

# KAFO

Product Standards

HFN

# PURPOSE

## Hanger Fabrication Product Standards

The Hanger Fabrication Product Standards are a collaborative effort to deliver Best in Class O&P devices to our patients.

The goals of the product standards are to:

- 1) **ALIGN** expectations between clinicians and technicians
- 2) **CONTROL** input and output variations and
- 3) **REFERENCE** best in class blueprints and orthomerty sheets to fabricate products that translate into maximizing clinical outcomes for Hanger patients
- 4) **SUPPORT** future system integration (MRP)
- 5) **REINFORCE** clinical research outcome reliability through controlling design variation

**Endorsements:** Mary-Kate Ennis, MBA, CO | Aaron Flores, PhD  
Jim Campbell, PhD | Phil Stevens, CPO | Erin O'Brien, CPO | Tim Fair, CPO  
Tom DiBello, L/CO, FAAOP | Chris Toelle, CO | Eric Weber, CPO

**Acknowledgment:** We would like to extend our appreciation to the many clinicians and technicians across Hanger who collaborated on the Hanger Product Standards development.

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## OVERVIEW

Anatomy and terminology  
Planes of motion  
Leg anatomy (lateral)  
Foot anatomy  
Leg anatomy (anterior)  
Mechanical joint locations  
Foot positions and heel modification  
AFO tuning  
Measurement terms  
Glossary

## FUNDAMENTALS

Cast assessment  
Footplate lengths | Strap placements  
Toeplate modifications  
Foot trim lines  
Midfoot trim lines  
Trimline profiles  
Standard plantar surface modifications

## DESIGNS

KAFO  
KAFO metal and leather  
C-Brace  
Agilik  
HiTronic (coming soon)  
Tectus (coming soon)

## VARIATIONS

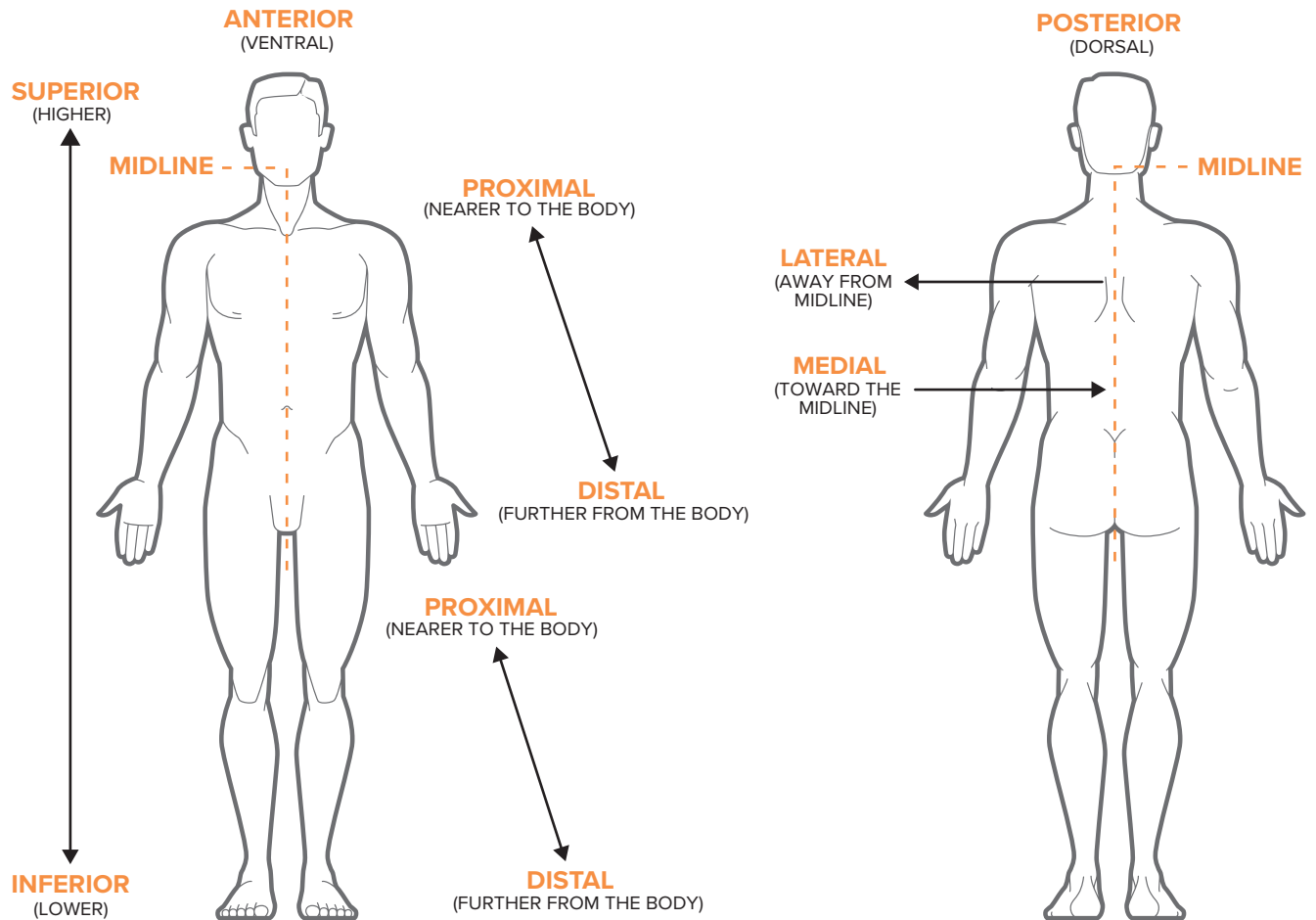
KAFO metal and leather variations  
Varus/valgus prevention modification  
ST modification  
Anterior removable shell  
Dorsal wrap  
Inner boot-combo  
PTB – Removable pre-tibial shell



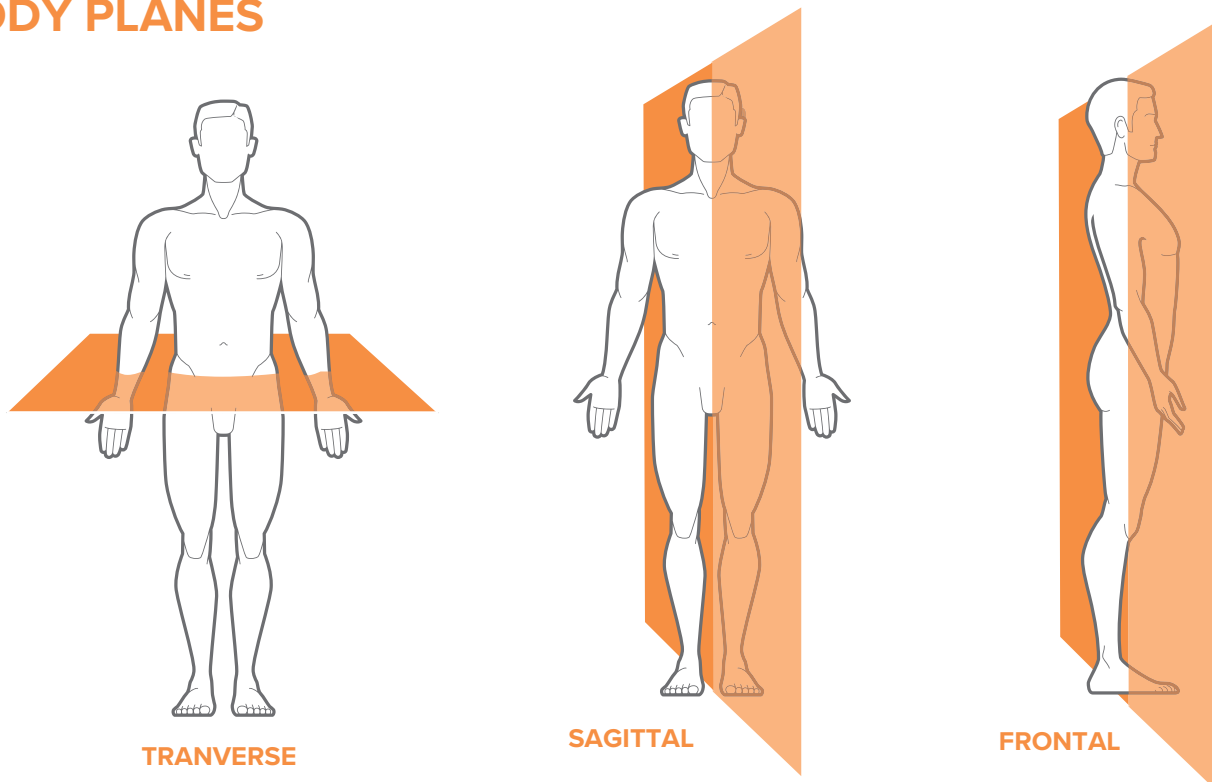
# OVERVIEW

- Anatomy and terminology
- Planes of motion
- Leg anatomy (lateral)
- Foot anatomy
- Leg anatomy (anterior)
- Mechanical joint locations
- Foot positions and heel modification
- AFO tuning
- Measurement terms
- Glossary

# ANATOMY AND TERMINOLOGY



## BODY PLANES

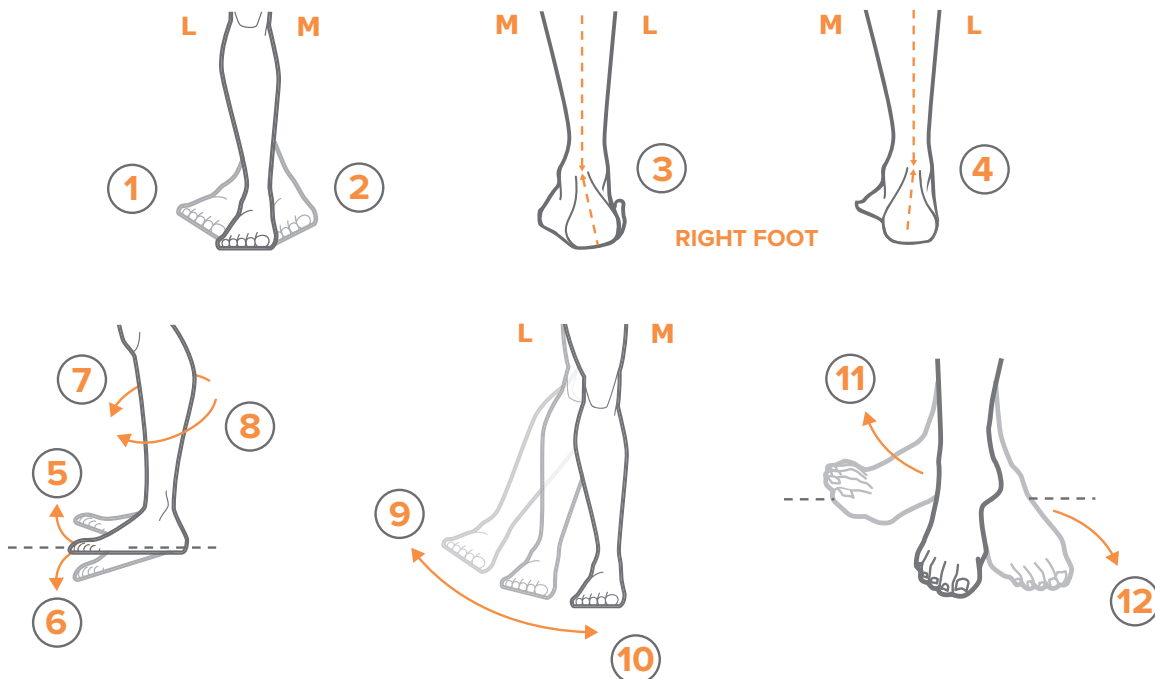


# PLANES OF MOTION

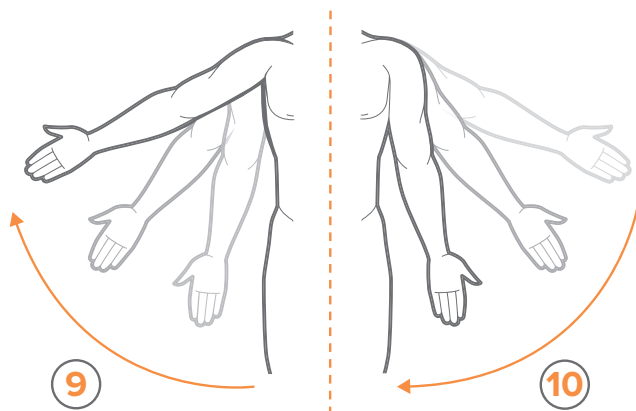
## DEFINITIONS

- 1 Eversion – the outward turning or rotation of a body part, typically the foot.
- 2 Inversion – the movement of the foot where the sole turns inward, towards the midline of the body.
- 3 Valgus – a bone in which the distal segment of a bone is angled outward toward the midline of the body.
- 4 Varus – a bone in which the distal segment of a bone is angled inward toward the midline of the body.
- 5 Dorsi flexion – movement of the foot where the toes point upward towards the shin.
- 6 Plantar flexion – movement of the foot that involves pointing the toes downwards.
- 7 External Rotation – movement where a limb or body part turns away from the midline of the body.
- 8 Internal Rotation – movement where a limb or body part rotates inward towards the midline of the body.
- 9 Abduction – movement of a limb or body part away from the midline of the body.
- 10 Adduction – movement of a limb or other part toward the midline of the body or toward another part.
- 11 Pronation (1,5,9) – the inward rolling motion of the foot, causing the sole to face inward.
- 12 Supination (2,6,10) – the opposite movement, where the sole rotates to face outward.
- 13 Prone – lying face down with the chest and abdomen facing downwards.
- 14 Supine – lying on the back with face and torso facing upward.

