

The human body is designed to adapt to motion. Below a mechanical strain threshold, muscles atrophy and bone is resorbed. Stressors exceeding the minimum strain threshold prompt growth at muscle, bone, and even cellular levels. Recent research on oscillatory mechanical strain proves that specific frequencies of vibration enhance physical therapy, improve post-surgical outcomes, increase training effectiveness, and reduce pain. We call this Mechanical Oscillatory Strain Therapy - MOST. We combine **evidence-based** MOST with cryotherapy (to address inflammation) and compression (to reduce edema). Our **M-Stim**<sup>®</sup> technology is proven to reduce pain up to 80%.

## M-Stim<sup>®</sup> for Pain

**Crossover trial of novel mechanical oscillatory vibration frequency device versus TENS for musculoskeletal pain.** Tiziano M, Baxter A. Mean pain relief with VC high frequency vibration was 3.60 +/- 1.60 (95%CI 2.85 to 4.35). Pain relief with TENS was 1.40 +/- 1.05 (95%CI 0.91 to 1.89), with a mean difference of -2.2 +/- 1.34 (95%CI -2.85 to -1.55, P<.0001). Pain relief with VC was greatest for spine, injury and post-surgical pain (5-6) and least for OA (2-3). AAPM&R November 2019, Poster 721211A.

**Efficacy of the Buzzy device for pain management during needle-related procedures: a systematic review and meta-analysis.** Ballard A, Khadra C, Adler S, Doyon-Trottier E, Le May S. Clin J Pain. 2019 Jun;35(6):532-543. (N= 1138, pain reduction -1.11; 95% confidence interval [CI]: -1.52 to -0.70; P<0.0001), anxiety reduction (SMD -1.37; 95% CI: -1.77 to -0.96; P<0.00001). PMID: 30829735.

**Effectiveness of vibratory stimulation on needle-related procedural pain in children: a systematic review.** Ueki S, Yamagami Y, Makimoto K. JBI Database System Rev Implement Rep. 2019 Jul;17(7):1428-1463. Included Buzzy, Dental Vibe, Blaine Labs. "The effect size for the BUZZY tended to be higher than that for the other devices." "Overall, vibratory stimulation was significantly effective: self-rated pain: -0.55, 95% confidence interval [95% CI]: -0.92 to -0.18) observer-rated pain outcomes (SMD: -0.47, 95% CI: -0.76 to -0.18). [With Buzzy] the effect on the child's anxiety (SMD: -1.03, 95% CI: -1.85 to -0.20) was significant." PMID: 31021972

**Pain Therapy Options for Home: a patient-based outcome review of at-home pain management devices, including Willow Curve, Quell, and VibraCool.** Tiziano M, Majewski M. Practical Pain Management 19(1):56-59. "valuable for very difficult-to-treat enthesopathic conditions that in many cases are unresponsive or recalcitrant to other forms of energy or manual therapies." OR pain relief for pooled data 2.25 with a 95% CI (1.34 - 3.77) and a z statistic (3.077), (P = 0.0021).

## Why Vibration Instead of Electrostimulation

Mechnoreceptors respond to mechanical sensations. In contrast to electrical stimulation, high-frequency low amplitude (HFLA) vibration improved physical function and reversed hypotrophy of quadriceps in OA. (Int J Rehabil Res. 2017 Jul 18) While vibration promoted GH gene expression, electrostim did not. In other studies, HFLA vibration vasodilated, likely by releasing endogenous nitric oxide. (J Athl Train. 2012 Sep-Oct;47(5):498-506.) In short, electrical stimulation to twitch a muscle to twitch a motion nerve is less effective than actual motion.

## 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.** PMID: 28723717

**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. PMID: 28236321

**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." PMID: 20048538

**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." PMID: 25354044

**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." PMID: 16939405

#### 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. PMID: 24618702
- **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. PMID: 23888287
- **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. PMID: 11641249
- **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. PMID: 21273897

### Vibration for Post-Surgical Rehabilitation

**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." PMID: 28074671

**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 7 days, 1m, 2m. PMID: 26198893

**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." PMID: 25083559

**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. PMID: 26869286

**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 or placebo (non-vibrated group). Sway decreased by 20%, vertical jump increased by 55%, and leg power increased by 35%. Effects maintained for at least 90 days. PMID: 19969163

#### 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. PMID: 17137514
- **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. PMID: 16763853

### Vibration for Delayed Onset Muscle Soreness

**Does vibration benefit delayed-onset muscle soreness?: a meta-analysis and systematic review.** Lu X, Wang Y, et al. J Int Med Res. 2019 Jan;47(1):3-18. "Vibration significantly improved the VAS at 24, 48, and 72 hours after exercise, and significantly improved CK levels at 24 and 48 hours." PMID: 30526170

**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. PMID: 16763853

**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. PMID: 28168554

**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. PMID: 24596744

**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." PMID: 25121012

**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. PMID: 24259922

**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. PMID: 18812416

## Vibration for Pain Relief

**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. PMID: 24689133

**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. PMID: 28787233

**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). PMID: 26337247

**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. PMID: 6609524

**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. PMID: 6333660

**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. PMID: 12583869

**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." PMID: 9060015

**Additional Resources:**

- **Mechanisms of pain relief by vibration and movement.** J Neurol Neurosurg Psychiatry. 1992;55:282–286. Kakigi R, Shibasaki H. PMID: 1583512
- **Effects of local pressure and vibration on muscle pain from eccentric exercise and hypertonic saline.** Weerakkoby NS, et al Pain. 2003;105:425–435. PMID: 14527703

## Vibration for Muscle Strength and Athletic Training

**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 women volleyball players. PMID: 23187322

**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. PMID: 21273897

**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. PMID: 30233417

#### Additional Resources:

- **Muscle performance changes induced by muscle vibration.** Fattorini L, et al. Physiol 2006;98:79-87. PMID: 16896736
- **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. PMID: 15990068

## Why Vibration and Cryotherapy Together

Cryotherapy reduces inflammation but also constricts blood flow. HFLA vibration vasodilates, canceling 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); vibration improves this stiffness.

### Focal Cryotherapy for Pain

**Compressive cryotherapy versus cryotherapy alone in patients undergoing knee surgery: a meta-analysis.** Song M et al. 2016 Jul 13;5(1):1074. "compressive cryotherapy is beneficial to patients undergoing knee surgery at the early rehabilitation stage." PMID: 27462522

### 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. PMID: 25299442

**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. PMID: 26770417

**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. PMID: 21829501

### 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). PMID: 30425014

**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). PMID: 30318424

**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). PMID: 28601479

Pain Care Labs makes revolutionary science-backed therapies that tap into the body's physiological pain response system to stop pain in its tracks, naturally and drug-free. Our clinically-proven products are trusted by hospitals, doctors and patients across the globe. We give people power over their pain, eliminating the unnecessary suffering and anxiety that comes with it.