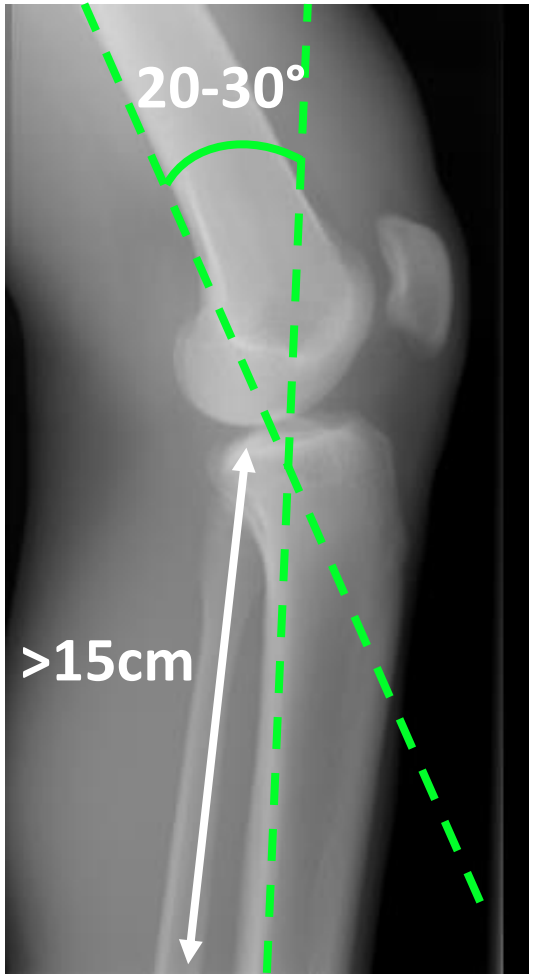
Sufficient Metaphyseal Bone for Wedge Removal and Fixation Hardware During Supratuberosity Tibial Deflexion Osteotomy in Knees with Excessive Posterior Tibial Slope

