Kantonsspital Baselland

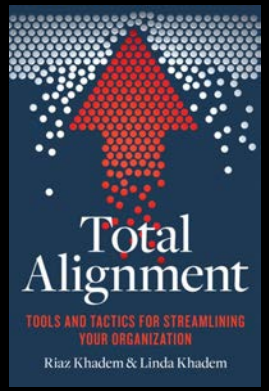
KOMITEE KNIE-ARTHROSE/GELENKERHALT

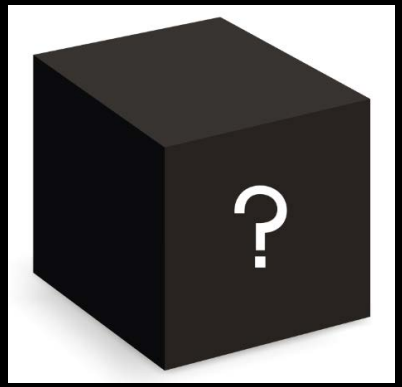
EKA

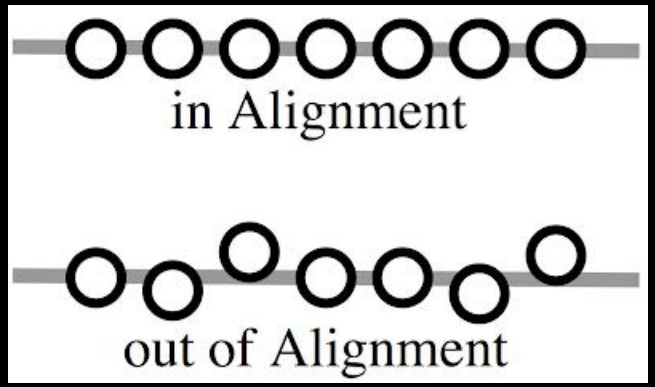
UNI BASEL

HOSPITATIONS ZENTRUM

Are Knee Phenotypes in TKA the perfect tool to choose the ideal alignment?







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Chair of Orthopaedic Surgery and Traumatology
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PERSONALIZED ARTHROPLASTY SOCIETY

Disclosures Prof. Hirschmann

Journals: Deputy Editor in Chief Knee Surgery Sports Traumatology Arthroscopy (KSSTA), Board member: APKASS journal, MLT journal, Arthroskopie, Das Knie (DKG)

Society: ESSKA Board Member, European Knee Associates (EKA) Chairman, Scientific Chairman ESSKA Milan 2020 and 2021, ISAKOS Arthroplasty Comittee, ESSKA Cartilage Committee, Board member German Knee Society,

Consultancy: DepuySynthes, Smith&Nephew, LIMA, Symbios, Medacta

Research Grants: DepuySynthes, Finceramica, Symbios Mathys, Arthrex

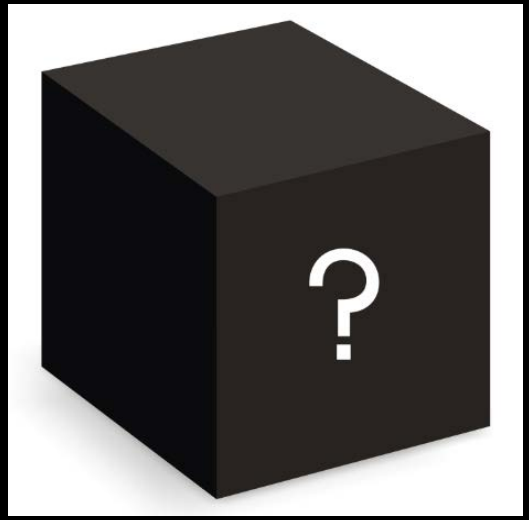
Deutsche Arthrose-Hilfe e.V.
Eingetragener gemeinnütziger Verein
Hilfe für gelenkkranke Menschen

Knee Surgery, Sports Traumatology, Arthroscopy
https://doi.org/10.1007/s00167-019-05558-4

EDITORIAL

Alignment in TKA: what has been clear is not anymore!

Michael T. Hirschmann[1,2] · Roland Becker[3] · Reha Tandogan[4] · Pascal-André Vendittoli[5] · Stephen Howell[6]



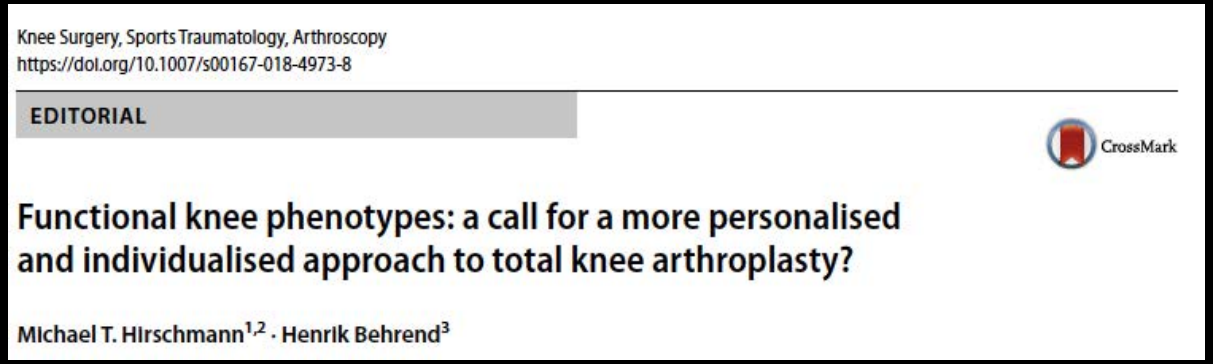
Definition – „knee phenotypes“

Phenotype:

A phenotype (from Greek phainein, meaning 'to show', and typos, meaning 'type') is the composite of an organism's observable characteristics or traits, such as its morphology, development, biochemical or physiological properties, behavior, and products of behavior.

Wikipedia 2018

Personalised medicine- personalised TKA!



Knee Surgery, Sports Traumatology, Arthroscopy
https://doi.org/10.1007/s00167-018-4973-8

EDITORIAL

CrossMark

Functional knee phenotypes: a call for a more personalised and individualised approach to total knee arthroplasty?

Michael T. Hirschmann[1,2] · Henrik Behrend[3]

- Difference in terms of laxity, alignment, biology and morphology
- Big data helps to understand the variability in our patient populations
- Knowledge of the individual anatomy is key!

Laxity is different!

Knee Surgery, Sports Traumatology, Arthroscopy
https://doi.org/10.1007/s00167-021-06688-4

KNEE

A single type of varus knee does not exist: morphotyping and gap analysis in varus OA

Heiko Graichen[1] · Kreangsak Lekkreusuwan[1,2] · Kim Eller[1] · Thomas Grau[3] · Michael T. Hirschmann[4] · Wolfgang Scior[1]

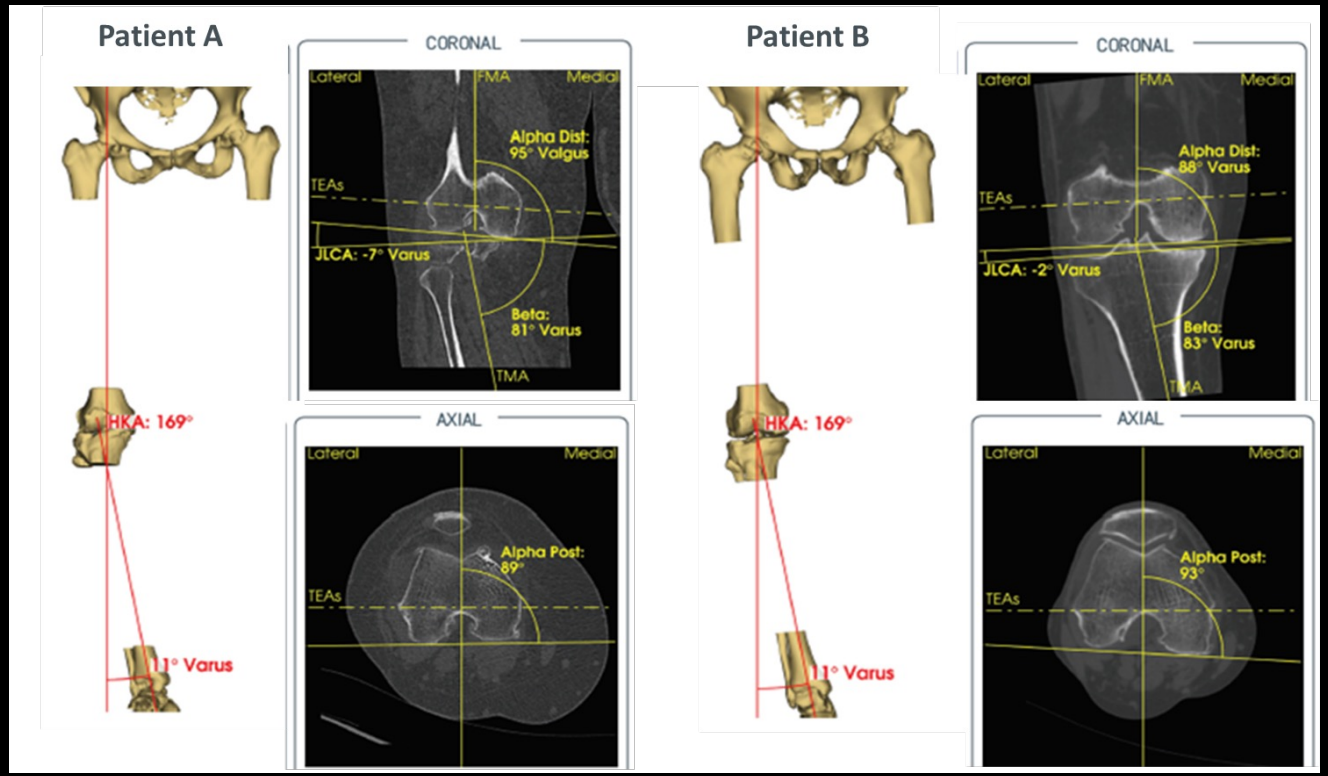
- „The envelope of laxity“
- Started getting information about gaps dependent from different knee phenotypes

