Echelon

Echelon was the first hydraulic ankle available on the prosthetic market. Released in 2009, it built on the already successful Esprit foot springs by incorporating a damped articulating ankle joint. This joint is able to absorb the impact shock at heel strike and enable the ankle to self-align and adapt to changing walking surfaces. The benefits can include improved posture, standing stability, gait biomechanics and mobility level.

A hydraulic damping system within the ankle helps to control the movement at the joint, producing a viscoelastic property closer to the behaviour of human muscle. This allows the device to self-align and adapt to different gradients and uneven ground resulting in fewer compensations needed and a higher level of balance, and therefore safety, for the user. Because of the ankle movement now available, the leg is able to rotate over the device so that when energy is released from the springs, it acts at an angle, proving more beneficial to gait and user comfort and exertion. The default position of the ankle also results in a dorsiflexed position during swing, resulting in better toe clearance and can help to reduce the risk of tripping or falling.

Improvements in Clinical Outcomes using Echelon compared to ESR feet

Improvement in **SAFETY**

- Reduced risk of tripping and falls
  - Increased minimum toe clearance during swing phase[1,2]
- Improving standing balance on a slope
  - 24-25% reduction in mean inter-limb centre-of-pressure root mean square (COP RMS)[3]

Improvement in **ENERGY CONSUMPTION**

- Reduced energy expenditure during walking
  - Mean 11.8% reduction in energy use on level ground, across all walking speeds[4]
  - Mean 20.2% reduction in energy use on slopes, across all gradients[4]
  - Mean 8.3% faster walking speed for the same amount of effort[4]

Improvement in **MOBILITY**

- Improved gait performance
  - Faster self-selected walking speed[2,5-7]
  - Higher PLUS-M scores than FlexFoot and FlexWalk style feet[8]
- Improved ground compliance when walking on slopes
  - Increased plantarflexion peak during level walking, fast level walking and cambered walking[9]
  - Increased dorsiflexion peak during level walking, fast level walking and cambered walking[9]
- Less of a prosthetic “dead spot” during gait
  - Reduced aggregate negative COP displacement[5]
  - Centre-of-pressure passes anterior to the shank statistically significantly earlier in stance[5]

  - Increased minimum instantaneous COM velocity during prosthetic-limb single support phase[5]
  - Reduced peak negative COP velocity[7]
  - Reduced COP posterior travel distance[7]
- Improved ground compliance when walking on slopes
  - Increased plantarflexion range during slope descent[10]
  - Increased dorsiflexion range during slope ascent[10]

Improvement in **RESIDUAL LIMB HEALTH**

- Helps protect vulnerable residual limb tissue, reducing likelihood of damage
  - Reduced peak stresses on residual limb[11]
  - Reduced stress RMS on residual limb[11]
  - Reduced loading rates on residual limb[11]

Improvement in **LOADING SYMMETRY**

- Greater contribution of prosthetic limb to support during walking
  - Increased residual knee negative work[6]
- Reduced reliance on sound limb for support during walking
  - Reduced intact limb peak hip flexion moment[6]
  - Reduced intact limb peak dorsiflexion moment[6]
  - Reduced intact ankle negative work and total work[6]
  - Reduced intact limb total joint work[6]
- Better symmetry of loading between prosthetic and sound limbs during standing on a slope
  - Degree of asymmetry closer to zero for 5/5 amputees[3]
- Reduced residual and sound joint moments during standing of a slope
  - Significant reductions in both prosthetic and sound support moments[12]
- Less pressure on the sole of the contralateral foot
  - Peak plantar-pressure[13]
- Improved gait symmetry
  - Reduced stance phase timing asymmetry[14]

Improvement in **USER SATISFACTION**

- Patient reported outcome measures indicate improvements
  - Mean improvement across all Prosthesis Evaluation Questionnaire domains[15]
  - Bilateral patients showed highest mean improvement in satisfaction[15]
- Subjective user preference for hydraulic ankle
  - 13/13 participants preferred hydraulic ankle[13]

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