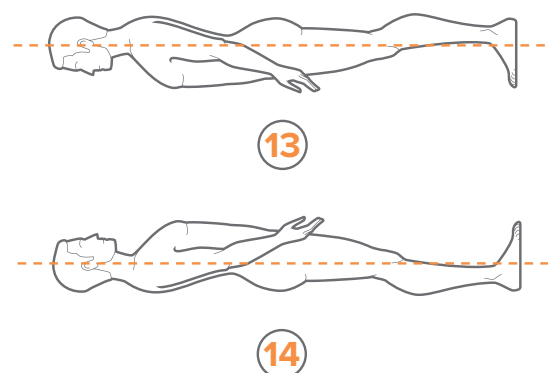
## LOWER EXTERMITY



## UPPER EXTERMITY

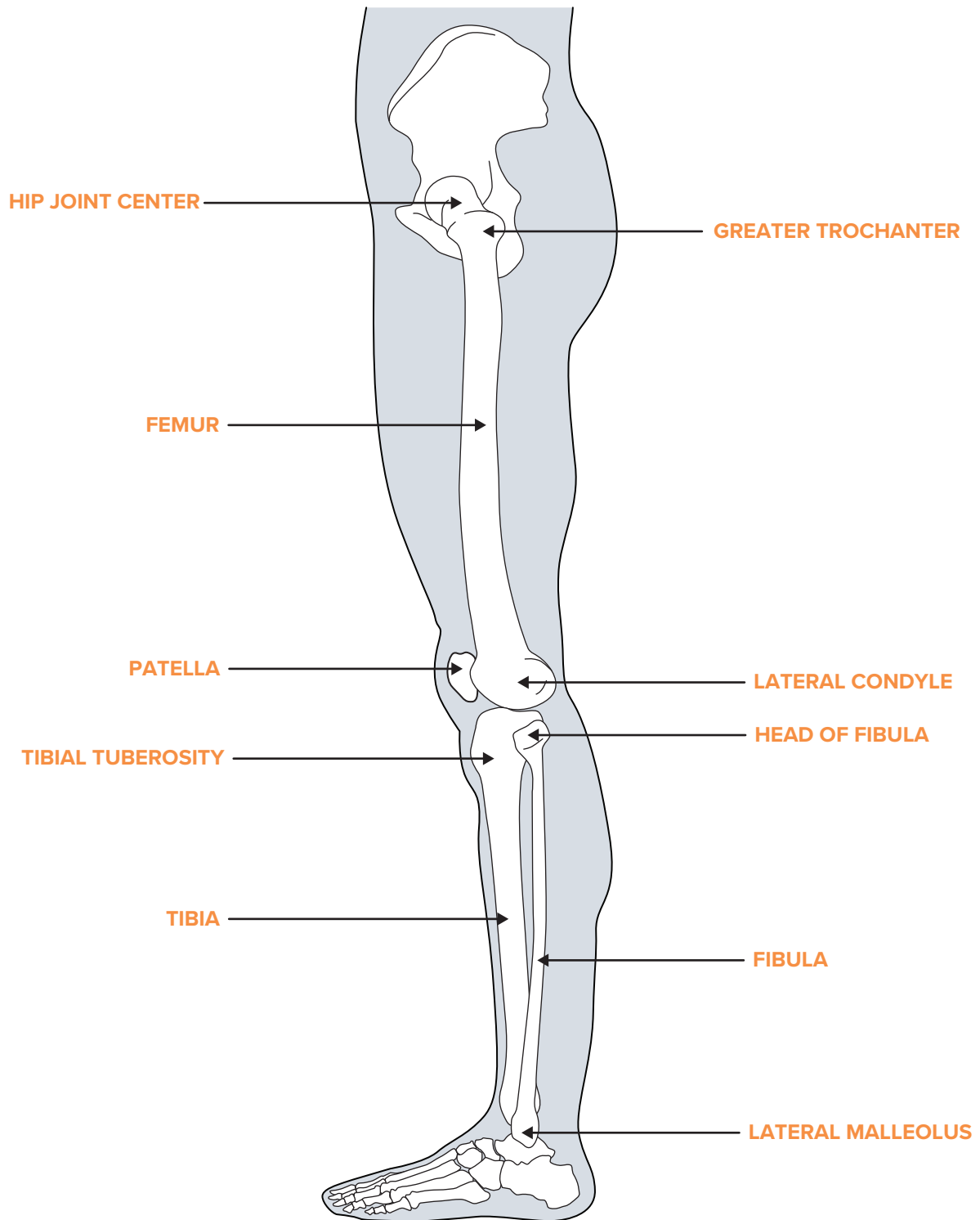


## ENTIRE BODY



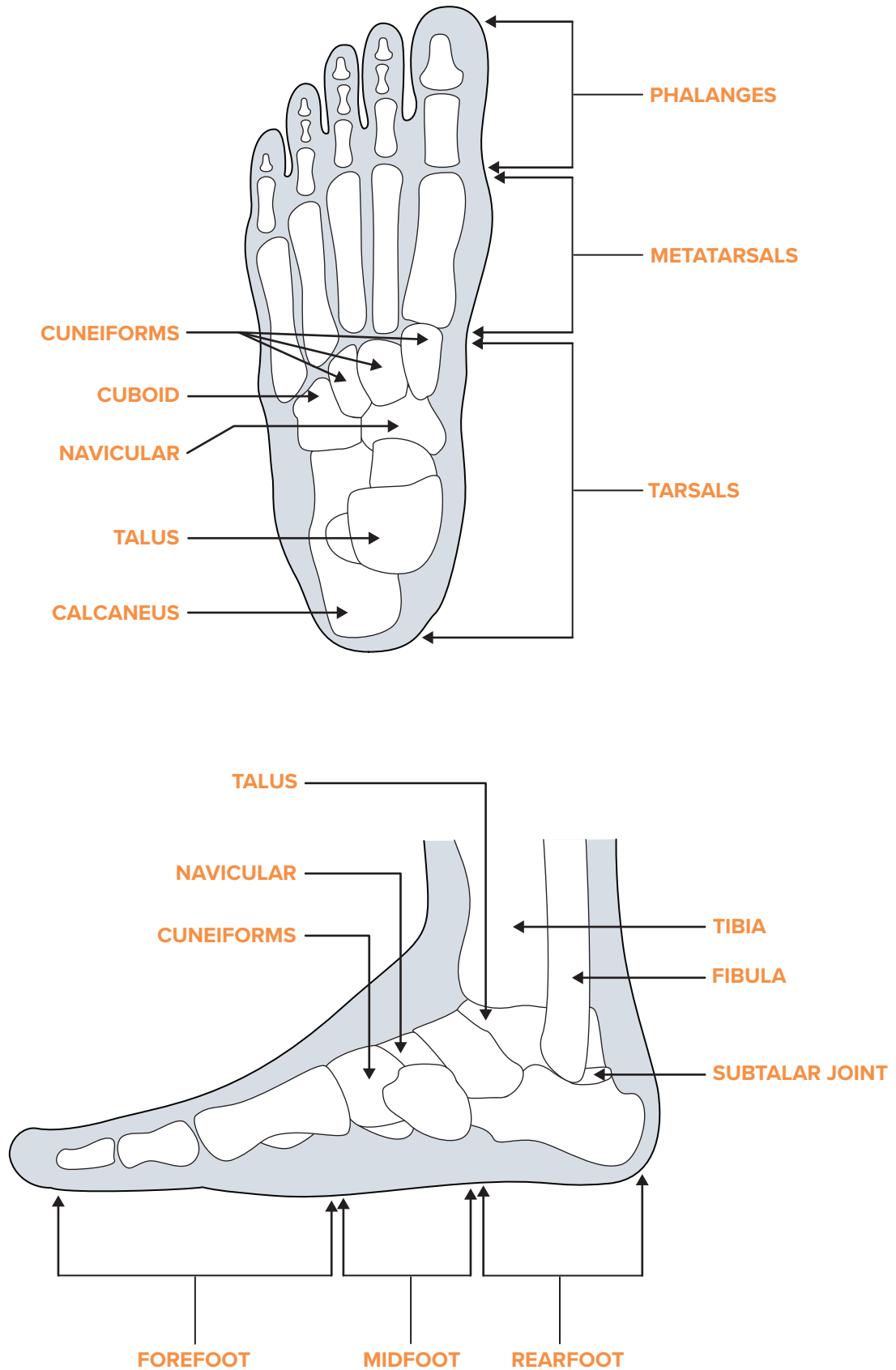
# LEG ANATOMY

## Lateral View



# FOOT ANATOMY

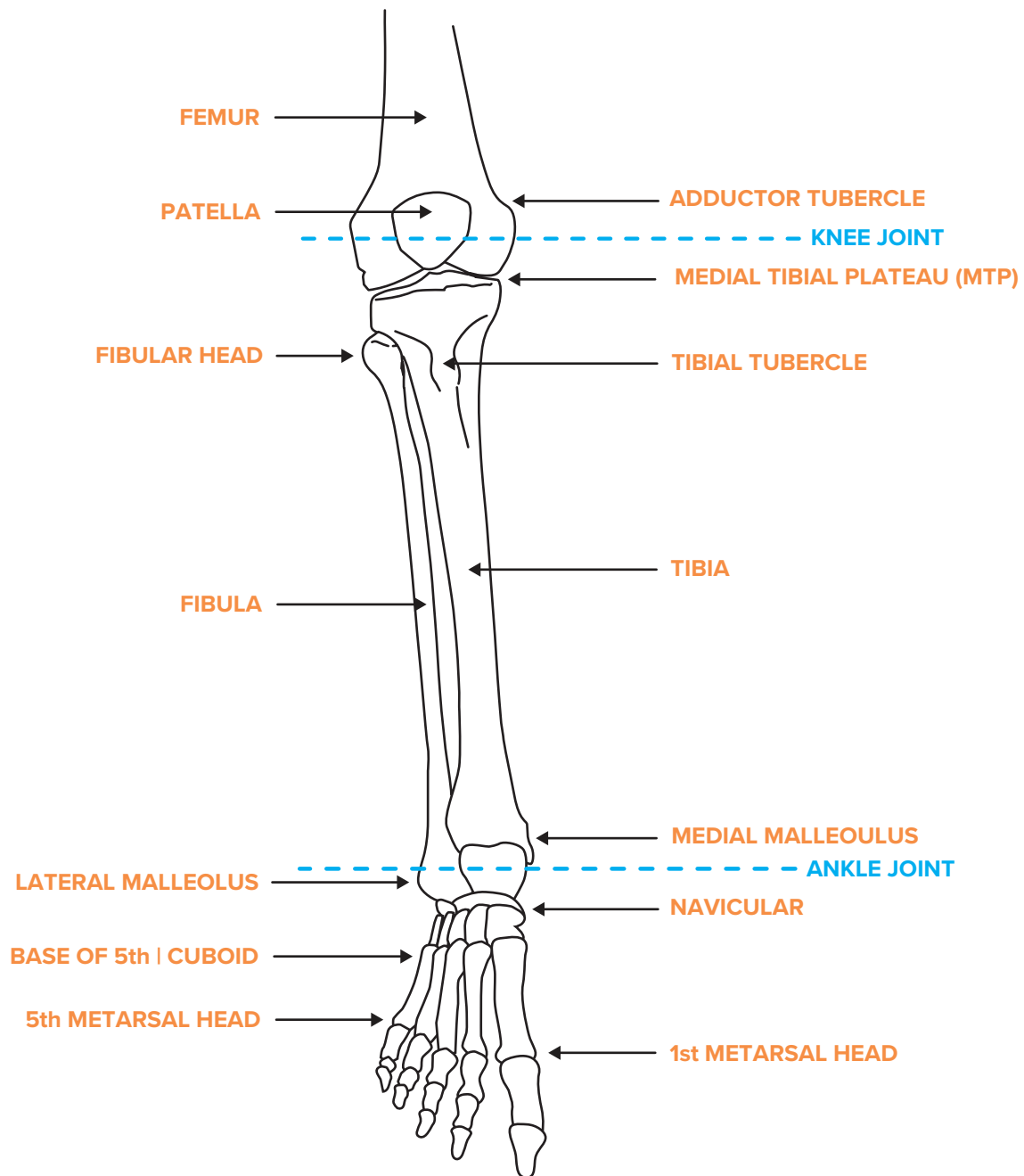
## Top and Lateral Views





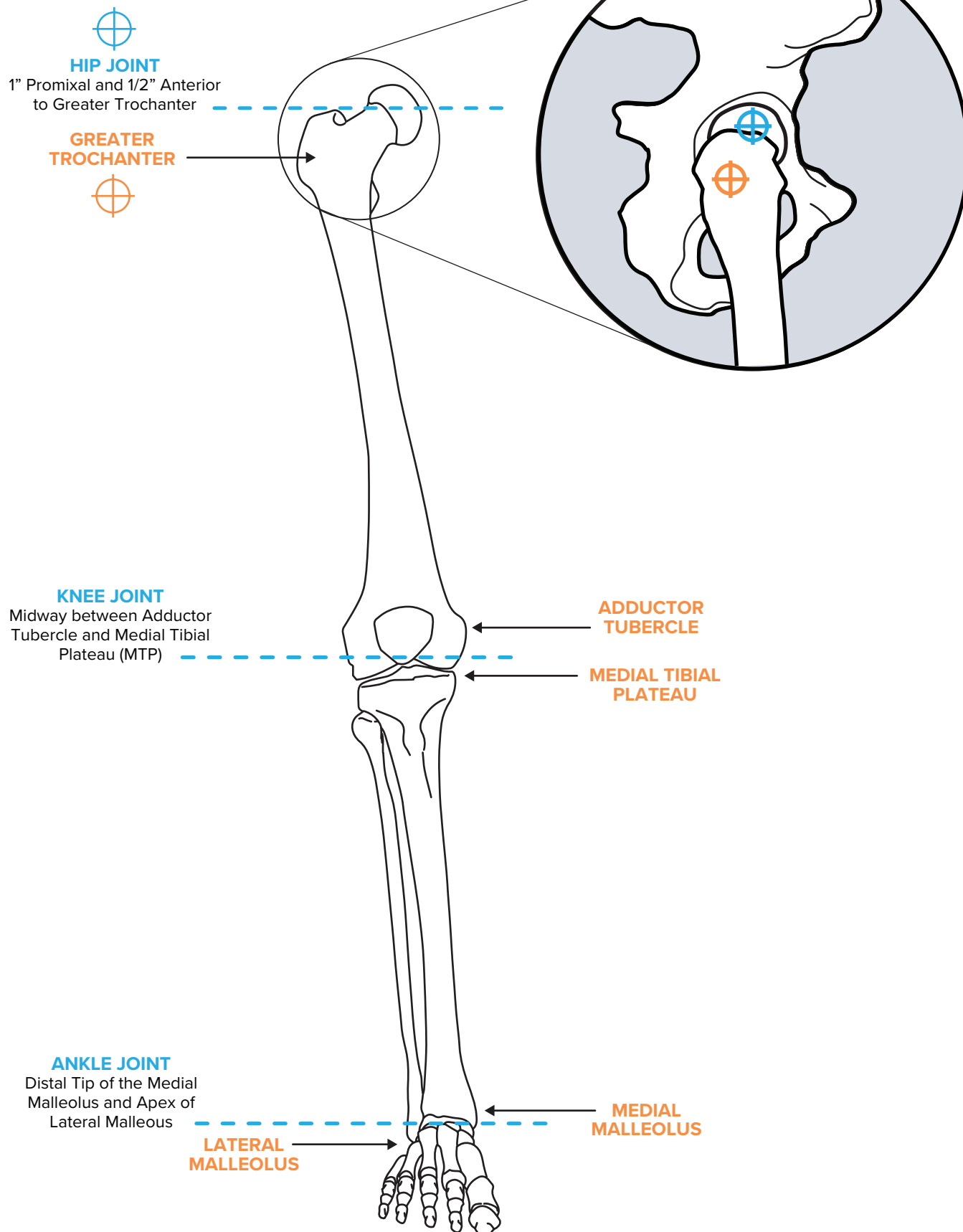
# LEG ANATOMY

## Anterior View | Right Leg

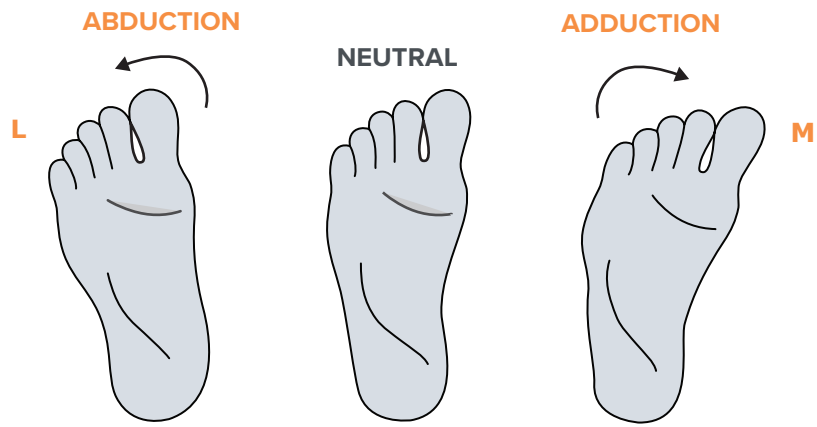


# MECHANICAL JOINT LOCATIONS

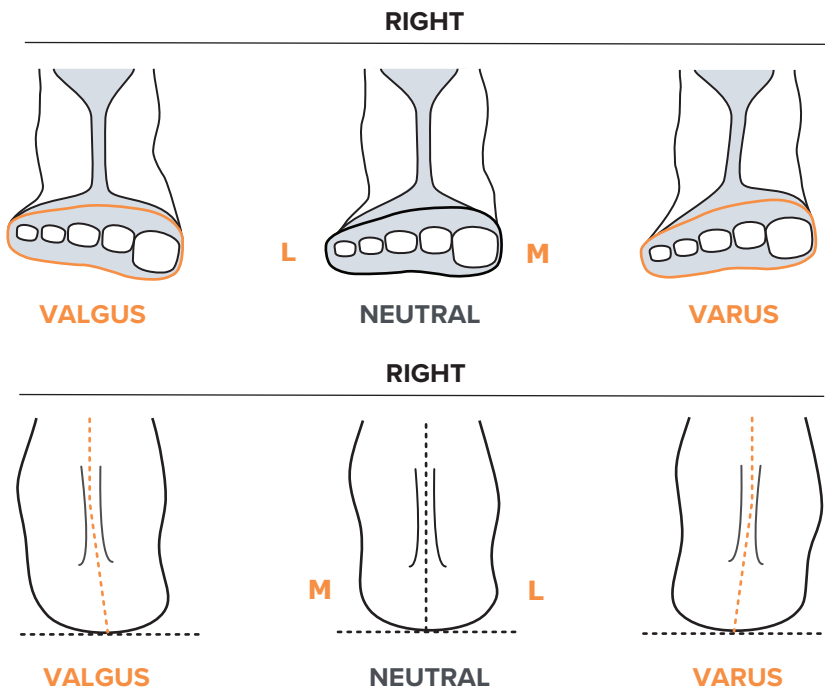
Lower Extremity | Anterior | Right Leg



# FOOT POSITIONS AND HEEL MODIFICATION

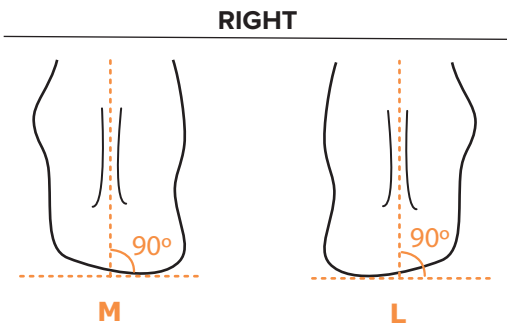


## FOREFOOT/HINDFOOT POSITIONS



## INTRINSIC HEEL MODIFICATION

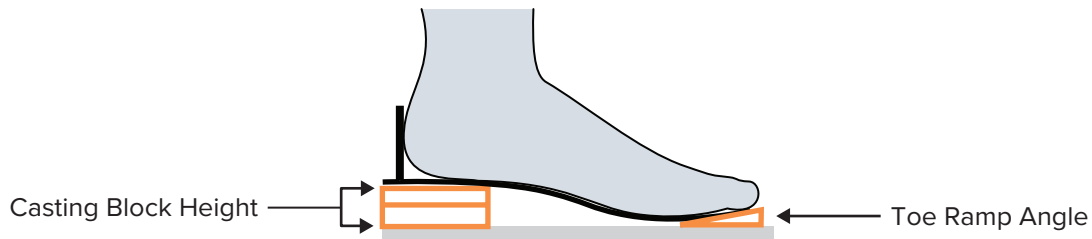
(Will be posted externally)



