Vibration Therapy
-
Overview & Application

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Mechanical Stimulation

- **Wolff's law (19th century, Julius Wolff)**
  - Bone is deposited and resorbed to achieve an optimum balance between strength and weight

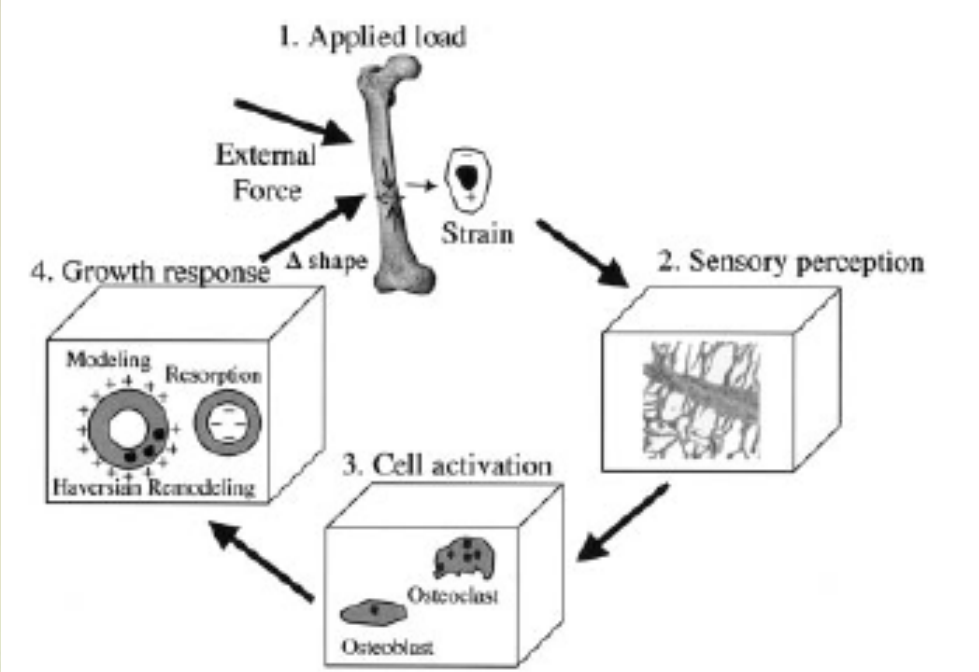


Fig. 1. Responses of bone to loading.

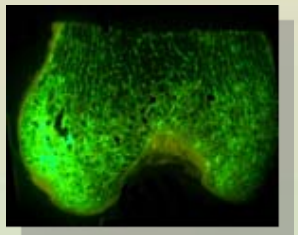
Mechanical Stimulation

- **Musculoskeletal system**
  - Bone
  - Muscle
  - Tendon
  - Ligament
- **↓ 1.5% of bone mass every month in space flight**

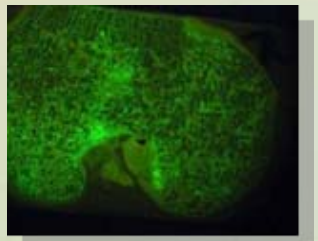
Mechanical Stimulation

- **Exercise**
- **Biophysical interventions**
  - Extracorporeal shockwave ***(Tam, 2005)***
  - Low intensity pulsed ultrasound (LIPUS) ***(Leung, 2004)***

LIPUS



Treatment



Control

Shockwave

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What Is Vibration Therapy?

- **A biophysical modality to provide systemic vibration signals at 30-50Hz**
- **Magnitude:** variable
- **Treatment period:** 3-20mins/day
- **Vibration modes:**
  - Up and down (Vertical)
  - Left and Right (Tilting)
- **Brands:** Fitvibe, Galileo, Juvent, Nemes, Powerplate, Smitech, Turbosonic, Vibraflex ...

