



HOW IT WORKS

The motor effects of high frequency mechanical muscle vibration (about 150 Hz) was studied... the technique seems to have diagnostic as well as therapeutic applications... It is now well documented that high frequency mechanical vibration applied to any skeletal muscle in man tends to induce the following reflex response: sustained contraction of the muscle vibrated and simultaneous relaxation of its prime antagonists. This response has been named **TVR (tonic vibration reflex)**, — Eklund and Hagbarth, 1966).

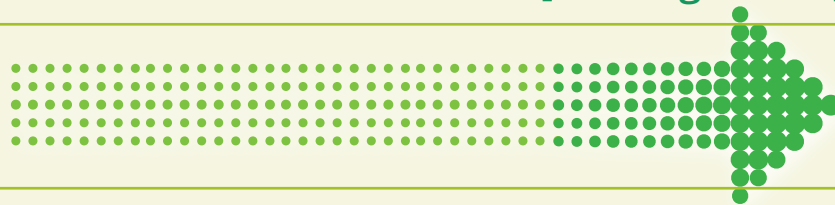
There is strong evidence to suggest that acute indirect vibration acts on muscle to enhance force, power, flexibility, balance and proprioception suggesting neural enhancement. One proposal suggests that spinal reflexes enhance muscle contraction through a reflex activity known as **tonic vibration stretch reflex (TVR)**. — J Sports Sci Med. 2011 Mar; Cochrane

Scar Tissue has a resonant frequency of 147Hz — Dr Paul Nogier, MD in Treatise of Auriculotherapy. Maisonneuve. (1972)

From Physiopedia: http://www.physio-pedia.com/Ultrasound_therapy

As the penetration (or transmission) of US is not the same in each tissue type, it is clear that some tissues are capable of greater absorption of US than others. Generally, the tissues with the higher protein content will absorb US to a greater extent, thus tissues with high water content and low protein content absorb little of the US energy (e.g. blood and fat) whilst those with a lower water content and a higher protein content will absorb US far more efficiently. Tissues can be ranked according to their relative tissue absorption and this is critical in terms of clinical decision making[6].

Fat Nerve Muscle Skin Tendon [Cartilage Bone]



Increasing Protein Content gives Increasing Absorption

Best Absorption in TENDON, LIGAMENT, FASCIA JOINT CAPSULE and SCAR TISSUE

Relative tissue absorption relates to protein content

Although cartilage and bone are at the upper end of this scale, the problems associated with wave reflection mean that the majority of US energy striking the surface of either of these tissues is likely to be reflected. The best absorbing tissues in terms of clinical practice are those with high collagen content – LIGAMENT, TENDON, FASCIA, JOINT CAPSULE, SCAR TISSUE[5][6][16][3][18][19].

