‘The Stretching Debate’


Introduction

In August 2002, an article appeared in The British Medical Journal that created a great deal of interest and controversy. The paper in question (Herbert & Gabriel 2002) evaluated the benefits (or lack of benefits) associated with stretching procedures in relation to protection from injury and post-exercise soreness.

In order to clarify the issues, JBMT invited 10 experts including those with specific involvement in athletics as well as practitioner/therapists (with backgrounds in osteopathy, chiropractic, physiotherapy, massage therapy and Rolfing) who use stretching modalities in their work, to comment on the article from their perspectives.

JBMT invited the original authors to respond to the 10 commentaries in order to create an open forum. Their response follows from the 10 commentaries, which are published in alphabetical order.

If you, the reader, have further comments to make that JBMT’s editorial team consider to contain useful insights, JBMT undertakes to publish these in a subsequent issue.

REFERENCES

Herbert R, Gabriel M 2002 Effects of stretching before and after exercising on muscle soreness and risk of injury: systematic review. British Medical Journal 325: 468

Leon Chaitow
Editor
Commentary 1

Joel W. Beam

In response to the recent study by Herbert and Gabriel (2002), I would like to make several points which center on the all-inclusive nature of the findings. The authors state pre- and post-exercise stretching does not offer protection from muscle soreness. To determine the effects of stretching on muscle soreness, five studies were reviewed (Herbert & Gabriel 2002). In each investigation, delayed-onset muscle soreness (DOMS) was the dependent variable. DOMS is believed to be a combination of damage to muscle membranes and a secondary inflammatory reaction (Wilmore & Costill 1999) as a result of eccentric contractions (Talag 1973, Newham et al. 1983) and maximal isometric exercise (Clarkson et al. 1986).

Recreational and competitive athletic activities normally do not place eccentric and isometric loads upon the musculature similar to the loads produced in the laboratory setting. Investigations examining the effects of stretching on general muscle soreness, which accompanies fatigue (Prentice 2003), may provide practical significance for the recreational and competitive athlete. Because of the limited data, caution should be exercised in the dismissal of the effects of stretching on other forms of muscle activity.

The authors also conclude pre-exercise stretching does not practically reduce the risk of injury. Stretching techniques are commonly utilized in therapeutic exercise and strengthening programs to increase range of motion (ROM) and flexibility. Theoretically, creep, hysteresis, and autogenic and reciprocal inhibition can affect the physical, mechanical, and neurological properties of connective tissue in the promotion and maintenance of ROM and flexibility (Houglum 2001). Full, non-restricted ROM has been viewed as an important aspect in the prevention of injury and re-injury (Shellock & Prentice 1985, Armiger 2000). Prior to rejecting the beneficial effects of stretching or other techniques in the prevention, treatment, and rehabilitation of conditions and injuries, we must carefully examine study findings and the applications to our therapeutic purposes and goals.

REFERENCES

Armiger P 2000 Preventing musculotendinous injuries: a focus on flexibility. Athletic Therapy Today 5: 20
Houglum PA 2001 Therapeutic Exercise for Athletic Injuries. Human Kinetics, Champaign, IL: 127–144
Talag TS 1973 Residual muscular soreness as influenced by concentric, eccentric, and static contractions. Research Quarterly 44: 458–469
Wilmore JH, Costill DC 1999 Physiology of Sport and Exercise. 2nd edn.

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Commentary 2

Judith DeLany

Whereas the objective goal of Herbert and Gabriel might be a worthy one, the means by which they arrived at their conclusions are build on a less than ideal foundation. There are several points that are lacking in the cited research and also several questionable protocols. Critical factors are often not clear in the evidence provided and several are questionable. This literature review, therefore, offers little to the astute reader.

(1) The working status of the muscle may have influence on its ability to effectively stretch. That this, if the person is standing while performing the stretch on the posterior leg, gastrocnemius and soleus are in a working state. In what position were the stretches performed? It is unknown from this evidence.

(2) Was any warm-up of the muscle (such as simple walking) done prior to the stretch or was it performed on a ‘cold’ myofascial tissue? It is unknown from this evidence.

(3) The length of time the stretch was held may have significant influence, particularly depending upon the degree of tension placed on the muscle. These stretches were held for varying lengths of time, some as long as 2 minutes and others for 10 seconds. Could this duration (especially depending upon the amount of tension placed on the muscle) have stimulated the stretch reflex mechanisms and caused subsequent tightening of the tissues? If so, this would have bearing on resultant injury.

(4) The number of repetitions is of significance. Two repetitions are not likely enough, especially if significant exercise is to follow.

(5) The degree of elongation during the stretch is of significance. Is it possible that the participants overstretched the tissues, thereby stimulating a stretch reflex mechanism? Is it possible that they understretched the tissues due to the wearing of a fairly inflexible army boot, for instance, during the performance of the stretch? Did they receive adequate training in appropriate stretching techniques? It is unknown from this evidence.

(6) One study involved new military recruits who were in their 12 weeks of initial training. Is it possible that their training routine was so severe that no amount of prior stretching would have prevented injury? (Military training tends to be more rigorous than most athletic participation.)

(7) In one study, stretching was performed on two muscles and then six different injuries evaluated. Five of those injuries were, for the most part, irrelevant to the muscles being stretched. Some of those injuries being assessed may have actually occurred due to the fact that only two muscles of the joint were stretched, which may have imbalanced the joint.

Conclusion

One cannot take on the findings of published research at face value, and especially when filtered by someone else. This literature search concludes that ‘stretching before or after exercise does not confer protection for muscle soreness’ and that ‘stretching before exercising does not seem to confer a practical useful reduction in the risk of injury’. Indeed, what this literature search has shown is only that the methods and protocols used in these particular studies (the number of repetitions used, the length of time the stretches were held, the amount and appropriateness of training the participants received, etc.) failed to provide protection and reduction of risk. The unknown factors of the cited studies unfortunately render them useless and insignificant.
Commentary 3

Wayne Hayes

Important points ignored in both literature reviews include:

(a) An understanding that stretching is a specific tool to be utilized as part of a systematic, progressive and multiskilled program for exercise training and rehabilitation (Brukner & Khan 2001, Haynes 2002b). It is not a stand alone intervention as applied in the studies reviewed. This principle has failed to be recognized in many manual therapy "gold standard" examinations of care, including the BMJ study.

