KAFO Alignment Guidelines

A correct alignment is critical for a functional orthosis. To ensure that the patient walks safely in all gait phases, the different orthosis construction characteristics and how they affect the overall orthosis' alignment, and thus the patient as well, must already be considered when the orthosis is being planned.

This online tutorial reflects the alignment of a KAFO (Knee Ankle Foot Orthosis) and the effects through varied adjustments during the various gait phases.

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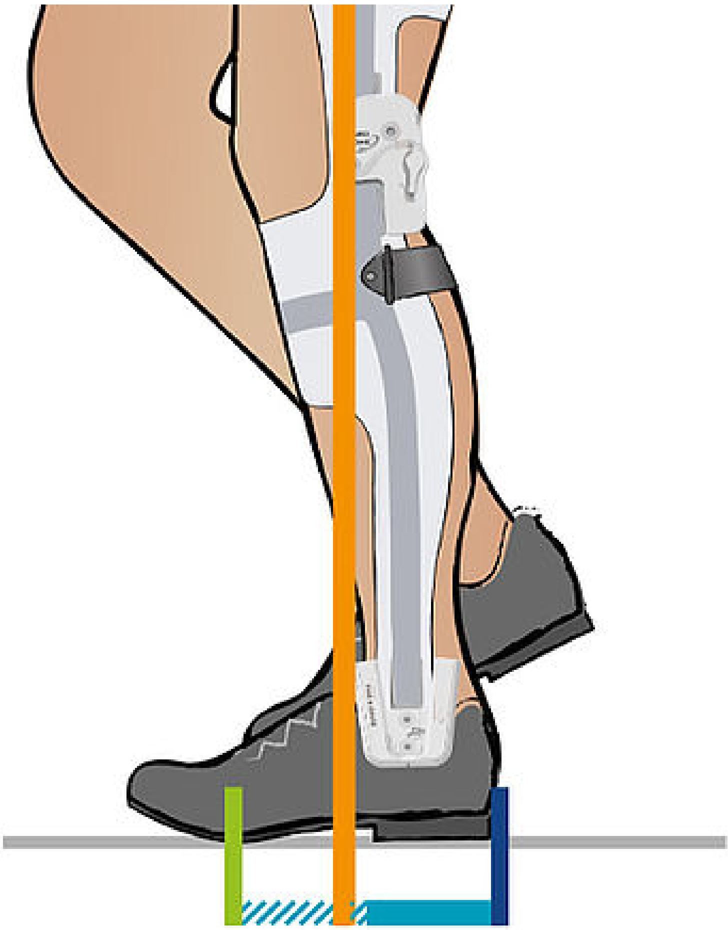
Step 1/2



The loading line should run through the front half of the supportive area. The supportive area in mid stance is defined by the heel lever and the rolling-off area. For the course of the loading line to be correct, measures ought to be taken, such as a posterior offset of the heel or an anterior offset of the mechanical rolling-off area.

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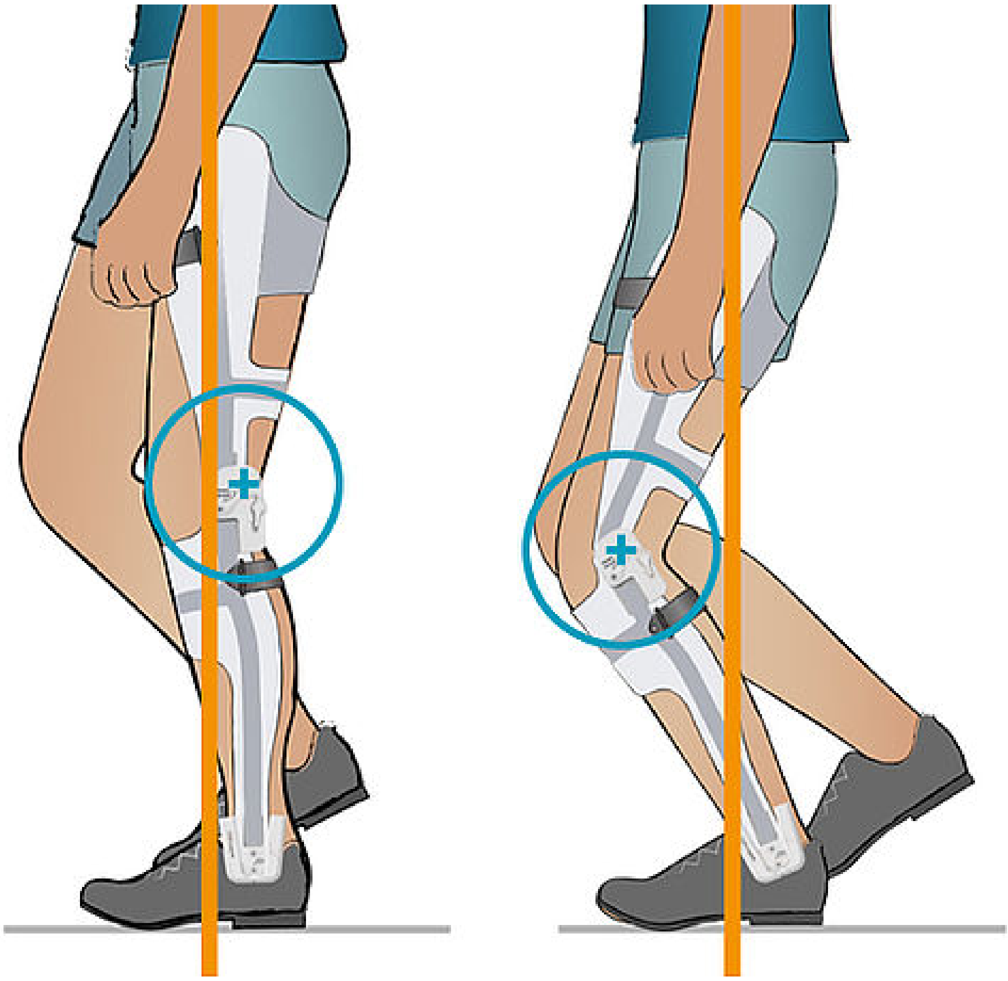
FIOR & GENTZ ORTHOPÄDIETECHNIK MIT SYSTEM

Step 2/2



The knee's pivot point should be located behind the loading line. As a result, especially in case of shortenings, the offset of the anatomical foot must be considered in regards to the supportive area. Concerning motion limits of the ankle, knee and/or hip joint, the knee's pivot point can often remain behind the loading line as well. If the knee's pivot point shall be located before the loading line due to motion limits, the patient's muscle strength must be very good (see right side of the picture). In case of paralyses, the patient can not sufficiently secure the knee with this alignment and thus needs a lock function for the stance phase.

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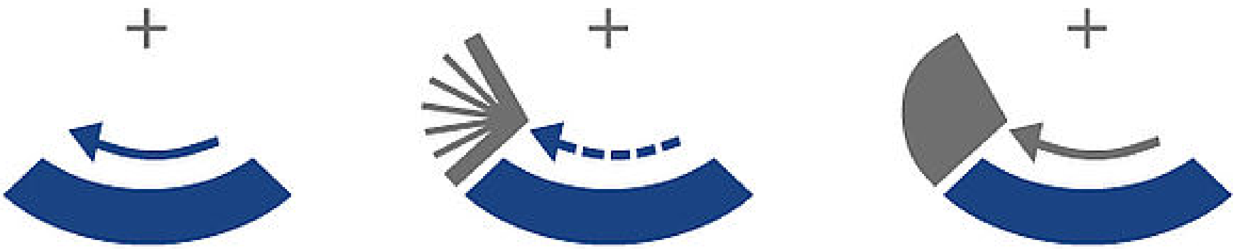
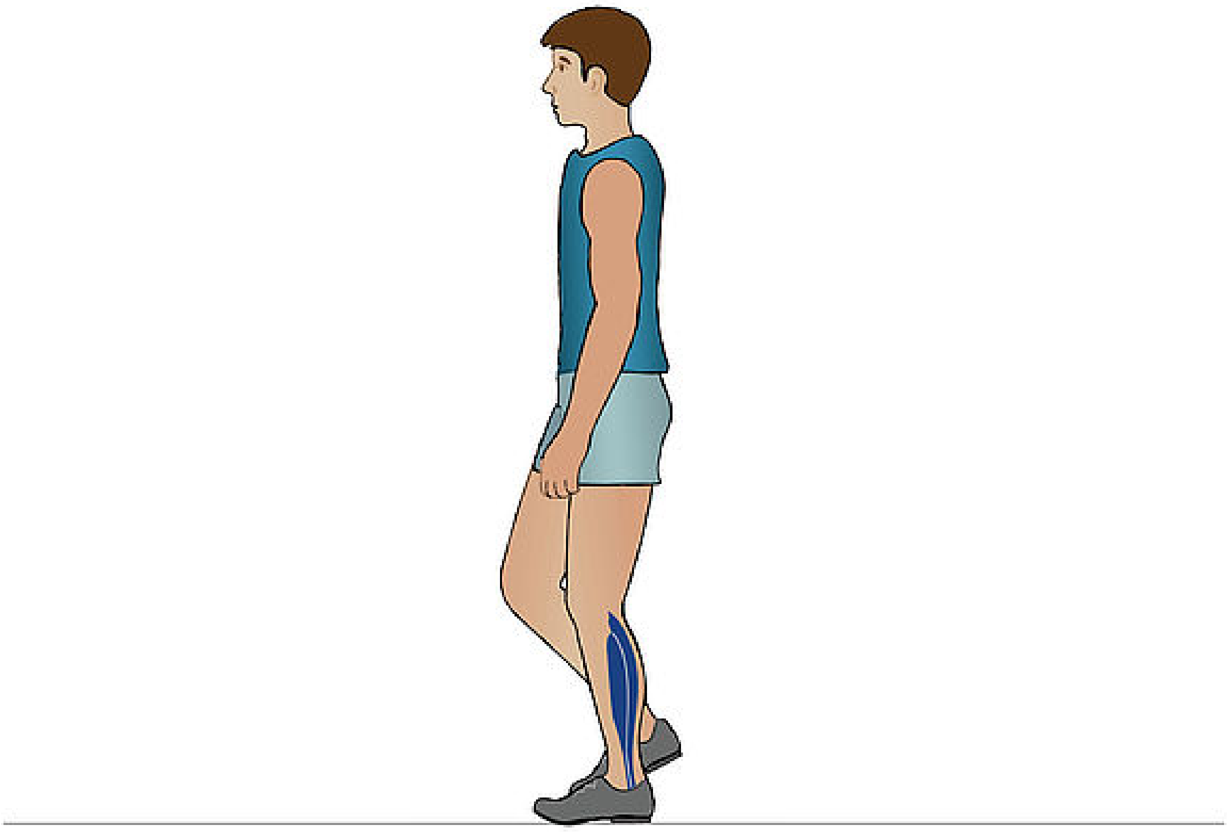
Dorsalanschlag

Dorsiflexion stop



The dorsiflexion stop affects the gait phases mid stance, late mid stance, terminal stance and pre swing. In these phases, the dorsiflexion is limited by the dorsiflexion stop. In the other phases, with correct alignment, the dorsiflexion stop is not reached. The effects on the gait phases must always be considered in regards to the toe spring and the forefoot construction.

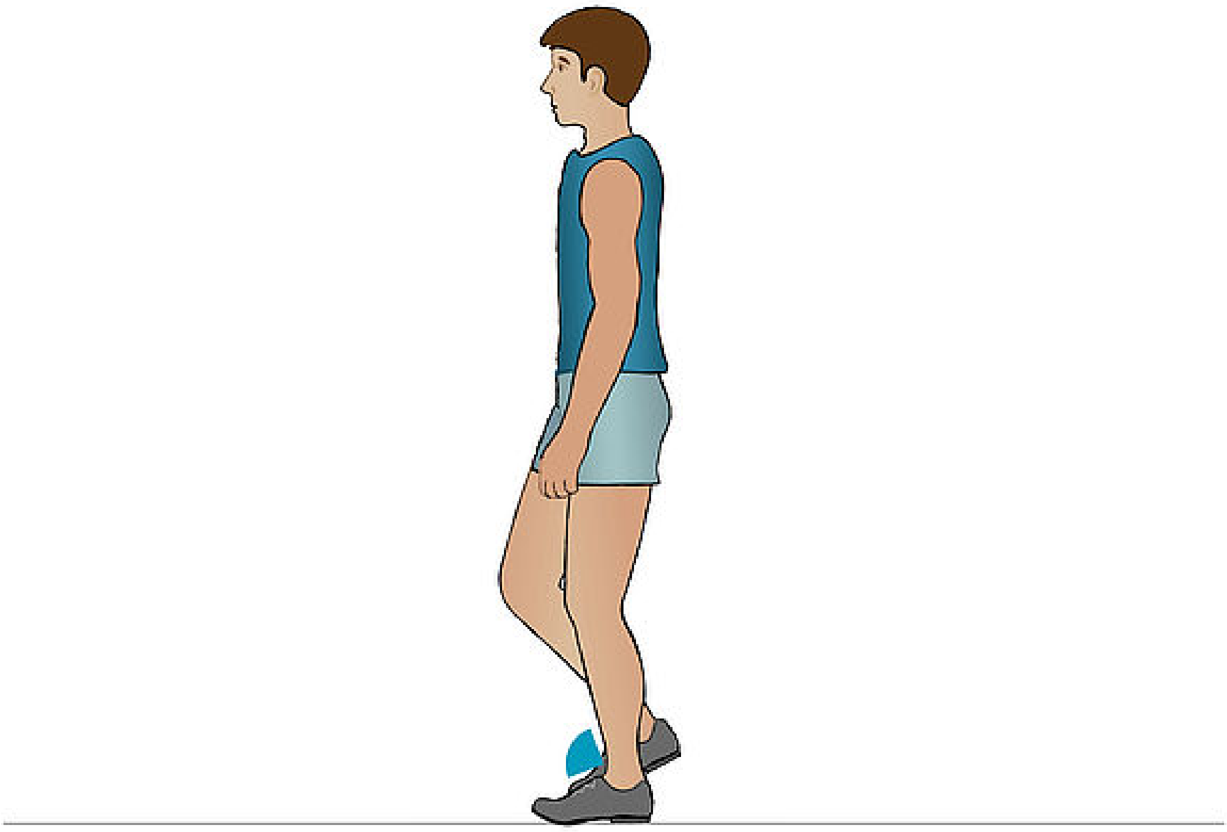
Step 2/13



Dorsiflexion Stop in mid stance

In case of system joints without a dorsiflexion stop, the patient should activate the muscle groups of the plantar flexors (in particular the soleus and the gastrocnemius muscle). As a result:

- the angle from lower leg to foot in dorsiflexion direction is limited by the muscles;
- it is possible that the leg can take the load, because a knee flexion is only possible to a lesser extent, limited or slowed down by the muscles;
- the body's centre of gravity does not drop.



Dorsiflexion Stop in mid stance

In case of system joints with a **static dorsiflexion stop**, the stop is reached here. As a result:

- the angle from lower leg to foot in dorsiflexion direction is limited;
- it is possible that the leg can take the load, because the knee joint can not be flexed any further as a knee extending moment is in effect;
- the body's centre of gravity does not drop.

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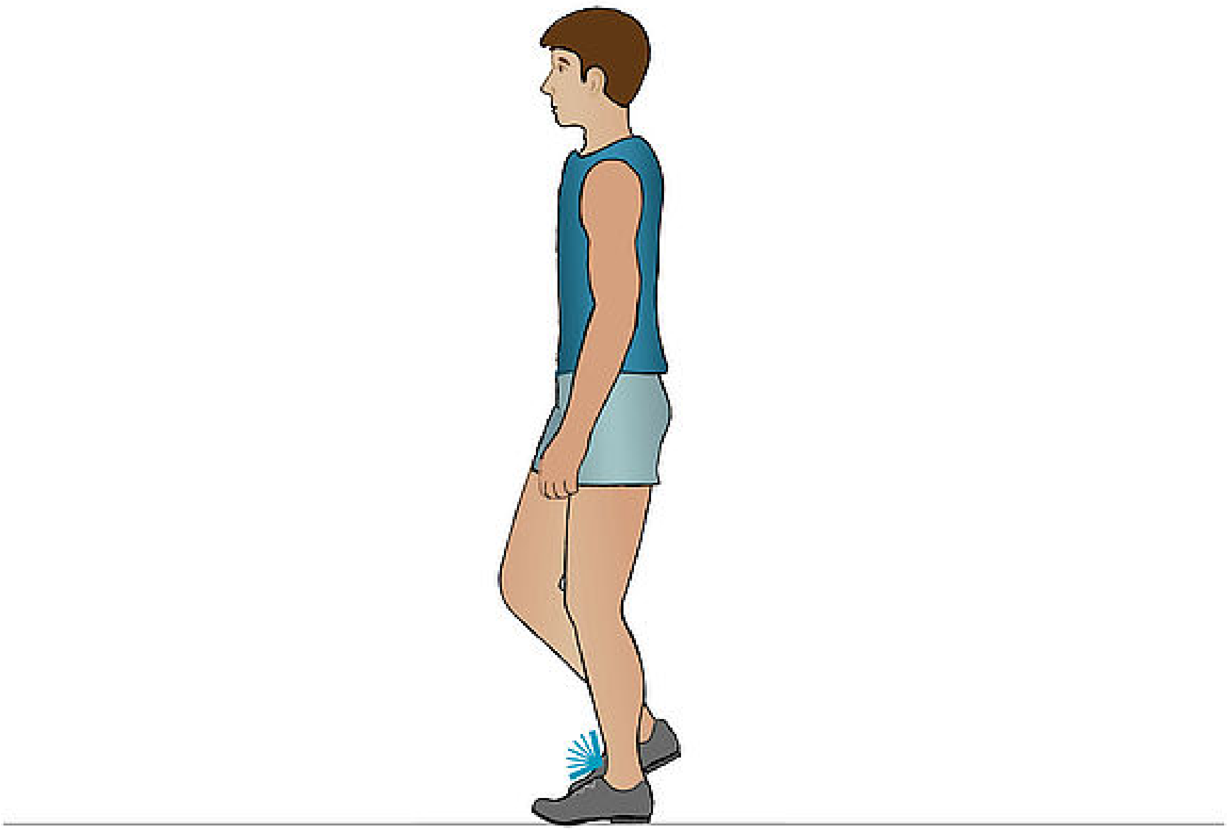
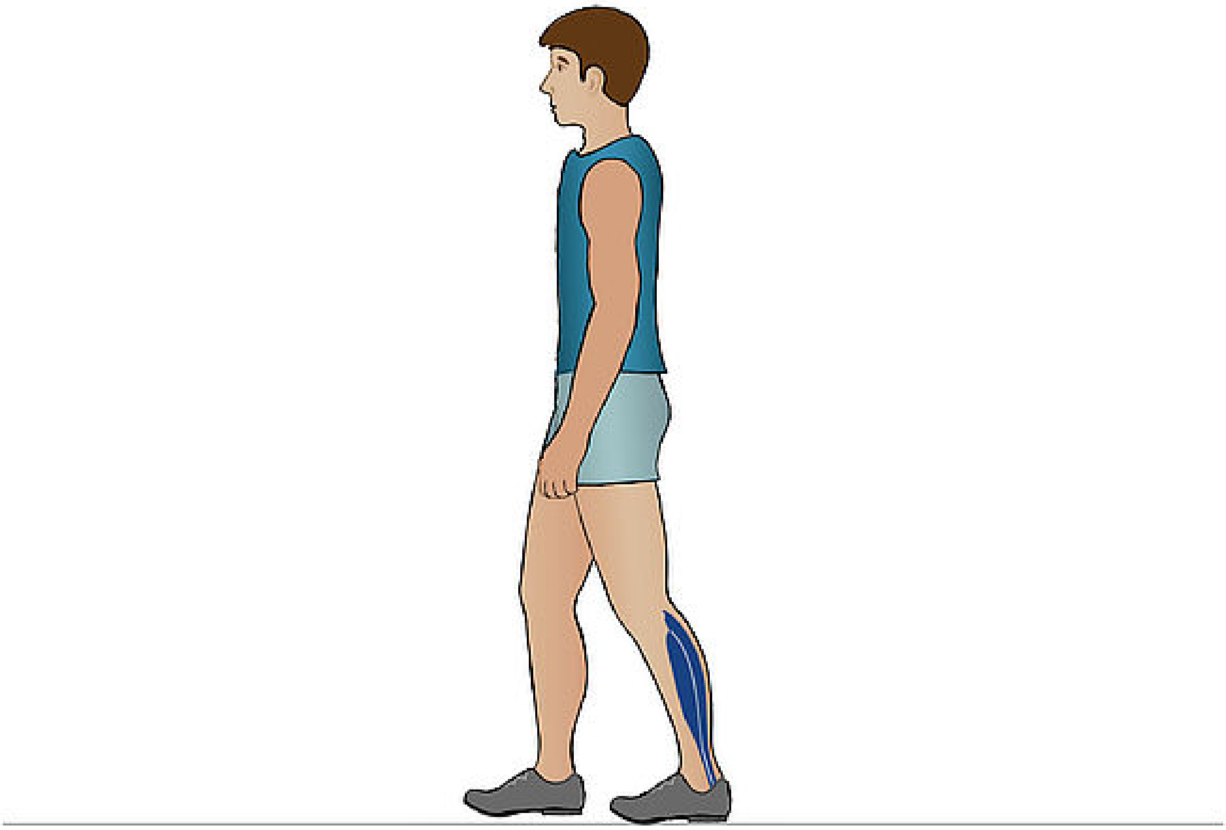


Dorsiflexion Stop in mid stance

In case of system joints with a dynamic dorsiflexion stop, the first spring contact is made here. As a result:

- the angle from lower leg to foot in dorsiflexion direction still varies to a small extent towards the spring's resistance;
- it is possible that the leg can take the load, because a knee flexion against the spring's resistance is only possible to a small extent;
- the body's centre of gravity does not drop.



Dorsiflexion Stop in late mid stance
In case of system joints **without a dorsiflexion stop**, the muscles of the plantar flexors remain active here. As a result:

- the further dorsiflexion is controlled;
- the motion is completely limited at a certain point;
- the heel still remains on the floor at this point;
- the body's centre of gravity acts physiologically and drops slightly;
- the loading line can fall before the knee’s pivot point without the knee being flexed;
- the leg can still take the load on this side.

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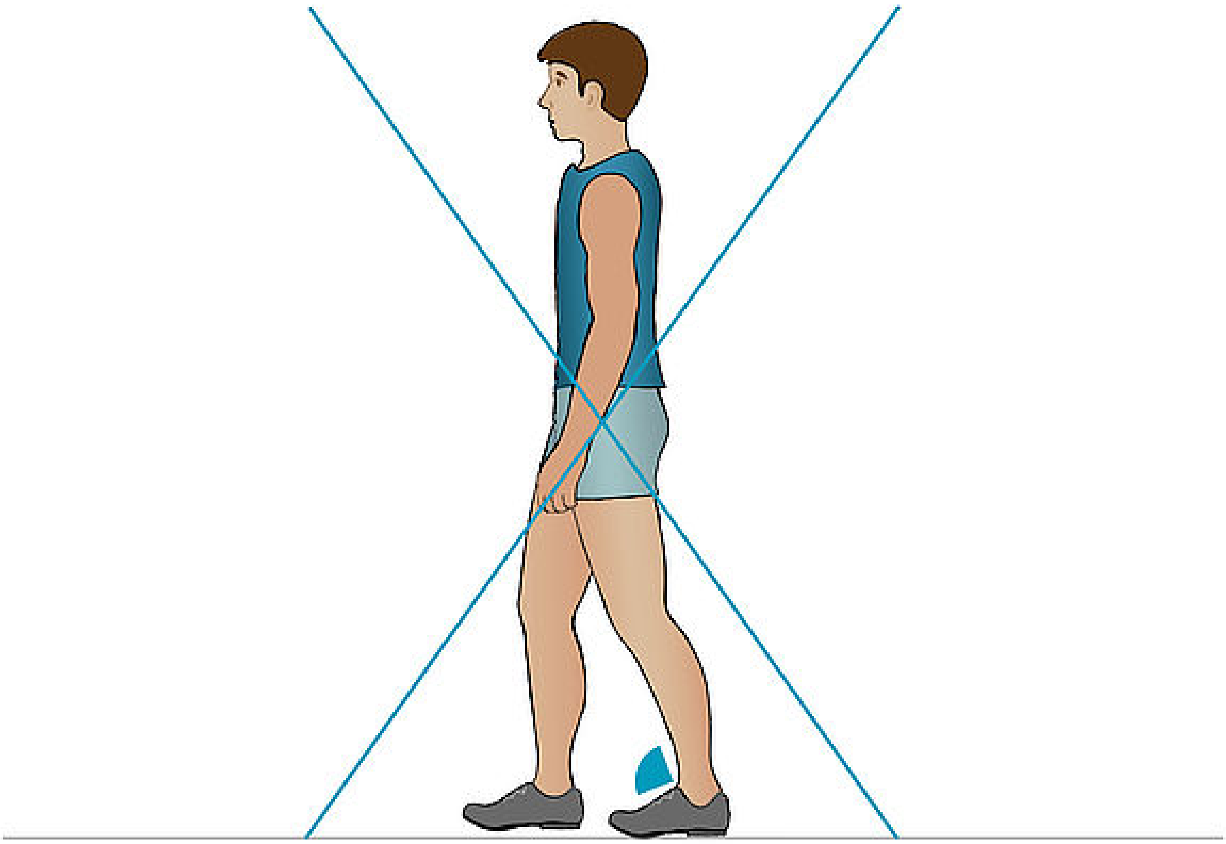

Dorsiflexion Stop in late mid stance

In case of system joints with a **static dorsiflexion stop**, the patient can not stand in this position as this requires a further dorsiflexion from mid stance to late mid stance. The system joint prevents that, and thus, this phase is skipped.