1. 1.0 1.1 1.2 Williams AR. Production and transmission of ultrasound. *Physiotherapy*. 1987;73(3): 113-116.
2. 2.0 2.1 2.2 Baker KG, Robertson VJ, Duck FA. A Review of Therapeutic Ultrasound: Biophysical Effects. *Physical Therapy*. 2001 Jul 1;81(7):1351-8.
3. 3.0 3.1 3.2 3.3 3.4 3.5 3.6 3.7 ter Haar G. Therapeutic ultrasound. *European Journal of Ultrasound*. 1999 Mar;9(1):3-9.
4. 4.0 4.1 4.2 4.3 Nussbaum EL. Ultrasound: to heat or not to heat—that is the question. *Physical Therapy Reviews*. 1997 Jun 1;2(2):59-72.
- 5.0 5.1 5.2 Watson T. The role of electrotherapy in contemporary physiotherapy practice. *Manual Therapy*. 2000 Aug;5(3):132-41.
5. 6.00 6.01 6.02 6.03 6.04 6.05 6.06 6.07 6.08 6.09 6.10 Watson T. Ultrasound in contemporary physiotherapy practice. *Ultrasonics*. 2008 Aug;48(4):321-9.
6. Straub SJ, Johns LD, Howard SM. Variability in effective radiating area at 1 MHz affects ultrasound treatment intensity. *Phys Ther*. 2008 Jan;88(1):50-7.
7. Johns LD, Straub SJ, Howard SM. Analysis of effective radiating area, power, intensity, and field characteristics of ultrasound transducers. *Arch Phys Med Rehabil*. 2007 Jan;88(1):124-9.
8. Pye S. Ultrasound Therapy Equipment — Does it Perform? *Physiotherapy*. 1996 Jan 1;82(1):39-44.
9. Robertson VJ, Low J. *Electrotherapy explained principles and practice*. Edinburgh: Elsevier Butterworth-Heinemann; 2006
10. 11.0 11.1 Ward AR. *Electricity, Fields and Waves in Therapy*. Marrickville, Australia, Science Press 1986
11. Casarotto RA, Adamowski JC, Fallopa F, Bacanelli F. Coupling agents in therapeutic ultrasound: acoustic and thermal behavior 1,2. *Archives of Physical Medicine and Rehabilitation*. 2004 Jan 1;85(1):162-5.
12. Klucinec B, Scheidler M, Denegar C, Domholdt E, Burgess S. Effectiveness of wound care products in the transmission of acoustic energy. *Phys Ther*. 2000 May;80(5):469-76.
13. Docker MF, Foulkes DJ, Patrick MK. Ultrasound couplants for physiotherapy. *Physiotherapy*. 1982 Apr;68(4):124-5.
14. Poltawski L, Watson T. Relative transmissivity of ultrasound coupling agents commonly used by therapists in the UK. *Ultrasound Med Biol*. 2007 Jan;33(1):120-8.
15. 16.0 16.1 16.2 16.3 Watson T, Young S. *Therapeutic Ultrasound*. *Electrotherapy: evidence-based practice*. Elsevier Health Sciences; 2008. 414 p.
16. Hoogland R. *Ultrasound Therapy*. Delft, Enraf Nonius. 1995
17. 18.0 18.1 18.2 18.3 18.4 Nussbaum E. The influence of ultrasound on healing tissues. *J Hand Ther*. 1998 Jun;11(2):140-7.
18. Frizzell LA, Dunn F. *Therapeutic Heat and Cold*. In: Lehmann J, editor. *Biophysics of ultrasound*. Baltimore: Williams &amp;amp;amp;amp;amp;amp; Wilkins, 1982
19. Wilkin LD, Merrick MA, Kirby TE, Devor ST. Influence of therapeutic ultrasound on skeletal muscle regeneration following blunt contusion. *Int J Sports Med*. 2004 Jan;25(1):73-7.
20. Markert CD, Merrick MA, Kirby TE, Devor ST. Nonthermal ultrasound and exercise in skeletal muscle regeneration. *Arch Phys Med Rehabil*. 2005 Jul;86(7):1304-10.
