Changes in the Distribution of Coronal Plane Alignment of the Knee Classification through the Knee Osteoarthritis Process: A Longitudinal Study from the TOEI Survey

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INTRODUCTION:

Interest in restoring native (constitutional) alignment of the knee has increased in recent years. Kinematic alignment during total knee arthroplasty (TKA) restores the constitutional alignment and provides excellent long-term survival. To restore constitutional alignment, surgeons must consider the patient's pre-arthritic knee alignment. However, the lack of knowledge regarding the variability of coronal alignment in patients with knee osteoarthritis (OA) is a challenge of personalized TKA. Therefore, understanding the changes in coronal alignment in individuals with progression of knee OA is crucial and helps surgeons restore the pre-arthritic alignment. However, it is difficult to determine the constitutional alignment following the onset of arthritis as it varies significantly in healthy individuals and changes during the progression of knee OA. The coronal plane alignment of the knee (CPAK) classification system proposes nine phenotypes for predicting the pre-arthritic alignment of the knee. There are no reports regarding changes in the distribution of CPAK classifications within individuals with knee osteoarthritis (OA) progression. This longitudinal study investigated the CPAK phenotypes of individuals with knee OA progression.

METHODS:

A total of 248 patients (79 men and 169 women) participated in the first survey in 2012 and the fifth survey in 2020 in Toei Town in Aichi Prefecture, Japan. Patients with at least one knee with Kellgren-Lawrence (KL) grade 0–2 in 2012 and progression of knee OA in 2020 were included in the study. Alignment parameters including the arithmetic hip-knee-ankle (aHKA), joint line obliquity (JLO), hip-knee-ankle angle (HKA), lateral distal femur angle (LDFA), medial proximal tibial angle (MPTA), and joint line convergence angle (JLCA), were measured. Changes in the distribution of the CPAK classifications and alignment parameters were investigated.

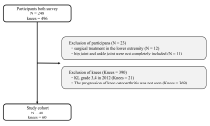
RESULTS:

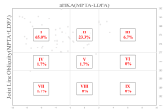
This study included 48 patients (60 knees). The frequencies of all CPAK phenotypes were similar between 2012 and 2020. The MPTA ($p < 0.05$), aHKA ($p < 0.05$), and JLO ($p < 0.05$) decreased significantly, and the JLCA ($p < 0.05$) and HKA ($p < 0.05$) increased significantly over the eight-year period. In contrast, the LDFA did not change significantly ($p = 0.384$).

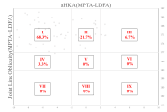
DISCUSSION AND CONCLUSION:

The most important finding of this study was the aHKA and JLO significantly decreased with knee OA progression, nevertheless the frequencies of all CPAK phenotypes were similar before and after an eight-year period of progression of knee OA in this study. To our knowledge, this is the first longitudinal study to examine CPAK phenotypes. In this study, radiographs of the same patients before and after the progression of knee OA were compared, demonstrating that all CPAK phenotypes had similar frequency distributions despite the progression of knee OA during an eight-year period. Therefore, the CPAK classification system is useful in patients before or after the progression of knee OA. This study showed that the aHKA and JLO decreased significantly with the progression of knee OA. The MPTA decreased significantly, though the LDFA did not differ before and after the progression of knee OA. These results suggest that the change in the MPTA during the arthritic process affected the aHKA and JLO more than changes of the LDFA and are consistent with previous reports.

In conclusion, the aHKA and JLO changed as knee OA progressed, although all CPAK phenotypes were of a similar frequency before and after the eight-year progression of knee OA. Therefore, the CPAK classification system is useful for individual patients before or after the progression of knee OA.







Baseline data of the study cohort in 2012

Baseline data	2012 survey (n=48)
Age (years)	71.9 ± 6.1
Sex (men/women)	9 / 39
BMI (kg/m²)	22.9 ± 2.5
KL grade (%)	0 = 0%
	1 = 15%
	2 = 85%

Comparison of radiographic parameters in 2012 and 2020 survey

Parameters	2012 survey	2020 survey	p Value
HKA (°)	4.8 ± 3.9	8.8 ± 5.4	<0.01*
LDFA (°)	87.4 ± 3.2	87.2 ± 3.1	0.384
MPTA (°)	83.7 ± 2.8	92.3 ± 4.8	0.013*
JLCA (°)	1.17 ± 2.2	3.1 ± 4.7	<0.01*
aHKA (°)	-3.6 ± 3.8	-4.9 ± 6.2	0.029*
TLV (°)	175.1 ± 4.6	169.5 ± 5.3	0.014*

Values are expressed as mean ± SD
HKA angle, hip-knee-ankle angle; mLDFA, mechanical lateral distal femoral angle; MPTA, medial proximal tibial angle; JLCA, joint line convergence angle; aHKA, arithmetic HKA; JLO, joint line obliquity
* p < 0.05