

## Knees with Isolated Lateral Compartment Osteoarthritis Show a Substantial Variability in Functional Knee phenotypes with Demographic-specific Variations

G.V. ten Noever de Brauw<sup>1,2</sup>, T. Bayoumi<sup>1,2</sup>, L.V. Ruderman<sup>1</sup>, G.M.M.J. Kerkhoffs<sup>2</sup>, H.A. Zuiderbaan<sup>3</sup>, A.D. Pearle<sup>1</sup>

Hospital for Special Surgery, New York, United States<sup>1</sup>; Amsterdam UMC, Location University of Amsterdam, Amsterdam, The Netherlands<sup>2</sup>; Medische Kliniek Velsen, Velsen-Noord, The Netherlands<sup>3</sup>



: QR-code to article



ISAKOS  
CONGRESS  
2025



MUNICH  
GERMANY  
June 8–11

**Neither I nor my co-authors have any relevant financial relationships or conflict of interest to disclose in relation to this presentation**

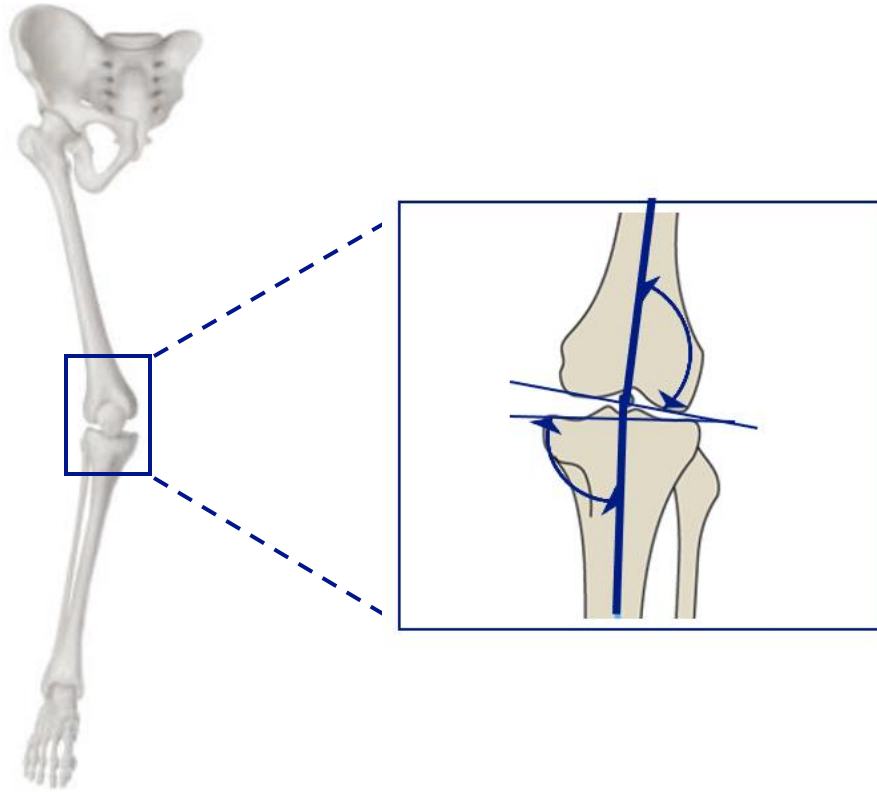
Dr. Hendrik A. Zuiderbaan is a paid consultant for Smith & Nephew Inc

Dr. Andrew D. Pearle is a paid consultant for Smith & Nephew Inc, and and DePuy Synthes



**ISAKOS**  
**CONGRESS**  
**2025**

# Background and Objectives



- To compare, assess, and describe the phenotypic variation in the coronal plane of knees affected by isolated lateral compartment osteoarthritis (OA)
- To investigate potential gender-specific and age-related differences in functional knee phenotypes



