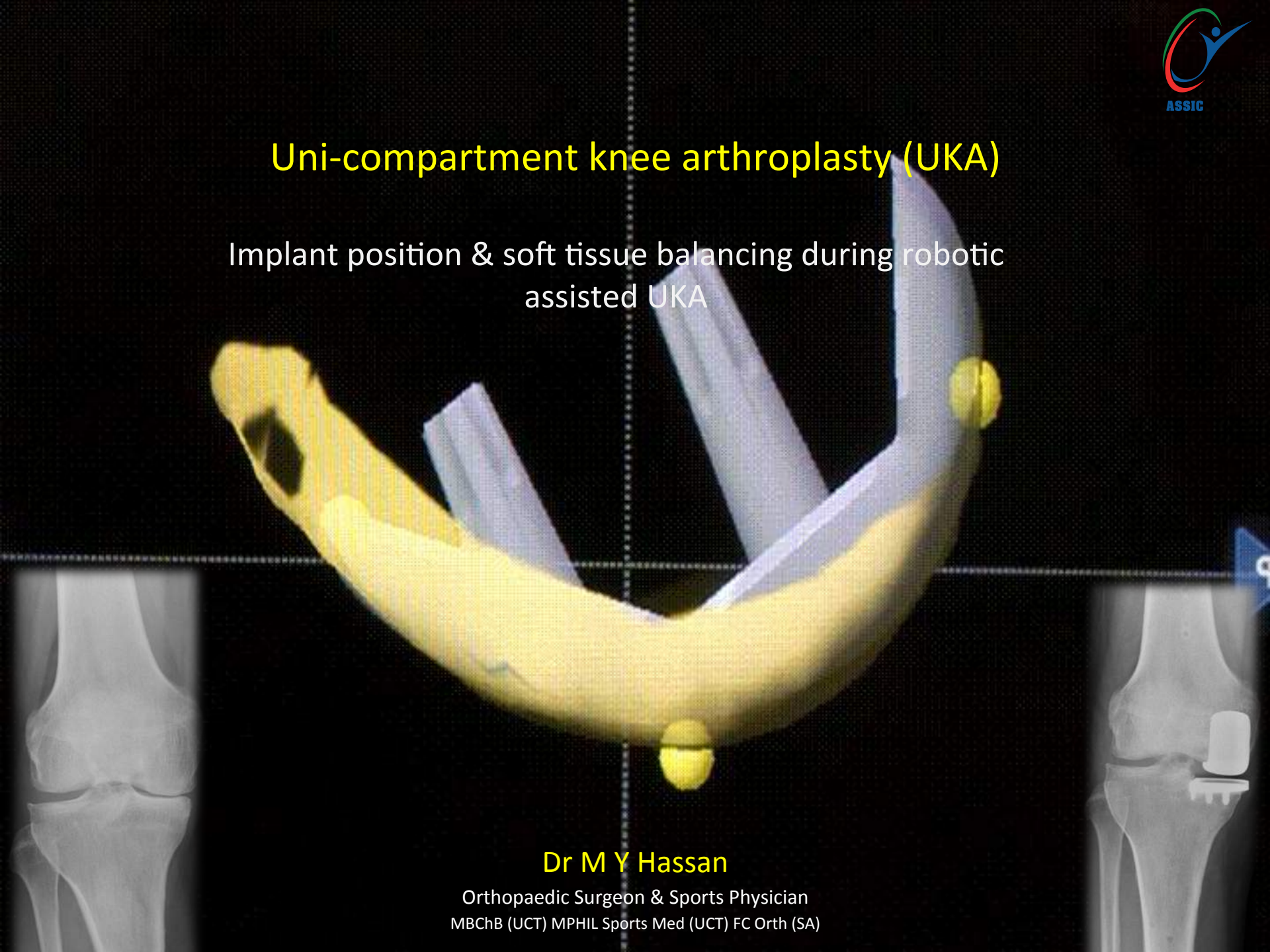
Uni-compartment knee arthroplasty (UKA)

Implant position & soft tissue balancing during robotic assisted UKA



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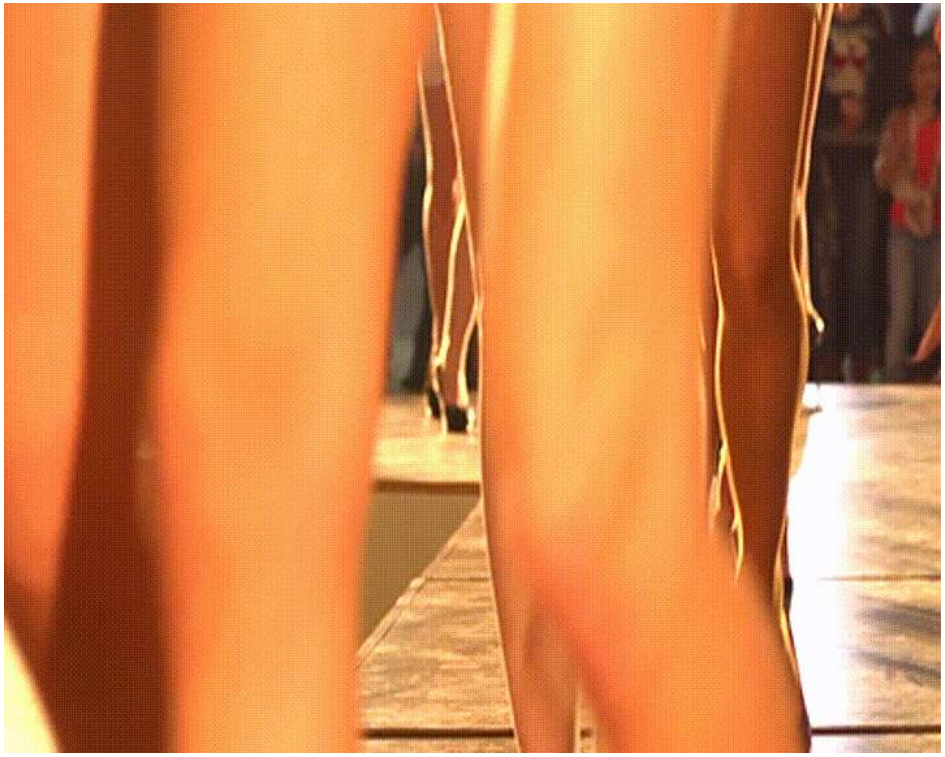
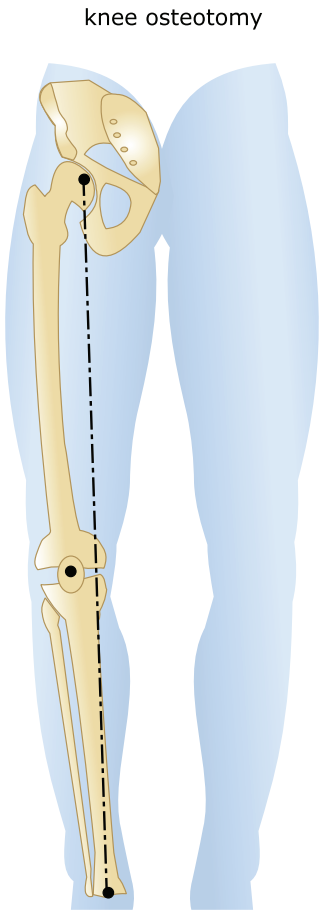
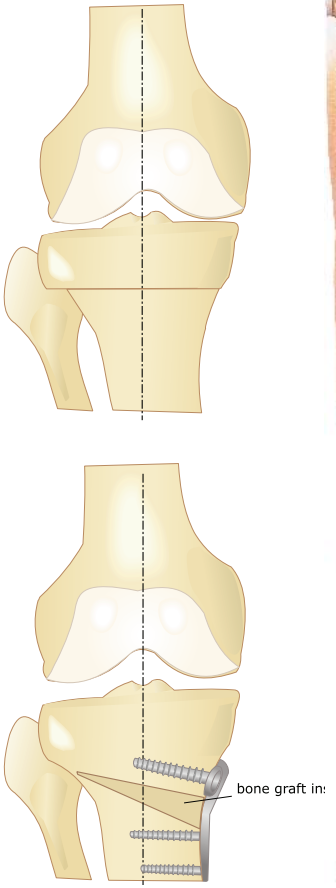
Introduction

- Malalignment of the knee joint is important in the etiology of knee OA[1]
- Realignment osteotomies around the knee reduce force/area[2] in the affected early degenerative compartment, facilitating return to functional activity levels[2]