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Vibration Platform

Powerplate

Juvent

Galileo

Turbosonic

Fitvibe

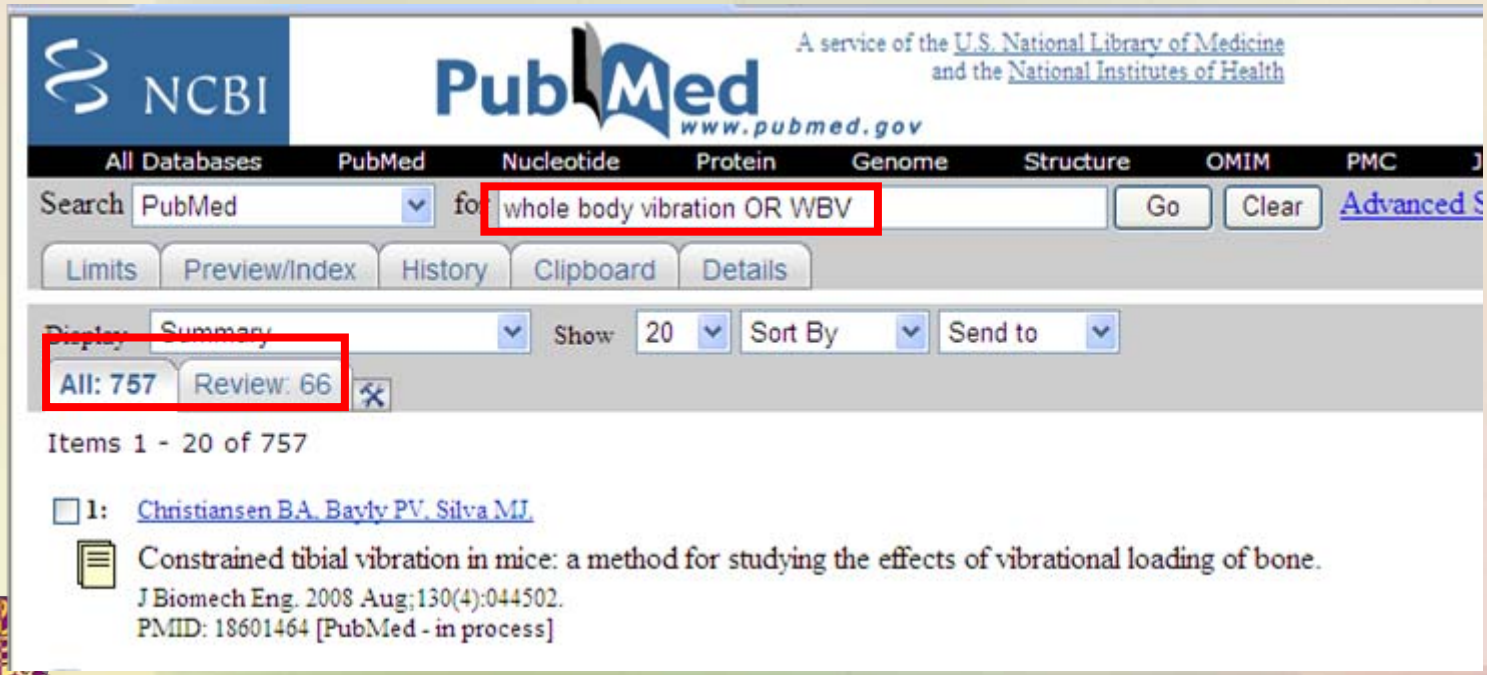
Vibraflex

Nemes

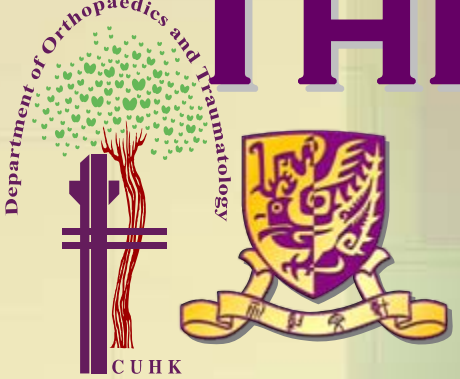
Smitech

Research on Whole-Body Vibration

» **PubMed:** 757 papers with keyword “whole body vibration” (WBV) and 66 reviews up to 2008 Jun