(b) The benefits of stretching are multifactoral and compliment other interventions (Bjorklund et al. 2001, Gajdosik 2001). The positive effects from stretching accrue from its application in an individual specific prescription of care in combination with other complementary therapeutic approaches, not as a non-specific recipe cure-all (Haynes 2002b). Again this was not addressed in the BMJ study.

When any new skill is intentionally practiced, the motor system relies on feedback mechanisms to develop a perception of the movement task (Mitra et al. 1998, Carson & Riek 2001). Novel motor skill development also involves an excessive agonist/antagonist co-contraction, increased metabolic cost and extra biomechanic load (Mitra et al. 1998, Milner 2002). The natural outcome from these events – when a new environment/task/individual challenge, reaches a pre-set threshold, is the disruption to a muscle’s normal physiologic characteristics. This probably leads to post-activity soreness (Ebbeling & Clarkson 1989).

The transitional motor learning experience, with time, leads to a mature motor control skill reliant on a feed-forward predictive perception of the task. This pattern requires less antagonistic co-contracture, less metabolic load, and less biomechanical stress (Milner 2002, Mitra et al. 1998). The neurologic and muscular adaptations that have taken place enable a new motor action to shift the pre-set threshold values that are required for muscle soreness to occur.

This principle applies to any high-intensity eccentric contraction activity or novel movement act involving multiple motion segments (Liebler & Friden 1999). Muscle soreness frequently occurs as part of a motor learning event. Until the individual adapts to the demands of the task and environment then muscular soreness is inevitable.

As would be expected, the literature review therefore indicates that pre- and post-stretching has little effect on the reduction of muscle soreness during the process of a transitional motor learning experience. Further, muscle stretching does not increase the short-term adaptive abilities of muscles to excessive task requirements during novel movement acts.

Pre- and post-myofascial stretching may however allow control systems the ability to prevent inappropriate adaptive muscle/fascial shortening over time, and the subsequent development of trigger points, postural distortions and alterations to preferred motor control strategies, if applied as part of a specific prescription of care (Lewit 1993, Haynes 2002a).

The study comparing a stretching and non-stretching group in the prevention of injuries is also misleading.

Both studies reviewed were set in the harsh environment of an American boot camp. Taking untrained individuals with varying degrees of motor control skills and placing them in this tough environment appears to be an under-rated factor in this review. The combination of individuals variable motor skills, with no task-specific adaptations, high environmental and physical challenge, psychological stress with new complex and demanding tasks, combine to create a level of ‘perceptual and mechanistic perturbation’ beyond the novices ability to suddenly adapt.

During motor tasks involving extremely high mechanical and perceptual difficulty, dynamical influences lead to a threshold event where a switch in motor control strategies occur (Mouchino et al. 1998) involving a freezing of the available degrees of freedom to articular segments. If the challenge goes beyond this point (as likely in a ‘boot camp’) then a further threshold is met in which the control mechanism attempts to complete the difficult tasks as well as prevent a loss of postural orientation. There is a moment to moment re-assessment of postural goals and movement tasks. This leads to a highly
The Herbert and Gabriel review supports the proposition that muscle stretching may not effect the normal short-term adaptive responses that occur during a motor learning experience. In contrast, it is a primary intention of muscle stretching programs to address the long-termmal adaptive muscle-fascial restrictions found when musculoskeletal dysfunction syndromes include alterations in normal motor control repertoires (Gajdosik 2001).

I fear that this paper may promote as ‘scientific fact’ the premise that musculoskeletal pain syndromes are ineffectively addressed by active care solutions. The simplistic assumptions presented in the BMJ review may therefore have far-reaching, unwelcome, clinical significance.

REFERENCES

Ebbeling CB, Clarkson PM 1989 Exercise induced muscle damage and adaptation. Sports Medicine 4: 207–234


Haynes WI 2002a New directions in labile surface training and new tools for musculo-skeletal rehabilitation. Australasian Faculty of Rehabilitation Medicine Tenth Annual Scientific Conference, Brisbane. Abstract and poster demonstration

Haynes WI 2002b New strategies in the treatment and rehabilitation of the lumbar spine. Presented for review: Journal of Bodywork and Movement Therapies

Herbert RD, Gabriel M 2002 Effects of stretching before and after exercising on muscle soreness and risk of injury: systematic review. British Medical Journal 7362: 468


Milner TE 2002 Adaptation to destabilising dynamics by means of muscle cocontraction. Experimental Brain Research 143: 406–416


It is commendable that research questions the long-held beliefs, myths and traditions, regarding various procedures both prophylactic and rehabilitative. The evidence for stretching as a prevention for DOMS clinically has never been strong and is rightly called into question.

In regard to stretching and injury prevention, there is definitely more general and tenuous relationship with a multi-factorial basis that makes it difficult to evaluate just this aspect of injury prevention while ignoring other factors that contribute to the risk of injury.

There is always a risk of disappointing results in efficacy when a procedure or technique is applied inappropriately as a recipe solution appears to lead to even more excessive metabolic and biomechanical overload, increasing substantially the risk of injury, beyond the point where any single simplistic and non-specific tool could have any real preventative impact.

A modern neuromuscular training routine involves a multiskilled approach applied with progressive and more challenging demands to enable a time dependent acquisition of skill through a gradual increase in task and environmental demands. In this approach stretching is applied specifically, and is an important and complimentary tool (Liebenson 1996, Haynes 2002b).

The BMJ study therefore does provide evidence that such difficult task/environment/individual interactions will promote injury outcomes, irrespective of the use of simplistic non-specific tools (such as stretching).

Considering the evidence outlined above it is unsurprising that the review by Herbert and Gabriel (2002) supports the notion that single-care, stand-alone, interventions (particularly if applied inappropriately as a recipe application) are ineffective.

Commentary 4

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throughout a population with varied diagnoses that involves different factors such as age, prior training, type and level of activity, muscle imbalances, structural problems, fitness status, etc. A similar result is seen in the study on low back pain (Cherkin, Deyo et al. 1998). No procedure stands out as definitely superior, yet no health practitioner would then advocate that educational booklets alone or any of the other procedures would be the key to treating low back pain or even preventing it. If the diagnostic triage is well done then the choice of an appropriate procedure becomes more effective. The causes of spinal pain are too varied to support use of a particular procedure alone, and the same goes for injury prevention.