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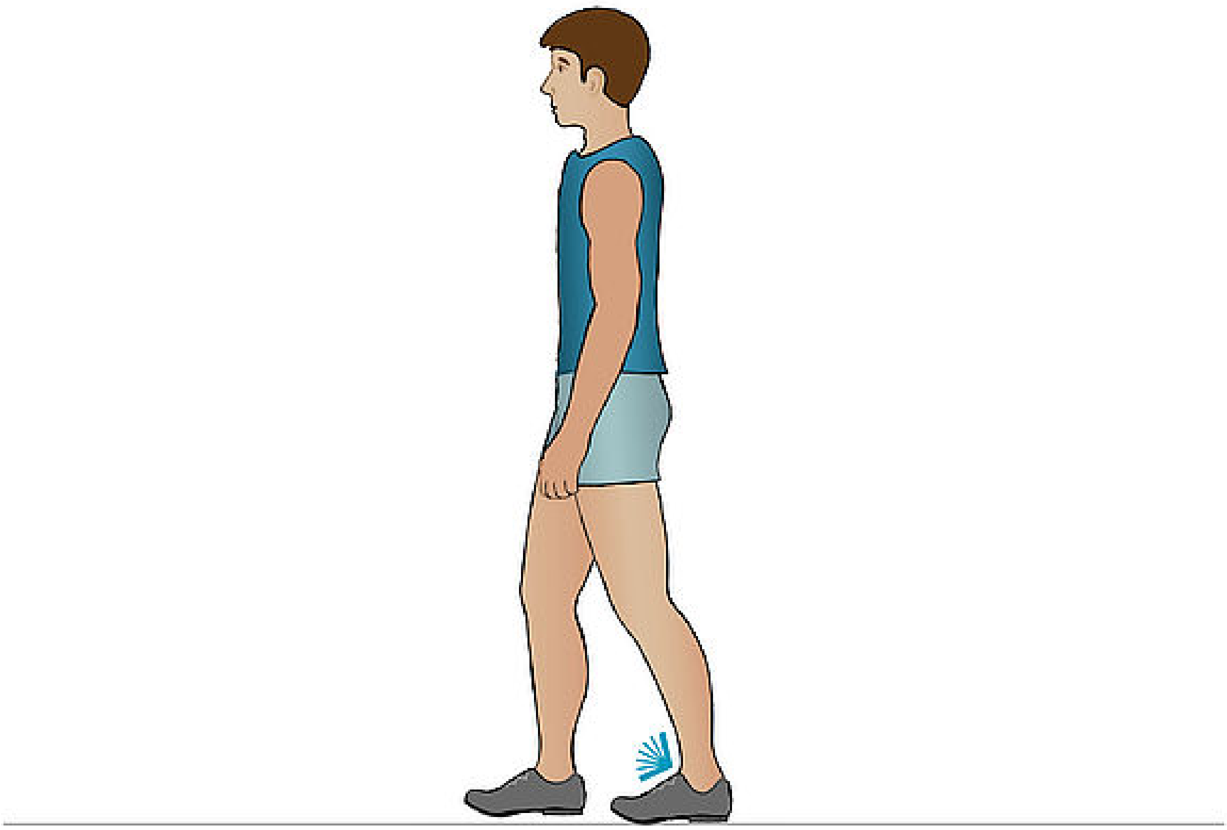

Dorsiflexion Stop in late mid stance

In case of system joints with a **dynamic dorsiflexion stop**, the dorsiflexion motion is limited here. As a result:

- the further dorsiflexion up to the final limitation is controlled;
- the heel still remains on the floor at this point;
- the body's centre of gravity acts physiologically and drops slightly;
- the loading line can be shifted before the knee’s pivot point without the knee being flexed, because a knee extending moment is in effect;
- the leg can still take the load on this side.

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Dorsiflexion Stop in terminal stance

In case of system joints **without a dorsiflexion stop**, the plantar flexors remain fully active here. As a result:

- the heel does lift from the ground;
- the body's centre of gravity remains high;
- the knee is not flexed further, even if the loading line falls before the knee's pivot point;
- the step length is physiological and matches the contralateral side;
- the leg can still take the load on this side.

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Dorsiflexion Stop in terminal stance
In case of system joints with a **static dorsiflexion stop**, the dorsiflexion motion is still completely limited here. As a result:

- the heel does lift from the ground;
- the body's centre of gravity remains high;
- the knee is not flexed further, even if the loading line falls before the knee's pivot point;
- the step length is physiological and matches the contralateral side;
- the leg can still take the load on this side.

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Dorsiflexion Stop in terminal stance

In case of system joints with a **dynamic dorsiflexion stop**, the dorsiflexion motion is still completely limited here. As a result:

- the heel does lift from the ground;
- the body's centre of gravity remains high;
- the knee is not flexed further, even if the loading line falls before the knee’s pivot point;
- the step length is physiological and matches the contralateral side;
- the leg can still take the load on this side.

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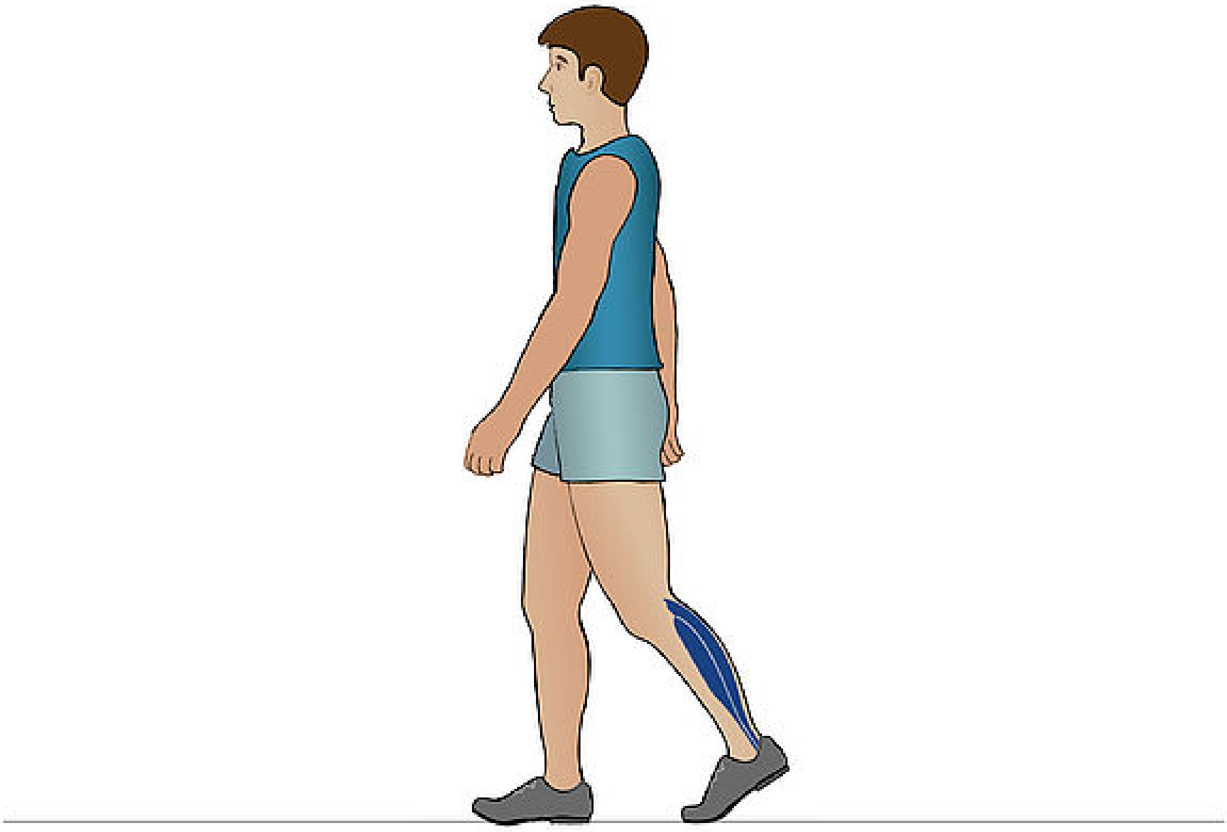

Dorsiflexion Stop in pre swing

In case of system joints **without a dorsiflexion sto**p, the plantar flexors still remain active. As a result:

- a slight plantar flexion takes place;
- the knee is slightly flexed;
- the body's centre of gravity remains high;
- the load is on the contralateral side.

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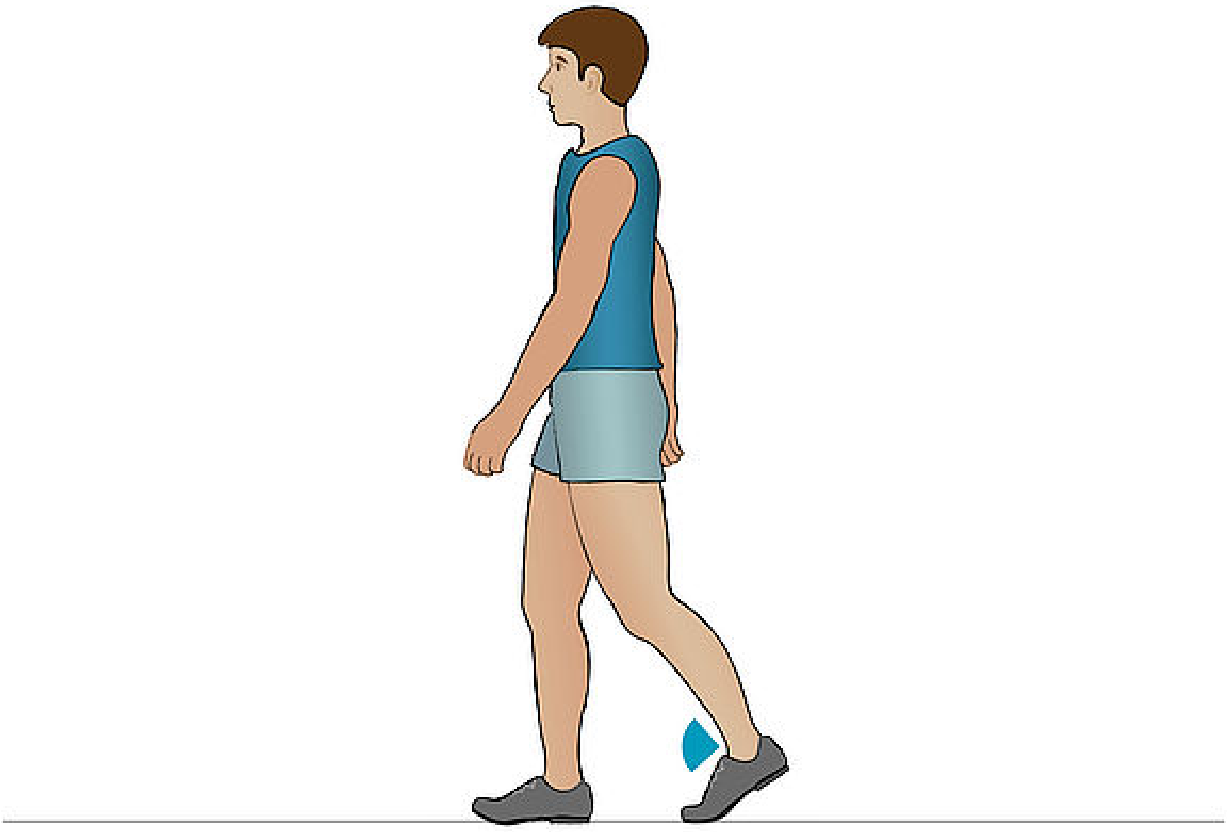

Dorsiflexion Stop in *pre swing*

In case of system joints with a s**tatic dorsiflexion stop**, the dorsiflexion motion is still limited. As a result:

- the knee is flexed;
- the swing phase is prepared;
- the body's centre of gravity remains high;
- the load is on the contralateral side.

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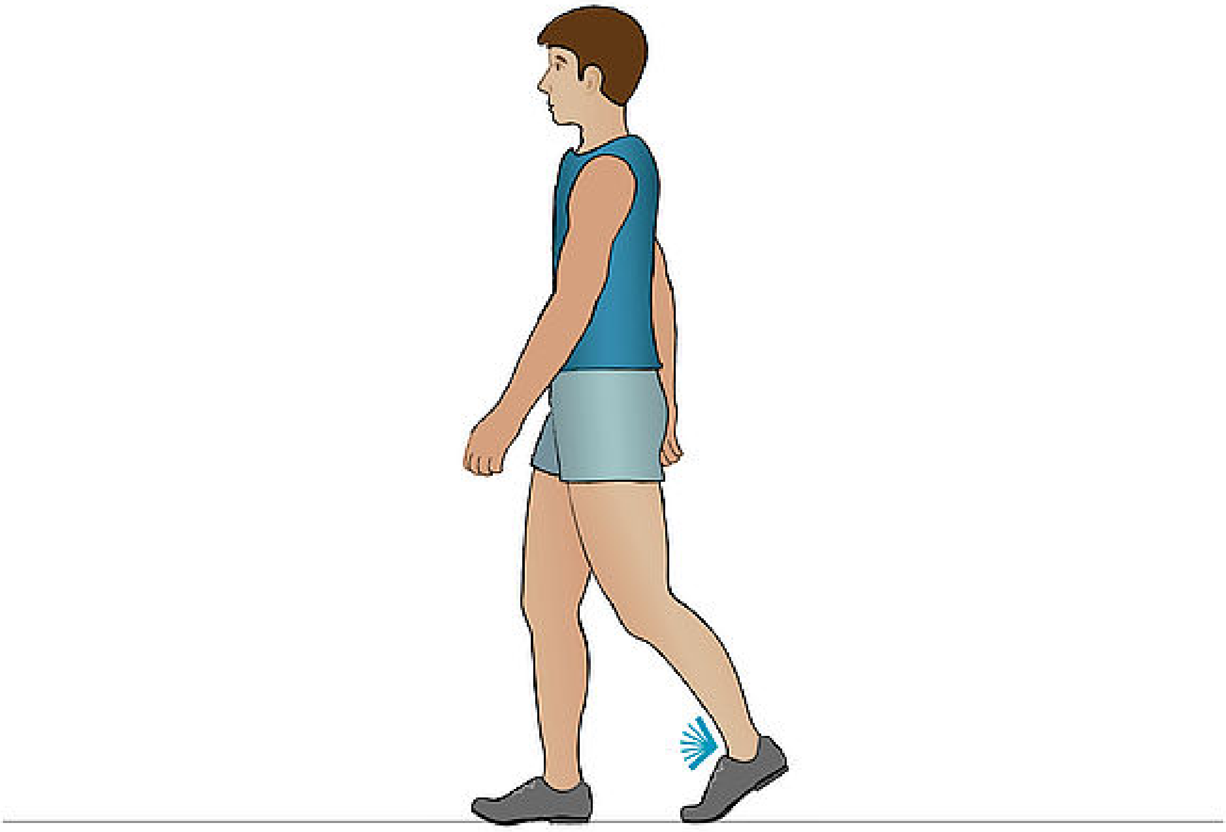

Dorsiflexion Stop in *pre swing*

In case of system joints with a **dynamic dorsiflexion stop**, the spring unit is decompressed here. As a result:

- a slight plantar flexion takes place;
- the knee is slightly flexed;
- the body's centre of gravity remains high;
- the load is on the contralateral side.

Foot Piece of the Orthosis – Toe Spring

The toe spring affects the gait phases terminal stance, pre swing and initial swing. It does not affect any other phases. The effects on the gait phases must always be considered in regards to the dorsiflexion stop and the forefoot construction.

Step 2/4

Toe Spring in terminal stance
In case of a **long rigid** or **long partially flexible foot piece**, the toe spring results in:

- a step, which is neither shortened nor discontinued while shifting into terminal stance and a heel, which is lifted while the load does not need to be taken from the leg;
- a step length, which adapts to the contralateral side;
- a knee, which remains extended.

In case of a **short foot piece**, the toes are extended and thus the same effect is achieved.

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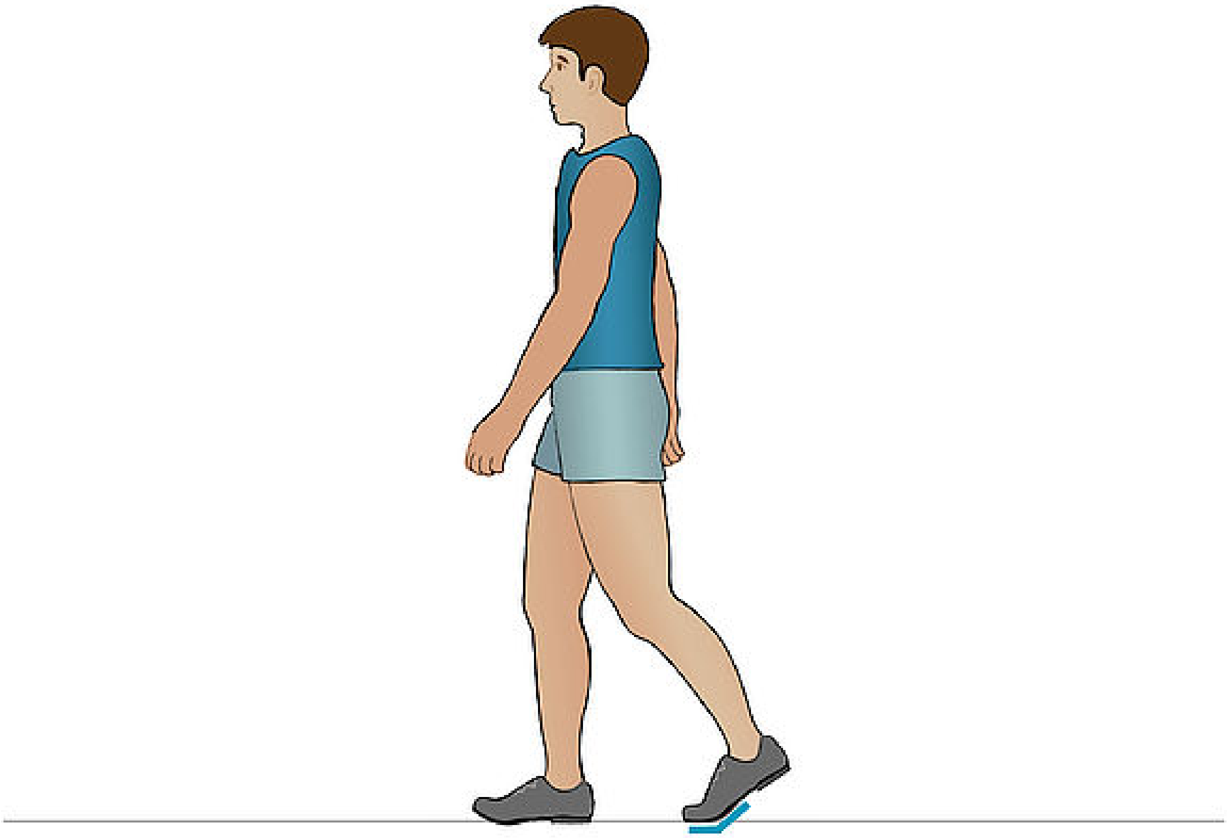
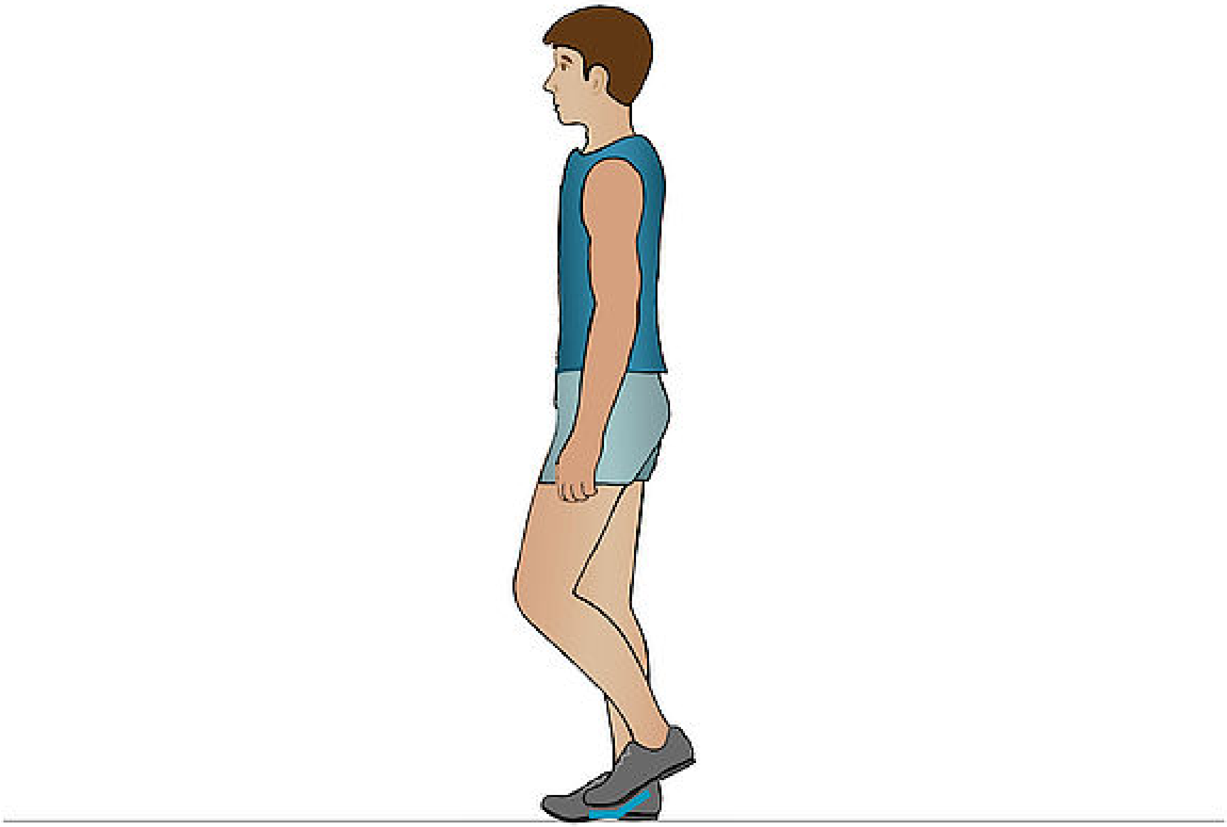
Step 3/4



Toe Spring in pre swing
In case of a **long rigid** or **long partially flexible foot piece**, the toe spring results in:

- a flexed knee, initiating the flexion in initial swing.

In case of a **short foot piece**, the toes are extended and thus the same effect achieved.



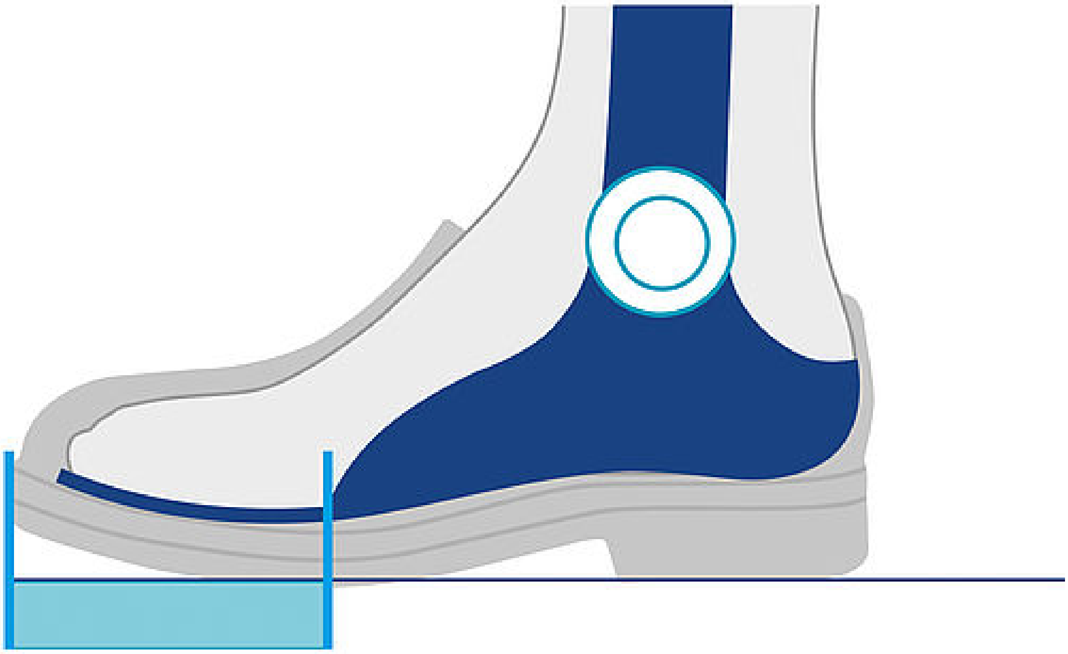
Toe Spring in initial swing
In case of a **long rigid** or **long partially flexible foot piece**, the toe spring results in:

- a leg, which does not need a vaulting/a circumduction or to be lifted additionally in order to be able to swing. The patient does not get stuck with the toes.

In case of a **short foot piece**, the toes are extended and thus the same effect is achieved.