Guillaume Demey, Resurg, David Dejour

LYON ORTHO CLINIC, Clinique de la Sauvegarde, LYON

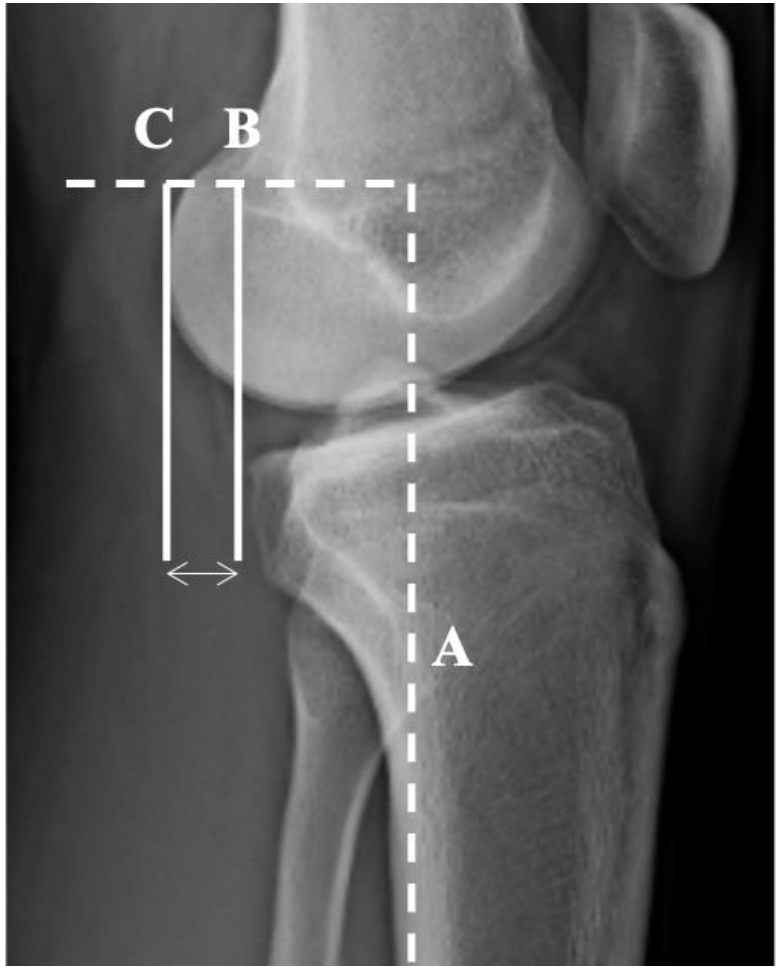
Sagittal Plane

Monopodal weightbearing X-Rays

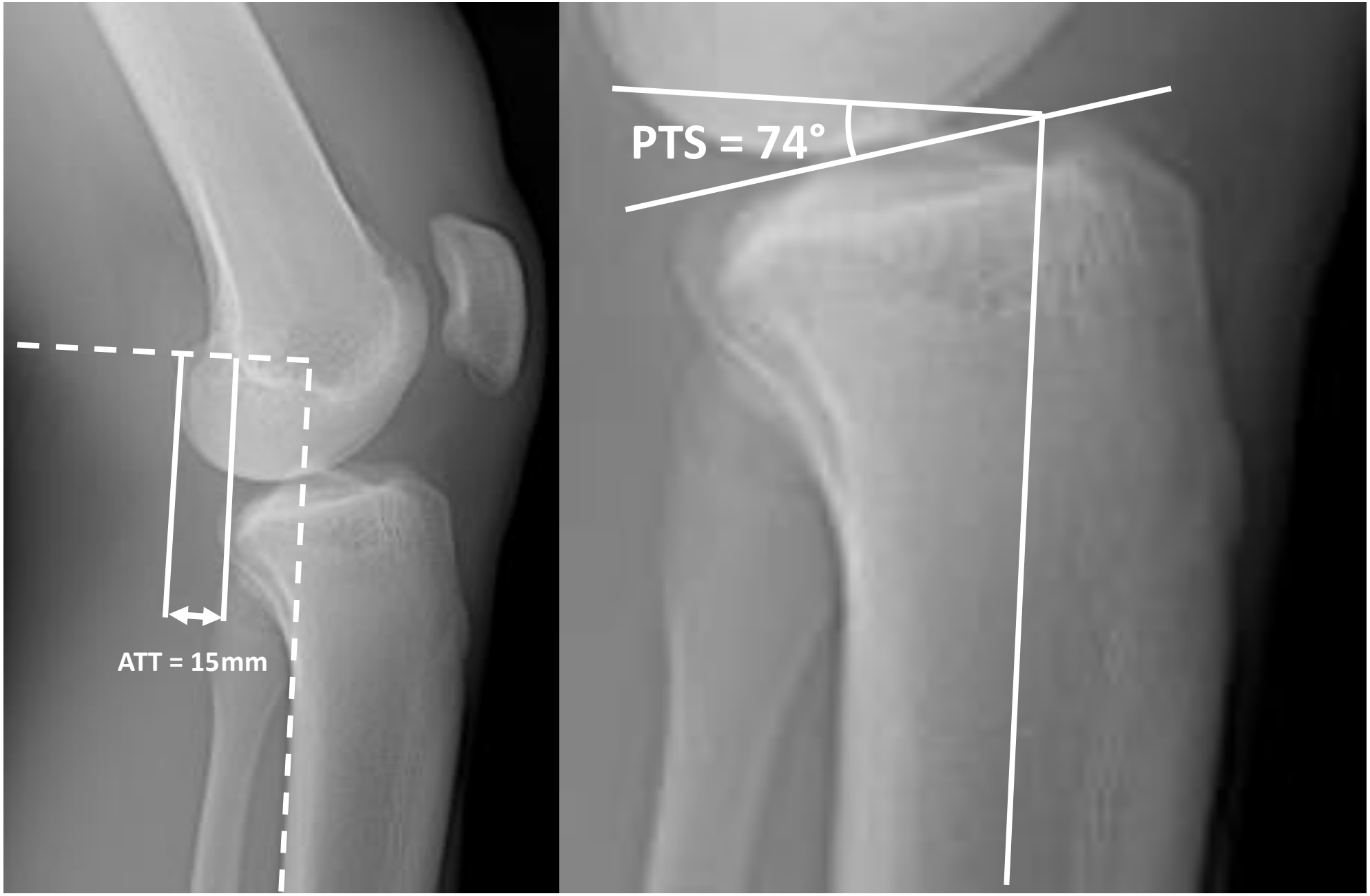


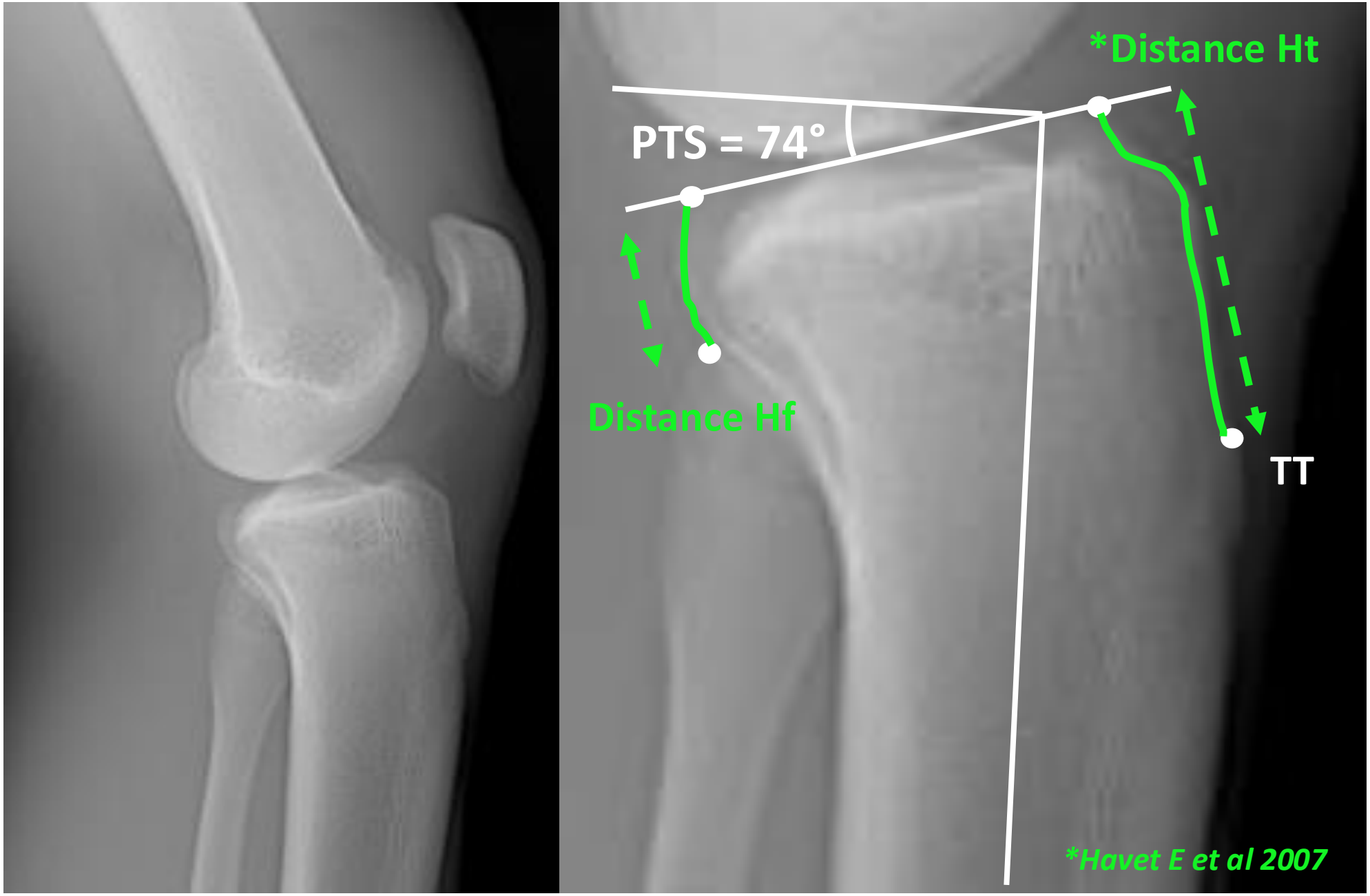
Posterior Tibial Slope (PTS)

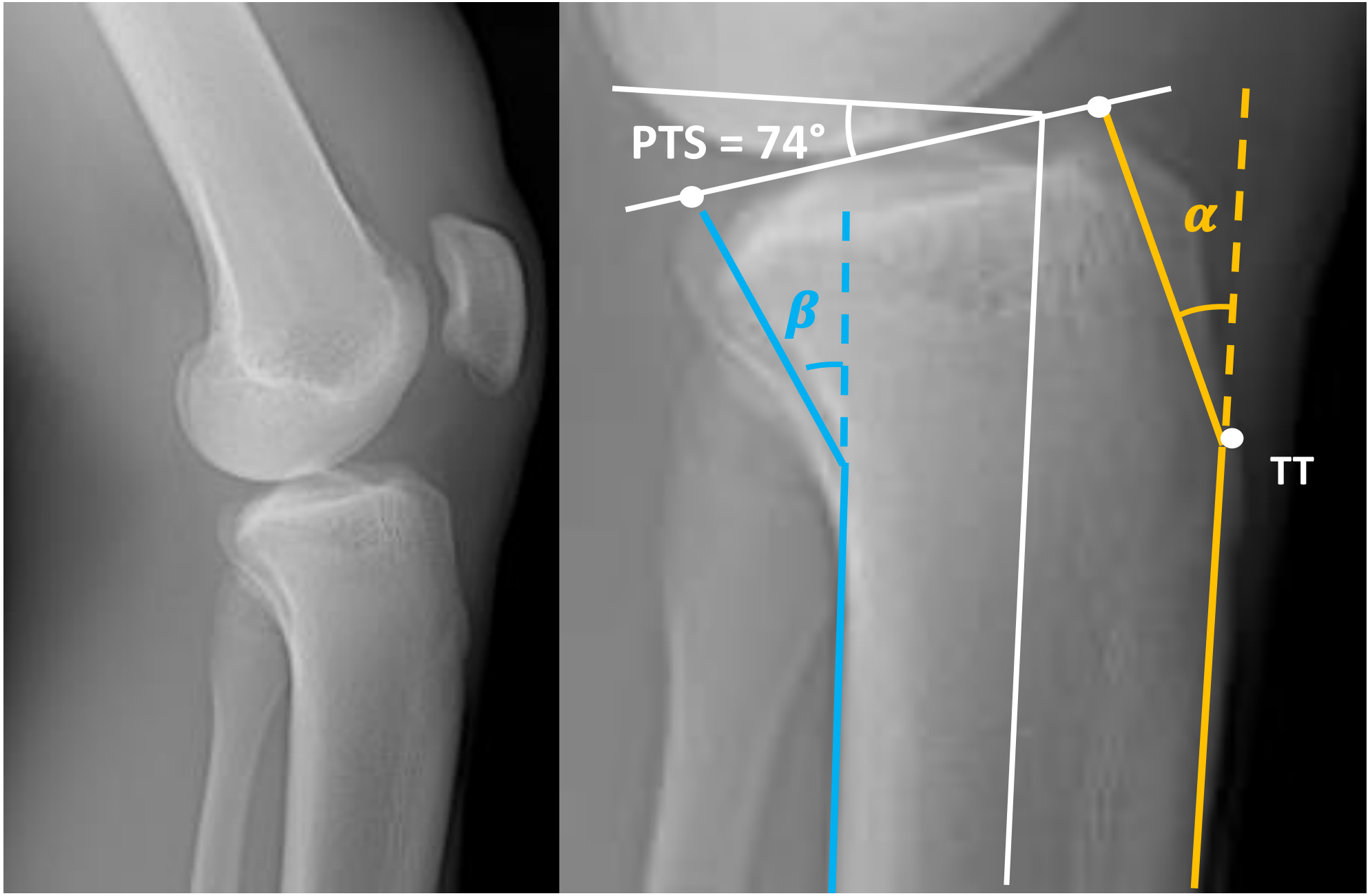
Anterior Tibial Translation (ATT)

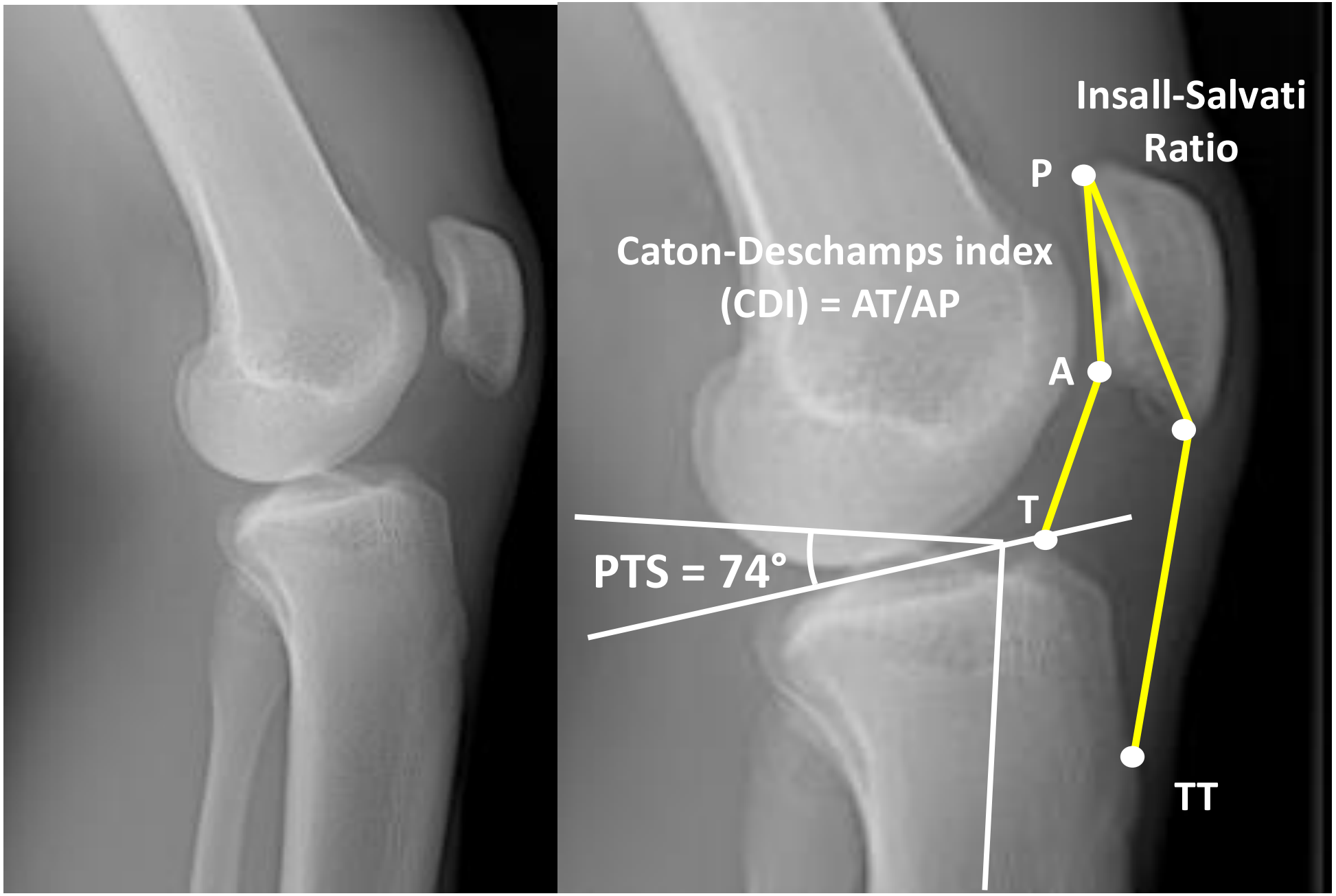


Patellar Height (CD & IS Index…)