## AFO TUNING

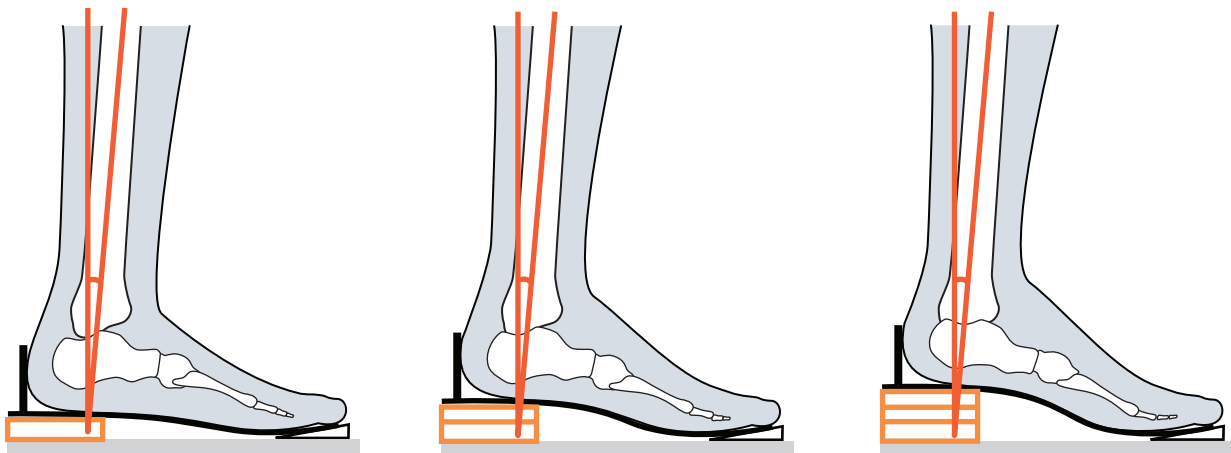
**Best Practice:** Please use a casting block to capture the desired finished AFO position for your patient. Using a casting board helps our design and technical teams process your project with improved accuracy and efficiency.

### HEEL HEIGHT/ CASTING BLOCK ACCOMMODATION



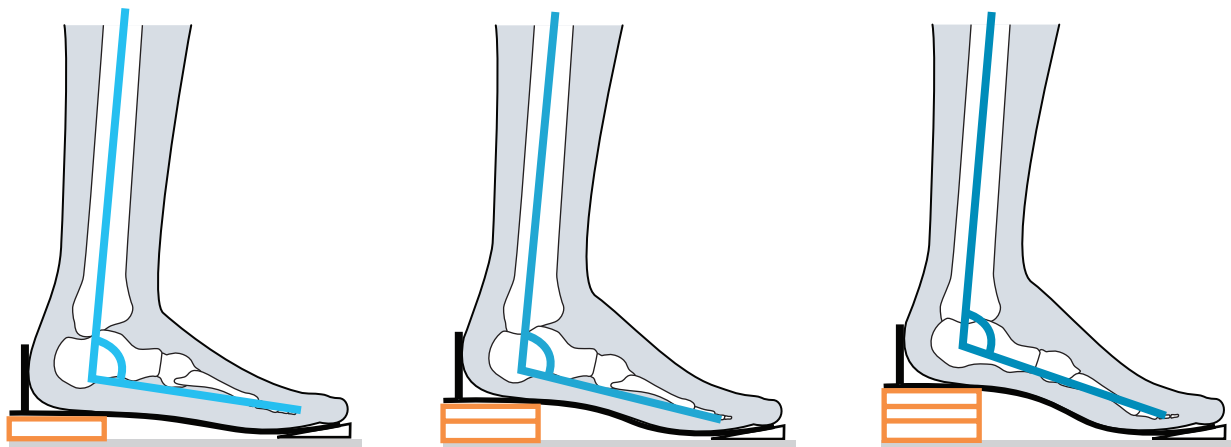
### SHANK VERTICAL ANGLE (SVA) TIBIAL INCLINATION ANGLE (TIA)

SVA is the angle between a vertical line and the midline of the shank.  
In the drawing below, all the SVAs are equal, but the ankle angle is different.

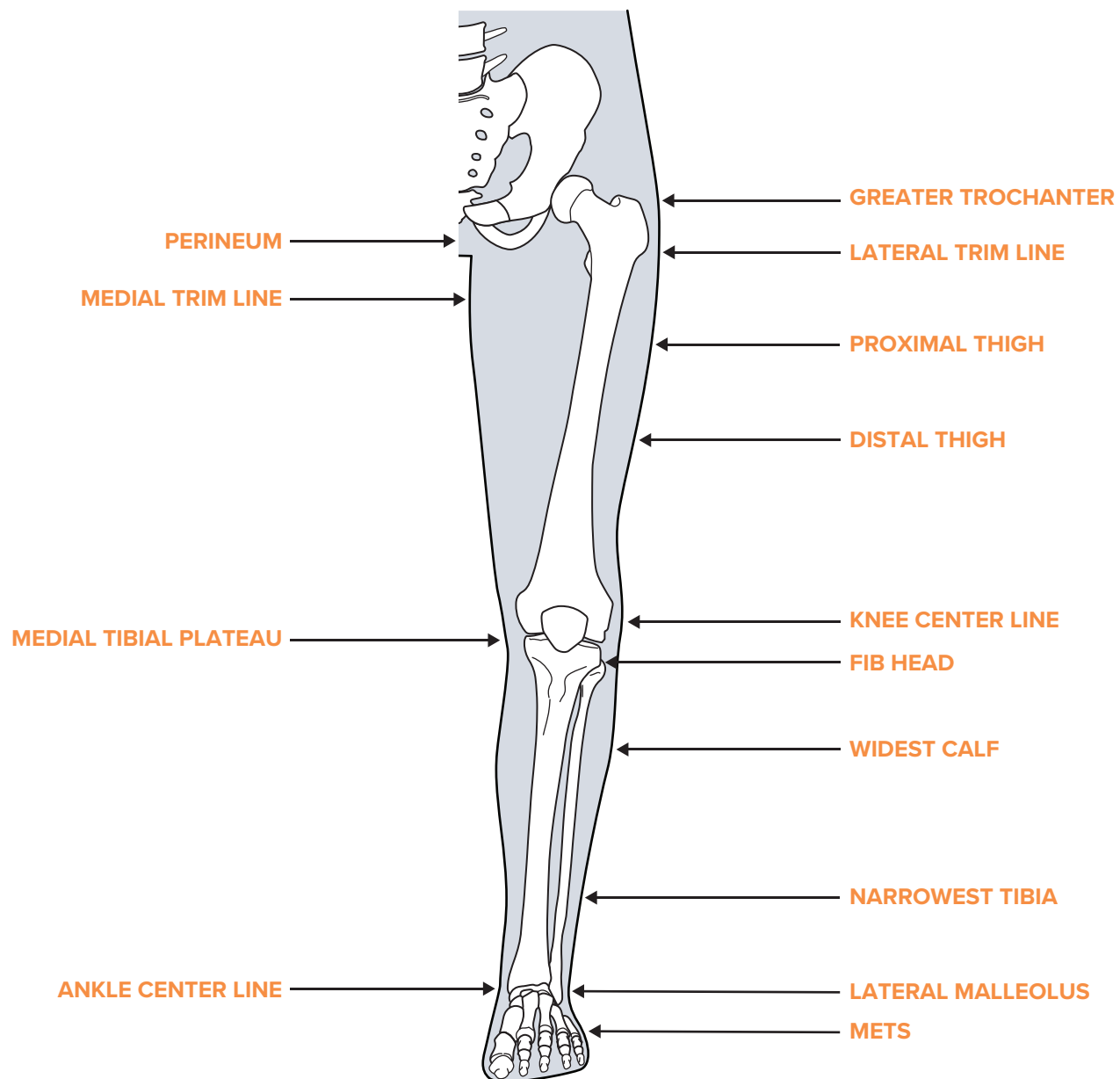


### ANKLE ANGLE

Measured midline of shank, through lateral malleolus, and along a line parallel to the 5th metatarsal shaft



# MEASUREMENT TERMS





# GLOSSARY

## General O&P and Orthotic Terms

### GENERAL O&P TERMS

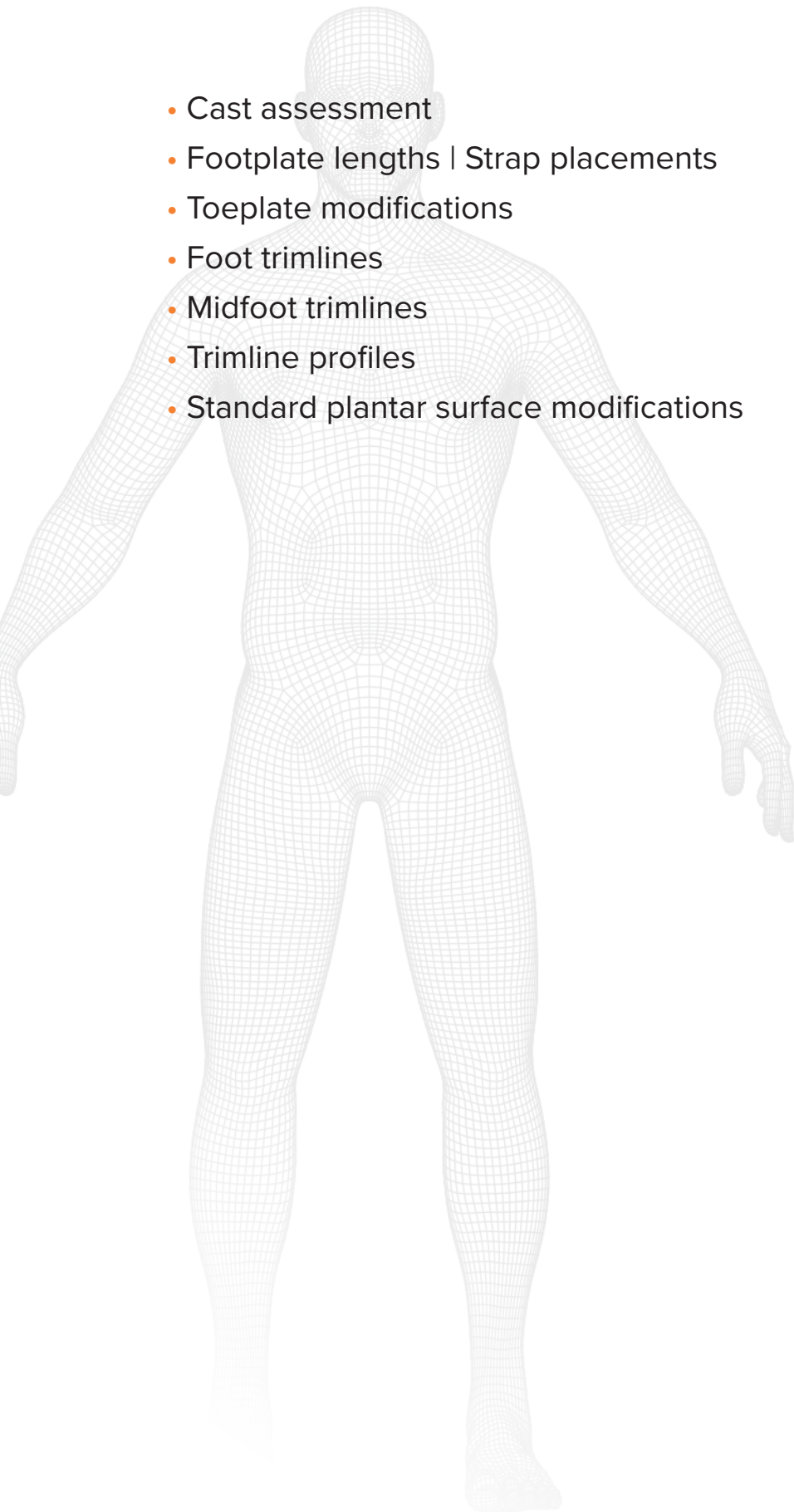
<b>Orthosis (Orthoses)</b>	Device used to stabilize or immobilize a body part, prevent deformity, protect against injury, or assist with function.
<b>Prosthesis (Protheses)</b>	Device that is designed to replace, as much as possible, the function or appearance of a missing limb or body part
<b>Custom Fabricated</b>	Made for a specific patient by using a positive mold, measurements, &/or scan
<b>Custom Fitted</b>	Pre-fabricated item that requires some adjustment, alteration, or assembly during the fitting process
<b>Critical To Quality (CTQ)</b>	Pertains to inputs that are critical for creating an optimum device
<b>Fracture (FX)</b>	A break in the continuity of the bone
<b>History (HX)</b>	Refers to the pertinent medical history of the patient
<b>Left-L</b>	Left side of patient
<b>Right-R</b>	Right side of patient
<b>Multidurometer</b>	Composed of two or more materials with sectional areas of differing shore hardness
<b>Pre-Fabricated</b>	Device that has been manufactured from standard molds or patterns
<b>Physical Therapy (PT)</b>	Rehabilitations therapy for medical problems or injuries
<b>Range Of Motion (ROM)</b>	The amount of movement you have at each joint
<b>Passive Range Of Motion (PROM)</b>	Movement of a segment within the ROM that is produced entirely by an external force
<b>Active Range Of Motion (AROM)</b>	Movement of a segment with the ROM that is produced by active contraction of the muscles crossing that joint
<b>Prescription (RX)</b>	Orders given by a medical provider for specific services or devices
<b>Semi-Rigid</b>	Partially rigid, having some rigid elements
<b>Single Axis</b>	Having only one axis of rotation
<b>Thermoplastic</b>	Able to be remolded with the application of heat
<b>Ultra-Light Material</b>	Materials such as titanium, carbon fiber, or equal
<b>Unilateral</b>	Being of, or pertaining to, one side of the patient's body
<b>Bi-Lateral</b>	Pertaining to both sides of the patient's body