Multifactorial Effects of Vibration Therapy

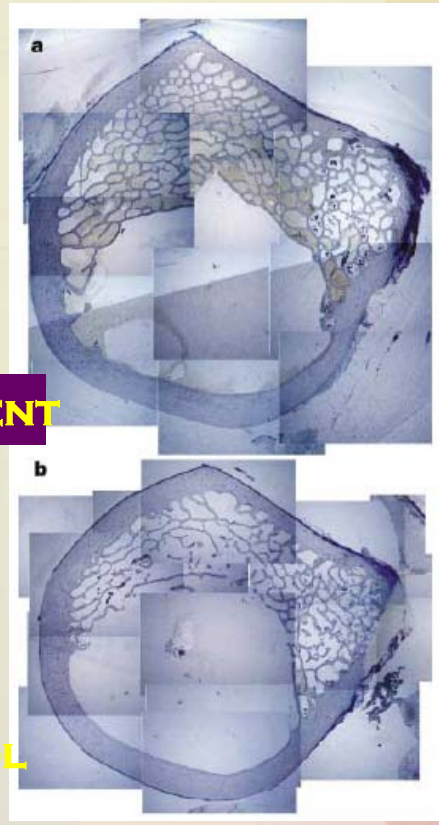


Multifactorial Effects of Vibration Therapy

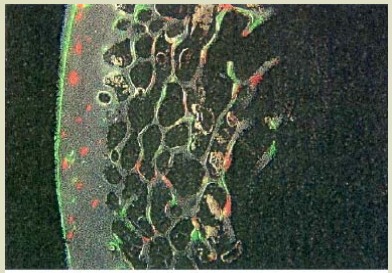
- **Muscle** (Balancing, Jumping height, Lower limb extension strength, Low back pain)
- **Bone** (Bone mineral density: spine, lower limb)
- **Circulation** (Blood flow at lower limb)
- **Hormonal** (Growth hormone, Testoterone)
- **Fracture healing** (Callus formation)
- **Psychological** (Pain relief)

Effect of Vibration Therapy on Bone

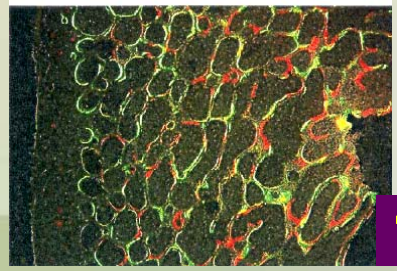
- **Osteogenic**
- **Animal Study** ***(Rubin, 2001)***
  - Adult sheep (6-8 years)
  - 30Hz, 0.3g, 20min/day
  - tBMD ↑ by 34.2%
  - Tb.N ↑; Tb.Sp ↓



