Kinematics Comparisons of Patella Alta with the Normal Patella after Total Knee Arthroplasty

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INTRODUCTION:

Patella complication is one of the most common reasons for total knee arthroplasty (TKA) revision. Several studies have shown that patellar height affects the range of motion (ROM) and causes anterior knee pain after TKA. While patella height relates to pseudo patella alta directly, the evidence of the effects of patella alta is still limited. Thus, evaluating correlations between pseudo-patella alta and postoperative TKA mechanics will provide a more in-depth understanding of patellar compilations after TKA.

METHODS:

The Insall-Salvati Ratio is typically used for classifying the patella heights. However, when using fluoroscopic videos, classification based on a single image can introduce bias. We proposed an enhanced Insall-Salvati Ratio (eISR) to classify patellar height from fluoroscopic video based on the average ISR from five still images, shown in Figure 1, to improve the accuracy of the classification step. In this case, the patella alta is detected for TKA patients with eISR>1.2 (patella baja has eISR<0.8; normal patella has 0.8≤eISR≤1.2). This study was conducted on 40 subjects implanted with a Bi-Cruciate Stabilized (BCS) TKA, 40 subjects implanted with a Posterior Cruciate Retaining (PCR) TKA, and 10 normal, non-implanted knees. No instances of patella baja occurred in our dataset. Kinematic and kinetic data of those 90 subjects were collected using validated 3D-to-2D fluoroscopic registration techniques. Specific parameters of interest were anterior/posterior motion of either condyle (LAP/MAP), femorotibial axial rotation, and weight-bearing range-of-motion (ROM).

RESULTS: The patella height classification results are shown in Table 1. While around 20% of non-implanted subjects have patella alta, the percentage for both implanted cohorts are around 40%. In other words, this indicates that TKA subjects are more likely to have patella alta than non-implanted subjects. There were no significant differences between the normal patella and patella alta groups for lateral antero-posterior (LAP), medial antero-posterior (MAP), and axial rotation (AR) for both BCS and PCR implants, as shown in Table 2. Interestingly, however, there was a significant statistical difference in ROM for both the BCS cohort (P=0.016) and PCR cohort (P=0.04), with normal patellar groups having significantly higher weight-bearing range of motion than patella alta groups. The non-implanted group shows no significant differences for all the kinematics indexes.

DISCUSSION AND CONCLUSION: Two significant findings were discovered in this study. First, TKA subjects appear to have higher occurrences of patella alta compared to non-implanted subjects, and second, there was a significant difference in weight-bearing ROM between the normal patella and patella alta groups for TKA patients. This is likely because quadricep wrapping happens earlier for the patella alta group, leading to a tighter extensor mechanism and a limited range-of-motion. This phenomenon did not happen with the non-implanted cohort, which is particularly interesting and may indicate that patella alta might reduce ROM after TKA. Thus, it's important to maintain the natural position of the joint line of the patella for TKA patients by choosing correctly implant sizes and polyethylene thickness.

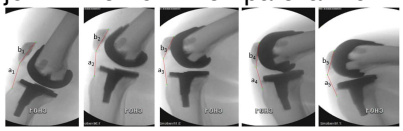

Figure 1: The enhanced Install-Salvati Ratio (eISR) = $(a_1/b_1+a_2/b_2+a_3/b_3+a_4/b_4+a_5/b_5)/5$

Classification		BCS (n=40)	PCR (n=40)	Non-implanted (n=10)
eISR< 0.8	Baja	0 (0%)	0 (0%)	0 (0%)
0.8 ≤ eISR ≤ 1.2	Normal	24 (60%)	23 (57.5%)	8 (80%)
1.2 ≤ eISR	Alta	16 (40%)	17 (42.5%)	2 (20%)

Table 1: Statistics of TKA with patella heights classification

	PCR (μ±σ)			BCS (μ±σ)			Non-implanted (μ±σ)		
	Normal patella	Patella alta	P-value	Normal patella	Patella alta	P-value	Normal patella	Patella alta	P-value
LAP (mm)	-3.9±6.3	-3.7±5.1	0.91	-12.2±5.2	-8.5±6.2	0.08	-18.1±6.8	-16.7±0.2	0.59
MAP (mm)	0.6±4.0	1.1±4.4	0.72	-6.2±3.1	-4.5±3.4	0.17	-9.1±4.9	-9.3±7.3	0.97
Axial Rotation (°)	5.6±6.2	6.2±5.5	0.46	6.9±5.8	7.6±4.6	0.24	24.7±8.5	19.6±1.6	0.15
ROM (°)	120.3±21.3	108.1±13.6	**0.04**	99.3±21.7	84.5±-0.6	**0.016**	140.3±13.4	134±19.8	0.73

Table 2: Kinematics comparison