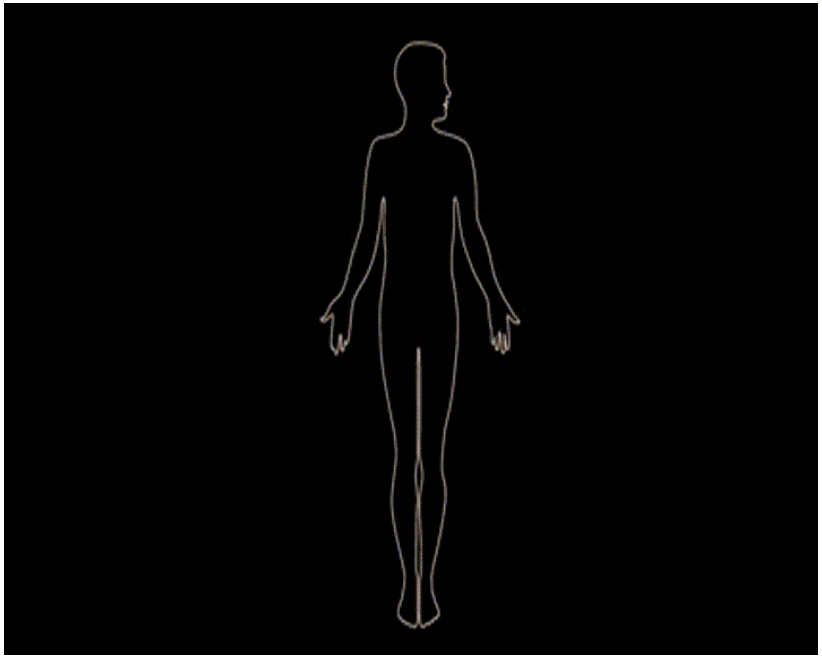


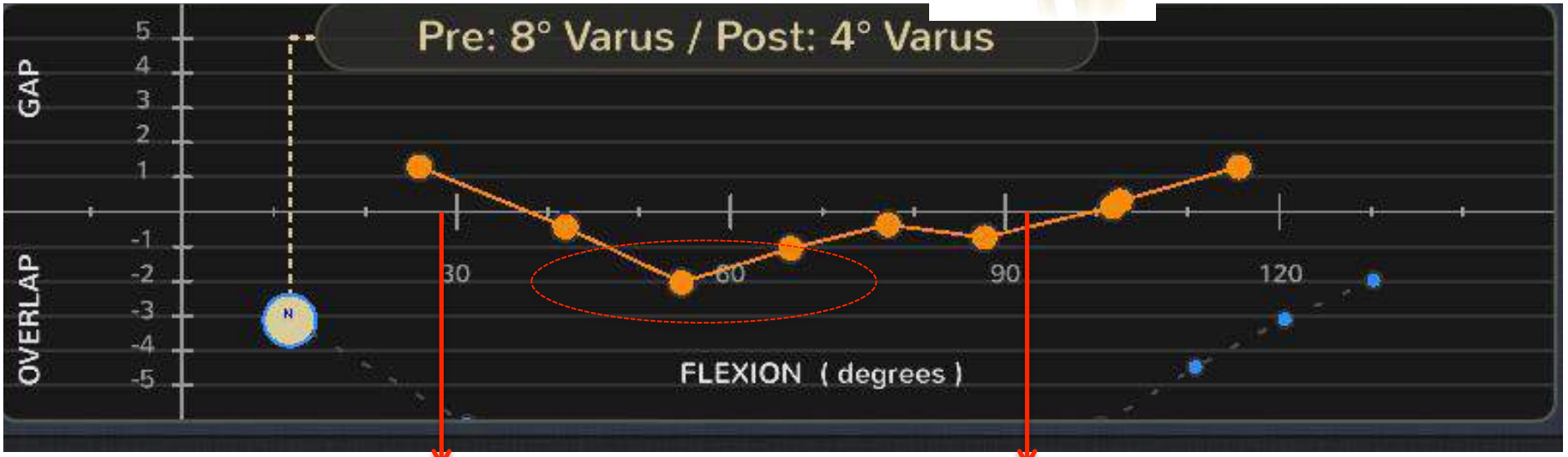




Introduction

- Knee arthroplasty principles include restoration of knee alignment, range of motion with pain relief in a well balanced knee
- Malalignment during UKA can predispose to implant aseptic loosening (>2mm difference between implant & contralateral space, [3]) or an increase risk of contralateral compartment OA[3]
- Traditional methods of soft tissue balance testing: spacers &/or tensioners
- Creating a block shaped femur, soft tissue balance is assessed in extension and flexion
- Mid-flexion instability testing is done at 30°-60° knee flexion





Traditional gap testing in extension

Traditional gap testing in flexion

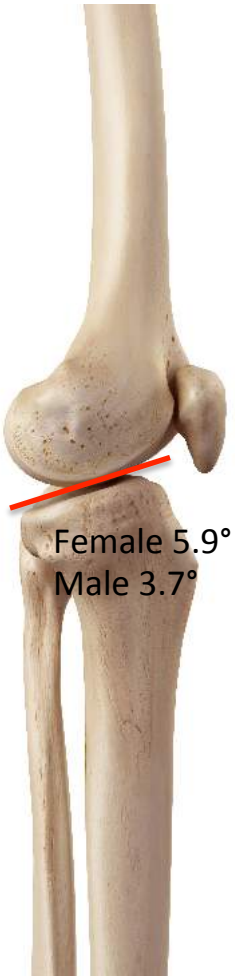
Introduction

Computer assisted navigation allow soft tissue balancing assessment throughout ROM

- Assessment before bone resection
- A systematic approach to data registration and gap balancing will expedite surgery planning

Anatomic considerations for medial & lateral UKA

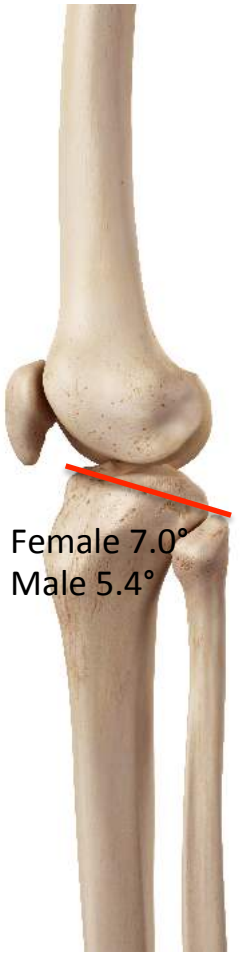
Slope comparison between medial and lateral tibial condyles



Medial tibial slope of left knee

Medial, lateral & coronal slopes of the tibial plateau for male & female subjects. SD standard deviation [3]

	Sagittal Tibial Slope		Coronal tibial slope
	Medial tibial slope	Lateral tbial slope	
Female (n=33)			
Mean	5.9°	7.0°	2.5°
SD	3.0°	3.1°	1.9
Male (n=22)			
Mean	3.7°	5.4°	3.5°
SD	3.1°	2.8°	1.9°
p	0.01	0.02	0.03



Lateral tibial slope of left knee

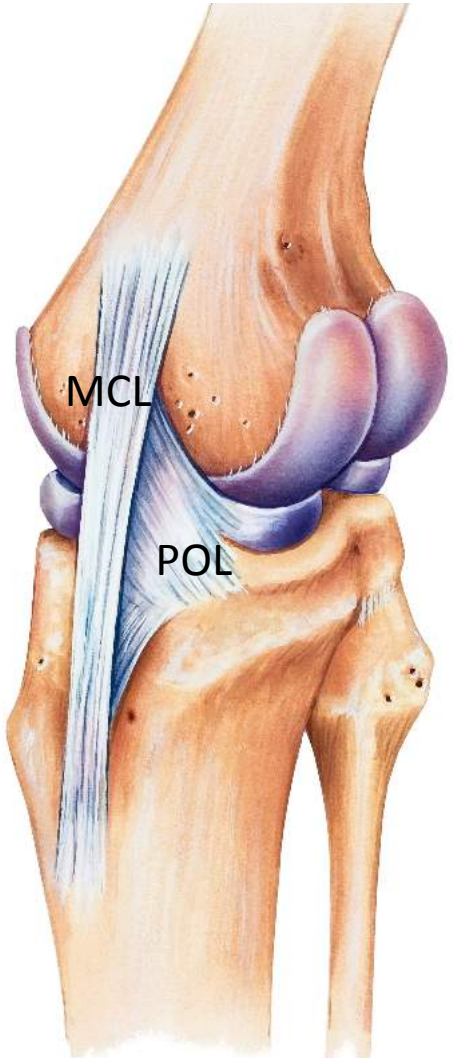
Lateral collateral ligament posterolateral structures

Right knee :LCL

Right knee: Popliteus posterior view

Right knee Popliteus lateral view

Medial collateral ligament posteromedial structures



Right knee: MCL Medial collateral ligament, POL posterior oblique ligament

Implant selection during robotic assisted UKA

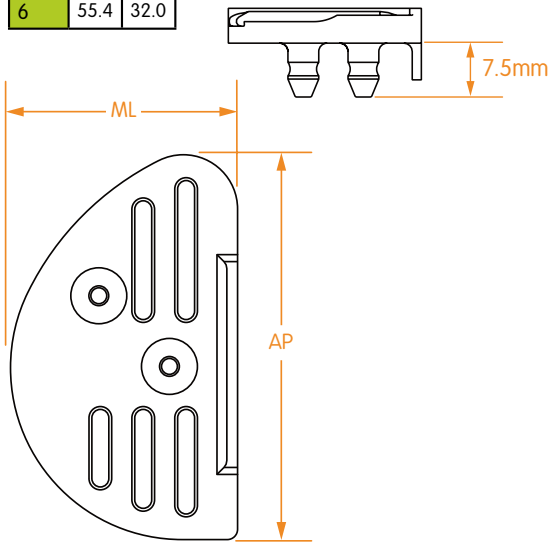
Smith & Nephew Journey UKA

Implant selection and its biomechanics:

Implant shape: specs of implant

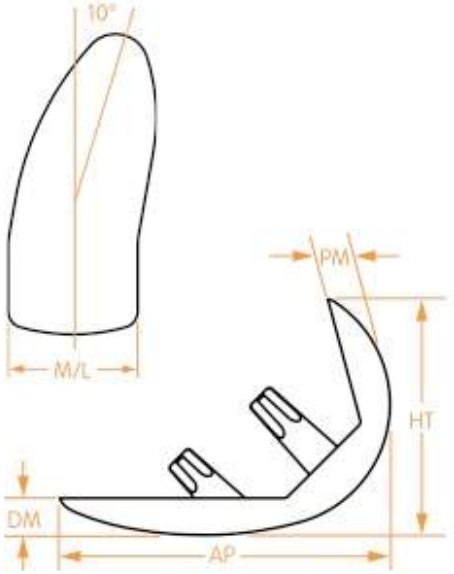
Tibial tray dimensions (mm)

Size	AP	ML
1	38.0	23.5
2	41.7	25.3
3	45.6	26.9
4	48.8	28.8
5	52.3	30.4
6	55.4	32.0



Articular insert thickness (mm)

	7	8	9	10	11	12*	14*
Modular		●	●	●	●	●	●
All-Poly	●	●	●	●	●		



Femoral component dimensions (mm)

Size	AP	HT	ML	DM	PM
1	40	31	19	5.5	5.5
2	43	32	20	5.5	5.5
3	46	34	21	6.5	6.5
4	49	36	22	6.5	6.5
5	52	38	23	6.5	6.5
6	55	40	24	6.5	6.5
7	58	42	25	6.5	6.5