21. 22.0 22.1 22.2 Leung MC, Ng GY, Yip KK. Effect of ultrasound on acute inflammation of transected medial collateral ligaments. *Arch Phys Med Rehabil*. 2004 Jun;85(6):963-6.
22. Sparrow KJ, Finucane SD, Owen JR, Wayne JS. The Effects of Low-Intensity Ultrasound on Medial Collateral Ligament Healing in the Rabbit Model. *Am J Sports Med*. 2005 Jan 7;33(7):1048-56.
23. 24.0 24.1 Watson T. Tissue Repair: The Current State of the Art. *SportEx Medicine*. 2005;28.
24. Draper DO, Sunderland S, Kirkendall DT, Ricard M. A comparison of temperature rise in human calf muscles following applications of underwater and topical gel ultrasound. *J Orthop Sports Phys Ther*. 1993 May;17(5):247-51.
25. Draper DO, Ricard MD. Rate of Temperature Decay in Human Muscle Following 3 MHz Ultrasound: The Stretching Window Revealed. *J Athl Train*. 1995 Oct;30(4):304-7.
26. Draper DO, Schulthies S, Sorvisto P, Hautala AM. Temperature changes in deep muscles of humans during ice and ultrasound therapies: an in vivo study. *J Orthop Sports Phys Ther*. 1995 Mar;21(3):153-7.
27. Jamie L. Leonard MAM. A Comparison of Intramuscular Temperatures During 10-Minute 1.0-MHz Ultrasound Treatments at Different Intensities [Internet]. *Human Kinetics Journals*. 2010 [cited 2016 Mar 5]. Available from: <http://journals.humankinetics.com/jsr-back-issues/jsrvolume13issue3august/acomparisonofintramusculartemperaturesduring10minute10mhzultrasoundtreatmentsatdifferentintensities>
28. Meakins A, Watson T. Longwave ultrasound and conductive heating increase functional ankle mobility in asymptomatic subjects. *Physical Therapy in Sport*. 2006 May;7(2):74-80.
29. Lehmann J. *Therapeutic Heat and Cold*. Baltimore: Williams &amp;amp;amp;amp;amp; Wilkins, 1982.
30. Dyson M, Niinikoski J. Stimulation of tissue repair by therapeutic ultrasound. *Infections in Surgery* 1982; 37-44.
31. 32.0 32.1 Dyson M, Suckling J. Stimulation of tissue repair by ultrasound: a survey of the mechanisms involved. *Physiotherapy*. 1978 Apr;64(4):105-8.
32. Dinno MA, Dyson M, Young SR, Mortimer AJ, Hart J, Crum LA. The significance of membrane changes in the safe and effective use of therapeutic and diagnostic ultrasound. *Phys Med Biol*. 1989 Nov;34(11):1543-52.
33. Werner S, Grose R. Regulation of wound healing by growth factors and cytokines. *Physiol Rev*. 2003 Jul;83(3):835-70.
34. Toumi H, Best TM. The inflammatory response: friend or enemy for muscle injury? *Br J Sports Med*. 2003 Aug;37(4):284-6.
35. 36.0 36.1 Watson T. Soft Tissue Healing. In *Touch* 2003;104: 2-9
36. Hill M, Wernig A, Goldspink G. Muscle satellite (stem) cell activation during local tissue injury and repair. *Journal of Anatomy*. 2003 Jul 1;203(1):89-99.
37. Neidlinger-Wilke C, Grood E, Claes L, Brand R. Fibroblast orientation to stretch begins within three hours. *J Orthop Res*. 2002 Sep 1;20(5):953-6.
38. Lorena D, Uchio K, Alto Costa AM, Desmoulière A. Normal scarring: importance of myofibroblasts. *Wound Repair and Regeneration*. 2002 Mar 1;10(2):86-92.

