Why a curved treadmill with multi drive technology for rehab?

Francesco Cuzzolin
Research & Innovation Director
Technogym Scientific Department

Athletic Training Professor
Sport University of Padova
Reh-Ability Training Approach

- Biological Healing
- Functional Recover
- Retraining
- Sport
- Performance (RTP)
Reh-Ability Training Approach

- Biological Healing
- Functional Recover
- Retraining
- Sport
- Performance (RTP)
Motion-Centric

- From Function to Action
- From Action to Ability
- From Ability to Training
- From Training to Sport
- From Sport to Performance
Reh-Ability 5 Key Points

1. Don’t sleep the Nervous System
2. Motion Centric Approach
3. Gradual Stimolation
4. Progression without compensation
5. Not like before, better than before
From Needs to Solutions
Why a Curved Treadmill (CT) for Rehab?
Science behind – CT vs MT

The curved platform has been demonstrated to alter the physiological requirements of sub-maximal running.

A study showed that 9 expert distance runners made a greater running effort on the CT compared to a motorized treadmill (MT). When running for 6 minutes at 50%, 65%, 80% of the lactate threshold (LT) and at LT running speed, the Oxygen Uptake (VO2), Heart Rate (HR), blood lactate (HLa), and rate of perceived exertion (RPE) were significantly greater for the CT than the MT.

C. Snyder, PhD, CSCS, N. Weiland, C. Myatt, J. Bednarek and K. Reynolds (2010).

Energy Expenditure During Sub-Maximal Running on a Non-Motorized Treadmill.

Department of Human Movement Sciences Human Performance Laboratory University of Wisconsin-Milwaukee, Milwaukee, WI, USA
## More Effort – CT vs MT

<table>
<thead>
<tr>
<th>Variable</th>
<th>Treadmill</th>
<th>50% LT</th>
<th>65% LT</th>
<th>80% LT</th>
<th>LT</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VO₂ (mL·kg⁻¹·min⁻¹)</td>
<td>MT</td>
<td>25.2 ± 8.0</td>
<td>33.9 ± 5.6</td>
<td>41.9 ± 8.4</td>
<td>49.9 ± 9.2</td>
<td>62.2 ± 10.7</td>
</tr>
<tr>
<td></td>
<td>CT</td>
<td>33.4 ± 9.8*</td>
<td>45.9 ± 11.4*</td>
<td>54.6 ± 8.9*</td>
<td>60.2 ± 11.0*</td>
<td>-</td>
</tr>
<tr>
<td>HR (bpm)</td>
<td>MT</td>
<td>118 ± 14</td>
<td>130 ± 7</td>
<td>151 ± 9</td>
<td>170 ± 11</td>
<td>195 ± 7</td>
</tr>
<tr>
<td></td>
<td>CT</td>
<td>136 ± 16*</td>
<td>158 ± 15*</td>
<td>175 ± 11*</td>
<td>190 ± 10*</td>
<td>-</td>
</tr>
<tr>
<td>HLa (mM)</td>
<td>MT</td>
<td>1.8 ± 0.7</td>
<td>1.7 ± 0.4</td>
<td>2.4 ± 1.1</td>
<td>4.5 ± 1.6</td>
<td>10.3 ± 2.5</td>
</tr>
<tr>
<td></td>
<td>CT</td>
<td>2.3 ± 1.8*</td>
<td>3.6 ± 1.1*</td>
<td>6.8 ± 2.3*</td>
<td>11.1 ± 2.9*</td>
<td>-</td>
</tr>
<tr>
<td>RPE (0-10)</td>
<td>MT</td>
<td>0.7 ± 0.5</td>
<td>1.1 ± 1.0</td>
<td>1.9 ± 1.3</td>
<td>4.1 ± 1.6</td>
<td>9.3 ± 1.0</td>
</tr>
<tr>
<td></td>
<td>CT</td>
<td>1.2 ± 0.7*</td>
<td>2.1 ± 1.0*</td>
<td>3.6 ± 0.8*</td>
<td>8.2 ± 1.1*</td>
<td>-</td>
</tr>
<tr>
<td>StO₂ (%)</td>
<td>MT</td>
<td>76 ± 19</td>
<td>66 ± 24</td>
<td>57 ± 20</td>
<td>41 ± 21</td>
<td>28.3 ± 20.3</td>
</tr>
<tr>
<td></td>
<td>CT</td>
<td>71 ± 10</td>
<td>52 ± 18</td>
<td>34 ± 23*</td>
<td>22 ± 13*</td>
<td>-</td>
</tr>
</tbody>
</table>
## More Effort – CT vs MT