# Methods

- This study comprised of 305 knees with symptomatic isolated lateral compartment OA (i.e., Kellgren-Lawrence grade III-IV and pain localized to the lateral compartment of the knee
- Radiographic measurements included the hip-knee-ankle angle (HKA), femoral mechanical angle (FMA) and tibial mechanical angle (TMA) (Fig. 1)
- Knees were classified according to the Functional Knee Phenotype system<sup>1</sup>
- Phenotypic variation was analyzed by sex and age



**Figure 1.** Coronal Plane Alignment of the Knee (CPAK) classification with nine identified CPAK phenotypes

# Methods: Functional knee phenotype classification<sup>1</sup>

**Table 1.** Functional knee phenotype classification system

Variable	Alignment	Phenotype	Range	Average value
<b>Limb phenotype</b> HKA	Varus	VAR <sub>HKA</sub> 6°	4.5 to 7.5°	6°
		VAR <sub>HKA</sub> 3°	1.5(6) to 4.5°	3°
	Neutral	NEU <sub>HKA</sub> 0°	-1.5 to 1.5	0°
		VAL <sub>HKA</sub> 3°	-1.5 to -4.5°	-3°
		VAL <sub>HKA</sub> 6°	-4.5 to -7.5°	-6°
		VAL <sub>HKA</sub> 9°	-7.5 to -10.5°	-9°
		VAL <sub>HKA</sub> 12°	-10.5 to -13.5°	-12°
<b>Femoral phenotype</b> FMA	Varus	VAR <sub>FMA</sub> 6°	85.5 to 88.5°	87°
		VAR <sub>FMA</sub> 3°	88.5 to 91.5°	90°
	Neutral	NEU <sub>FMA</sub> 0°	91.5 to 94.5°	93°
		VAL <sub>FMA</sub> 3°	94.5 to 97.5°	96°
		VAL <sub>FMA</sub> 6°	97.5 to 100.5°	99°
<b>Tibial phenotype</b> TMA	Varus	VAR <sub>TMA</sub> 6°	79.5 to 82.5°	81°
		VAR <sub>TMA</sub> 3°	82.5 to 85.5°	84°
	Neutral	NEU <sub>TMA</sub> 0°	85.5 to 88.5°	87°
		VAL <sub>TMA</sub> 3°	88.5 to 91.5°	90°
		VAL <sub>TMA</sub> 6°	91.5 to 94.5°	93°
		VAL <sub>TMA</sub> 9°	94.5 to 97.5°	96°
		VAL <sub>TMA</sub> 12°	97.5 to 100.5°	99°

The functional knee phenotype classification utilizes three variables –the limb phenotype (HKA), femoral phenotype (FMA), and the tibial phenotype (TMA) – each defined with their corresponding range. For each variable the data is presented in degrees. *FMA*, femoral mechanical angle; *HKA*, mechanical hip-knee-ankle angle; *TMA*, tibial mechanical angle.



**ISAKOS**  
CONGRESS  
2025

<sup>1</sup> Hirschmann et al. Functional knee phenotypes: a novel classification for phenotyping the coronal lower limb alignment based on the native alignment in young non-osteoarthritic patients.

# Results: Functional knee phenotypes

- Sixty preoperative functional knee phenotypes identified; top 10% account for 63.9% of all cases (Table 2).
- Most common functional knee phenotype:  $VAL_{HKA}6^{\circ}NEU_{FMA}0^{\circ}VAL_{TMA}3^{\circ}$  (10.8% of knees)
- Tibial involvement observed in 68% of cases, with 37% presenting with isolated tibial valgus deformities (no femoral involvement)

