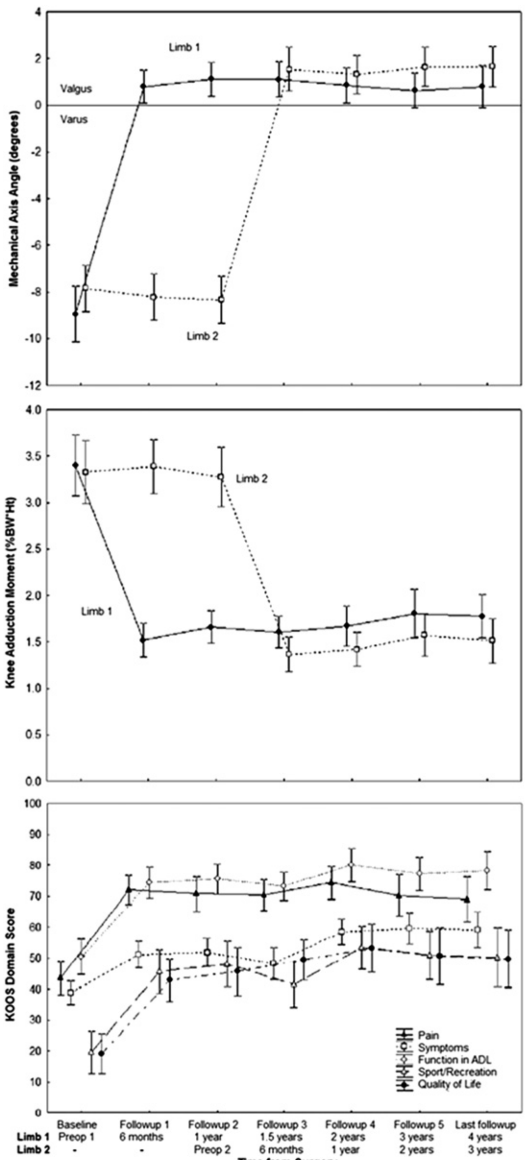
(external knee adduction moment). Patients also completed the Knee Injury and Osteoarthritis Outcomes Scores (KOOS), the Lower Extremity Functional Scale (LEFS), the Short Form Health Survey (SF-12) and the six-minute walk test (6MWT). Both limbs of all patients were evaluated preoperatively (baseline) and approximately 6, 12 and 24 months post-operatively after each surgery.

Results: There were large improvements in outcomes. Mean changes (95%CI) were: mechanical axis angle 9.43° (8.37, 10.39°); peak knee adduction moment -1.72 %BW*Ht (-2.06, -1.38 %BW*Ht); KOOS Pain 25.60 (19.76, 31.44); SF-12 Physical Component Summary 12.02 (8.50, 15.53); 6MWT 36.72 m (19.43, 54.01m). There were no statistically significant differences in the improvements at final assessment between those patients who had the second HTO staged either within or beyond 12 months of the first HTO.



Conclusions: Patients experience large, clinically important improvements in knee joint biomechanics, pain and function bilaterally after staged medial opening wedge HTO. Current findings suggest no difference in outcomes for patients who have the second surgery staged within or beyond 12 months of the first surgery.

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THE INFLUENCE OF AGE, STRENGTH AND STIFFNESS ON PROPRIOCEPTION IN KNEE OSTEOARTHRITIS

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Purpose: The perception of limb position in space requires the input signals from joint capsule mechanoreceptors, ligaments, muscle spindles and tendon receptors of the joint surrounding muscles. Proprioceptive accuracy and quadriceps weakness have been reported to be worse in patients with symptomatic knee osteoarthritis (OA) compared with asymptomatic one's, and pain is known to influence quadriceps strength. Reduction of joint mobility is consequence of decrease strength and also of joint stiffness, compromising joint position sense; therefore the aim of this study was to analyze the contributions of several variables in the knee proprioception.

