. OCA graft failure was defined as (1) conversion to total knee or patellofemoral joint arthroplasty, (2) revision cartilage procedure, or (3) subchondral collapse noted on second-look arthroscopy or magnetic resonance imaging (MRI). Reoperation was defined more broadly as any subsequent ipsilateral knee surgery. Pre-operative tibial tubercle-trochlear groove (TT-TG) distance was measured for all patients on MRI. Graft survivorship and reoperation-free survivorship were compared between OCA + TTO and OCA only groups using Kaplan-Meier analysis and the log-rank test. An identical sub-analysis was then performed using propensity-matched cohorts based on total graft size, age, sex, body mass index (BMI), and preoperative TT-TG distance. Continuous variables were compared using independent samples t-test and categorical variables using Fisher's exact test. Significance was set at $p < 0.05$ for all analyses.

RESULTS:

A total of 93 patients (46.2 % female) were included with mean age of 34.2 ± 10.6 years, BMI of 26.4 ± 4.8 kg/m^2, and follow-up time of 3.3 ± 2.4 years. The OCA + TTO and OCA only groups contained 36 and 57 patients respectively and differed significantly with respect to sex (69.4% vs. 31.6% female; $p < 0.001$), pre-operative TT-TG distance (13.3 vs. 10.2 mm; $p = 0.003$), and total OCA graft size (26.6 vs. 20.9 mm; $p = 0.010$). Groups did not significantly differ with respect to graft failure (OCA + TTO: 4 [11.1%]; OCA only: 5 [8.8%]; $p = 0.731$) or Kaplan-Meier graft survivorship (mean graft survival estimate of 5.9 vs. 8.6 years; $p = 0.703$). However, the OCA + TTO group demonstrated a significantly higher rate of reoperation (16 [44.4%] vs. 13 [22.8%]; $p = 0.039$) and inferior Kaplan-Meier reoperation-free survivorship (3.3 vs. 7.2 years; $p = 0.005$). The leading causes for reoperation in the OCA + TTO group were arthrofibrosis requiring lysis of adhesions/manipulation under anesthesia (13.9%) and TTO-specific complications (11.1%), compared to chondroplasty (12.3%) in the OCA only group (Table 1) (Figure 1).

Propensity matching for age, sex, BMI, pre-operative TT-TG distance, and total graft size yielded 58 total patients (36 with OCA + TTO and 22 with OCA only) that were 65.5% female with mean TT-TG of 12.5 ± 4.6 mm and total graft size of 25.1 ± 11.4 mm. Groups did not significantly differ with respect to graft failure, reoperations, graft survivorship, or reoperation-free survivorship (Table 2) (Figure 2).

DISCUSSION AND CONCLUSION:

Concomitant TTO was found to have no effect on graft survivorship after PF OCA transplantation in both unmatched and propensity-matched cohorts. However, patients who underwent PF OCA with TTO experienced a higher rate of reoperation and reduced reoperation-free survivorship, largely due to TTO-specific complications and post-operative arthrofibrosis. These findings provide no evidence to suggest that concomitant TTO aids in PF OCA graft preservation and suggest, on the contrary, that TTO may pose additional postoperative morbidity. Surgeons should carefully consider this risk-benefit balance when indicating patients for TTO with PF OCA. Higher-powered prospective studies are needed to determine the effect of concomitant TTO on PF OCA outcomes independent of confounders such as pre-operative TT-TG distance and lesion size.

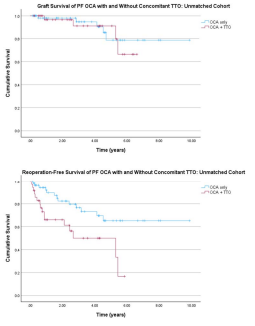

Figure 1. Kaplan-Meier analysis of PF OCA with and without concomitant TTO in overall study cohort. Dash mark indicates censorship due to loss of follow-up. Log-rank test found no difference in graft survivorship (p = 0.703), but inferior reoperation-free survivorship in the OCA+TTO group (p = 0.005)

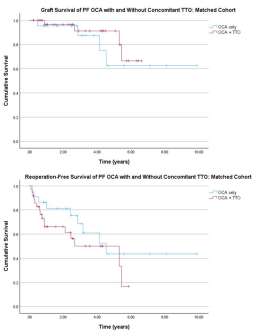

Figure 2. Kaplan-Meier analysis of PF OCA with and without concomitant TTO in cohorts propensity-matched for age, sex, BMI, TT-TG distance, and total graft size. Dash mark indicates censorship due to loss of follow-up. Log-rank test found no difference in graft survivorship (p = 0.513) or reoperation-free survivorship (p = 0.227).

