# WHAT RESEARCH TELLS US ABOUT FLEXIBILITY - II

Jason Holt, Laurence E. Holt & Thomas W. Pelham
Dalhousie University, Halifax, Nova Scotia, Canada

Essentially, there are two factors which have a negative influence on flexibility. These are, not being sufficiently active, and being sufficiently active in selected sports without compensatory exercises. It is especially the latter that is of primary concern here, and there are two activities that exemplify this better than any others, running and cycling. Compared to average people, runners tend to be quite restricted in terms of hip flexion with knee extended (Bach, Green, Jensen & Savinar, 1985), cyclists likewise. The reason for this lies in the highly specific nature of the exercises, which, because of their intense, strenuous and repetitive character, shorten relevant tissues. We can by analogy show that many other activities of this sort are in the absence of effective countermeasures deleterious to flexibility. For the active and inactive alike the implications are clear. It is good t be flexible. It is good to increase flexibility. This said, a question remains. How?

Massage is sometimes held to be a suitable alternative to stretching. Others, prudently more hesitant, sing the praises of massage without mention of stretching (Crosman, Chateauvert & Weisberg, 1984; Salzmann, 1982). Overall, the effects of massage on flexibility are comparably minimal and shortlived. That the more respected massage exponents fail to even mention stretching suggests a narrowmindedness that is best acknowledged yet best untouched but by those with an eye to critique.

Warmup, as it may increase tissue temperature and thus to some extent flexibility, is often recommended. There are no pretensions here, however, as warmup is held by and large to be inferior to, though in no way incompatible with, a proper stretching regimen (Shellock & Prentice, 1985). Though both massage and warmup aim at those goals achieved by stretching as regards flexibility, neither measures up in terms of efficacy (Wiktorsson-Moller, Oberg, Ekstrand & Gillquist, 1983).

Research, furthermore, provides us with three principles of training, principles which must be by techniques adhered to if those techniques are to be successful. First, to increase functional ability in those tissues upon which flexibility depends, they must be "taxed toward their present capacity to respond" (Enoka, 1988). Second, adaptation through training is specific both to cells themselves and to those structural and functional cellular elements that are taxed toward their present responsive capacity (McCafferty & Horvath, 1977; Zernicke & Loitz, 1992). Yet to be discovered, however, are many of the causal and conditional relationships between the biochemical, morphological and biomechanical aspects of such adaptation (Zernicke & Loitz, 1992). Third, the effects of training are transient (Thorstensson, 1977).

The above principles tell us a lot. The first reveals that, in the case of stretching, the most effective technique will be that which, without putting the stretcher at risk, taxes toward the threshold of present responsive capacity those tissues the pliability of which are for flexibility relevant. The second reveals that the visible effects of stretching are caused by functional and structural changes on the cellular level. The third tells us that the benefits of stretching are not permanent, that is, that ongoing stretching is necessary to maintain whatever increase in flexibility is by such techniques accrued.

There are, however, constraints. First are neurogenic constraints, that is, willed and reflex control over the muscle group that is being stretched. Second are myogenic constraints, that is, the resistive properties, both passive and active, of muscles undergoing stretch. Neurogenic and myogenic constraints are interactive under active resistance. Third are joint constraints, determined in part by the articulation of bones, joint capsule structure and ligament attachment. Fourth are frictional, skin, and subcutaneous constraints. Research tells us that it is within these constraints that adaptation, if it is to be successful, must occur (Hutton, 1992).

Within such constraints, increases in flexibility can be achieved by altering soft tissues, including tendons, ligaments, fascia, muscles and skin (Mathews, Stacy & Hoover, 1964). Deformations in tissue shape or size may be either elastic (relatively temporary) or plastic (relatively permanent), and take place under a variety of conditions (Alter, 1988). Elastic deformation is appreciably due to the presence of collagenous glycoaminoglycan, or GAG, which in short supply does not allow for much range of motion augmentation (Akeson, Amiel & Woo, 1980; Donatelli & Owens-Burkhardt, 1981; McDonough, 1981), even when tissues are subjected to a thorough stretching regimen.

