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Varus Is Not One Deformity

Preoperative Coronal Plane Alignment of the Knee (CPAK) Phenotypes in Knees Undergoing Total Knee Arthroplasty

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Why CPAK Matters

- Coronal knee deformity is often reduced to varus, neutral, or valgus.
- That description does not show how the joint line is oriented.
- The Coronal Plane Alignment of the Knee (CPAK) classification combines arithmetic hip–knee–ankle angle (aHKA) and joint line obliquity (JLO).
- This separates knees with similar varus magnitude into different reconstructive phenotypes.

JLO category	aHKA		
	Varus	Neutral	Valgus
Distal apex	Type I	Type II	Type III
Neutral	Type IV	Type V	Type VI
Proximal apex	Type VII	Type VIII	Type IX

$$\text{aHKA} = \text{MPTA} - \text{LDFA} \quad \text{JLO} = \text{MPTA} + \text{LDFA}$$

CPAK Classification Framework

Methods

COHORT

24
patients

39
knees

15
bilateral patients

Descriptive analysis of a
preoperative radiographic dataset

RADIOGRAPHIC MEASUREMENTS

Lateral distal femoral angle (**LDFA**)

Medial proximal tibial angle (**MPTA**)

Arithmetic hip–knee–ankle angle (**aHKA**)

Joint line obliquity (**JLO**)

CPAK phenotype

ANALYSIS

- **Primary:** knee-level CPAK phenotype distribution
- **Secondary:** alignment category, JLO category, and bilateral concordance

Preoperative Alignment

n = 39

Alignment category



■ Varus: 36 (92.3%) ■ Neutral: 2 (5.1%) ■ Valgus: 1 (2.6%)

Joint line obliquity



■ Distal apex: 30 (76.9%) ■ Neutral: 9 (23.1%) ■ Proximal apex: 0 (0.0%)

Mean radiographic values

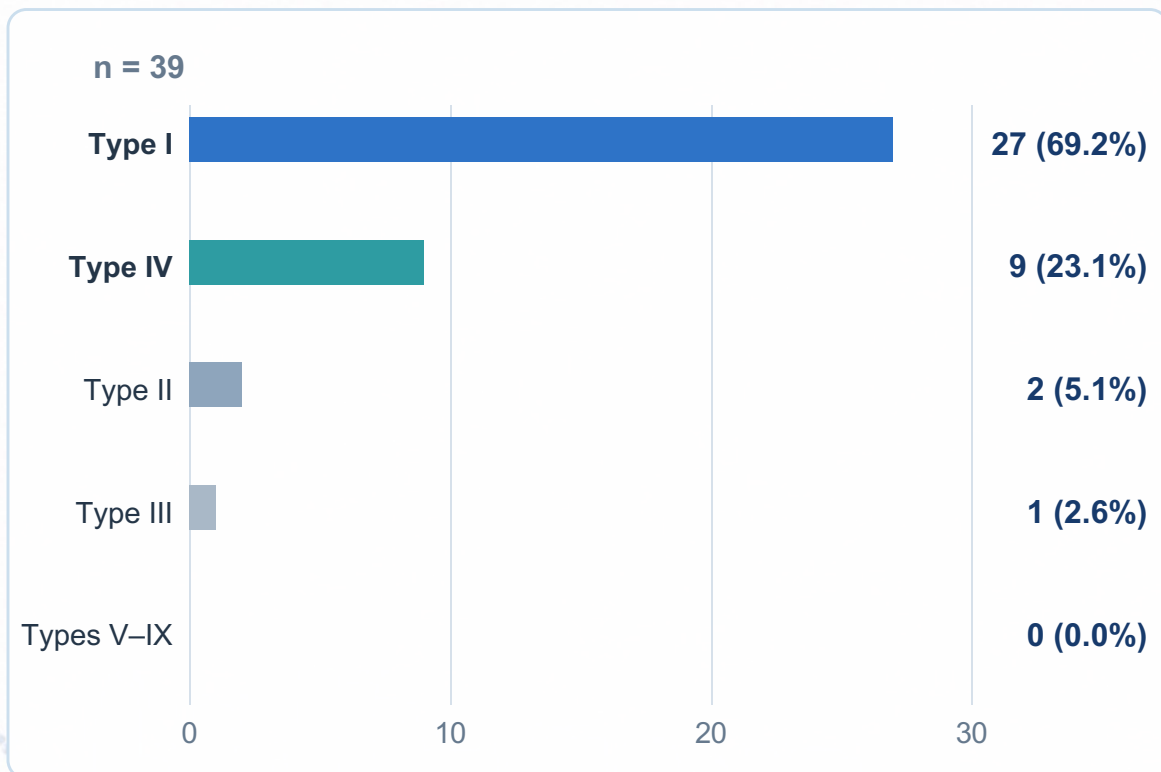
Lateral distal femoral angle **$91.1 \pm 3.4^\circ$**

Medial proximal tibial angle **$82.6 \pm 4.1^\circ$**

Arithmetic hip–knee–ankle angle **$-8.5 \pm 5.9^\circ$**

Joint line obliquity **$173.7 \pm 4.6^\circ$**

CPAK Phenotype Distribution



JLO category	aHKA		
	Varus	Neutral	Valgus
Distal apex	Type I	Type II	Type III
Neutral	Type IV	Type V	Type VI
Proximal apex	Type VII	Type VIII	Type IX

Types I and IV: 36 of 39 knees (92.3%)

No Types V–IX were observed.

Phenotype Comparison and Bilateral Concordance

Type I and Type IV: similar varus, different joint lines

CPAK type	n	Mean aHKA	Mean JLO	JLO category
Type I	27	-9.8°	171.7°	Distal apex
Type IV	9	-8.3°	179.7°	Neutral

Mean aHKA differed by 1.5°, whereas mean JLO differed by 8.0°.

Bilateral concordance

15 patients with both knees available

Broad alignment category 12/15 80.0%

JLO category 10/15 66.7%

Full CPAK type 8/15 53.3%

Contralateral alignment may reflect general tendency, but only 53.3% of bilateral patients shared the same full CPAK phenotype.

Conclusion

Key Findings	Limitations	Future Remarks
• Preoperative alignment was predominantly varus, but not phenotypically uniform. • CPAK Types I and IV accounted for 36/39 knees (92.3%). • Similar aHKA values showed different JLO patterns. • Full bilateral CPAK concordance was limited: 8/15 patients (53.3%).	• Descriptive, single-center preoperative radiographic analysis. • Small cohort with knee-level analysis including bilateral cases. • No postoperative alignment, soft-tissue balance, or clinical outcome data in this phase.	• Early and late postoperative outcomes are being collected. • Future analyses will relate CPAK phenotype to correction strategy, achieved alignment, balancing requirements, and outcomes. • Current findings remain hypothesis-generating.

Take Home Message: CPAK mapping adds joint-line information to coronal alignment and may support individualized, deformity-aware total knee arthroplasty planning.