Fußteil der Orthese – Vorfuß

Foot piece of the orthosis – forefoot

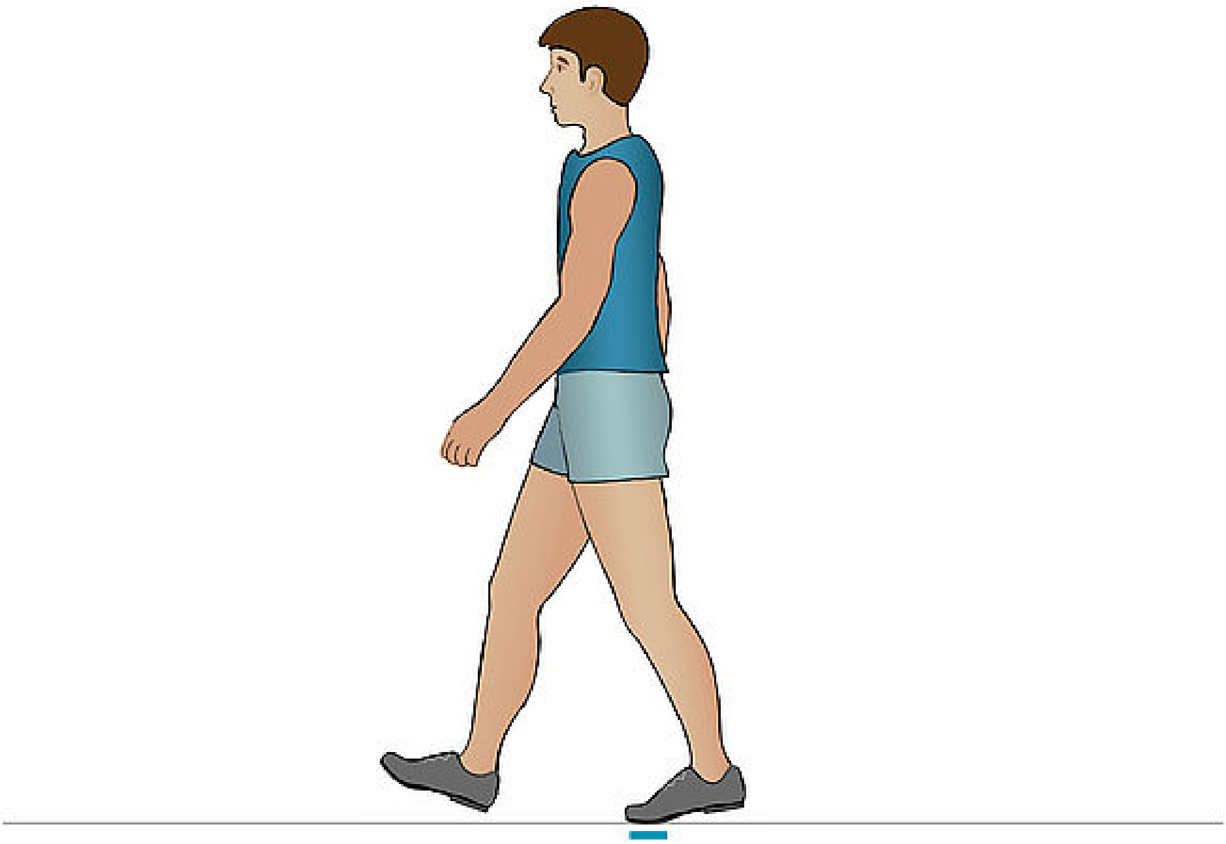


The orthosis' foot piece can either:

- be produced rigidly up to the rolling-off area and end there (**short foot piece**);
- be produced rigidly up to the rolling-off area and flexibly up to the complete inner shoe dimension (**partially flexible foot piece**);
- be produced rigidly up to the complete inner shoe dimension (**rigid foot piece**).

If the foot piece is either rigid or flexible does not depend on the material but on the mobility of the forefoot in comparison to the hindfoot. A rigid forefoot cannot be moved against the heel. Here you can find information about the production.

A toe spring must be taken into consideration in case of a rigid or partially flexible foot piece, so they can fulfil their function properly. **In addition, the forefoot lever co-operates with the dorsiflexion stop**. The forefoot affects the gait phases terminal stance and pre swing. It does not affect any other phases.



Forefoot in terminal stance
In case of insufficient toe flexors, a **rigid forefoot** results in:

- a hindfoot which is limited in its motion against the forefoot (in toe extension´s direction);
- the load remaining on the leg;
- the heel being lifted;
- the body's centre of gravity remaining high;
- the knee being not flexed too much.

A **partially flexible forefoot** has the same effect. But, therefore, the toe flexors must be active.

Without a forefoot on the foot piece, this work must be done by the toe flexors alone.

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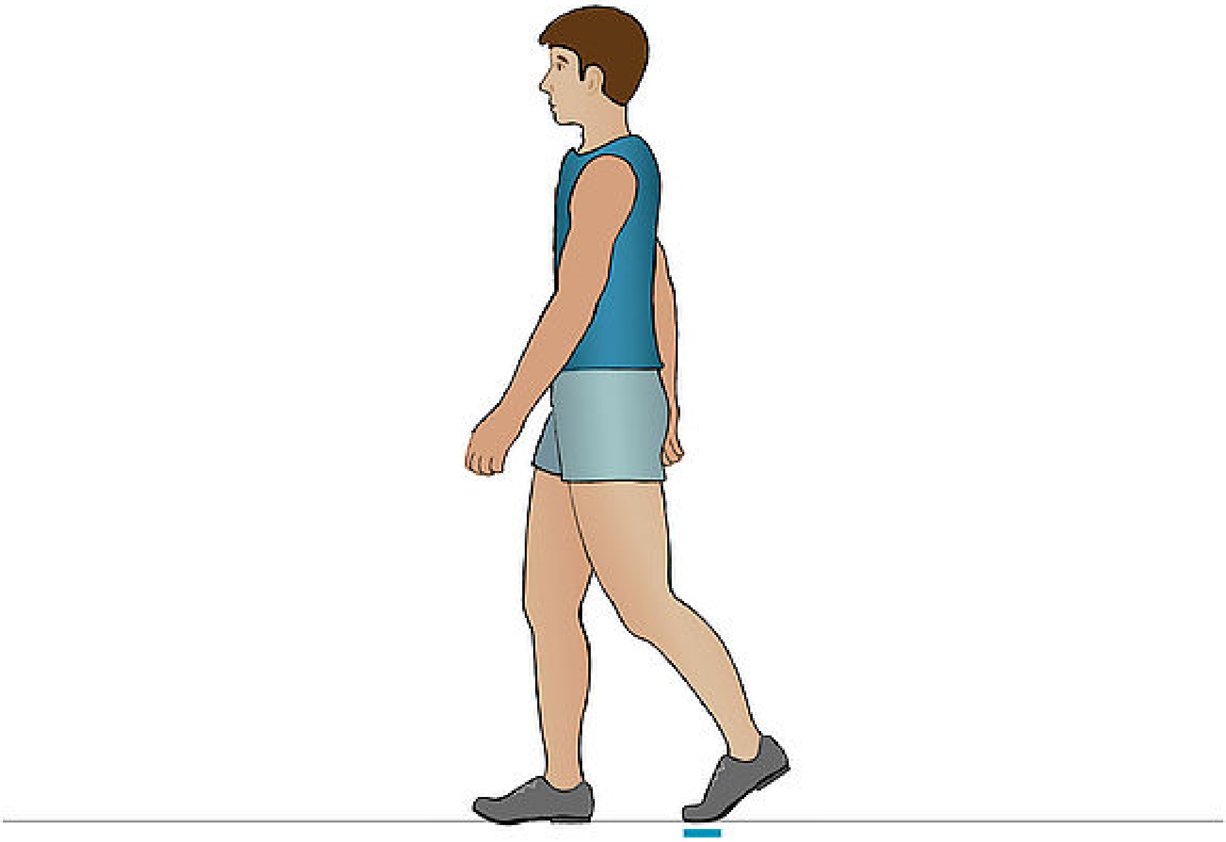

Forefoot in pre swing

A **rigid forefoot** prevents a toe extension, which still increasingly occurs in this phase, from happening. As a result:

- the knee is increasingly flexed;
- the heel is being lifted higher;
- the contact to the floor is decreased.

A **partially flexible forefoot** enables this physiological, increased toe extension. But, therefore, the toe flexors must be able to counteract actively. As a result:

- the knee angle can remain physiologically;
- the heel is not being lifted higher.

Without a forefoot, the same is happening as with a partially flexible foot piece. But, therefore, the toe flexors must be able to completely counteract actively.

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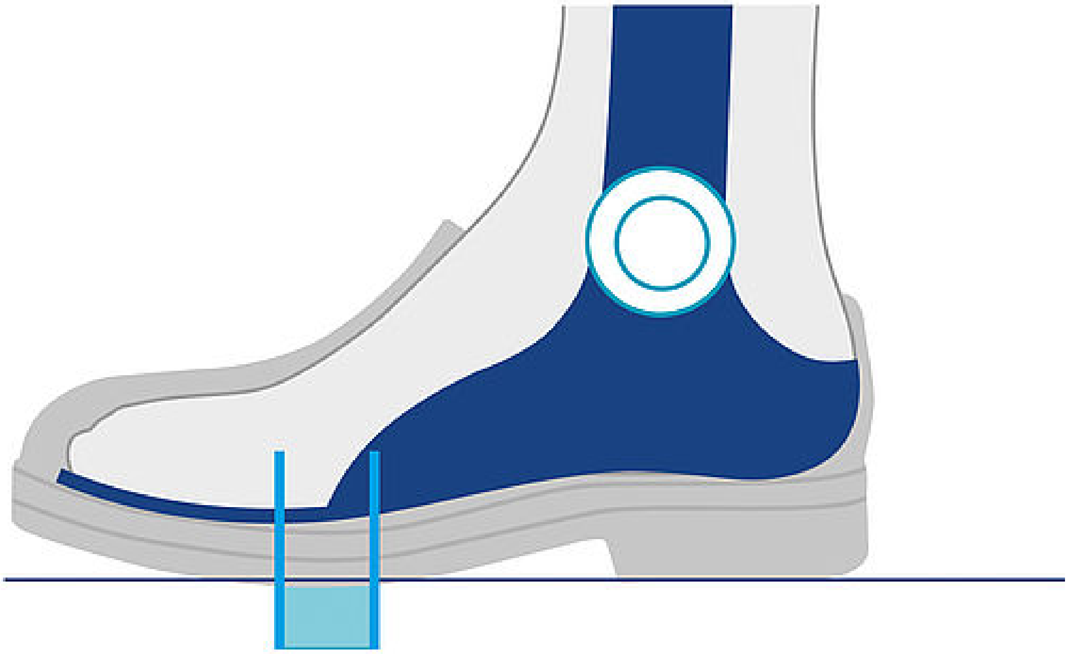
Fußteil der Orthese – Abrolllinie

Foot piece of the orthosis – rolling-off line



The foot piece's mechanical rolling-off area separates the forefoot from the heel construction and defines an axis by doing so. The anatomical rolling-off area can significantly differ from the mechanical one. If the deviation should be too high, a rigid forefoot construction can be taken into consideration, even if it is not indicated on a muscular level.

The mechanical rolling-off area affects the gait phases mid stance, late mid stance and terminal stance.

The functionality of the mechanical rolling-off area significantly depends on the forefoot construction, the dorsiflexion stop and the pitch.

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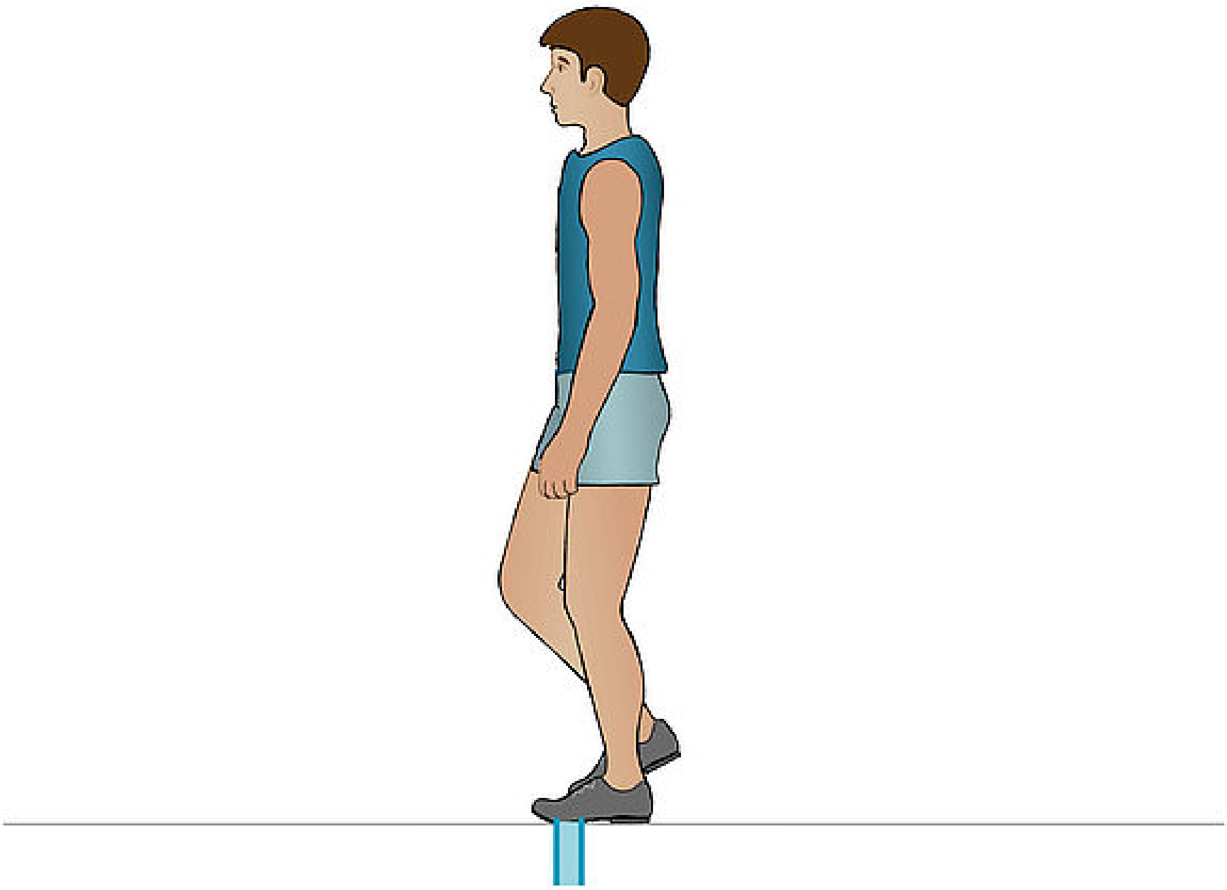
Step 2/4

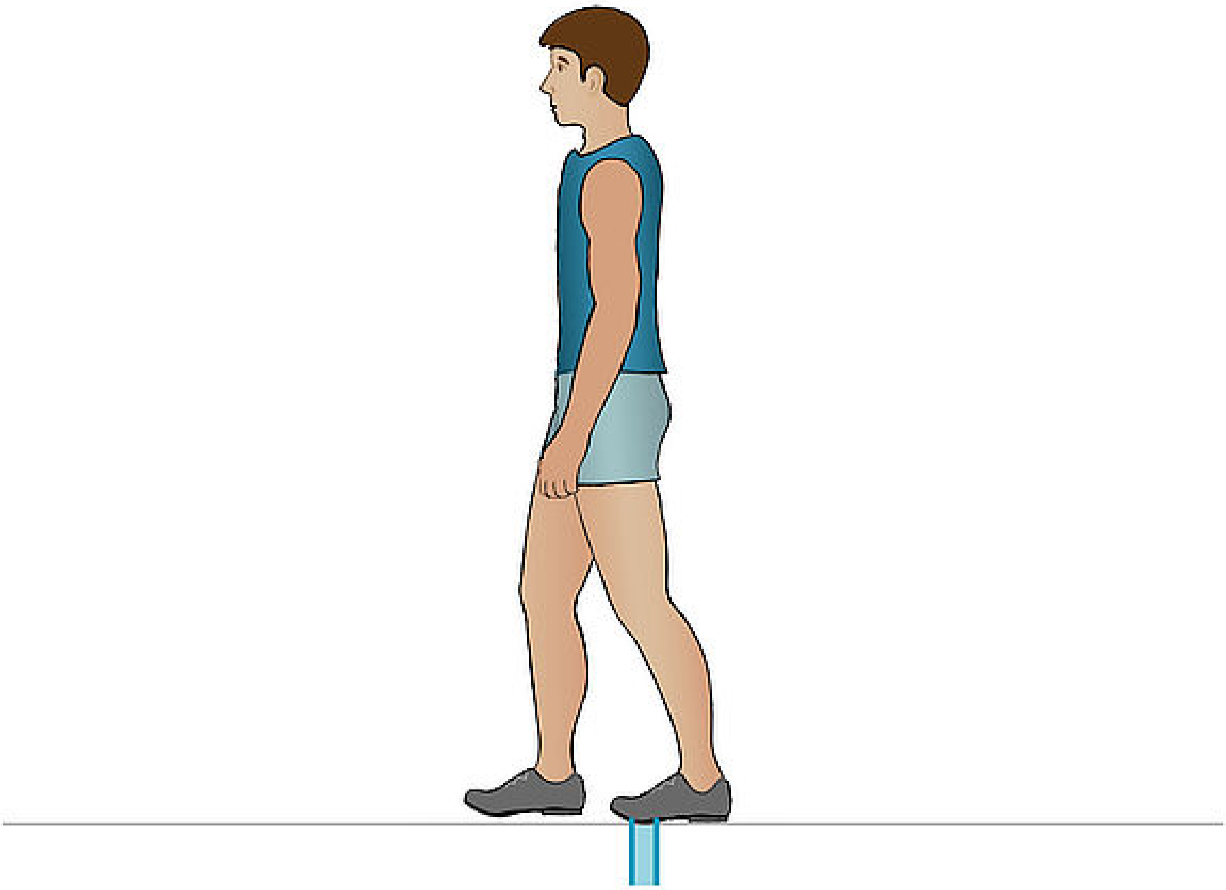


Rolling-Off Area in mid stance

The mechanical rolling-off area limits the stance area (supportive area) distally. This way, it expands from the heel lever to the mechanical rolling-off area.

The GRF (ground reaction force) vector must fall into the supportive area in order for the legs to be able to take the load. This is an important task for the orthotist or qualified/trained expert, especially when height compensations and knee flexion contractures are involved.

Step 3/4

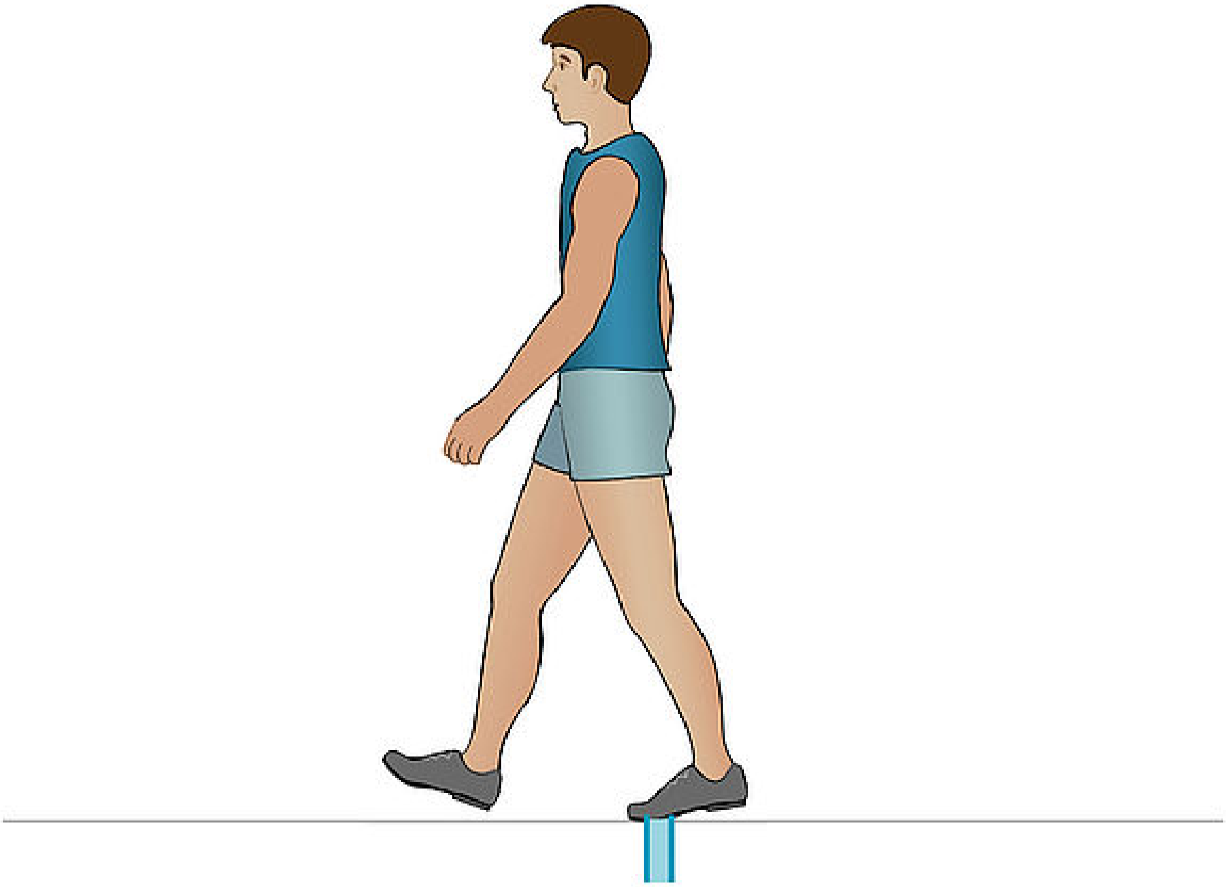


Rolling-Off Area in late mid stance

The mechanical rolling-off area limits the stance area (supportive area) distally. This way, it expands from the heel lever to the mechanical rolling-off area.

The GRF (ground reaction force) vector must fall into the supportive area in order for the legs to be able to take the load. This is an important task for the orthotist or qualified/trained expert, especially when height compensations and knee flexion contractures are involved.

Step 4/4



Rolling-Off Area in terminal stance

The mechanical rolling-off area contains one axis. The foot rotates around this axis, because the GRF vector falls ahead of the rolling-off area, now. This way, the heel is lifted from the ground. The body's centre of gravity remains high.

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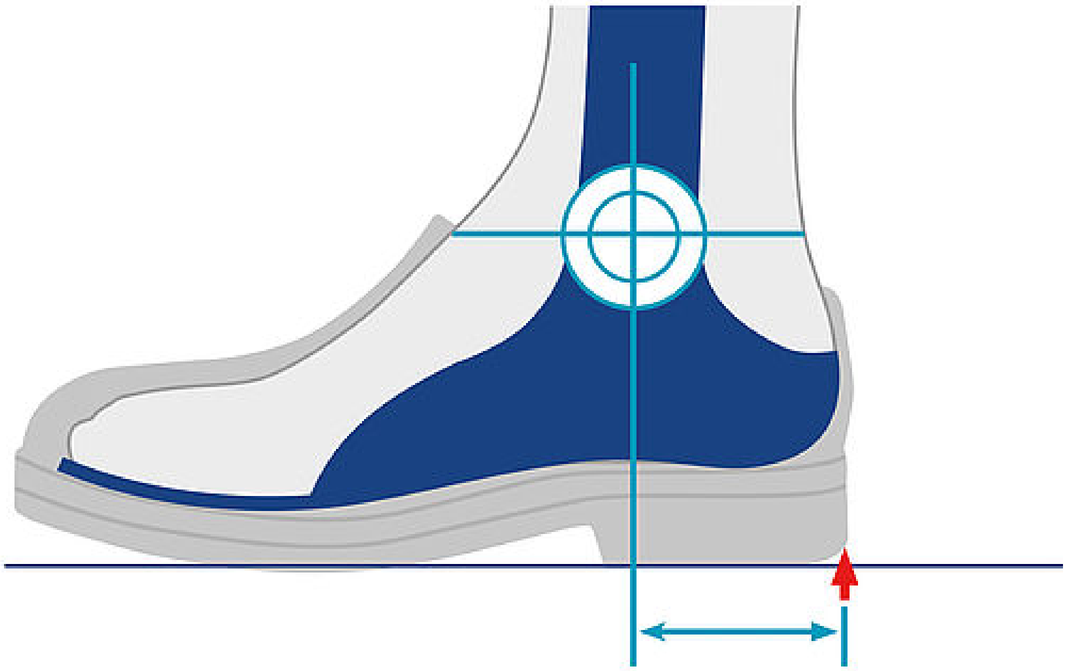
Fuß – Fersenkipphebel

Foot – heel lever



The mechanical heel lever represents an axis. The foot rotates around this axis. In addition, the heel lever limits the stance area (supportive area) proximally. The anatomical heel lever can significantly differ from the mechanical one. The heel lever affects the gait phases initial contact, loading response, early mid stance, mid stance and late mid stance.

