VIBRATION LITERATURE REVIEW 2019

The human body is designed to adapt to motion. Below a mechanical strain threshold, muscles atrophy and bone is resorbed. Stressors that exceed the minimum strain threshold prompt growth on a muscle, bone, and even on a cellular level. An explosive recent growth in research on oscillatory mechanical pressure has proven vibration benefits physical therapy, improves post-surgical outcomes, increases benefits of athletic training, with short and long term benefits. High frequency vibration reduces the pain of training, injury, and even chronic conditions. When combined with cryotherapy, vibration can block even intense pain.

VIBRATION FOR PHYSICAL THERAPY

Localized muscle vibration reverses quadriceps hypotrophy, improves function. Benedetti MG Boccia G et al. Int J Rehabil Res. 2017 Dec;40(4):339-346. Thirty patients with OA randomized to 150Hz or electrostimulation; only vibration effective.

Effect of illusory kinesthesia on hand function in patients with distal radius fractures: a quasi-randomized controlled study. Imai R, Osumi M et al. Clin Rehabil. 2017 May;31(5):696-701 "[Tendon vibration] was an effective post-surgery management strategy not only for pain alleviation, but also hand function...with improvements persisting for up to two months."

Effects of local vibration and pulsed electromagnetic field(PEMF) on bone fracture: A comparative study. Bilgin HM Celik F et al. Bioelectromagnetics 2017 Jul;38(5):339-348 Three and a half hours of PEMF/day was less effective than 15 minutes vibration/day to increase osteogenic (bone) formation.

The acute effects of local vibration therapy on ankle sprain and hamstring strain injuries. Peer KS, Barkley JE, Knapp DM Phys Sports Med. 2009;37(4):31-38 " Local vibration for 10 minutes increased ankle dorsiflexion and eversion and hamstring flexibility ($P < 0.03$ for all), and significantly ($P <$or$= 0.05$) decreased perceived ankle and hamstring stiffness."

Vibration therapy: clinical applications in bone. Thompson WR, et al. Curr Opin EndocrDiabetes Obes.2014;21:447–453. "Additional physiological mechanisms [of] vibration include improved blood flow to injury and enhanced hormonal responses, including testosterone and growth hormone, evidence for a more systemic effect [on] tissue healing."

Additional Resources:

- **Low-intensity vibration(LIV) improves angiogenesis and wound healing in diabetic mice.** Weinheimer-Haus EM, Judex S, Ennis WJ, Koh TJ PLoS One. 2014; 9(3):e91355.
- **Localized application of vibration improves passive knee extension in women with apparent reduced hamstring extensibility: a randomized trial.** J of physiotherapy. Bakhtiary AH, Fatemi E, Khalili MA, Ghorbani R. 2011;57:165–171.
- **The anabolic activity of bone tissue, suppressed by disuse, is normalized by brief exposure to extremely low-magnitude mechanical stimuli.** Rubin C, Xu G, Judex S. FASEB J. 2001;15(12):2225-2229.
- **Effect of vibration treatment on symptoms associated with eccentric exercise-induced muscle damage.** Lau W.Y., Nosaka K. (2011) American Journal of Physiology Medicine & Rehabilitation 90(Pt 8), 648-657

VIBRATION FOR POST-SURGICAL REHABILITATION

Whole body(WBV) and local muscle vibration(LMV) reduce quadriceps muscle inhibition. Blackburn JT Arch Phys Med Rehabil. 2014 Nov;95(11):2021-8 (WBV $p=.021$, LMV $P<.001$) "WBV and LMV improve quadriceps function equivocally after simulated knee pathology."

Whole Body vibration ACL reconstruction Pamukoff DN Arch Phys Med Rehabil. 2018 May;99(5):973-980 A single session of WBV acutely improved knee flexion excursion.

Local Muscle Vibration after ACL Repair Pamukoff DN et al Arch Phys Med Rehabil 2016 Jul;97(7):1121-9 Increase in Central Activation Ratio (+2.7%, $P=.001$) and a reduction in quadriceps active motor threshold (-2.9%, $P<.001$) after LMV.