Methods: From a cohort of 89 subjects, 52 (39 women; 13 men) were eligible and diagnosed for knee osteoarthritis according to ACR clinical and radiological criteria (K-L grade 2 or 3). Subjects had mean (SD) age 65.3 (8.2) yr, BMI 29.6 (5.5) kg/m^2, height 1.60 (0.07) m and weight 75.2 (13.5) kg. Joint position sense (JPS) was measured asking the subjects to reproduce three knee angles (20o, 45o, 70o) without visual control. Each position was repeated three times at random and accuracy was estimated by the difference between target and reproduced angles. Concentric knee extensor and flexion strength (peak torque) was assessed with a Biodex dynamometer at 60o/s, through a range of motion from 20o to 80o. Active knee joint range of motion was measured with a digital goniometer and degrees of maximal extension and flexion were recorded. Self-reported pain and joint stiffness were assessed by the Western Ontario and McMaster Universities Index (WOMAC). Pearson correlations between the quantitative variables were calculated. Flexor and extensor knee strength were highly correlated (r=0.880, p <0.001), therefore only the last one was chosen for the stepwise variable selection (p_{IN}=0.10; p_{OUT}=0.10). Multiple linear regression models were adjusted to find out which variables (extensor knee strength, knee flexion, knee extension, WOMAC pain and stiffness, and age) explain the JPS

Results: Table 1 shows the correlations between JPS and predictors. Two models emerged from two sets of variables which differ only in age predictor (Table 2 and 3). Despite the low proportion of variance explained by stiffness and knee extensor strength, these variables have a significant influence in JPS. When age was considered in the set of predictors, the knee extensor strength was not included in the model, probably due to the significant correlation between age and knee extensor strength (r=-0.332, p=0.016), and to the higher correlation of JPS with age (r=0.488, p<0.001) than with knee extensor strength (r=-0.164, p=0.245). The proportion of variance in the JPS explained by stiffness and age (R^2=0.306) was higher than the one achieved by model 1.

Conclusions: Proprioception and quadriceps muscle are fundamental to maintain joint stability under dynamic conditions. The results showed that age together with joint stiffness had more predictive value on joint position sense than quadriceps strength combined with joint stiffness in patients with knee OA.

Table 1
Pearson correlation coefficients between joint position sense and independent variables.

Independent variables	WOMAC pain	WOMAC stiffness	Knee flexion strength	Knee extensor strength	Knee flexion	Knee extension	Age
r	-0.077	-0.337	-0.146	-0.164	-0.037	0.006	0.488
p	0.586	0.014	0.301	0.245	0.795	0.966	< 0.001

Table 2
Coefficients results of the multiple linear regression models.

model	predictors	B	Beta	t	p
1	(constant)	6.008		9.526	<0.001
	WOMAC Stiffness	-0.012	-0.377	-2.842	0.007
	Knee extensor strength	-0.014	-0.229	-1.727	0.090
2	(constant)	1.100		-0.650	0.519
	WOMAC Stiffness	-0.001	-0.263	-2.176	0.034
	Age	-0.088	-0.444	3.678	0.001

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DIFFERENCES IN MULTI-JOINT SYMPTOMATIC OSTEOARTHRITIS PHENOTYPES BY RACE AND GENDER: THE JOHNSTON COUNTY OSTEOARTHRITIS PROJECT

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Purpose: We have identified differences in multi-joint patterns of radiographic osteoarthritis (rOA) by race and gender, and sought to determine whether similar differences were present for symptomatic osteoarthritis (sOA).

Methods: We used a subset of the Johnston County Osteoarthritis Project (data collected 2003-10) with complete symptom and radiographic data at multiple joint sites (n=1650, 36% men, 32% African American, mean age 66 $\pm$ 10 years, mean body mass index [BMI] 31 $\pm$ 6 kg/m2). Definitions of sOA were based on findings of both rOA (as defined in Table 1) and symptoms in the same joint site. Sixteen mutually exclusive phenotypes including all possible combinations of the 4 sOA variables were constructed, and Fisher exact tests with Hochberg correction for multiple comparisons were used to compare their frequencies by race and gender. Logistic regression with adjustment for race/gender, age, and BMI was performed for those phenotypes affecting at least 40 persons. Interactions between race and gender were considered noteworthy at p<0.2 and stratified analyses were performed as indicated.

