The anti-gravity treadmill as a post-operative rehabilitation tool: Reduction in contact forces and muscle activity with partial-weight running

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Financial Disclosure

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Our disclosures are in the Final AOFAS Mobile App
We have no potential conflicts with this presentation
Overview

• Partial-weight bearing running on an anti-gravity treadmill has been shown to be clinically advantageous by decreasing the rate of re-injury over NWB exercises when rehabilitating foot/ankle injury or surgical repair. ¹,²

• Such modalities can be difficult to administrate³
  – For example, underwater treadmill running can limit impact forces but alters muscle recruitment and timing patterns compared to ground running.⁴,⁵
Overview II

• The anti-gravity (AG) treadmill reduces ground reaction impact forces and muscle fatigue.\textsuperscript{6,7}

• We hypothesize that reduced percent body weight running on the AG treadmill will translate to a significant proportional decrease in all dynamic loading variables while still maintaining normal muscle recruitment patterns.
Data collection

• We recruited 20 healthy athletes (10 male, 10 female), age 18-29 with no history of significant foot and ankle injury who could run for 20 minutes at a 10:00 minute/mile pace.
• Electromyography: surface electrodes were affixed to 7 muscles on the athlete’s left leg:
  – biceps femoris
  – rectus femoris
  – vastus lateralis
  – gluteus medius
  – medial gastrocnemius
  – soleus
  – tibialis anterior
• Athletes ran for 12 minutes to acclimate to the AG treadmill then ran on a regular treadmill for one minute at 6.5 mph.
Data collection II

- Athletes then ran on the AG treadmill at 6.5 mph at 100%, 90%, 80%, 70%, 60%, and 50% body weight (BW) administered in random order for one minute each.
- For each trial, dynamic plantar loading data including contact area, maximum force, peak pressure, and force-time integral (FTI) was recorded using the Pedar-X insole system.
- EMG electrodes recorded timing and magnitude of muscle activity. Stride length and cadence subsequently calculated.
Results

• As body weight support increased, subjects ran with a lower cadence and longer stride time.
• All results are compared to 100% BW on the AG treadmill and all data is normalized to body weight.
• Maximum reduction in forces was seen in the hindfoot, with an average 51% reduction in max force and 59% reduction in FTI between 100% and 50% BW.
• Decreases in plantar pressures became significant at 90% BW for all regions of the forefoot, with the medial and lateral midfoot and hindfoot becoming significant at 80% BW.
• No significant reduction in contact area in forefoot, but a significant reduction in contact area in the hindfoot below 70% BW.
Percent increase from 100% BW AG Treadmill to Normal Treadmill

• There was also a 13% increase in peak pressure in the great toe (p<0.05).
Results – Muscle Activity

- Mean Root-Mean-Square (RMS) activity of all muscles decreased with increasing body weight support.

Soleus muscle activity

Vastus lateralis decreased in near direct proportion to body weight
Gender Differences

- There were no significant differences in muscle activity between genders.
- Compared to 100% BW, at 50% BW, male participants had a 57% decrease in hindfoot pressures and a 47% decrease in midfoot pressures, while female participants only had decreases of 29% and 31% in the same respective regions.
- Conversely, compared to 100% BW, female participants experienced a greater reduction in forefoot loading at 50% BW.
- Furthermore, at 50% BW, 4 of 10 male athletes ran with an altered center of pressure, while only 1 female athlete experienced substantial gait changes.
Discussion/Conclusion

• Our data show a significant reduction in peak pressure, maximum force, and FTI as BW decreased on the AG treadmill.

• This reduction in dynamic loading variables along with the repeatability of foot loading patterns while using the AG treadmill make the AG treadmill an efficacious rehabilitative tool. Athletes returning from hindfoot and midfoot injuries can train at a relatively high %BW on the AG treadmill to maintain cardiovascular endurance and optimally rehabilitate.

• The magnitude of muscle activity significantly decreased, but muscle function remained similar on the AG treadmill.
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