Improvement of stance control and muscle performance induced by focal muscle vibration in young-elderly women: a randomized controlled trial. Filippi GM, Brunetti O, Botti FM. Arch Phys Med Rehabil. 2009 Dec(12):2019-25 . Sixty sedentary women had three 10-minute vibration sessions a day for 3 consecutive days applied to contracted or relaxed quadriceps, or received placebo (non-vibrated group). At 24 hours, the area of sway decreased by 20%, vertical jump increased by 55%, and leg power increased by 35%. These effects were maintained for at least 90 days.

Focal vibration of quadriceps muscle enhances leg power and decreases knee joint laxity in female volleyball players. Brunetti O, Botti FM et al. J Sports Med Phys Fitness. 2012 Dec;52(6):596-605. Eighteen volleyball athletes, (age=22.7 ± 3 years) were assigned to vibration on contracted or relaxed quads or sham vibration (NV). Combined contraction and vibration can significantly and persistently improve muscle performance and knee laxity in volleyball women players.

A portable vibrator for muscle performance enhancement by means of direct muscle tendon stimulation. Luo J, McNamara BP, Moran K. Med Eng Phys. 2005;27(6):513-522.

Low-level, high-frequency mechanical signals enhance musculoskeletal development of young women with low bone mass density (BMD). Gilsanz V, Wren TA, Sanchez M, Dorey F, Judex S, Rubin C. J Bone Miner Res. 2006;21(9):1464-1474. "Short bouts of extremely low-level mechanical signals, several orders of magnitude below that associated with vigorous exercise, increased bone and muscle mass in the weight-bearing skeleton of young adult females with low BMD."

Additional Resources:

• **Low-frequency vibratory exercise reduces the risk of bone fracture more than walking: a randomized controlled trial**. Gusi N, Raimundo A, Leal A. BMC Musculoskelet Disord. 2006;7:92.

• **Improvement of posture stability by vibratory stimulation following anterior cruciate ligament reconstruction.** Brunetti O, Filippi GM, Lorenzini M, et al. Knee Surg Sports Traumatol Arthrosc. 2006; 43(11):1180-1187.

VIBRATION FOR MUSCLE STRENGTH, ATHLETIC TRAINING, DELAYED ONSET MUSCLE SORENESS

Local high-frequency vibration therapy following eccentric exercises reduces muscle soreness perception and posture alterations in elite athletes. Iodice P et al. Eur J Appl Physiol 2018 Oct 30. 120Hz vibration applied for 15 minutes decreased eccentric effect of exercise on pain and posture in 30 professional athletes.

Effectiveness of using wearable vibration therapy to alleviate muscle soreness. Cochrane DJ. Eur J Appl Physiol 2017 Mar;117(3):510-509. Thirteen males used VT or nothing prior to eccentric arm exercises in a crossover trial separated by arms over 14 days. Acute and short-term VT significantly attenuated muscle soreness, creatine kinase and improved range of motion.

Intermediate Muscle Length and Tendon Vibration… Souron R. et al. Front Physiol. 2018 Sep 5;9:1226 Motor-evoked potentials more than doubled with vibration, with the best results applying vibration to the tendon at an intermediate muscle length. Vibration significantly increased knee extensor neuromuscular function.

To Compare the Effect of Vibration Therapy(VT) and Massage in Prevention of Delayed Onset Muscle Soreness (DOMS). Imtiyaz S, Vegar Z, Shareef MY. J Clin Diagn Res. 2014 Jan;8(1):133-6. Forty-five nonathletic women were randomized to 15 minutes of massage, 5 minutes of focal vibration, or no intervention prior to exercise. Vibration therapy and massage prevented DOMS equally versus control; only VT decreased 48h lactate dehydrogenase level.