Treatment



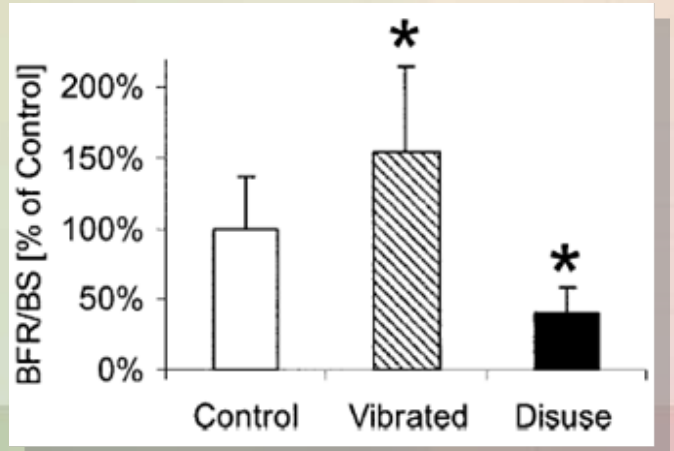
Control



Treatment

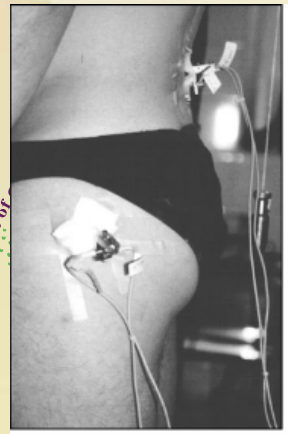
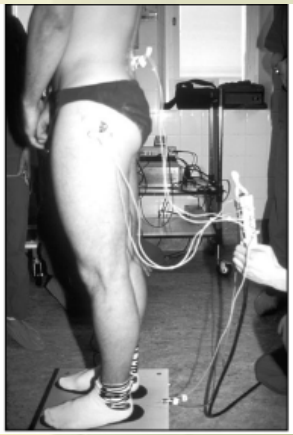
Effect of Vibration Therapy on Bone

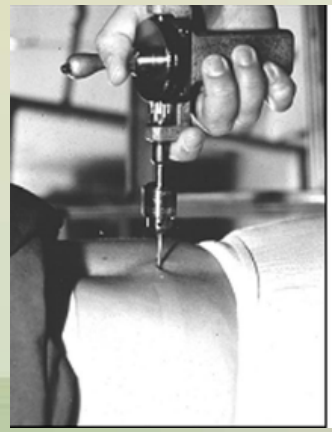
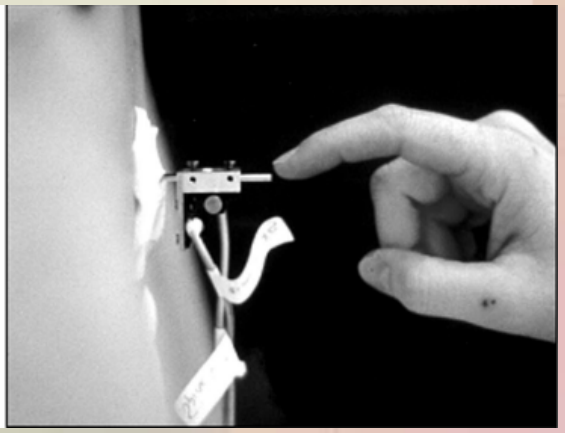
- **Animal-Molecular Study** ***(Judex, 2005)***
  - Adult female BALB mice
  - Control vs. Vibration vs. Disuse
  - ↑ in iNOS (+39%), MMP-2 (+54%), RANKL (+32%) after 21 days
  - 60% suppression by disuse vs. 55% increase by vibration



Effect of Vibration Therapy on Bone

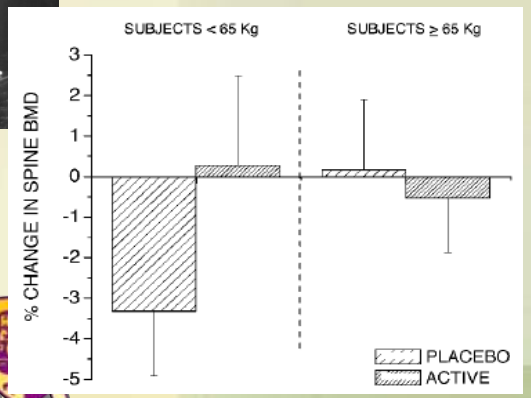
- **Confirm signal transmissibility** ***(Rubin, 2003)***
  - 5 females, 1 male
- **Transcutaneous K-wire at L4 and greater trochanter**
  - >100% transmissibility at <20Hz
  - 80% transmissibility at >25Hz
  - 30% transmissibility with 20° knee flexion