Warning up is not stretching and stretching is not warming up. Most activities involve a graded increase in intensity and repetition of some sort to allow the body to adjust physiologically to the increasing demands placed upon it whether perceived as a warm-up or not. I doubt you will find many sprinters who wish to race full out without any prior preparation whatsoever. Stretching is a procedure applied to attempt to normalize shortened or tight structures that in turn may alter or hinder an individual's activity. In the clinic, the positive results in function of an individually tailored and appropriate stretching program are often observed. Indeed stretching may not be necessary for many individuals and general stretching advice may at best be useless or at worst even predispose certain individuals to injury. As the authors rightly point out more research is definitely needed.

Commentary 5

Craig Liebenson

The question of whether stretching can prevent injury is a fascinating one. Systematic literature reviews suggest there is a paucity of evidence. What evidence does exist is largely negative. The question is whether we can generalize, based on a few moderate-quality studies that stretching is proven to be ineffective as preventive of injury? Certainly, there is a dearth of evidence supporting the effectiveness of stretching, but to say there is strong evidence of its ineffectiveness as preventive of injury is largely negative. The question is whether we can generalize, based on a few moderate-quality studies that stretching is proven to be ineffective as preventive of injury? Certainly, there is a dearth of evidence supporting the effectiveness of stretching, but to say there is strong evidence of its ineffectiveness as preventive of injury would be to over-state the evidence.

A second issue is the fact that there may be subgroups of patients in whom stretching is effective, but when a study considers a heterogenous group as one homogenous group this smaller subgroup is likely to be missed (Laboef et al. 1997). Future research involving stratification of subjects into reasonable subgroups is needed.

The literature suggests that such subgroups do exist (Moffroid 1994). For instance:

- Biering-Sorensen (1984) found that increased trunk flexion mobility not hypomobility predicted future low back pain (LBP) in men.
- It has also been recently reported that patients with spondylolisthesis tended to be hypermobile while those with spinal stenosis, disc prolapse or degenerative disc disease tended to be hypomobile (McGregor et al. 1997).
- Other examples of subgroups include:
  - Decreases in hip internal rotation have shown correlation to LBP (Cibulka 1998, Ellison et al. 1990).
  - Tight muscles (iliopsoas and gastro-soleus) are shown to be correlated with increased injury risk – especially of the knee – in male college athletes (Krivickas & Feinberg 1996).
  - McGill (unpublished study) has recently suggested that decreased hip extension mobility may be predictive of disabling LBP.
  - Van Dillen et al. (2000) reported that chronic LBP subjects had less passive hip extension mobility than asymptomatic subjects.
  - Studies in adolescents have documented that future episodes of LBP are correlated with decreased hip extension mobility (Kujala 1994, Van Dillen 2000).
- Some controversy exists, however, as Nadler (2000, 2001) reported that hypermobility in the lower extremity was correlated with future LBP in college athletes.
Finally, even if the question of the value of stretching was clear it is quite possible that even more important as an injury preventive would be limbering or ‘warm-up’. At the present time, clinicians should consider carefully the individual needs of their patient. Some may require increases in mobility (via stretching) while others certainly may not.

REFERENCES

Biering-Sorensen F 1984 Physical measurements as risk indicators for low-back trouble over a one-year period. Spine 9: 106–119
Laboef-Yde C, Lauritsen JM, Lauritzen T 1997 Why has the search for causes of low back pain largely been non-conclusive? Spine 22: 877–881
McGill SM Study in progress
McGregor AH, McCarthy ID, Dore CJ et al. McGill SM Study in progress
Distinguishable groups of musculoskeletal low back pain patients and asymptomatic control subjects based on physical measures of the NIOSH low back atlas. Spine 19:12; 1350–1358

Commentary 6

Simon Martin

It is difficult to see the purpose of publishing this paper. Not only does the evidence quoted by Herbert and Gabriel not support their conclusions, but what they claim to have shown is already well-known.

The data in their selected studies only suggests that one specific type of stretching – passive/static stretching – confers no protection from soreness nor against injury. Their major error is not to acknowledge that there are different types of stretching.

By not identifying the type of stretching used, let alone whether it was static or active, the authors have not compared like with like. They have compared the effects of different forms and intensity of exercises followed – or preceded – by different stretches to different parts of the body, held for varying lengths of time, and repeated (or not) at widely varying time intervals. For example, one of the studies tested stretching before an extreme form of resistance training rarely if ever used outside the physiology lab, namely 100 reps (10 sets of 10) maximal eccentric hamstring curls; while in contrast another study ‘stressed’ muscles with a single 80% maximal bicep curl.

‘Total stretch time’ in one study was 80 seconds (4 × 20 seconds) before exercise, while another study used 4 × 120 seconds, repeated six, 25, 30, 49 and 54 hours after the exercise. This begs the question of whether either the exercise or the stretching studied bears any relation to what people actually do. Most people who stretch before and/or after exercise – or, indeed, AS exercise – do so on a regular basis to improve flexibility and not in the rather bizarre ways described.

It is well established that appropriate stretching does improve flexibility and prevent injury.

The New Jersey Medical School study in 1996, for instance, tested the flexibility of 200 college athletes and monitored them for injury for several months. In male athletes, the
risk of injury decreased as flexibility increased. In fact, for each additional point on a 10-point flexibility scale, the chances of injury declined by about 15%; for each one-point increase in muscle tightness, the risk of injury increased more than 20% (Krivickas & Feinberg 1996). In contrast, six of the eight studies quoted by Herbert and Gabriel excluded regular exercisers – and I include here the military recruits, whose general level of physical unfitness is well-known.

What seems to be going on in the reviewed studies is that inappropriate timing, repetition and style of stretching actively caused soreness and/or injury, as this passive stretching is known to do. For example, a well-known 1993 study showed that static stretching was as bad as ballistic stretching in leading to delayed onset muscle soreness and increases in serum creatine kinase, the enzyme used as a marker for muscle damage (Smith et al. 1993).

It is well established that this type of stretching is inappropriate before dynamic activities such as repetitive eccentric muscle contractions and step-up tests – let alone military training exercises. Stretching of this type may harm performance and increase the risk of injury. Several studies, for instance, have shown that static stretches reduce the force production of the stretched muscles (Rosenbaum & Hennig 1995, Kokkonen et al. 1998, Fowles et al. 2000, Knudson et al. 2000). Scientists at the Neuromuscular Research Centre at Finland’s University of Jyväskylä actually referred to, ‘a clear deterioration of muscle function immediately after RPS’ (repeated passive stretching) (Avela et al. 1999).