Table 3 Number of patients in the subgroups of patient factors and their gap widths (mm)

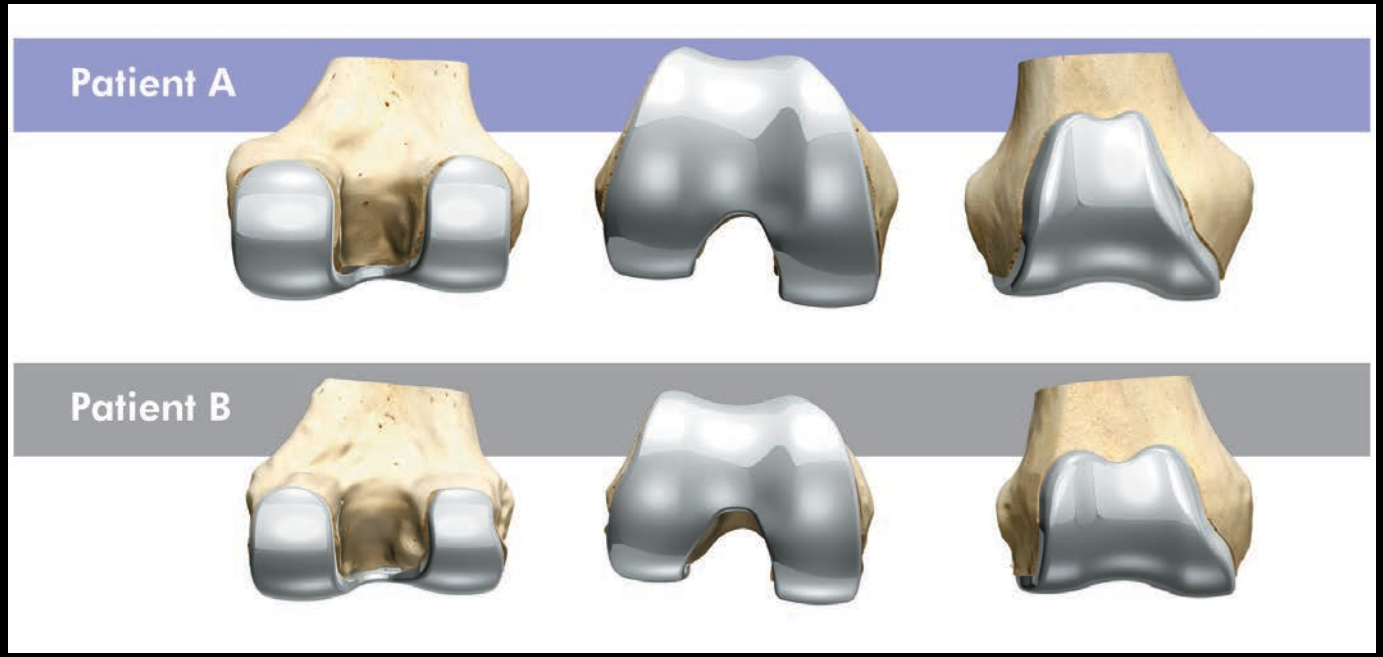
		Quantity (*n*)	Extension gap	Flexion gap
Gender				
I	Male	351	2.1 (±2.4)*	4.0 (±2.9)*
II	Female	329	2.6 (±2.3)*	4.5 (±2.7)*
BMI				
I	< 25	89	2.4 (±2.5)^{N}	4.1 (±2.9)^{N}
II	25–30	235	2.2 (±2.5)^{N}	3.9 (±2.9)***
III	25–30	356	2.4 (±2.1)^{N}	4.5 (±2.7)**
Age				
I	< 55	54	3.1 (±2.5)**/***	4.0 (±3.0)^{N}
II	55–75	447	2.3 (±2.3)^{N}	4.3 (±2.8)^{N}
III	> 75	179	2.2 (±2.4)^{N}	4.0 (±2.8)^{N}

*Significant difference within the gender subgroups
**Significant difference to age/BMI subgroup II
***Significant difference to age/BMI subgroup III
^{N}No significant difference within the patient factor subgroups

Alignment is different!



Morphology is different!



The basics- the knee phenotype concept

Knee Surgery, Sports Traumatology, Arthroscopy
https://doi.org/10.1007/s00167-018-4973-8

EDITORIAL

Functional knee phenotypes: a call for a more personalised and individualised approach to total knee arthroplasty?

Michael T. Hirschmann[1,2] · Henrik Behrend[3]

Knee Surgery, Sports Traumatology, Arthroscopy (2019) 27:1378–1384
https://doi.org/10.1007/s00167-019-05507-1

KNEE

Phenotyping of hip–knee–ankle angle in young non-osteoarthritic knees provides better understanding of native alignment variability

Knee Surgery, Sports Traumatology, Arthroscopy (2019) 27:1385–1393
https://doi.org/10.1007/s00167-019-05508-0

KNEE

Phenotyping the knee in young non-osteoarthritic knees sho a wide distribution of femoral and tibial coronal alignment

Knee Surgery, Sports Traumatology, Arthroscopy
https://doi.org/10.1007/s00167-019-05587-z

KNEE

Healthy knees have a highly variable patellofemoral alignment: a systematic review

ss[2,4] · Lukas Moser[2,3] · Michael T. Hirschmann[2,3] · Felix Amsler[5] · Henrik Behrend[1]

Knee Surgery, Sports Traumatology, Arthroscopy (2019) 27:1434–1441
https://doi.org/10.1007/s00167-018-5041-0

KNEE

Due to great variability fixed HKS angle for alignment of the distal cut leads to a significant error in coronal TKA orientation

Maurin Lampart[1,2] · Henrik Behrend[3] · Lukas B. Moser[1,2] · Michael T. Hirschmann[1,2]

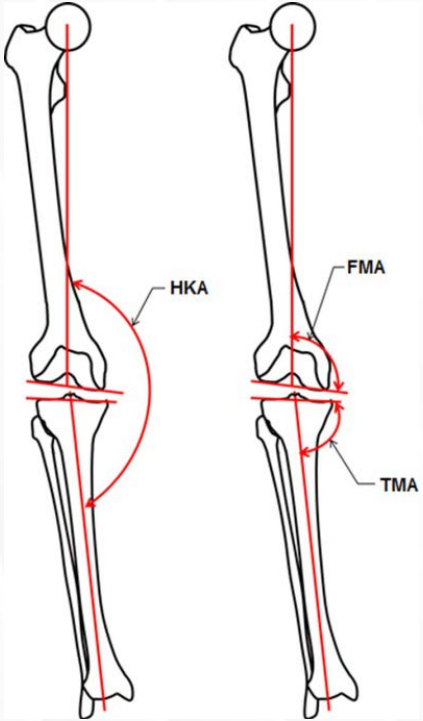
Knee Surgery, Sports Traumatology, Arthroscopy
https://doi.org/10.1007/s00167-020-05928-3

KNEE

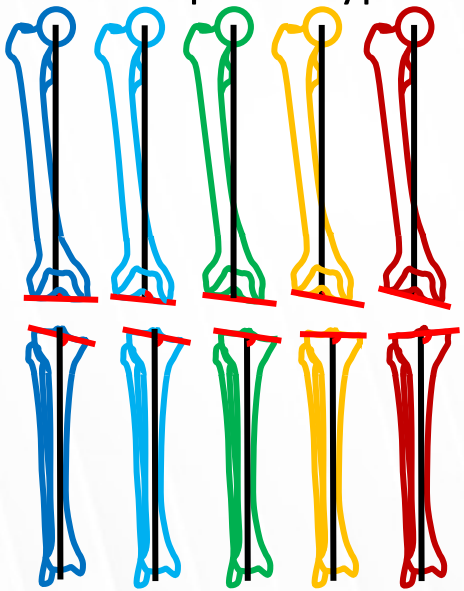
Osteoarthritic knees have a highly variable patellofemoral alignment: a systematic review

Bettina Hochreiter[1] · Lukas B. Moser[2,3] · Silvan Hess[2,4] · Michael T. Hirschmann[2,3] · Felix Amsler[5] · Henrik Behrend[1]

Material and Methods (1)