ATT = 15mm
PTS = 74°


*Distance Ht
PTS = 74°
Distance Hf
TT
*Havet E et al 2007


PTS = 74°
β
α
TT


Insall-Salvati
Ratio
P
Caton-Deschamps index
(CDI) = AT/AP
A
T
PTS = 74°
TT

Material & Methods

350 patients with ACL tear

01/2019 – 12/2019

Standardized digital radiographs

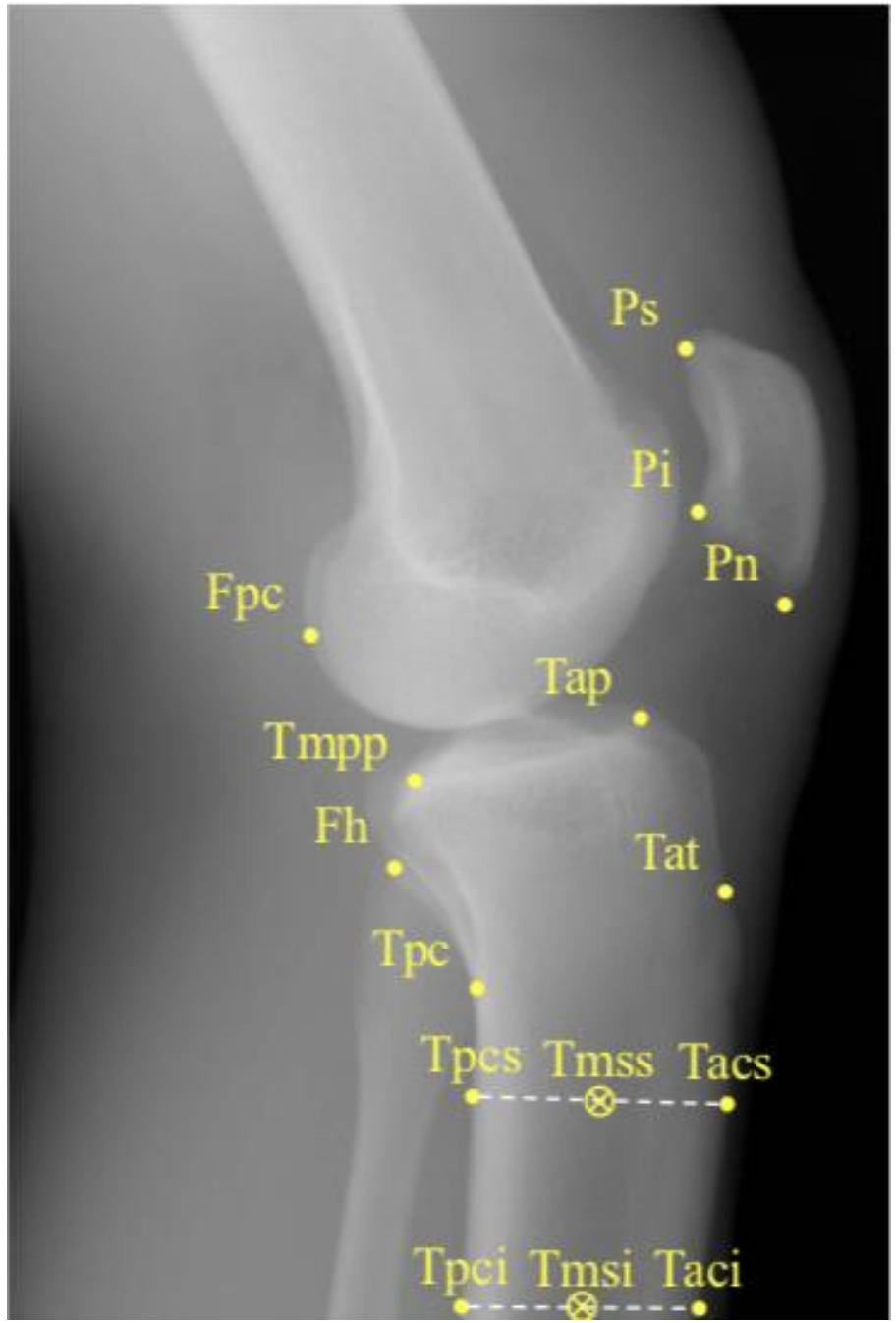
Tibia length >15cm

15 landmarks

Osirix MD 13

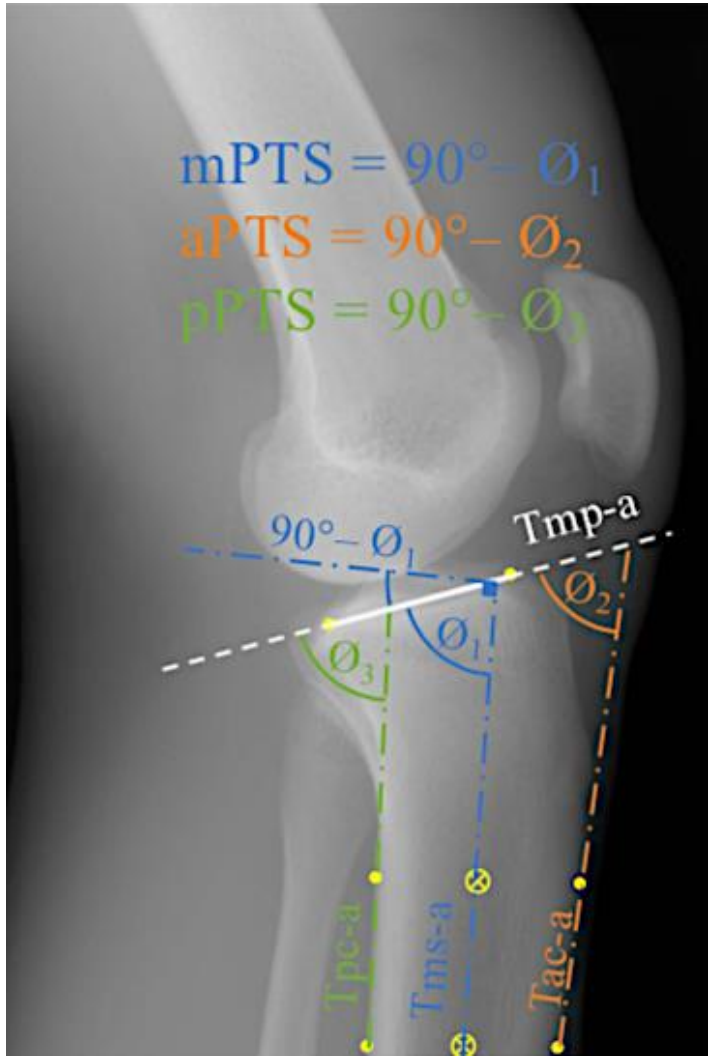
Coordinates of each landmark

Export to R 4.1.3 (R Core)