Table 1. Definitions of Symptomatic OA*

Joint Site	Symptoms†	+	Radiographic OA criteria
Hand	hand	+	KL ≥2 in at least 1 DIP and at least 3 total hand joints
Knee	knee	+	Tibiofemoral KL≥ 2 or patellofemoral osteophyte ≥2‡ or joint replacement§
Hip	hip	+	Hip joint KL ≥2 or joint replacement§
Lumbosacral Spine	back	+	Disc narrowing and an osteophyte ≥1 at the same level (L1/2 to L5/S1)‡

**Symptomatic OA requires both symptoms and radiographic criteria in the same joint site, on the same side*
†Answered yes to: "on MOST days do you have pain, aching, or stiffness of your ____?"
‡Osteophyte and disc narrowing graded 0-3 according to the Burnett atlas
§Joint replacement done for OA per participant
KL=Kellgren Lawrence grade, DIP=Distal InterPhalangeal joint

Results: Overall, the frequency of any sOA was as follows: hand 13%, hip 11%, knee 25%, and Lumbar Spine (LS) 28%. Compared to Caucasians, African Americans had less frequent Hand sOA, but more frequent Knee sOA (Table 2, left). After adjustment, African Americans had 70-80% lower odds of Hand sOA alone (aOR 0.19, 95% CI: 0.08-0.49) and the combination of Hand and Knee sOA (aOR 0.31, 95%CI: 0.13-0.76), but 80% higher odds of Knee sOA alone (aOR 1.78, 95% CI: 1.27-2.50).

Men were more likely to have no sOA in any site, and were less likely than women to have the combinations of Hand/Knee sOA or Hand/Knee/LS sOA (Table 2, right). After adjustment, men had 50-70% lower odds of Hand sOA alone or of Hand/Knee sOA in combination (Hand aOR 0.50, 95%CI: 0.27-0.91; Hand/Knee aOR 0.31, 95%CI: 0.13-0.75), but 50% higher odds of LS Only sOA (aOR 1.48, 95% CI: 1.09-2.01).

TABLE 2. Differences in multiple joint symptomatic osteoarthritis phenotypes by race and gender

Symptomatic OA Phenotype	Comparisons by Race: Caucasian n(%)	Comparisons by Race: African American n(%)	Comparisons by Race: Fisher exact p value†	Comparisons by Gender: Women n(%)	Comparisons by Gender: Men n(%)	Comparisons by Gender: Fisher exact p value†
No OA	544 (48.6)	292 (55.1)	*0.015*	**488 (46.4)**	**348 (58.1)**	***<0.001†***
Hand Only	**59 (5.3)**	**5 (0.9)**	***<0.001†***	50 (4.8)	14 (2.3)	*0.016*
Hip Only	33 (3.0)	12 (2.3)	*0.518*	25 (2.4)	20 (3.3)	*0.272*
Knee Only	**87 (7.8)**	**75 (14.2)**	***<0.001†***	115 (10.9)	47 (7.9)	*0.048*
LS Only	136 (12.1)	59 (11.1)	*0.569*	108 (10.3)	87 (14.5)	*0.011*
Hand/Hip	12 (1.1)	1 (0.2)	*0.073*	11 (1.1)	2 (0.3)	*0.151*
Hand/Knee	36 (3.2)	6 (1.1)	*0.011*	**36 (3.4)**	**6 (1.0)**	***0.002†***
Hand/LS	**38 (3.4)**	**4 (0.8)**	***0.001†***	34 (3.2)	8 (1.3)	*0.022*
Hip/Knee	20 (1.8)	6 (1.1)	*0.400*	12 (1.1)	14 (2.3)	*0.067*
Hip/LS	20 (1.8)	8 (1.5)	*0.839*	21 (2.0)	7 (1.2)	*0.239*
Knee/LS	50 (4.5)	38 (7.2)	*0.026*	60 (5.7)	28 (4.7)	*0.425*
Hand/Hip/Knee	6 (0.5)	0 (0)	*0.186*	5 (0.5)	1 (0.2)	*0.426*
Hand/Hip/LS	15 (1.3)	2 (0.4)	*0.113*	16 (1.5)	1 (0.2)	*0.009*
Hand/Knee/LS	28 (2.5)	4 (0.8)	*0.020*	**30 (2.9)**	**2 (0.3)**	***<0.001†***
Hip/Knee/LS	25 (2.2)	12 (2.3)	*1.000*	24 (2.3)	13 (2.2)	*1.000*
All sites	11 (1.0)	6 (1.0)	*0.797*	16 (1.5)	1 (0.2)	*0.009*
Total	1120 (100)	530 (100)	--	1051 (100)	599 (100)	--