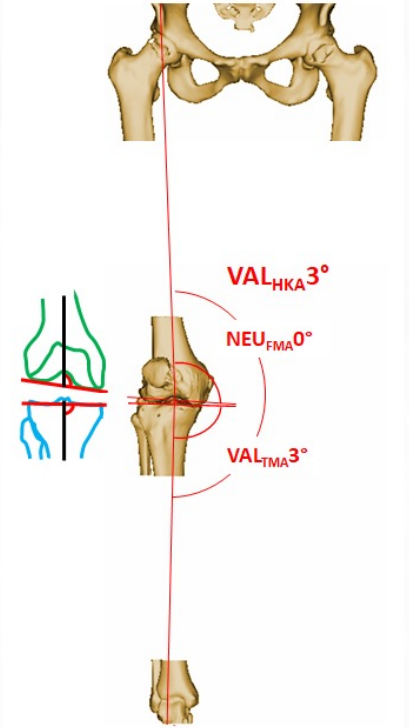


Femoral phenotypes

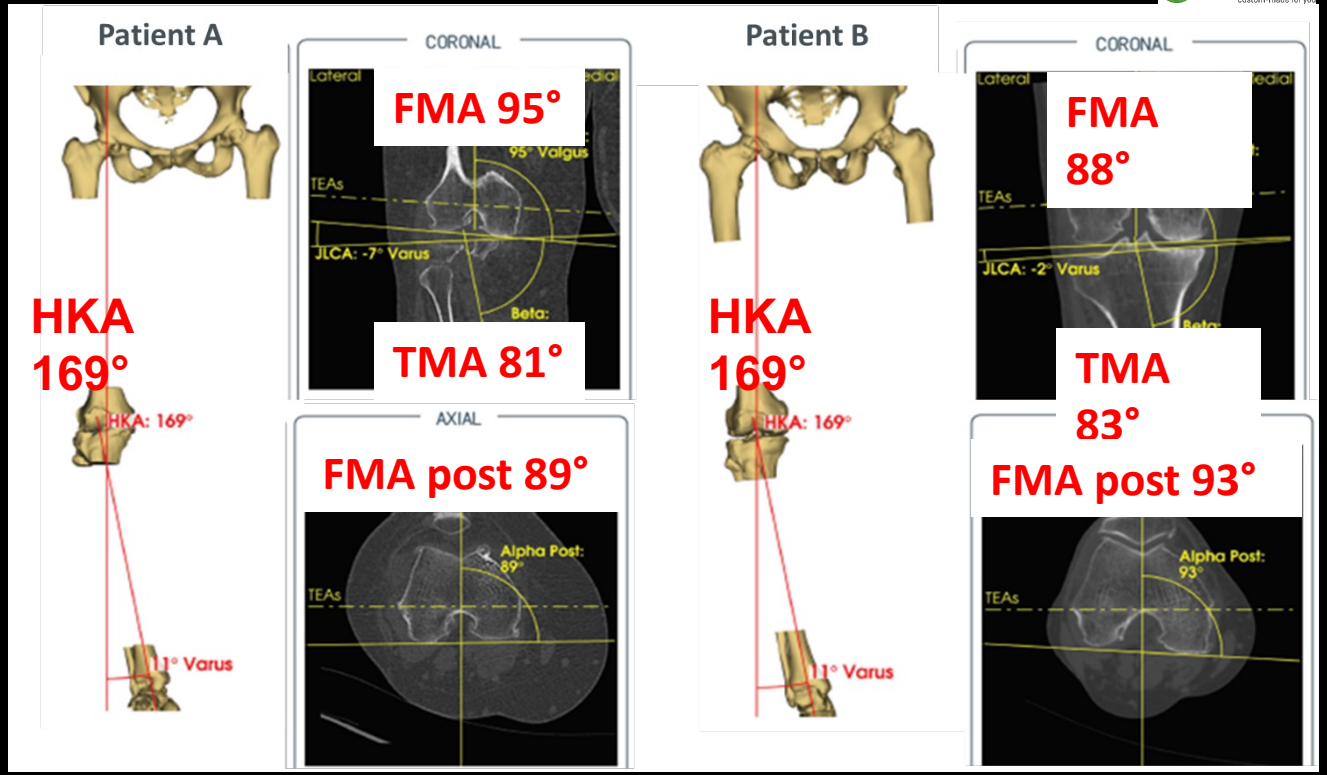


Tibial phenotypes

Functional knee phenotypes



Same HKA but...



$VAR_{HKA}12° VAL_{FMA}6° VAR_{TMA}6°$

$VAR_{HKA}12° NEU_{FMA}3° VAR_{TMA}6°$

Consequences in TKA

Mechanical alignment ($NEU_{HKA}0°VAR_{FMA}3°VAL_{TMA}3°$)

5.6% males, 3.6% females

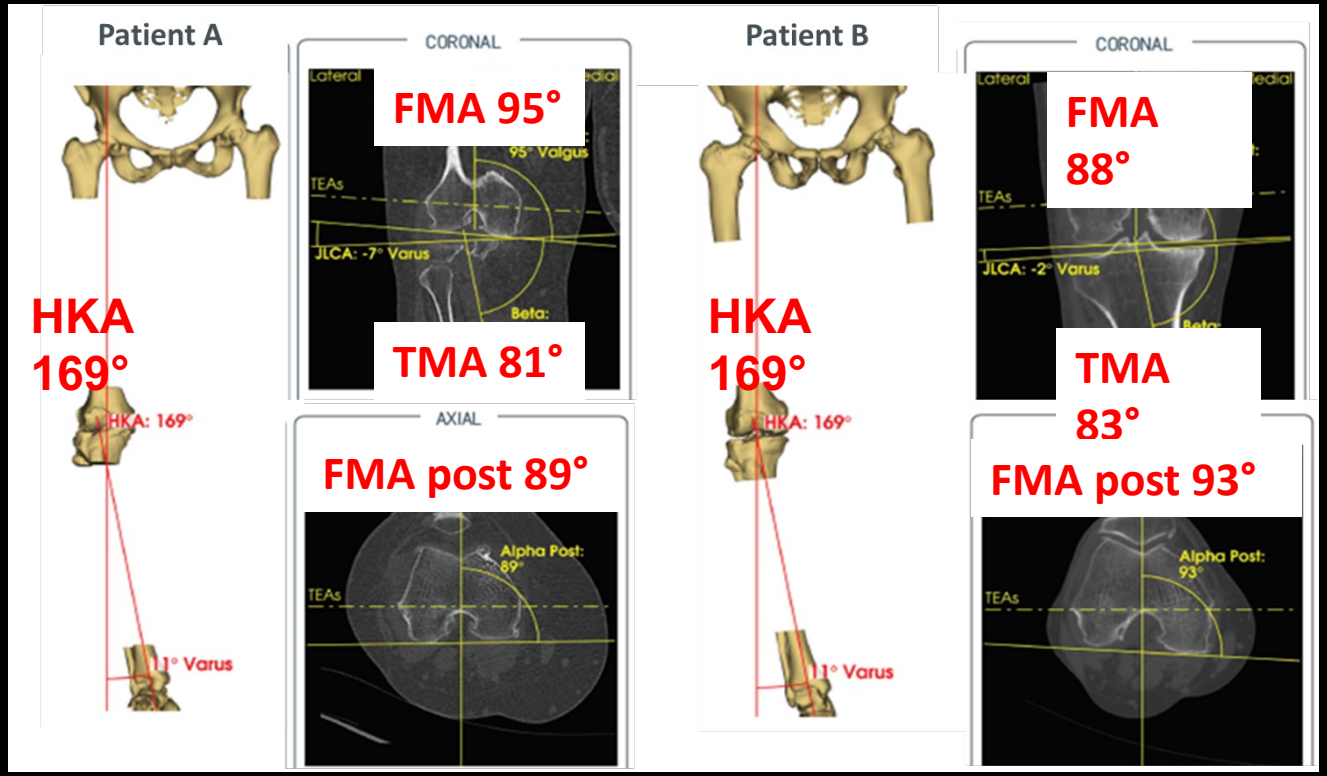
Anatomical alignment ($NEU_{HKA}0°NEU_{FMA}0°NEU_{TMA}0°$)

18% males, 17% females

Restricted kinematic alignment (different phenotypes)

31.3% males, 45.1% females

Different target for different phenotypes!

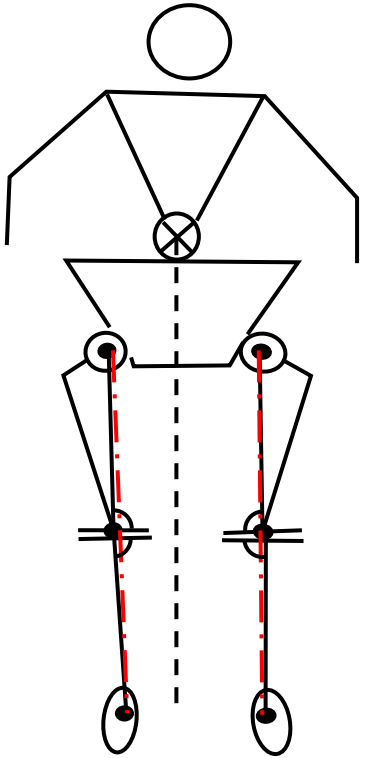


$VAR_{HKA}12°\ VAL_{FMA}6°VAR_{TMA}6°$

$VAR_{HKA}12°\ NEU_{FMA}3°VAR_{TMA}6°$

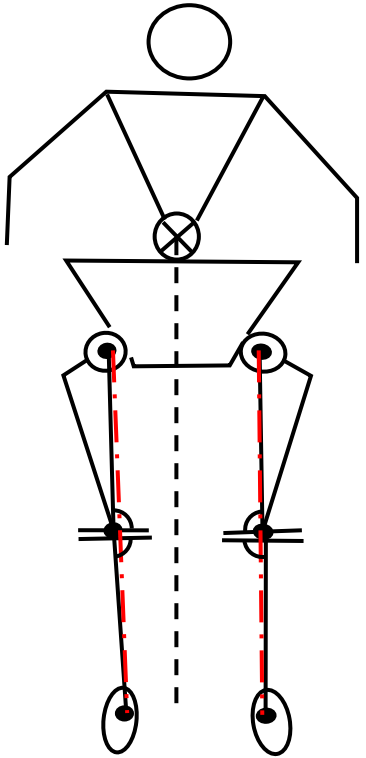
1st NEU phenotype : $HKA_{NEU}\_FMA_{VAR}\_TMA_{VAL}$