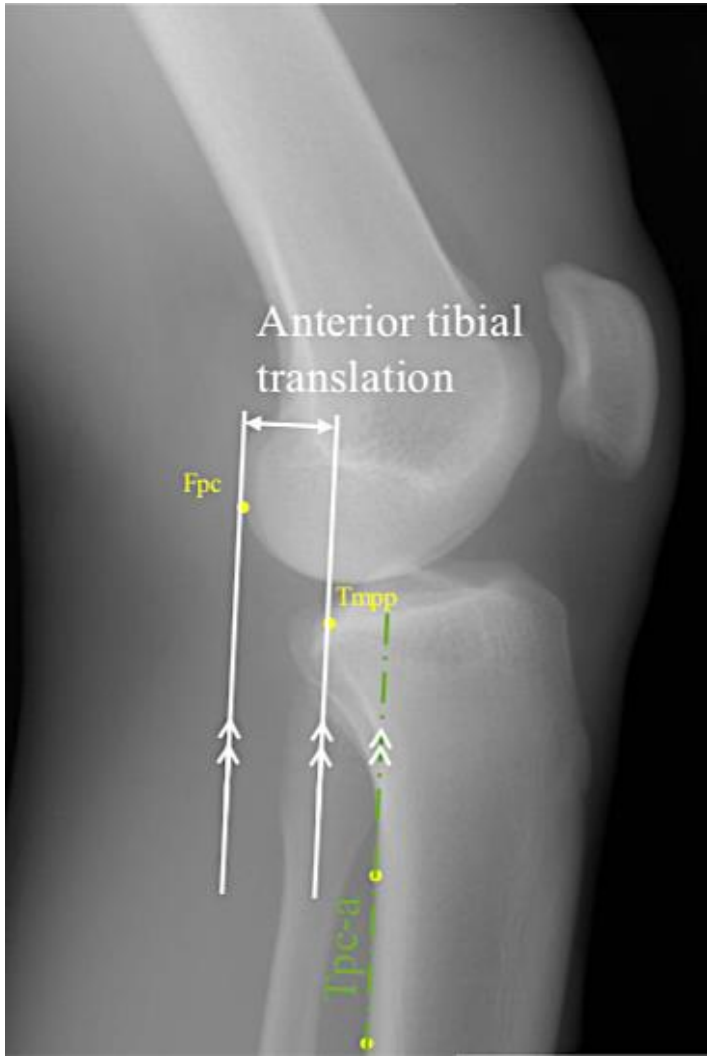


ACL Study Group

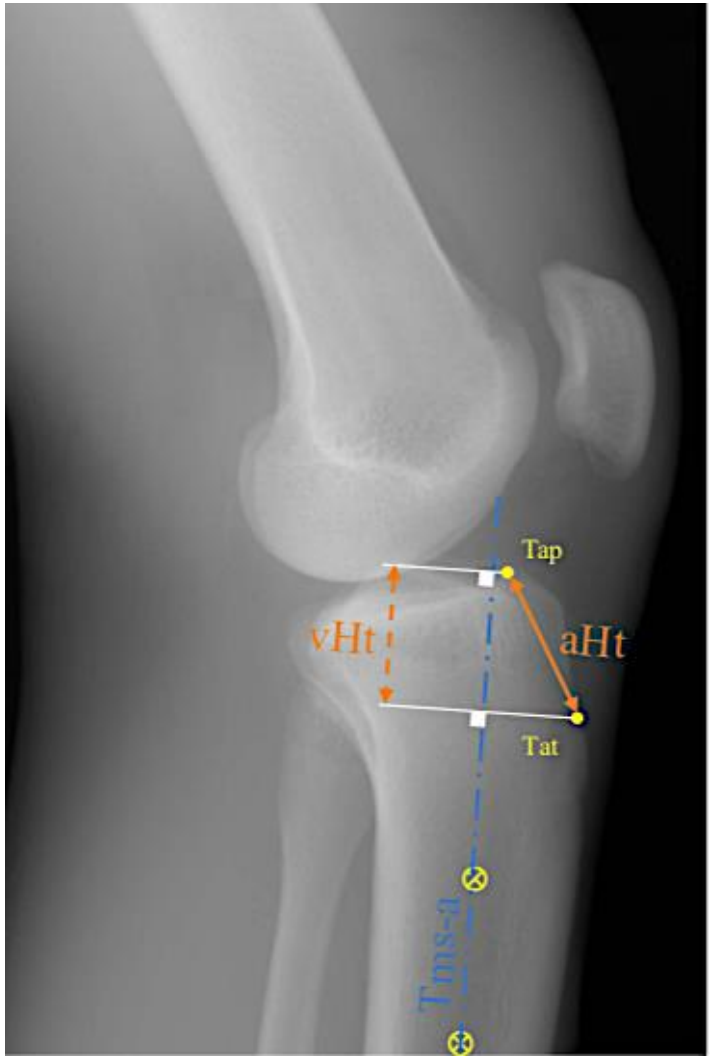
PTS



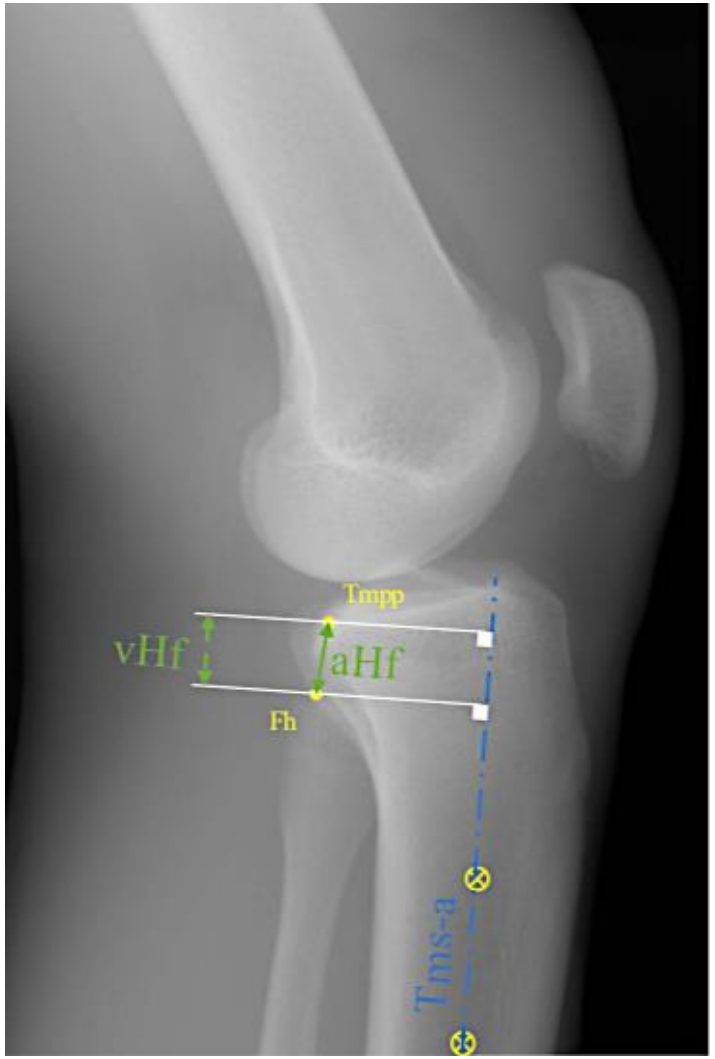
ATT



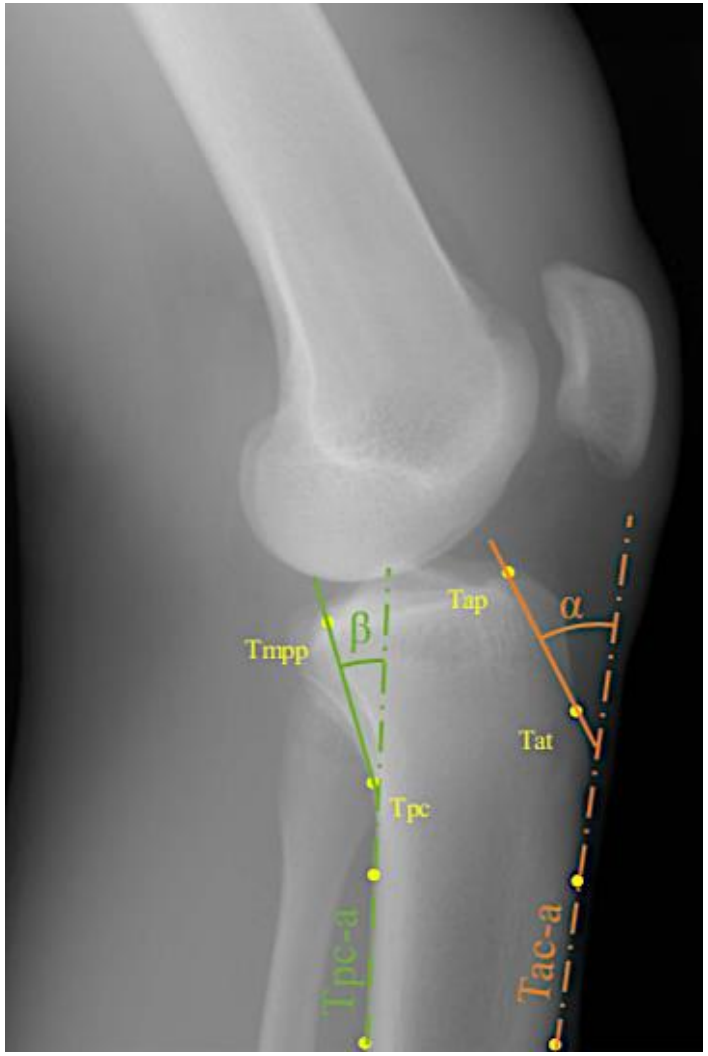
Distances aHt & vHt



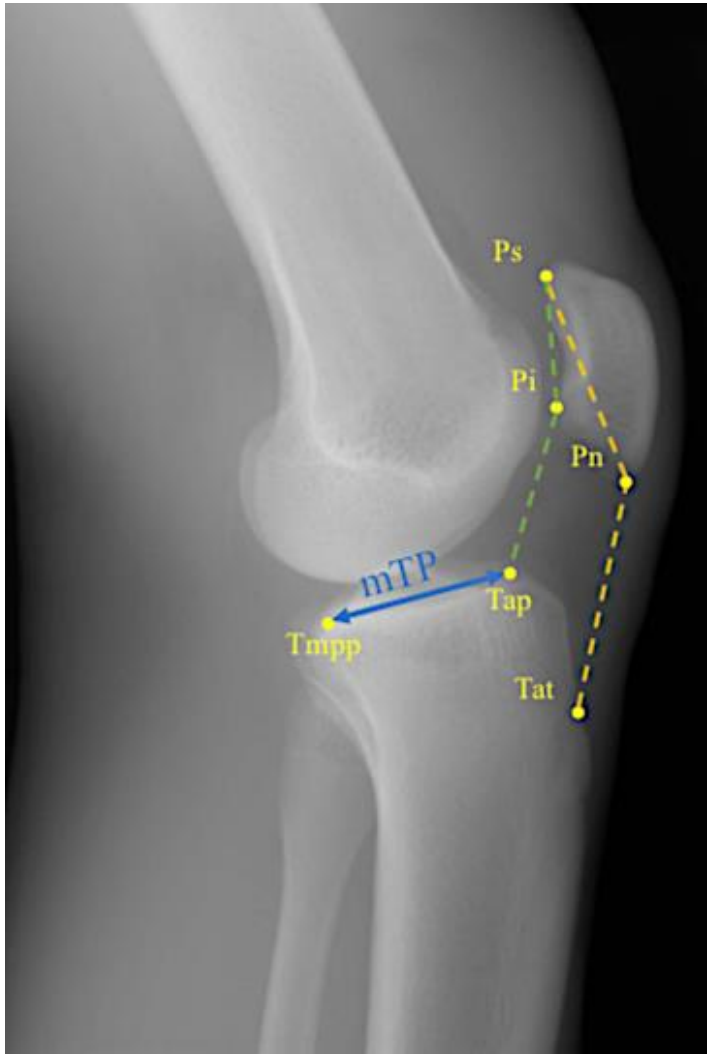
Distances aHf & vHf

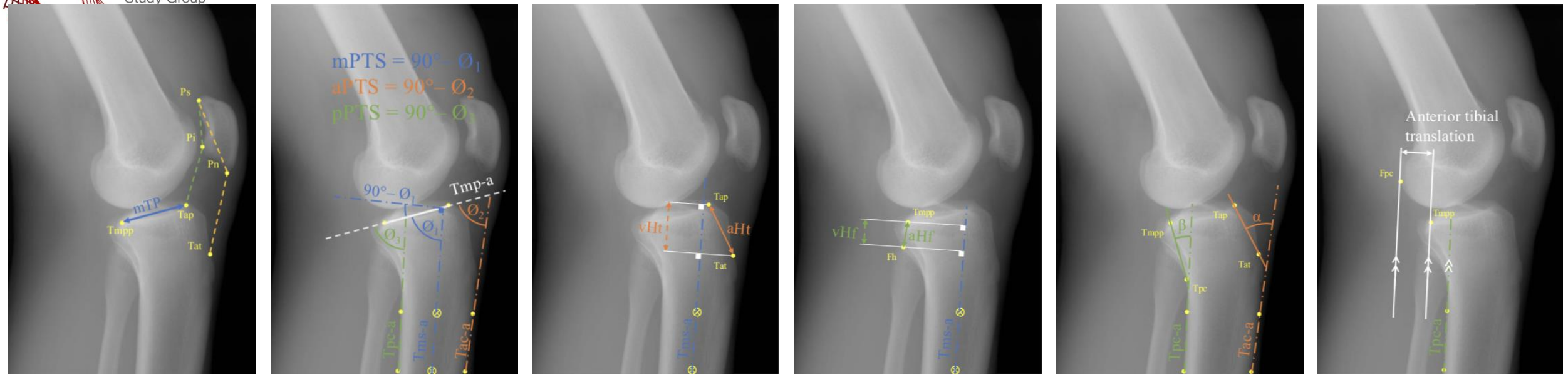


α & β Angles



Patellar height (CDI & ISR)