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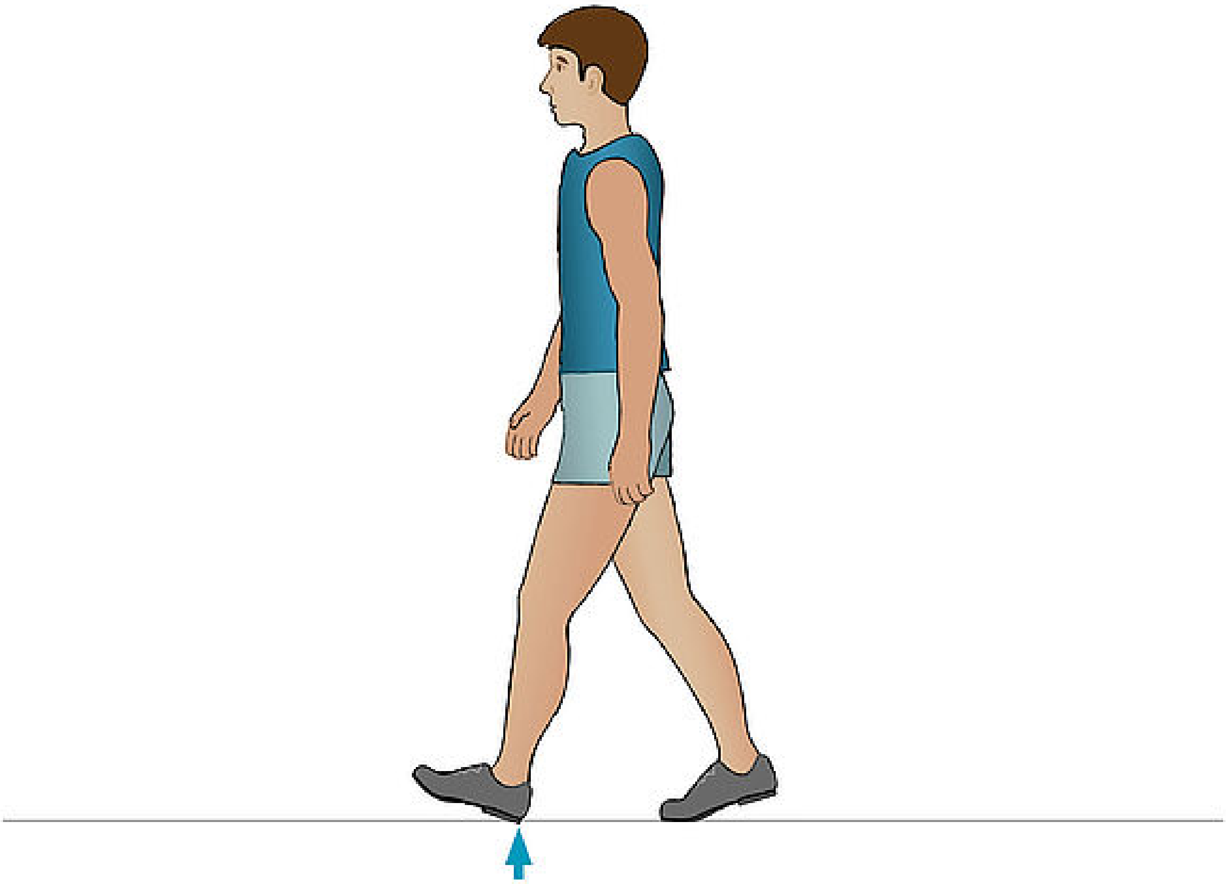

Heel Lever in initial contact

The mechanical heel lever represents the first ground contact.

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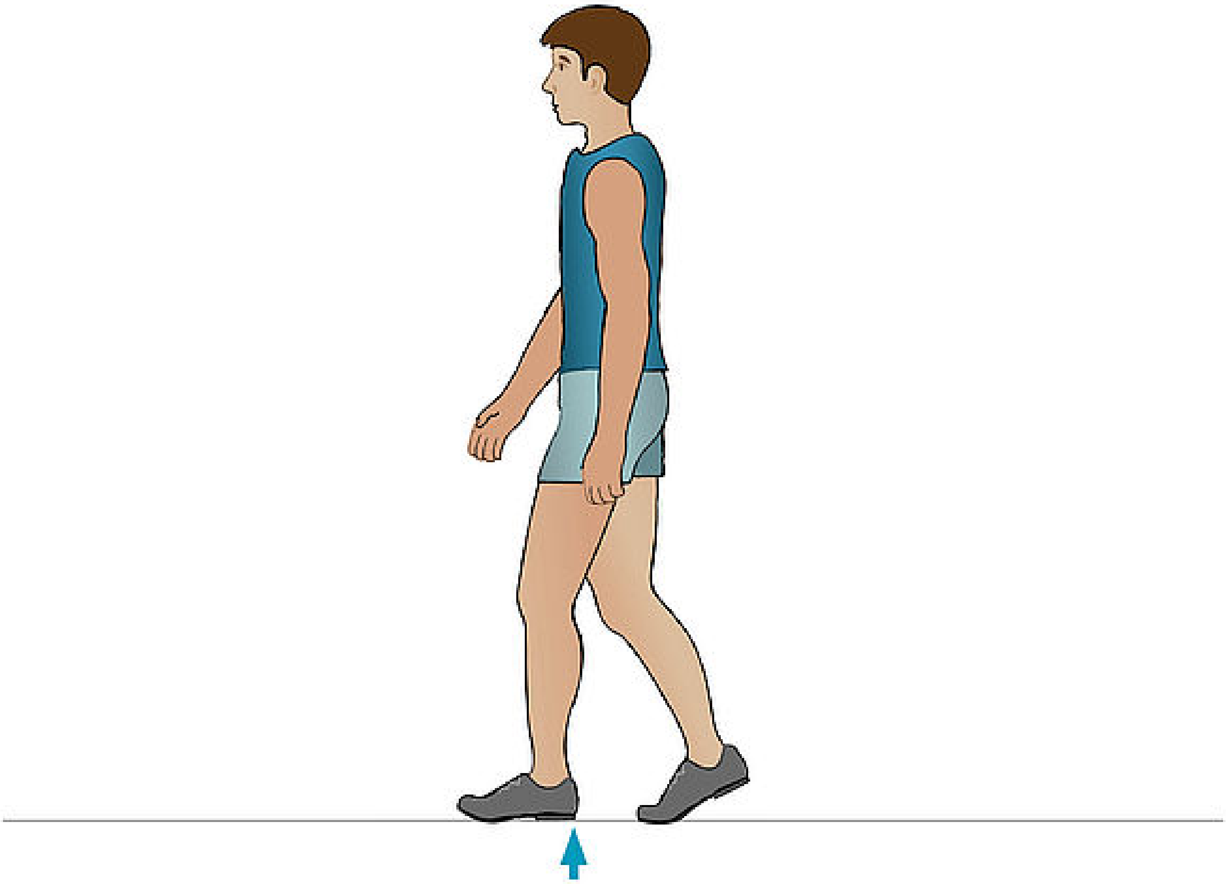

Heel Lever in loading response

The foot rotates around the mechanical heel lever. This results in:

- a plantar flexion, if the system ankle joint allows such (plantar flexion: free or against spring force) - otherwise, there will solely be a tibia inclination;
- a tibia inclination and a knee flexion, if the system knee and ankle joint allow such (plantar flexion: free or against spring force; flexion: free) - otherwise, there will solely be a tibia inclination or in case of a locked system knee joint an inclination of the hip and thigh.

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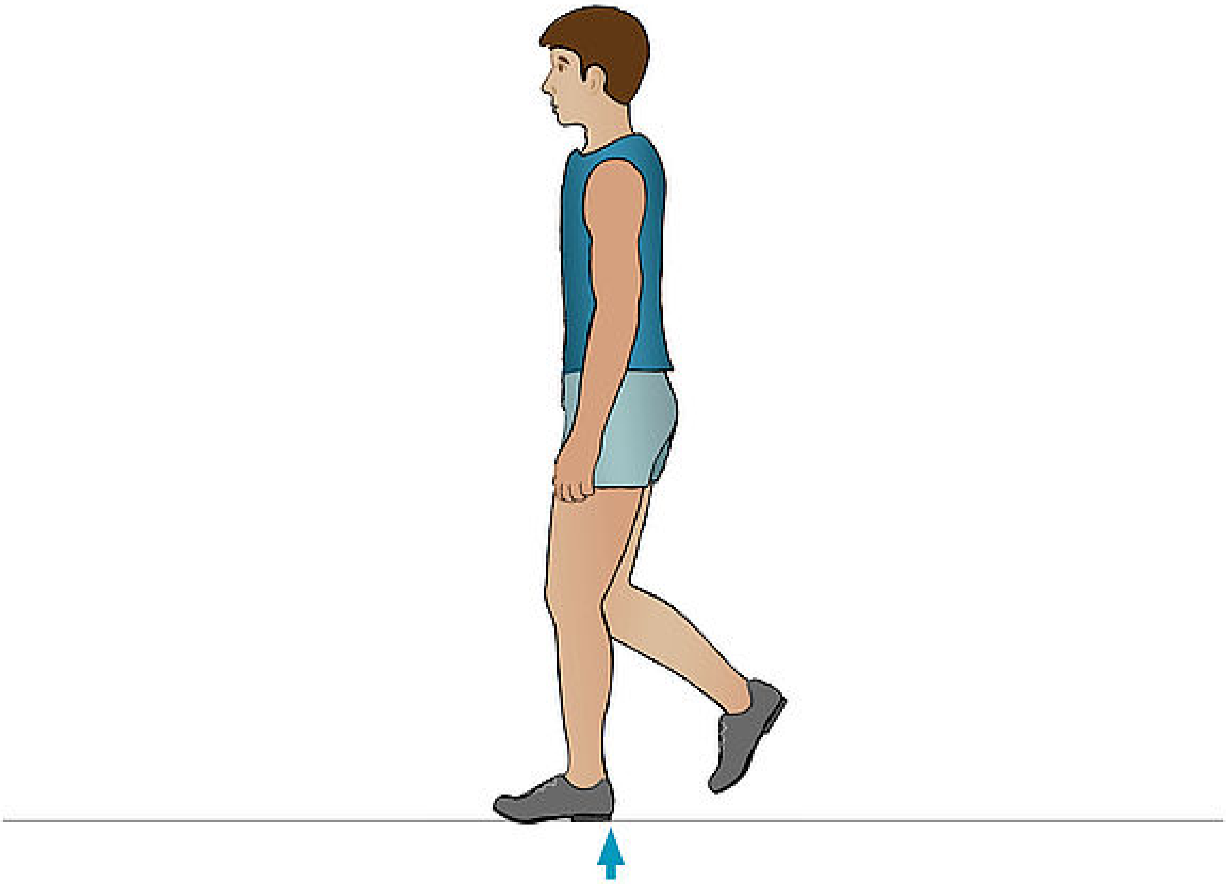

Heel Lever in early mid stance

The mechanical heel lever limits the stance area (supportive area) proximally. This way, it expands from the heel lever to the mechanical rolling-off area.

The GRF (ground reaction force) vector must fall into the supportive area in order for the legs to be able to take the load. This is an important task for the orthotist or qualified/trained expert, especially when height compensations and knee flexion contractures are involved.

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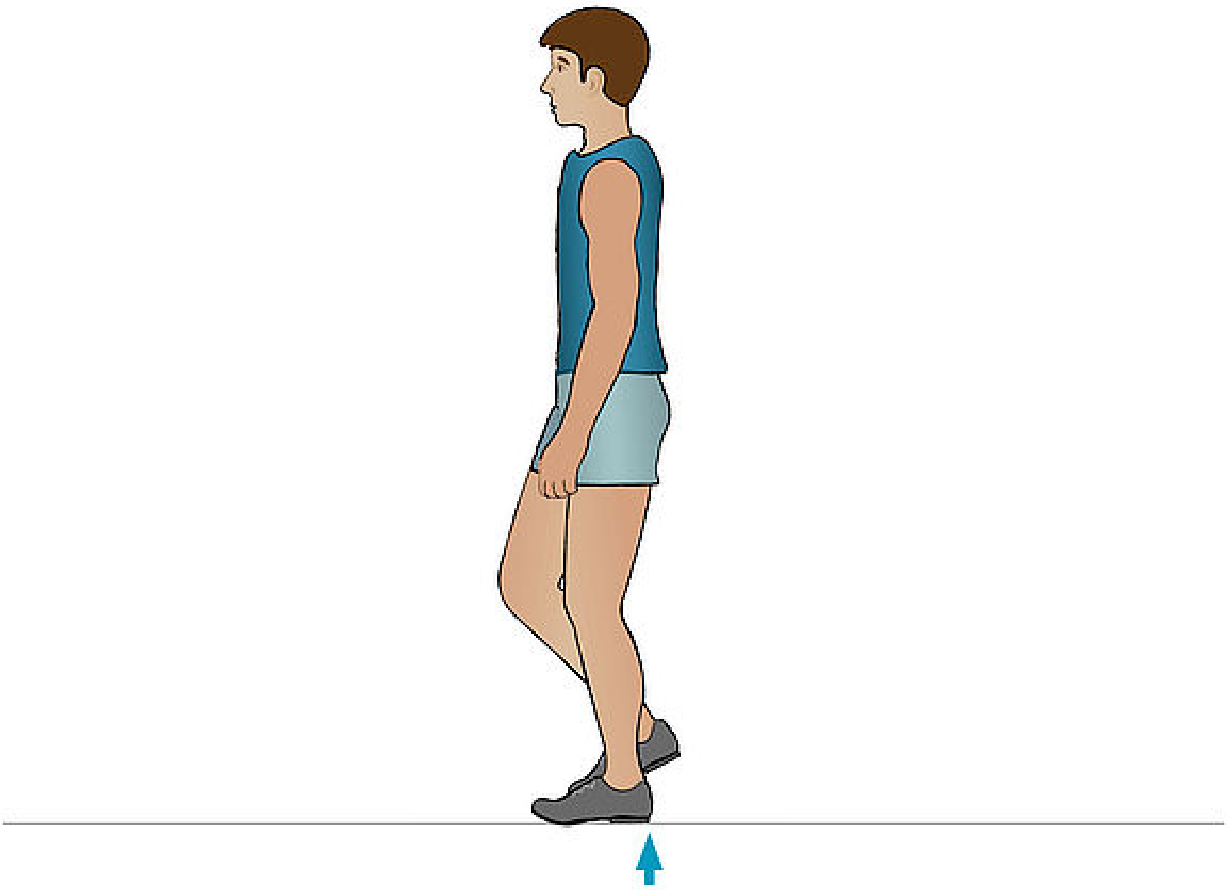
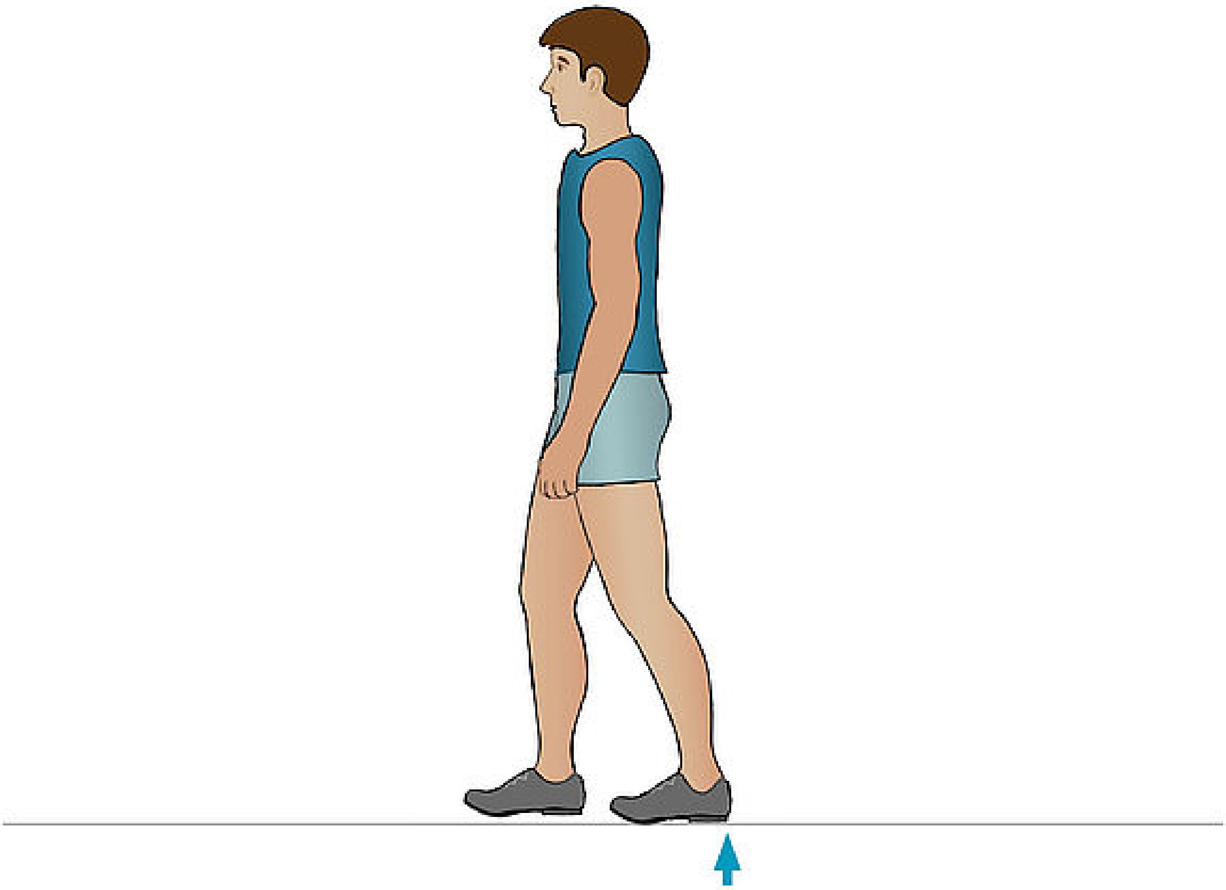


Heel Lever in mid stance

The mechanical heel lever limits the stance area (supportive area) proximally. This way, it expands from the heel lever to the mechanical rolling-off area.

The GRF (ground reaction force) vector must fall into the supportive area in order for the legs to be able to take the load. This is an important task for the orthotist or qualified/trained expert, especially when height compensations and knee flexion contractures are involved.

Step 6/6



Heel Lever in late mid stance

The mechanical heel lever limits the stance area (supportive area) proximally. This way, it expands from the heel lever to the mechanical rolling-off area.

The GRF (ground reaction force) vector must fall into the supportive area in order for the legs to be able to take the load. This is an important task for the orthotist or qualified/trained expert, especially when height compensations and knee flexion contractures are involved.

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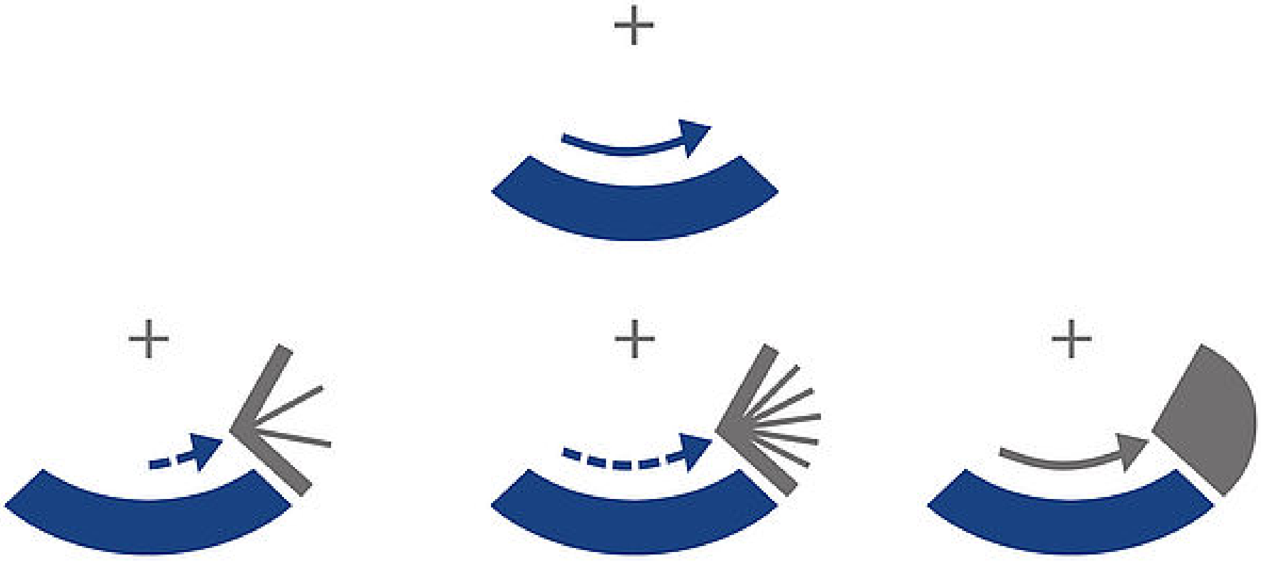
Knöchel – Plantaranschlag/ Plantarflexionsbegrenzung

Ankle – plantar flexion stop/plantar flexion limitation



Similar to the dorsiflexion stop, the plantar flexion stop can be realised in a number of ways and the effects differ, depending on the gait phase. Instead of a plantar flexion stop, this is often referred to as a foot lifting effect.

The plantar flexion stop affects the gait phases initial contact, loading response, early mid stance, pre swing, initial swing, mid swing and terminal swing.

It does not affect the other three gait phases, because here, the GRF vector falls before the system ankle joint's pivot point and the dorsiflexion stop is reached. The contact to the plantar flexion stop is lost or is no longer in effect.

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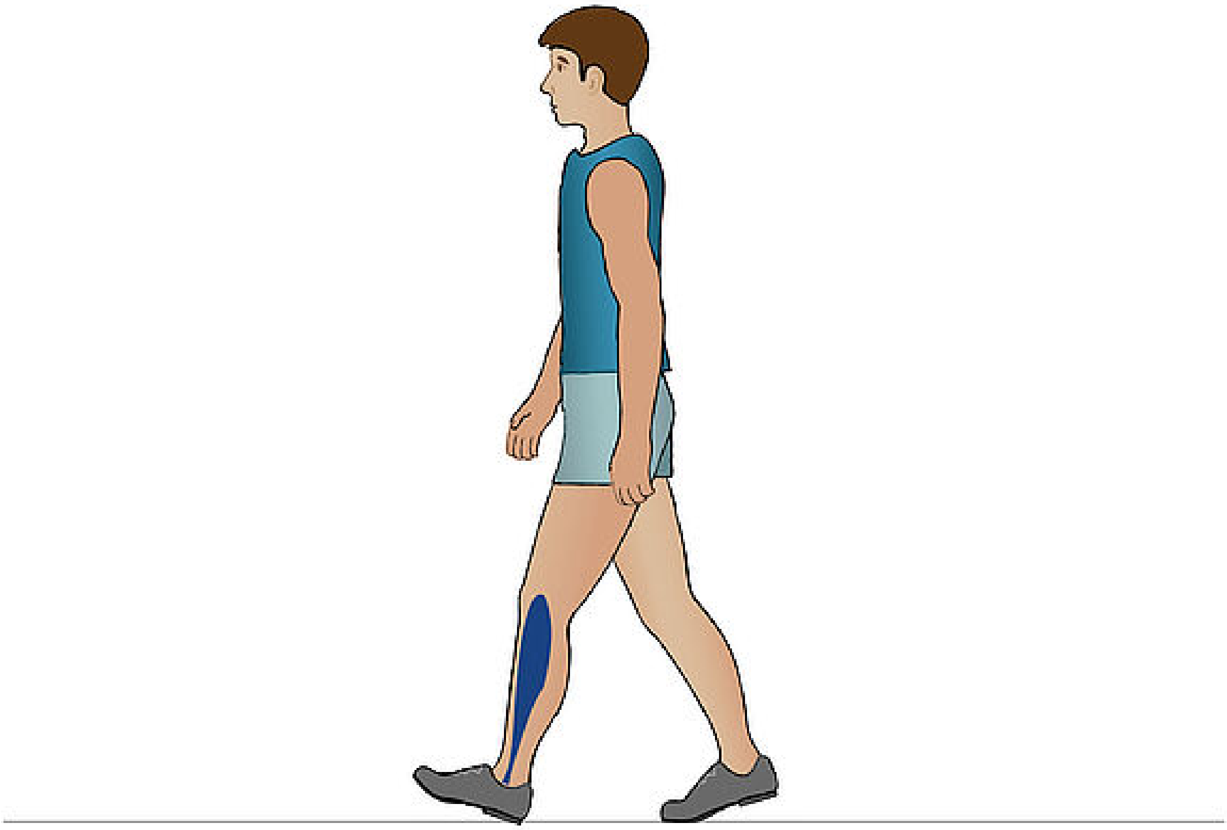

Plantar Flexion Stop/Plantar Flexion Limitation in initial contact
The heel lever gets in contact to the ground and results in a plantar flexion, which - in co-operation with the tibia inclination - initiates the loading response. This is the physiological process and should be reached, whenever possible. The plantar flexion stop can limit the plantar flexion here, or enable a resistance against this motion. The latter results in a controlled plantar flexion.

Without Plantar Flexion Stop:
If a plantar flexion without limitation or without resistance is possible, the situation is the same as for the variation against the spring force. But, therefore, the dorsal flexors must be active.