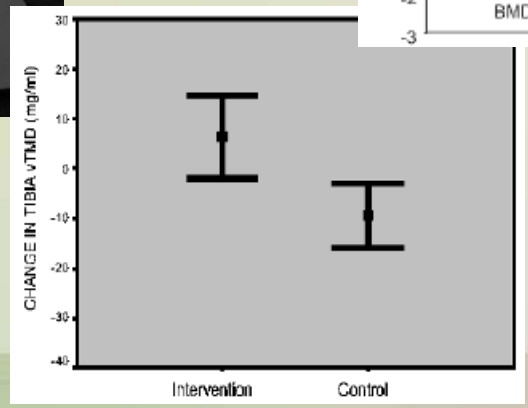



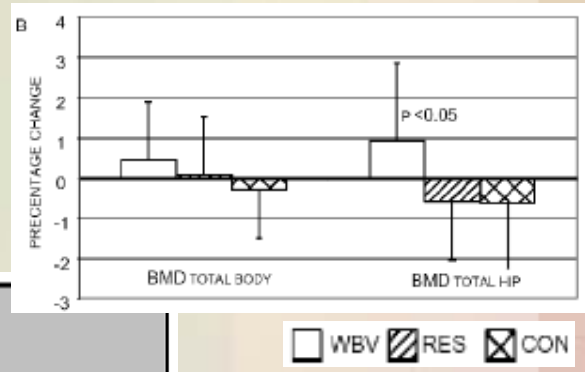



Effect of Vibration Therapy on Bone

- **Clinical Studies**
  - 70 postmenopausal women *(Rubin, 2004)*
  - 20 disabled, ambulant children *(Ward, 2004)*
  - 70 postmenopausal women *(Verschueren, 2004)*





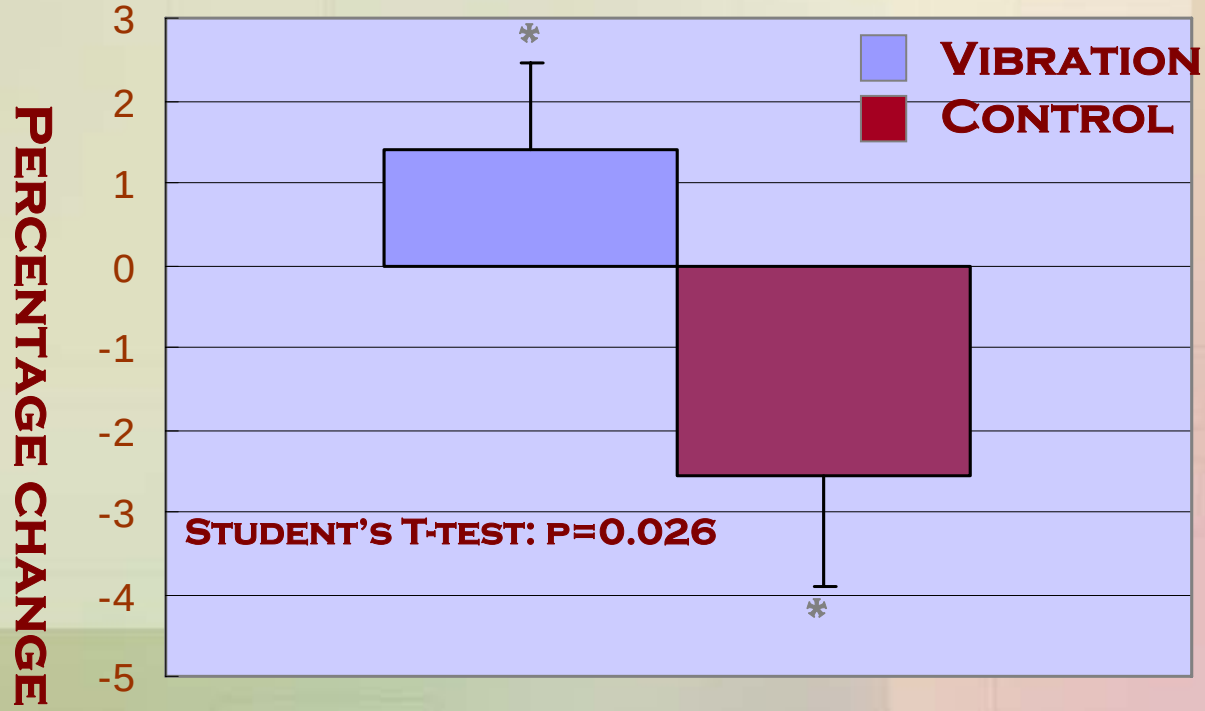


Effect of Vibration Therapy on Bone

- **Clinical Studies**
  - **48 young women (15-20 years) with low BMD and at least one skeletal fracture** ***(Gilsanz, 2006)***
    - 30Hz, 0.3g, 10 mins for 12 months
    - Cancellous bone in lumbar vertebrae (2.1%)
    - Cortical bone in femoral midshaft (3.4%)