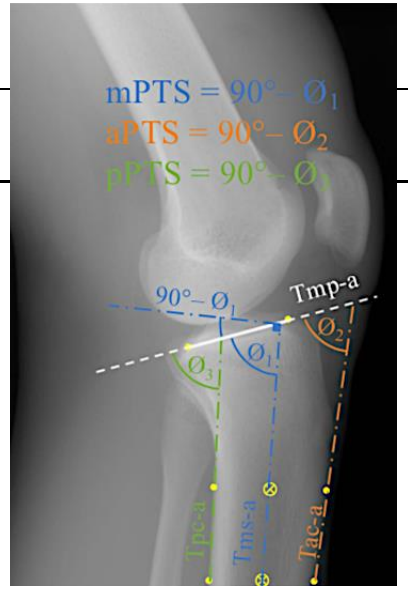
Statistical Analysis

- ✓ Data normality: Shapiro–Wilk *test*
- ✓ *Student's* t-test if normality, otherwise Wilcoxon rank sum test (Mann Whitney U test)
- ✓ Effect size: Cohen's d
- ✓ **Comparison of mPTS <12° and ≥12°, sample of 24 knees to obtain 95% power**
- ✓ $p < 0.05$ considered statistically significant

Cohort characteristics

n=326

Cohort characteristics (n = 326).



	Mean ± SD n (%)	(range)
Age (years)	30.2 ± 10.0	(18–85)
Body mass index (kg/m^2)	24.1 ± 3.9	(17–47)
Men	200 (61%)	
Distances		
mTP (mm)	43.2 ± 5.4	(27–59)
aHt (mm)	30.9 ± 4.6	(14–44)
vHt (mm)	26.3 ± 4.3	(10–38)
aHf (mm)	16.1 ± 4.0	(7–35)
vHf (mm)	14.5 ± 3.8	(5–30)
Static ATT (mm)	6.7 ± 4.0	(0–27)
Angles & ratios		
Posterior tibial slope (°)		
aPTS	12.6 ± 3.4	(4–22)
mPTS	9.8 ± 3.1	(1–20)
pPTS	7.0 ± 3.2	(0–19)
[illegible]	[illegible]	[illegible]
vHt-ratio (mm/mm)	0.61 ± 0.08	(0.25–0.93)
aHf-ratio (mm/mm)	0.37 ± 0.08	(0.16–0.71)
vHf-ratio (mm/mm)	0.34 ± 0.08	(0.13–0.62)
α (°)	33.8 ± 7.2	(6–53)
β (°)	22.0 ± 5.8	(5–39)
Patellar height (mm/mm)		
Caton–Deschamps	1.11 ± 0.20	(0.62–1.78)
Insall–Salvati	1.13 ± 0.18	(0.48–1.78)

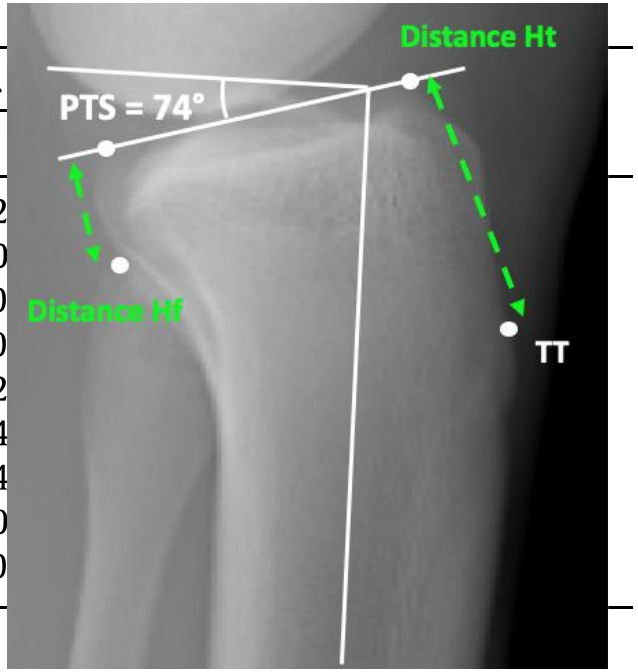
mPTS = 9.8° ± 3.1

Correlation analysis

n=324

Correlation analysis of tibial morphology and posterior tibial slope.

	vs. aPTS (df = 324)			vs. mPTS (df = 324)			vs.
	r	(95% CI)	*P*	*r*	(95% CI)	*P*	*r*
aHt-ratio	0.231	(0.125–0.331)	<0.001	0.225	(0.119–0.326)	<0.001	0.2
vHt-ratio	−0.003	(−0.112–0.106)	n.s.	−0.007	(−0.116–0.102)	n.s.	0.0
aHf-ratio	−0.188	(−0.291 to −0.081)	0.001	−0.183	(−0.286 to −0.076)	0.001	−0
vHf-ratio	−0.185	(−0.288 to −0.078)	<0.001	−0.171	(−0.275 to −0.064)	0.002	−0
α	0.453	(0.362–0.536)	<0.001	0.385	(0.287–0.474)	<0.001	0.2
β	0.298	(0.196–0.394)	<0.001	0.417	(0.322–0.503)	<0.001	0.4
Static ATT	0.255	(0.151–0.354)	<0.001	0.363	(0.265–0.454)	<0.001	0.4
Caton–Deschamps	0.042	(−0.068–0.150)	n.s.	0.021	(−0.088–0.130)	n.s.	0.0
Insall–Salvati	−0.028	(−0.136–0.081)	n.s.	−0.040	(−0.148–0.069)	n.s.	−0



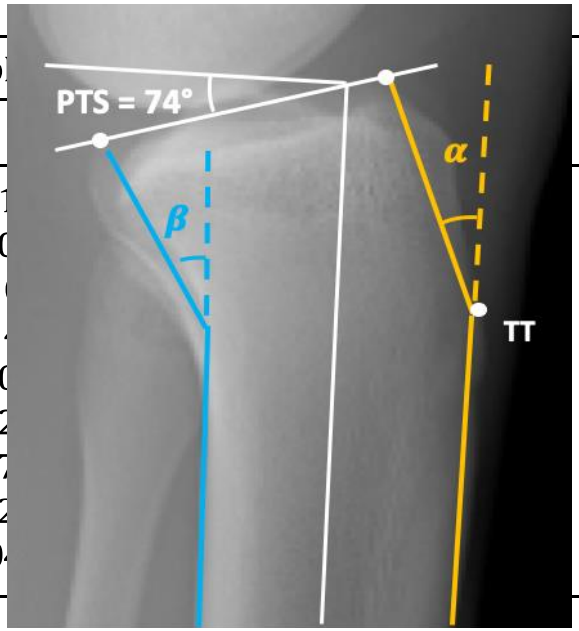
mPTS is weakly correlated with Ht & Hf distances

Correlation analysis

n=324

Correlation analysis of tibial morphology and posterior tibial slope.

	vs. aPTS (df = 324)			vs. mPTS (df = 324)			vs. p
	r	(95% CI)	*P*	*r*	(95% CI)	*P*	*r*
aHt-ratio	0.231	(0.125–0.331)	<0.001	0.225	(0.119–0.326)	<0.001	0.23
vHt-ratio	−0.003	(−0.112–0.106)	n.s.	−0.007	(−0.116–0.102)	n.s.	0.02
aHf-ratio	−0.188	(−0.291 to −0.081)	0.001	−0.183	(−0.286 to −0.076)	0.001	−0.1
vHf-ratio	−0.185	(−0.288 to −0.078)	<0.001	−0.171	(−0.275 to −0.064)	0.002	−0.1
α	0.453	(0.362–0.536)	<0.001	0.385	(0.287–0.474)	<0.001	0.28
β	0.298	(0.196–0.394)	<0.001	0.417	(0.322–0.503)	<0.001	0.49
Static ATT	0.255	(0.151–0.354)	<0.001	0.363	(0.265–0.454)	<0.001	0.42
Caton–Deschamps	0.042	(−0.068–0.150)	n.s.	0.021	(−0.088–0.130)	n.s.	0.00
Insall–Salvati	−0.028	(−0.136–0.081)	n.s.	−0.040	(−0.148–0.069)	n.s.	−0.0



mPTS is correlated with α & β angles and static ATT

Correlation analysis

n=324

Correlation analysis of tibial morphology and posterior tibial slope.

	vs. aPTS (df = 324)			vs. mPTS (df = 324)			vs. p
	r	(95% CI)	*P*	*r*	(95% CI)	*P*	*r*
aHt-ratio	0.231	(0.125–0.331)	<0.001	0.225	(0.119–0.326)	<0.001	0.23
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aHf-ratio	−0.188	(−0.291 to −0.081)	0.001	−0.183	(−0.286 to −0.076)	0.001	−0.1
vHf-ratio	−0.185	(−0.288 to −0.078)	<0.001	−0.171	(−0.275 to −0.064)	0.002	−0.1
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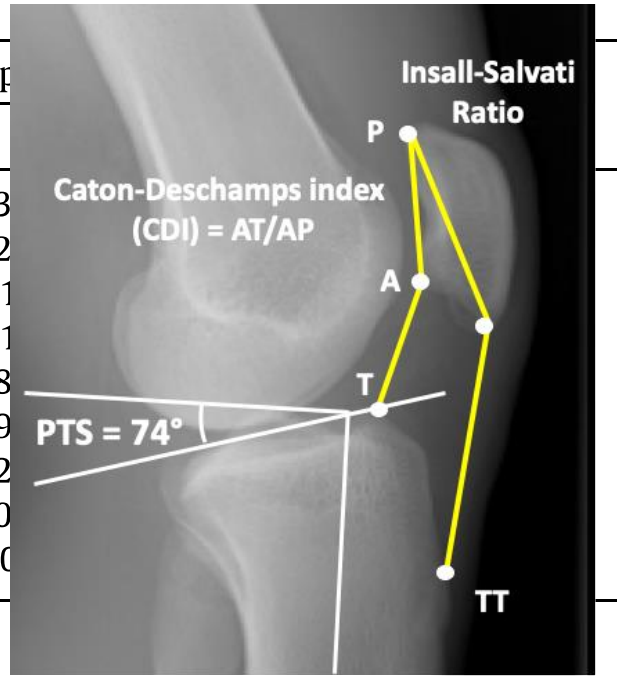


mPTS is NOT correlated with patellar height

Normal slope (n=243) vs slope ≥12° (n=83)