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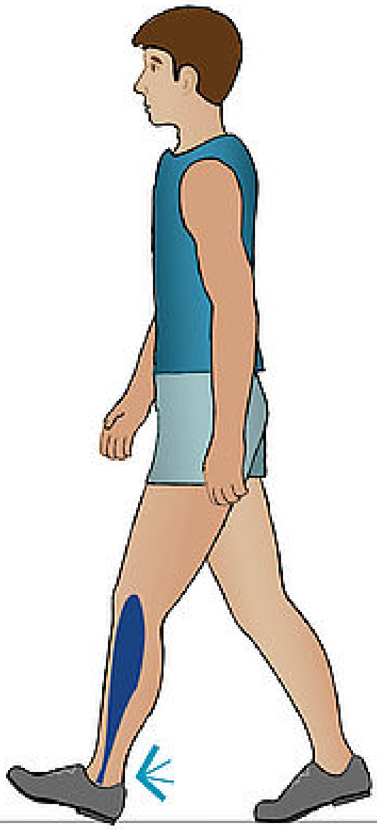
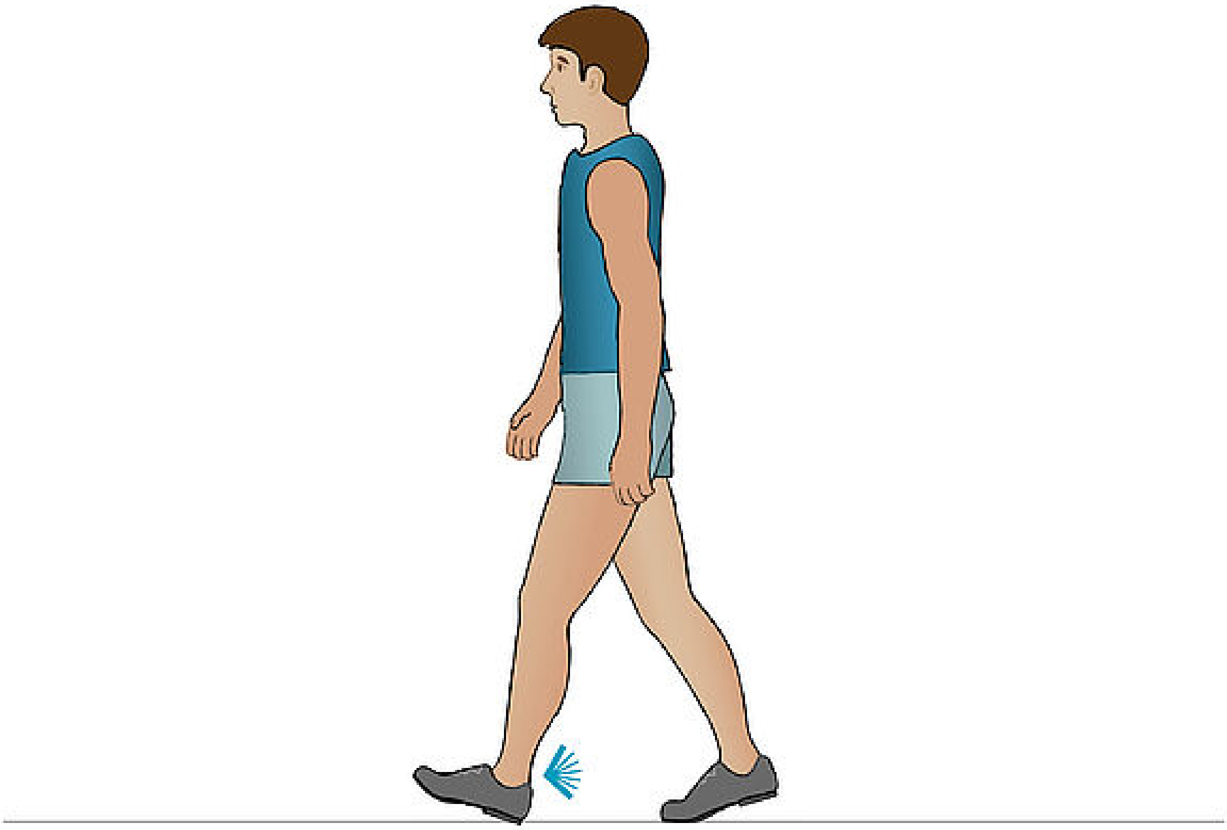


Plantar Flexion Stop/Plantar Flexion Limitation in initial contact

Without Plantar Flexion Stop, with Dorsiflexion Assist:
If a plantar flexion without limitation or without resistance is possible, the situation is the same as for the variation against the spring force. But, therefore, the dorsal flexors must be active.

This is also valid for system joints with a spring unit, if the spring is just very weak.



Plantar Flexion Stop/Plantar Flexion Limitation in initial contact

Dynamic Plantar Flexion Stop:
If a plantar flexion against a spring resistance is possible (not in case of a NEURO SPRING/VARIO-SPRING), this results in:

- a physiological plantar flexion;
- a physiological tibia inclination;
- a physiological slight knee flexion;
- a high remaining body's centre of gravity;
- a symmetric step length.

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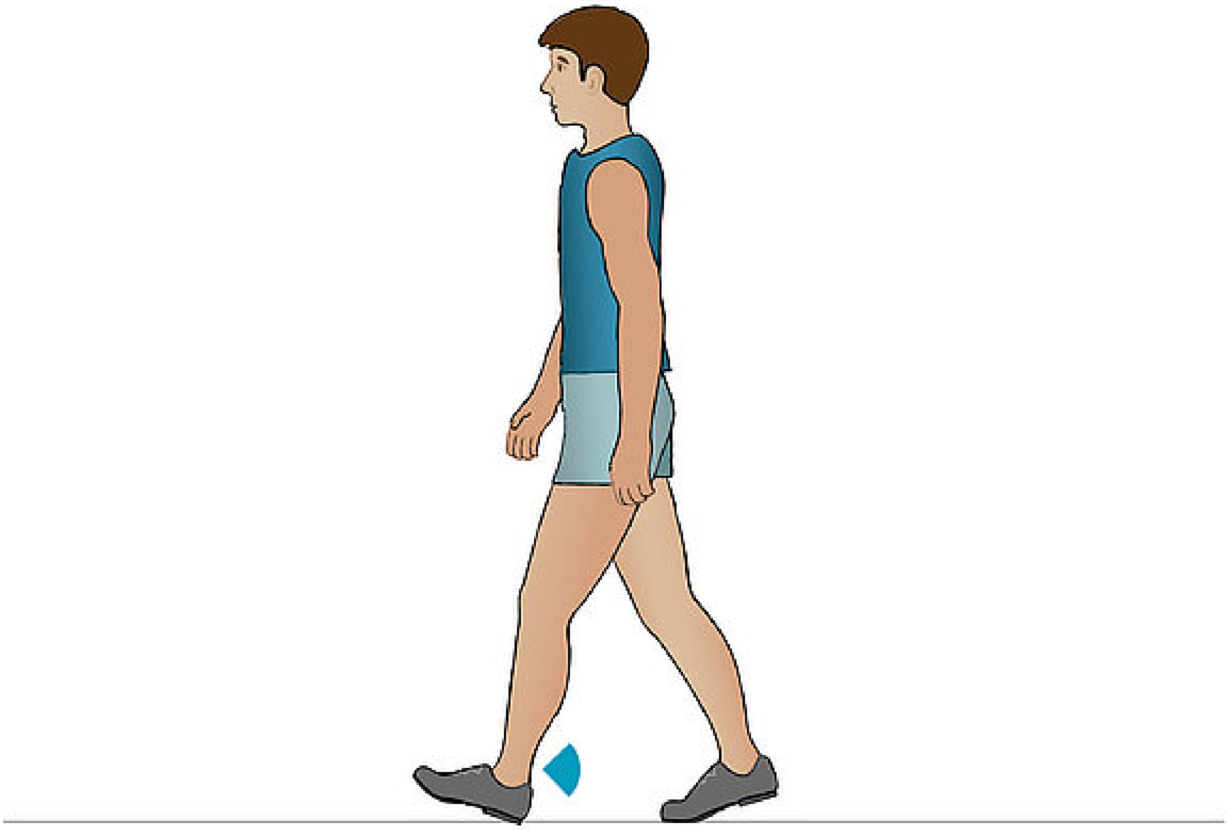

Plantar Flexion Stop/Plantar Flexion Limitation in initial contact

A **static plantar flexion stop** in the shape of any kind of motion limitation, does not enable a plantar flexion. As a result:

- a physiological plantar flexion cannot take place;
- the angle from lower leg to foot remains the same;
- the lower leg is significantly more accelerated forwards;
- the knee is highly flexed;
- the hip is moved forward in a highly accelerated way;
- the body's centre of gravity drops due to the increased flexion;
- the step length on the contralateral side is shortened as the patient tries to compensate the feeling of insecurity.

Plantar Flexion Stop/Plantar Flexion Limitation in loading response

This phase is physiologically characterised by a plantar flexion. The foot reaches complete contact to the ground and the lower leg moves forward while the knee is flexed. The plantar flexion stop can limit the plantar flexion here or enable a resistance against this motion. The latter results in a controlled plantar flexion.

Without Plantar Flexion Stop:

If a plantar flexion without limitation or without resistance is possible, the situation is the same as for the variation against the spring force. But, therefore, the dorsal flexors must be active.

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Plantar Flexion Stop/Plantar Flexion Limitation in loading response

Without Plantar Flexion Stop, with Dorsiflexion Assist:
If a plantar flexion without limitation or without resistance is possible, the situation is the same as for the variation against the spring force. But, therefore, the dorsal flexors must be active.

This is also valid for system joints with a spring unit, if the spring is just very weak.

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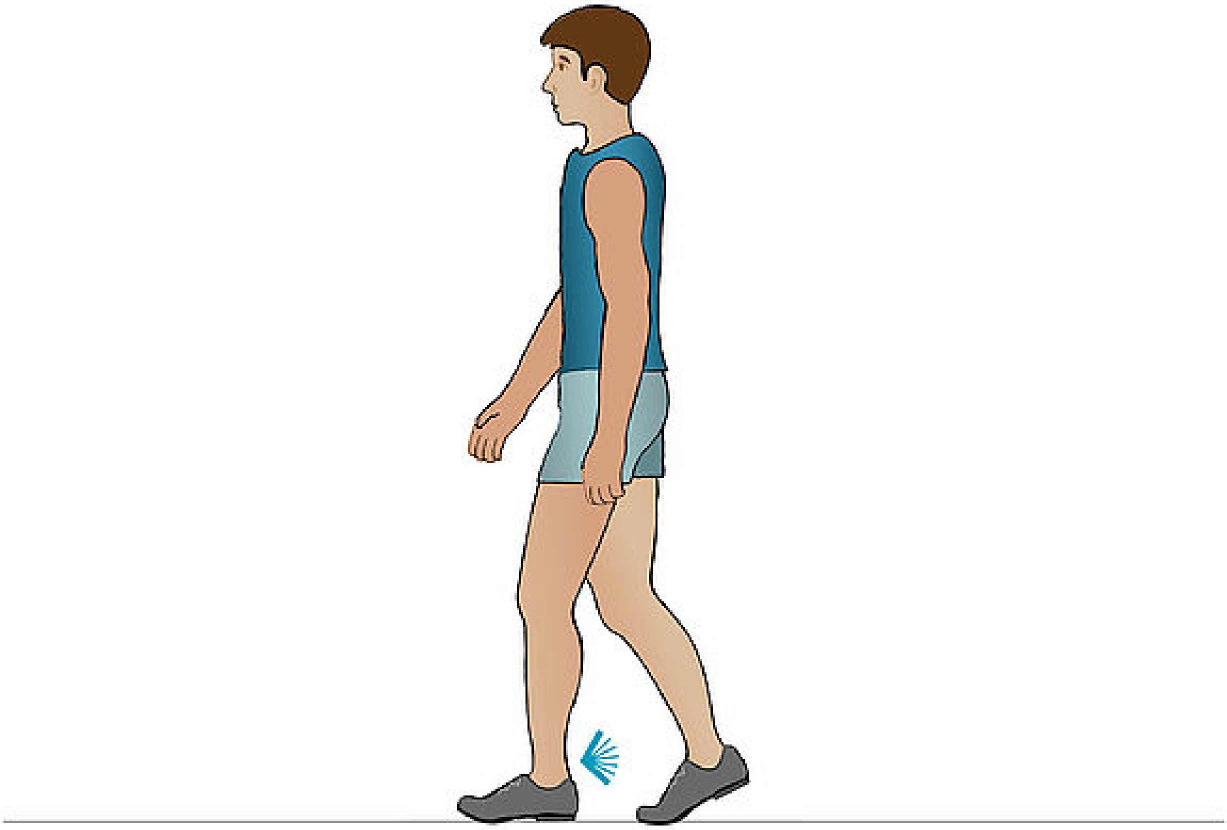
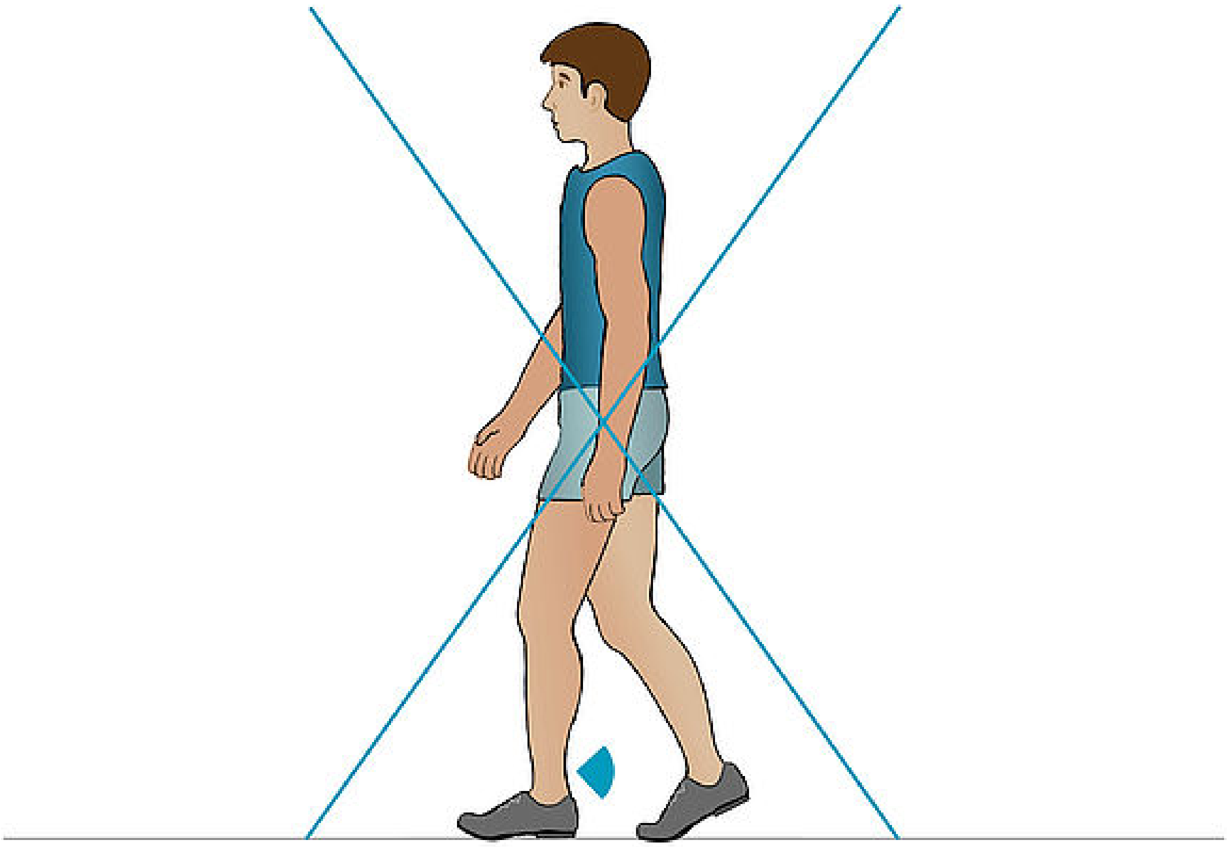


Plantar Flexion Stop/Plantar Flexion Limitation in loading response

Dynamic Plantar Flexion Stop:

If a plantar flexion against a spring resistance is possible, this results in:

- a physiological plantar flexion;
- a physiological tibia inclination;
- a physiological slight knee flexion;
- a high remaining body's centre of gravity;
- a symmetric step length.



Plantar Flexion Stop/Plantar Flexion Limitation in loading response
A **static plantar flexion stop** in the shape of any kind of motion limitation does not enable a plantar flexion. This results in skipping this phase.

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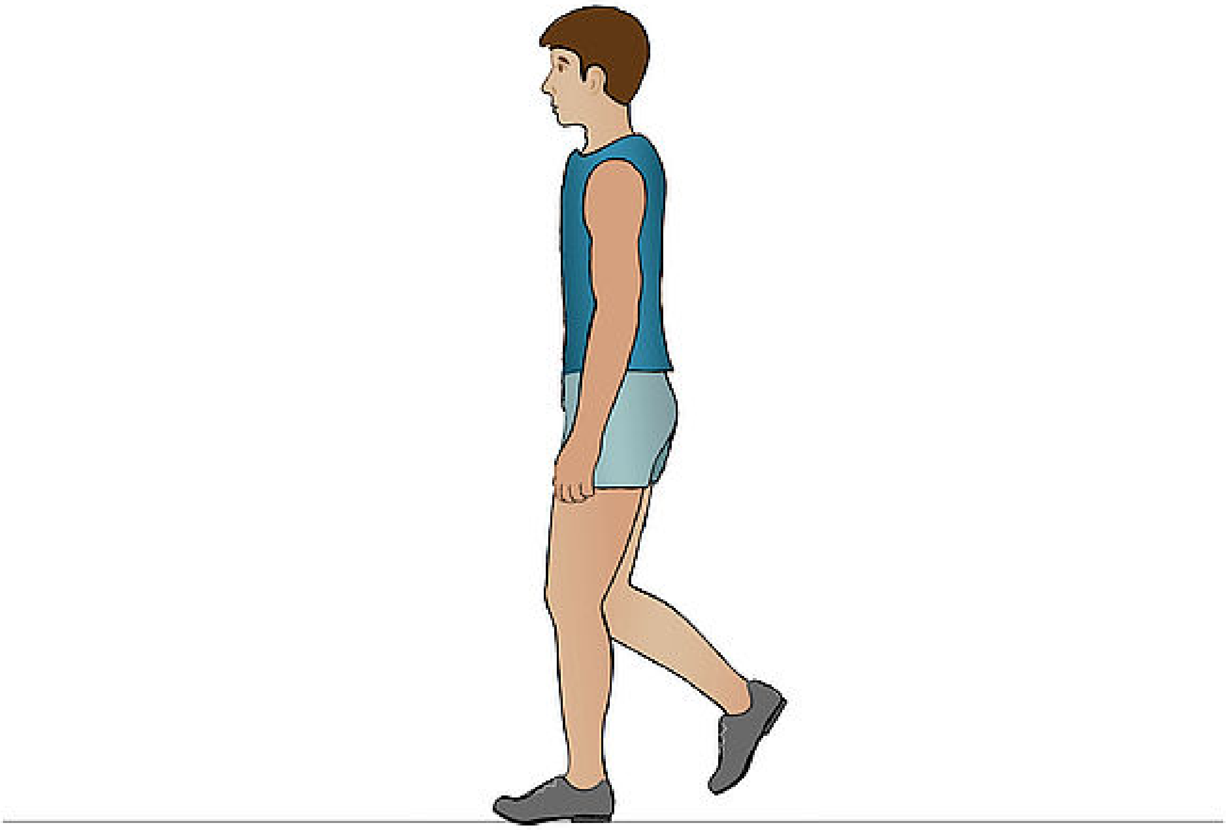

Plantar Flexion Stop/Plantar Flexion Limitation in early mid stance
The plantar flexion is reduced, because the lower leg moves forward.

Without Plantar Flexion Stop:
If a plantar flexion without limitation or without resistance is possible, this has no effects here.

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Plantar Flexion Stop/Plantar Flexion Limitation in early mid stance

Without Plantar Flexion Stop, with Dorsiflexion Assist:
If a plantar flexion without limitation or without resistance is possible, this has no effects here.

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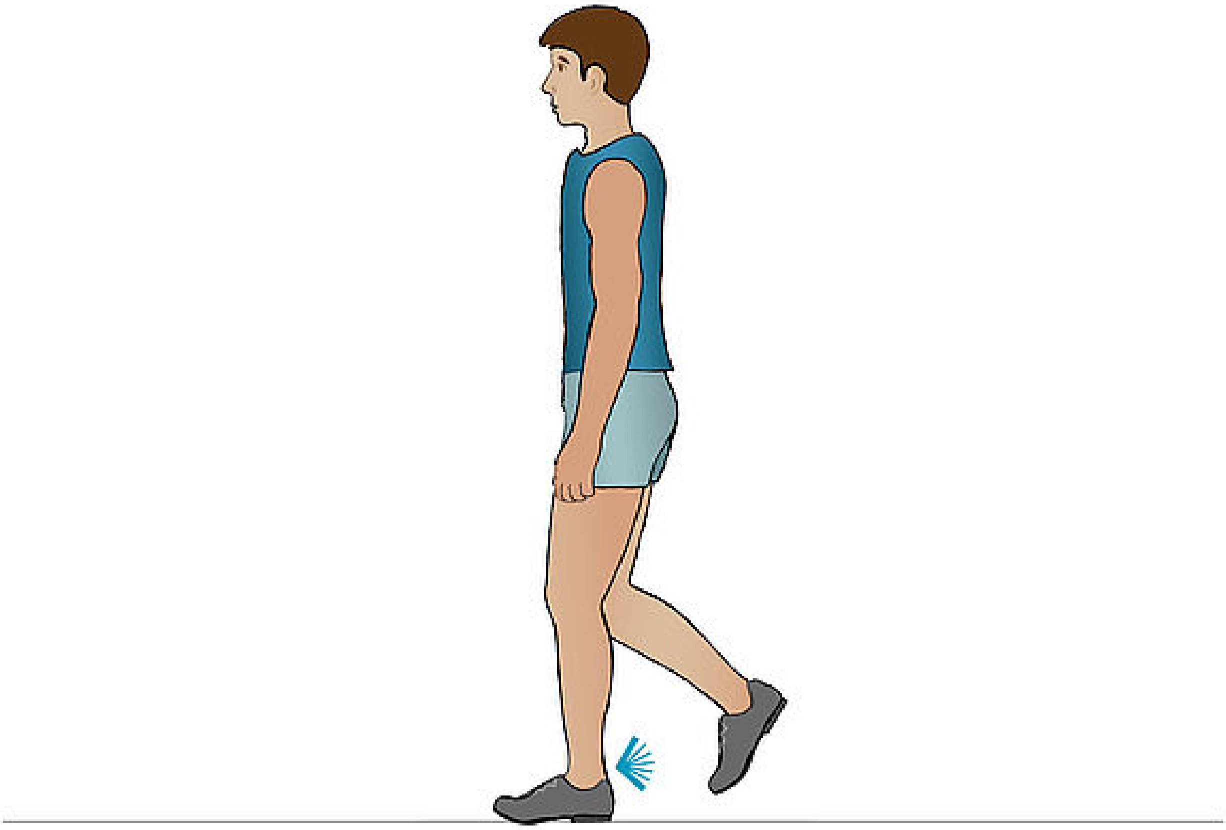

Plantar Flexion Stop/Plantar Flexion Limitation in early mid stance

Dynamic Plantar Flexion Stop:
If a plantar flexion against a spring resistance is possible, this results in a supported dorsiflexion.

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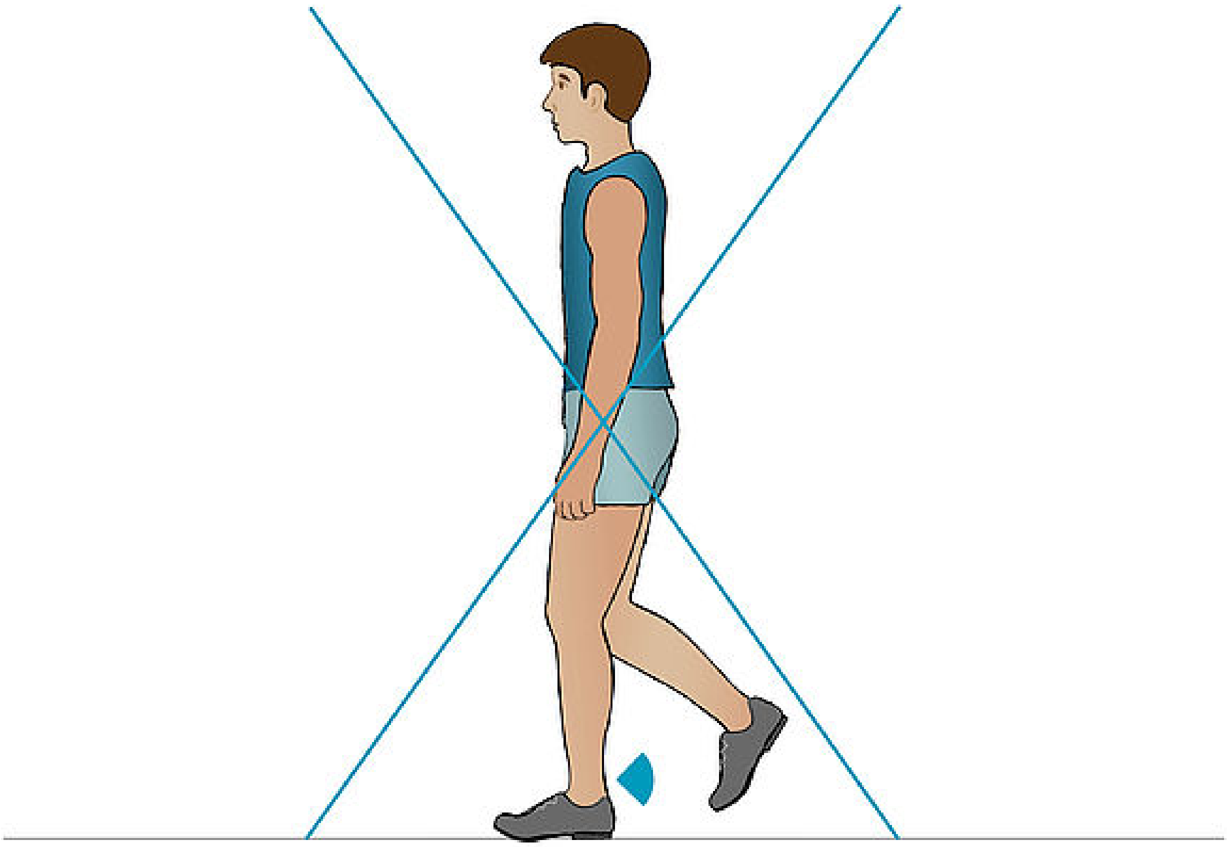
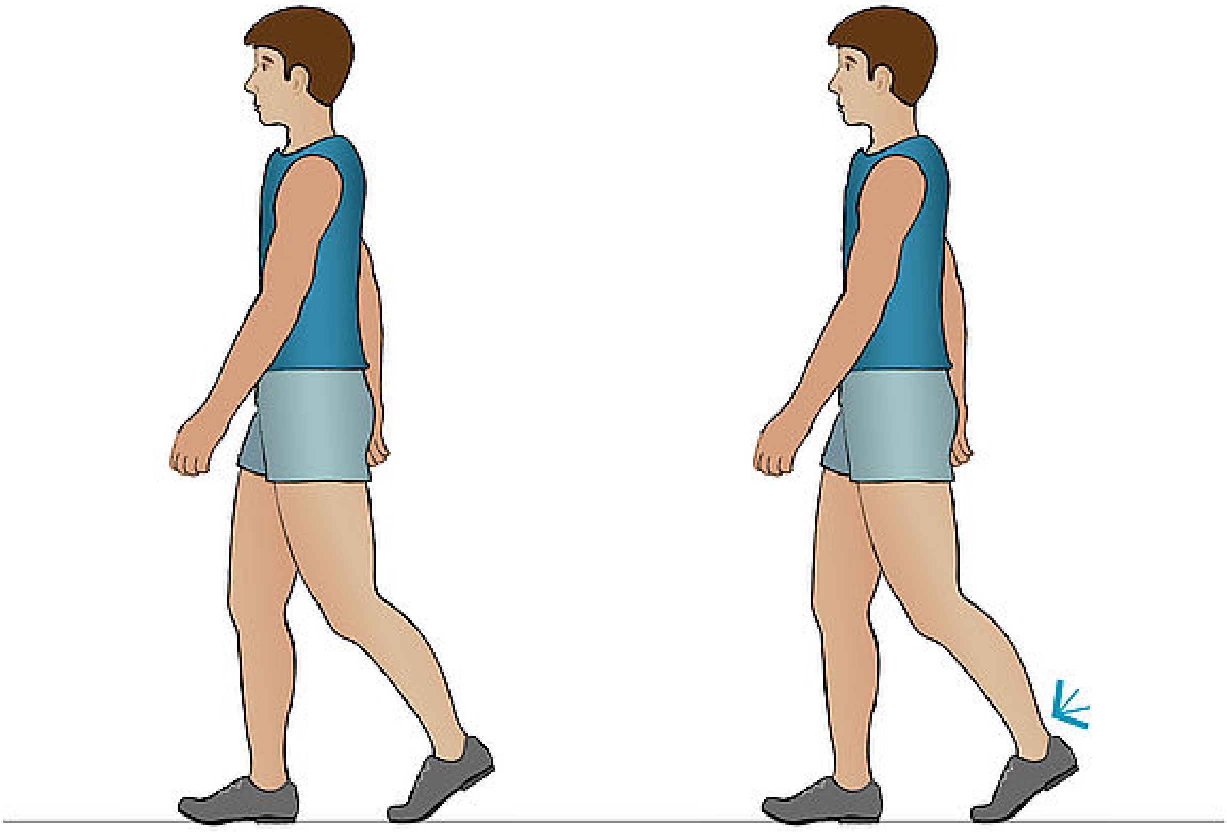


Plantar Flexion Stop/Plantar Flexion Limitation in early mid stance

Static Plantar Flexion Stop:
If the plantar flexion is limited, this phase is skipped.