In a review of hamstring injuries sustained by student ballet dancers at the Ballet Academy in Stockholm, researchers concluded that ‘stretching could induce severe strain injuries to the proximal hamstrings in dancers’ (Askling et al. 2002). The same is likely to be true for multiple repetitions of eccentric resistance exercise used in some of the reviewed studies; indeed Olympic weightlifting coach Charles Staley, MSc, says, ‘Static stretching is contraindicated prior to resistance training’ (Staley 1999). Lally’s survey of more than 1500 runners competing in the Honolulu marathon in 1994 concluded that marathoners who ‘stretched’ (type of stretch undefined) before training sessions had higher rates of injuries, compared to runners who didn’t stretch. However, athletes who stretched after their workouts had fewer injuries (Anderson 2000).

Following Lally, researchers at James Madison University in Virginia tried out hamstring stretches (PNF type) in four different ways: crucially, they found that stretching the tissues in the cold condition didn’t improve flexibility (Horwill 2002). As a result, passive stretching of the sort included in the systemic review is already recommended to be carried out, if at all, immediately following exercise, while muscles, connective tissue etc. are warm and circulation is enhanced. However, in those reviewed studies where stretches were performed immediately after exercise, the stretches were also repeated many hours after exercise (i.e. on ‘cold’ tissue), an activity which can be expected to increase the likelihood of soreness and/or injury.

Among those actively involved in the preparation and maintenance of athletes the consensus is that before exercising, the athlete’s job is to warm up (Shrier & Gossal 2000). Any pre-event stretching should therefore be ‘dynamic’ or ‘active’, such as the active isolated stretching (AIS) system developed by kinesiologist Aaron Mattes and favoured by double Olympic gold medallist and world record-holder Michael Johnson, among others (Mattes 2000, Hartmann 2002).

The review authors say that they may be over-generalising when using just two papers on army recruits to conclude that stretching before exercising does not seem to reduce risk of injury. Rather, the message from the army studies is that random ‘stretching’ cannot injury-proof unfit recruits suddenly subjected to massive and sustained physical abuse. Fitness, age and enlistment date were reliable indicators of injury (Pope et al. 2000), in line with many previous studies on the attrition rates during basic military training (see for example, Lee et al. 1997, Shaffer et al. 1999). In contrast, Hartig and Henderson (1999) showed in a controlled trial that adding three specific hamstring stretches to the basic training of military recruits significantly reduced lower extremity over-use injuries.

REFERENCES
Anderson O 2000 ‘Does stretching really lower the risk of injury? Here’s the scientific evidence’. Sports Injury Bulletin 1:1. Also see Anderson’s Does stretching before a workout increase the risk of injury? Interview with David A. Lally, PhD, exercise physiologist at the University of Hawaii-Manoa. Peak Performance Newsletter online, http://www.pponline.co.uk/encyc/0396.htm accessed September 20, 2002. Lally’s research was presented at a 1994 meeting of the American College of Sports Medicine
Fowles JR, Sale DG, MacDougall JD 2000 Reduced strength after passive stretch of...
Staley CI 1999 The Science of Martial Arts Training. Multi-Media Books, USA

Commentary 7

Phil Rowland

Semantics poses the first problem. Both ‘stretching’ and ‘exercise’ represent different things to different people, and much of the expert discussion over the contribution of the former to successful participation in the latter seems to take place without clear definitions of the words. (As though two protagonists are debating the impact of fuel quality on car performance without either of them or their audience knowing that one is talking of a Ford Escort primed with tractor fuel and the other of a Porsche primed with high octane petrol – their divergent views would both be right, the debate heated, and the audience none the wiser.)

From my perspective, stretching is recommended for two completely different goals: to increase flexibility in general – as an end in itself – and to prepare for an imminent, significant increase in activity (e.g. a sporting or athletic endeavour).

Some form of static stretching seems to be most frequently recommended for those seeking to increase flexibility as an end in itself; the aim being to achieve some permanent elongation of tissue. My concern is when static stretching techniques are deemed suitable preparation for an active bout of exercise.

The riskiness of undertaking prolonged static stretches prior to participating in athletic or sporting events has been recognized for over 30 years, but old habits die hard. Until fairly recently, sports/athletic warm-ups tended to comprise a general warm-up followed by static stretching, or a longer, gradually intensifying warm-up (essentially an informal dynamic stretching programme) based on the activity to be pursued, with minimal specific stretching. In my experience, the latter approach results in fewer injuries, as it results in muscles that are warmer and less tight, rather than ones that are temporarily overstretched.

Increasingly, we hear that after a prolonged passive stretch the muscle should be allowed to rest – not subsequently be subjected to prolonged bursts of near maximum effort – and that failure to do so can cause unnecessary injuries.

Unfortunately, there doesn’t seem to be a consensus; the only things that everyone agrees on are that some form of warm-up prior to...
exercise is essential, and that uncontrolled, ballistic stretching is to be avoided.

In the last few years, the Whartons’ system of active isolated stretching (AIS), seems to be gaining popularity in the sports and athletic worlds. The Wharton’s (Wharton & Wharton 1996) propose a series of repetitions of brief stretches, following a particular sequence, instead of a conventional warm-up. AIS aims to treat individual muscle groups separately, thereby avoiding problems when several different groups are stretched simultaneously and compensation can mask specific weaknesses. This approach is based on the original work of Aaron Mattes. I would like to see further research concentrated in this area: comparing the benefits of a conventional ‘sport-specific, dynamic’ warm up with those from a system of stretching that purports to largely replace it.

REFERENCES

Commentary 8

Robert Schleip

Critical questioning by scientists about common stretching assumptions is not new. German research in the mid-1990s showed that most of the common hypotheses about the neurophysiological effects in stretching are wrong. For example, it had been postulated that brief active contraction prior to stretching would lead to a subsequent tonus decrease in the stretched muscle. Similarly, it had been suggested that a simultaneous antagonist contraction during static stretching would achieve the same. Yet, the German measurements have shown that both procedures actually lead to an increased excitability of the musculature as well as a slightly increased muscle resistance to stretching (Wiemann & Hahn 1997, Freiwald et al. 1998). It had also been assumed that a slow and long stretch at a moderate force would lead to a tonus decrease, yet EMG measurements have shown that there is generally a slow tonus increase when a joint is moved close to its maximum range of motion. Given the complex properties of biological soft tissues these findings, as well as those of Herbert and Gabriel should not be too surprising. Nevertheless, it is plausible that prolonged static stretching, directly after exercise, might be contraindicated for regeneration, as static stretching is likely to inhibit capillary blood supply in the stretched tissues (similar to the water extrusion in squeezing a sponge).