Table 2: Tibial metaphysis geometry of knees with normal versus excessive PTS

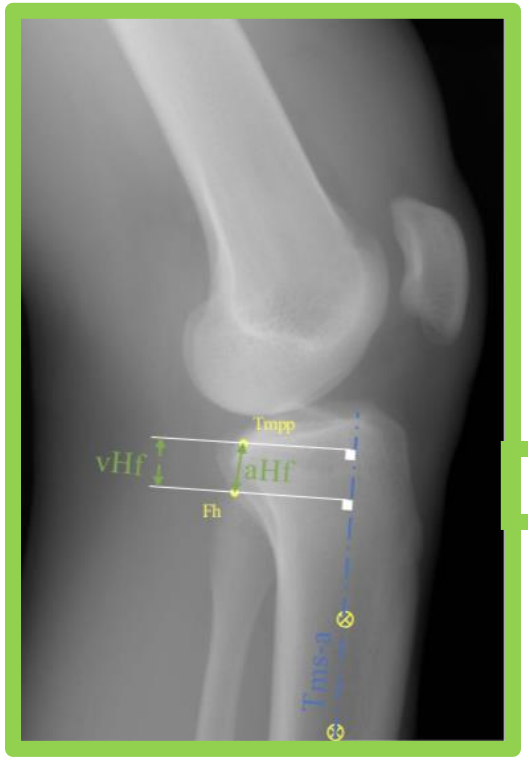
	Normal PTS (mPTS <12°, n=243)		Excessive PTS (mPTS ≥12°, n=83)			
	Mean ±SD	(range)	Mean ±SD	(range)	p-value	Effect size
Angles						
Posterior tibial slope (°)						
aPTS	11.2 ±2.6	(4 – 16)	16.7 ±1.7	(14 – 22)	<0.001	2.5
mPTS	8.5 ±2.3	(1 – 12)	13.7 ±1.6	(12 – 20)	<0.001	2.7
pPTS	5.8 ±2.4	(0 – 13)	10.7 ±2.2	(7 – 19)	<0.001	2.1
α (°)	32.6 ±7.1	(6 – 53)	37.4 ±6.3	(20 – 53)	<0.001	0.7
β (°)	21.1 ±5.6	(5 – 39)	24.6 ±5.5	(13 – 38)	<0.001	0.6
Distances (mm)						
mTP	43.1 ±5.4	(27 – 59)	43.3 ±5.6	(31 – 56)	0.910	
aHt	30.7 ±4.5	(14 – 43)	31.6 ±4.9	(21 – 44)	0.270	
vHt	26.4 ±4.2	(10 – 38)	25.9 ±4.5	(15 – 36)	0.300	
aHf	16.5 ±4.1	(7 – 33)	13.2 ±3.6	(7 – 23)	0.031	0.3
vHf	14.7 ±3.9	(5 – 30)	13.7 ±3.5	(6 – 22)	0.070	
sATT	6.1 ±3.7	(0 – 21)	8.3 ±4.5	(0 – 27)	<0.001	0.5
Patellar height (mm/mm)						
Caton-Deschamps	1.11 ±0.21	(0.62 – 1.78)	1.13 ±0.19	(0.73 – 1.74)	0.470	
Insall-Salvati	1.13 ±0.17	(0.48 – 1.66)	1.13 ±0.19	(0.70 – 1.78)	0.990	

Abbreviations: mTP, medial tibial plateau length; aHt, absolute anterior tibial metaphyseal height; vHt, vertical component of anterior tibial metaphyseal height; aHf, absolute posterior tibial metaphyseal height; vHf; vertical vertical component of posterior tibial metaphyseal height; aPTS; anterior axis posterior tibial slope; mPTS, mid-shaft axis posterior tibial slope; pPTS, posterior axis posterior tibial slope; α, anterior tibial metaphyseal inclination; β, posterior tibial metaphyseal inclination; sATT, static anterior tibial translation

aHt ns

vHt ns

Normal slope (n=243) vs slope ≥12° (n=83)



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Angles						
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mPTS	8.5 ±2.3	(1 – 12)	13.7 ±1.6	(12 – 20)	<0.001	2.7
pPTS	5.8 ±2.4	(0 – 13)	10.7 ±2.2	(7 – 19)	<0.001	2.1
α (°)	32.6 ±7.1	(6 – 53)	37.4 ±6.3	(20 – 53)	<0.001	0.7
β (°)	21.1 ±5.6	(5 – 39)	24.6 ±5.5	(13 – 38)	<0.001	0.6
Distances (mm)						
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aHt	30.7 ±4.5	(14 – 43)	31.6 ±4.9	(21 – 44)	0.270	
vHt	26.4 ±4.2	(10 – 38)	25.9 ±4.5	(15 – 36)	0.300	
aHf	16.5 ±4.1	(7 – 35)	15.2 ±3.6	(7 – 23)	0.031	0.3
vHf	14.7 ±3.9	(5 – 30)	13.7 ±3.5	(6 – 22)	0.070	
sATT	6.1 ±3.7	(0 – 21)	8.3 ±4.5	(0 – 27)	<0.001	0.5
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aHf p=0.03

vHf ns

Normal slope (n=243) vs slope ≥12° (n=83)

angle ∝
p<0.001

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pPTS	5.8 ±2.4	(0 – 13)	10.7 ±2.2	(7 – 19)	<0.001	2.1
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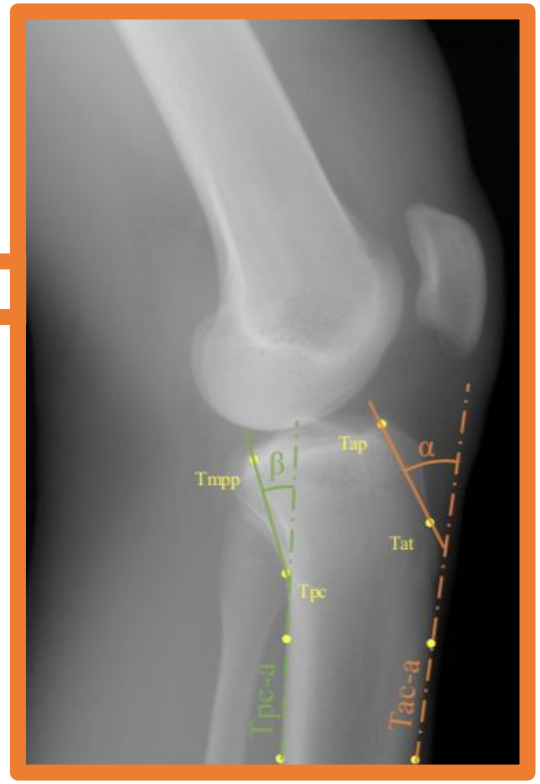

Normal slope (n=243) vs slope ≥12° (n=83)

angle β p<0.001

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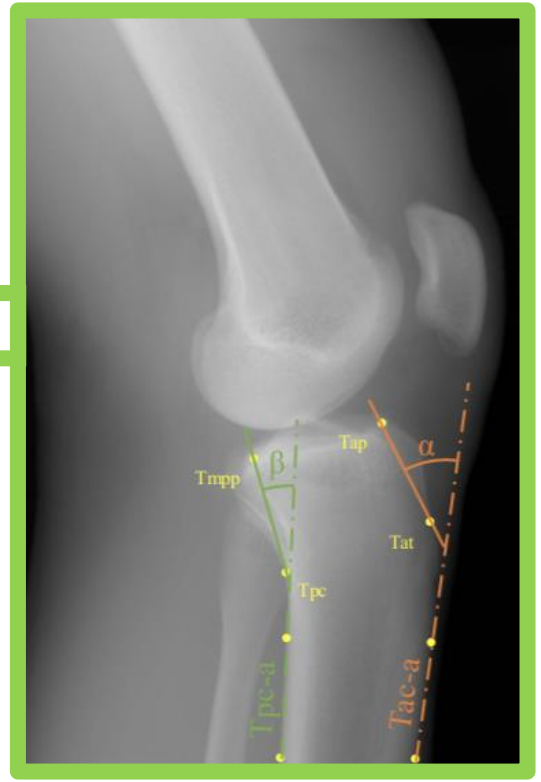
Posterior tibial slope (°)						
aPTS	11.2 ±2.6	(4 – 16)	16.7 ±1.7	(14 – 22)	<0.001	2.5
mPTS	8.5 ±2.3	(1 – 12)	13.7 ±1.6	(12 – 20)	<0.001	2.7
pPTS	5.8 ±2.4	(0 – 13)	10.7 ±2.2	(7 – 19)	<0.001	2.1
β (°)	21.1 ±5.6	(5 – 39)	24.6 ±5.5	(13 – 38)	<0.001	0.6
mTP	43.1 ±5.4	(27 – 59)	43.3 ±5.6	(31 – 56)	0.910	
aHt	30.7 ±4.5	(14 – 43)	31.6 ±4.9	(21 – 44)	0.270	
vHt	26.4 ±4.2	(10 – 38)	25.9 ±4.5	(15 – 36)	0.300	
aHf	16.5 ±4.1	(7 – 35)	15.2 ±3.6	(7 – 23)	0.031	0.3
vHf	14.7 ±3.9	(5 – 30)	13.7 ±3.5	(6 – 22)	0.070	
sATT	6.1 ±3.7	(0 – 21)	8.3 ±4.5	(0 – 27)	<0.001	0.5
Patellar height (mm/mm)						
Caton-Deschamps	1.11 ±0.21	(0.62 – 1.78)	1.13 ±0.19	(0.73 – 1.74)	0.470	
Insall-Salvati	1.13 ±0.17	(0.48 – 1.66)	1.13 ±0.19	(0.70 – 1.78)	0.990	