Smith & Nephew Journey UKA

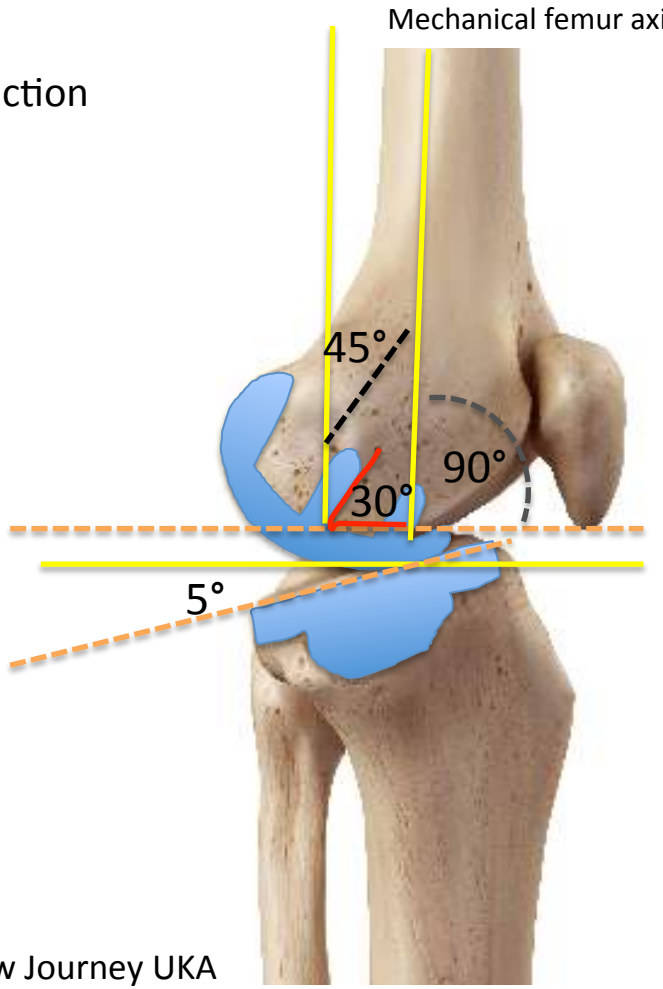
Implant default position

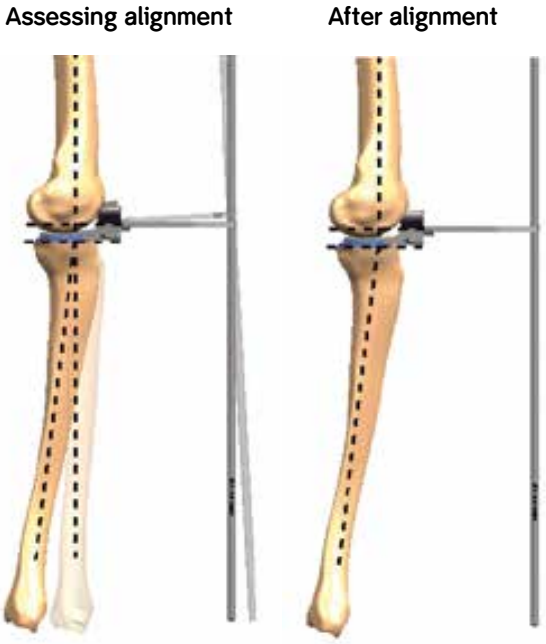
Femur:

- Z axis perpendicular to distal femur cut
- Implant 45° flexion

Tibia

- 5° slope
- 9mm depth resection





Smith & Nephew Journey UKA

Robotic Uni knee replacement: Setup technique

Register:

Mechanical axis

Knee ROM

Femur & tibia mapping

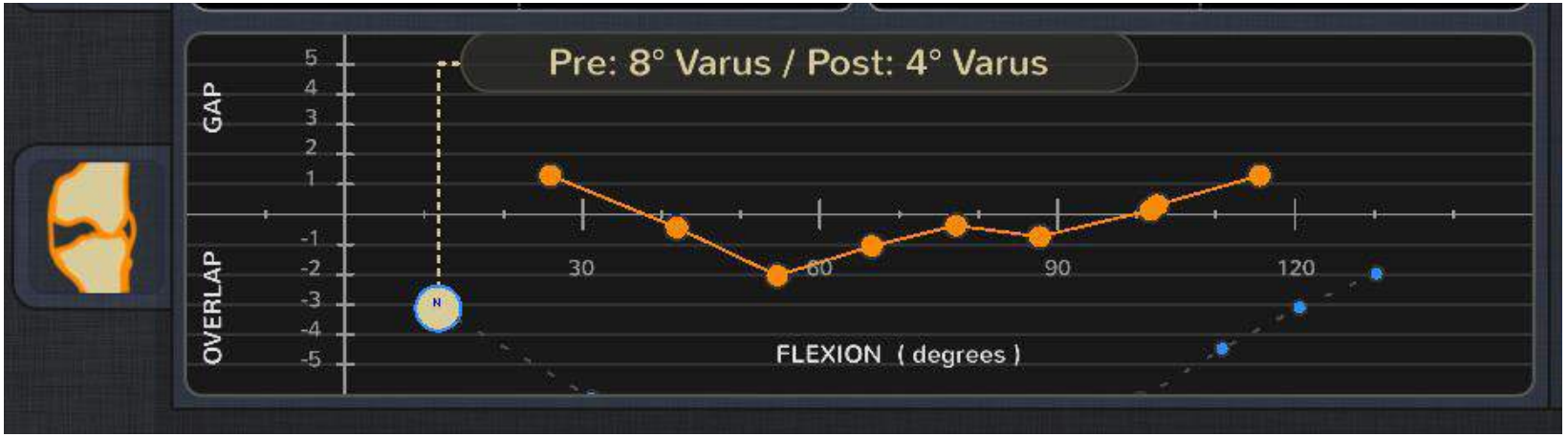
Plan prosthesis position

Assess gap balance

Bone resection

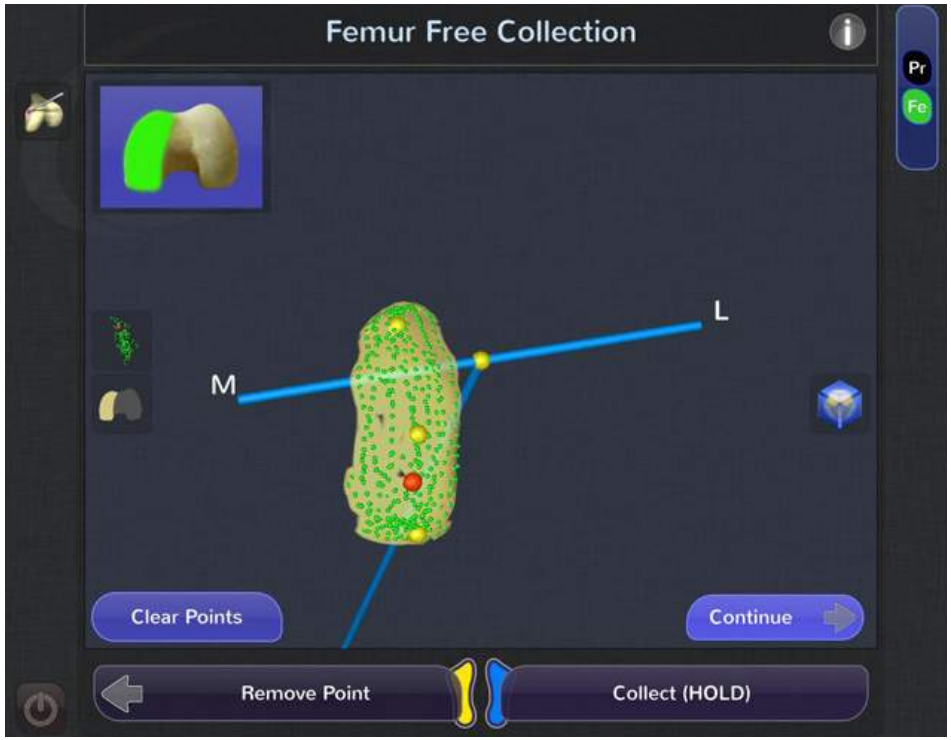
Insert prosthesis

Soft tissue balance capturing



Mapping of components

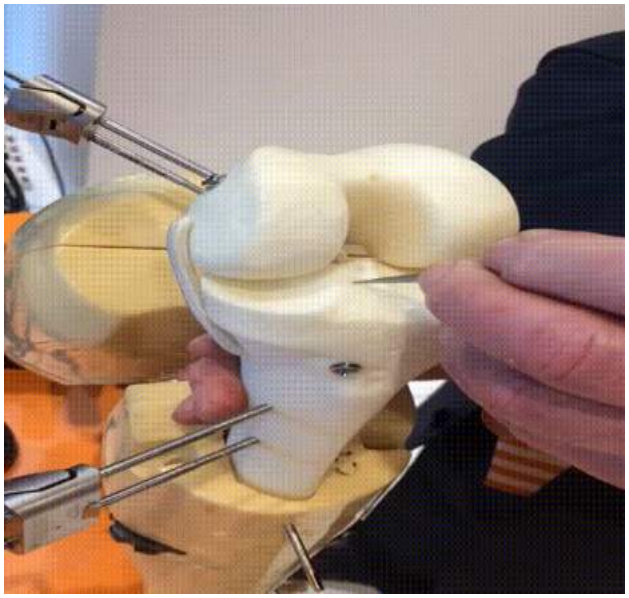
Mapping of components
Impact on soft tissue balancing

