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Lower limb dynamics in two approaches of stair descent initiation: Walk and stand

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The purpose of this study was to match the height moments and peak power at hip, knee and ankle joints between the walk approaches and stand approach. The walk approach included components of level walking and stair walking whereas the stand approach included only stair walking component. Fourteen young, healthy adults (6 males; 8 females) participated in the study. A three step customized stairway with a further walkway (~2.4m) was used for the motion trials. For both the approaches, the limb striking the second step was lead limb and therefore the limb striking the topmost step (step 1) was trail limb. Walk approach showed a significantly higher hip abductor moment (p=0.006), knee extensor moment (p=0.049) and knee eccentric power (p=0.003) for the trail limb during controlled lowering phase compared to face approach. No significant difference was found in any variable for the lead limb between the two approaches. The results imply that the consequences of velocity during stair descent initiation from a walk approach diminish on the second step and maximum balance control occurs when transitioning from level walk to stair walk. This study highlights the required adjustments made by the healthy young adults to realize a secure stair descent, which could help reduce the danger of fall in older adults.

Purpose-
The purpose of this study was to review the consequences of various stair descent strategy on peak joint moment and peak joint power in healthy young adults. Fourteen healthy young subjects (8 males and 6 females) performed the stair descent. Walk approach included the component of level walking and stair walking. Stand approach included the component of only stair walking. A three-step stairway with a walkway was used for the motion trials. Significant difference was found in hip abductor moments, knee extensor moment and knee eccentric power between the 2 approaches. No significant difference was found for any variable between the genders. Stair descent initiation with walk approach requires larger hip and knee dynamics than stand approach in both the genders so as to realize a secure stair descent Walk approach included the component of level walking and stair walking. Stand approach included the component of only stair walking. A three-step stairway with a walkway was used for the motion trials. Significant difference was found in hip abductor moments, knee extensor moment and knee eccentric power between the 2 approaches.

No significant difference was found for any variable between the genders. Stair descent initiation with walk approach requires larger hip and knee dynamics than stand approach in both the genders so as to realize a secure stair descent. To compare peak joint moments and peak joint powers at the hip, knee and ankle between the 2 approaches of stair descent initiation and between the genders among healthy young adults Participants 14 healthy collegiate adults Males (n=8) and Females (n=6) Age: 25.7 ± 2.5 years Mass: 71.8 ± 13.9 kg Height:167.8 ± 8.5 cm Data Collection 10-camera, 250-Hz VICON motion capture system Modified Hayes marker set (24 markers) Walk approach: level walk on the walkway and stair walk Stand approach: Stand on step 1 and stair walk 5 successful trials of every approach for every participant METHODS PURPOSE LimbJointVariable Walk (n = 14) Stand (n=14) Trail Hip Abductor M (N-m) -1.60 ± 0.18-1.42 ± 0.18* Knee Extensor M (N-m) 1.20 ± 0.30 1.04 ± 0.25* Eccentric P (W/kg) -3.40 ± 0.60-2.88 ± 0.68* Lead Knee Extensor M (N-m) 0.91 ± 0.220.85 ± 0.27 Eccentric P (W/kg) -2.98 ± 0.57-2.82 ± 0.79 Ankle Plantarflexor M (Nm/kg) -1.00 ± 0.25-0.99 ± 0.24 Extensor M (N-m) -3.86 ± 1.61-3.63 ± 1.66

Results-
Significant different from the walk approach ($p<0.05$). Abbreviations: M (moment) and P (power). For trail limb, Hip Abductor moment, p=0.006 Knee extensor moment, p=0.049 Knee eccentric power, p=0.003 Study highlights the necessary adjustments made by a healthy young adult for a safe stair descent during the transition from level walk to the lower step Larger hip abductor moment in walk approach signifies increased body control in frontal plane Larger knee extensor moment and maximum power absorption in walk approach signifies increased sagittal plane control during lowering of the body The component of level walk additional to a stair descent necessitates higher hip and knee dynamics on the transition step (top-most step) to achieve a safe stair descent McFadyen, B., & Winter, D.
Discussion-
Due to enhanced momentum when initiating stair ascent from a walk (increased velocity) compared to initiating stair ascent from a stand, we hypothesized that the frontal plane joint dynamics would be greater as one ascends stairs from a walk and such differences would be augmented in the next ipsilateral step. Collectively, our results supported both hypotheses. The greater peak knee abductor moment when initiating stair ascent from a walk demonstrates that the lateral portions of the knee experience higher levels of stress. Greater peak hip abductor moment when initiating stair ascent from a walk (Figure 3A) indicates an increased activity of the ipsilateral hip abductors. This increased activity could assist the contralateral limb to avoid contact with the intermediate step by counteracting the pelvic drop on the contralateral side .1 Peak joint moments and power in two approaches of stair descent initiation (mean ± SD).
Conclusion-

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Results from the present study demonstrated that the knee and hip joints experience greater peak abductor moments when initiating stair ascent from a walk and at the next ipsilateral step. These findings could provide therapists a comprehensive understanding of the mechanisms involved during stair climbing when used as a training/testing module for evaluating hip strength. In addition, results have methodological implications for the stair negotiation biomechanical research, especially in individuals with documented frontal plane abnormalities (i.e. knee and hip osteoarthritis, ACL injury).

References-

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