	3 Neutral Phenotypes	1st NEU Phenotype ($NEU_{HKA0°}$)				
		$HKA_{NEU}\_FMA_{VAR}\_TMA_{VAL}$			Lateral Condyle distalisation	Medial Tibia distalisation
		HKA	FMA	TMA		
Preop Alignment	**Constitutional**	180	90	90		
Postop Alignment	Mechanical Anatomical Kinematic Phenotype					

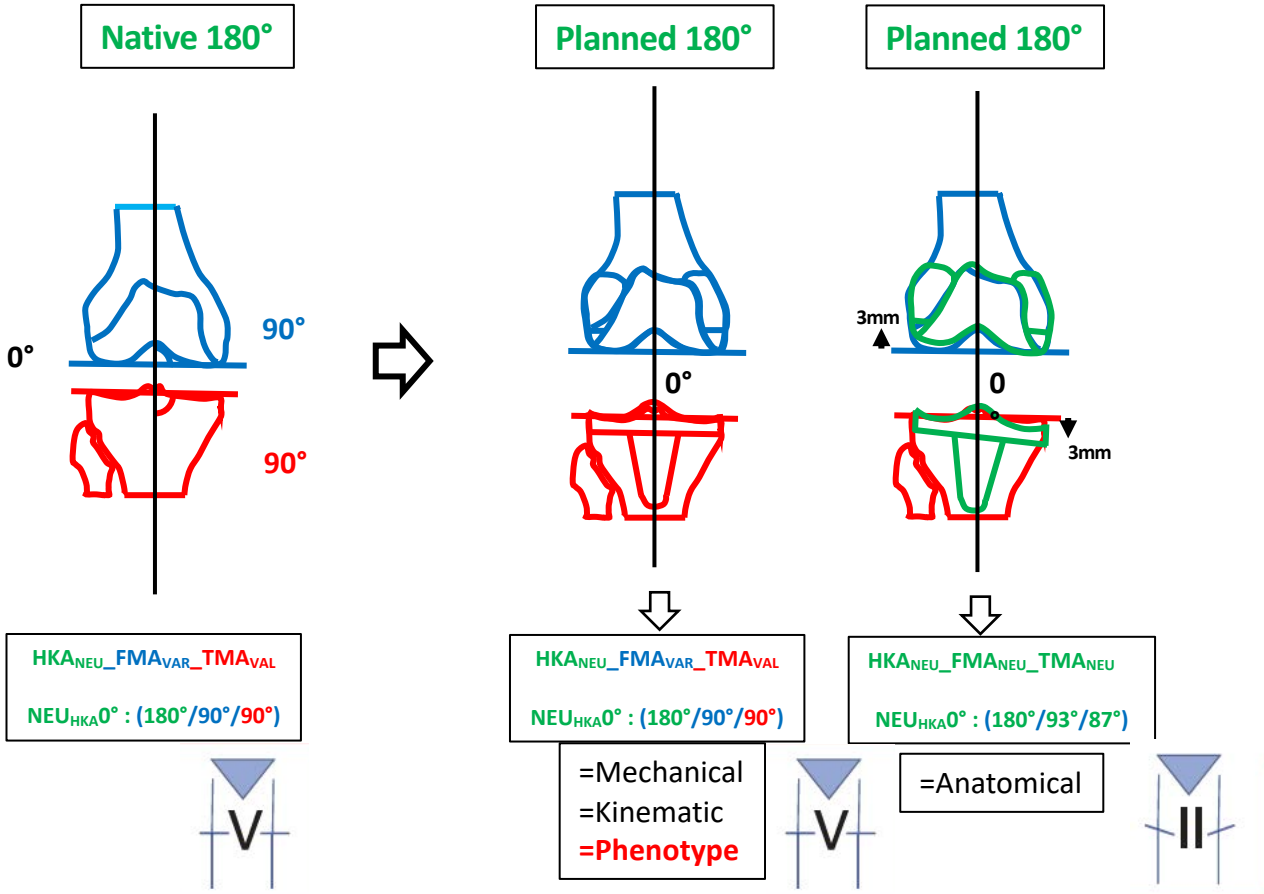


1st NEU phenotype : $HKA_{NEU}\_FMA_{VAR}\_TMA_{VAL}$

	3 Neutral Phenotypes	1st NEU Phenotype ($NEU_{HKA0°}$)				
		$HKA_{NEU}\_FMA_{VAR}\_TMA_{VAL}$			Lateral Condyle distalisation	Medial Tibia distalisation
		HKA	FMA	TMA		
Preop Alignment	**Constitutional**	**180**	**90**	**90**		
Postop Alignment	Mechanical	180	90	90	0	0
	Anatomical		92	88	-2mm	+2mm
	Kinematic		90	90	0	0
	Phenotype		90	90	0	0

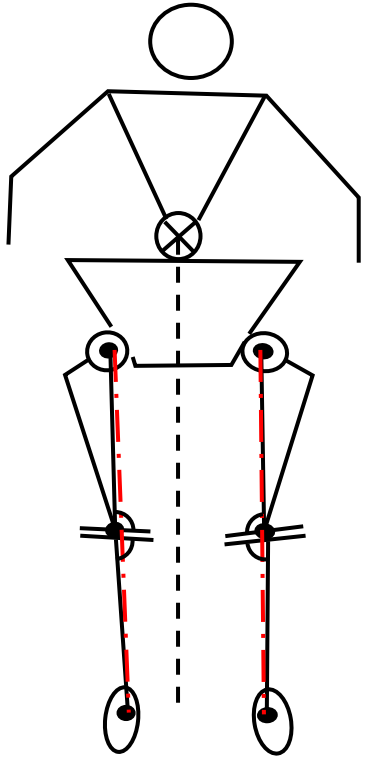


1st main NEU “native” phenotype (5.12%)



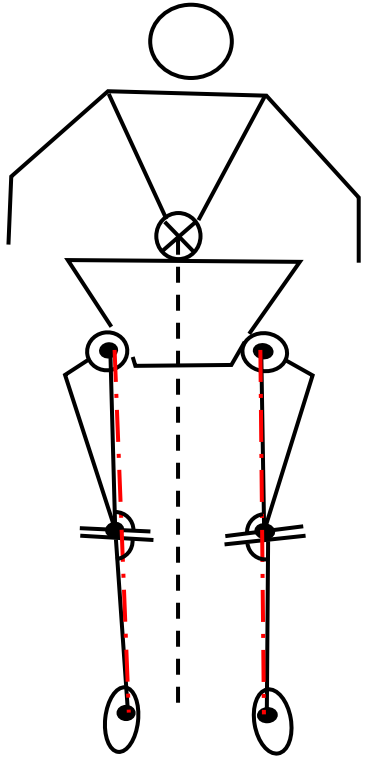
2nd NEU phenotype : $HKA_{NEU}\_FMA_{NEU}\_TMA_{NEU}$

	3 Neutral Phenotypes	2nd NEU Phenotype ($NEU_{HKA}0°$)				
		$HKA_{NEU}\_FMA_{NEU}\_TMA_{NEU}$			Lateral Condyle distalisation	Medial Tibia distalisation
		HKA	FMA	TMA		
Preop Alignment	**Constitutional**	180	92	88		
Postop Alignment	Mechanical Anatomical Kinematic Phenotype					