### ORTHOTIC TERMS

<b>Lower Extremity (LE)</b>	Pertains to the legs
<b>Upper Extremity (UE)</b>	Pertains to the arms
<b>Ankle Foot Orthosis (AFO)</b>	Orthosis that crosses the ankle & foot
<b>Knee Ankle Foot Orthosis (KAFO)</b>	Orthosis that crosses foot, ankle & knee
<b>Micro Processor KAFO (MPKAFO)</b>	Advanced medical brace for the leg that uses computer-controlled sensors & joints
<b>Shank Vertical Angle (SVA)</b>	The angle of the midline of the calf at quiet standing or at midstance when compared to a vertical line
<b>UCBL</b>	University of California Berkeley Laboratories – foot orthosis, controls valgus/varus
<b>SMO</b>	Supramalleolar orthosis that extends just above the medial & lateral malleoli & underneath the foot
<b>PLS</b>	Posterior leaf spring, flexible AFO
<b>PTB</b>	Patellar tendon bearing, offloads lower extremity

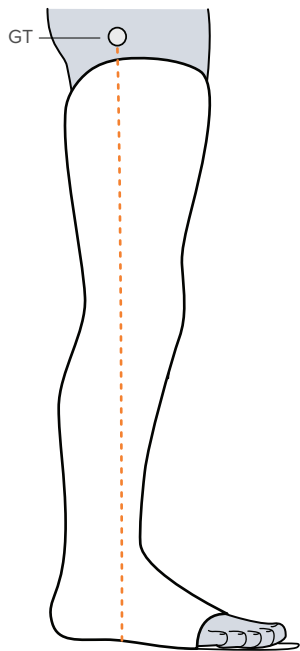
# FUNDAMENTALS

- Cast assessment
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- Foot trimlines
- Midfoot trimlines
- Trimline profiles
- Standard plantar surface modifications

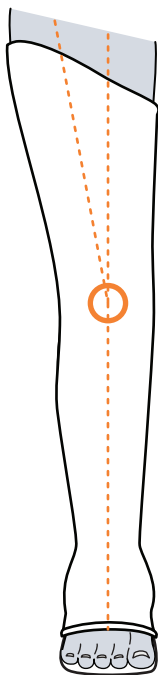


# CAST ASSESSMENT

## NEUTRAL

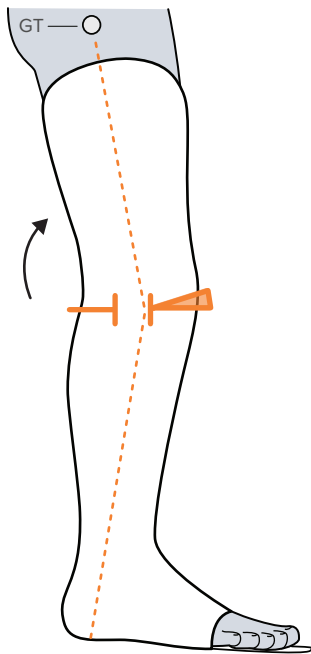


LATERAL- RIGHT

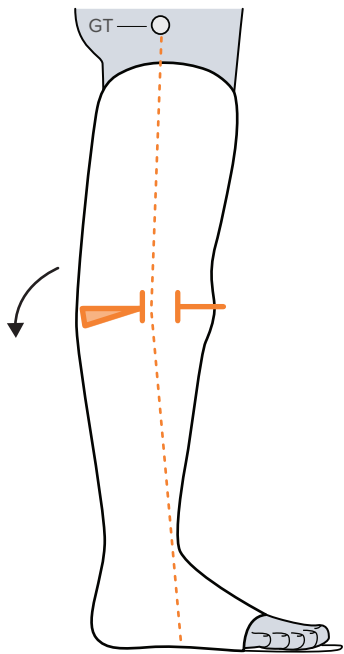


ANTERIOR  
FEMUR-TIBIA ANGLE 10°

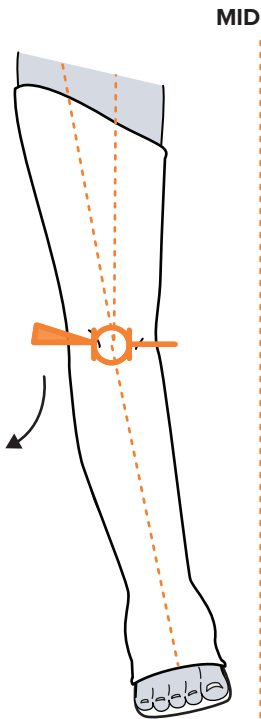
## CAST CORRECTION



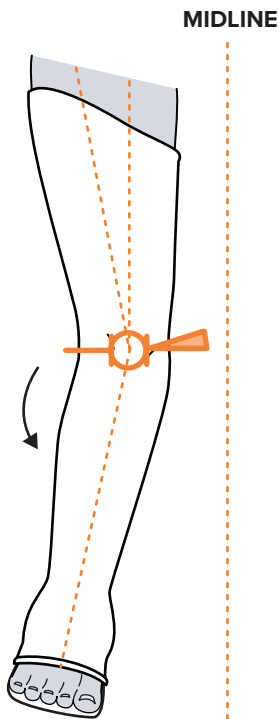
EXCESSIVE FLEXION



HYPEREXTENSION  
RECURVATUM

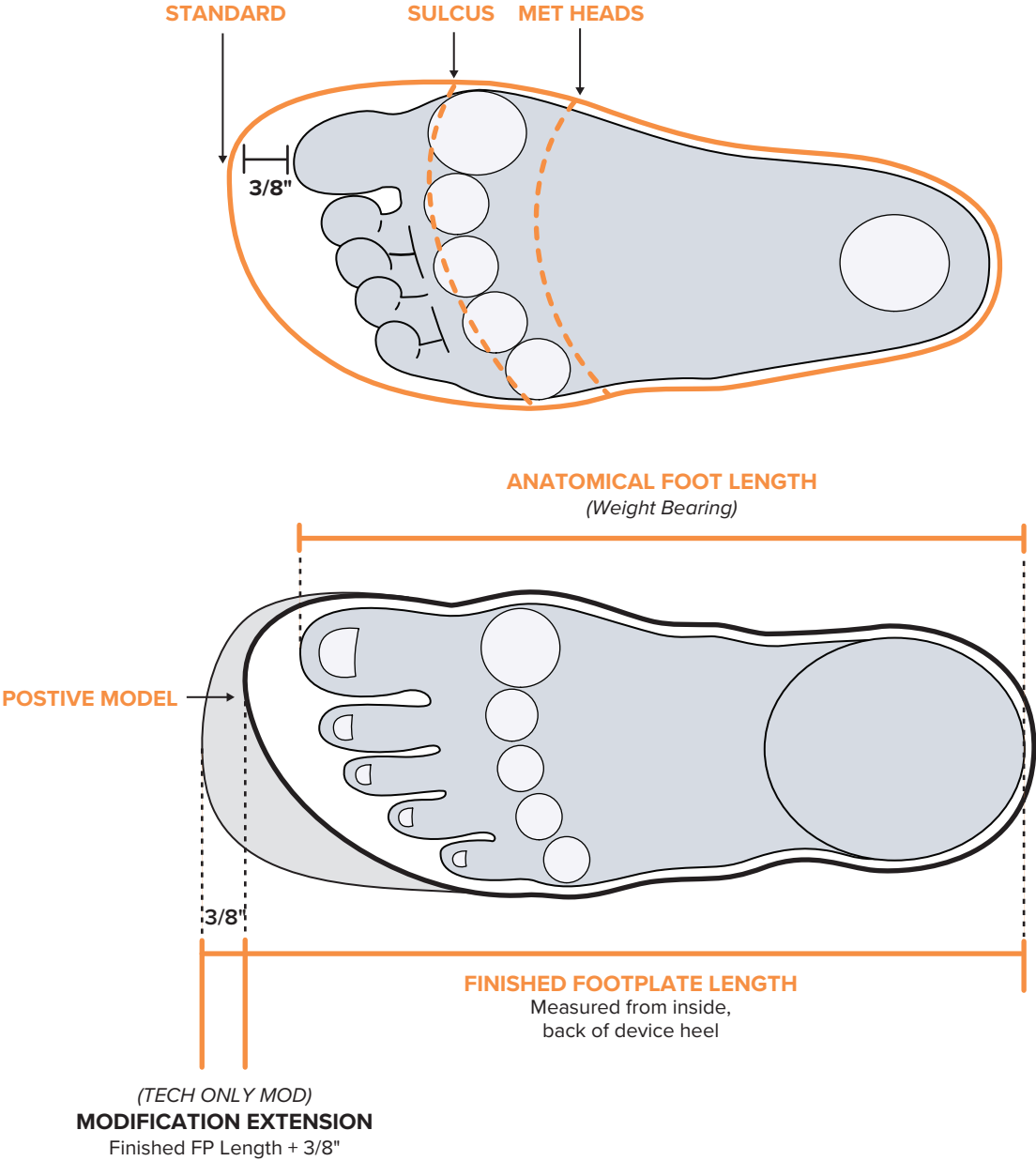


VARUM  
CORRECTION  
FEMUR-TIBIA ANGLE -10°

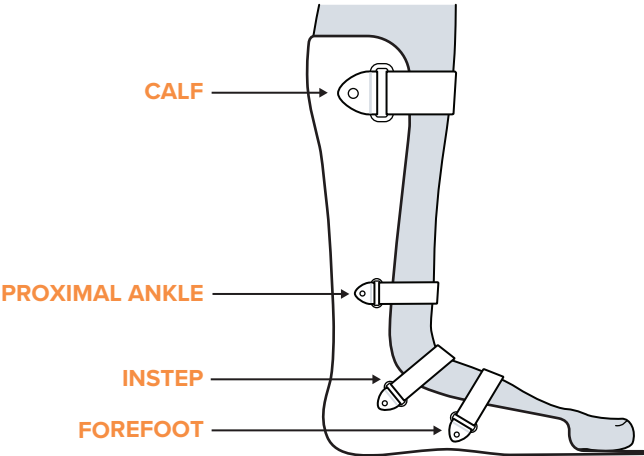


VALGUM  
CORRECTION  
FEMUR-TIBIA ANGLE +10°

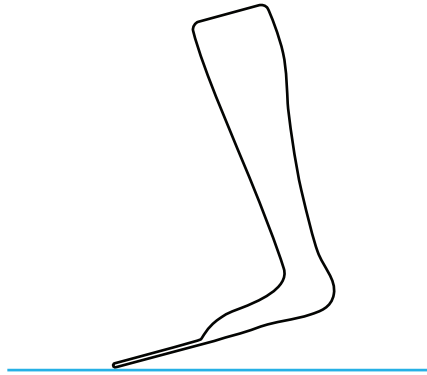
# FOOTPLATE LENGTHS



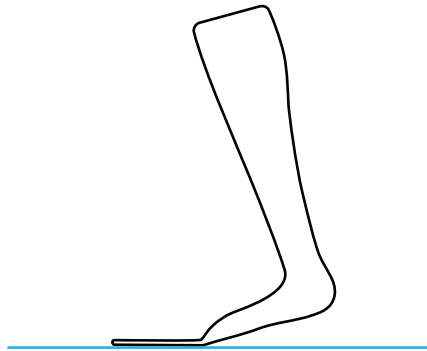
# STRAP PLACEMENT



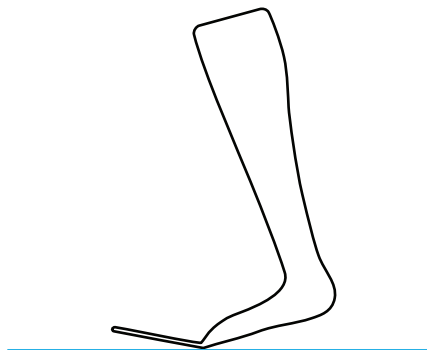
# TOEPLATE MODIFICATIONS



TOEPLATE STRAIGHT



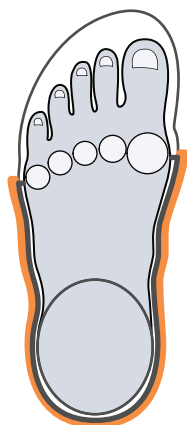
TOEPLATE FLEXED TO FLOOR



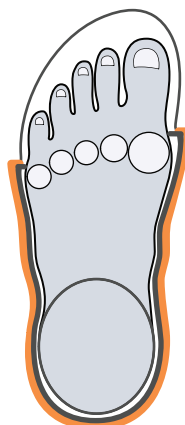
TOEPLATE RAMPED TO ANGLE



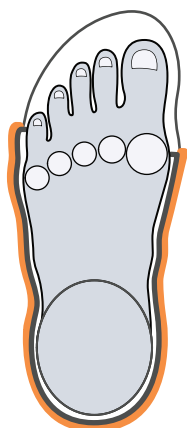
# FOOT TRIMLINES



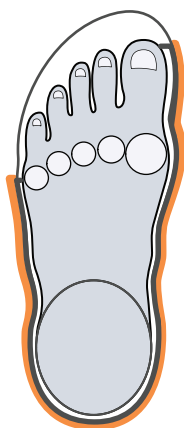
**STANDARD FOREFOOT**  
ie: METS



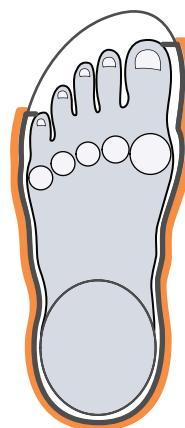
**CONTAINED FOREFOOT**



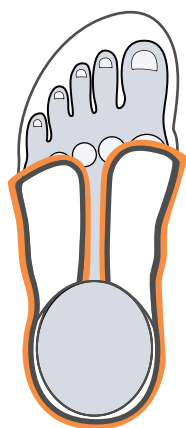
**EXTENDED LATERAL**  
ie: Abduction/Valgus Control  
ie: Pronation Control



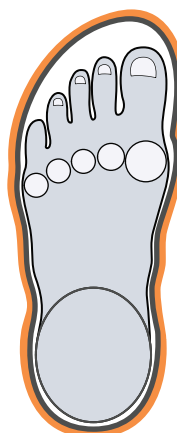
**EXTENDED MEDIAL**  
ie: Adduction/Varus Control  
ie: Supination Control



**EXTENDED BILATERAL**  
ie: Floor Reaction

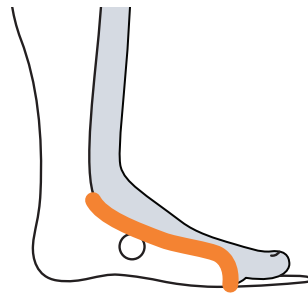


**DORSAL WRAP**

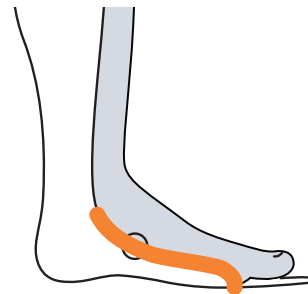


**SOLID**

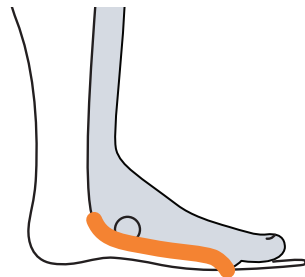
# MIDFOOT TRIMLINES



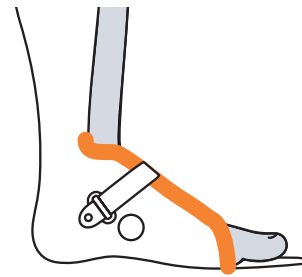
**STANDARD**  
(superior to navicular)