39. Lately P. Aspects of inflammation: A study of injury, healing and repetitive strain. *Journal of Bodywork and Movement Therapies*. 2001 Apr 1;5(2):124–31.
40. Fyfe MC, Chahl LA. Mast cell degranulation: A possible mechanism of action of therapeutic ultrasound. *Ultrasound in Med & Biol* 1982;8(Suppl 1): 62.
41. Maxwell L. Therapeutic Ultrasound: Its Effects on the Cellular and Molecular Mechanisms of Inflammation and Repair. *Physiotherapy*. 1992 Jun 10;78(6):421–6.
42. Mortimer AJ, Dyson M. The effect of therapeutic ultrasound on calcium uptake in fibroblasts. *Ultrasound Med Biol*. 1988;14(6):499–506.
43. Ciccone CD, Leggin BG, Callamaro JJ. Effects of ultrasound and trolamine salicylate phonophoresis on delayed-onset muscle soreness. *Phys Ther*. 1991 Sep;71(9):666–75; discussion 675–8.
44. ElHag M, Coghlan K, Christmas P, Harvey W, Harris M. The anti-inflammatory effects of dexamethasone and therapeutic ultrasound in oral surgery. *Br J Oral Maxillofac Surg*. 1985 Feb;23(1):17–23.
45. Hashish I, Harvey W, Harris M. Anti-inflammatory effects of ultrasound therapy: evidence for a major placebo effect. *Br J Rheumatol*. 1986 Feb;25(1):77–81.
46. Hashish I, Hai HK, Harvey W, Feinmann C, Harris M. Reduction of postoperative pain and swelling by ultrasound treatment: a placebo effect. *Pain*. 1988 Jun;33(3):303–11.
47. Ramirez A, Schwane J, McFarland C, Starcher B. THE EFFECT OF ULTRASOUND ON COLLAGEN SYNTHESIS AND FIBROBLAST PROLIFERATION IN VITRO: 294. *Medicine & Science in Sports & Exercise*. 1995 May;27(Supplement):S51.
48. Young SR, Dyson M. The effect of therapeutic ultrasound on angiogenesis. *Ultrasound Med Biol*. 1990;16(3):261–9.
49. Young SR, Dyson M. Macrophage responsiveness to therapeutic ultrasound. *Ultrasound Med Biol*. 1990;16(8):809–16.
50. Harvey W, Dyson M, Pond JB, Grahame R. The stimulation of protein synthesis in human fibroblasts by therapeutic ultrasound. *Rheumatol Rehabil*. 1975 Nov;14(4):237.
51. Enwemeka CS. The effects of therapeutic ultrasound on tendon healing. A biomechanical study. *Am J Phys Med Rehabil*. 1989 Dec;68(6):283–7.
52. Enwemeka CS, Rodriguez O, Mendosa S. The biomechanical effects of low-intensity ultrasound on healing tendons. *Ultrasound Med Biol*. 1990;16(8):801–7.
53. Turner SM, Powell ES, Ng CS. The effect of ultrasound on the healing of repaired cockerel tendon: is collagen cross-linkage a factor? *J Hand Surg Br*. 1989 Nov;14(4):428–33.
54. Gan BS, Huys S, Sherebrin MH, Scilley CG. The effects of ultrasound treatment on flexor tendon healing in the chicken limb. *J Hand Surg Br*. 1995 Dec;20(6):809–14.
55. Warden SJ, Avin KG, Beck EM, DeWolf ME, Hagemeyer MA, Martin KM. Low-intensity pulsed ultrasound accelerates and a nonsteroidal anti-inflammatory drug delays knee ligament healing. *Am J Sports Med*. 2006 Jul;34(7):1094–102.
56. Zhou S, Schmelz A, Seufferlein T, Li Y, Zhao J, Bachem MG. Molecular mechanisms of low intensity pulsed ultrasound in human skin fibroblasts. *J Biol Chem*. 2004 Dec 24;279(52):54463–9.
57. Reher P, Doan N, Bradnock B, Meghji S, Harris M. Effect of ultrasound on the production of IL-8, basic FGF and VEGF. *Cytokine*. 1999 Jun;11(6):416–23.
58. Leung MCP, Ng GYF, Yip KK. Therapeutic ultrasound enhances medial collateral ligament repair in rats. *Ultrasound Med Biol*. 2006 Mar;32(3):449–52.
59. McBrier NM, Lekan JM, Druhan LJ, Devor ST, Merrick MA. Therapeutic ultrasound decreases mechano-growth factor messenger ribonucleic acid expression after muscle contusion injury. *Arch Phys Med Rehabil*. 2007 Jul;88(7):936–40.
60. Tsai W-C, Pang J-HS, Hsu C-C, Chu N-K, Lin M-S, Hu C-F. Ultrasound stimulation of types I and III collagen expression of tendon cell and upregulation of transforming growth factor beta. *J Orthop Res*. 2006 Jun;24(6):1310–6.
61. Nussbaum EL, Locke M. Heat shock protein expression in rat skeletal muscle after repeated applications of pulsed and continuous ultrasound. *Arch Phys Med Rehabil*. 2007 Jun;88(6):785–90.
62. Culav EM, Clark CH, Merrilees MJ. Connective Tissues: Matrix Composition and Its Relevance to Physical Therapy. *Physical Therapy*. 1999 Mar 1;79(3):308–19.
63. Gomez MA, Woo SL, Inoue M, Amiel D, Harwood FL, Kitabayashi L. Medical collateral ligament healing subsequent to different treatment regimens. *J Appl Physiol*. 1989 Jan;66(1):245–52.
64. el-Batouty MF, el-Gindy M, el-Shawaf I, Bassioni N, el-Ghawet A, el-Emam A. Comparative evaluation of the effects of ultrasonic and ultraviolet irradiation on tissue regeneration. *Scand J Rheumatol*. 1986;15(4):381–6.
65. Haar G ter. Recent Advances and Techniques in Therapeutic Ultrasound. In: Repacholi MH, Grandolfo M, Rindi A, editors. *Ultrasound [Internet]*. Springer US; 1987 [cited 2016 Mar 6]. p. 333–42.
66. Wang ED. Tendon repair. *J Hand Ther*. 1998 Jun;11(2):105–10.
67. Yeung CK, Guo X, Ng YF. Pulsed ultrasound treatment accelerates the repair of Achilles tendon rupture in rats. *J Orthop Res*. 2006 Feb;24(2):193–201.
68. Byl NN, Hill-Toulouse L, Sittou P, Hall J, Stern R. Effects of ultrasound on the orientation of fibroblasts: An in-vitro study. *European journal of physical medicine & rehabilitation*. 1996;6(6):180–4.
69. Srbely JZ, Dickey JP. Randomized controlled study of the antinociceptive effect of ultrasound on trigger point sensitivity: novel applications in myofascial therapy? *Clin Rehabil*. 2007 May;21(5):411–7.
70. Schabrun S, Chipchase L, Rickard H. Are therapeutic ultrasound units a potential vector for nosocomial infection? *Physiother Res Int*. 2006 Jun;11(2):61–71.