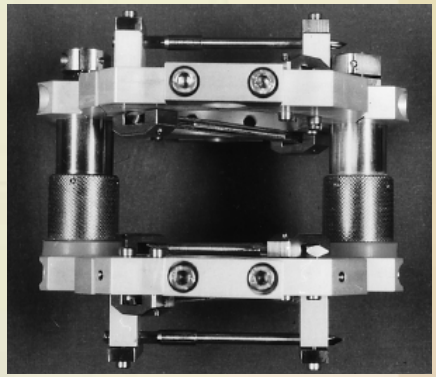
Effect of Vibration Therapy on Bone

- Clinical Studies
  - Postmenopausal women *(Hong Kong)*
    - 30Hz, 0.3g, 20 mins for 12 months
    - BMD in lumbar spine significant improved

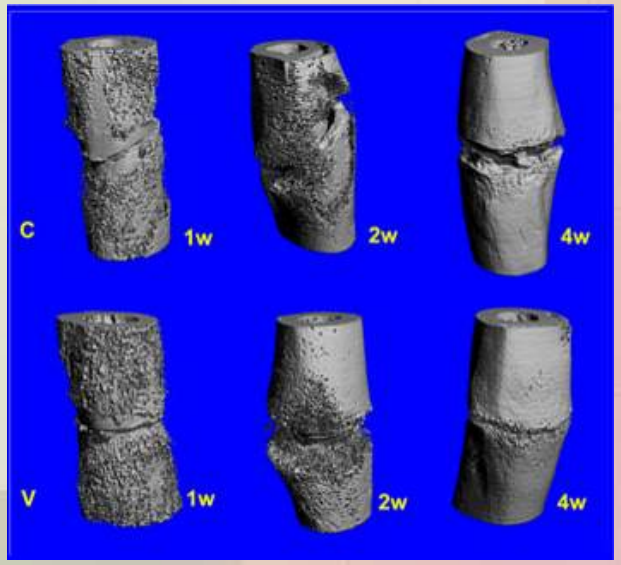


Effect of Vibration Therapy on Bone Fracture

- **12 Skeletal Mature Sheep** ***(Wolf , 2001)***
  - Osteotomy + External fixator
  - 5 days/week for 8 weeks
  - Enhancement of callus formation
- **34 Adult SD Rats** ***(Leung, ORS, 2007)***
  - Fracture + internal fixation
  - 6 days/week for 4 weeks
  - Callus formation, bridging ↑
  - Bone structure ↑



External fixator



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Clinical study on Fracture healing

- 40 hip fracture patients
- Start VT on Day 7
- Con’t for 6 months
- Gradually increase to 20 min daily
- Fracture healing, functional outcomes, BMD

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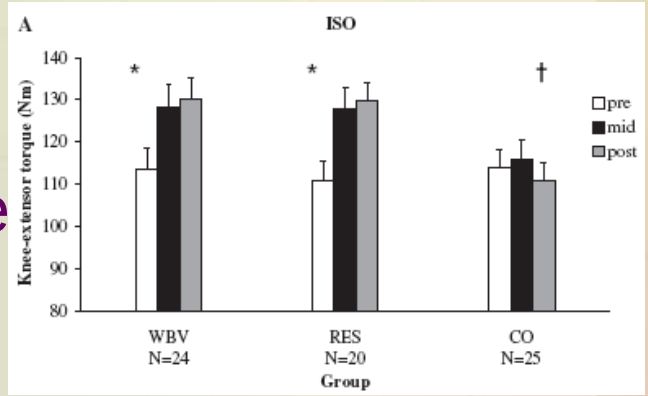
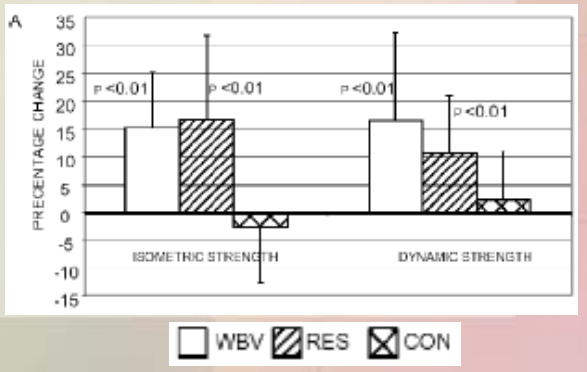
Effect of Vibration Therapy on Muscle