**MIDDLE**  
(bisect navicular)



**MINIMAL**  
(inferior to navicular)

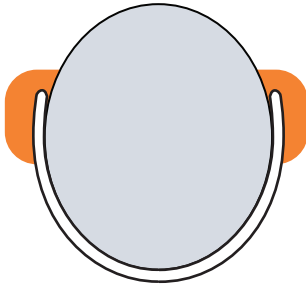


**DORSAL WRAP**  
(plastic dorsal extensions)

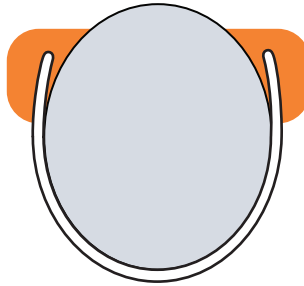
# TRIMLINE PROFILES

- **Anatomical** – No deflection; trim contours the anatomical shape captured in cast/scan
- **Standard** – Trim contours the anatomical shape captured in cast/scan with full anterior trough at the malleoli on
- **Easy On/Off** – Trim deflects away from anatomical shape captured in cast/scan 20% with full anterior trough at the malleoli only
- **Full/Gutter** – Trim deflects away tangentially from the anatomical shape captured in cast/scan along the specified location

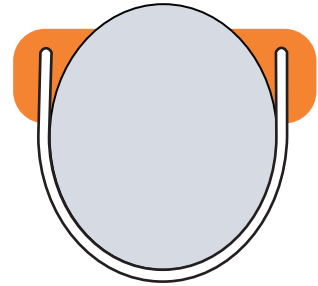
## ANTERIOR | TOP DOWN VIEW OF CALF



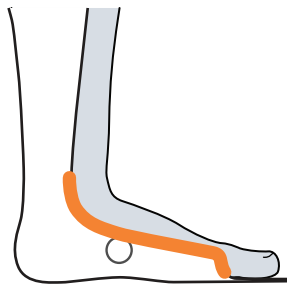
**STANDARD**



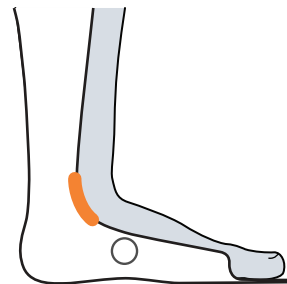
**EASY ON/OFF**



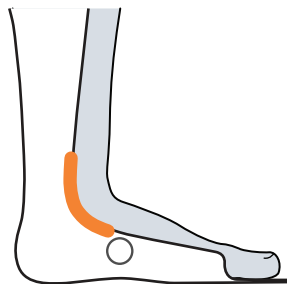
**FULL GUTTER**



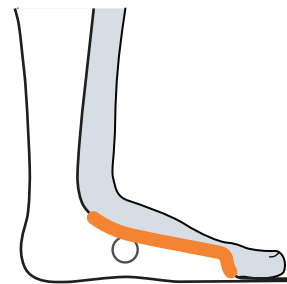
**FULL**  
tibia to toes



**LEG ONLY**  
tibial



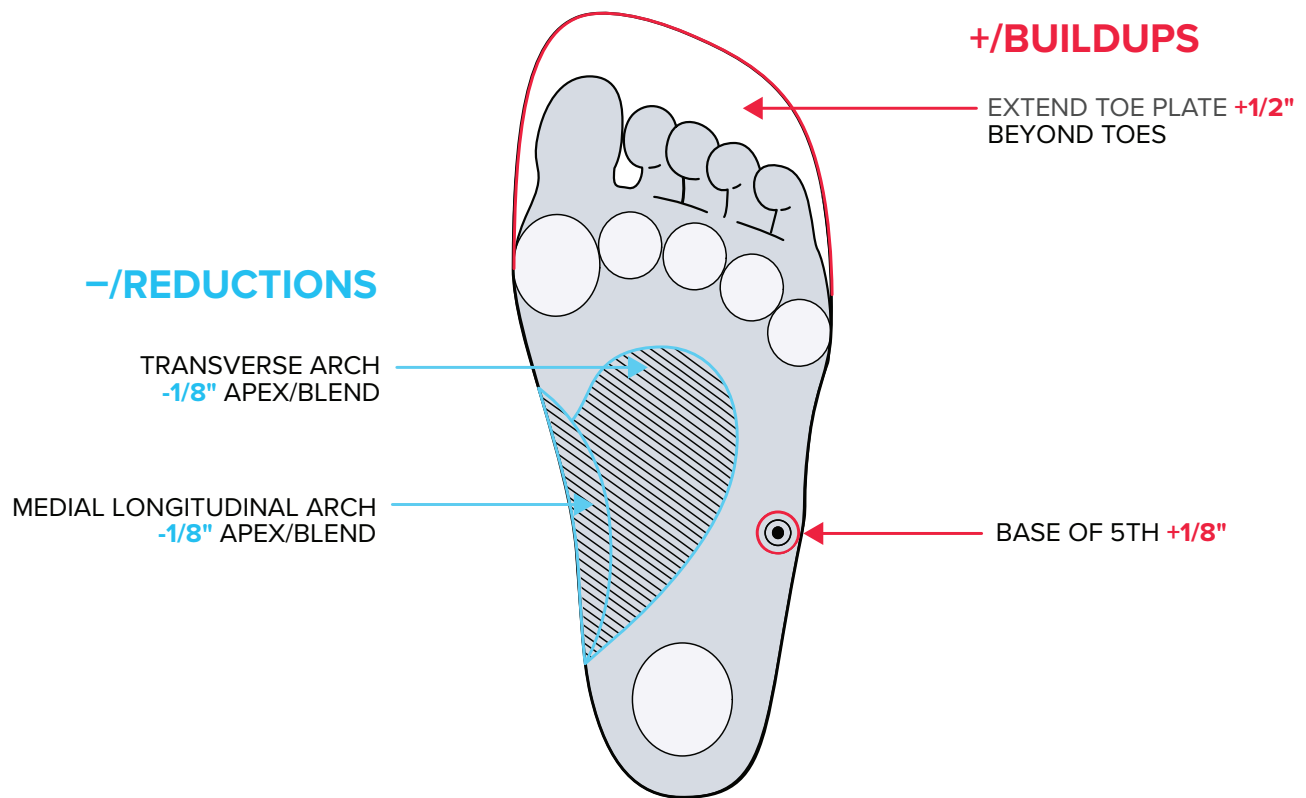
**ANKLE ONLY**  
(dorsal web) malleolae



**FOOT ONLY**  
distal to malleolae to met heads

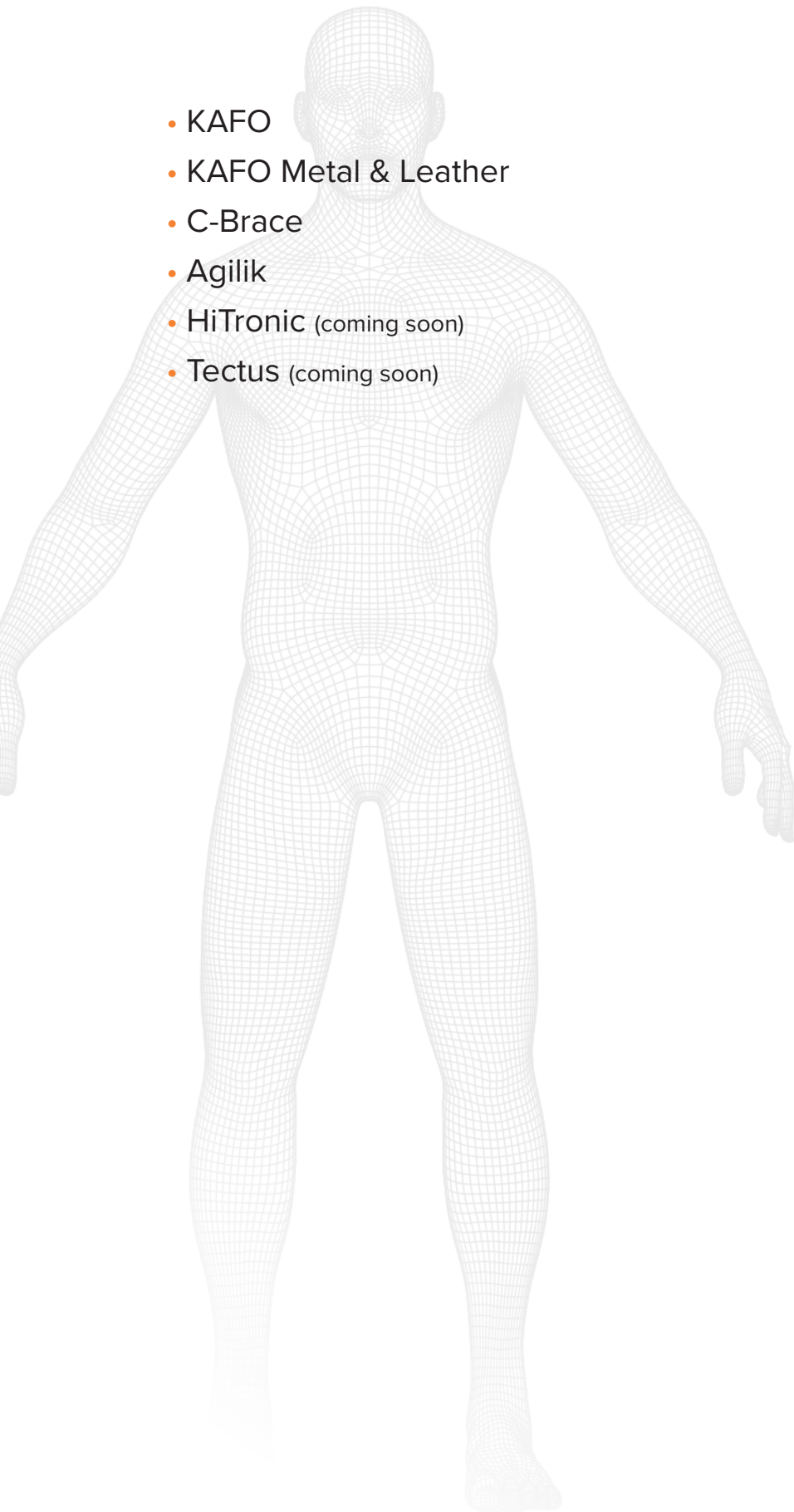
# STANDARD PLANTAR SURFACE MODIFICATIONS

◎ BUILD UP    ▨ REDUCTION  
(Blend will vary according to patient's anatomy)



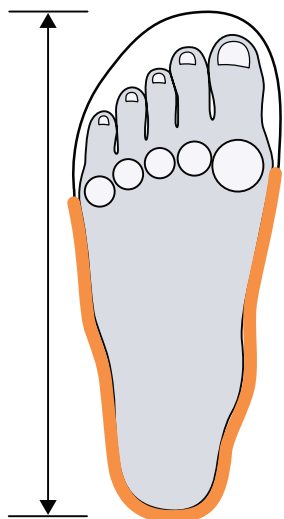
# DESIGNS

- KAFO
- KAFO Metal & Leather
- C-Brace
- Agilik
- HiTronic (coming soon)
- Tectus (coming soon)

