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Static knee alignment measurements among Caucasians and African-Americans: The Johnston County Osteoarthritis Project

Amanda E. Nelson, MD [Clinical Fellow],
Department of Medicine, University of North Carolina at Chapel Hill

Larissa Braga, MD MPH [Assistant Professor],
Department of Radiology, University of Nebraska Medical Center at Omaha

Andresa Braga-Baiak, MD,
Post-Graduate program, University of São Paulo, Brazil

Julius Atashili, MD MPH [Doctoral student],
Department of Epidemiology, University of North Carolina at Chapel Hill

Todd A. Schwartz, DrPH [Research Assistant Professor],
Department of Biostatistics, University of North Carolina at Chapel Hill

Jordan B. Renner, MD [Professor],
Departments of Radiology and Allied Health Sciences, University of North Carolina at Chapel Hill

Charles G. Helmick, MD [Medical Epidemiologist], and
Centers for Disease Control and Prevention, Atlanta, GA

Joanne M. Jordan, MD MPH [Professor]
Departments of Medicine, Orthopaedics, and Epidemiology, University of North Carolina at Chapel Hill

Abstract

Objective—To determine if knee alignment measures differ between African Americans and Caucasians without radiographic knee osteoarthritis (rOA).

Methods—A single knee was randomly selected from 175 participants in the Johnston County Osteoarthritis Project without rOA in either knee. Anatomic axis, condylar, tibial plateau, and condylar plateau angles were measured by one radiologist; means were compared and adjusted for age and body mass index (BMI).

Results—There were no significant differences in knee alignment measurements between Caucasians and AfrAm among men or women.

Conclusions—Observed differences in knee rOA occurrence between AfrAm and Caucasians are not explained by differences in static knee alignment.

Address reprint requests to: Amanda E. Nelson, M.D., Thurston Arthritis Research Center, University of North Carolina at Chapel Hill, 3300 Thurston Bldg, CB #7280, Chapel Hill, NC 27599-7280, AENelson@unch.unc.edu.

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Keywords

Knee osteoarthritis; racial differences; knee alignment

Static knee malalignment contributes to osteoarthritis (OA) progression at the knee, with varus alignment leading to increased odds of medial compartment progression, and valgus alignment to more lateral progression (1). The extent of malalignment is related to magnitude of joint space narrowing (JSN), accelerated functional decline, and increased pain, over 18 months of follow up (1). There may be an association between malalignment and incident radiographic knee OA (knee rOA), although data are inconsistent (2–4).

Known racial/ethnic differences in knee OA prevalence (5;6) suggest that race/ethnicity and alignment might be related. Lateral knee rOA was more common among elderly Chinese compared to Caucasians; greater valgus alignment was identified as a potential explanatory factor in a subsample of 100 individuals without knee rOA (5). Recently, a larger follow-up study (n=570) evaluated static knee alignment indices among Chinese and Caucasian subjects without knee rOA, confirming greater valgus alignment among Chinese subjects (7). We have previously identified increased odds of lateral JSN among AfrAm men (OR 2.19, 95%CI 1.32–3.65) and AfrAm women (OR 1.48, 95% CI 1.02–2.16) compared to their Caucasian counterparts (8). The purpose of this study was to assess whether differences exist in indices of static knee alignment between AfrAm and Caucasians without knee rOA that might contribute to the increased risk of lateral JSN at the knee in AfrAm.

METHODS

This cross-sectional analysis used baseline visit (1991–1997) data from the Johnston County Osteoarthritis Project, described in detail elsewhere (6). In brief, this is a population-based study of OA in rural North Carolina among AfrAm and Caucasians aged 45 years and older. All individuals underwent anteroposterior, weight-bearing, extended knee radiography, and all radiographs were read for Kellgren-Lawrence (K-L) grade by a single musculoskeletal radiologist (JBR) for whom inter- and intra-rater reliability were high (kappas 0.86 and 0.89, respectively)(9). Participants without knee rOA (n=175) were randomly selected by gender and race; a single knee from each individual was randomly selected for study (115 knees with K-L grade = 0; 60 knees with K-L grade =1). A difference of 2 degrees in anatomic axis was chosen to calculate sample size based on the observed differences in the Beijing and Framingham samples (7). Using a two-sided 0.05 significance level, a sample size of 43 knees per group (AfrAm men and women, Caucasian men and women) was needed to achieve 90% power to detect a 2 degree difference in anatomic axis (this sample size provides 68% power to detect a 1.5 degree difference).