Plantar Flexion Stop/Plantar Flexion Limitation in pre swing

Without Plantar Flexion Stop (with or without dorsiflexion assist)**:**
If a plantar flexion without limitation or without resistance is possible, this has no effects here.

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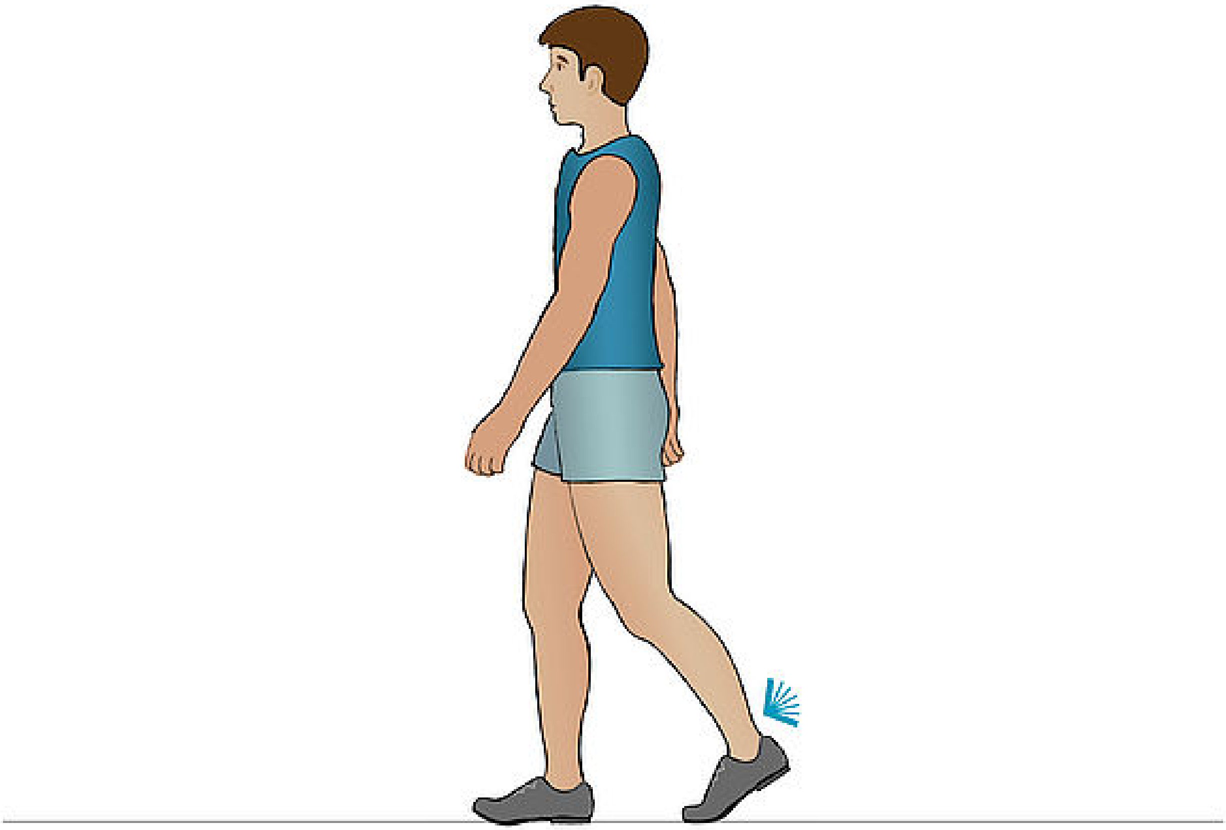
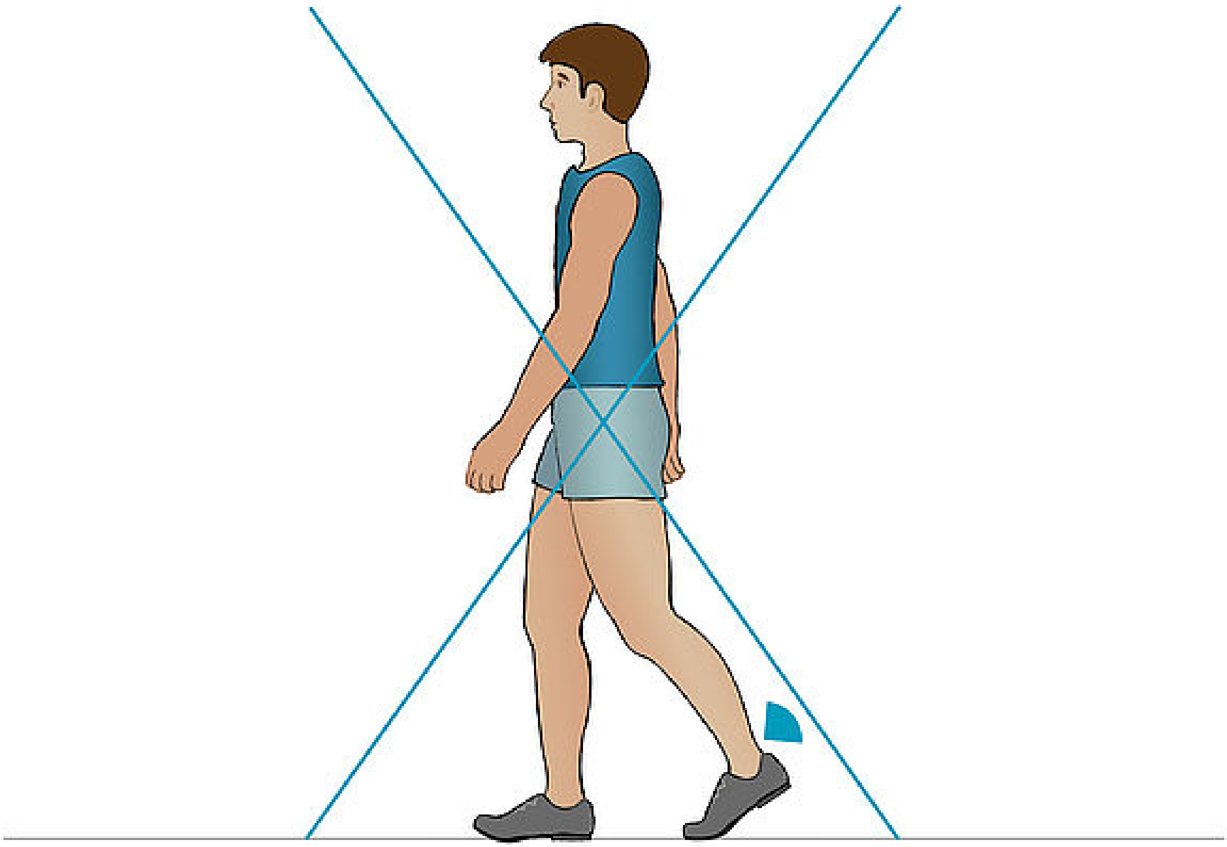


Plantar Flexion Stop/Plantar Flexion Limitation in pre swing

Dynamic Plantar Flexion Stop:

In case of a very strong spring resistance and due to the leverage ratio, a plantar flexion is not possible in this phase. In case of weaker resistances, the same applies as for without plantar flexion stop (with or without dorsiflexion assist).



Plantar Flexion Stop/Plantar Flexion Limitation in pre swing

Static Plantar Flexion Stop:

A plantar flexion stop can prevent the physiological plantar flexion stop.

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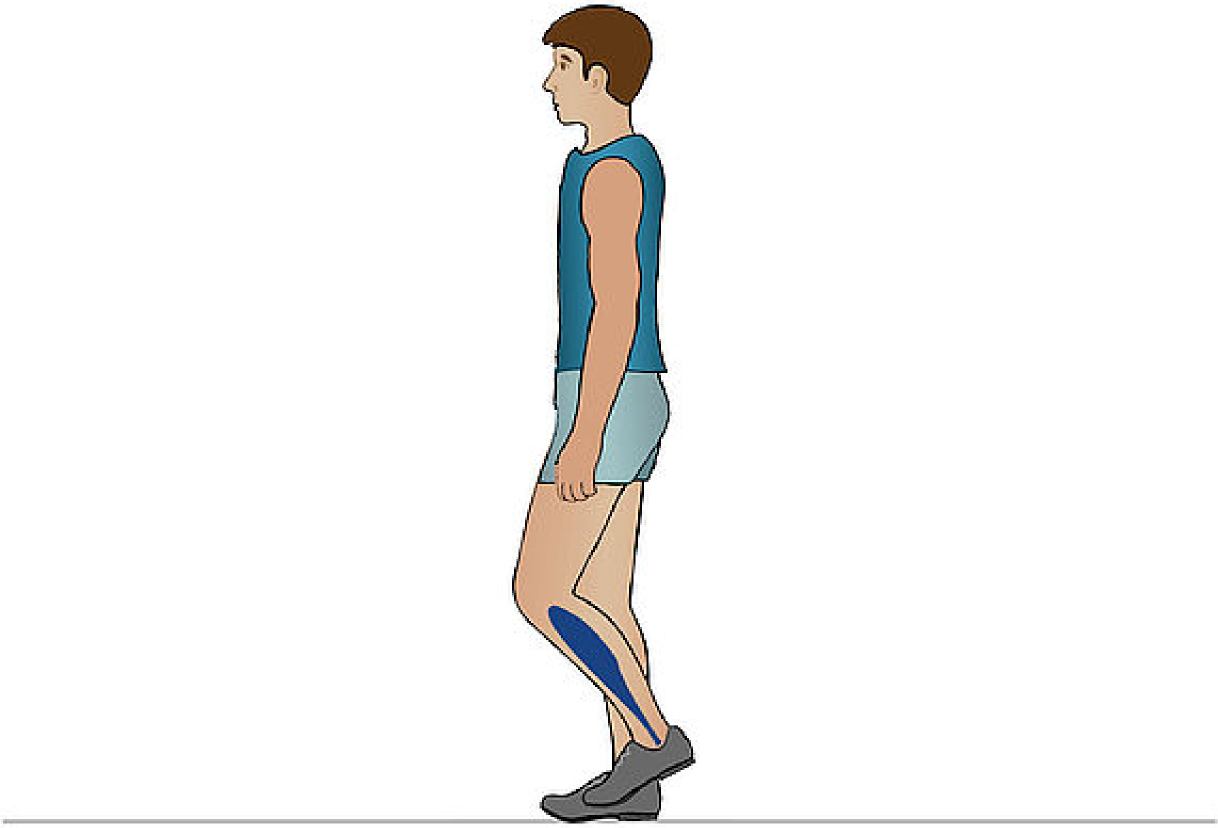

Plantar Flexion Stop/Plantar Flexion Limitation in initial swing

Without Plantar Flexion Stop:
The foot must be kept high by the dorsal flexors in order for a physiological, functional shortening of the leg to happen and to prevent compensatory movements (circumduction, vaulting etc.).

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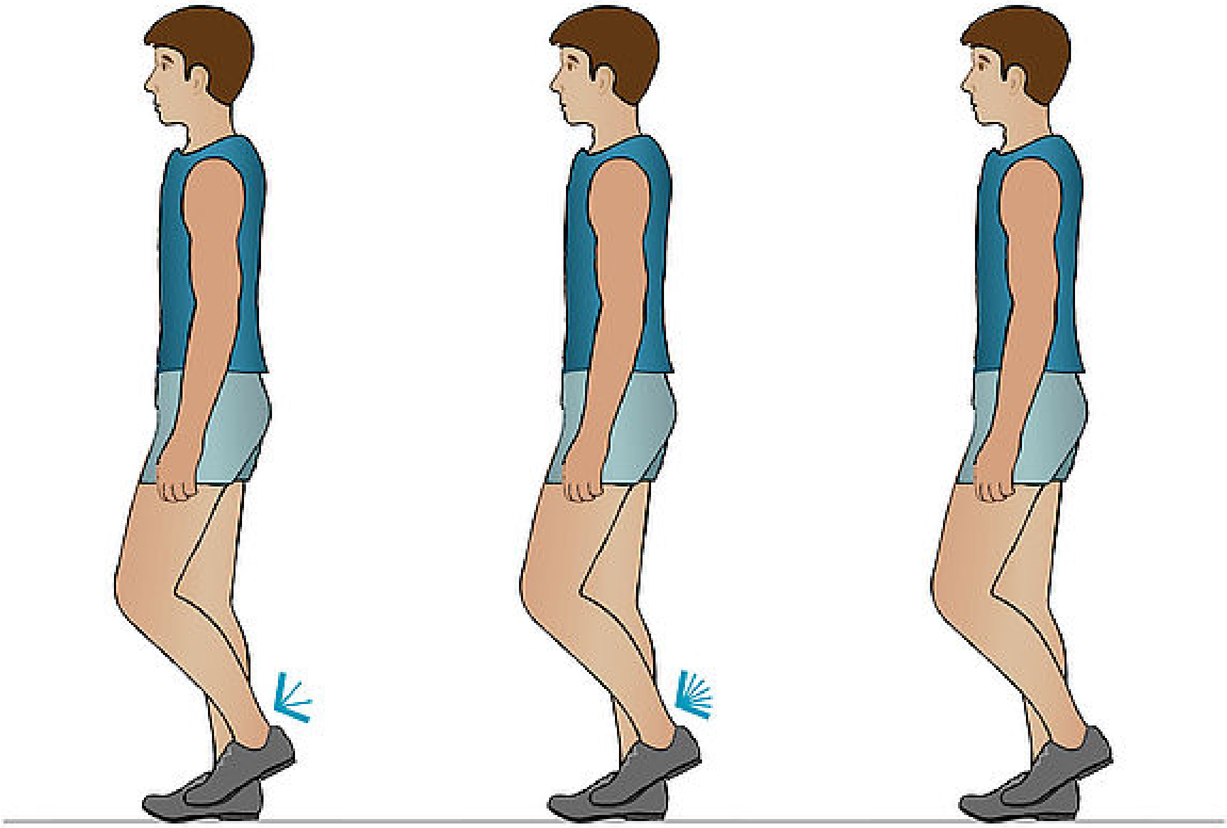
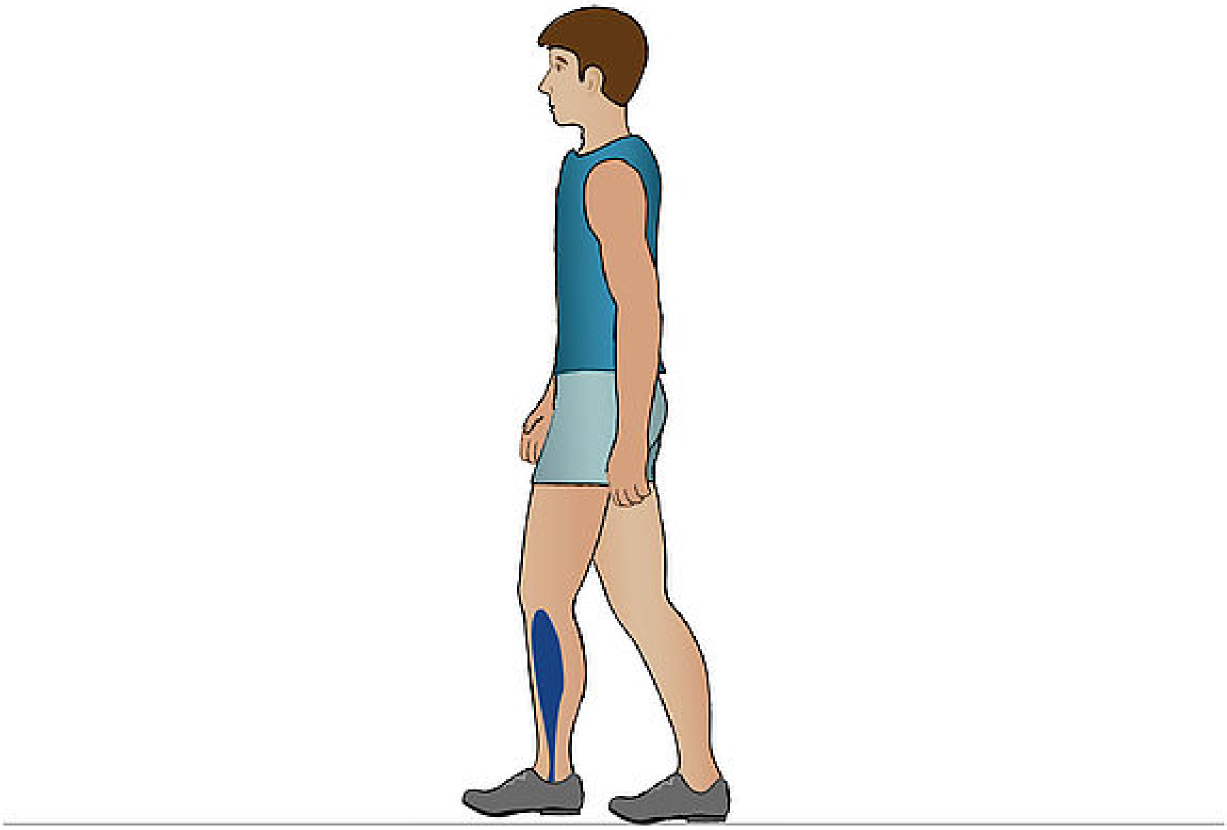


Plantar Flexion Stop/Plantar Flexion Limitation in initial swing

Without plantar flexion stop, **with dorsiflexion assist** or a **dynamic plantar flexion stop** (with a sufficient spring resistance) as well as a **static plantar flexion stop** result in:

- a physiological, functional shortening of the leg;
- no compensatory movements (circumduction, vaulting etc.).



Plantar Flexion Stop/Plantar Flexion Limitation in mid swing

Without plantar flexion stop, the pretibial muscles must be active for:

- a physiological, functional shortening of the leg;
- the prevention of compensatory movements (circumduction, vaulting etc.).

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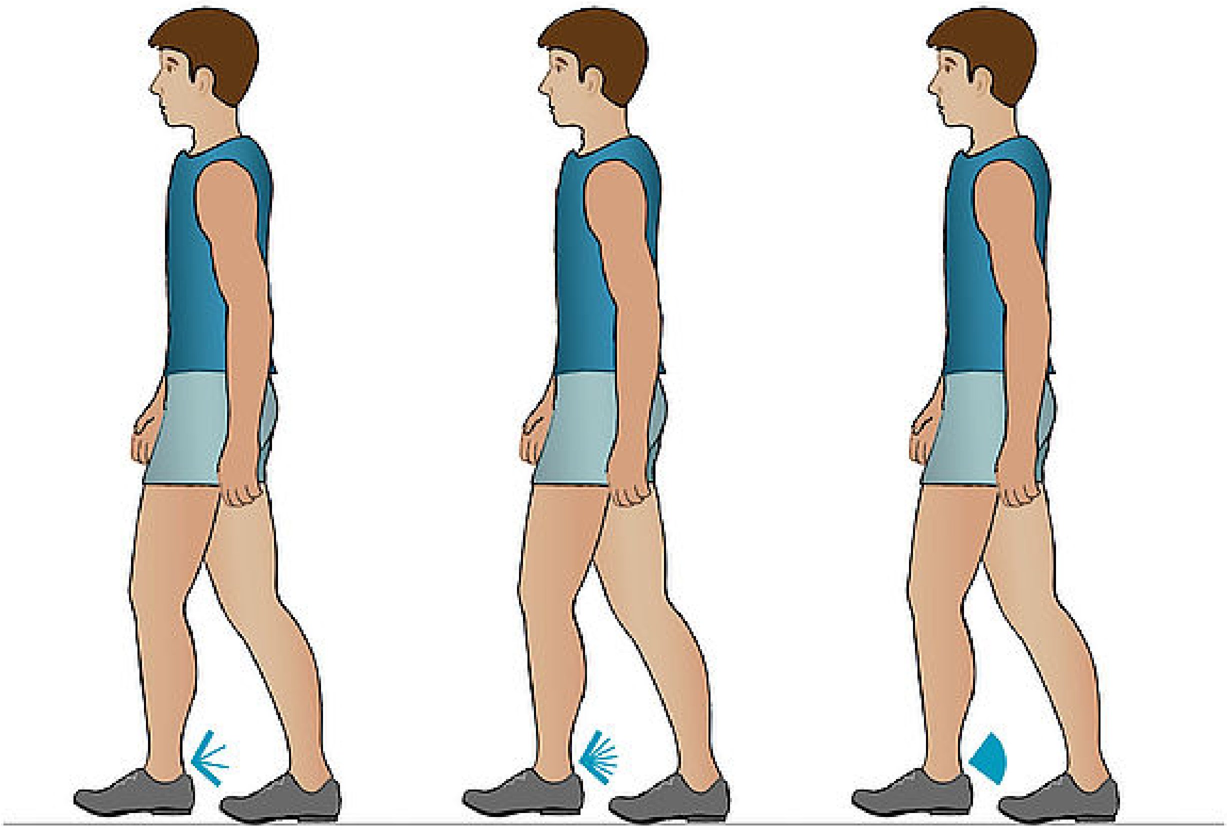

Plantar Flexion Stop/Plantar Flexion Limitation in mid swing

Without plantar flexion stop with dorsiflexion assist, **dynamic** and **static plantar flexion stop** enable:

- a physiological, functional shortening of the leg;
- the prevention of compensatory movements (circumduction, vaulting etc.).

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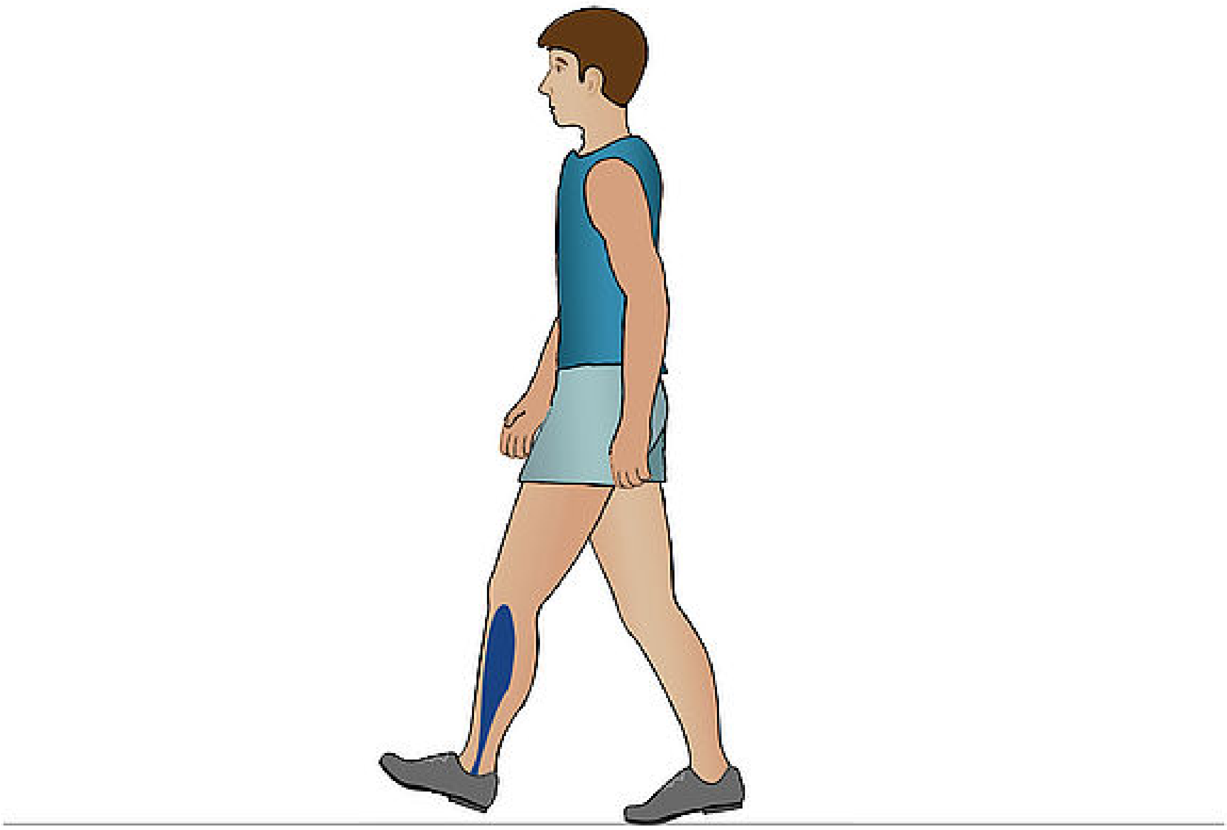

Plantar Flexion Stop/Plantar Flexion Limitation in terminal swing

Without plantar flexion stop, the pretibial muscles must be active for:

- a physiological, functional shortening of the leg;
- the prevention of compensatory movements (circumduction, vaulting etc.).