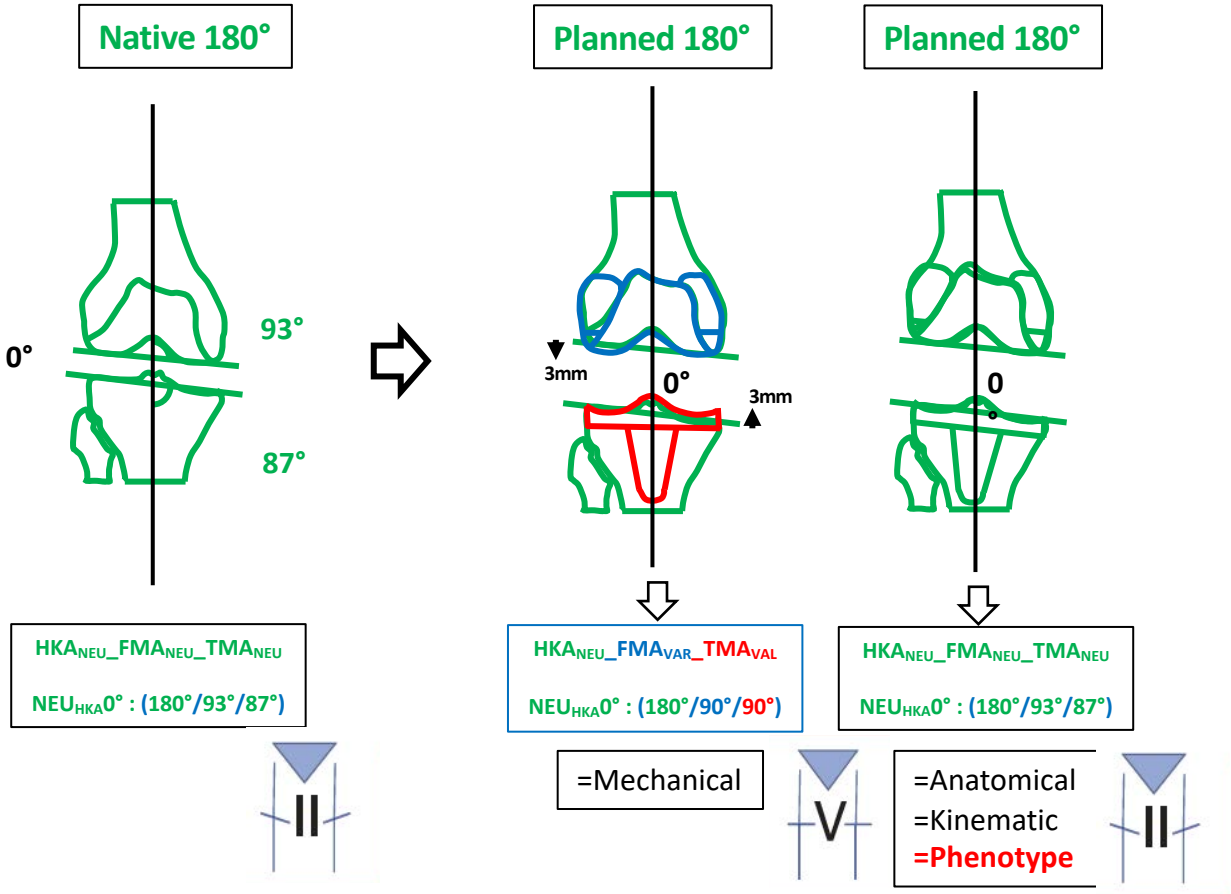


2nd NEU phenotype : $HKA_{NEU}\_FMA_{NEU}\_TMA_{NEU}$

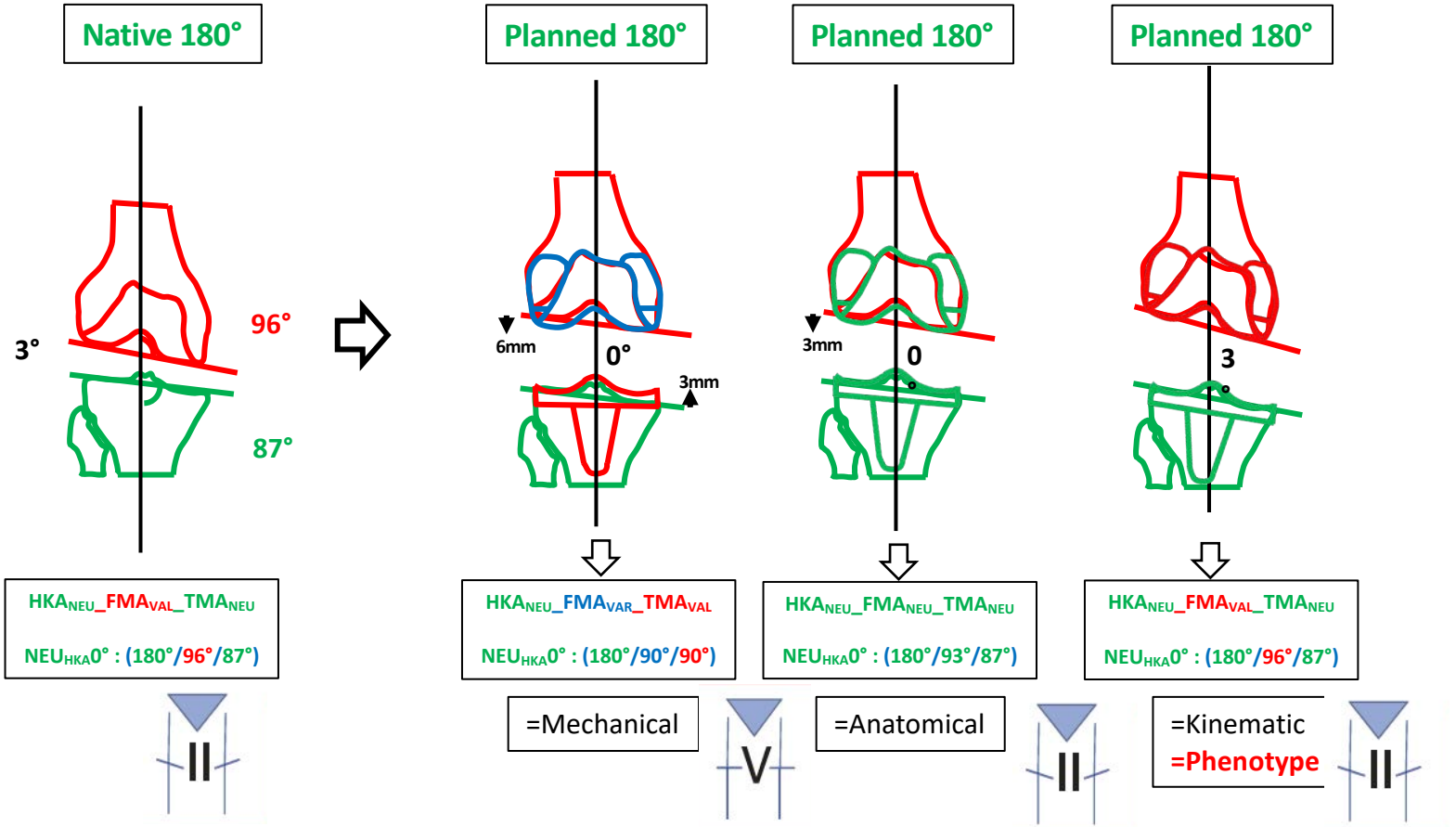
	3 Neutral Phenotypes	2nd NEU Phenotype ($NEU_{HKA0°}$)				
		$HKA_{NEU}\_FMA_{NEU}\_TMA_{NEU}$			Lateral Condyle distalisation	Medial Tibia distalisation
		HKA	FMA	TMA		
Preop Alignment	**Constitutional**	**180**	**92**	**88**		
Postop Alignment	Mechanical	180	90	90	+2mm	-2mm
	Anatomical		92	88	0	0
	Kinematic		92	88	0	0
	Phenotype		92	88	0	0



2nd main NEU “native” phenotype (29.11%)



3rd main NEU “native” phenotype (19.14%)