Alignment measurements were performed by a trained musculoskeletal radiologist (ABB), based on the method described by Harvey (7) and Cooke (10). Intra-reader reliabilities (38 films) using intraclass correlation statistics were excellent (0.85 to 0.97). Measurements were made by hand directly on 14 × 17 inch knee films, a method comparable to full-length limb radiographs (11) and to digital alignment measurements (12). The following angles (degrees) were assessed (Figure):

1. Anatomic axis (AA): angle between lines drawn from the visual center of the femur and tibia at a point 10cm from the joint line, through visual midpoint of the tibial spines
2. Condylar angle (CA): angle between a line tangent to the distal end of the femur (condylar line) and the line through visual center of the femur

3. Tibial plateau angle (PA): angle between a line tangent to the lateral aspect of the tibial plateau (tibial plateau line) and the line through the visual center of the tibia

4. Condylar-plateau angle (CP): angle formed by the condylar line and the tibial plateau line Statistical analyses used SAS version 9 (SAS Institute, Cary, NC). Means for each continuous measurement were compared using analysis of covariance, adjusting for age and body mass index (BMI); all analyses were stratified due to known gender differences (5).

RESULTS

There were 92 male knees and 83 female knees included in the study (Table). The mean age for men was 59, and for women was 62 years; age did not differ by race within gender groups. The mean BMI was 27 kg/m^2 for men; Caucasian men were significantly heavier than AfrAm men (p=0.04). For women, the mean BMI was 28 kg/m^2; AfrAm women were significantly heavier than Caucasian women (p=0.003). For Caucasian and AfrAm knees, the proportion with K-L grade 1 was similar among men (27% vs. 31%, respectively) and women (43% vs. 37%).

The mean anatomic angle was >180 degrees for all groups, and greater in men than in women (Table). No differences were seen by race, in men or women, in any of the knee angles or standard deviations (Figure, Table).

DISCUSSION

We did not identify any significant differences in measures of static knee alignment or their standard deviations among AfrAm and Caucasians without knee rOA. Our overall results were qualitatively similar to those reported by Harvey et al for the Framingham cohort (7). That group identified more valgus alignment among subjects from Beijing without knee rOA, with a larger standard deviation, in comparison to Framingham subjects, and concluded that the Beijing subjects' tendency toward valgus alignment may explain the observed increase in lateral rOA among Beijing compared to Framingham participants (7). In the current study, we found no significant differences by race within gender groups. The differences observed in the current study were extremely small, ranging from 0.1 to 0.5 degrees, and would be highly unlikely to be clinically meaningful or reach statistical significance even in a much larger sample. Therefore, it seems unlikely that variations in static knee alignment are responsible for the differences in knee rOA pattern or prevalence we have previously observed among AfrAm and Caucasians. We did not assess symptoms in the current analysis, and full-length radiographs were not available, so variations in proximal or distal anatomy could have been missed (13). However, the methods used were directly comparable to other published studies. Other potential factors, such as hip anatomic differences and dynamic alignment (4), need to be explored further, ideally in a young, healthy population, to better understand the race differences in knee rOA patterns and prevalence.