Vibration Therapy in Management of Delayed Onset Muscle Soreness (DOMS). Vegar Z. Imtiyaz S. J Clin Diagn Res. 2014 Jun;8(6)LE01-4. "Vibration therapy improves muscular strength, power development, kinesthetic awareness, decreased muscle sore, increased range of motion, and increased blood flow under the skin. VT was effective for reduction of DOMS and regaining full ROM… and lower creatine kinase levels in the blood."

Effects of vibratory stimulations on maximal voluntary isometric contraction from delayed onset muscle soreness. Koh HW, Cho SH et al. J Phys Ther Sci. 2013 Sep;25(9):1093-5. DOMS was induced in the musculus extensor carpi radialis longus of 60 adults. Ultrasound or vibratory stimulation for 10 minutes or control was used. Vibration had a positive effect on recovery of muscle function from DOMS compared to the control group, while ultrasound did not.

Effect of vibration treatment on symptoms associated with eccentric exercise-induced muscle damage. Lau WY et al. Am J Phys Med Rehabil 2011 Aug;90(8):648-57. Thirty minutes of vibration after exercise reduced DOMS and improved recovery of range of motion.

Additional Resources:
Vibration therapy(VT) reduces plasma IL6 and muscle soreness after downhill running. Broadbent S, Rousseau J, J. Throp RM, Choate SL, Jackson FS, Rowlands DS. Br J Sports Med. 2010;44:888–894.

Muscle performance changes induced by muscle vibration. Fattorini L, et al. Physiol 2006;98:79-87

VIBRATION FOR PAIN RELIEF

Vibratory tendon stimulation on acute pain after surgery for distal radius fractures. Imai R, Osumi M et al. Clin Rehabil. 2016 Jun;30(6):594-603. After a week of daily vibration, pain reduced at 7days, 1m, 2m.

How does vibration reduce pain? Hollins M. et al. Perception. 2014;43(1):70-84 Elegant review of physiologic studies to date, underscores Pacinian influence and lack of cognitive distraction as mechanism.

Comparison of a vibration roller and nonvibration on knee pain and ROM. Cheatham SW J Sport Rehabil. 2018 Oct1:1-7 Vibrating roller superior for knee pain relief and ROM to regular roller or sham P<.001.

A randomized, double-blinded, placebo-controlled clinical trial evaluating the effectiveness of daily vibration after arthroscopic rotator cuff repair. Lam PH, Hansen K, et al. Am J Sports Med 2015 43: 2774. Five minutes of vibration was applied daily after arthroscopic rotator cuff repair for 6 months. Vibration did provide acute pain relief at 6 weeks after surgery (visual analog scale [VAS] score, 2.24 (0.29 cm)) compared with placebo (VAS score, 3.67 (0.48 cm)) (P=.003).

Vibratory stimulation for the alleviation of chronic pain. Lundeberg T. Acta Physiol Scand Suppl. 1983;523:1-51 Seventy percent of 596 chronic pain patients reported reduction of pain with vibration; 100-150Hz were most effective, with subsequent cold enhancing duration of pain relief 12 hours or more.

Pain alleviation by vibratory stimulation. Lundeberg T, et al. Pain. 1984 Sep;20(1):25-44. In 366 patients with acute or chronic pain, direct application of vibration for 25 – 45 minutes achieved the best pain relief.

Therapeutic effects of whole-body vibration(WBV) training in knee osteoarthritis: a systematic review and meta-analysis. Zafar H, Alghadir A, Anwer S, Al-Eisa E. Arch Phys Med Rehabil. 2015 Aug;96(8):1525-32. Additive effects of WBV for reducing pain, improving function in knee OA.

Reduction of TMD pain by high-frequency vibration: a spatial and temporal analysis. Roy EA, Hollins M, Maixner W. Pain. 2003;101:267–74. 100Hz, but not 20Hz, reduced pain in 17 patients with facial pain.

Vibration reduces thermal pain adjacent dermatomes. Yarnitsky D, Kunin M, Brik R, Specher E. Pain. 1997;69:75–7. "Vibration can reduce pain across dermatomes"

Additional Resources:
•**Mechanisms of pain relief by vibration and movement.** J Neurol Neurosurg Psychiatry. 1992;55:282–286. Kakigi R, Shibasaki H.