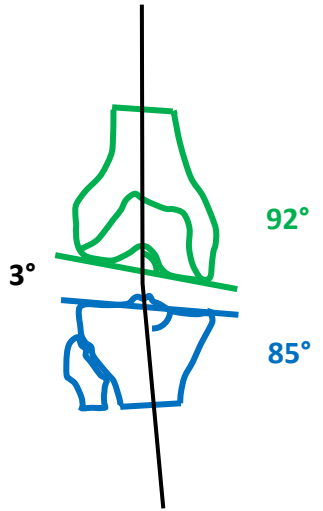


3rd VAR phenotype : $HKA_{VAR}\_FMA_{NEU}\_TMA_{VAR}$

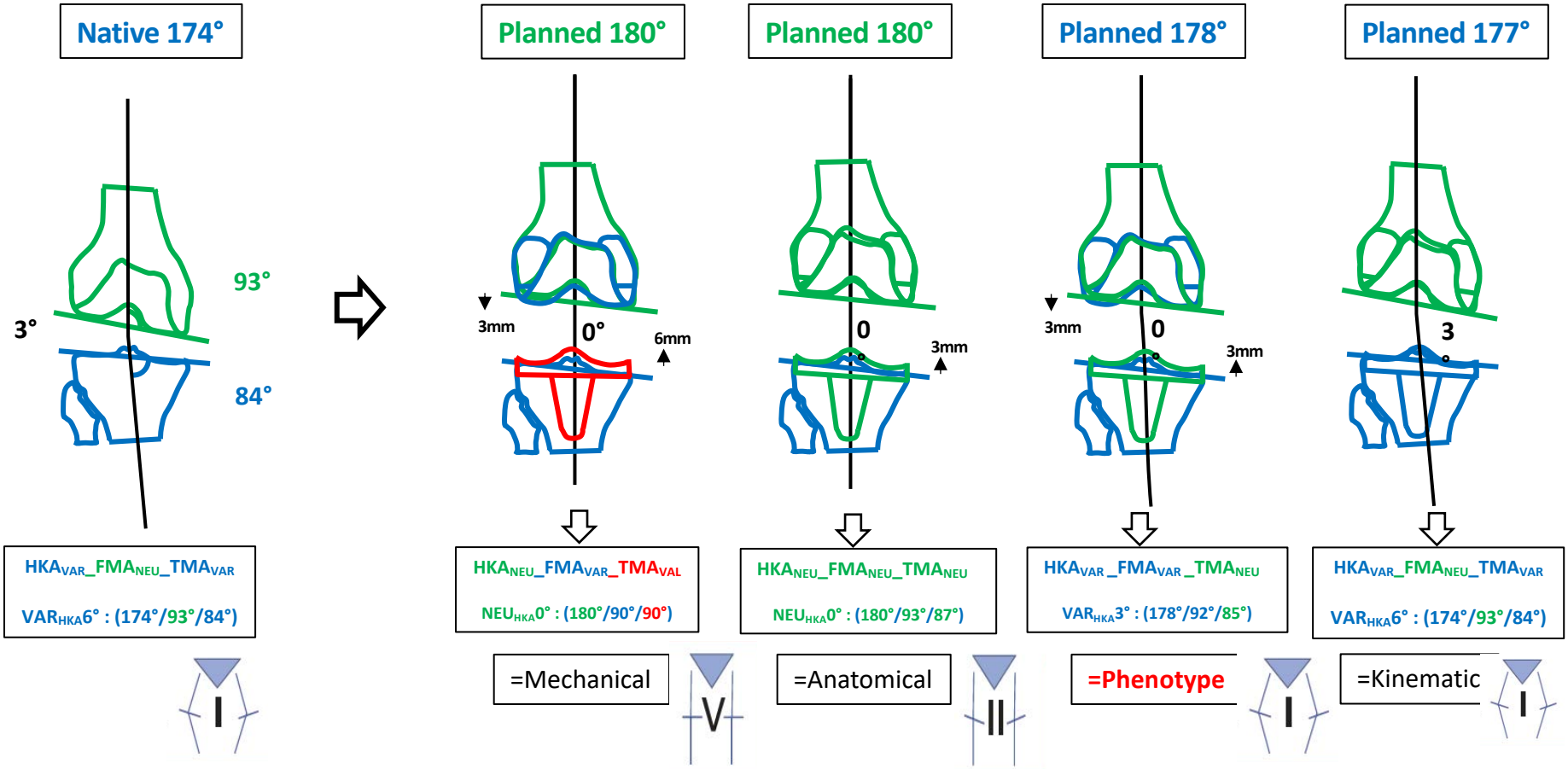
$(VAR_{HKA}3°)$

	5 Varus Phenotypes	3rd VAR Phenotype ($VAR_{HKA}3°$)				
		$HKA_{VAR}\_FMA_{NEU}\_TMA_{VAR}$			Lateral Condyle distalisation	Medial Tibia distalisation
		HKA	FMA	TMA		
Preop Alignment	Constitutional	177	92	85		
Postop Alignment	Mechanical	180	90	90	+2mm	-5mm
	Anatomical		92	88	0	-3mm
	Kinematic	177	92	85	0	0
	Phenotype		92	85	0	0

Phenotype 3 (13.50%)



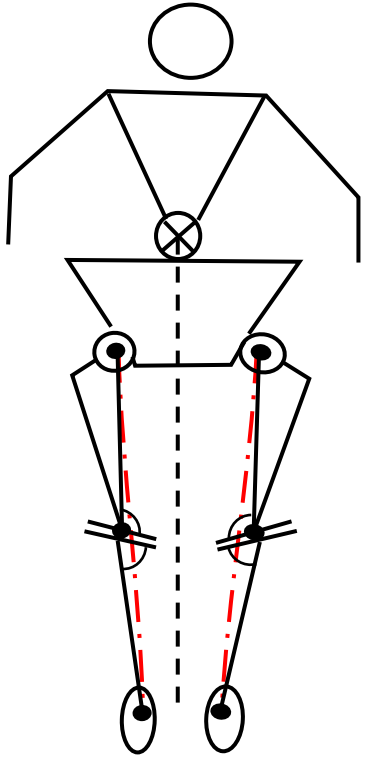
3rd main VAR “native” phenotype (13.50%)



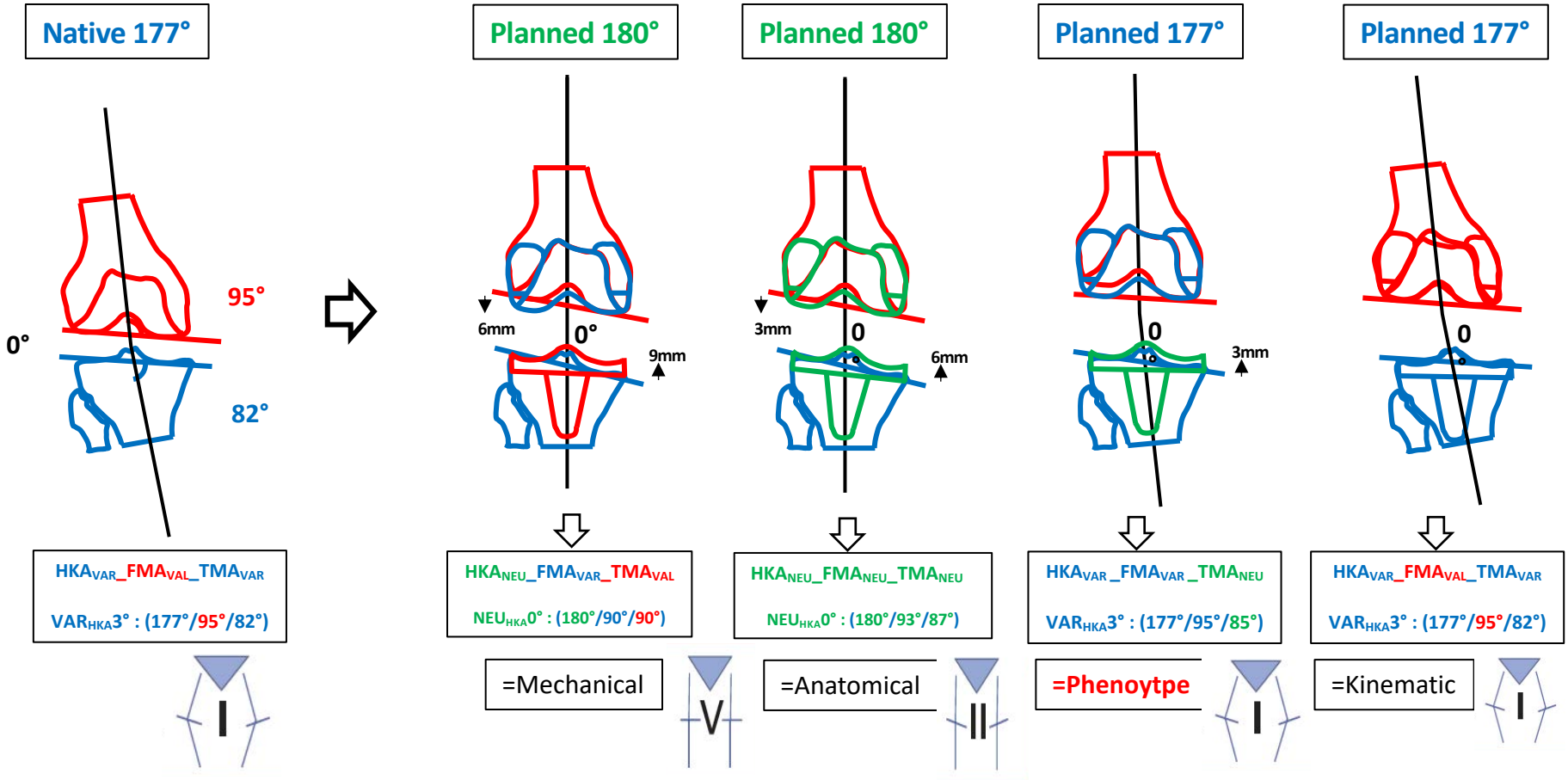
5th VAR phenotype : $HKA_{VAR}\_FMA_{VAL}\_TMA_{VAR}$

($VAR_{HKA}3°$)

	5 Varus Phenotypes	5th VAR Phenotype ($VAR_{HKA}3°$)				
		$HKA_{VAR}\_FMA_{VAL}\_TMA_{VAR}$			Lateral Condyle distalisation	Medial Tibia distalisation
		HKA	FMA	TMA		
Preop Alignment	Constitutional	177	95	82		
Postop Alignment	Mechanical	180	90	90	+5mm	-8mm
	Anatomical		92	88	+3mm	-6mm
	Kinematic	177	95	82	0	0
	Phenotype		92	85	+3mm	-3mm

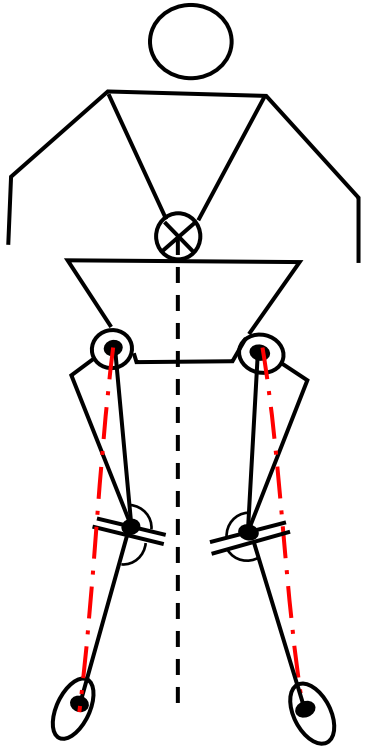


5th main VAR “native” phenotype (0.47%)



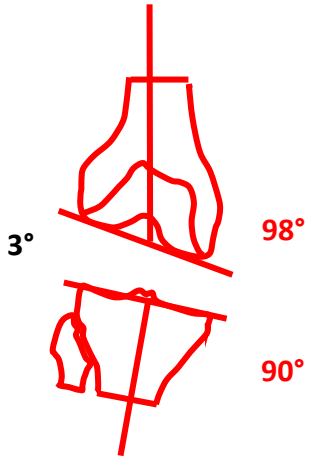
1st VAL phenotype : $HKA_{VAL}\_FMA_{VAL}\_TMA_{VAL}$ ($VAL_{HKA}9°$)

	5 Valgus Phenotypes	1st VAL Phenotype ($VAL_{HKA}9°$)				
		$HKA_{VAL}\_FMA_{VAL}\_TMA_{VAL}$			Lateral Condyle distalisation	Medial Tibia distalisation
		HKA	FMA	TMA		
Preop Alignment	Constitutional	188	98	90		
Postop Alignment	Mechanical Anatomical					
	Kinematic Phenotype					



2nd main VAL “native” phenotype (14.77%)