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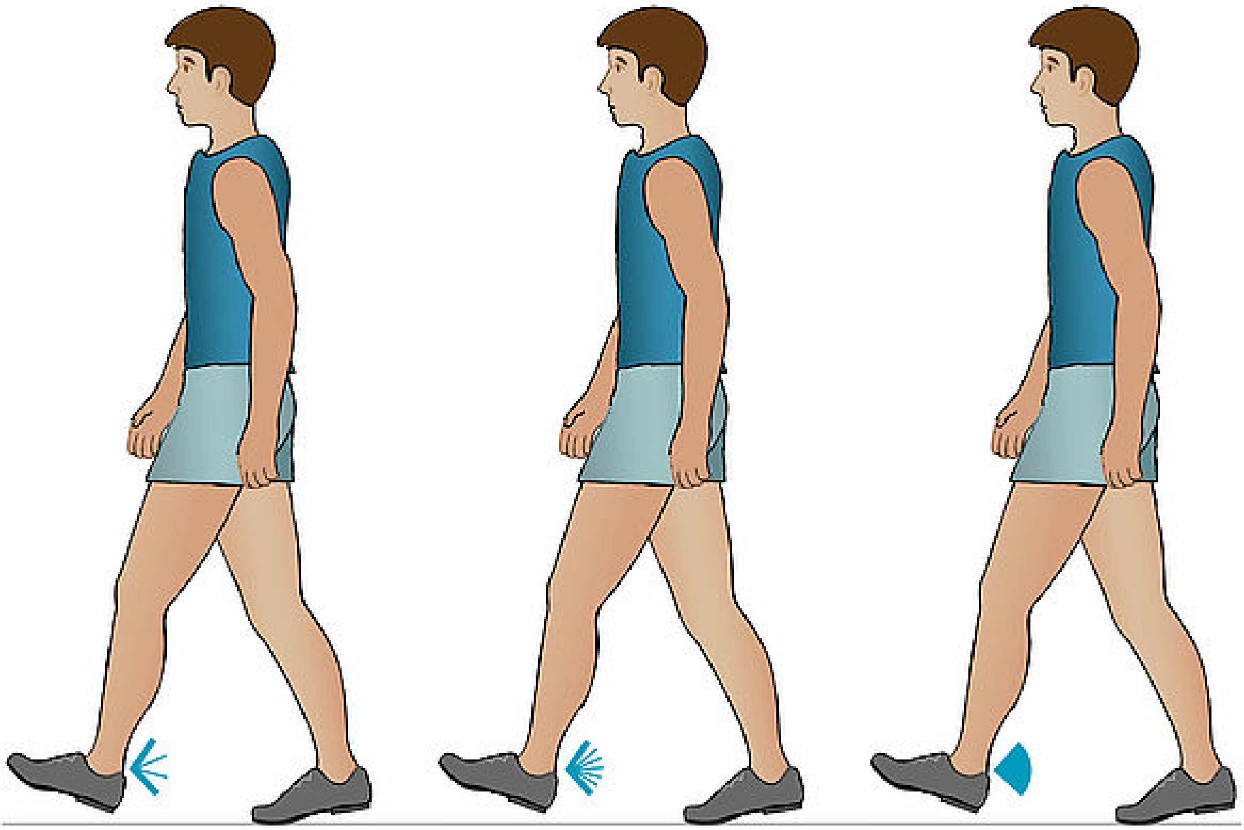

Plantar Flexion Stop/Plantar Flexion Limitation in terminal swing

Without plantar flexion stop with dorsiflexion assist, **dynamic** and **static plantar flexion stop**, enable:

- a physiological, functional shortening of the leg;
- the prevention of compensatory movements (circumduction, vaulting etc.).

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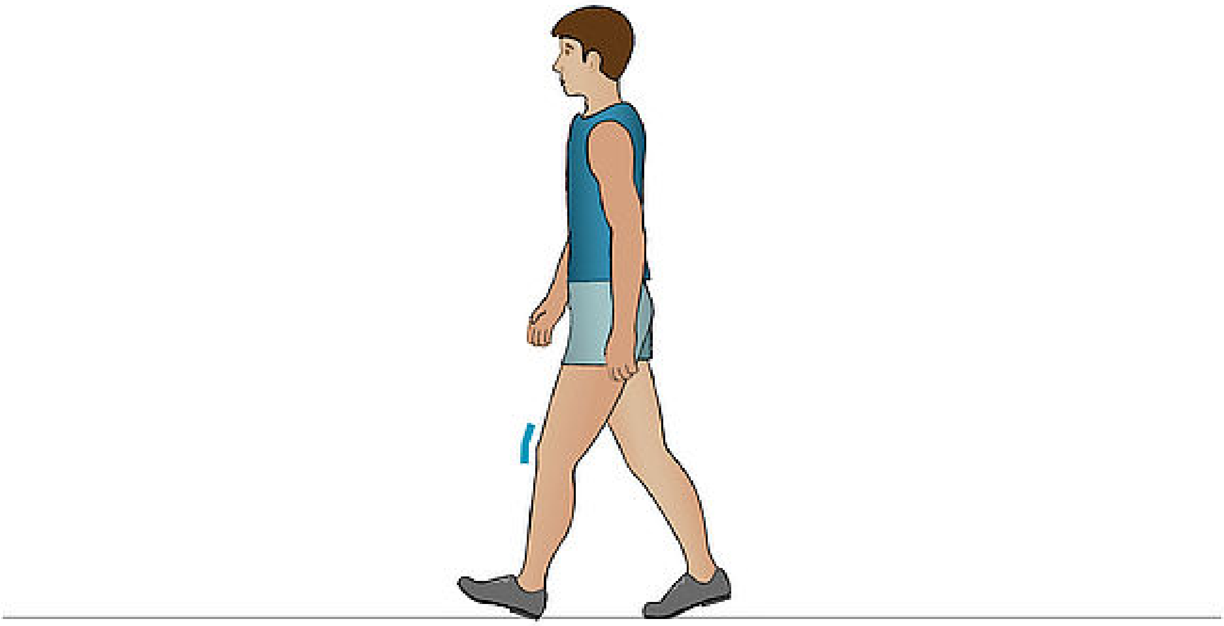
Knie – Extensionsanschlag

Knee – extension stop



The mechanic extension stop prevents a further extension of the knee, when the orthosis is fitting well and the shells are well positioned. All system knee joints have an extension stop. In some, it can be exchanged and thus the angle of the joint changed. When the extension stop is reached depends on the orthosis' alignment. First, the orthotist or qualified/trained expert defines at which knee angle the extension stop should be reached. The extension stop affects the gait phases initial contact, mid stance, late mid stance, terminal stance and terminal swing.

During all other phases, the physiologic knee angle is wider (= more flexion) and therefore the extension stop is not reached.

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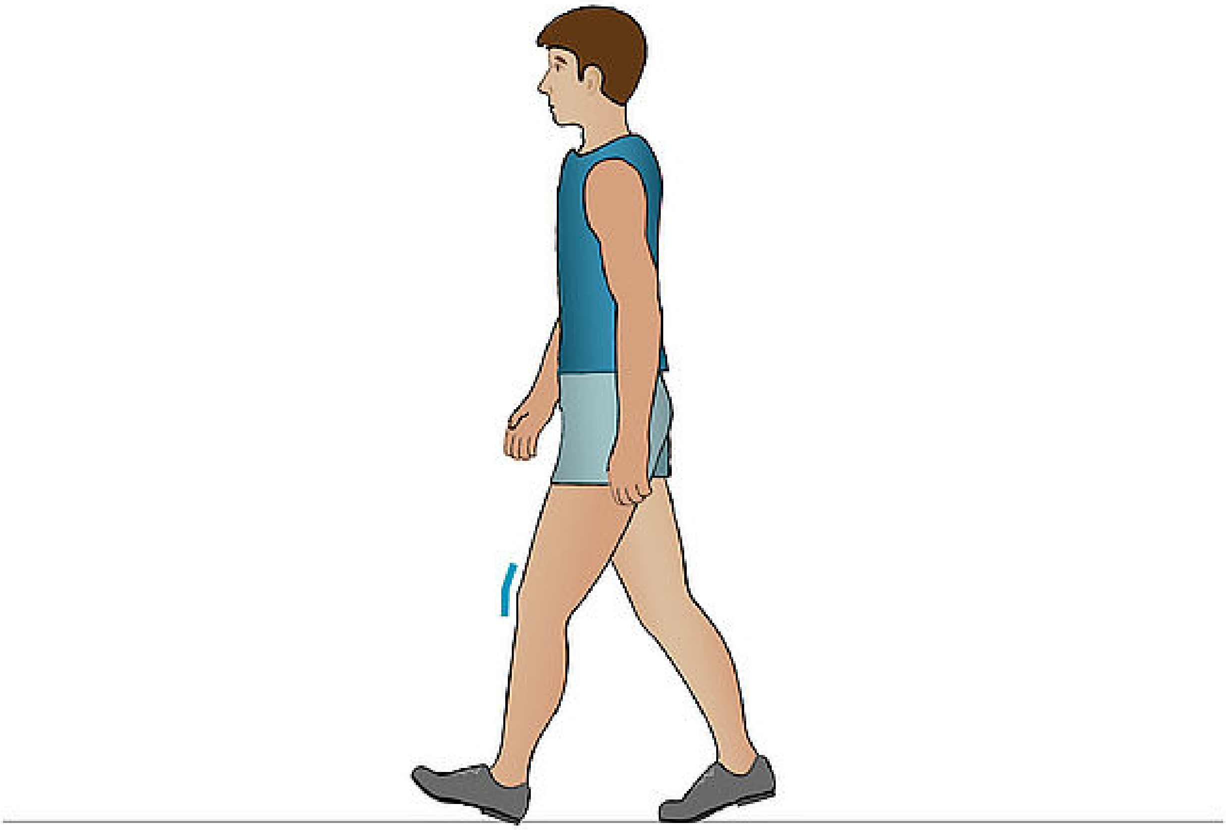
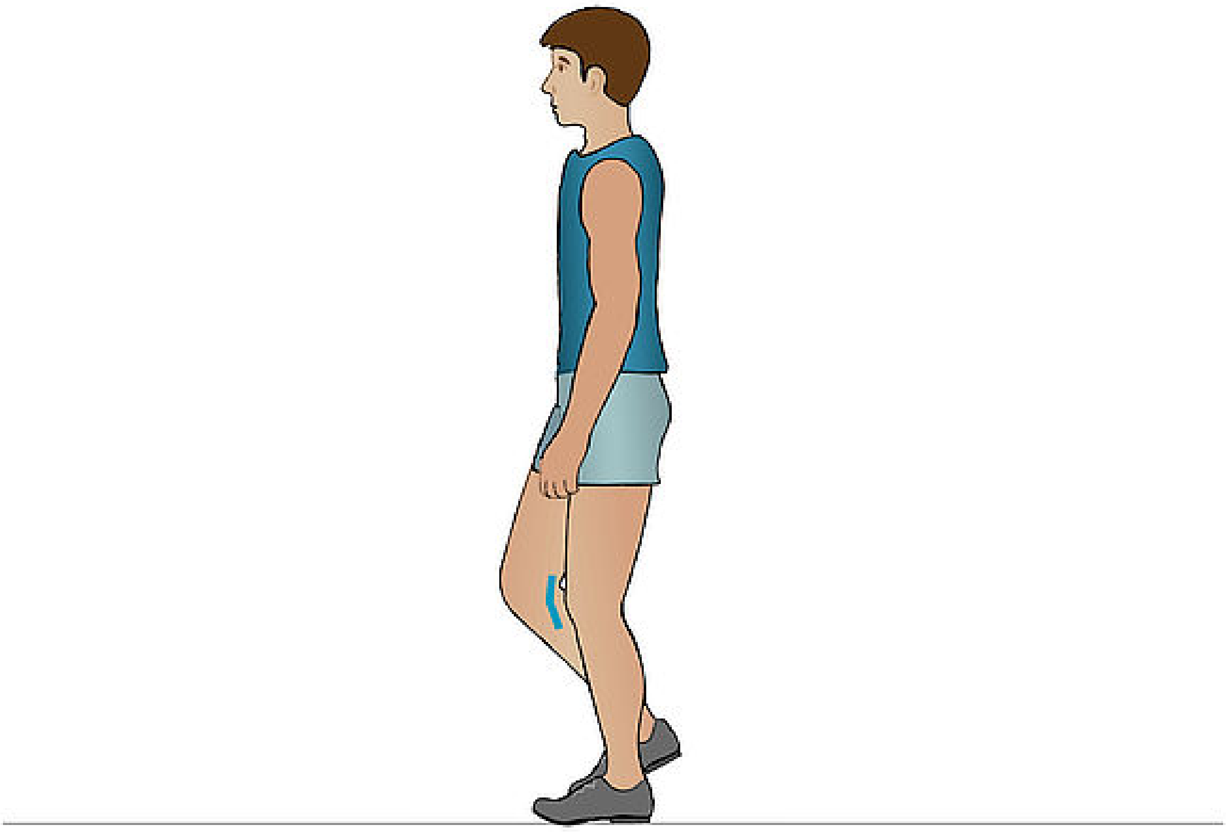
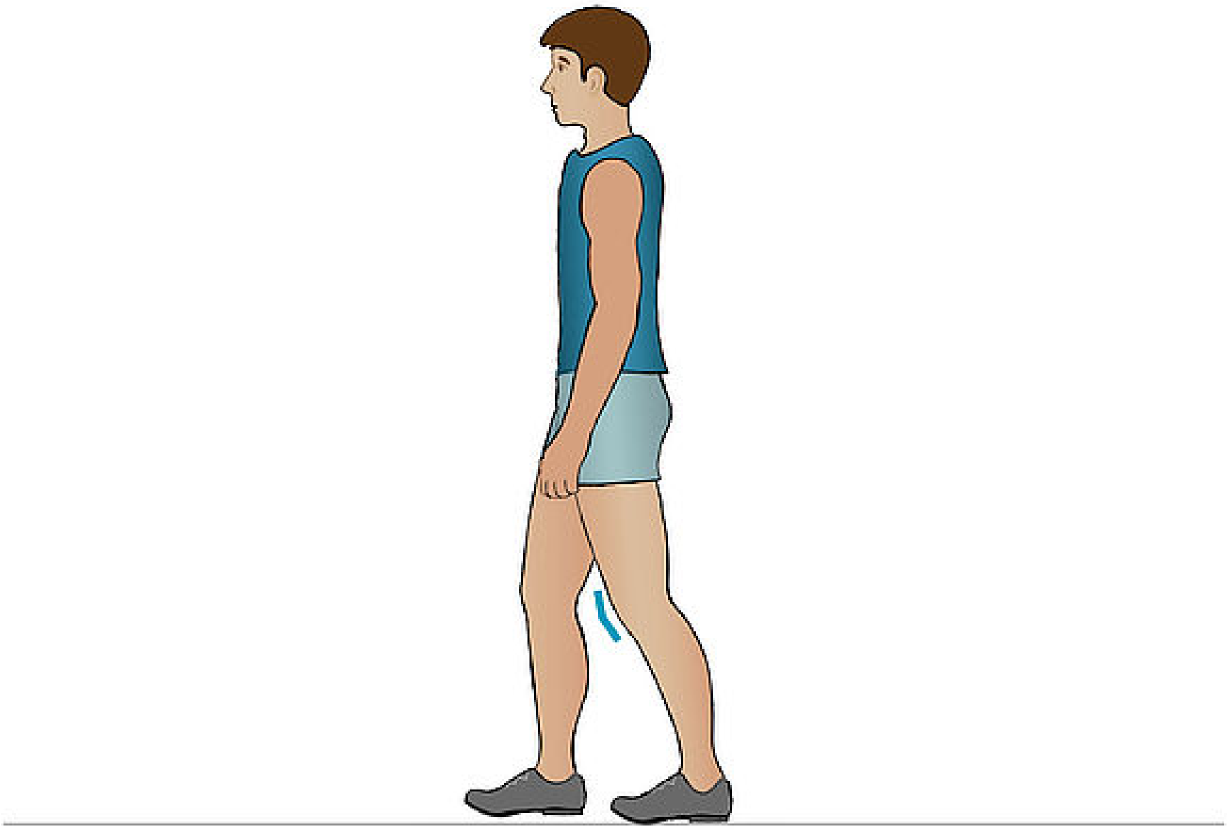


Extension Stop in initial contact
The mechanic extension stop prevents an overextended knee and enables knee flexion in loading response.



Extension Stop in mid stance

- the dorsiflexion stop will be reached;
- the patient gains more stability by the frontal shells and the dorsiflexion stop as well as the position of the rolling-off area;
- the extension stop is automatically reached as the ground reaction force vector shifts before the knee's pivot point;
- an overextended knee is prevented.



Extension Stop in late mid stance

- the dorsiflexion stop is reached;
- the patient gains more stability by the frontal shells and the dorsiflexion stop as well as the position of the rolling-off area;
- the extension stop is automatically reached as the ground reaction force vector lies before the knee's pivot point;
- an overextended knee is prevented.

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Extension Stop in terminal stance

- the dorsiflexion stop is reached;
- the patient gains more stability by the frontal shells and the dorsiflexion stop as well as the position of the rolling-off area;
- the extension stop is automatically reached as the ground reaction force vector lies before the knee's pivot point;
- an overextended knee is prevented.

Here, in automatic system knee joints, the joint is unlocked mechanically. The extending moment on the knee results in the locking pawl coming off the toothing and the system joint being free for the following swing phase. As the ground reaction force vector lies before the knee's pivot point, the knee joint is still safe from an unintentional flexion.

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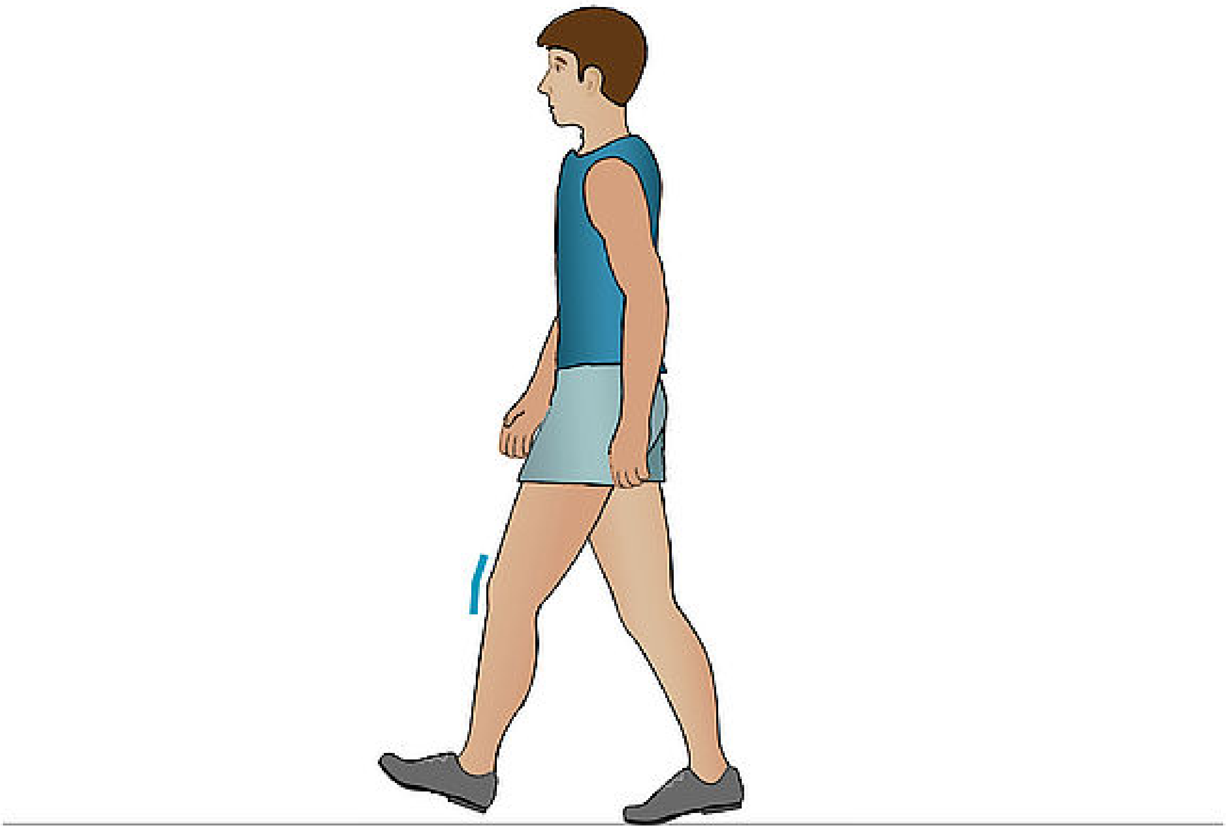
Step 6/6



Extension Stop in terminal swing

The extension stop limits the forward swinging of the lower leg. This ensures that there is no overextension during initial contact.

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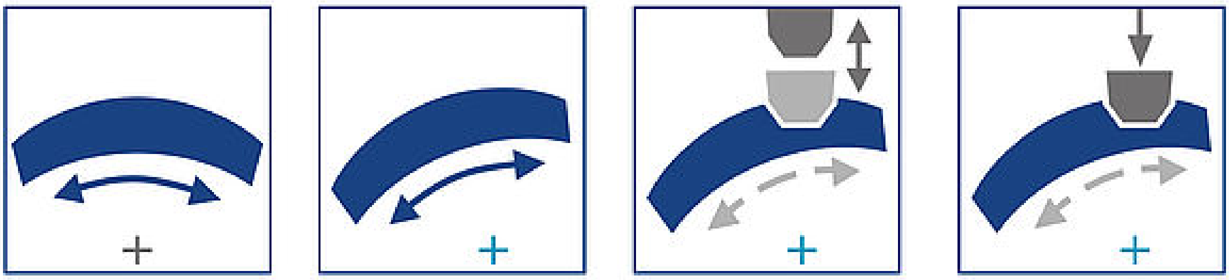
Knie – Flexionsanschlag/ Flexionsbegrenzung

Knee – flexion stop/flexion limitation

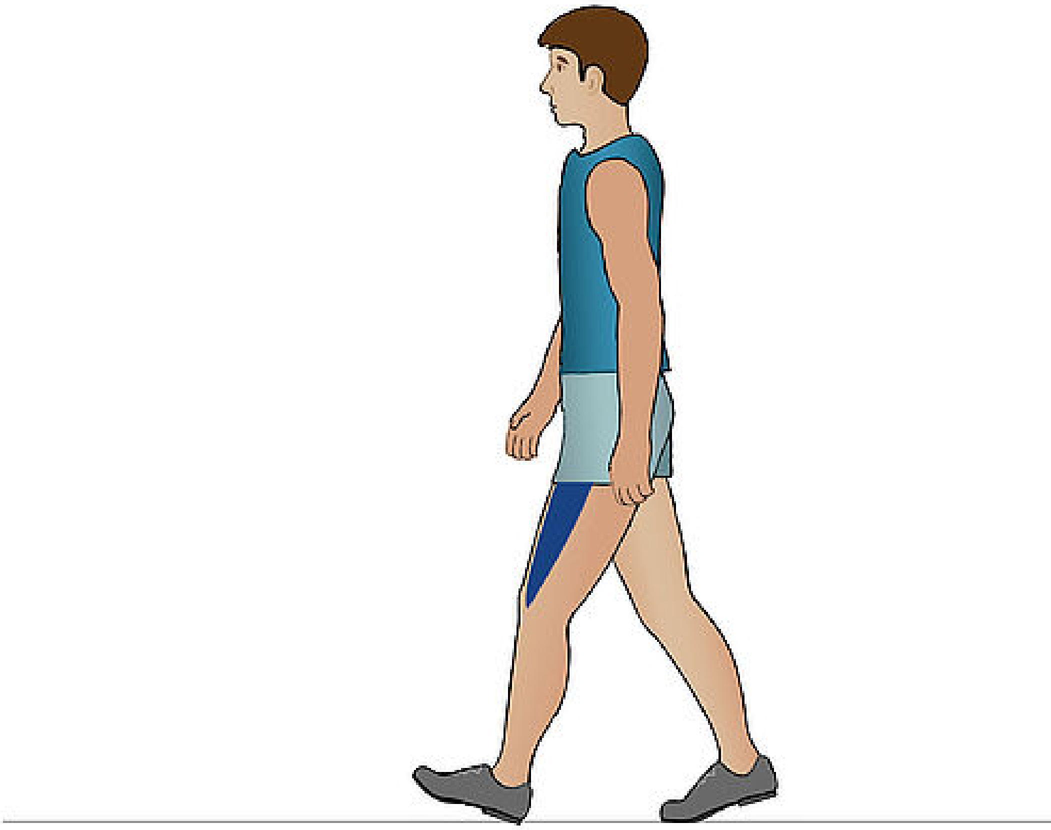


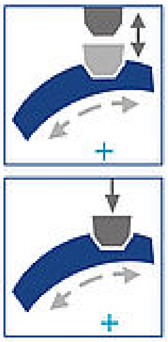
A flexion stop/a flexion limitation is realised through the joint's locking. It is either permanently locked or locks in swing phase. A flexion limitation through a stop, which is limiting the range of motion, is only useful in exceptional cases and does not serve stability while walking but is meant to prevent torn tendons or the like.