Table 1. Cohort Characteristics and Clinical Outcomes of PF OCA with and Without Concomitant TTO: Overall Comparison

	PF OCA + TTO (n = 36)	PF OCA only (n = 57)	p-value
Age (years)	33.6 ± 9.2	34.5 ± 11.5	0.664[a]
Sex (% female)	69.4%	31.6%	**< 0.001**[a]*
BMI (kg/m²)	26.5 ± 4.8	26.3 ± 4.9	0.867[b]
Follow-up time (years)	3.1 ± 2.1	3.4 ± 2.6	0.517[b]
TT-TG distance (mm)	13.3 ± 4.3	10.2 ± 4.8	**0.003**[b]*
Total graft size (mm)	26.6 ± 11.4	20.9 ± 9.1	**0.010**[b]*
Graft failures, n (%)	4 (11.1%)	5 (8.8%)	0.733[b]
Conversion to arthroplasty	3 (8.3%)	3 (5.3%)	0.674[b]
Revision OCA	1 (2.8%)	1 (1.8%)	1.000[b]
Subchondral collapse	0 (0.0%)	1 (1.8%)	1.000[b]
Reoperations, n (%)	16 (44.4%)	13 (22.8%)	**0.039**[b]*
Chondroplasty	1 (2.8%)	7 (12.3%)	0.143[b]
Conversion to arthroplasty	3 (8.3%)	2 (3.5%)	0.372[b]
Loose body removal	1 (2.8%)	2 (3.5%)	1.000[b]
Lysis of adhesions/manipulation under anesthesia	5 (13.9%)	2 (3.5%)	0.104[b]
Revision OCA	1 (2.8%)	0 (0%)	0.387[b]
Irrigation and debridement	1 (2.8%)	0 (0%)	0.387[b]
TTO hardware complication	3 (8.3%)	0 (0%)	0.055[b]
TTO osteonecrosis	1 (2.8%)	0 (0%)	0.387[b]
Kaplan-Meier mean graft survival estimate (years)	5.9 [95% CI: 5.3 – 6.5]	8.6 [95% CI: 7.6 – 9.6]	0.703[c]
Kaplan-Meier 2-year graft survivorship estimate (%)	95.0%	97.4%	-
Kaplan-Meier 5-year graft survivorship estimate (%)	84.4%	80.8%	-
Kaplan-Meier mean reoperation-free survival estimate (years)	3.3 [95% CI: 2.5 – 4.2]	7.2 [95% CI: 6.0 – 8.4]	**0.005**[c]*
Kaplan-Meier 2-year reoperation-free survivorship estimate (%)	66.1%	82.5%	-
Kaplan-Meier 5-year reoperation-free survivorship estimate (%)	50.0%	65.3%	-

* indicates statistical significance. All values repeated as means (± standard deviation) unless otherwise indicated. (a) independent samples t-test; (b) Fisher's exact test; (c) log-rank test; PF: patellofemoral; OCA: osteochondral allograft transplantation; TTO: tibial tubercle osteotomy; TT-TG: tibial tubercle-trochlear groove; CI: confidence interval

Table 2. Cohort Characteristics and Clinical Outcomes of PF OCA with and Without Concomitant TTO: Propensity-Matched Comparison

	PF OCA + TTO (n = 36)	PF OCA only (n = 22)	p-value
Age (years)	33.6 ± 9.2	37.2 ± 12.1	0.197[a]
Sex (% female)	69.4%	59.1%	0.570[b]
BMI (kg/m²)	26.5 ± 4.8	26.9 ± 5.1	0.733[a]
Follow-up time (years)	3.1 ± 2.1	3.8 ± 2.5	0.236[a]
TT-TG distance (mm)	13.3 ± 4.3	11.2 ± 4.9	0.091[a]
Total graft size (mm)	26.6 ± 11.4	22.8 ± 11.1	0.217[a]
Graft failures, n (%)	4 (11.1%)	4 (18.2%)	0.697[b]
Conversion to arthroplasty	3 (8.3%)	2 (9.1%)	1.000[b]
Revision OCA	1 (2.8%)	1 (4.5%)	1.000[b]
Subchondral collapse	0 (0.0%)	1 (4.5%)	0.379[b]
Reoperations, n (%)	16 (44.4%)	9 (40.9%)	1.000[b]
Chondroplasty	1 (2.8%)	3 (13.6%)	0.148[b]
Conversion to arthroplasty	3 (8.3%)	2 (9.1%)	1.000[b]
Loose body removal	1 (2.8%)	2 (9.1%)	0.553[b]
Lysis of adhesions/manipulation under anesthesia	5 (13.9%)	2 (9.1%)	0.698[b]
Revision OCA	1 (2.8%)	0 (0%)	1.000[b]
Irrigation and debridement	1 (2.8%)	0 (0%)	1.000[b]
TTO hardware complication	3 (8.3%)	0 (0%)	0.281[b]
TTO osteonecrosis	1 (2.8%)	0 (0%)	1.000[b]
Kaplan-Meier mean graft survival estimate (years)	5.9 [95% CI: 5.3 – 6.5]	7.5 [95% CI: 5.6 – 9.4]	0.513[c]
Kaplan-Meier 2-year graft survivorship estimate (%)	95.0%	95.5%	-
Kaplan-Meier 5-year graft survivorship estimate (%)	84.4%	62.5%	-
Kaplan-Meier mean reoperation-free survival estimate (years)	3.3 [95% CI: 2.5 – 4.2]	5.7 [95% CI: 3.8 – 7.6]	0.227[c]
Kaplan-Meier 2-year reoperation-free survivorship estimate (%)	66.1%	81.3%	-
Kaplan-Meier 5-year reoperation-free survivorship estimate (%)	50.0%	43.6%	-

* indicates statistical significance. All values repeated as means (± standard deviation) unless otherwise indicated. (a) independent samples t-test; (b) Fisher's exact test; (c) log-rank test; PF: patellofemoral; OCA: osteochondral allograft transplantation; TTO: tibial tubercle osteotomy; TT-TG: tibial tubercle-trochlear groove; CI: confidence interval