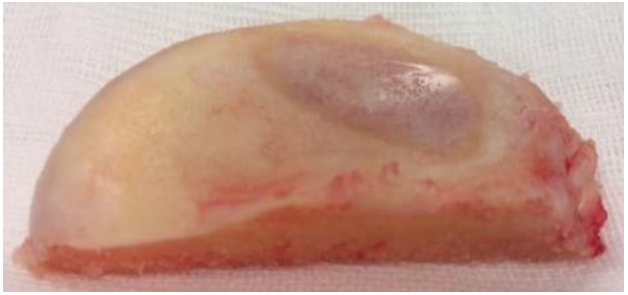


During mapping of femur assess the geographic wear pattern

- Cross correlate this pattern to implant: implant variance during mapping

Mapping of tibia component
Impact on soft tissue balancing

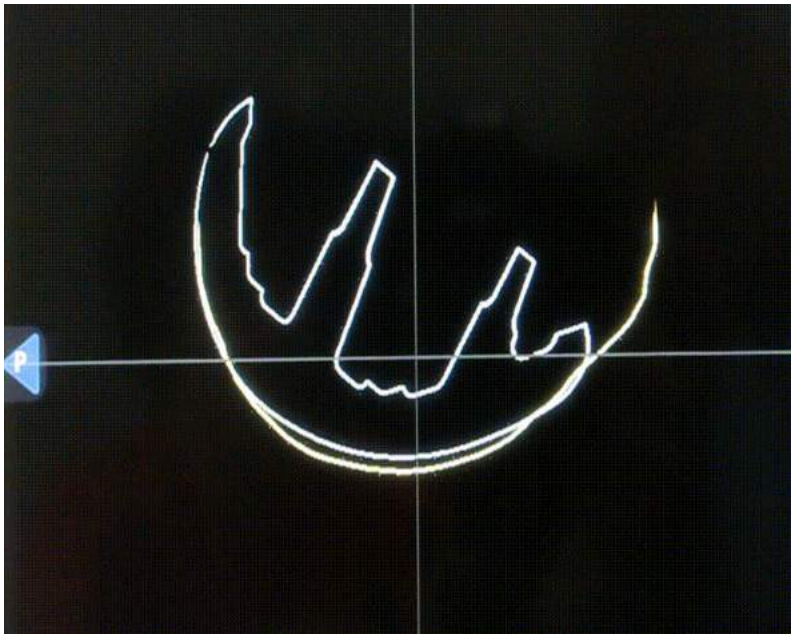


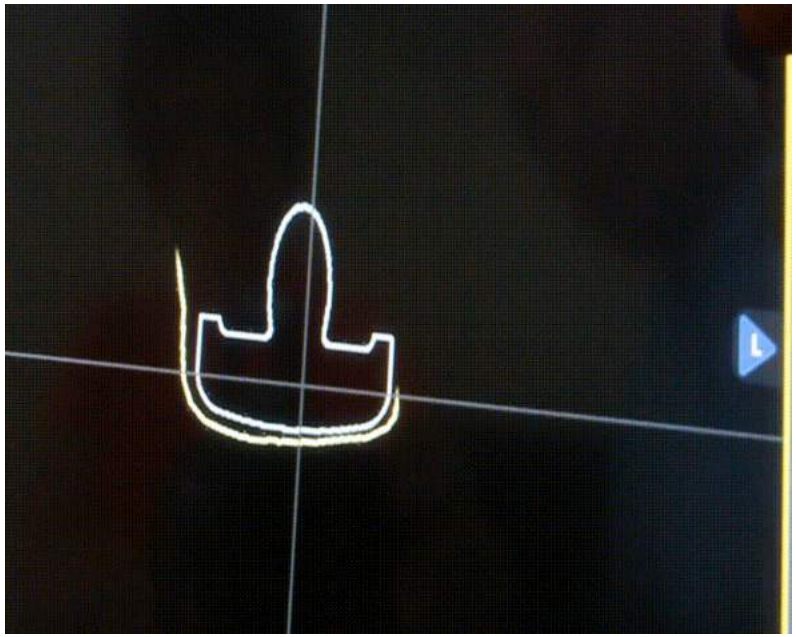


During mapping of tibia assess the geographic wear pattern

- Cross correlate this pattern to implant: implant variance during mapping

Mapping of components
1st step: Systematic approach to soft tissue balancing

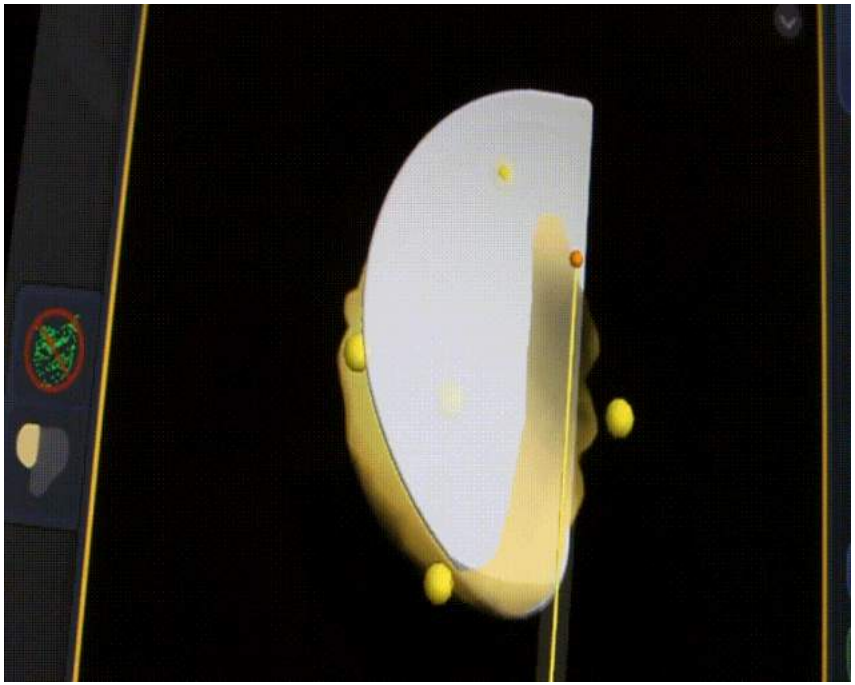


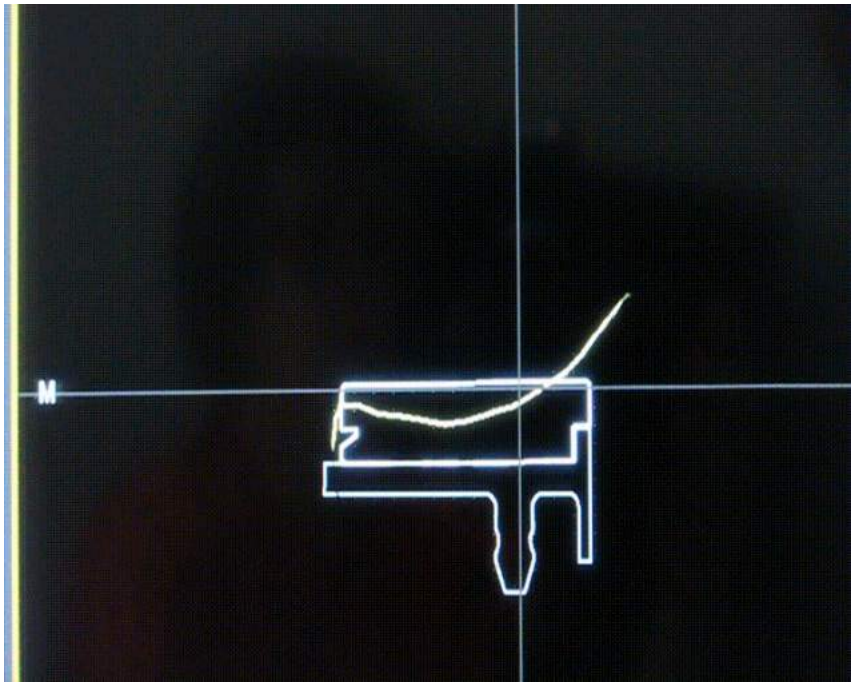


Femur default position

- Femur mid axis in sagittal plane
- Femur position: tidemark as anterior reference point (constant), ensure no notching
- Correlate wear pattern (implant variance) to potential overlapping of implant
- Rotation: sagittal plane, also coronal plane

Tibia

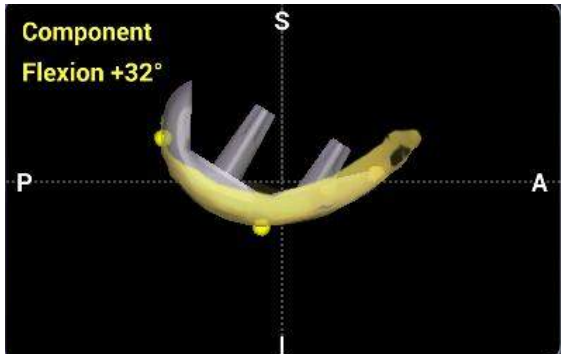


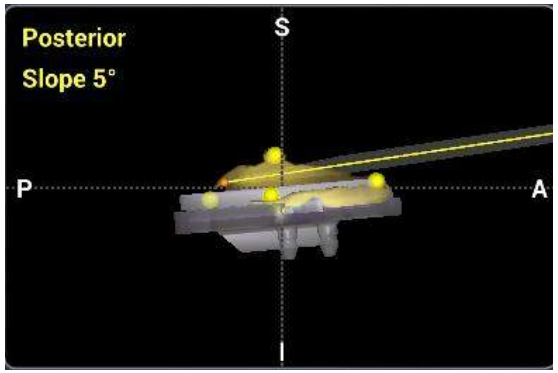


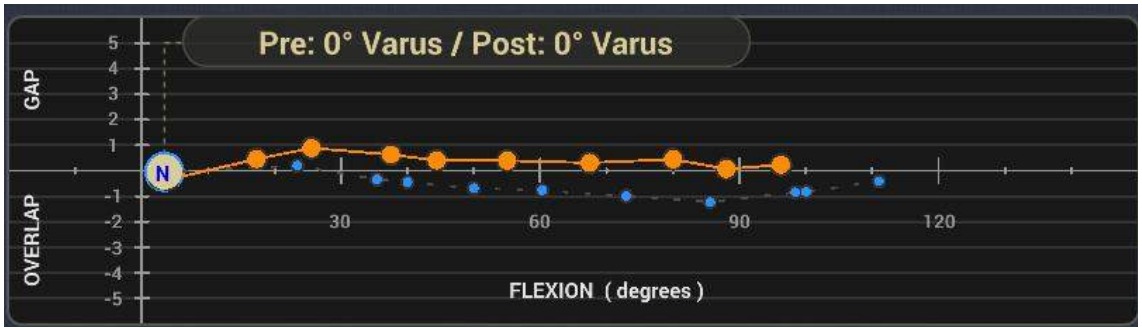
Rotational alignment
Size tibia
Slope
Resection depth