Locking a system knee joint is useful if the ground reaction force vector lies behind the knee's pivot point and the patient is unable to generate sufficient stability against an unintentional flexion. This is valid for the gait phases initial contact, loading response, early mid stance and the beginning of mid stance.

During all other phases, a flexion limitation prevents a physiological gait and should only be used in exceptional cases.

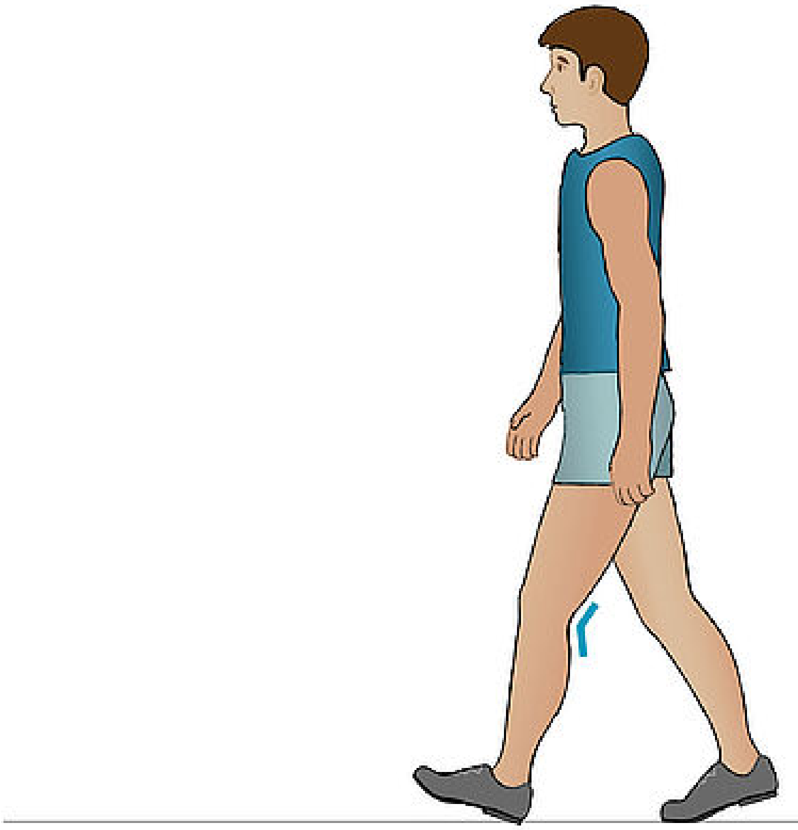
Here you can find information on what to do in case of flexion contractures.

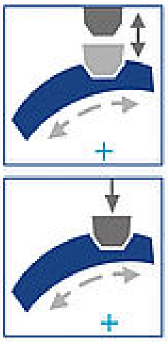




Flexion Limitation in initial contact

Free moving with or without posterior offset:
In order to secure the knee against unintentional flexion, it must be possible to activate the knee extending muscles.





Flexion Limitation in initial contact

Automatic or **locked**:
A flexion limitation can offer stability as it initiates the knee's flexion and prepares the load bearing.

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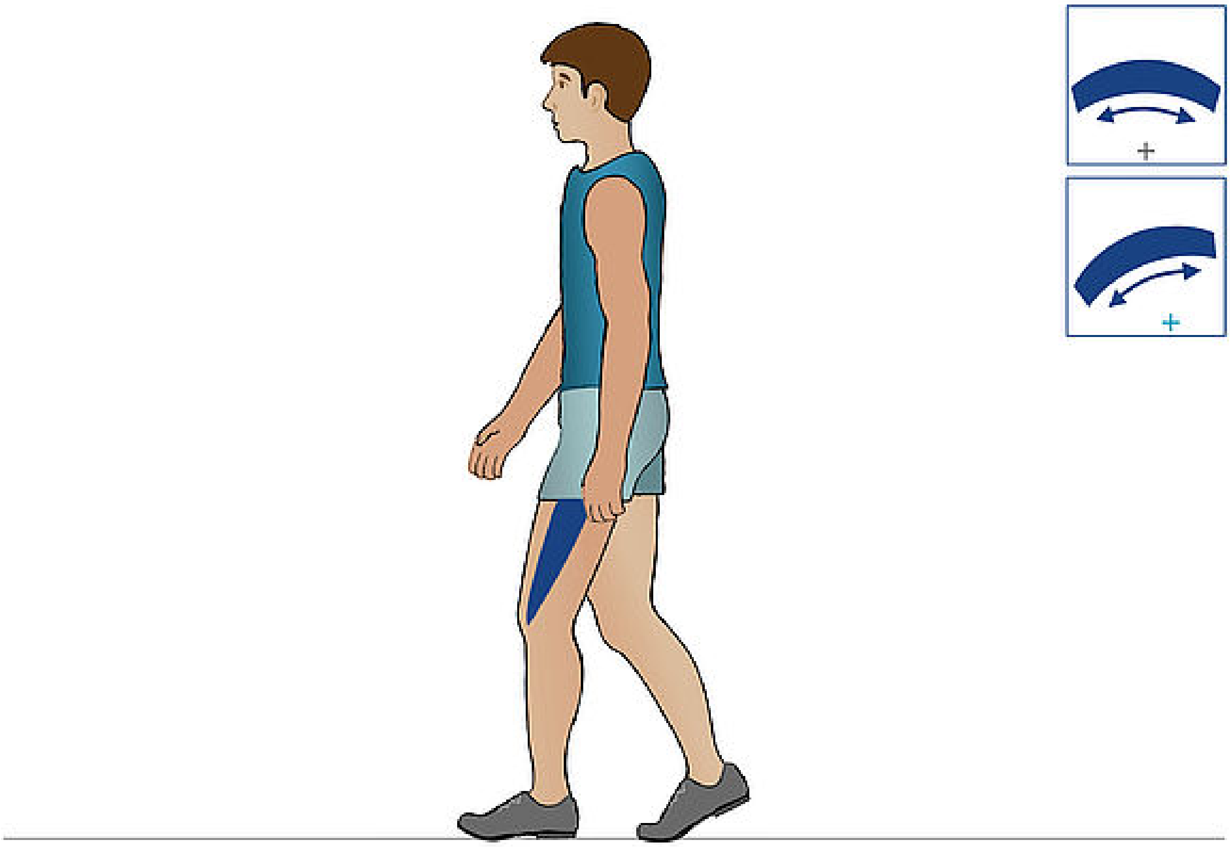

Flexion Limitation in loading response

Free moving with or without posterior offset:
The load is taken and the knee is flexed. The GRF vector lies behind the knee’s pivot point. The knee extending muscles must be active.

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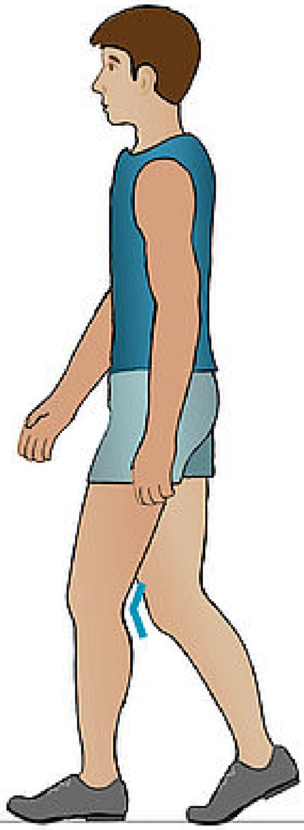

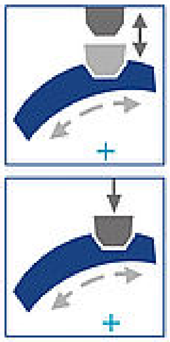

Flexion Limitation in loading response

Automatic or **locked**:
A flexion limitation prevents a knee flexion and that way results in skipping this phase.

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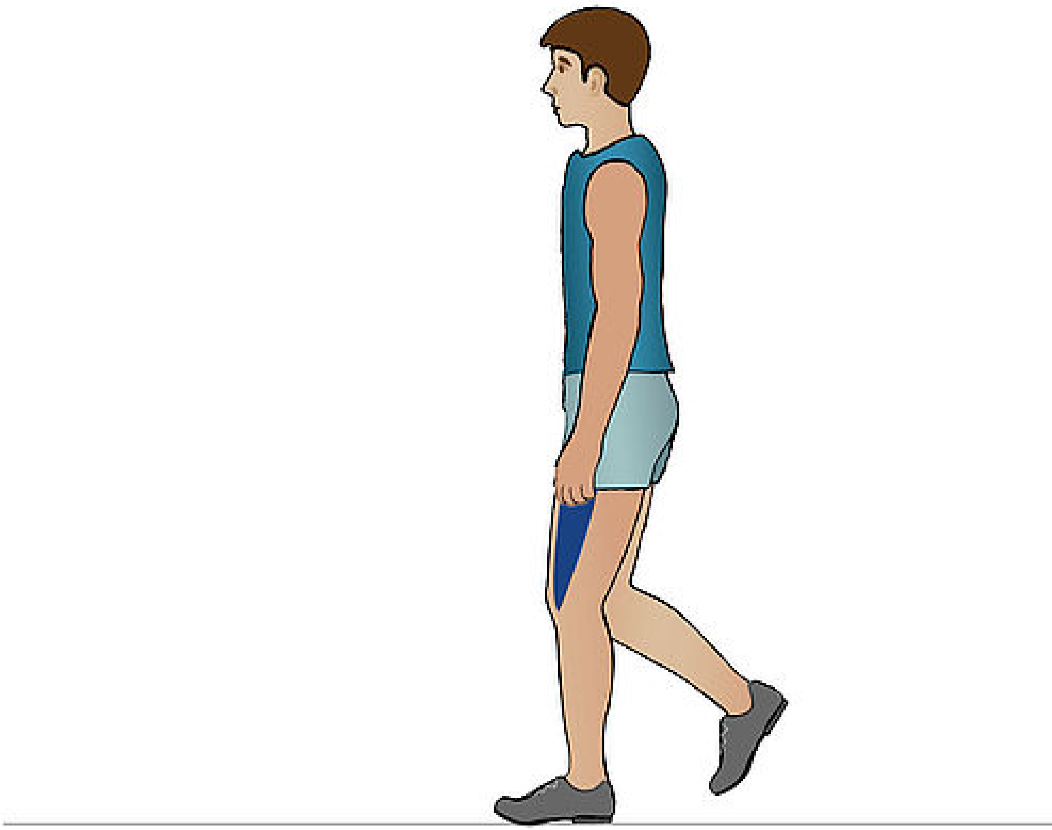

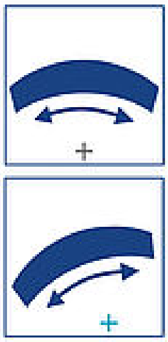

Flexion Limitation in early mid stance

Free moving with or without posterior offset:
An activity results in:

- the knee flexion being physiological;
- the body's centre of gravity remaining on a physiological height;
- the knee being safe from an unintentional flexion;
- enabling the load to be borne in a safe way.

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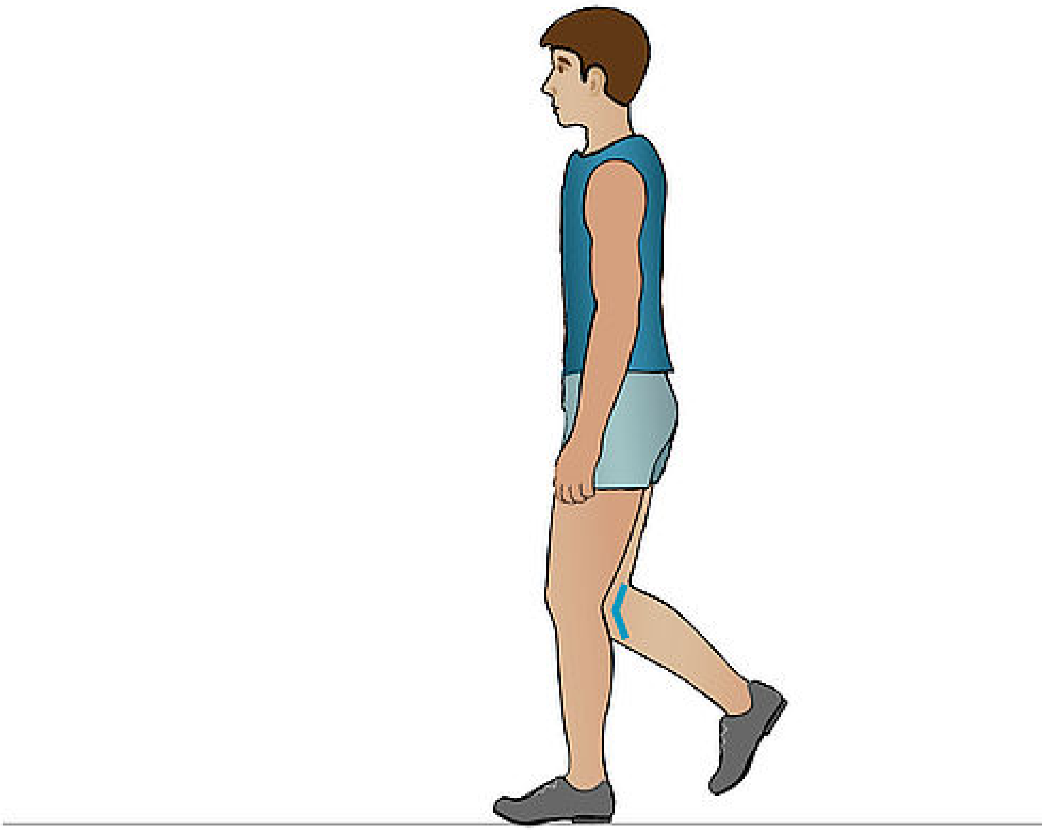

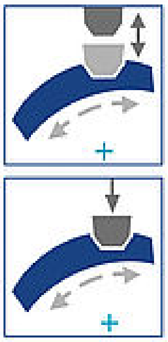

Flexion Limitation in early mid stance

Automatic or **locked**:
A flexion limitation results in:

- the knee flexion being reduced;
- the leg being too long concerning its functionality;
- the body's centre of gravity being too low (it must be lifted);
- the knee being safe from an unintentional flexion;
- enabling the load to be borne in a safe way.

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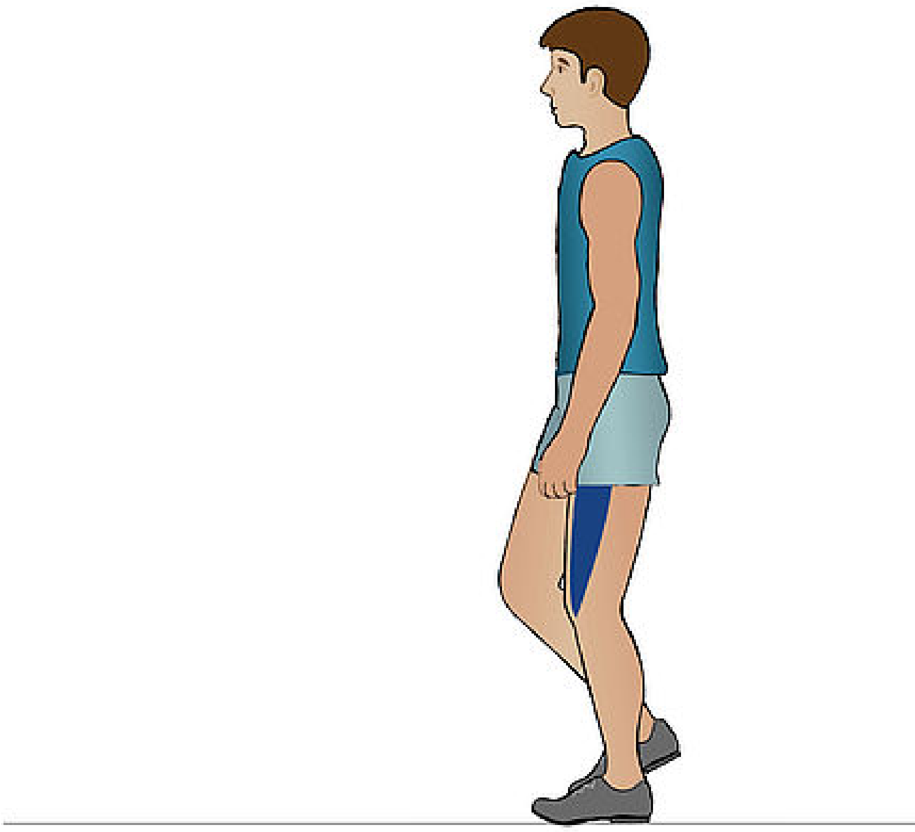

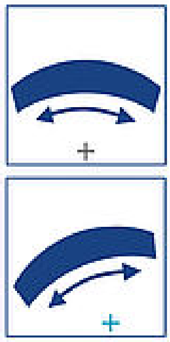

Flexion Limitation in mid stance

Free moving with or without posterior offset:
The knee is secured by the GRF vector as it lies before the knee's pivot point. A flexion limitation would have no impact.
In case of a wider knee flexion angle, it must be possible to activate the knee extending muscles in order to counteract an unintentional, additional increased flexion of the knee joint.

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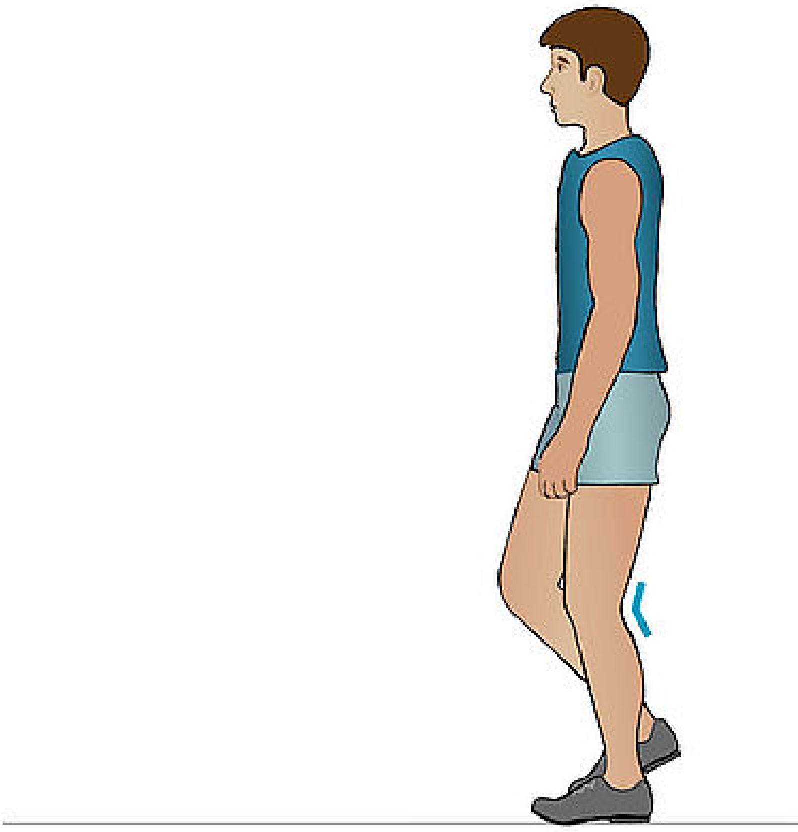

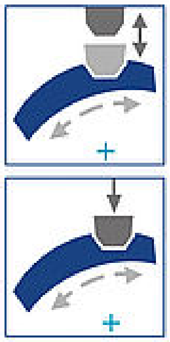

Flexion Limitation in mid stance

Automatic or **locked**:
When the knee flexion is getting wider, the distance from vector to pivot point is getting miner and the knee extending moment can become a knee flexing moment. A flexion limitation:

- secures the knee against unintentional flexion;
- enables the load being borne in a safe way;
- enables a physiological swinging of the contralateral leg.

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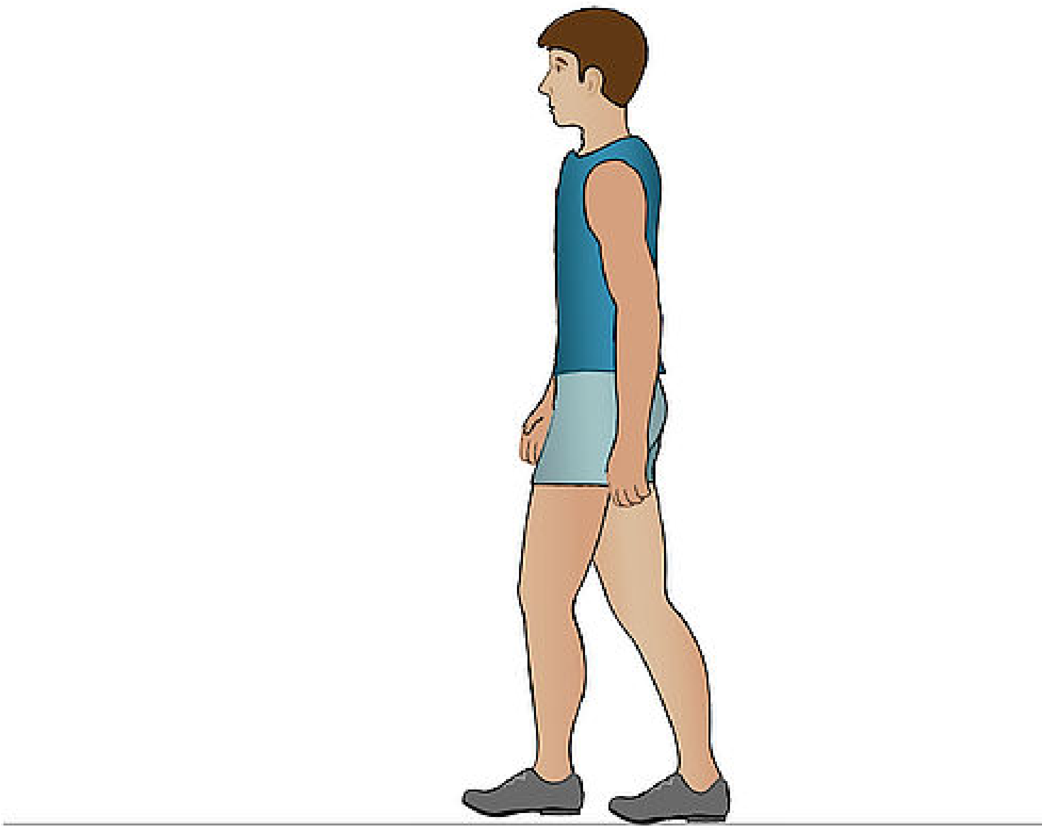

Flexion Limitation in swing phase

Free moving with or without posterior offset or **automatic**:
The swing phase can proceed physiologically. Muscle activity is not necessary here.

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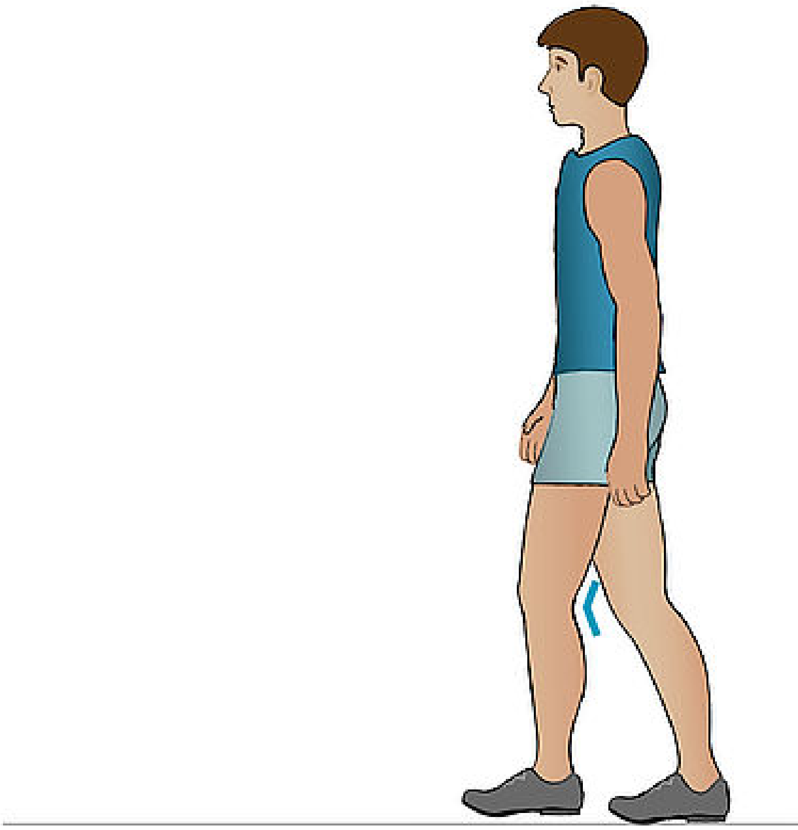

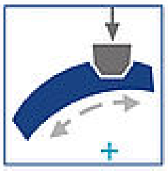

Flexion Limitation in swing phase

Locked:
Swing phase does not proceed physiologically. This results in the following:

- the occurrence of compensatory mechanisms (e.g. circumduction, vaulting);
- the body's centre of gravity being either lifted or drifting into the transversal plane;
- the energy consumption being increased.

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