Linx

Blatchford is the first, and currently only, company in the world to have a fully-integrated limb system available on the prosthetic market. The limb combines existing technology from Blatchford's Orion3 microprocessor-controlled knee and Elan microprocessor-controlled hydraulic ankle, utilising the individual sensors in both and collating the information within one central control unit in real-time.

This ability to actively sense and analyse data on user movement, activity, environment and terrain provides situational awareness. A coordinated stream of instructions to the hydro-pneumatic support system enables the limb to make continuous adjustments across both joints in unison, providing biomimetic behaviour. This not only allows for a more natural gait, reducing the need for compensations and the magnitude of irregular forces acting on joints, but improves the safety of the user, ensuring efficient swing through and placement of the limb and adapting resistances for more stability during stance.

Improvements in Clinical Outcomes using Linx compared to mechanical knees

Improvement in **SAFETY**

- Significantly reduced number of falls[1,2]
- Reduced centre-of-pressure fluctuations by 9-11% with standing support active when standing on sloped ground[3]
- Less cognitive demand during walking, leading to reduced postural sway[4]

Improvement in **MOBILITY**

- Increased walking speed[5]
- Easier to walk at different speeds[6]
- Higher scores in mobility-related patient-reported outcome measures[7]
- More natural gait[6,8]
- Easier to walk on slopes[6]

Improvement in **ENERGY EXPENDITURE**

- Reduced energy expenditure compared to mechanical knees[9-13]
- Equivalent energy expenditure to other MPKs[14]
- Reduced self-perceived effort[6,8]
- Energy expenditure closer to that of able-bodied control subjects[15]
- Able to walk further before becoming tired[6]

Improvement in **SYMMETRY**

- Better step length symmetry[5]
- Reduced loading asymmetry with standing support active when standing on sloped ground[3]

Improvement in **USER SATISFACTION**

- Reduced fear of falling[1]

- Reduced limitations due to an emotional problem[8]
- Preference over other prosthetic knees[1,6]
- Greater prosthetic confidence in slope descent and gait termination[16]

Improvement in **HEALTH ECONOMICS**

- Reductions in direct and indirect healthcare costs when using an MPK[17]

Improvements in Clinical Outcomes using Linx compared to ESR feet

Improvement in **SAFETY**

- Reduced risk of tripping and falls
  - Increased minimum toe clearance during swing phase[18,19]
- Improved knee stability on the prosthetic side during slope descent
  - Increased mid-stance external prosthetic knee extensor moment[20]
- 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[21]
  - Mean 20.2% reduction in energy use on slopes, across all gradients[21]
  - Mean 8.3% faster walking speed for the same amount of effort[21]

Improvement in **MOBILITY**

- Improved gait performance
  - Faster self-selected walking speed[18,22-25]
- Improved ground compliance when walking on slopes
  - Increased plantarflexion peak during level walking, fast level walking and cambered walking[26]
  - Increased dorsiflexion peak during level walking, fast level walking and cambered walking[26]
- Less of a prosthetic "dead spot" during gait
  - Reduced aggregate negative COP displacement[23]
  - Centre-of-pressure passes anterior to the shank statistically significantly earlier in stance[23]
  - Increased minimum instantaneous COM velocity during prosthetic-limb single support phase[23]
  - Reduced peak negative COP velocity[25]
  - Reduced COP posterior travel distance[25]
- Improved ground compliance when walking on slopes
  - Increased plantarflexion range during slope descent[19]
  - Increased dorsiflexion range during slope ascent[19]

- Less effort on residual hip for trans-femoral amputees on varied terrains
  - Reduced the mean hip extension and flexion moments[27]
- Effects consistent over time
  - Same gait variable changes in two gait lab sessions one year apart[22]
  - Magnitude of changes comparable between sessions[22]
- Brake mode during slope descent to control momentum build up
  - Reduced mean prosthetic shank angular velocity in single support[28]
  - Increased Unified Deformable Segment (prosthetic ‘ankle’) negative work[28]
- Less gait compensation movements during slope descent
  - Reduced residual knee flexion at loading response[28]

