

Arteriosclerosis in Patients with Osteoarthritis of the Knee Prior to Total Knee Arthroplasty as Evaluated by Cardio-Ankle Vascular Index

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INTRODUCTION: Cardiovascular disease (CVD) is a major risk factor for mortality in patients with osteoarthritis, and comorbidities increase postoperative complications after total knee arthroplasty (TKA). Arteriosclerosis plays a main role in hemodynamic dysfunction and CVD; however, arteriosclerosis has not been preoperatively evaluated before TKA using the cardio-ankle vascular index (CAVI). In this study, we evaluated the degree of preoperative arteriosclerosis using the CAVI in patients undergoing TKA, as well as its correlations with several preoperative patient factors.

METHODS: Informed consent was obtained from all patients after a discussion of the study, which included a description of the protocol and possible CAVI measurement-related complications. The institutional review board approved the study before commencement. Arteriosclerosis was evaluated in 209 consecutive patients (251 knees) with osteoarthritis who underwent TKA at our institution between May 2011 and June 2022 (Table 1). The CAVI was measured by the standardized method using a noninvasive blood pressure-independent device (VaSera VS-1 3000; Fukuda Denshi, Tokyo, Japan) [1] at 1 day before surgery, and the correlations between the CAVI and several clinical factors were analyzed. CAVI measurements were performed in the supine position. Cuffs were applied bilaterally to the upper arms and lower legs superior to the ankles. Electrocardiogram electrodes and a microphone were placed on both wrists, both ankles, and the sternum. An electrocardiogram, blood pressure, and waveforms of the brachial and ankle arteries were measured. The pulse wave velocity (PWV) was calculated by measuring the time between the closing sound of the aortic valve, the notch of the brachial pulse wave, and the ankle pulse wave. Using this value, the CAVI was calculated by the following equation: $CAVI = 2\rho / (\text{systolic blood pressure} - \text{diastolic blood pressure}) \times (\ln \text{ systolic blood pressure} / \text{diastolic blood pressure}) \times PWV^2$, where ρ = blood viscosity. The CAVI cut-off values of 8 and 9 were proposed by the Japan Society for Vascular Failure (<8, normal; 8 to <9, borderline; and ≥ 9 , abnormal) [2]. The following preoperative factors were analyzed: sex, age, body mass index (BMI), body weight (BW), blood cholesterol level, blood triglyceride level, smoking history, diabetes mellitus, hypertension (all of which have been previously reported to affect the CAVI), body height, American Society of Anesthesiologists grade, Kellgren-Lawrence classification, Hospital for Special Surgery knee score, and knee range of motion. Because data for certain variables did not pass the Kolmogorov-Smirnov normality test or Shapiro-Wilk normality test, we used the non-parametric Wilcoxon rank sum test and Spearman's rank correlation test. Multiple linear regression analysis was performed to identify variables significantly associated with the preoperative CAVI. In all tests, a p value of <0.05 was considered significant.

RESULTS: The CAVI was normal in 62 knees (25%), borderline in 71 knees (28%), and abnormal in 118 knees (47%). Univariate analysis revealed a moderate positive correlation between preoperative CAVI and age ($r = 0.451$, $p < 0.001$) (Fig. 1) and a weak negative correlation between preoperative CAVI and BW ($r = -0.306$, $p < 0.001$) and BMI ($r = -0.319$, $p < 0.001$) (Fig. 2). Multivariate analysis showed that age ($\beta = 0.349$, $p < 0.001$) and BMI ($\beta = -0.235$, $p < 0.001$) were significantly correlated with preoperative CAVI.

DISCUSSION: Arteriosclerosis should be carefully managed intraoperatively and postoperatively in patients with osteoarthritis undergoing TKA, particularly in older patients and patients with a low BMI.

SIGNIFICANCE/CLINICAL RELEVANCE: Patient characteristics that warrant caution for arteriosclerosis during perioperative TKA surgery may include low BMI and older patients.

REFERENCES: 1. Shirai, K. *J. Atheroscler. Thromb.* **2011**,18,924. 2. Tanaka, A. *Hypertension* **2018**;72:1060.

Table 1. Patients' backgrounds

Variables (patients/ knees)	209/ 251
Sex (Male vs. Female)	42/ 209
Body height (cm)	150 (146, 155)
Body weight (kg)	59 (53, 67)
Body mass index (kg/m ²)	26 (24, 28)
Age (years)	74 (69, 79), M; 76 (70, 81), F; 73(69, 78)
Smoking history (yes/ no)	12/ 239
Diabetes Mellites (yes/ no)	35/ 216
Hypertension (yes/ no)	164/ 87
Preop. blood cholesterol level (mg/dl)	205 (185, 234)
Preop. blood triglyceride level (mg/dl)	132 (101, 175)
Knee flexion (Preop) (°)	115 (100, 125)
Knee extension (Preop) (°)	-10.0 (-15, -5)
Knee range of motion (Preop) (°)	100 (90, 120)
HSS score	45 (37, 52)
Kellgren- Lawrence classification	III 10, IV 241
ASA Grade	I 34, II 217

Data are presented as n or median (25th percentile, 75th percentile).

M, male; F, female; Preop, preoperative; HSS, Hospital for Special Surgery; ASA, American Society of Anesthesiologists