<table>
<thead>
<tr>
<th>Variable</th>
<th>Treadmill</th>
<th>50% LT</th>
<th>65% LT</th>
<th>80% LT</th>
<th>LT</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VO₂ (ml·kg⁻¹·min⁻¹)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT</td>
<td>33.4 ± 9.8*</td>
<td>45.9 ± 11.4*</td>
<td>54.6 ± 8.9*</td>
<td>60.2 ± 11.0*</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>MT</td>
<td>25.2 ± 8.0</td>
<td>33.9 ± 5.6</td>
<td>41.9 ± 8.4</td>
<td>49.9 ± 9.2</td>
<td>62.2 ± 10.7</td>
<td></td>
</tr>
<tr>
<td>HR (bpm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MT</td>
<td>118 ± 14</td>
<td>130 ± 7</td>
<td>151 ± 9</td>
<td>170 ± 11</td>
<td>195 ± 7</td>
<td></td>
</tr>
<tr>
<td>CT</td>
<td>136 ± 16*</td>
<td>158 ± 15*</td>
<td>175 ± 11*</td>
<td>160 ± 10*</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>HLα (mM)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MT</td>
<td>1.6 ± 0.7</td>
<td>1.7 ± 0.4</td>
<td>2.4 ± 1.1</td>
<td>4.5 ± 1.8</td>
<td>10.3 ± 2.5</td>
<td></td>
</tr>
<tr>
<td>CT</td>
<td>2.3 ± 1.8*</td>
<td>3.6 ± 1.1*</td>
<td>6.8 ± 2.3*</td>
<td>11.1 ± 2.9*</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>RPE (0-10)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MT</td>
<td>0.7 ± 0.5</td>
<td>1.1 ± 1.0</td>
<td>1.9 ± 1.3</td>
<td>4.1 ± 1.6</td>
<td>9.3 ± 1.0</td>
<td></td>
</tr>
<tr>
<td>CT</td>
<td>1.2 ± 0.7*</td>
<td>2.1 ± 1.0*</td>
<td>3.6 ± 0.8*</td>
<td>8.2 ± 1.1*</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>StO₂ (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MT</td>
<td>76 ± 19</td>
<td>66 ± 24</td>
<td>57 ± 20</td>
<td>41 ± 21</td>
<td>28.3 ± 20.3</td>
<td></td>
</tr>
<tr>
<td>CT</td>
<td>71 ± 10</td>
<td>52 ± 18</td>
<td>34 ± 23*</td>
<td>22 ± 13*</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>
Less joints overload – CT vs MT

Results showed that while the fore-foot pressures were not different between the three treadmills, the rear-foot ones were significantly less on the CT.

A study from 2011 compared foot pressure when walking at 1.34, 2.23, and 3.13 m/s on 3 different treadmills; 2 MT, a belt driven (BT) and a slatted (ST), and a CT. Results showed that while the fore-foot pressures were not different between the three treadmills, the rear-foot ones were significantly less on the CT then for the 2 MT at all three speeds. On the contrary there appears to be no difference with the individuals step length between treadmills at a given speed.


Foot Pressures of Walking, Jogging, and Running on Non-Motorized and Motorized Treadmills.

Department of Human Movement Sciences, Human Performance Laboratory University of Wisconsin-Milwaukee, Milwaukee, WI, USA.
More Strength – CT vs MT

Training on the MT showed an increase in concentric hamstring’s strength (CH) and a decrease in concentric quadriceps strength (CQ) resulting in greater values of Conventional Ratio (ratio of concentric hamstrings to concentric quadriceps). On the other hand, subjects who trained on the CT revealed a slight increase in CH and a great increase in CQ, thus causing a decline in Conventional Ratio.


THE EFFECT OF AN INNOVATIVE NON-MOTORIZED TREADMILL ON WALKING AND RUNNING BIOMECHANICS

N. Petrone, M.Nardon, P. Pavan - Department of Industrial Engineering
G. Marcolin - Department of Biomedical Sciences
S. Zanuso – University of Greenwich
P. Benvenuti – University of Verona
METHODS: EMG channels & markers

- SMART BTS - 60 Hz Motion Capture
- Pocket EMG – 1KHz electromyograph
- Software Tools for the data Analysis:
  - Smart Capture
  - Smart Tracker
  - Smart Analyzer
METHODS: EMG channels & markers
When running at high-moderate speed, showed higher average and peak activations on SKM vs TRD.
Optimize Movement Biomechanics

- Increased ankle ROM during walking
- Increased hip ROM during running
- Decreased trunk ROM during running

Petrone et al, 2016
Clinical applications:

• Post-operative rehabilitation
• Running mechanics/analysis
• Optimize biomechanics
• Aerobic training/testing
• Anaerobic training/testing
• Athletic Performance
• Sport specific training
Post-Operative Rehabilitation

- Gait facilitation/muscle activation
- Partial weight bearing
- Promote proper biomechanics while progressing to full weight bearing
- From Gait to Running progression
- From Ability to Sport progression
Post-Operative Rehabilitation

- Gait facilitation/muscle activation
- Partial weight bearing
Post-Operative Rehabilitation
Post-Operative Rehabilitation
Post-Operative Rehabilitation
Post-Operative Rehabilitation
Post-Operative Rehabilitation
Running Mechanics – TM vs OG

- Muscle activity of the rectus femoris and the biceps femoris has a lower magnitude of EMG values in treadmill running than that in overground running during the stance phase (Wang et al, 2014)

- Weaker amplitudes of the soleus in the push-off during [treadmill running] suggest adaptation to the movement of the treadmill belt (Baur et al, 2007)
Running Mechanics – SM vs TM

• Athletes can naturally and spontaneously train pace regulation
Sprinting on the conventional treadmill ask a longer ground contact time, a longer braking phase, a more extended knee at foot strike and a faster extending hip than the non-motorized treadmill and over-ground.

Non-motorized treadmill is more appropriate for laboratory sprinting analyses and training than the conventional treadmill. (Mckenna et al, 2007)
Athletic Performance

- Resisted sprinting has similar kinematics to the acceleration phase of a sprint (LeBlanc et al, 2004)

- Statistically significant correlations were observed in sprinting ability, jumping ability, and strength to sled pushing (Hoffmann, 2014)
Multi Drive Technology
Athletic Performance

Three weeks of eccentric training combined with overspeed exercises enhances power and running speed performance gains in trained athletes (Cook et al, 2013)

Assisted sprinting has similar kinematics to free top-speed sprinting

Assisted sprinting does not have greater stride rates than free sprinting (Leblanc et al, 2004)
Sport Specific Training
Thanks for your kind attention!

Francesco Cuzzolin
Research & Innovation Director
Technogym Scientific Department
Athletic Training Professor
Sport University of Padova

The Wellness Company