- **Knee Extension Strength, Speed of Movement** ***(Roelants, 2004)***
  - 89 postmenopausal women
  - 35-40Hz; 2.5-5.0mm amplitude
  - Max. 30min/day for 24 weeks



- **Muscle Strength, Postural Control** ***(Verschueren, 2004)***
  - 70 postmenopausal women
  - Same protocol as above



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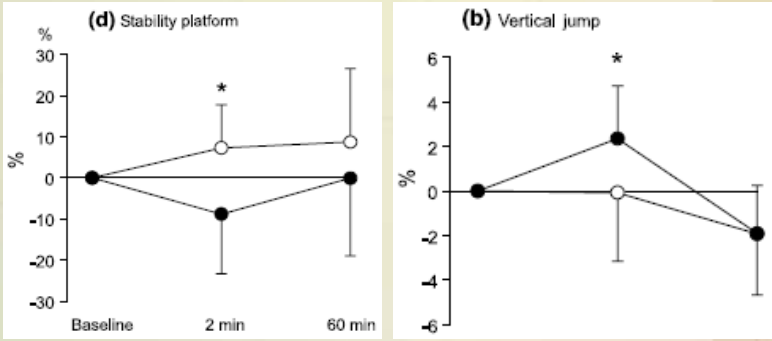
Effect of Vibration Therapy on Muscle

- **Sensory Organization, Timed up-and-go** ***(Schuhfried, 2005)***
  - Double-blind, randomized controlled
  - 20 patients with multiple sclerosis
  - 2.0-4.4Hz; 3mm amplitude for 2 weeks

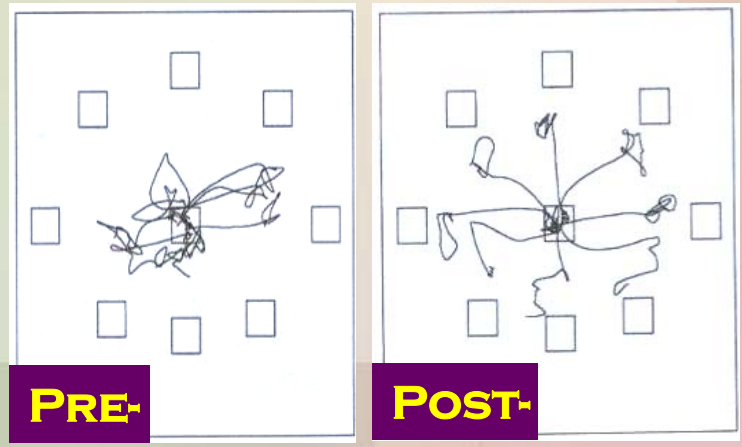
- **Timed up-and-go, Tinetti-test** ***(Bautmans, 2005)***
  - Randomized controlled trial
  - 24 institutional elderly
  - 30-40Hz, 2mm amplitude; 3days/week; for 6 weeks

Effect of Vibration Therapy on Muscle

- **Jump Height, Extension Strength, Balance** *(Torvinen, 2002)*
  - Randomized cross-over study
  - 16 volunteers (24-33 years)
  - 4min treatment



- **Movement Velocity, Max Point Excursion, Directional Control** *(Cheung , 2007)*
  - Randomized controlled trial
  - 69 elderly
  - 3mins/day; 3days/week for 3 months



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Effect of Vibration Therapy on Low Back Pain

- Drivers, pilots, machinery workers
- Cause of low back pain
- Early degeneration of the lumbar spinal system and herniated lumbar disc
- Dangerous OR benefit ?