Improvement in **RESIDUAL LIMB HEALTH**

- Helps protect vulnerable residual limb tissue, reducing likelihood of damage
  - Reduced peak stresses on residual limb[29]
  - Reduced stress RMS on residual limb[29]
  - Reduced loading rates on residual limb[29]

Improvement in **LOADING SYMMETRY**

- Greater contribution of prosthetic limb to support during walking
  - Increased residual knee peak extension moment[22]
  - Decreased residual knee peak flexion moment[22]
  - Increased residual knee negative work[24]
- Reduced reliance on sound limb for support during walking
  - Reduced intact limb peak hip flexion moment[24]
  - Reduced intact limb peak dorsiflexion moment[24]
  - Reduced intact ankle negative work and total work[24]
  - Reduced intact limb total joint work[24]
- Better symmetry of loading between prosthetic and sound limbs during standing on a slope
  - Degree of asymmetry closer to zero for 5/5 amputees[20]
- Reduced residual and sound joint moments during standing of a slope
  - Significant reductions in both prosthetic and sound support moments[30]
- Reduced residual joint moments during standing of a slope for bilateral amputees
  - Significant reductions in prosthetic support moment[30]
  - Permitted ‘natural’ ground reaction vector sagittal plane position, relative to knee joint centres[30]
- Less pressure on the sole of the contralateral foot
  - Peak plantar-pressure[31]
- Improved gait symmetry
  - Reduced stance phase timing asymmetry[32]

Improvement in **USER SATISFACTION**

- Patient reported outcome measures indicate improvements
  - Mean improvement across all Prosthesis Evaluation Questionnaire domains[33]
  - Bilateral patients showed highest mean improvement in satisfaction[33]

- Subjective user preference for hydraulic ankle
  - 13/13 participants preferred hydraulic ankle[31]

Improvements in Clinical Outcomes using Linx compared to non-microprocessor-control hydraulic ankle-feet

Improvement in **SAFETY**

- Improved knee stability on the prosthetic side during slope descent
  - Increased mid-stance external prosthetic knee extensor moment[19]

Improvement in **MOBILITY**

- Improved ground compliance when walking down slopes
  - Reduced time to foot flat[28]
- Brake mode during slope descent increases resistance to dorsiflexion to control momentum build up
  - Reduced dorsiflexion range during slope descent[19]
  - Reduced mean prosthetic shank angular velocity in single support[28]
  - Increased Unified Deformable Segment (prosthetic 'ankle') negative work[28]
  - Transition from dorsiflexion to plantarflexion moment occurs earlier in stance phase[34]
  - Increase in mean prosthetic 'ankle' plantarflexion moment integral[34]
- Assist mode during slope ascent decreases resistance to dorsiflexion to allow easier progression
  - Transition from dorsiflexion to plantarflexion moment occurs later in stance phase[34]
  - Decrease in mean prosthetic 'ankle' plantarflexion moment integral[34]
- Less gait compensation movements during slope descent
  - Reduced residual knee flexion at loading response[28]

Improvement in **LOADING SYMMETRY**

- Greater reliance on prosthetic side for bodyweight support during slope descent
  - Increased support moment integral[34]
- Less reliance on sound side for bodyweight support during slope descent
  - Decreased support moment integral[34]
- Less reliance on sound side for bodyweight support during slope ascent
  - Decreased support moment integral[34]
- Reduced sound joint moments during standing of a slope
  - Significant reductions in sound support moment[30]
- Reduced residual joint moments during standing of a slope for bilateral amputees
  - Significant reductions in prosthetic support moment[30]
  - Permitted 'natural' ground reaction vector sagittal plane position, relative to knee joint centres[30]

Improvement in **USER SATISFACTION**

- Greater prosthetic confidence in slope descent and gait termination[16]

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