But, as we have already seen, stretching is the best way to increase flexibility. And, as there are several types of technique from which to choose, we can, after brief explanation of each technique, determine on the bases of scientific data and the adaptation principles which is the superior technique. The three techniques from which to choose are slow, or static, ballistic and Proprioceptive Neuromuscular Facilitation. Slow stretching involves the gradual lengthening of the muscle group until the point where further lengthening is prevented by its own tension (Alter, 1988). Ballistic stretching involves movements which harshly lengthens the muscle group (McAtee, 1993). PNF and its many variations are all based on Kabat's original principles (Kabat, 1958). A popular variant involves a series of isometric contractions of the muscles in a lengthened state which comprise the muscle group to be stretched, followed by concentric contractions of the opposing muscle group in conjunction with light pressure from a partner (Holt, 1974). In the main, comparative studies show PNF to be superior to both slow stretch and ballistic methods (Etnyre & Abraham, 1986; Holt, Travis & Okita, 1970; Holt & Smith, 1983; McAtee, 1993; Prentice, 1983; Sady, Wortman & Blanke, 1982; Wallin, Ekblom, Grahn & Nordenborg, 1985). The superiority of PNF and its derivatives is not surprising, and is perfectly consonant with not only the first and second adaptation principles, but also the third, because PNF techniques seem, with little risk, to bring muscle groups closer to their present responsive capacity than do other techniques. Thus are PNF and its derivatives both in athletic (Holt, 1974) and in rehabilitative (McAtee, 1993) pursuits recommended. And it is by capitalizing on small, incremental gains that thresholds are through this stretching method approached, met, and finally surpassed.

## References


Akeson, W.H., Amiel, D. & Woo, S. (1980). Immobility effects on synovial joints: The pathomechanics of joint contracture. *Biorheology* 17, 95-110.

Alter, M.J. (1988). *Science of Stretching*. Champaign, Illinois: Human Kinetics Publishers, Inc.

Bach, D.K., Green, D.S., Jensen, G.M. & Savinar, E. (1985). A cornparison of muscular tightness in runners and nonrunners and the relation of muscular tightness to low back pain in runners. J *O* S *P* T May-June, 315-323.

Crosman, L.J., Chateauvert, S.R. & Weisberg, J. (1984). The effects of massage to the hamstring muscle group on range of motion. *J O S P T* Nov-Dec, 168-172.

Donatelli, R. & Owens-Burkhardt, H. (1981). Effects of immobilization on the extensibility of periarticular connective tissue. *J O S P T 3*, 67-72.

Enoka, R.M. (1988). *Neuromechanical Basis of Kinesiology*. Champaign, Illinois: Human Kinetics Publishers, Inc.

Etnyre, B.R. & Abraham, L.D. (1986). Gains in range of ankle dorsiflexion using three popular stretching techniques. *Am J Phy Med* 65, 189-196.

Holt, L.E., Travis, T.M. & Okita, T. (1970). A comparative study of three stretching techniques. *Perceptual and Motor Skills* 21, 611-616.

Holt, L.E. (1974). *Scientific Stretching for Sport* (3-s). Halifax, Nova Scotia: Sport Research Ltd.

Holt, L.E. & Smith, R.K. (1983). The effect of selected stretching programs on active an passive flexibility. *Proceedings of the International Symposium of Biomechanics in Sports*, 54-67.

Hutton, R.S. (1992). Neuromuscular basis of stretching exercises. *Strength and Power in Sport*, Oxford: Blackwell Scientific Publishing, 29-38.

Kabat, H. (1958). Proprioceptive facilitation in therapeutic exercise. In E. Licht (Ed.), *Therapeutic Exercise*. New Haven, Connecticut.

Matthews, D.K., Stacy, R.W. & Hoover, G.N. (1964). *Physiology of Muscular Activity and Exercise*. New York: Ronald Press.

McAtee, R.E. (1993). *Facilitated Stretching*. Champaign, Illinois: Human Kinetics Publishers, Inc.

McCafferty, W.B. & Horvath, S.M. (1977). Specificity of exercise and specificity of training: A subcellular review. *Res* Q 48, 358-371.

McDonough, A.L. (1981). Effects of immobilization and exercise on articular cartilage: A review of the literature. *J O S P T* 3, 2-5.

Prentice, W.E. (1983). A comparison of static stretching and PNF stretching for improving hip joint flexibility. *Athletic Training* Spring.

Sady, S.P., Wortman, M. & Blanke, D. (1982). Flexibility training: Ballistic, static or proprioceptive neuromuscular facilitation? *Arch Phys Med Rehahil* June, 261-263.

Salzmann, C.V. (1982). Sport Massage: A means of relieving pain and preventing further injuries. *Canadian Runner*. February, 24-27.

Shellock, F.G. & Prentice, W.E. (1985). Warming-up and stretching for improved physical performance and prevention of sports-related injuries. *Sports Med* 2, 267-278.

Thorstensson, A. (1977). Observations on strength training and detraining. *Acta Physiologica Scandinavica* 100, 491-493.

Wallin, D., Ekblom, B., Grahn, R., & Nordenborg, T. (1985). Improvement of muscle flexibility: A comparison between two techniques. *Am J Sports Med* 13, 263-268.

Wiktorsson-Moller, M., Oberg, B. Ekstrand, J., & Gillquist, J. (1983). Effect of warming up, massage, and stretching on range of motion and muscle strength in the lower extremity. *Am J Sports Med* 11, 249-252.

Zernicke, R.F. & Loitz, B.Z. (1992). Exercise-related adaptations in connective tissue. *Strength and Power in Sport,* Oxford: Blackwell Scientific Publishing, 77-95.