It is important to remember that stretching is practiced for many different reasons. Herbert and Gabriel only looked at three possible intentions: injury prevention in sports, prevention of muscle soreness, and an increase of sports performance in athletes. But stretching is also used to increase range of motion in the case of chronic myofascial shortness due to muscular imbalance, post-trauma or post-surgery. One recent study found that cyclic stretching stimulates the secretion of growth factors of tendon fibroblasts and may have a positive influence on tendon and ligament healing through stimulation of cell proliferation, differentiation and matrix formation (Skutek et al. 2001).

Further research is needed to clarify what type of stretching, over which time frame, is advisable for which conditions. There is evidence that active dynamic stretching techniques seem to be more effective for increasing range of motion than static stretching (Wiemann & Hahn 1997). A muscle is strongest at about its midrange of potential length. In many people, certain muscle groups are dominantly used in shortened positions due to repetitive movement (in sports or at a work station), poor posture, or a sedentary life style. In these cases, the tissue may slowly adapt by reducing its ultimate fiber length so that the habitually used joint position becomes the new ‘middle position’ where the muscle can work most economically. One approach that may gradually lead to a lengthening process is to give the tissue regular stimulations when it is both actively used and in extended positions.

This has an interesting parallel in the field of myofascial tissue manipulation, where the practitioner
may attempt to loosen soft-tissue restrictions by stretching the tissues using the application of manual pressure. It had been assumed by several authors that this type of passive stretching would stimulate the Golgi-tendon organs, which would then induce a tonus decrease of the shortened muscle fibers. Yet, more detailed studies have revealed that these stretch receptors are generally not stimulated by passive stretching. This research supports the use of myofascial release techniques, in which the patient temporarily contracts the same tissues which are being worked on. It seems that in both areas, stretching and soft-tissue manipulation, there is a trend towards more active movement participation, and that this shift is a reflection of recent research findings.

Regarding the benefits of stretching for athletes, it is advisable to differentiate between activities in which a wide range of free joint motion is important (in this case regular stretching may be beneficial) and activities in which explosive contraction power is more essential, for example for free-style, long-distance swimmers, a wide and free arm swing is necessary. On the other hand, German studies (Hennig & Podzielny 1994) demonstrated that static stretching, immediately prior to vertical jumping, tends to have a negative effect on the jumping height.

Comparing the differences in joint utilization between humans and other primates, Australian researchers found that humans are less prone to develop osteoarthritis in those joints (such as the elbow) which are used in a similar wide range of motion to that of other primates. Joints which we generally use in a more limited range of motion (like the cervical spine, shoulder, hand, fingers, knee and hip joint) are more likely to develop this degeneration (Alexander 1994). Regular dynamic stretching and other forms of gymnastics might therefore prove to offer prevention from osteoarthritis, and possibly other joint diseases.

Other possible advantages of stretching may include psychological functions. For example before sports, brief static stretching may be good for the overly nervous or hyper-agitated athlete, and active dynamic stretching may be better for individuals who would profit from some general activation. So far, there has been little or no research on the possible effects of stretching on proprioception. Since clinical studies have shown strong correlations between dysfunctions such as chronic low back pain (Radebold et al. 2001) or idiopathic scoliosis (Keesen et al. 1992) where proprioceptive accuracy is reduced this field of research may offer useful information. It seems that there are many interesting interrelations between body image organization, chronic pain, post-traumatic stress disorders, psychological and physical aging, and proprioceptive accuracy. Static stretching, such as is often performed in conventional Hatha yoga, as well as various forms of dynamic stretching, could indeed prove to have profound effects in this important dimension.

Conclusion

More research is needed to determine which type of stretching has what kind of advantages and side-effects, for what type of condition. Herbert and Gabriel’s research for athletes (and the unprecedented international attention given to their publication) make a valuable contribution in this direction.

References

Radebold A et al. 2001 Impaired postural control of the lumbar spine is associated with delayed muscle response times in patients with chronic idiopathic low back pain. Spine 26: 724–730
Commentary 9

John Sharkey

I support the conclusions of Herbert and Gabriel (BMJ 2002; 325: 468). Numerous claims have been made as to the benefits of static stretching while research and logic suggest that static stretching will do little or nothing to help prevent injury or reduce delayed onset of muscular soreness (DOMS). It is my experience and opinion that taking muscles dynamically through their full range of movement (ROM), beginning slowly and gradually building up to the sports (or training) specific speeds are appropriate both pre and post the main exercise/training event (i.e. warm up and cool down).

I view the role of static stretching as very different (and therefore a separate issue) from active ROM (i.e. flexibility) exercises. As opposed to being an element of the warm up or cool down periods, static stretching may be necessary to develop appropriate maximum static ROM. Therefore, I encourage static stretching as a separate unique component for areas or structures, providing time has been taken to ensure an increase in blood flow, core temperature, lowered viscosity, increased pliability and neural augmentation. Knowledge of reciprocal inhibition to avoid or minimize the effects of muscle spindle activity is essential. Static stretching should occur some hours after the training session, or on a rest day, as a specific component of fitness and not merely an afterthought to the primary training session.

Athletes, both recreational and professional, are well advised to ensure they complete an appropriate cool down to aid a safe return to homeostasis.

Review of literature

Numerous methods can be utilized to assess DOMS indirectly. Goniometry is widely used to assess reduction in the ROM specific to the affected limbs (Clarkson et al. 1992).

Intra-muscular swelling and oedema have been assessed using anthropometric measurements of the circumference of the affected area (Clarkson et al: 1992).

Diagnostic ultrasound can be used to visualize small amounts of intra-articular fluid surrounding an injured (or painful) joint and can provide a non-invasive method for assessing DOMS (Sipila & Svomineu, 1996).

It is interesting to note that as early as 1902, Hough (1902) found that DOMS was closely associated with mechanical tensions produced in the muscle. Hough suggested that some sort of rupture within the muscle itself was the cause of the phenomenon and pointed especially to the connective tissue as the site for these ruptures.

