The Functional Re-adaptive Exercise Device

Dr Nick Caplan
Reader in Health and Rehabilitation
Achieving a stable spine
Microgravity effects the spinal muscles
Current post flight rehabilitation

- **Specific local motor control training**
  - Helping astronauts re-establish their physiological spinal curves in upright alignment against gravity
  - Improve motor control of lumbo-pelvic muscles

- **Pros**
  - Safer than general strength exercise programmes in deconditioned individuals (Hides et al., 2011)
  - Sufficient to re-store deep spinal muscle volume (Hides et al., 2011)

- **Cons**
  - Little functional relevance
  - Difficult to teach and master
  - Supervision + biofeedback required

From 2nd Berlin Bed Rest Study, with kind permission from Gunda Lambrecht
The Functional Re-adaptive Exercise Device
The Evolution of FRED

2009  2011  2013
FRED recruits deep spinal muscles

- ↑ multifidus muscle thickness on FRED vs voluntary contraction or standing on ground
FRED achieves \( \uparrow \) spinal stability

- FRED vs walking
- \( \downarrow \) axial trunk rotation on FRED
FRED promotes tonic activity in superficial spinal extensors

- FRED vs walking
- Tonic activity of spinal extensors
- Reduction in spinal flexor activity
FRED promotes tonic activation in deep spinal extensors
FRED preferentially recruits deep spinal muscles compared to walking.
Effect of foot movement amplitude

![Image of foot movement apparatus]

- LM normalised to rest (%)
- Max-min LM thickness (mm)

Bar charts and graphs showing the effect of foot movement amplitude on LM thickness and normalisation.

- Crank 2: LM normalised to rest (%): 21
- Crank 3: LM normalised to rest (%): 20
- Crank 4: LM normalised to rest (%): 19
- Crank 5: LM normalised to rest (%): 18

- Crank 2: Max-min LM thickness (mm): 3
- Crank 3: Max-min LM thickness (mm): 2.5
- Crank 4: Max-min LM thickness (mm): 2
- Crank 5: Max-min LM thickness (mm): 1.5
FRED has potential for in-flight use
Summary

- FRED promotes:
  - Tonic activity of the deep and superficial spinal extensor muscles and postural muscles
  - Preferential recruitment of deep spinal muscles
  - Increased spinal stability
- FRED settings can be adjusted to enable progressive training programme
- FRED could even be used in space
Current FRED studies

- Spinal kinematics in low back pain
- Movement control feedback
- Influence of time spent on FRED on kinematics
Future directions

- Intervention in clinical populations (LBP)
- Post-bedrest rehabilitation
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