**Mutually exclusive, referent is all other phenotypes*
*†**Significant** after Hochberg adjustment for multiple comparisons*
LS=lumbosacral spine

Stratified analyses were performed for No sOA, Hand/LS sOA, and Knee/LS sOA due to race by gender interactions. Compared to Caucasian women, Caucasian men and African American men and women had 50-65% increased odds (aOR 1.48 to 1.65) of having No sOA in any joint site. Again compared to Caucasian women, African American women had 93% lower odds (aOR 0.07, 95%CI: 0.01-0.51), and Caucasian men had 73% lower odds (aOR 0.27, 95%CI: 0.10-0.70) of having a combination of Hand and LS sOA. For the combination of Knee and LS sOA, African American women had nearly twice the odds compared to Caucasian women (aOR 1.92, 95%CI: 1.12-3.29), with no significant differences for the men.

Conclusions: Consistent with our results looking at rOA phenotypes by race, African American individuals have lower frequencies of sOA of the hands, alone and in combination, but higher frequencies of knee sOA, compared to Caucasians. Compared to women, men are less likely to have sOA of the hands alone or in combination, but more likely to have isolated LS involvement.

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THE ASSOCIATION BETWEEN HAMSTRING STRENGTH AND HAMSTRING-QUADRICEPS STRENGTH RATIO WITH PATELLOFEMORAL JOINT CARTILAGE DAMAGE: THE MOST STUDY

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Purpose: It is known that quadriceps weakness is associated with patellofemoral joint (PFJ) structural damage. Recent in vitro biomechanical data suggests that hamstring loading increases joint stress on lateral PFJ cartilage, but this has not been linked to structural damage in vivo. The purpose of this study was to determine the association between hamstring strength and hamstring-quadriceps strength ratio (HQR), independent of quadriceps strength, with structural features of PFJ osteoarthritis (OA) on MRI.

Methods: The Multicenter Osteoarthritis (MOST) study is a prospective cohort study of individuals 60-79 years with or at risk for knee OA. Hamstrings and quadriceps strength were assessed using an isokinetic dynamometer and normalized per kilogram of body weight (Nm/kg). Cartilage damage on MRI was assessed by two musculoskeletal radiologists using the Whole Organ Magnetic Resonance Imaging Score (WORMS) scale on the lateral patella and trochlea (distal anterior femur). Analyses were performed in two groups of knees; those without whole knee radiographic knee OA (ROA) at baseline (n=391) and those with whole knee ROA at baseline (n=520). In the no OA group we examined worsening of cartilage damage (any increase in WORMS score) over 30 months as a function of muscle strength at baseline and in the ROA group, we examined prevalent full-thickness cartilage damage and concurrent muscle strength We began by examining the relationship between quadriceps strength, hamstring