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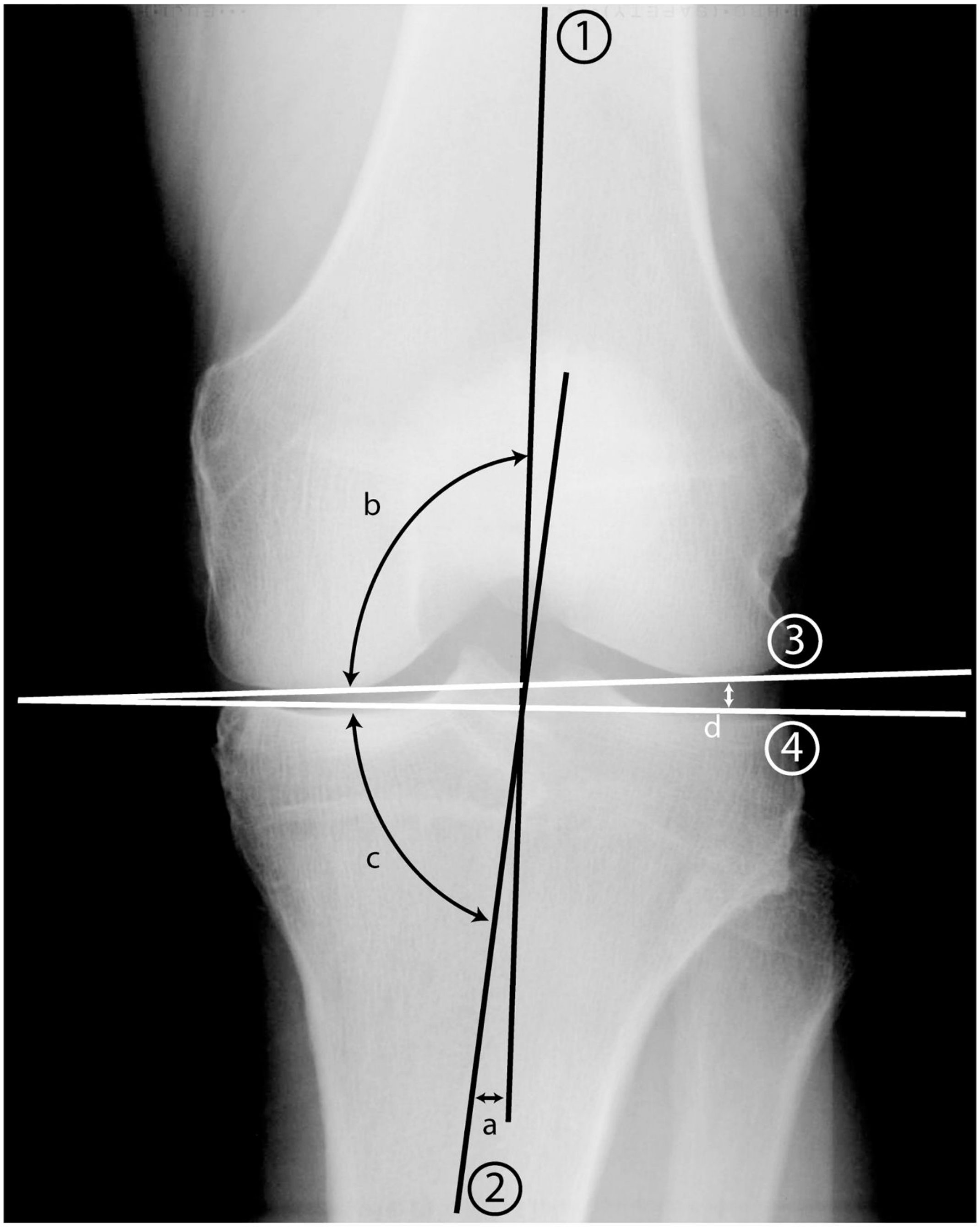

Figure.

Varus knee, showing the measurements of static alignment based on Harvey et al (7). 1) Femoral anatomic axis line. 2) Tibial anatomic axis line. 3) Condylar line. 4) Tibial plateau line. a) Anatomic axis angle. b) Condylar angle. c) Tibial plateau angle. d) Condylar plateau angle.

Table

Sample characteristics and knee alignment measures among Caucasians and African Americans (AfrAm), stratified by gender.

	MEN			**WOMEN**		
	Caucasian *(n=47)*	**AfrAm *(n=45)***		**Caucasian *(n=42)***	**AfrAm *(n=41)***	
	Mean (SD)	**Mean (SD)**	***p value***	**Mean (SD)**	**Mean (SD)**	***p value***
Age (years)	58.8 (9.6)	58.5 (10.2)	0.90*	63.2 (9.3)	60.3 (8.0)	0.35*
BMI (kg/m^2)	27.9 (5.1)	25.6 (5.4)	**0.04***	26.3 (4.8)	30.2 (6.6)	**<0.01***
%K-L grade=1	27.7%	31.1%	0.72*	42.9%	36.6%	0.56*
AA	182.1 (4.2)	182.0 (3.6)	0.99†	180.9 (4.5)	181.4 (4.1)	0.65†
CA	95.5 (2.4)	95.1 (2.6)	0.39†	94.8 (2.8)	95.4 (2.6)	0.32†
PA	87.3 (2.2)	87.6 (2.1)	0.43†	87.1 (2.6)	87.2 (2.0)	0.73†
CP	1.32 (2.3)	1.38 (2.3)	0.77†	1.83 (2.5)	1.68 (2.0)	0.77†

* p value comparing means in Caucasians to AfrAm, within gender

† p value comparing means in Caucasians to AfrAm, within gender, adjusted for age and BMI

AA=Anatomic axis; **CA**=Condylar angle; **PA**=Tibial plateau angle; **CP**=Condylar-plateau angle