ASSIC

After completing initial mapping and implant position: proceed to assess gap balance





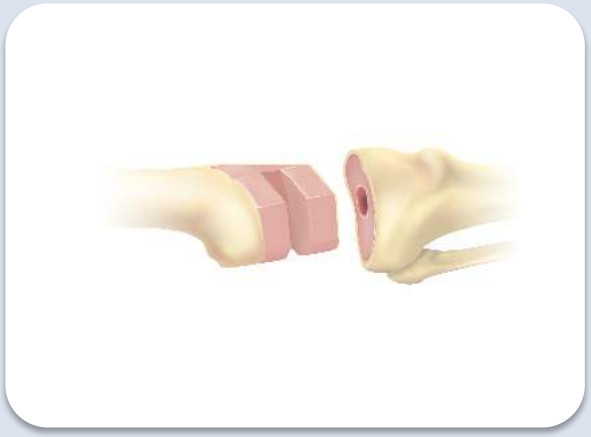


Balancing the gap mismatch

Uniform

Good flexion and good extension

Soft tissue balancing
uniform

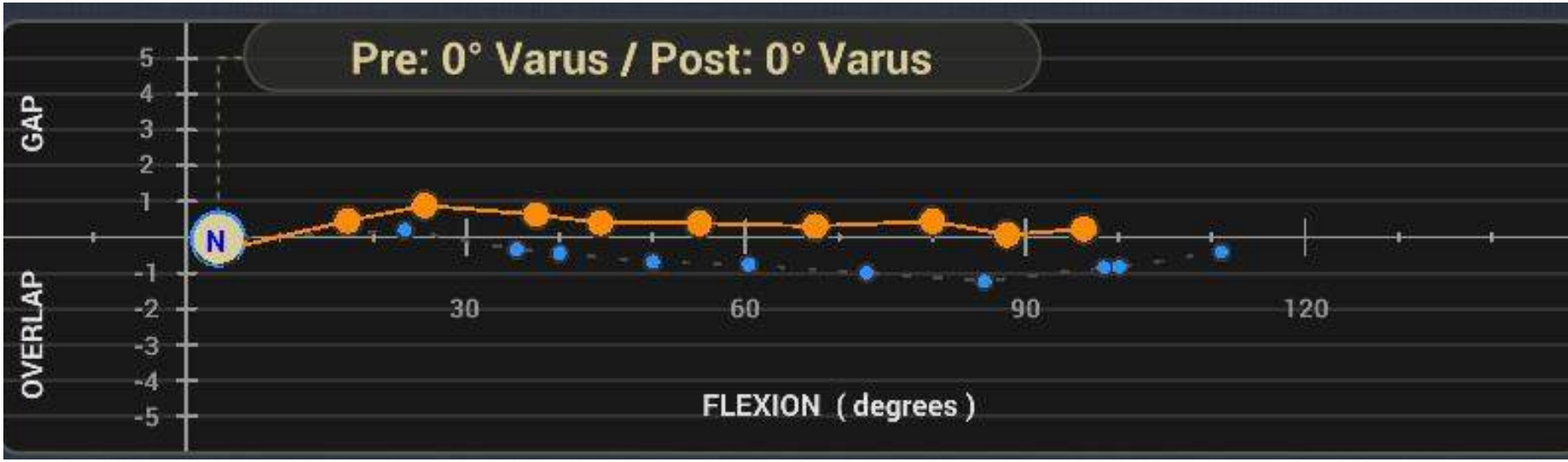


Uniform:
Good extension

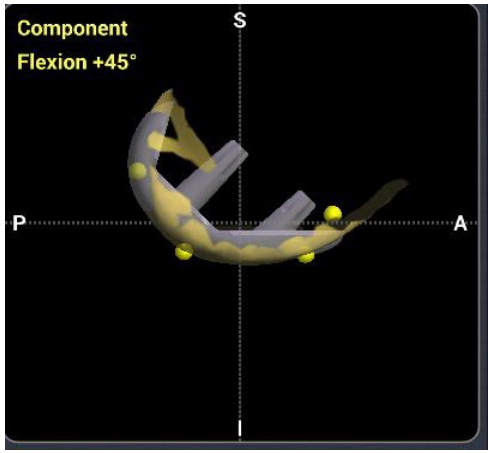
Uniform:
Good flexion

Extension	Flexion
Good	Good
Proceed with removal of equal amounts of distal & posterior femur bone	

Soft tissue balancing
uniform



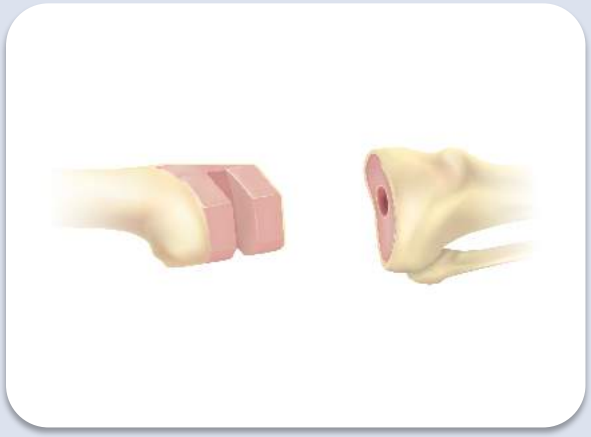
Flexion	Extension
Good	Good
Proceed with implant bone resection	



Uniform

Loose flexion and loose extension

Soft tissue balancing
uniform

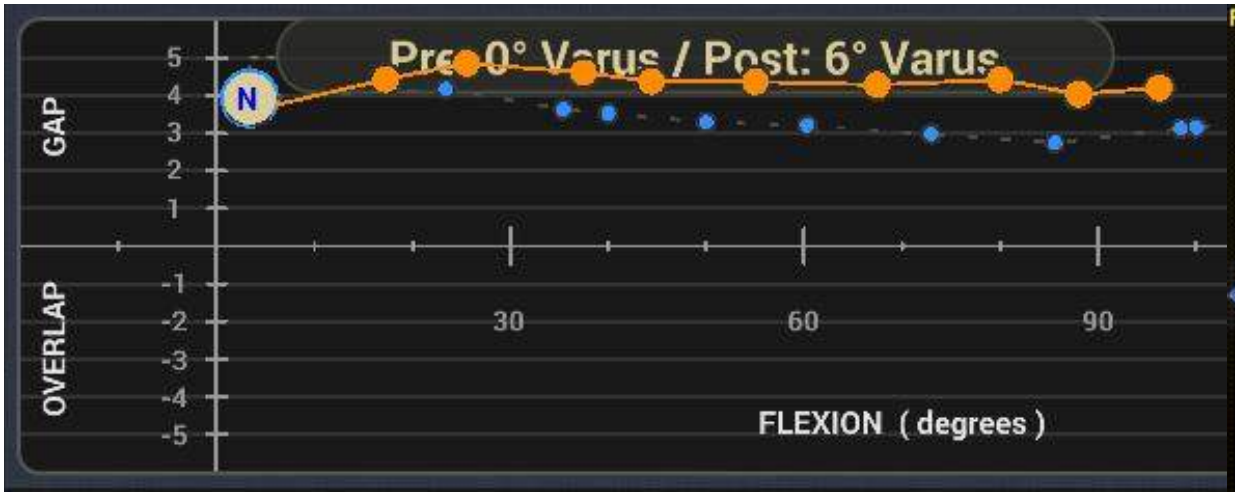


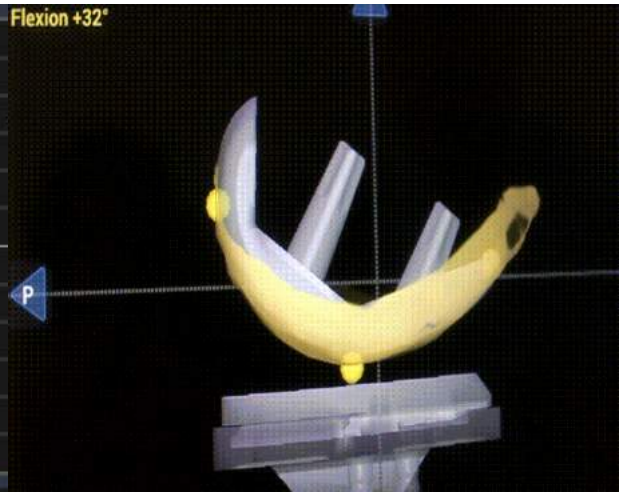
Uniform:
Loose in extension

Uniform:
Loose in flexion

Extension	Flexion
Loose	Loose
Trial with appropriate gap stick and insert appropriate thicker poly	

Soft tissue balancing
uniform



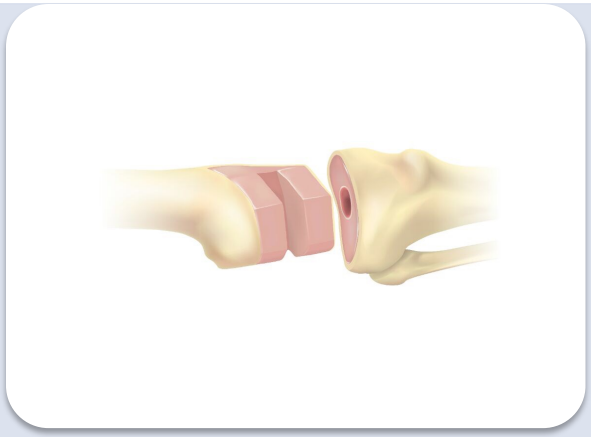


Flexion	Extension
Loose	Loose
Move tibial component superiorly and/or increase thickness	