•**Effects of local pressure and vibration on muscle pain from eccentric exercise and hypertonic saline.** Weerakkoby NS, et al Pain. 2003;105:425–435.

COLD AND FOCAL VIBRATION FOR ACUTE PAIN IN ADULTS

Influencing vaccinations: a buzzy approach to ease discomfort randomized controlled trial. Redfern RE et al. Pain Manag Nurs. 2018 Nov 10. In 497 adults, ice wings and 180Hz vibration reduced pain (0.87 v. 1.12, p=.035) and gave a better than previous vaccination experience (62% vs. 23.9%, p<.0001).

Effect of buzzy on pain and injection satisfaction in adult patients receiving IM [diclofenac] injections. Sahin M. Pain Manag Nurs. 2018 Dec;19(6):645-651. In 65 adults, ice wings and 180Hz vibration reduced pain (4.67 +/- 4.94 v. 17.69 +/- 9.85 p=.000) and increased satisfaction (94.82 v. 85.06, P<.0001).

Individual Satisfaction of Blood Donors. Yilmaz D et al. Pain Manag Nurs. 2017 Aug;18(4):260-267 In 90 male participants, ice "wings" and 180Hz vibration decreased pain and increased satisfaction (p<.05).

FOCAL CRYOTHERAPY FOR PAIN

Compressive cryotherapy versus cryotherapy alone in patients undergoing knee surgery: a meta-analysis. Springerplus. 2016 Jul 13;5(1):1074. Song M et al. "Patient with compressive cryotherapy is beneficial to patients undergoing knee surgery at the early rehabilitation stage."

CRYOTHERAPY FOR RECOVERY

Quadriceps muscle function after rehabilitation with cryotherapy in patients with anterior cruciate ligament reconstruction Hart J et al. J Athl Train. 2014 Nov-Dec; 49(6): 733–739. After ACL reconstruction, patients who performed rehabilitation exercises immediately after cryotherapy experienced greater strength gains than those who performed cryotherapy or exercises alone.

Comparison of the effects of pressurized salt ice packs with water ice packs on patients following total knee arthroplasty. Liying Pan et al Int J Clin Exp Med 2015;8(10):18179-18184 A compressing pack with -18 degree C cold worked better than standard ice and water for pain and swelling.

Time-course of changes in inflammatory response after whole-body cryotherapy multi exposures following severe exercise. Pournot H. et al. PLoS One. 2011;6(7):e22748. IL-1b (Post 1 h) and CRP (Post 24 h) levels decreased and IL-1ra (Post 1 h) increased following cryotherapy, supporting the decrease in pro-inflammatory cytokines activity, and increase in anti-inflammatory cytokines.

WHY VIBRATION AND CRYOTHERAPY TOGETHER

Cryotherapy reduces inflammation but also persistently reduces blood flow. Vibration vasodilates, cancelling the vasoconstriction effect while adding pain relief and separating muscle fibers to reduce stiffness. An increased number of residual cross-bridges between myosin heads and actin is thought to largely contribute to this exercise-induced increased stiffness (Proske and Morgan, 2001) which vibration addresses.

WHY VIBRATION INSTEAD OF ELECTROSTIMULATION

Electrostimulation does not increase blood flow, because it is the pulsatile vibration that mimics rapid heart rate, releasing nitric oxide and vasodilating. Electrostim does not cause muscle twitching in the amplitude and frequency that actual motion does. (J Athl Train. 2012 Sep-Oct;47(5):498-506.)

High frequency vibration, but not electrostim, improved physical function and reverses hypotrophy of quads. (Int J Rehabil Res. 2017 Jul 18) This is probably because electrostim does not promote hormonal repair gene expression.

Pain Care Labs products incorporate the latest oscillatory neuromodulatory science proven to speed rehabilitation, improve strength, and reduce pain. Our VibraCool Flex and Low Back product include both heat and ice options to address chronic problems over time.