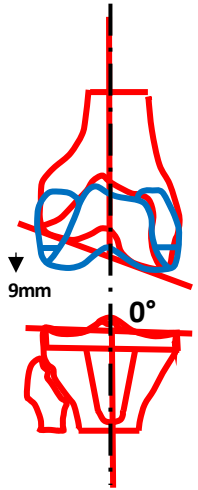
Phenotype 2 (14.77%)



$HKA_{VAL}\_FMA_{VAL}\_TMA_{VAL}$

$VAL_{HKA}6° : (186°/98°/90°)$

Planned 180°

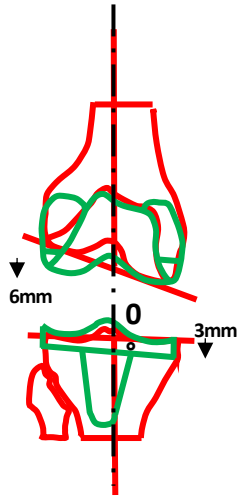


$HKA_{NEU}\_FMA_{VAR}\_TMA_{VAL}$

$NEU_{HKA}0° : (180°/90°/90°)$

=Mechanical

Planned 180°

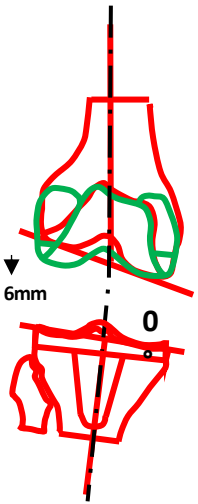


$HKA_{NEU}\_FMA_{NEU}\_TMA_{NEU}$

$NEU_{HKA}0° : (180°/93°/87°)$

=Anatomical

Planned 183°

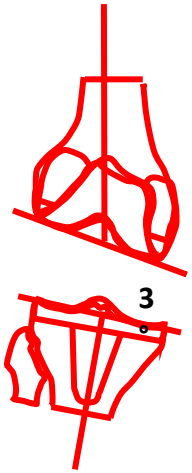


$HKA_{VAL}\_FMA_{NEU}\_TMA_{VAL}$

$VAL_{HKA}3° : (183°/93°/90°)$

=Phenotype

Planned 186°



$HKA_{VAL}\_FMA_{VAL}\_TMA_{VAL}$

$VAL_{HKA}6° : (186°/98°/90°)$

=Kinematic

«Safe zones» – Evidenz?

Knee Surgery, Sports Traumatology, Arthroscopy (2022) 30:365–367
https://doi.org/10.1007/s00167-021-06844-w

EDITORIAL

A safe transition to a more personalized alignment in total knee arthroplasty: the importance of a "safe zone" concept

Rüdiger von Eisenhart-Rothe[1] · Sebastien Lustig[2] · Heiko Graichen[3] · Peter P. Koch[4] · Roland Becker[5] · Arun Mullaji[6] · Michael T. Hirschmann[7,8]

Knee Surgery, Sports Traumatology, Arthroscopy (2022) 30:419–427
https://doi.org/10.1007/s00167-021-06811-5

KNEE

What is the "safe zone" for transition of coronal alignment from systematic to a more personalised one in total knee arthroplasty? A systematic review

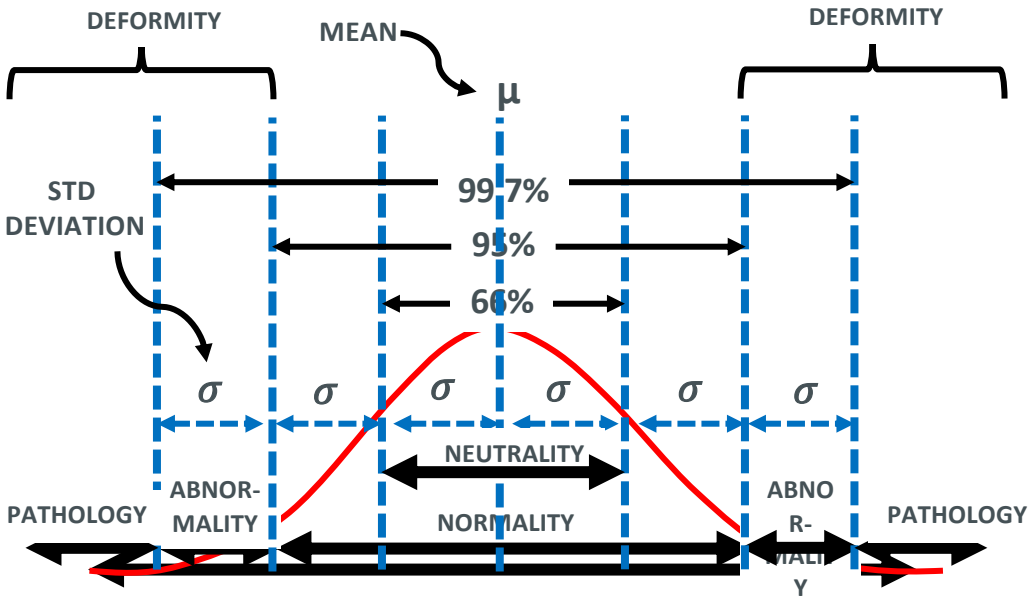
Benjamin L. Schelker[1,2] · Andrej M. Nowakowski[1,2] · Michael T. Hirschmann[1,2]

Received: 21 September 2021 / Accepted: 17 November 2021 / Published online: 1 January 2022

- HKA: 5°
- TMA: 3-5°
- FMA: 3-5°

Normal distribution of values

(empiric rule of the 3 SD in statistics)

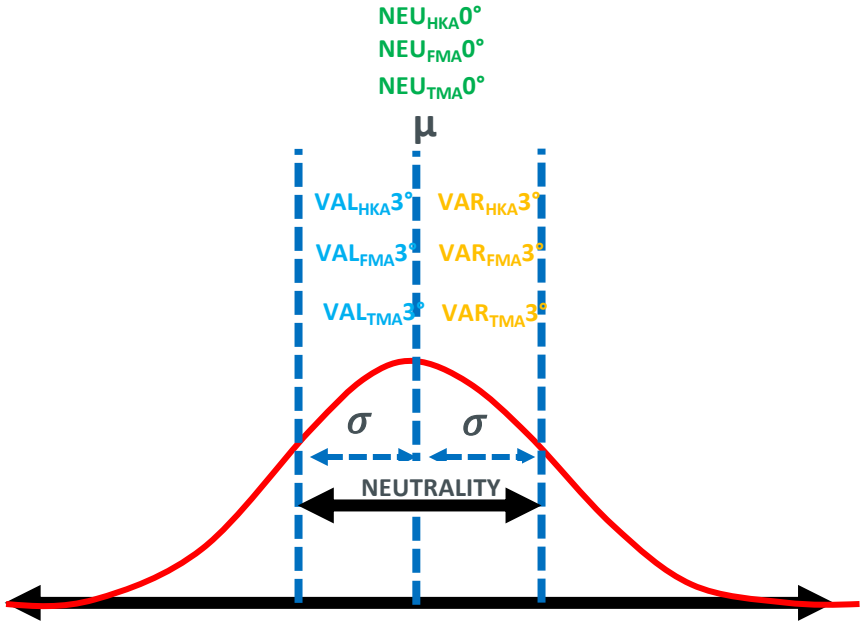


Values within :

- **1 SD** of the mean account for about 66% of the set;
- **2 SD** of the mean account for about 95% of the set;
- **3 SD** of the mean account for about 99.7% of the set.