Abbreviations: mTP, medial tibial plateau length; aHt, absolute anterior tibial metaphyseal height; vHt, vertical component of anterior tibial metaphyseal height; aHf, absolute posterior tibial metaphyseal height; vHf; vertical vertical component of posterior tibial metaphyseal height; aPTS; anterior axis posterior tibial slope; mPTS, mid-shaft axis posterior tibial slope; pPTS, posterior axis posterior tibial slope; α, anterior tibial metaphyseal inclination; β, posterior tibial metaphyseal inclination; sATT, static anterior tibial translation



Slope correction (n=83)

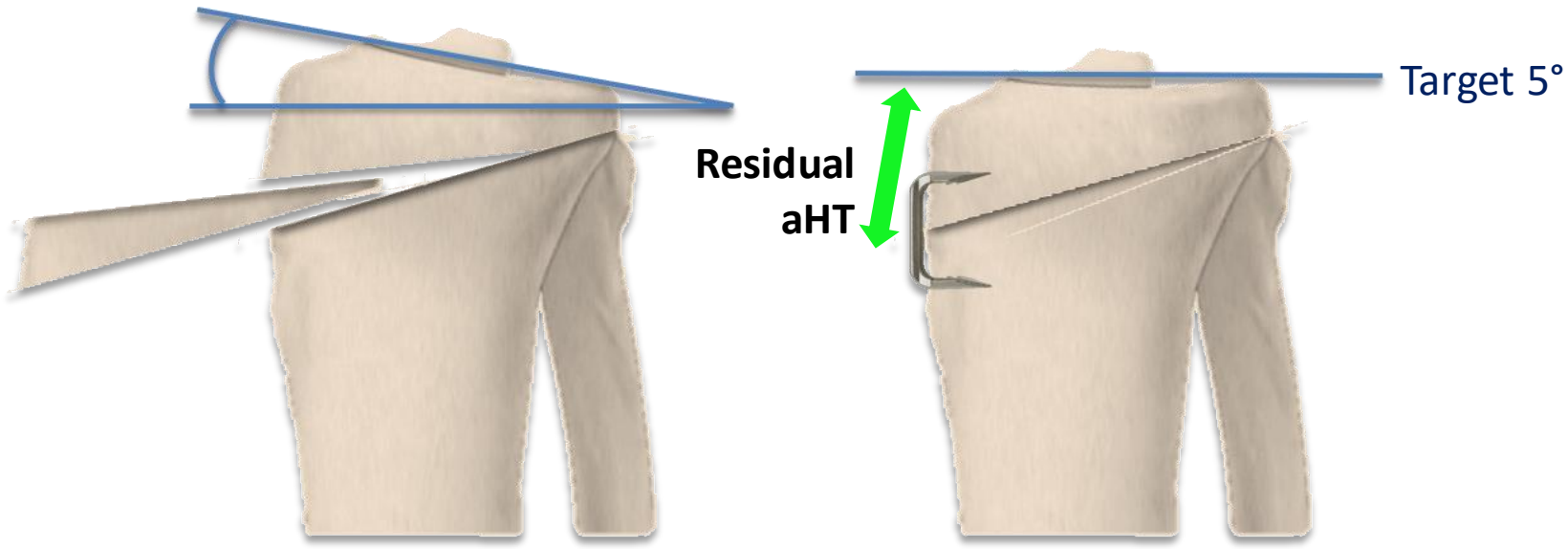


Table 3: Estimation of wedge height and residual aHt following supra-tuberosity TDO in knees with excessive PTS (mPTS ≥12°)

	Target mPTS=5°		Target mPTS=0°	
	mean ±SD n (%)	(range)	mean ±SD n (%)	(range)
Planned wedge height (mm)	6.5 ±1.4	(4 – 11)	10.2 ±1.7	(7 – 16)
Residual aHt following TDO (mm)	25.0 ±4.4	(15 – 36)	21.3 ±4.2	(11 – 32)
Knees with residual aHt <20 mm (%)	7 (8%)		36 (43%)	
Knees with residual aHt <15 mm (%)	1 (1%)		4 (5%)	