1: Int Arch Occup Environ Health. 1987;59(3):205-20.

Whole-body vibration and low-back pain. A review of epidemiologic studies.

Hulshof C, van Zanten BV.

1: Clin Orthop Relat Res. 1992 Jun;(279):49-59.

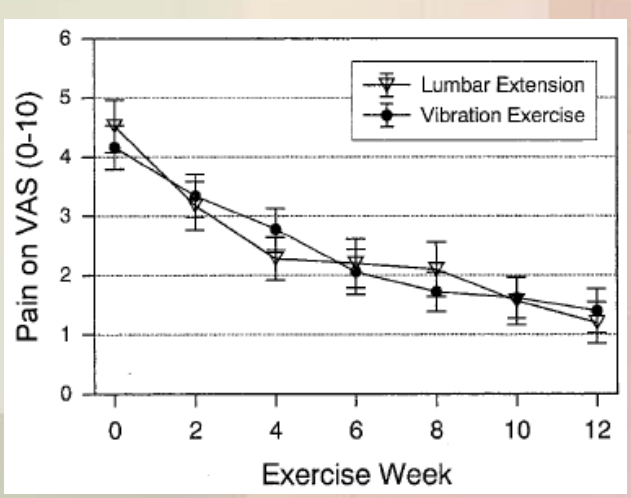
Vibration of the spine and low back pain.

Pope MH, Hansson TH.

McClure Musculoskeletal Research Center Department of Orthopaedics, University of Vermont, Burlington.

Effect of Vibration Therapy on Low Back Pain

- **Randomized, controlled trial for 6 months**
  (Rittweger, 2002)
  - 60 patients with chronic LBP
  - Compare lumbar extension exercise and whole-body vibration
  - ↓ pain sensation, disability; ↑ lumbar extension torque
- **Improve lumbosacral repositioning accuracy** ***(Fontana, 2005)***
- **Cure rather than the cause**



Effect of Vibration Therapy on Hormonal Changes

- **14 male subjects (average 25 years)**
  (Bosco, 2000)
- **26Hz, 4mm amplitude, 2 sets of 60s×10**
  - ↑ Testoterone, growth hormone; ↓ Cortisol
  - ↑ mechanical power output of leg extensor muscle, jumping performance
- **Biological adaptation – neuromuscular performance**

Parameter	Before vibration	After vibration	*P*, paired *t*-test
Cortisol (nmol · l^{-1})	682 (255)	464 (257)	0.03
Testosterone (nmol · l^{-1})	22.7 (6.6)	24.3 (6.6)	0.026
Growth hormone (ng · ml^{-1})	6.2 (16.2)	28.6 (29.6)	0.014

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Effect of Vibration Therapy on Circulation

- **Study 1** ***(Kerschan-Schindl, 2001)***
  - 20 volunteers (25-35 years)
  - Muscular circulation in calf and thigh ↑
  - Mean blood flow ↑
- **Study 2** ***(Stewart, McLeod, 2005)***
  - 18 women (46-63 years)
  - blood flow increased in calf (30%), pelvic (26%) and thoracic regions (20%) at 45Hz
  - Enhance peripheral and systemic blood flow, peripheral lymphatic flow, venous drainage

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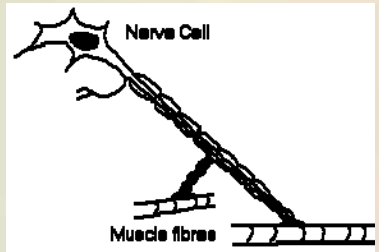
Implications for Clinical Applications

- Osteoporosis, Low BMD
- Astronauts
- Low back pain
- Loss of neurological coordination
- Muscular problem
- Athletic training
- Fracture
- Preventive



Contraindication?

- Pregnancy
- Acute thrombosis
- Acute infection of the skeletal system
- Malignant growth
- Fresh fracture
- Gall and bladder stones
- Following general operation
- Depression
- Implantation

Thank You