Ankle Joints with Power Units Compared

The following table compares currently available orthotic ankle joints which make use of a so-called power unit to produce movement through strong tension or counter force. Compared were two fixed shape L-carbon springs with movement in dorsiflexion, and three adjustable alignment ankle joints which produce plantar- and dorsiflexion forces that can be dynamically adjusted to gait. Orthotic joints not possessing similar characteristics, forces, or applications were left out.

Alignment

An orthosis using a power unit provides an energy saving and harmonious gait while enabling sturdy and upright standing. The power unit only permits ankle joint movement when the body's center of gravity is shifted during the stance phase. During swing phase the foot is returned to the neutral position.

AFO	**Shuttle-Booster** ORTHO-SYSTEMS	**Shuttle-Uno** **Shuttle-Turbo** ORTHO-SYSTEMS	**Neuro V Joint ***	**L-Feder** Spring and Ankle Seven **

Properties

Calf muscle replacement with defined force and permits min. 10° dorsiflexion by e.g. muscle paralysis	**yes** according to weight classification from manufacturer and corresponding selection of maximum high force power units	**not possible** power units produce only light to strong forces	**not possible** due to limited selection of power units and reduced range of motion when increasing force	**yes** according to weight classification from manufacturer
Muscle assisting with supporting forces in plantar- and dorsiflexion by e.g. CP patients	**yes** suitable power units available for all requirements	**yes** suitable power units available for all requirements	**yes** using the corresponding power unit	**not possible** reducing stiffness increases dorsiflexion angle and risk of breakage
Rotational stability by insufficient torsional stability the knee goes into valgus and the hip joint rotates inward	**very good** precisely defined joint sizes using weight classification	**very good** precisely defined joint sizes using weight classification	**good** depending on joint size chosen by configurator	**medium** flexion sacrifices rotational stiffness
Breakage by exceeding the maximum range of motion	**not possible** range of motion is limited by the movement stop and power unit	**not possible** range of motion is limited by the movement stop and power unit	**not possible** dorsiflexion is limited by power unit	**possible** with overweight or very active patients **Spring:** due to the 1/3 length guidelines **Ankle-Seven:** spring length not defined

Functions

Dorsiflexion	**up to 15 degrees** irrespective of chosen power unit and can be specified using changeable stops	**up to 15 degrees** irrespective of chosen power unit and can be specified using changeable stops	**up to 15 degrees possible** however, the stronger the force, the less range of motion	**not defined** no specifications from manufacturer
Plantarflexion .	**up to 15 degrees** irrespective of chosen power unit and can be specified using changeable stops	**up to 15 degrees** irrespective of chosen power unit and can be specified using changeable stops	**up to 15 degrees possible** however, the stronger the force, the less range of motion.	**not possible** due to unfavorable leverage ratios, even if specified by manufacturer
Downhill walking possibility to negotiate downhill slopes	**possible** using accordingly reduced plantarflexion force	**possible** using accordingly reduced plantarflexion force	**possible** using accordingly reduced plantarflexion force	**not possible** as no plantarflexion is present
Uphill walking possibility to negotiate inclined surfaces	**possible** using accordingly reduced dorsiflexion force	**possible** using accordingly reduced dorsiflexion force	**possible** using accordingly reduced dorsiflexion force	**not possible** too stiff (application is calf muscle replacement)

ORTHO SYSTEMS *in motion*

AFO	**Shuttle-Booster** ORTHO-SYSTEMS	**Shuttle-Uno** **Shuttle-Turbo** ORTHO-SYSTEMS	**Neuro V- Joint ***	**L-Feder** Spring und Ankle Seven **
Anomalies				
Plantarflexion contractures of the patient	**no problem** no restrictions	**no problem** no restrictions	**no problem** no restrictions	**severely restricted** **Spring:** no specifications from manufacturer **Ankle-Seven:** 115 degrees Negative heel necessary for both
Dorsiflexion contractures of the patient	**no problem** no restrictions	**no problem** no restrictions	**no problem** no restrictions	**not possible** due to the predetermined shape
Pronounced toe-out of the patient	**no problem** no restrictions	**no problem** no restrictions	**no problem** no restrictions	**limited**
Overweight patients	**no problem** within the weight classification	**no problem** within the weight classification	**limited** due to the limited selection of power units within the weight classification	**limited** **Spring:** due to the 1/3 length guidelines **Ankle-Seven:** spring length not defined
Patient Specific Adjustments				
Range of motion stops specifically tailored to patient needs	**adjustable** can be specified irrespective of chosen power unit	**adjustable** can be specified irrespective of chosen power unit	**limited adjustability** range of motion influences power unit selection	**not possible** dependent on construction
Power unit specifically tailored to patient needs	**adjustable** can be specified irrespective of range of motion.	**adjustable** can be specified irrespective of range of motion.	**limited adjustability** as it influences range of motion	**not possible** dependent on construction
Alignment adjustments of finished orthosis Independent adjustment of ankle angle (sagittal plane)	**at any time** up to 15 degrees	**at any time** up to 15 degrees	**at any time** up to 10 degrees	**not possible** due to the predetermined shape
Conversion of orthotic joint on finished orthosis E.g. according to improvement or deterioration of patient circumstances	**at any time** conversion to Shuttle-Turbo, Shuttle-Uno-back, Shuttle-Uno-front, Shuttle-Flex, or standard Shuttle joint	**at any time** conversion to Shuttle-Booster, Shuttle-Uno-back, Shuttle-Uno-front, Shuttle-Flex, or standard Shuttle joint	**not possible** by changing joint parts	**not possible** due to construction
Orthotic shoes	**normal size** (orthotic shoes)	**normal size** (orthotic shoes)	**normal size** (orthotic shoes)	**+1 shoe size** (orthotic shoes)
Additional				
Noise movement stops	**quiet** reduced through various preventative measures	**quiet** reduced through various preventative measures	**clearly audible** contact of power unit with joint stops	**none** due to construction
Pre-loading leans in dorsiflexion with minimal force applied	**not necessary** sturdy standing without wavering	**not necessary** sturdy standing without wavering	**not necessary** sturdy standing without wavering	**up to 4mm** **Spring:** until the carbon spring supports itself on the foot piece. **Ankle-Seven** initial force build-up somewhat reduced.
Defined joint axis	**yes** movement takes place about the joint axis	**yes** movement takes place about the joint axis	**yes** movement takes place about the joint axis.	**no** due to construction

* The Neuro V is an orthotic joint by which the power units sit in a V-position. In 1999 a patent was applied for the L-Feder (today known as the Spring) by Thomas Böckh together with Gottinger Handelshaus GbR. Consequently, named patent holders are F.Gottinger, N.Günther and T.Böckh. **The Ankle Seven is independently manufactured and marketed by Otto Bock under license. **The names Spring and Ankle Seven are registered trademarks of Gottinger Handelshaus and Otto Bock respectively.

(**Green is good, yellow is passable, red shouldn't be**)