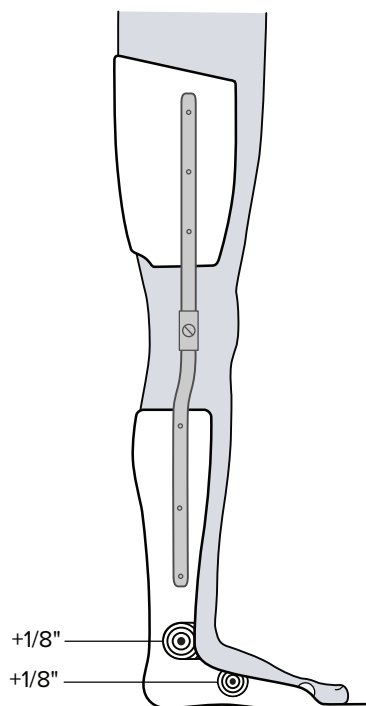




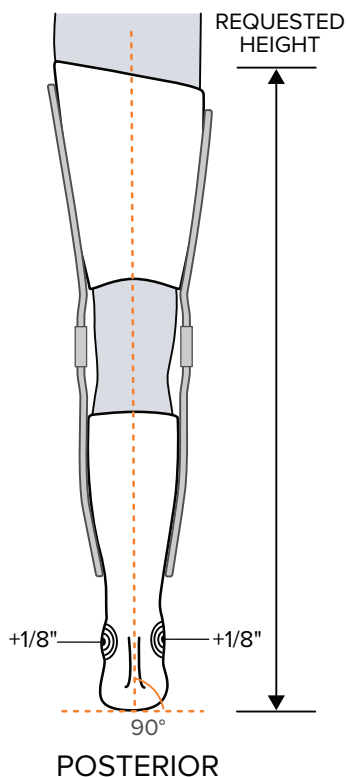
REQUESTED  
FOOT PLATE  
LENGTH



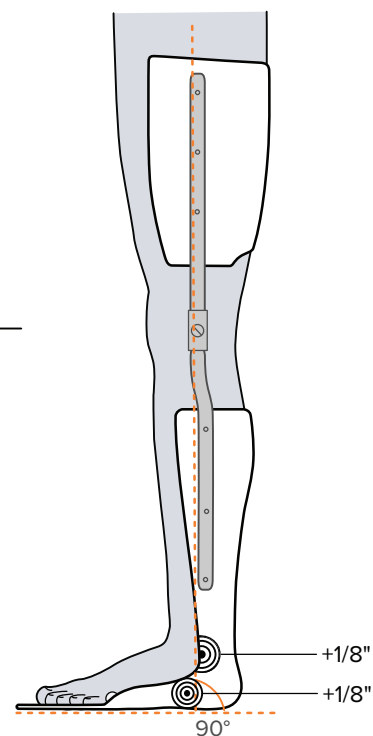
FOREFOOT TRIM  
**METS**



MEDIAL

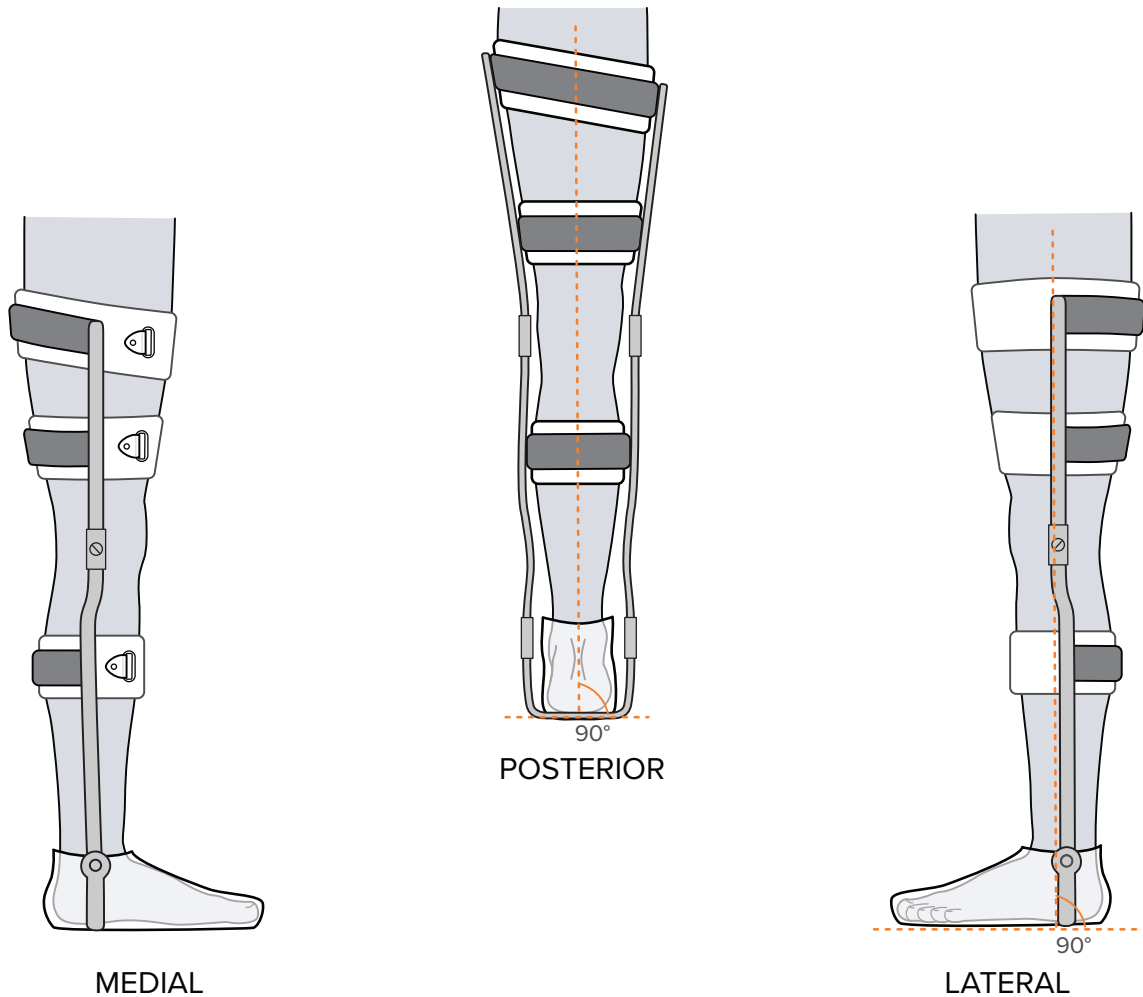


POSTERIOR



LATERAL



CTQ MEASUREMENTS CTQ = Critical to Quality		STANDARD MATERIAL /TRIMLINES	VARIATION ON REQUEST
<div>△</div> <div>○ Circumference</div> <div>□ Lat. Height to Floor</div> <div>□ Med. Height to Floor</div> <div>△</div> <div>○</div> <div>△</div> <div>□</div>	<div>△</div> <div>□</div> <div>○  </div> <div>△</div> <div>- Toe Out Degrees</div> <div>□ Med. Malleoli Height</div> <div>□ Foot Plate Length</div> <div>△ Met Heads</div>	<ul style="list-style-type: none"> <li>• Full Foot Plate</li> <li>• 5/32" Polypropylene – Finished</li> <li>• Chafes Medial</li> <li>• 1-1/2" White Velcro Straps</li> <li>• Proximal Flare</li> <li>• 1/16" PE tongue</li> <li>• 5 – 7° Toe out</li> </ul>	<ul style="list-style-type: none"> <li>• Varus/Valgus Mod</li> <li>• Inner Boot</li> <li>• Pre-tib Shell</li> <li>• Dorsal Wrap</li> <li>• Articulated</li> <li>• Hybrid</li> </ul>

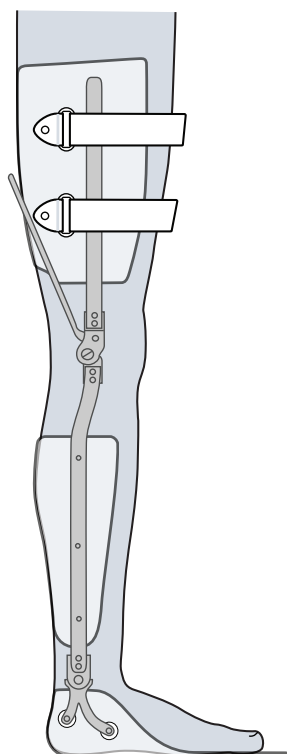


CTQ MEASUREMENTS CTQ = Critical to Quality		STANDARD MATERIAL /TRIMLINES	VARIATION ON REQUEST
<div>△</div> <div>○</div> Circumference	<div>△</div> <div>□</div> <div>○  </div> <div>△</div> - Toe Out Degrees	<ul style="list-style-type: none"> <li>Uprights as chosen by clinician for patient function, weight, and activity level</li> <li>Stirrups or caliper plate installed into shoe</li> <li>1-1/2" aluminum bands at calf, distal and proximal thigh</li> <li>Leather cuffs with velcro strap and strap for each band</li> <li>Cream cow covering over bands</li> </ul>	<ul style="list-style-type: none"> <li>Knee pad (4 buckle, 5 buckle, 3 buckle, infrapatellar)</li> <li>T-strap (med. or lat.) riveted to shoe</li> </ul>
<div>□</div> Lat. Height to Floor	<div>○</div> <div>△</div> - Med. Malleoli Height		
<div>□</div> Med. Height to Floor	<div>□</div> Foot Plate Length		
<div>△</div> <div>○</div> <div>△</div> <div>□</div>	<div>△</div> Met Heads		

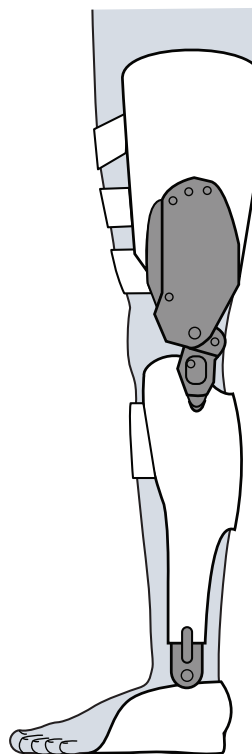
# C-BRACE

## DTO AND DEFINITIVE

 BUILD UP
  REDUCTION  
 (Blend will vary according to patient's anatomy)



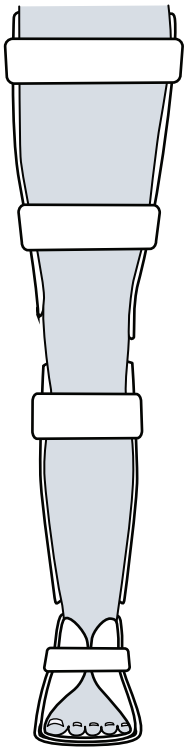
MEDIAL



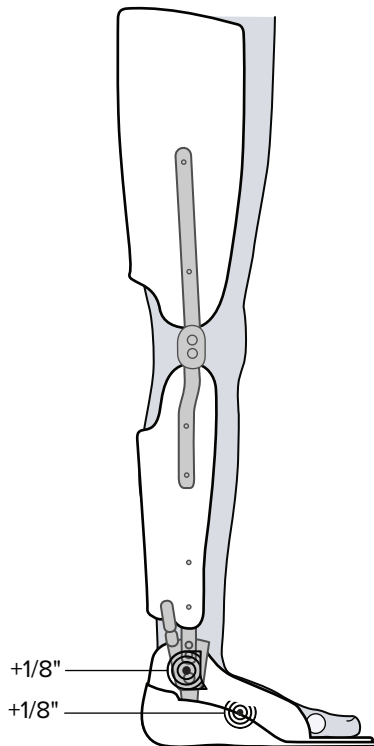
LATERAL

CTQ MEASUREMENTS CTQ = Critical to Quality		STANDARD MATERIAL /TRIMLINES	VARIATION ON REQUEST
<input type="checkbox"/> Perineum <input type="checkbox"/> Medial Trim Line <input type="checkbox"/> Greater Trochanter <input type="checkbox"/> Lat. Trim Line <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Knee Center Line	<input type="checkbox"/> Medial Tibial Plateau <input type="checkbox"/> Fibular Head <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Ankle Center Line <input type="checkbox"/> Ankle <input type="checkbox"/> Heel Height <input type="checkbox"/> Met Heads	<ul style="list-style-type: none"> <li>• Full Foot Plate</li> <li>• 3/16" Polypropylene – Finished</li> <li>• Chafes Medial</li> <li>• 1 1/2" White Velcro Straps</li> <li>• Proximal Flare</li> <li>• 1/16" PE tongue</li> <li>• 5-7° Toe out</li> </ul>	<ul style="list-style-type: none"> <li>• Varus/Valgus Mod</li> <li>• Inner Boot</li> <li>• Pre-tib Shell</li> <li>• Dorsal Wrap</li> <li>• Articulated</li> <li>• Hybrid</li> </ul>

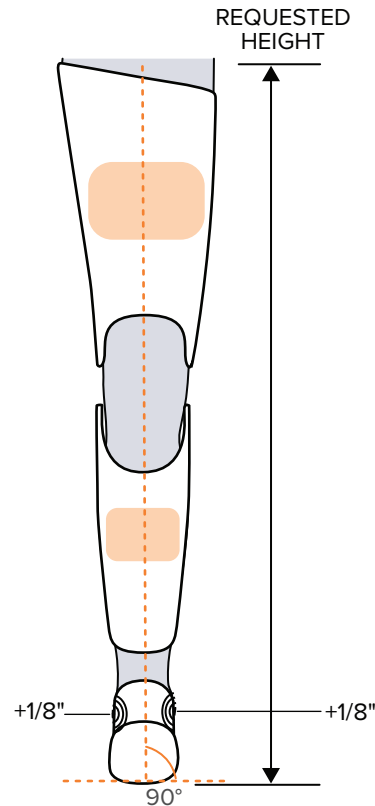
## ANTERIOR STRAPS



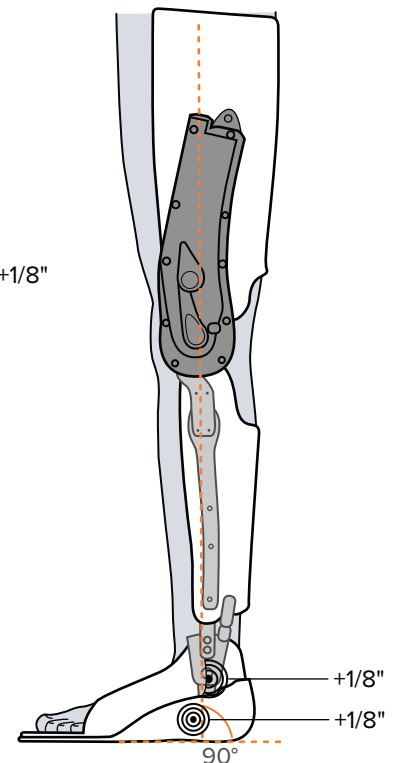
## FOREFOOT TRIM METS



MEDIAL



## POSTERIOR PADDING

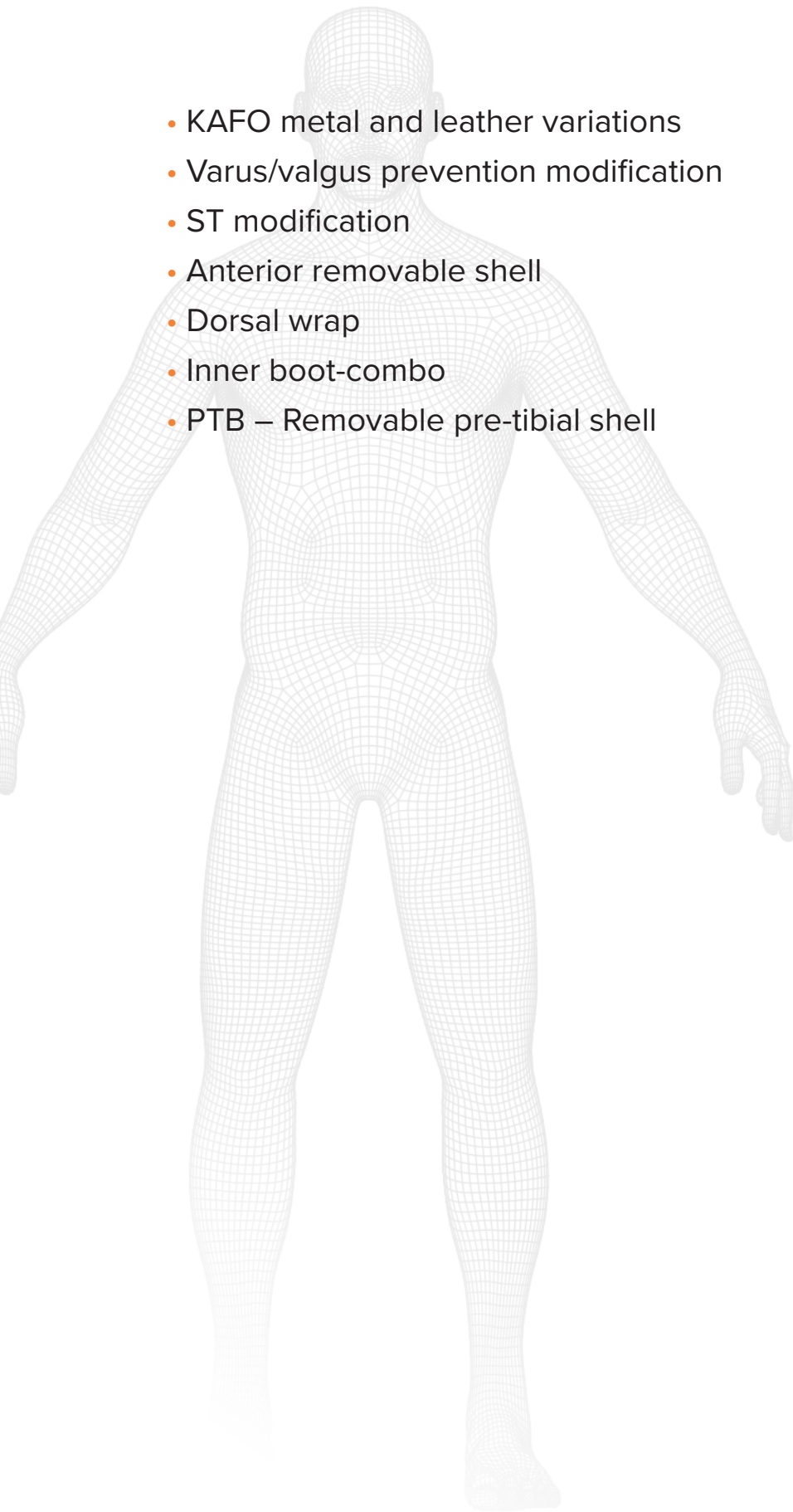


LATERAL

CTQ MEASUREMENTS CTQ = Critical to Quality		STANDARD MATERIAL /TRIMLINES	VARIATION ON REQUEST
<input type="checkbox"/> Height to Floor <input type="checkbox"/> Perineum Height to Floor <input type="checkbox"/> Knee Center <input type="checkbox"/> Calf Apex <input type="checkbox"/> ML Malleolae <input type="checkbox"/> Medial Malleolus Height <input type="checkbox"/> Foot Plate Length <input type="checkbox"/> Knee Center Height - Medium Knee Ext. Angle° - Ankle Angle° - Shank Angle°	- Toe Ramp Angle° <input type="checkbox"/> Casting Block Height <input type="checkbox"/> Trochanter Width <input type="checkbox"/> Waist <input type="checkbox"/> Top of Jacket <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<ul style="list-style-type: none"> <li>• Full footplate</li> <li>• Inner boot w/full plastic posting</li> <li>• 1/4" ProComp plastic</li> <li>• Corrugation to thigh and calf sections</li> <li>• Medial polycentric follower joint</li> <li>• Articulated ankle joints</li> <li>• 4 Dacron reinforced straps (size appropriate) - 2 thigh, 1 calf, 1 instep</li> </ul>	<ul style="list-style-type: none"> <li>• Varus/Valgus Mod</li> <li>• Pre-tib Shell</li> </ul>

# KAFO VARIATIONS

- KAFO metal and leather variations
- Varus/valgus prevention modification
- ST modification
- Anterior removable shell
- Dorsal wrap
- Inner boot-combo
- PTB – Removable pre-tibial shell