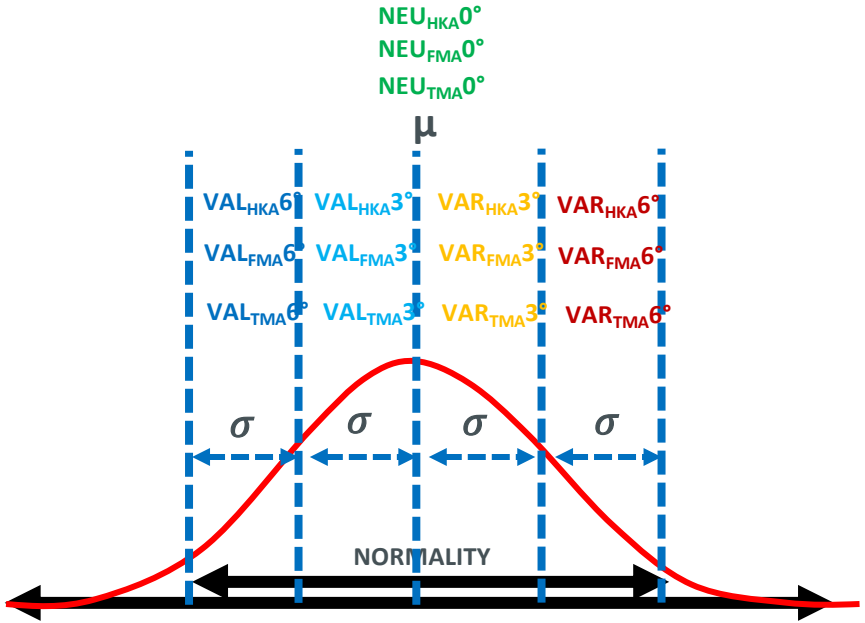
Normal distribution of values

Example with coronal phenotypes



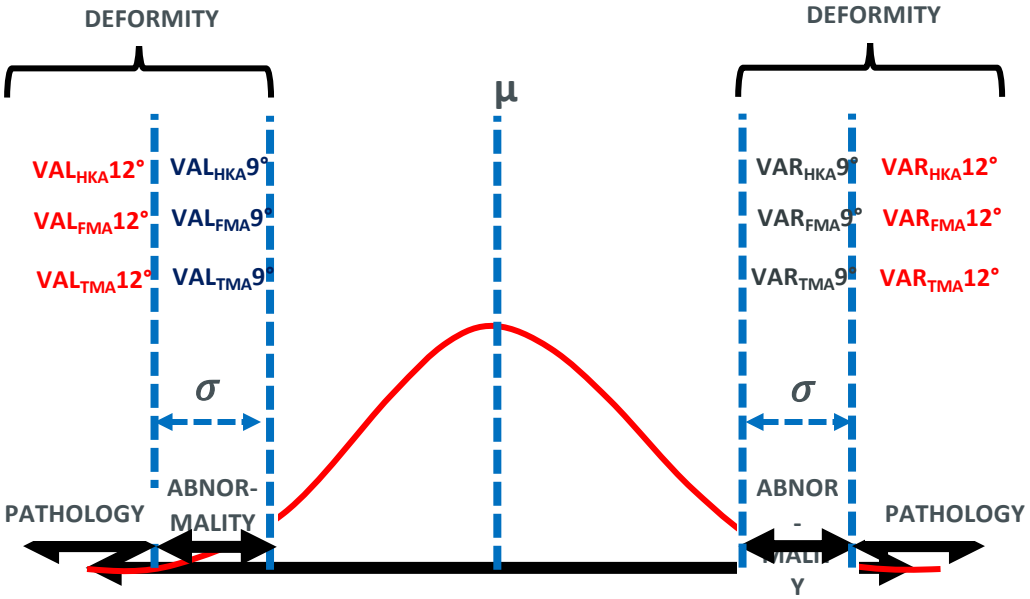
Normal distribution of values

Example with coronal phenotypes



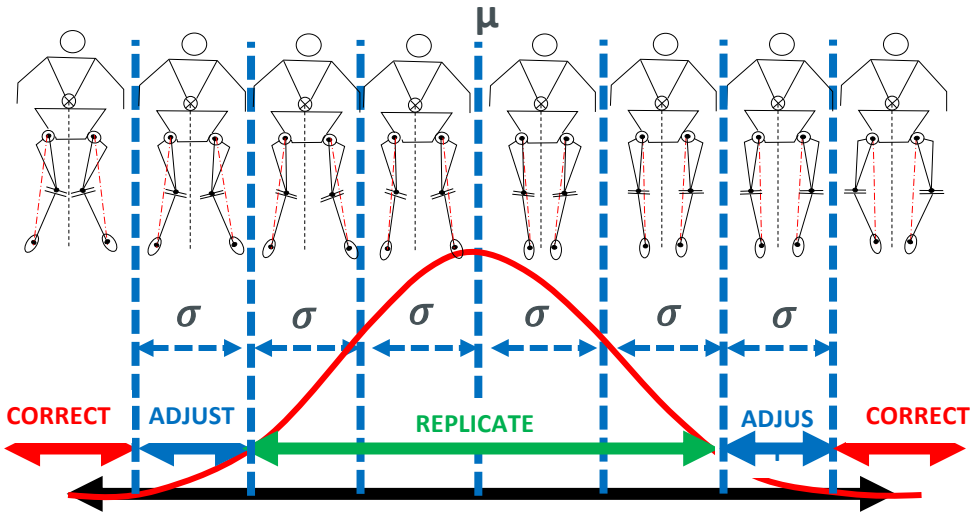
Normal distribution of values

Example with coronal phenotypes

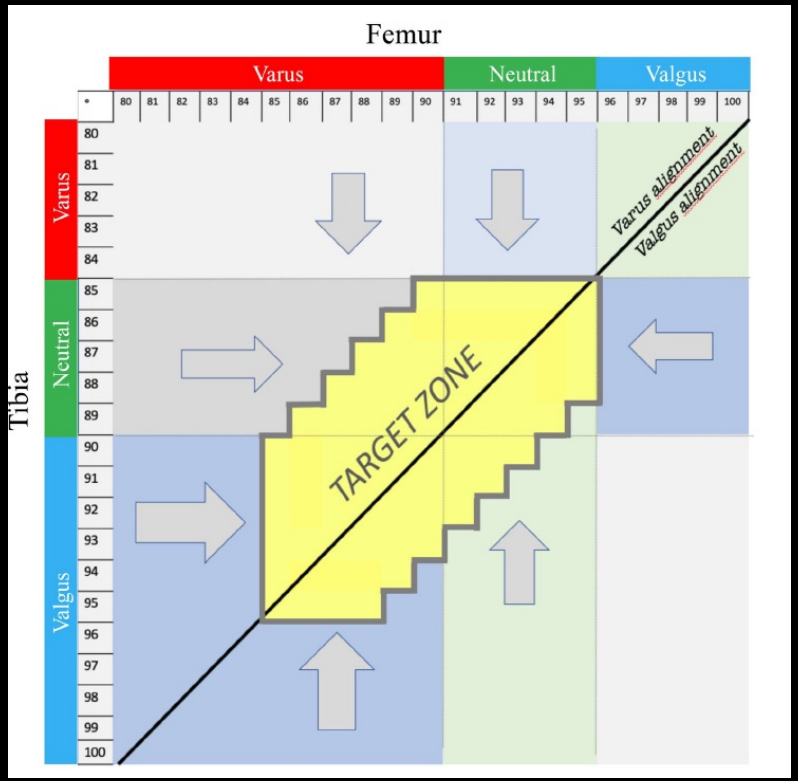


Normal distribution of values

"**Anatomical**" **Normality**



Phänotypisches Alignment in Koronarebene



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KNEE

Custom total knee arthroplasty facilitates restoration of constitutional coronal alignment

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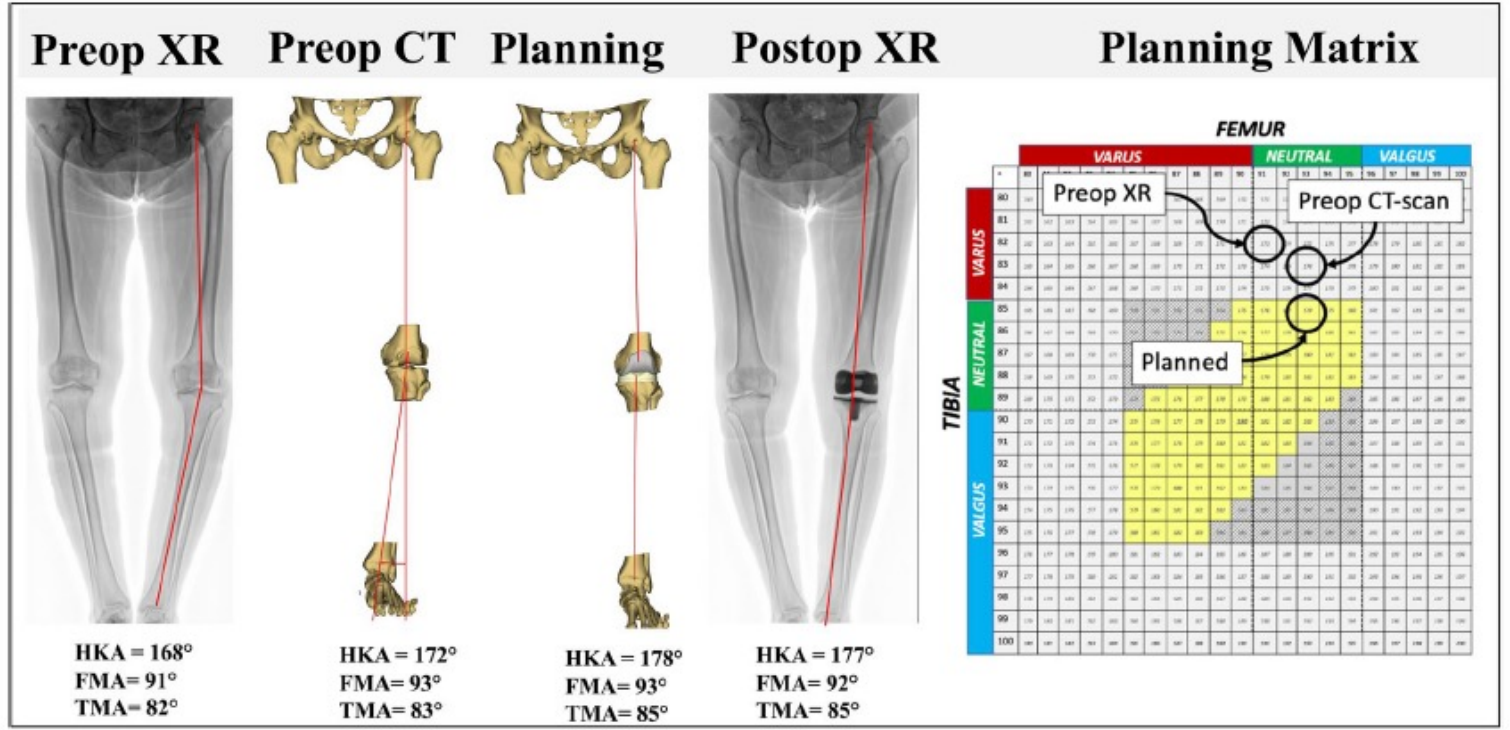
Safe target zone!

Phenotype alignment



Take Home Message

- Detailed analysis of knee phenotypes including HKA, FMA, TMA and JLCA necessary
- Bone cuts need to be preplaned and amount of ligament balancing limited
- Coronal alignment target needs to be adpated with regards to knee phenotypes
- Transition to Personalised Alignment (PA) should follow safe zones based on clinical evidence

Thank you for your attention!

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