**Table 2.** The ten most common functional knee phenotypes of knees with isolated lateral compartment osteoarthritis

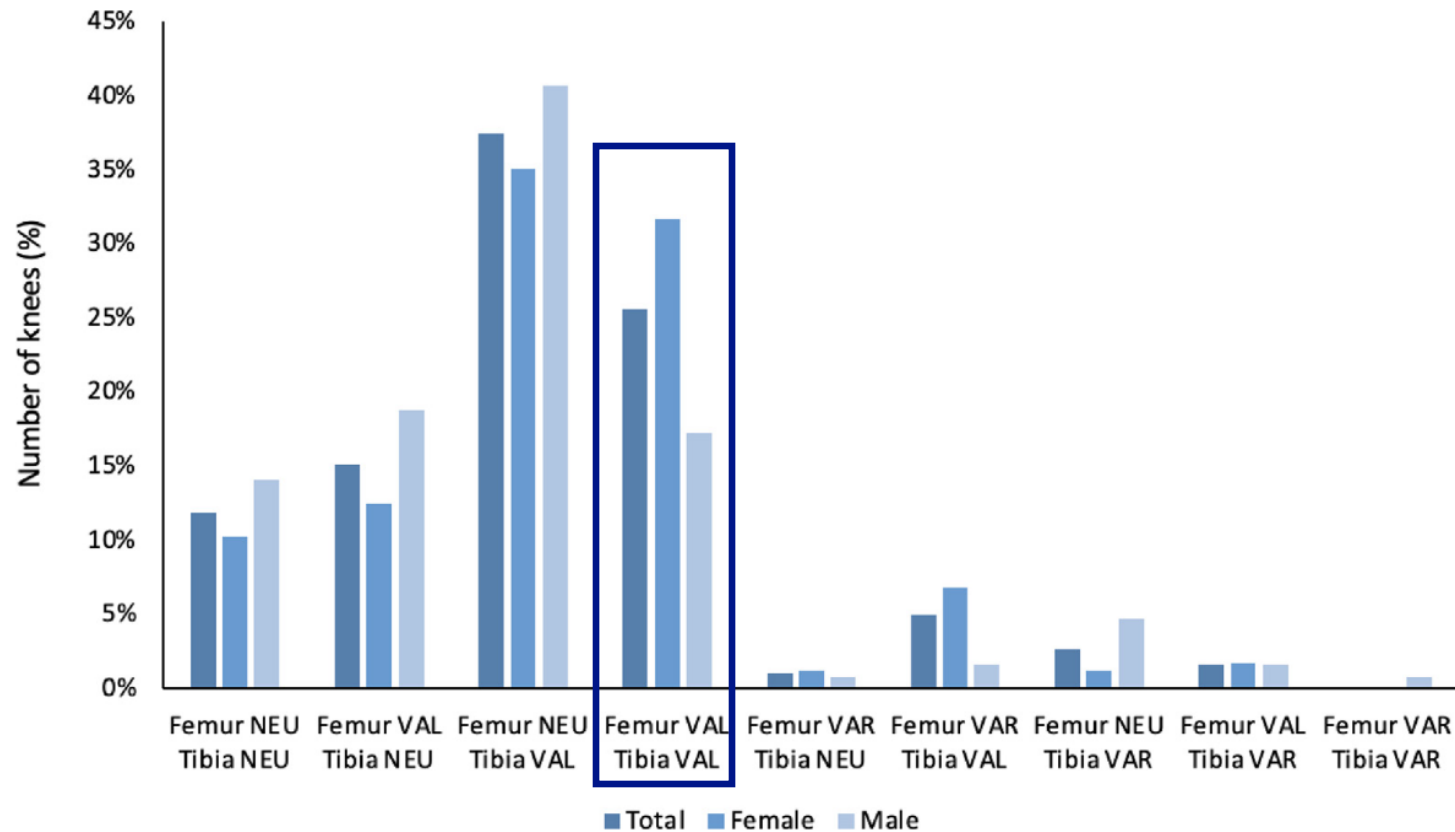
Rank	Functional knee phenotype	Total <i>n</i> = 231	Male <i>n</i> = 89	Female <i>n</i> = 106
1	$VAL_{HKA}6^{\circ}NEU_{FMA}0^{\circ}VAL_{TMA}3^{\circ}$	33 (10.8%)	16 (12.5%)	17 (9.6%)
2	$VAL_{HKA}3^{\circ}NEU_{FMA}0^{\circ}VAL_{TMA}3^{\circ}$	29 (9.5%)	15 (11.7%)	14 (7.9%)
3	$VAL_{HKA}6^{\circ}VAL_{FMA}3^{\circ}VAL_{TMA}3^{\circ}$	24 (7.9%)	7 (5.5%)	17 (9.6%)
4	$VAL_{HKA}6^{\circ}VAL_{FMA}3^{\circ}NEU_{TMA}0^{\circ}$	22 (7.2%)	11 (8.6%)	11 (6.2%)
5	$VAL_{HKA}3^{\circ}NEU_{FMA}0^{\circ}NEU_{TMA}0^{\circ}$	19 (6.2%)	10 (7.8%)	9 (5.1%)
6	$VAL_{HKA}9^{\circ}NEU_{FMA}0^{\circ}VAL_{TMA}3^{\circ}$	18 (5.9%)	8 (6.3%)	10 (5.6%)
7	$VAL_{HKA}9^{\circ}VAL_{FMA}3^{\circ}VAL_{TMA}3^{\circ}$	17 (5.6%)	6 (4.7%)	11 (6.2%)
8	$NEU_{HKA}0^{\circ}NEU_{FMA}0^{\circ}NEU_{TMA}0^{\circ}$	12 (3.9%)	6 (4.7%)	6 (3.4%)
9	$VAL_{HKA}6^{\circ}NEU_{FMA}0^{\circ}VAL_{TMA}6^{\circ}$	11 (3.6%)	3 (2.3%)	8 (4.5%)
10	$VAL_{HKA}3^{\circ}VAL_{FMA}3^{\circ}NEU_{TMA}0^{\circ}$	10 (3.3%)	7 (5.5%)	3 (1.7%)
<b>Total</b>		<b>195 (63.9%)</b>	<b>89 (69.5%)</b>	<b>106 (59.9%)</b>