Uniform

Tight flexion and tight extension

Soft tissue balancing
uniform

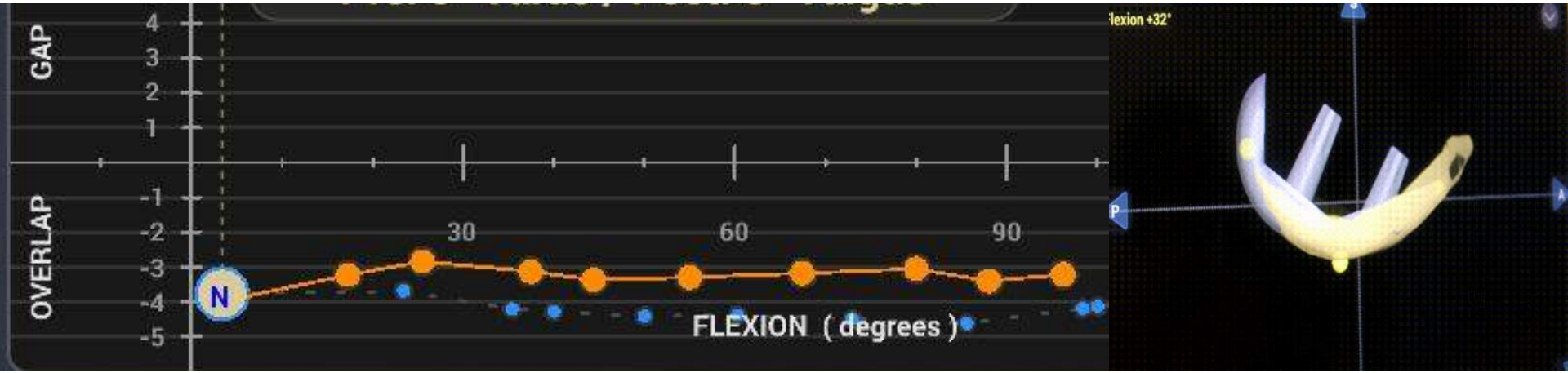


Uniform:
Tight in extension

Uniform:
Tight in flexion

Flexion	Extension
Tight	Tight
Resect more bone from tibia	

Soft tissue balancing
uniform



Flexion	Extension
Tight	Tight
Move tibial component inferior and/or reduce thickness	

Asymmetric pattern

Good extension and tight flexion

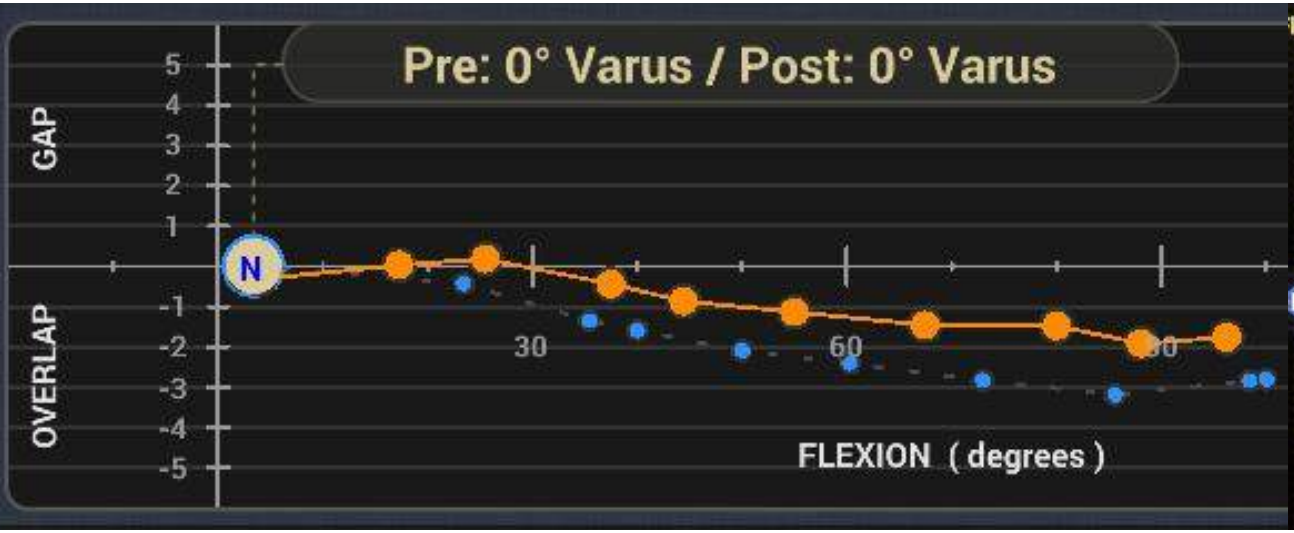
Soft tissue balancing asymmetry

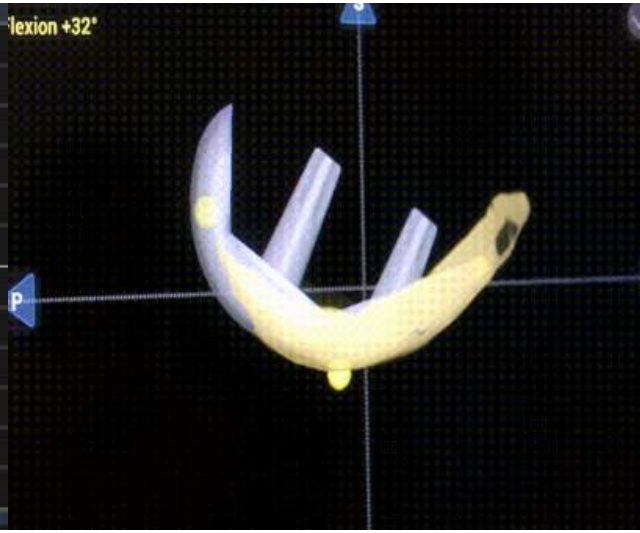
Asymmetric:
Normal extension

Asymmetric:
Tight flexion

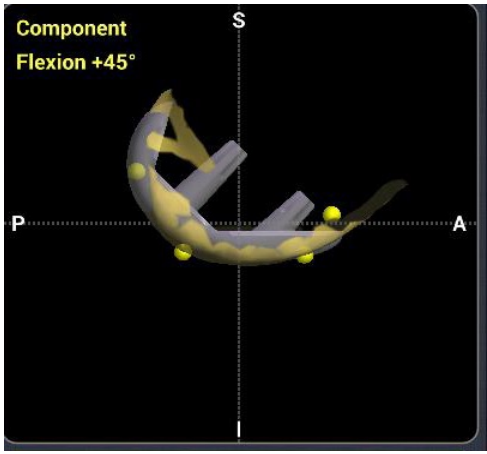
Extension	Flexion
Good	tight
Remove 1-2mm from posterior femur condyle	

Soft tissue balancing asymmetry





Extension	Flexion
Good	Tight
Move femur component anterior And/or increase tibia slope but ≤ 7° and move tibial component inferior	



Asymmetric pattern

Good extension and loose flexion

Soft tissue balancing asymmetry

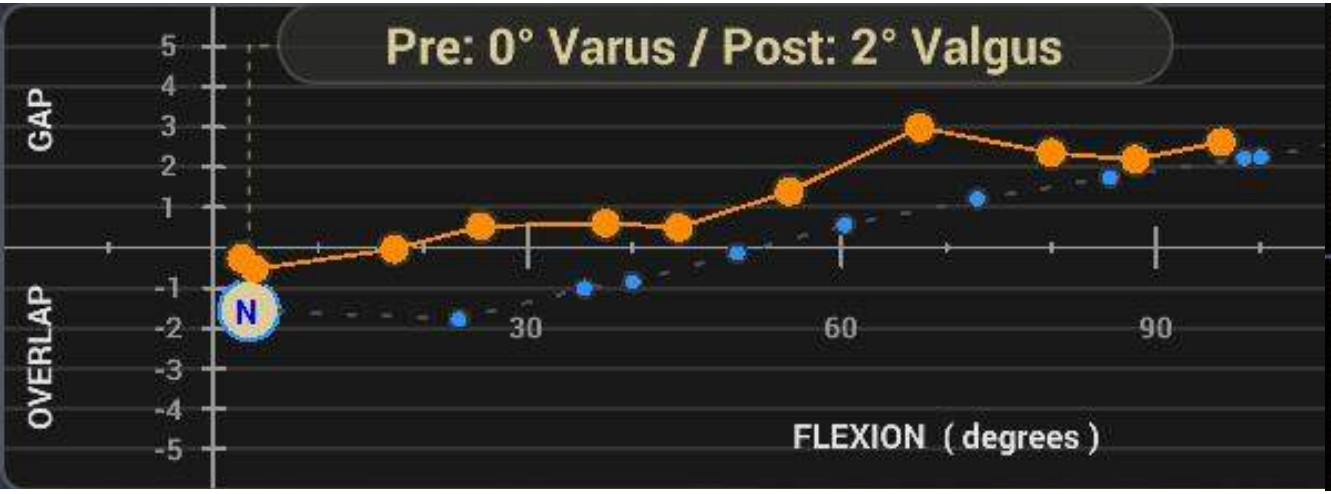
Asymmetric:
Normal extension

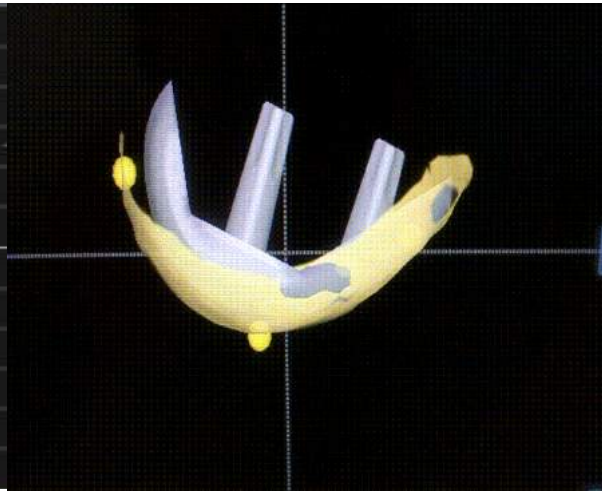
Asymmetric:
Loose flexion

Extension	Flexion
Good	Loose

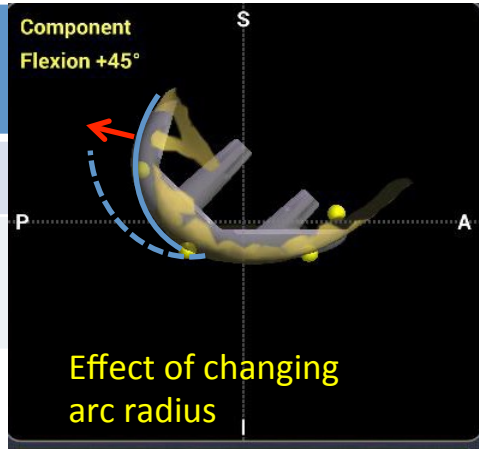
Flexion gap may be 1-2mm looser in flexion than extension. If definitely looser in flexion then resect less posterior femur condyle by putting a spacer in between the posterior paddle of the 2-in-1 cutting block thereby resecting less bone from the posterior femur condyle.