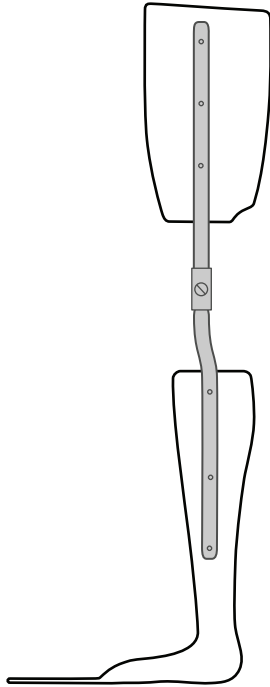




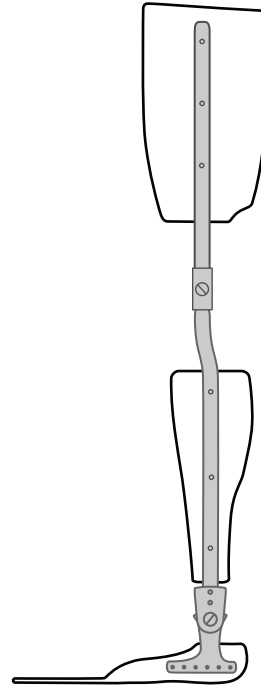
# KAFO

## METAL & LEATHER VARIATIONS

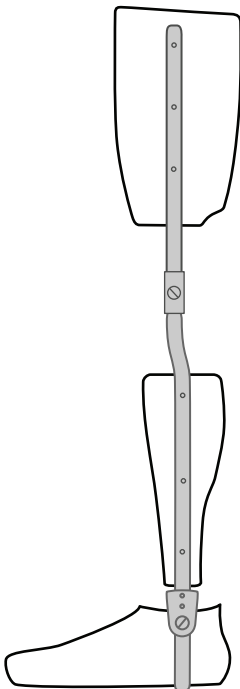
PLASTIC – PLASTIC AFO – PART OF PLASTIC AFO  
(STANDARD THERMOPLASTIC KAFO)



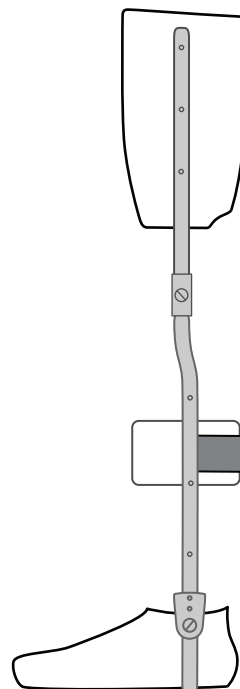
PLASTIC – PLASTIC CUFF – PLASTIC UCB STYLE



PLASTIC – PLASTIC CUFF – SHOE



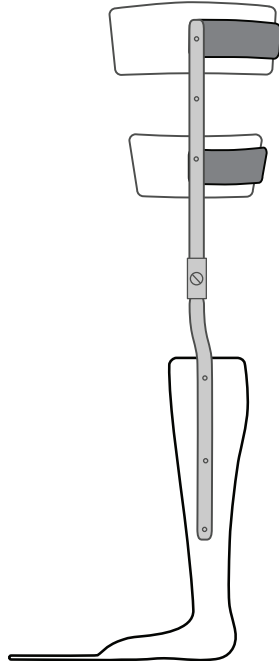
PLASTIC – METAL/LEATHER - SHOE



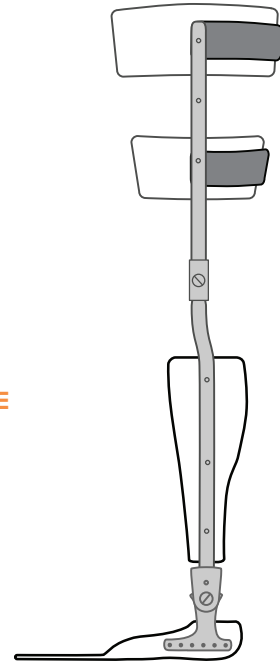
# KAFO

## METAL & LEATHER VARIATIONS

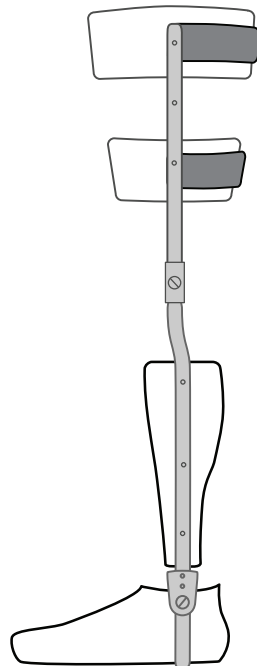
METAL LEATHER – PLASTIC AFO –  
PART OF PLASTIC AFO



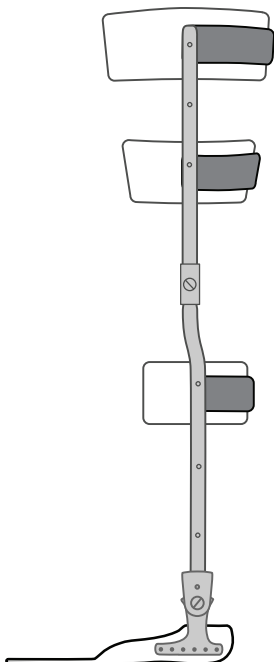
METAL/LEATHER – PLASTIC CUFF –  
PLASTIC UCB STYLE



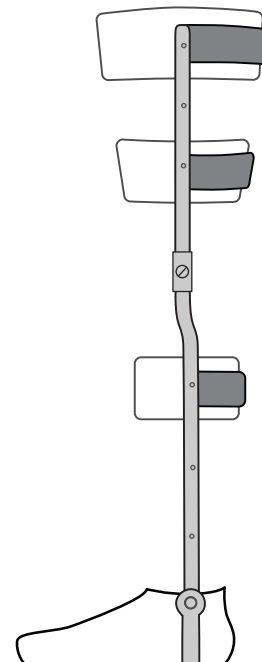
METAL/LEATHER – PLASTIC CUFF – SHOE



METAL/LEATHER – METAL/LEATHER –  
PLASTIC UCB STYLE



METAL/LEATHER – METAL/LEATHER – SHOE  
(STANDARD METAL/LEATHER KAFO)



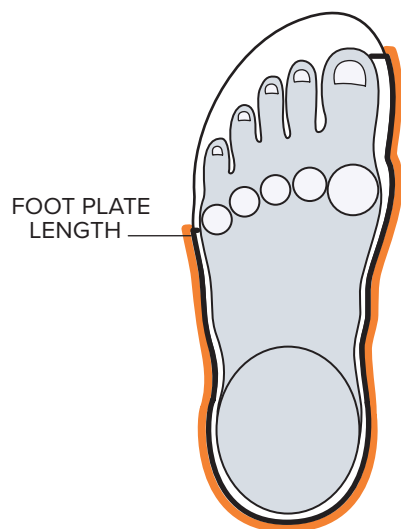
# VARUS/VALGUS PREVENTION

L2275, F1102

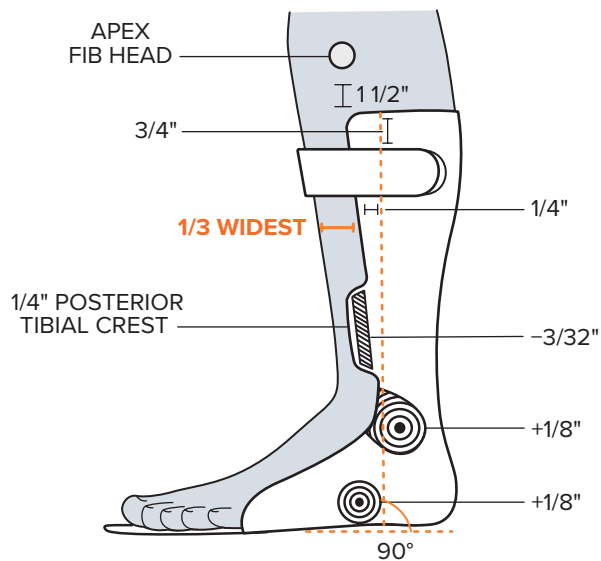
⊙ BUILD UP ▨ REDUCTION

(Blend will vary according to patient's anatomy)

## VARUS

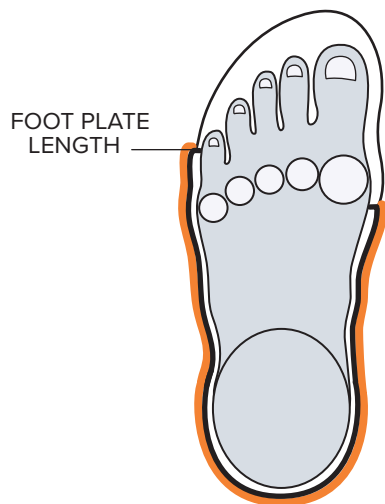


FOREFOOT TRIM  
EXTENDED MEDIAL

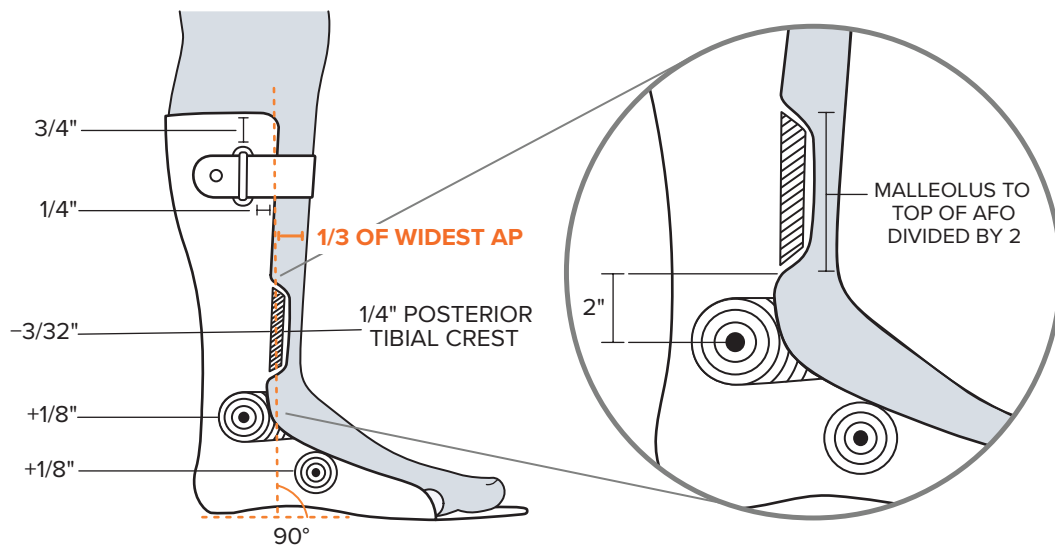


LATERAL

## VALGUS




FOREFOOT TRIM  
EXTENDED LATERAL



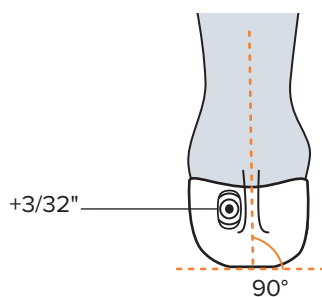
MEDIAL

# ST MODIFICATION (CARLSON MODIFICATION)

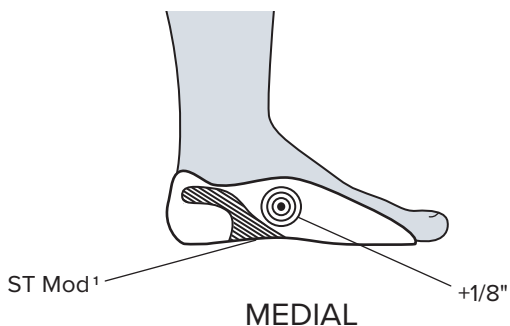
 BUILD UP  
  REDUCTION  
 (Blend will vary according to patient's anatomy)



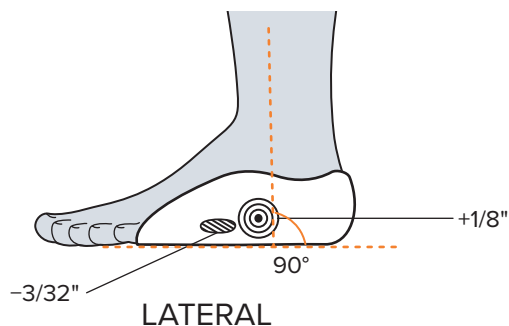
FOREFOOT TRIM  
**SULCUS**



POSTERIOR



MEDIAL



LATERAL

<sup>1</sup> Coleson, Martin J; Berglund, Gene; An Effective Orthotic Design for Controlling the Unstable Subtalar Joint. Orthotics and Prosthetics. 1979; 33:1, 39-49

# ANTERIOR REMOVABLE SHELL

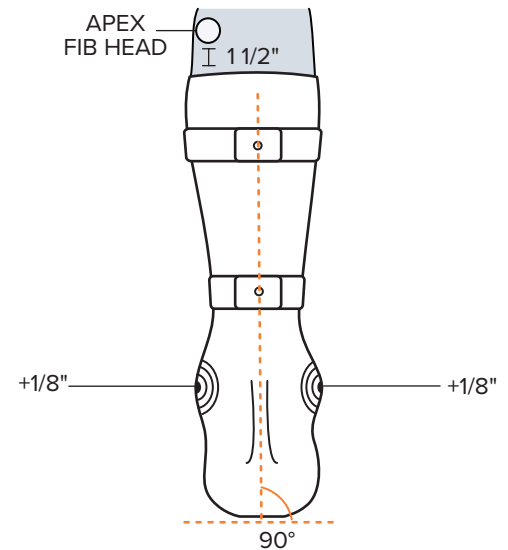
L2340, F2340

⊙ BUILD UP ▨ REDUCTION

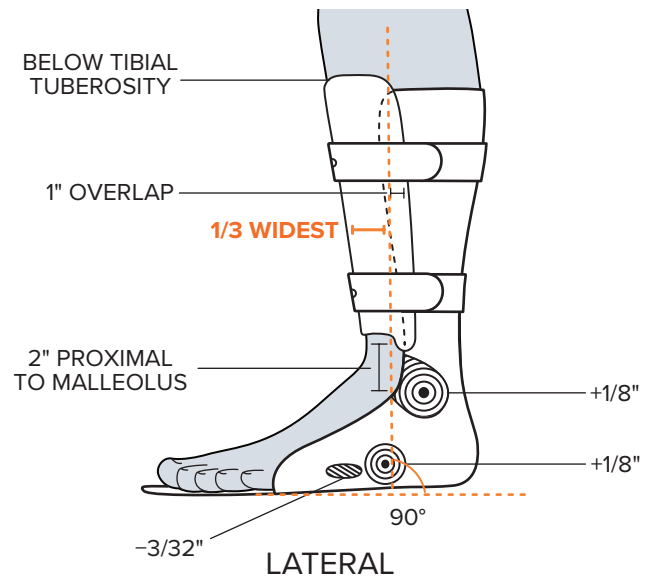
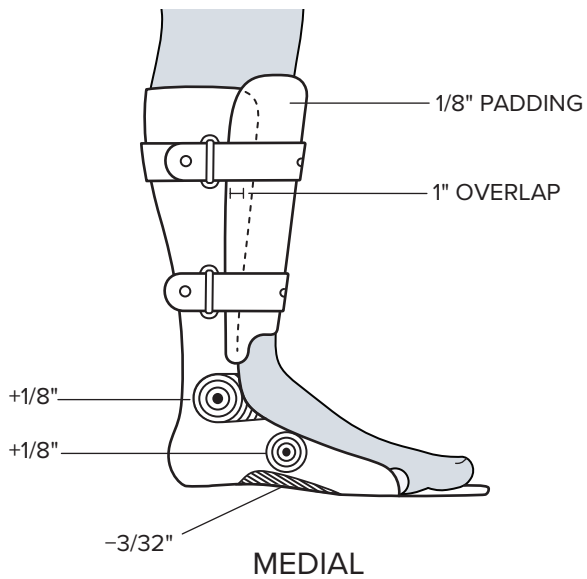
(Blend will vary according to patient's anatomy)