Assmussen (1956) postulated that DOMS was due to overstretching of the muscles elastic components including the tendons and connective tissue. He found that the tension per active unit was higher in negative phase than in positive phase, leading to more chance of mechanical strain with this type of exercise and that soreness and pain, as assessed by interview and palpation, was much more localized at the tendinous attachments.

It could be suggested therefore that stretching muscles after exercise may encourage further damage to already disturbed myofibrils, z-bands and streaming. Evidence already supports the notion that exercise involving eccentric contractions causes muscle tearing and skeletal muscle damage (Friden et al. 1981).

Such damage may be compounded or exacerbated by the tensional forces of stretching immediately after a workout or training session.

My approach is to promote ‘dynamic range of movement’ (DROM) during activities or workouts. The health-related component of total fitness described as flexibility (i.e. range of motion around a joint or joints) should be no less important than other components such as strength, endurance, etc. Allowing time for muscle tissue to begin the repair (and adaptations that may occur) is encouraged before static stretching is engaged.

Regarding study on risk of injury

Army recruits, as studied in the BMJ research, may seem to be ideal candidates for controlled randomized information about stretching and injury, DOMS or performance. It should be noted though that army recruits exercise very intensely during basic training and their rate of injury is high. They are not generally in great shape at the outset, nor do they train in the manner of typical endurance.
athletes. Therefore, extrapolating findings relating to army recruits may not be appropriate to the field of sporting activity involving highly trained individuals.

It is worth considering that the role of stretching in reducing or preventing DOMS, may be diluted by the significant effects of training quantity and quality, and the fitness, strength and motor skills of the participants involved in the training.

**Conclusion**

It should be noted that the stretch reflex has two components; a dynamic response to velocity of length increase and a static response to amplitude of length increase (Elson 1990, Murphy 1990). Both responses cause reflex contraction of the homonymous muscle. Where ballistic stretching stimulates the dynamic component of the stretch reflex, static stretching stimulates the static component (Elson 1990). This long-term stimulation of the stretch reflex may, over time, result in the clinical condition known as muscle tightness (Murphy 1990, 2000). Numerous authorities have shown the correlation between muscle tightness and increased incidence of muscle injury (Ekstrand & Gillquist 1982, 1983, Mora 1990).

Muscular soft-tissue elements shorten when muscles are hyperactive thus preventing the ability to comply with stretching forces applied to them during training and competition (Perle & Murphy 1991, Murphy 2000). The increased tension on the tendons may also increase likelihood of, or predisposition to, tendonitis (Safran et al. 1989). Muscle tightness has also been correlated to joint injuries (Liebenson 1990). Faulty movement patterns can also result (Murphy 1990, 2000) due to hyperexcitability of the tight muscle and the reduced threshold of motor neurons during activity, leading to both joint and general locomotor functional adaptations (Liebenson 1990, Murphy 2000). It is difficult to see how static stretching could act as anything other than a stimulant to muscle spindle activity setting off the stretch reflex and compounding the muscles short or tight status.

As static stretching is, by its very nature a passive activity, it is reasonable to assume it plays no significant role in eliminating physiologically by-products of muscular contraction (i.e. training) such as lactic acid, phosphate P, Bradykinins, etc. Appropriate cool downs would seem to provide an active means of facilitating the process of gradually returning the muscle to its resting homeostasis.

Regarding risk of injury, static stretching offers a very different mechanical action to those employed in actual sports where joints are moving at speed and muscles are actively contracting (and being inhibited specific to the motions) while they are changing length. McGlynn et al. (1979) and Buroker and Schwana (1989) attempted to reproduce findings by DeVries (1961) and Abraham (1977) that static stretching relieved soreness but their findings supported the notion that static stretching had no effect on DOMS. Static stretching failed to relieve soreness either immediately or in the long term.

**REFERENCES**


Clarkson PM, Nosaka K, Braun B 1992 Muscle function after exercise – induced muscle damage and rapid adaptation.


Elson LM 1990 The jolt syndrome. Muscle dysfunction following low velocity impact.


Guyton AC 1986 Textbook of Medical Physiology, Saunders, Philadelphia: 608-609


Murphy DR 1990 The neglected muscular system and its role in the pathophysiology of the subluxation complex. Journal of Chiropractic 27: 36–40


Perle SM, Murphy DR 1991 Hamstring injuries. Chiropractic Sportsmedicine


Sipila S, Svomineu H 1996 Quantitative ultrasonography of muscle. Detection of adaptations to training in elderly women. Archives of Physical Medical and Rehabilitation 77: 1173–1178


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Commentary 10

B.F. Vaughn

As a Licensed Sports Massage Specialist for 26 years as well as a Certified Athletic Trainer (ATC) and a Certified Strength and Conditioning Specialist (CSCS), I spend the majority of my clinical care with high-performance competitive athletes. The current debate over the efficacy of stretching for the prevention of injury begs the definition of ‘injury’. In the world of sport, ‘injury’ is a musculoskeletal dysfunction that prevents the athlete from performing at all, and certainly not at optimal levels commensurate with training and coaching. Many athletes have performed and competed with varying degrees of pain and discomfort that did not interfere with ROM or flexibility capacity. I have spoken with many flexibility specialists over the years to determine for myself how much and what type of stretching protocols would benefit my athlete clients.

I have also discussed this matter with three experts in this field, Ann and Chris Frederick, a former professional ballet dancer and Licensed Physical Therapist who operate a Flexibility Clinic in the United States (Arizona) and Juan Carlos Santana, a recognized expert in ‘functional training’ and human performance and the Director of the Institute of Human Performance in the US (Florida).

The article that spawned much of the current and renewed interest in this important debate was published in 1999 by Shier. The primary purpose of that study was to evaluate the clinical and basic science evidence surrounding the theory that pre-exercise stretching prevents injury.

A MEDLINE SEARCH was conducted that produced 138 articles of which only 12 had a control group in the study. In this group of articles, four suggest benefits, while three articles suggest a detrimental effect and five articles suggest no difference. A review of the scientific literature shows that current clinical evidence does not support the theory that stretching before exercise prevents injury.

The information on theories was compiled by Juan Carlos Santana M.Ed., Certified Strength and Conditioning Specialist (CSCS). Mr Santana is the Director of the Institute of Human Performance and a doctoral candidate in the Exercise and Sports Science Department, University of Miami, USA.