Soft tissue balancing asymmetry





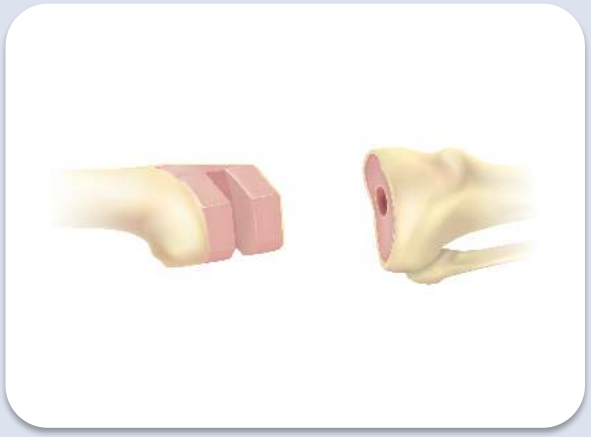
Extension	Flexion
Good	Loose
Move femoral component posterior Or reduce femoral component flexion	



Asymmetric pattern

Good flexion and loose extension

Soft tissue balancing asymmetry

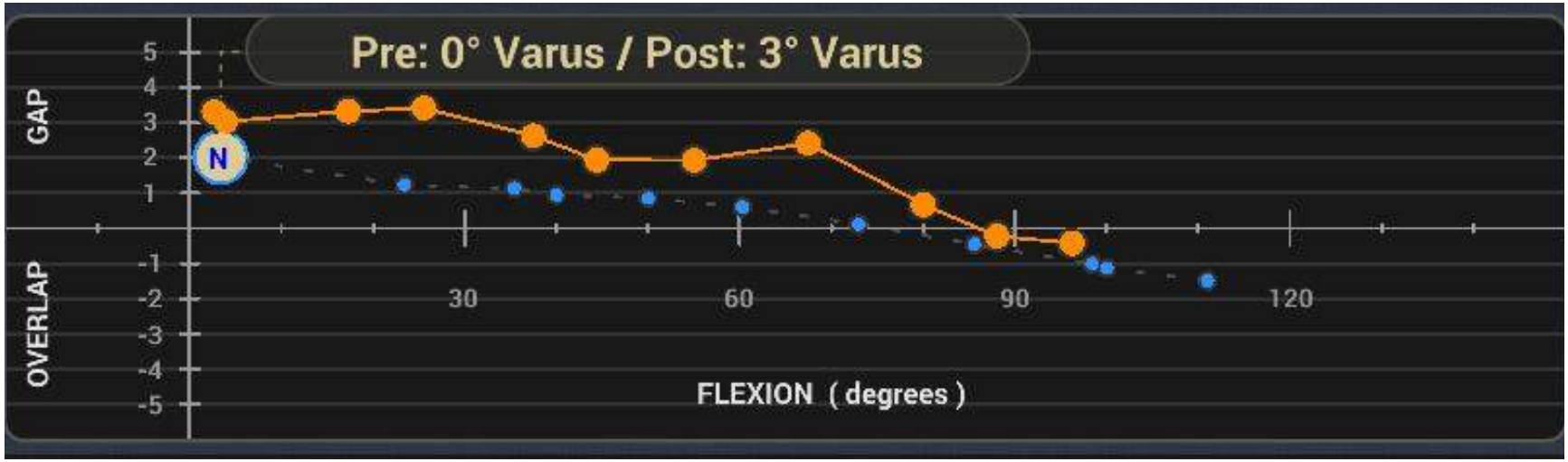


Asymmetric:
Loose extension

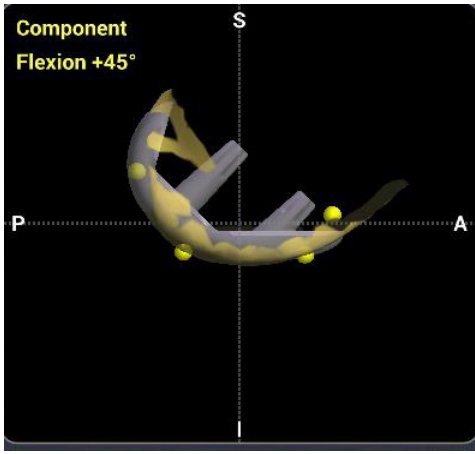
Asymmetric:
Normal flexion

Extension	Flexion
loose	Normal
Resect less distal femur with 4.5mm block	

Soft tissue balancing asymmetry



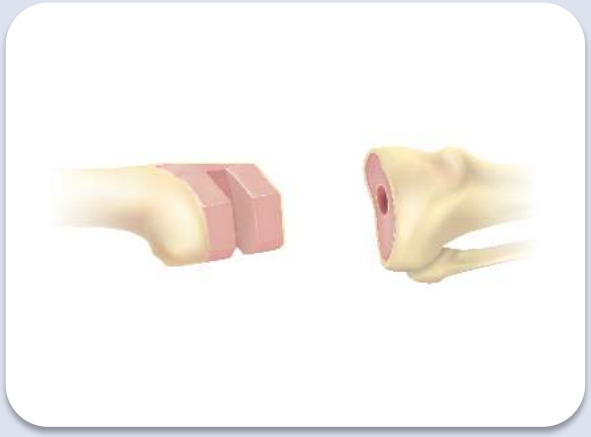
Extension	Flexion
Loose	Normal
Move femoral component inferiorly Or increase femoral component flexion	



Asymmetric pattern

Tight flexion and loose extension

Soft tissue balancing asymmetry

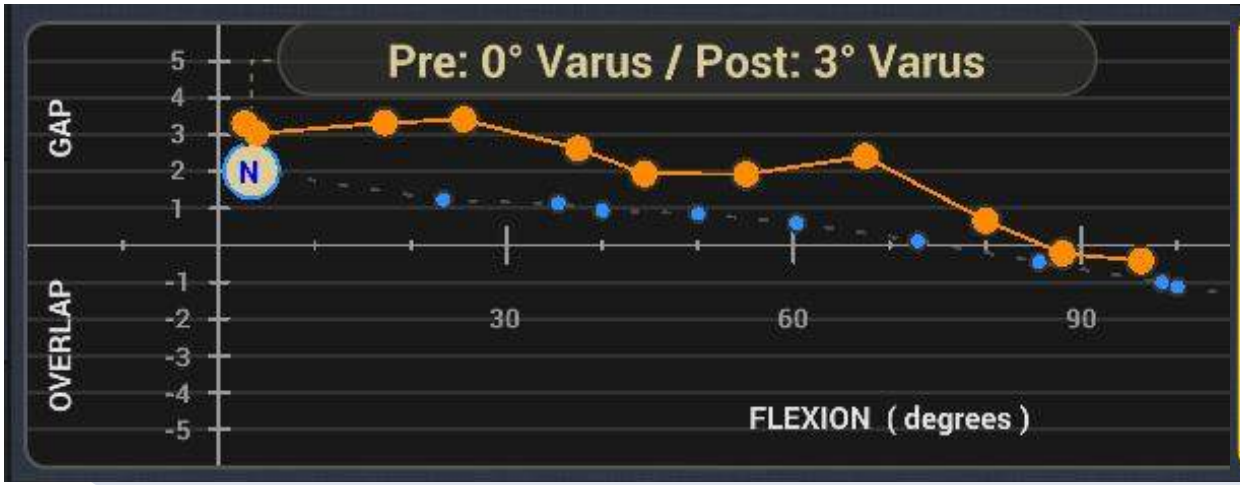


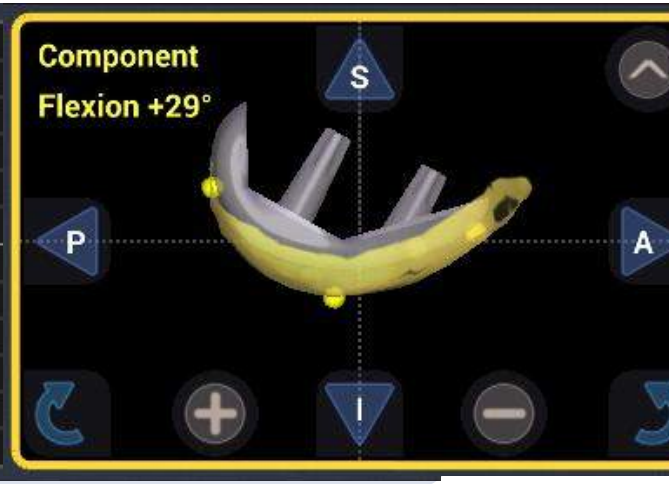
Asymmetric:
Loose extension

Asymmetric:
Tight flexion

Extension	Flexion
Loose	Tight
Resect less distal femur with 4.5mm block. Remove 1-2mm cartilage from posterior femur condyle. Assess tibia slope & consider increasing slope angle resection.	