FOREFOOT TRIM  
**METS**



POSTERIOR

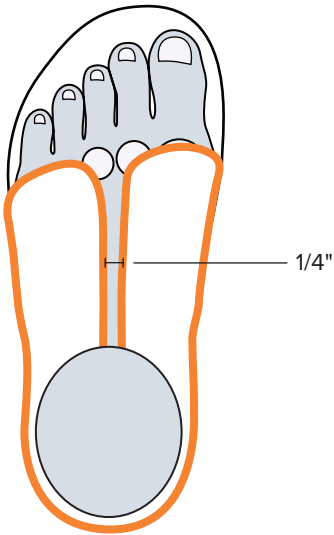


## STANDARD MATERIAL /TRIMLINES

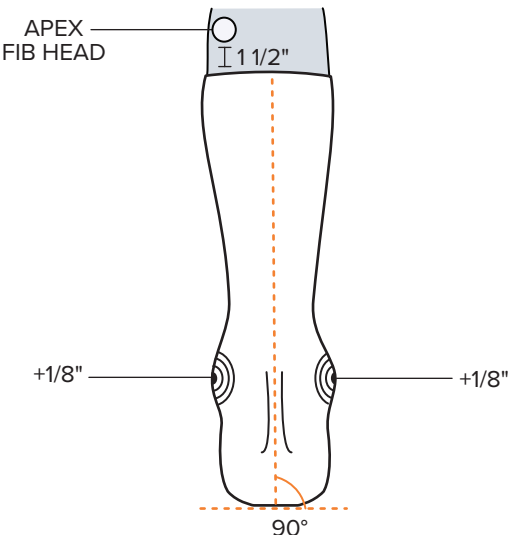
- 5/32" Polypropylene
- (2) Chafe Medial
- (2) 1 1/2" White Velcro Strap
- 1/8" Padded Anterior Shell

# DORSAL WRAP

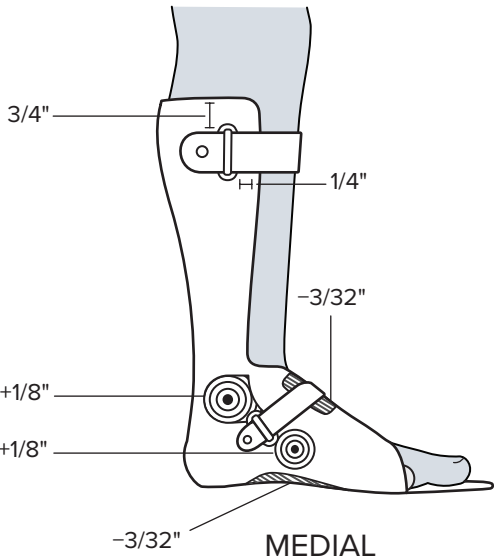
◎ BUILD UP    ▨ REDUCTION  
(Blend will vary according to patient's anatomy)



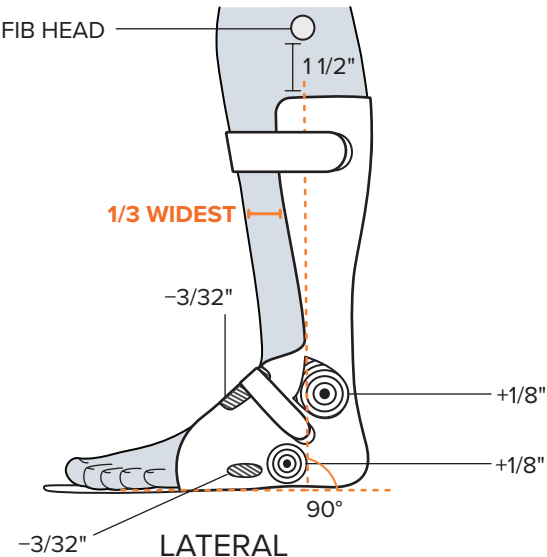
FOREFOOT TRIM  
DORSAL WRAP



POSTERIOR



MEDIAL



LATERAL

## CTQ MEASUREMENTS

CTQ = Critical to Quality

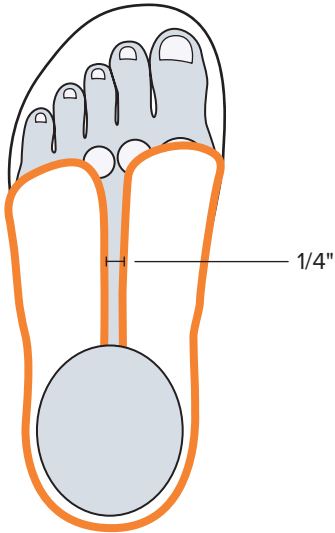
- Instep Circumference
- Heel to Dorsum Circumference

# INNER BOOT-COMBO

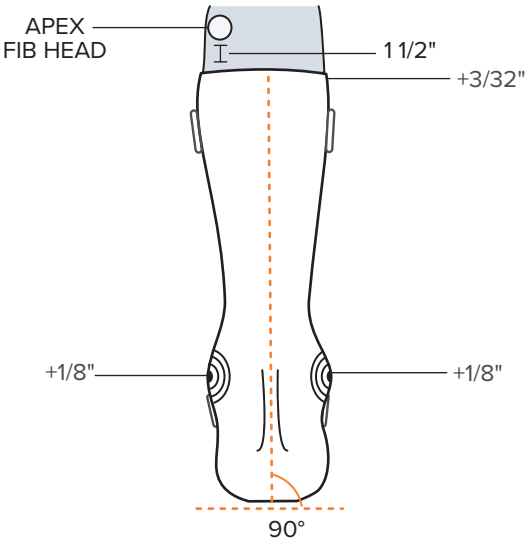
BUILD UP

REDUCTION

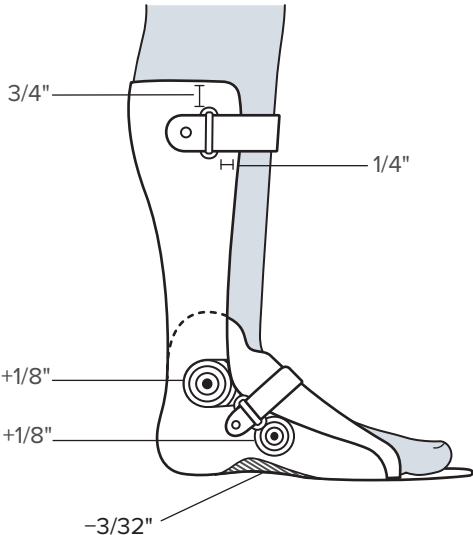
(Blend will vary according to patient's anatomy)



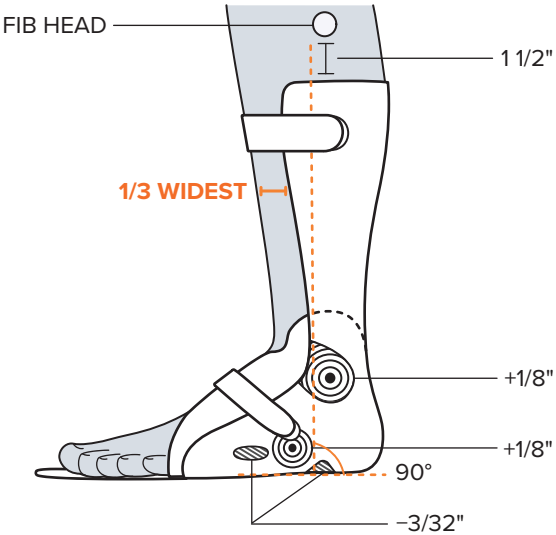
FOREFOOT TRIM  
DORSAL WRAP



POSTERIOR



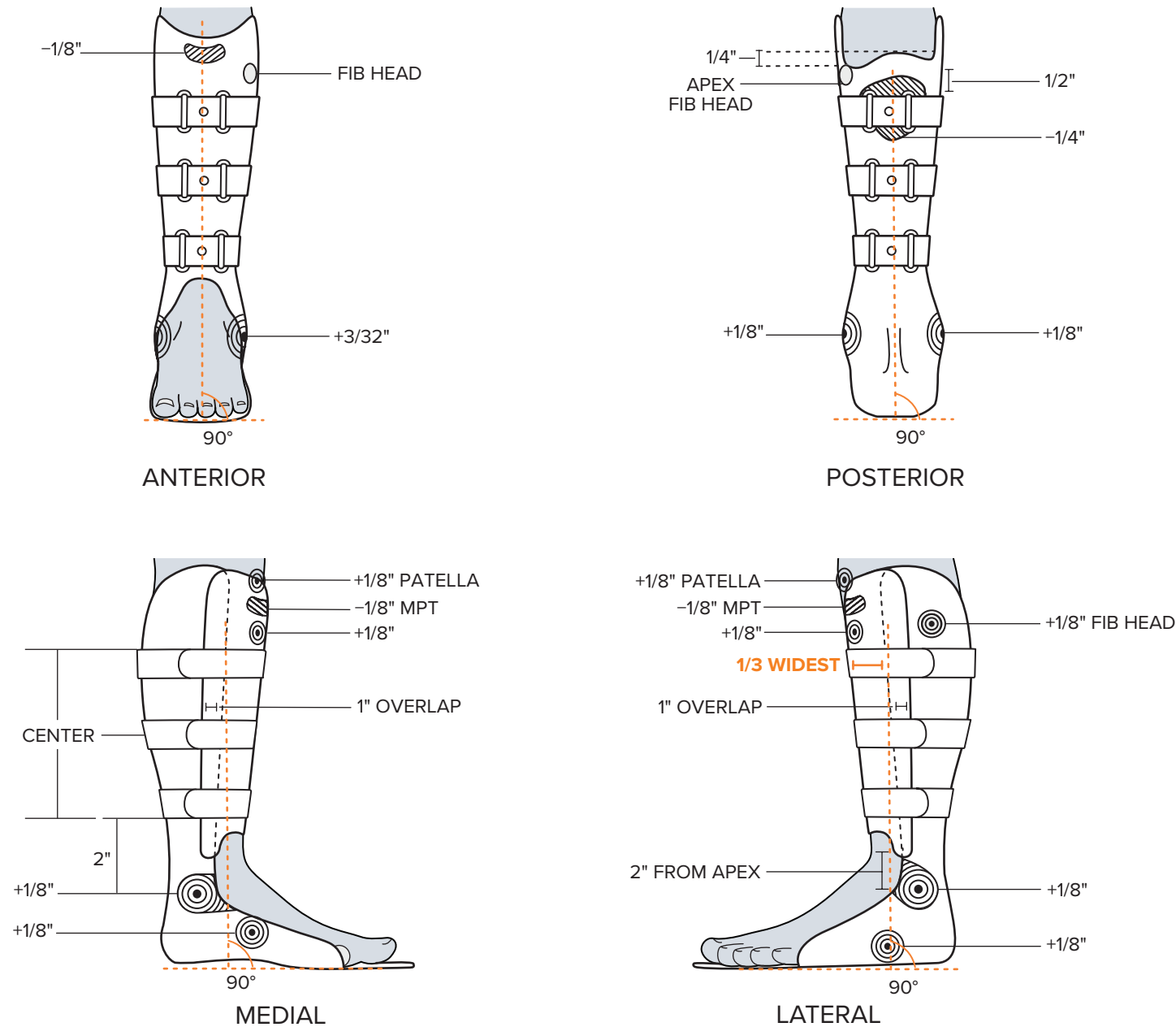
MEDIAL



LATERAL

CTQ MEASUREMENTS CTQ = Critical to Quality	STANDARD MATERIAL /TRIMLINES
<div>○ Instep Circumference</div> <div>○ Heel to Dorsum Circumference</div>	<div>• Full Foot Plate</div> <div>• 1/8" LD Polyethylene – Finished Posterior</div> <div>• Chafe Medial</div>

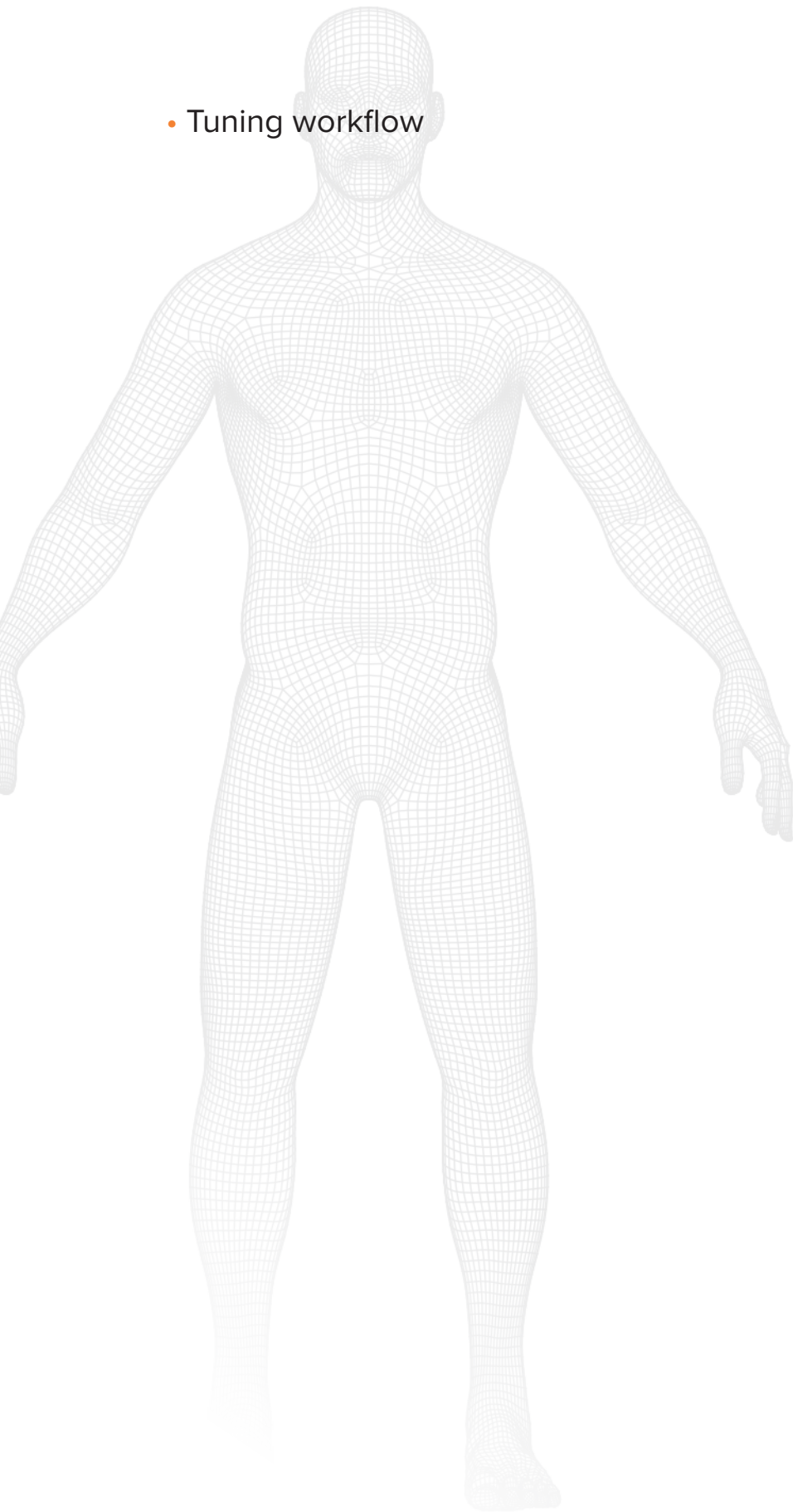




CTQ MEASUREMENTS CTQ = Critical to Quality	STANDARD MATERIAL /TRIMLINES	VARIATION ON REQUEST
<ul style="list-style-type: none"><li><input type="checkbox"/> MPT to Floor Height</li><li><input type="checkbox"/> ML Malleoli</li><li><input type="checkbox"/> ML Met Heads</li><li><input type="checkbox"/> AP at MPT</li><li><input type="checkbox"/> Finished Foot Plate Length</li><li><input type="checkbox"/> Medial Malleolus Height</li></ul>	<ul style="list-style-type: none"><li>• Full Foot Plate</li><li>• 5/32" Polypropylene</li><li>• 1/4" AliPlast Padding Anterior Shell</li><li>• (3) 1 1/2" White Straps attached to Posterior Shell</li><li>• (3) Double Chafes attached to Anterior Shell</li></ul>	<ul style="list-style-type: none"><li>• Hinged</li><li>• Proximal Flare</li><li>• Inner Boot</li><li>• Non-Skid Surface</li></ul>

# APPENDIX

- Tuning workflow



# TUNING WORKFLOW

