VARUS-VALGUS ALIGNMENT IN THE PROGRESSION OF KNEE OA

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Introduction. Most of the epidemiologic literature concerning OA deals with risk factors for the initial development of arthritis. However, in a large subset of people, knee OA remains a relatively mild condition. The form of knee OA responsible for the bulk of individual and societal cost is OA that progresses beyond mild stages. Identification of factors responsible for progression is critical to better understand pathogenesis, facilitate intervention development, and determine which factors influence response to disease-modifying agents.

Alignment is a key element of the loading environment at the knee. In theory, any shift from a collinear alignment of the lower extremity joints affects tibiofemoral compartment load distribution. One possible consequence of varus or valgus malalignment is capsular stretching and increased varus-valgus laxity, which may further impair the loading milieu. Alignment is a determinant of surgical outcomes, but the influence of malalignment in persons with established OA on natural OA progression is unclear.

In this prospective, longitudinal study, we tested the hypotheses: baseline varus valgus malalignment increases the risk of subsequent medial tibiofemoral OA progression; baseline valgus malalignment increases the risk of subsequent lateral tibiofemoral OA progression; the effect of malalignment is reduced after accounting for varus-valgus laxity.

Methods. In an ongoing study of radiographic progression and functional decline in OA, 240 community-recruited patients with knee OA have completed baseline and 18 month evaluations. For entry, patients were required to have definite knee osteoarthritis, and at least "a little" difficulty with 2 or more tasks in the WOMAC physical function subscale. Exclusion criteria were: steroid injection within 3 months; any inflammatory arthritis; OA secondary to other diseases (see reference 1 for full criteria list). IRB approval was obtained and all subjects provided informed consent.

To assess alignment, an AP radiograph of the lower extremity was obtained using a 51 by 14 inch graduated grid cassette. The subject stood without footwear, with the tibial tubercles facing forward. The x-ray beam was centered at the knee at a distance of 8 feet. A setting of 100-300 milliampereseconds and a kilovoltage of 80-90 was used depending on limb size and tissue characteristics to ensure landmark visualization. The alignment angle measured was formed by the intersection of the line from the center of the femoral head to the center of the femoral intercondylar notch, with the line from the center of the ankle talus to the center of the tips of the tibial spines. All measurements were made by a single, experienced reader. Reliability was high for measurements of varus (ICC = 0.899) and valgus (ICC 0.988) alignment.

The system to assess varus-valgus laxity consisted of a sled and an attached arc-shaped, low friction track (2). The distal shank was firmly attached to a sled, which traveled within the track. A hand held dynamometer was attached to a sled, which traveled within the track. A hand held dynamometer which fitted into either side of the sled was used to apply a fixed load. The subject was seated, with the thigh and ankle immobilized, and the study knee at 20° flexion. An auditory signal indicated when a load of 40 N was reached. Laxity was measured as the angular deviation at the sled after application of varus and valgus load. Between session reliability (ICCs = 0.84-0.90) was substantially improved over published results for physical exam methods.

Knee x-rays were obtained in the same unit by 1 of 2 technicians. The radiographic protocol (3) addressed joint position, beam alignment, magnification, and landmark definition for measurements. The semi-flexed position was used, with fluoroscopic confirmation of joint position. Medial and lateral compartment progression were defined as a 1 grade increase in joint space narrowing grade in the medial and lateral compartments respectively. The 4 grade (0-3) scale of the OARSI atlas was used.

To evaluate the relationship between alignment and progression, logistic regression was used. Dominant knee data were examined. Age, gender and BMI were included in multivariate analyses if they had a univariate relationship with progression.

Results. Of the 240 subjects, the highest grade of joint space narrowing at baseline were excluded, since, by definition, they could not progress. The sample of 200 included 146 women and 54 men. The mean age of the subjects was 64 years (+ 11 years (s.d.) (range 35-90 years). Mean BMI was 30.3 ± 5.8 (s.d.) (range 20.3-52.3). The dominant knee was varus in 94 subjects, valgus in 91, and neutral in 15.

Over the 18 month period, 37 of 200 subjects progressed in the medial compartment and 163 did not. Of the 37 medial progressors, 28 were varus at baseline, 5 were valgus, and 4 were neutral (p < .001). Lateral compartment progression occurred in 26 of 200 knees, including 1 of 15 neutral knees, 19 of 91 valgus knees, and 6 of 94 varus knees (p = .009).

Varus malalignment at baseline was associated with an adjusted OR of 3.65 (95% CI 1.57-8.52) for medial progression between baseline and 18 months, adjusting for gender and BMI. Valgus malalignment at baseline was associated with an OR of 3.85 (95% CI 1.54-9.63) for lateral progression between baseline and 18 months.

Multiple logistic regression analyses were repeated after additionally controlling for varus-valgus laxity, without any effect on the strength of the relationships between alignment and progression. Varus malalignment at baseline was associated with an adjusted OR of 3.67 (95% CI 1.57-8.55) for medial progression, adjusting for gender, BMI, and varus-valgus laxity. Valgus malalignment at baseline was associated with an adjusted OR of 3.83 (95% CI 1.50-9.77) for lateral progression, adjusting for varus-valgus laxity.

The direction of malalignment was contrasted against any other alignment that might be present in a given knee, in recognition that OA in each compartment may progress in the setting of varus, valgus or neutral alignment. In additional analyses, we confirmed that the likelihood of progression was increased when the comparison group included only neutral or near-neutral knees.

Conclusion. Varus malalignment at baseline increased the risk of medial tibiofemoral OA progression over the subsequent 18 month period. Valgus malalignment at baseline increased the risk of subsequent lateral tibiofemoral OA progression. These effects were independent of varus-valgus laxity. To our knowledge, this is the first demonstration that malalignment, reflected by the intersection of the femoral and tibial mechanical axes, increases the natural risk of subsequent OA progression in an unselected sample, and that this effect is demonstrable as early as 18 months using optimal radiographic techniques after controlling for important covariates. It is likely that the malalignment-associated odds of progression are even greater at longer follow-up. In future studies, the threshold severity of malalignment necessary for progression will be determined.

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