Soft tissue balancing asymmetry

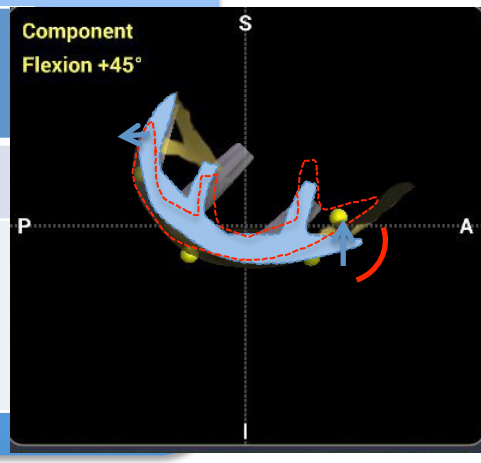




Asymmetric:
Loose extension

Asymmetric:
Tight flexion

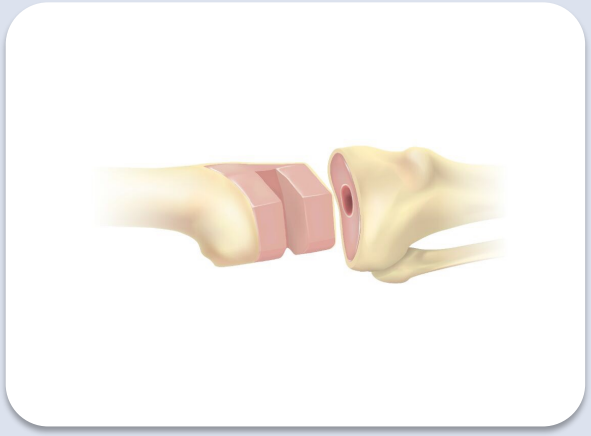
Extension	Flexion
Loose	Tight
Confirm femur rotation satisfactory:Increase femoral component flexion/ move inferiorly Or increase posterior tibia slope	



Asymmetric pattern

Normal flexion and tight extension

Soft tissue balancing asymmetry

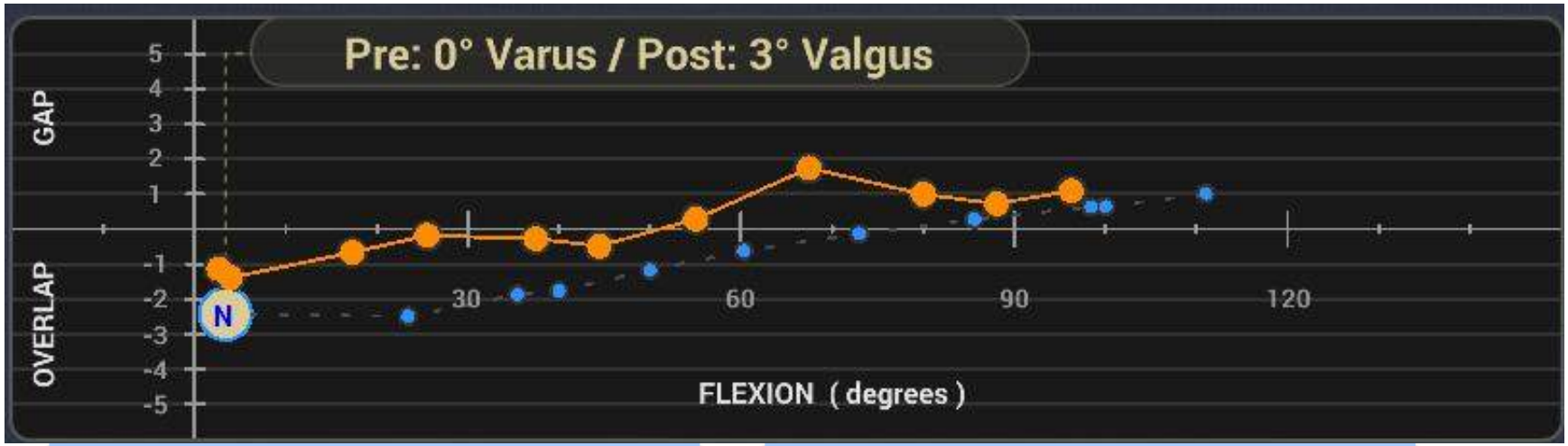


Asymmetric:
Tight extension

Asymmetric:
Normal flexion

Extension	Flexion
Tight	Good
Remove more distal femur cartilage (1-2mm) before femur resection	

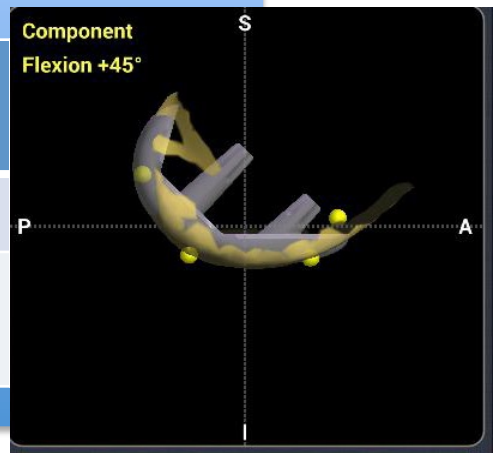
Soft tissue balancing asymmetry



Asymmetric:
Tight extension

Asymmetric:
Normal flexion

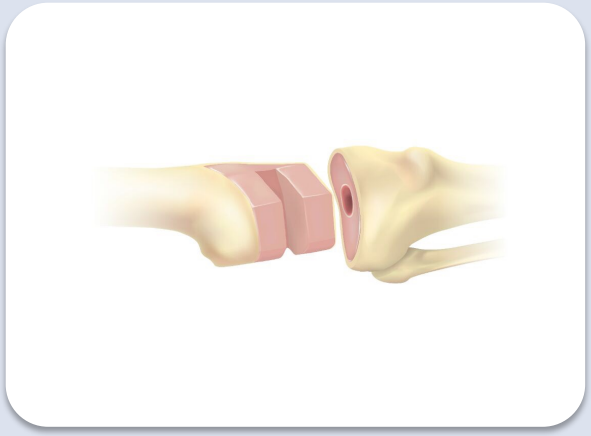
Extension	Flexion
Tight	Good
Move femur prosthesis superiorly Assess prosthesis flexion angle	



Asymmetric pattern

Tight extension and loose flexion

Soft tissue balancing asymmetry

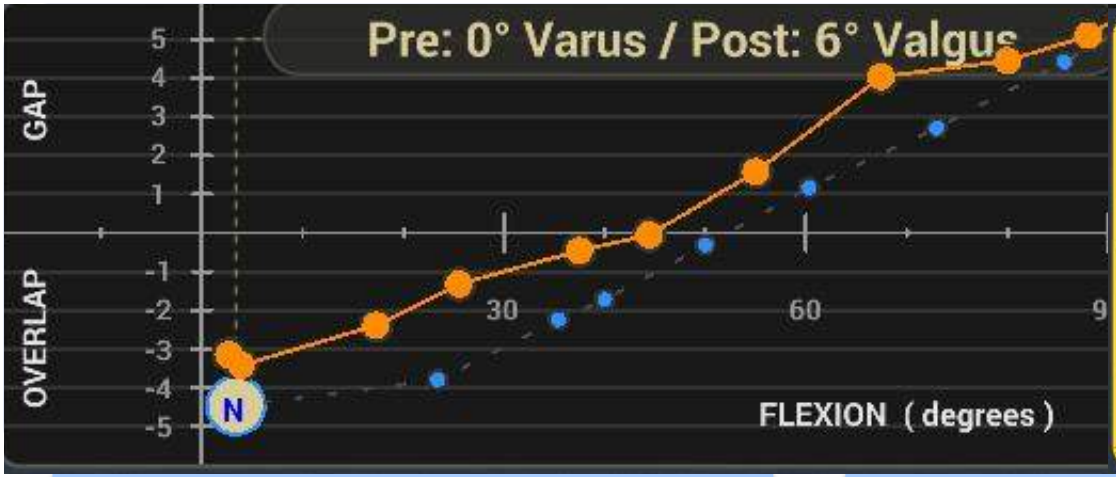


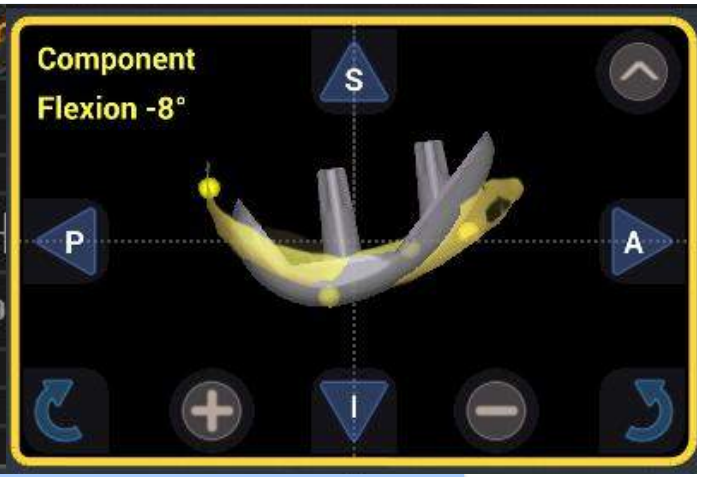
Asymmetric:
Extension tight

Asymmetric:
Flexion loose

Extension	Flexion
Tight	loose
Flexion gap may be 1-2mm looser in flexion than extension. If definitely looser in flexion then resect less posterior femur condyle by putting a spacer in between the posterior paddle of the 2-in-1 cutting block.	

Soft tissue balancing asymmetry



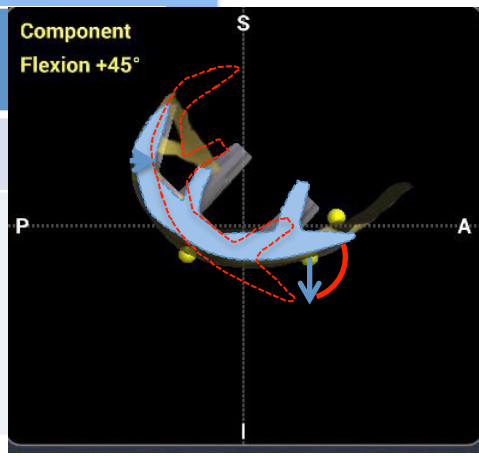


Asymmetric:
Extension tight

Asymmetric:
Flexion loose

Extension	Flexion
Tight	Loose

Move femoral component posterior and/or inferiorly
And/or reduce femoral component flexion



Summary

- Robotic assisted UKA allows intraoperative soft tissue assessment and appropriate balancing throughout knee ROM
- Real time, intraoperative patient specific anatomical template is created
- Implant position and sizing is template on the native patients anatomy
- Gap balance is assessed before bone resection
- After resection outcome confirmation of the soft tissue balance
- A stepwise, systematic approach to balancing the soft tissue envelop will aid the surgeons planning using this technology

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