Top 10 functional phenotypes of knees with lateral compartment osteoarthritis. The incidence of each functional knee phenotype is given in numbers and frequencies (%), for the entire cohort and stratified by gender. *FMA*, femoral mechanical angle; *HKA*, mechanical hip-knee-ankle angle; *NEU*, neutral; *TMA*, tibial mechanical angle; *VAL*, valgus; *VAR*, varus.

# Results: Gender-specific differences

- Females exhibited significantly greater valgus limb and tibial phenotypes compared to males (HKA  $-6.4^{\circ}$  vs.  $-5.4^{\circ}$ ,  $p = 0.02$ ; TMA  $94.4^{\circ}$  vs.  $89.0^{\circ}$ ,  $p = 0.005$ )

- Females were nearly twice as likely to present with combined tibial and femoral valgus deformities compared to males (32.0% vs 17%, respectively)



# Results: Age-related differences

Primary deformities in knees affected by lateral compartment OA

Isolated **femoral** valgus deformities  
31% of knees

< 50 years

Isolated **tibial** valgus deformities  
37% of knees

Combined tibial and femoral valgus  
deformities  
25% of knees

50 to 70 years

Isolated **tibial** valgus deformities  
37% of knees

Combined tibial and femoral valgus  
deformities  
25% of knees

> 70 years



# Conclusions:

- Phenotype analysis using the functional knee phenotype system demonstrated a wide diversity of coronal alignment phenotypes among knees with isolated lateral compartment OA
- Gender-specific and age-related differences were evident
- Females exhibited more pronounced valgus phenotypes and a higher prevalence of combined tibial and femoral valgus deformities
- Younger patients (< 50 years) predominantly presented with isolated femoral valgus deformities



: QR-code to article



**ISAKOS**  
**CONGRESS**  
**2025**

# References

- [1] Hirschmann, M. T., Moser, L. B., Amsler, F., Behrend, H., Leclercq, V., & Hess, S. (2019). Functional knee phenotypes: a novel classification for phenotyping the coronal lower limb alignment based on the native alignment in young non-osteoarthritic patients. *Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA*, 27(5), 1394–1402. <https://doi.org/10.1007/s00167-019-05509-z>



: QR-code to article



**ISAKOS**  
**CONGRESS**  
**2025**