Five theories showing why stretching will not reduce injury:

1. Making a muscle compliant before it produces/absorbs force actually weakens the muscle (absorbs less energy) – making it more susceptible to injury.
2. Stretching a muscle can cause the actin and myosin to lose interaction. This will cause force to be transmitted through the cytoskeleton of the muscle fiber, causing fiber damage.
3. Active vs. static compliance. Active and static compliance are not related. Active compliance is more important – An active muscle is LESS compliant but absorbs MORE energy. SO – compliance is not related to muscle injury.
4. Overstretching a muscle can produce injury (i.e. strains that are as small as 20% can produce damage that reduces force output).
5. Increasing ROM may mask pain (increase in pain tolerance). If stretching masks the perception of pain – it could pre-dispose to injury if performed before exercise.

Significance of study – debunks the old myth that static stretching and increasing ROM before exercise reduces injury.

Master Flexibility Specialists Ann & Chris Frederick, Physical Therapist, presented a workshop entitled Advanced Flexibility Techniques for Weight Training at the annual Society of Weight Training Injury Specialists (SWIS) conference held in Toronto, Canada in September 2002.

The following information derives from an interview conducted by the author (Benny Vaughn) with Ann and Chris Frederick in September 2002 after their presentation in Toronto:

- The majority of research done on flexibility is limited to static stretch technique. When most studies looked at whether there were pure gains in ROM, there was almost always, some increase in ROM. When other studies took the next step and examined whether that increase in ROM correlated with any improvements with strength, power or injury reduction, the results were generally, not favorable.
The Stretching Debate

- If we examine the effects of static stretch on the muscle and fascia, we begin to understand why static stretching may be a detrimental activity prior to any vigorous athletic or sporting activity but may be extremely beneficial post-activity, when rest and recovery are the primary goals.

- Ann and Chris Frederick have over 25 years experience with flexibility training and have found in their clinical experience that static stretching can have either an inhibitory or a facilitatory effect depending on how one adjusts the parameters of intensity, duration and frequency during the stretch. For example, they have observed clinically, that practitioners of styles of yoga whose emphasis is static based, i.e. stretches held for long periods of time (>60 seconds), cause myofascial structures to become hypotonic, with gamma gain profoundly diminished, deep tendon reflexes absent, and with the muscle belly exhibiting a palpatory texture similar to that of atrophy and hypotonicity. This is especially evident if these stretches are not countered with a regular strengthening program using progressive resistance exercise.

- "On the other hand, we have observed some martial artists and dancers try for years to force their lower extremity (LE) splits without any significant gains in ROM. Or, if they do perform their LE splits passively, they cannot translate it into an active split when jumping into the air, otherwise known as a 'non-functional split'. In either of these cases, static stretching performed in these manners can have a detrimental effect on the body by either not preventing injury (best-case scenario) or actually increasing the chances of injury, as some studies on static stretching have shown" (Personal communication).

- A key point made by Ann and Chris Frederick is that a static stretch is not just a static stretch and that most of the research, to date, on human flexibility has not investigated the parameters of intensity, duration and frequency of the stretch. The manipulation of these parameters will influence change of the effects of the static stretch. Consequently, these research studies that do not recognize such clinical parameters are limited in their clinical usefulness for human stretching guidelines.

- According to Ann and Chris Frederick, when performed properly, static stretches have an overall effect of relaxing the neuromyofascial system. "As a result of these effects, we reserve its use for recovery and maintenance after activity, so that we can regain functional flexibility that was lost through activity-generated tightness and/or soft-tissue injury. Therefore, we advise static stretching after activity to ensure parasympathetic nervous system stimulation with emphasis on stretching that is pain free and guided by deep breathing and imagery. When we combine this approach with a comprehensive dynamic stretch program for activity preparation we have clinical evidence of both injury reduction and performance enhancement.'

My clinical experience supports the Frederick’s position, that ‘dynamic’ stretching is more appropriate for pre-competition or pre-training and that ‘static’ stretching is more appropriate for post-competition or post-training. This stretching should be done in multiple combinations of planes of motion to stimulate and imitate more accurately the neuromuscular pathways that are used during physical activities. For example, to stretch the hamstring muscle group adequately, to prepare it for real locomotion loads such as running, requires multi-angle and ‘spiral’ movement patterns and not single-angle ‘linear’ patterns such as a straight leg raise stretch.

In the end, the prevention of injury is a combination of stretching and strength training utilizing progressive resistance exercises to create a neuromuscular adaptive response of measured strength gains. It is the balanced combination of stretching and strength training that produces muscle power. In my experience, a flexible, strong, and powerful person is less likely to sustain injury than one who is not. Many of the studies that paint flexibility in a negative light failed to study the parameters of flexibility noted by the Fredericks and often did not include consideration of the necessary balance of strength training and power in the equation. Many of the studies done on stretching did not have control groups nor did they compare dynamic spiral stretching to static linear stretching patterns. I will certainly continue to include stretching in my treatment, care, and prevention of athletic injuries. When done with balance, prevention is the result.

REFERENCES

Authors’ response

Rob Herbert and Michael Gabriel

We thank the commentators for their analyses of our systematic review. It is pleasing to have been given the opportunity to respond. Several issues were raised. We address what we believe to be the main issues below:

1. Why do people stretch? What potential benefits arise from stretching? Our study specifically addressed the effects of stretching before or after exercise on muscle soreness, risk of injury and athletic performance. We made no claims about the effects of stretching on other outcomes.

Most of the commentators (Beam, Schleip, Hayes, Rowland) argued that even if stretching does not reduce injury risk or soreness it may produce other benefits. The list of benefits of stretching they provide is extensive: increased flexibility (Schleip, Hayes), an increase in serial sarcomere number (Hayes), improvement in the muscle length-tension relationship (Hayes), mobilization of neural tissue (Hayes), increased performance (Schleip, Frederick & Frederick cited by Vaughn), facilitation of tendon and ligament healing (Schleip), ‘client re-activation’ (Hayes), improved pain-free activity tolerances (Hayes), increased confidence in specific movements (Hayes), as an aid in education of specific tasks (Hayes), prevention of osteoarthritis (Schleip), psychological benefits including empowerment towards self-reliance (Schleip, Hayes), enhanced proprioception (Schleip, Hayes), increased performance at sport (Rowlands), or as therapy for people with ‘chronic muscle shortness’ (Schleip, Hayes). If stretching has just some of these consequences it is a remarkable therapy indeed.