Residual aHT >15 mm in 99%

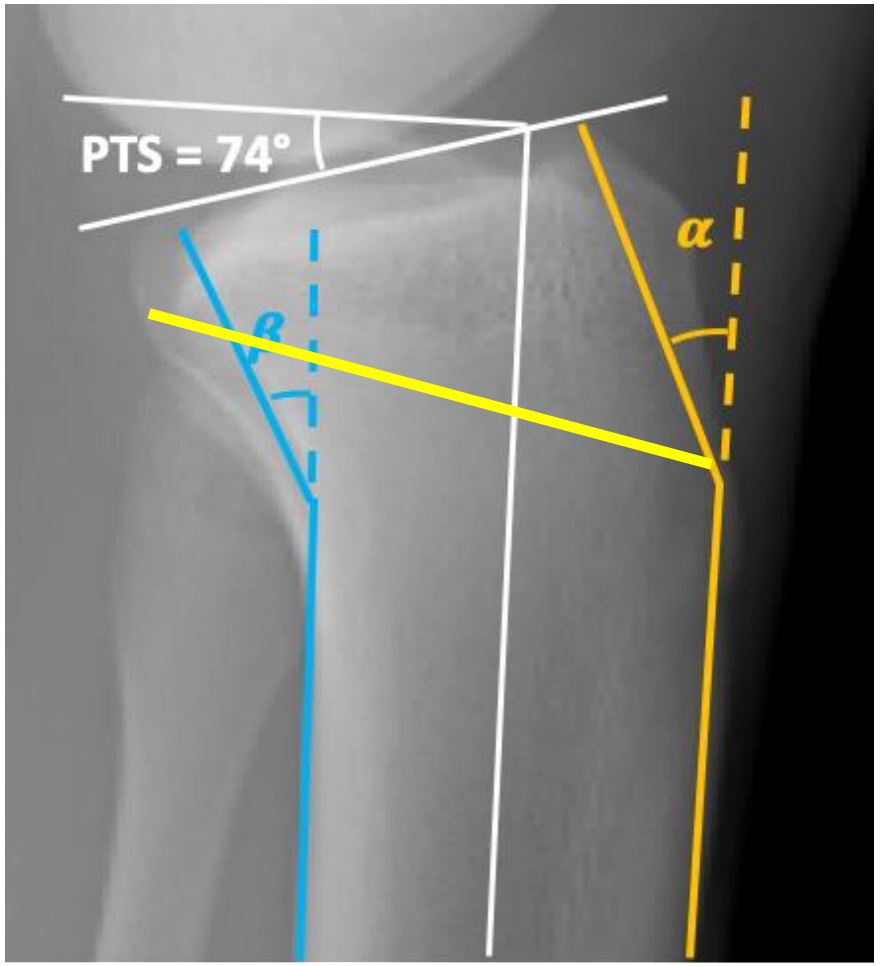
n=83

Take Home 1

Excessive slope

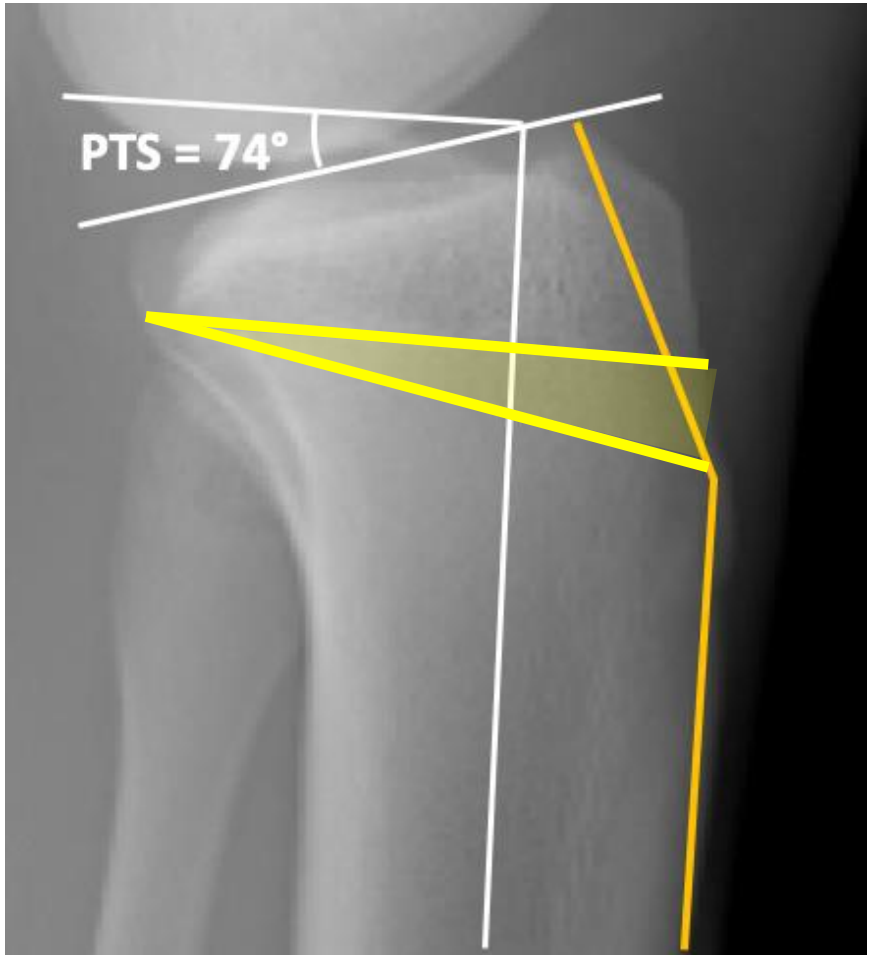
=

Posterior inclination of the metaphysis



Take Home 2

The supra-tuberosity osteotomy is performed at the site of the deformity



Take Home 2

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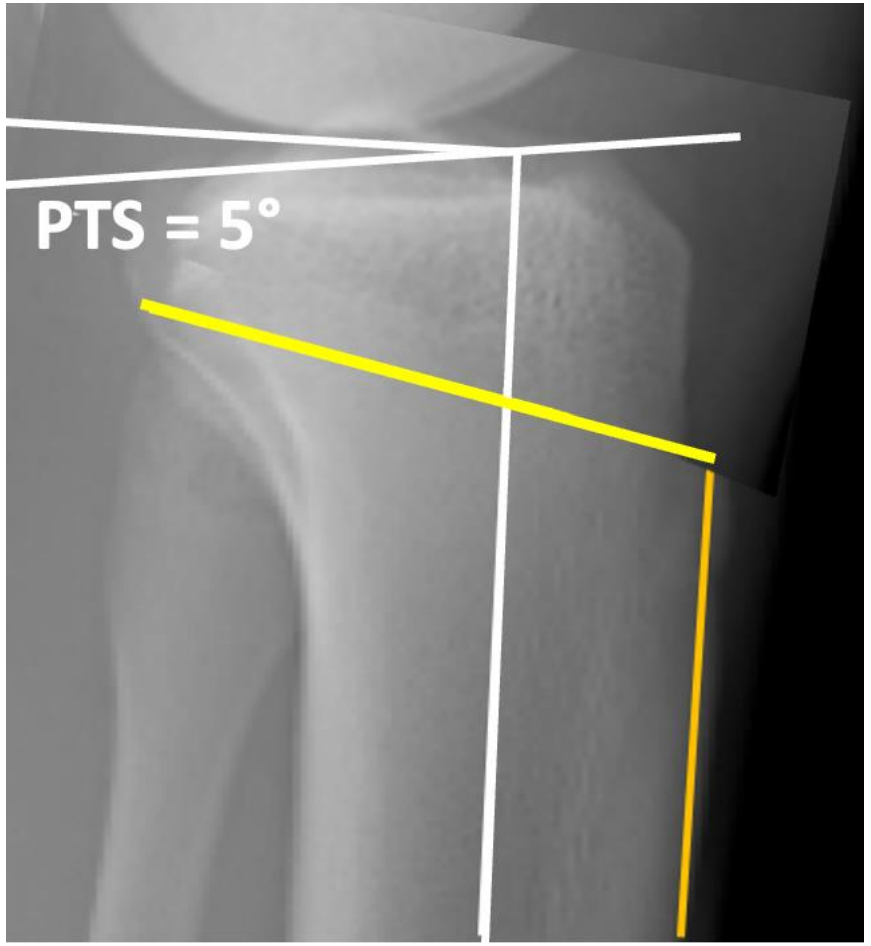
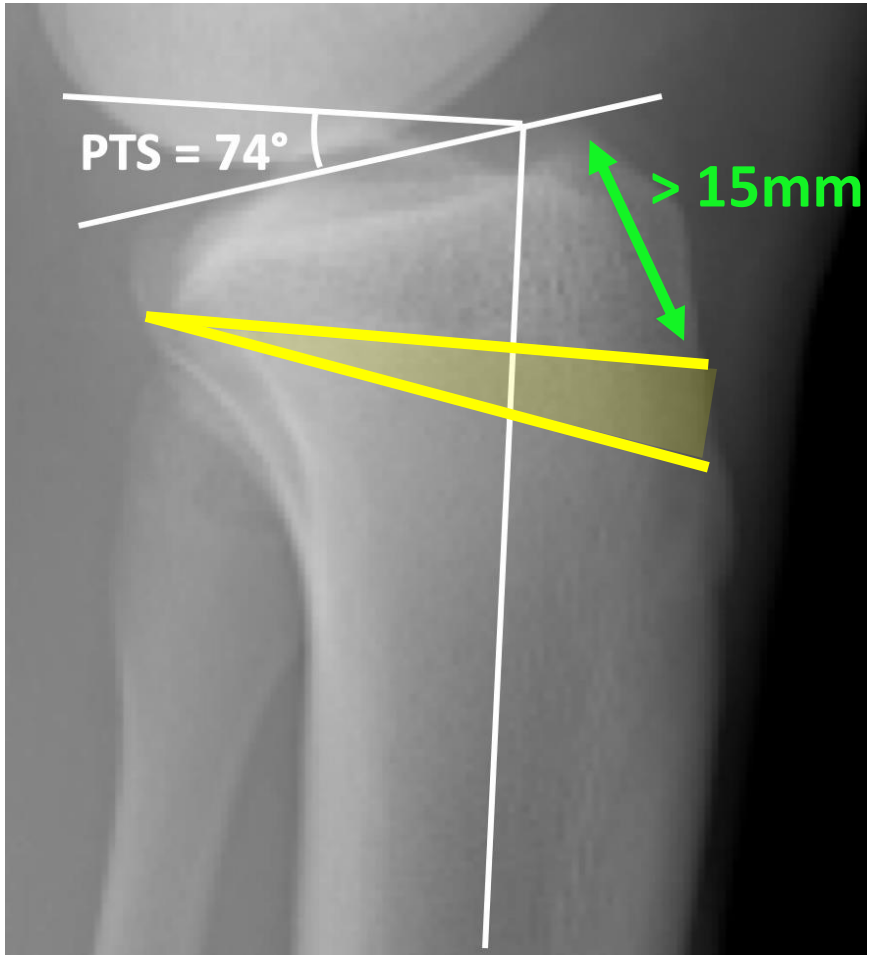


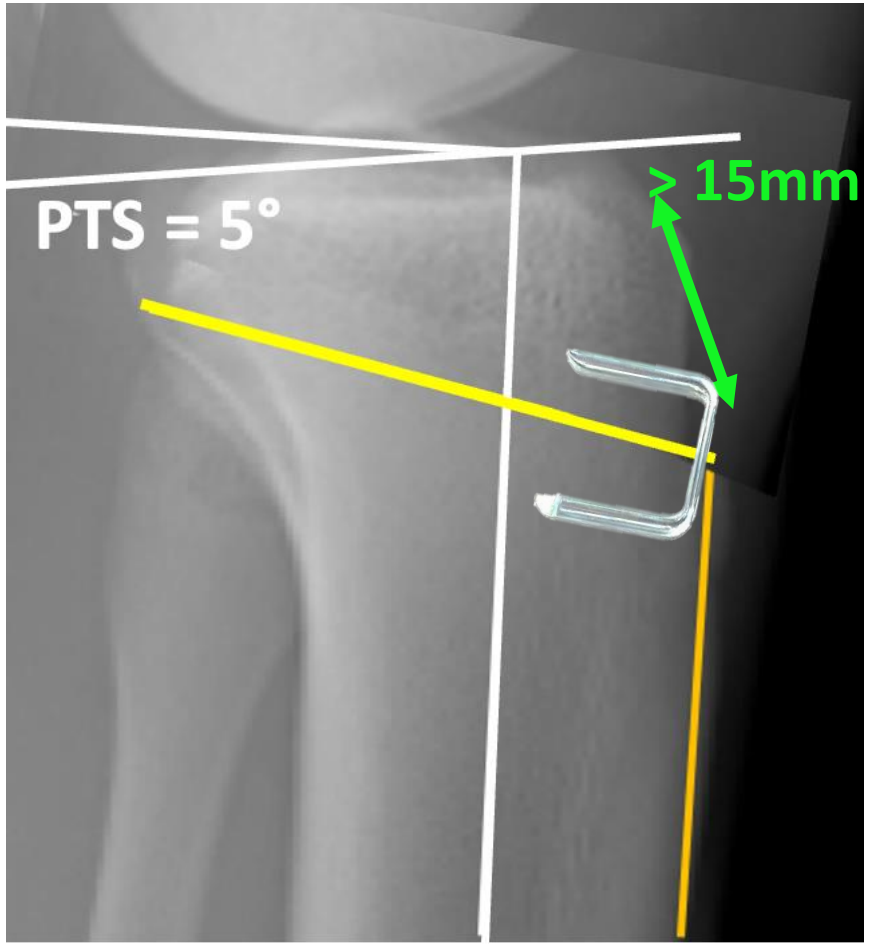
Take Home 3

The supra-tuberosity osteotomy leaves a residual metaphysis >15 mm in 99%



Take Home 3

The supra-tuberosity osteotomy leaves a residual metaphysis >15 mm in 99%



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JOURNAL HOMEPAG

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Radiographic Investigation of Coronal Plane and Patellar Height and Changes Following Tibial Deflection Osteotomy for Correction of Tibial Slope in Combination With ACL Reconstruction

Nicolas Cance, MD ✉, Michael J. Dan, MBBS, PhD, FRACS(Orth), [...], and David H. DeJour, MD +2 View all authors and affiliations

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n=68

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ACL Study Group

Sufficient Metaphyseal Bone for Wedge Removal and Fixation Hardware During Supratuberosity Tibial Deflexion Osteotomy in Knees With Excessive Posterior Tibial Slope

Guillaume Demey,* MD, Edoardo Giovannetti de Sanctis,* MD, Guillaume Mesnard,* MD, Jacobus H. Müller,† MSc, PhD, Mo Saffarini,†‡ MSc, MBA, and David H. Dejour,* MD
Investigation performed at Lyon-Ortho-Clinic, Clinique de la Sauvegarde, Ramsay Santé, Lyon, France

Thank You !

Posterior tibial slope correlated with metaphyseal inclination more than metaphyseal height

Guillaume Demey [a,*], Edoardo Giovannetti de Sanctis [a], Guillaume Mesnard [a], ReSurg [b,†], David H. Dejour [a]

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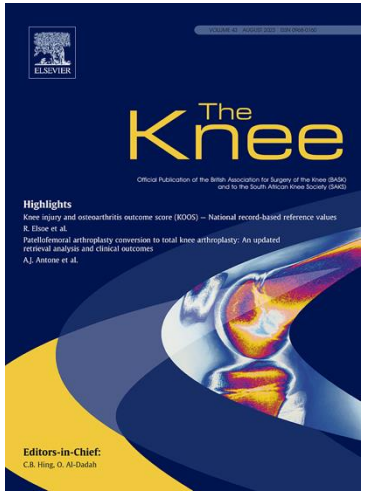

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