We do not disagree that such effects are possible, but we do not share the commentators’ convictions that the effects are self-evident. With the exception of an increase in flexibility there is, quite simply, no rigorous evidence (evidence from properly controlled studies on humans) that stretching meets any of these claims. Until there is good evidence these ideas should be treated as speculation or hypotheses, not fact.

There is an irony here. Hayes argues that stretching must be considered as part of a holistic intervention (‘The positive effects from stretching accrue from its application in an individual specific prescription of care in combination with other complementary therapeutic approaches, not as a non-specific recipe cure all’). Yet, he claims benefits that are reductionist in nature (adjustment of sarcomere number, reflex effects). He provides no evidence of effects of stretching on holistic outcomes.

Hayes states that ‘it is a primary intention of muscle stretching programs to address the long term maladaptive muscle–fascial restrictions found when musculoskeletal dysfunction syndromes include alterations in normal motor control repertoires’. We think that would be news to most people who stretch. In our experience, most recreational athletes say they stretch because they do not want to be sore after they exercise, or because they do not want to get injured.

2. Does pre- or post-exercise stretching prevent muscle soreness? Hayes states that ‘the section of the review that concludes that stretching does not affect post-exercise soreness is, in my opinion, inappropriately claimed’. His argument appears to be that the studies of the effects of muscle soreness only used tasks that involved ‘acquisition of novel motor control skills – movements not usual in activities of daily living’. The implication is that, had these studies employed activities that the subject was accustomed to, stretching would have been effective. The problem with this argument is that muscle soreness only results from unaccustomed exercise – familiar exercises do not generally produce muscle soreness. Stretching cannot reduce muscle soreness that follows familiar exercise because familiar exercise does not cause muscle soreness.

Hayes subsequently concludes that ‘Until the individual adapts to the demands of the task and environment then muscular soreness is inevitable’. This is what our analysis of studies of stretching showed.

3. Could stretching be effective in carefully selected populations? Four of the commentators suggest that, while stretching may not reduce injury risk in army recruits, it may prevent injury in other populations (Beam, Sharkey), especially in populations at lower risk (Sharkey, Hayes, DeLany) or those doing other sorts of activity (Beam). We
do not rule out this possibility (in fact we specifically nominated this as an important avenue for future research), but we are not optimistic.

Why are we pessimistic? The subjects in the two large trials of injury risk were at an unusually high risk of injury. (Approximately 20% were injured over a 12-week period). In lower-risk populations, the maximal possible effect is reduced (Herbert 2000). For example, if stretching completely abolished injury risk in a population that had a 5% risk of being injured in 1 year, the average person would have to stretch for 20 years to prevent one injury. Most people would not consider the return adequate. Of course, stretching cannot abolish injury risk – the best we can hope for is a diminution of risk – so this is an optimistic scenario. If stretching halved risk, the typical person from this population would need to stretch for 40 years to prevent one injury.

Liebenson suggested that research should examine a range of subgroups to see if there is any effect of stretching in these subgroups. We appreciate this constructive suggestion. However, while it is tempting to explore data for effects in subgroups, such explorations are likely to produce spurious findings if they are not grounded in strong theory. (For humorous explanations of this technical issue, see the report on DICE therapy (Counsell et al. 1994) and the analysis in the ISIS2 report of the effects of streptokinase by astrological star sign (Anonymous 1988).)

One subgroup that is sufficiently strongly grounded in theory to be worth exploring is the subgroup of people with poor flexibility (Liebenson). In fact, our own incident data from an inception cohort (Pope et al. 1998) provide some of the strongest evidence of an association between risk of injury and lack of flexibility. We point out in the original report that this association need not be causal: flexibility may be associated with injury risk even if it has no effect on injury risk simply because it is associated with variables (perhaps cardiovascular fitness, physical strength or coordination) that do modify risk.

We directly tested the possibility that stretching reduces risk in inflexible people in the most rigorous possible way: by looking at the interaction between flexibility and effect of stretching in a randomized trial (Pope et al. 1998). There was no evidence of such an interaction.

4. Stretching is ineffective in isolation, but not when accompanied by other interventions: Hayes argued that it is ‘simplistic’ to examine the effects of stretching in isolation, as it may be an effective therapy when combined with other interventions. We disagree. If we are to understand which interventions are effective and which are not it is necessary to examine the isolated effects of therapies. Sometimes, when there are strong grounds for suspecting interactions between therapies, there may be reason to examine the interactions of therapies as well.

In fact, stretching was not provided in isolation in the studies of injury risk. In those studies, stretching was one component of a program of interventions (involving task modification, equipment modification, a progression of training intensities and specific interventions) designed to reduce injury risk. Nonetheless, the randomized design enabled isolation of the unique contribution of stretching when accompanied by these other measures.

Martin cites a study by Hartig and Henderson which he claims provides evidence that stretching reduces injury risk. This study lacked randomization to stretch and control conditions and therefore does not satisfy the most basic determinant of internal validity.

5. The stretching was ineffective because inappropriate techniques were used: Several commentators expressed opinions about how stretching should be conducted (Schleip, Sharkey, Hayes, Rowland, Liebenson, Frederick & Frederick cited by Vaughn, Martin, DeLany). It is illustrative that all offer different opinions. There is almost no consistency in the stretching techniques or protocols they recommend. This illustrates how, in the field of stretching, speculation has triumphed over data. The diversity of ideas about how stretching should be conducted is based on wild theories and anecdote, not rigorous science.

This presents a dilemma for researchers. Whose protocol should be used in a clinical trial? Whatever protocol is used, someone will say that ‘but I think subjects should stretch differently’ (and, the implication is, ‘my way works better’).

The only solution is for practitioners to resist speculative and untested theories. Professional practice ought to be based on the best available evidence, even if this slows innovation.

6. The review promotes a view that active care is ineffective: Hayes claims that our paper ‘promotes as scientific fact the premise that musculo-skeletal pain syndromes are ineffectively addressed by active care solutions’. This is scurrilous nonsense. Of course we do not.

It is time that the role of stretching before or after exercise is openly debated in scientific journals. Open debate is the best way to combat the pseudo-science that is so damaging to progress in this field. We thank the Editor of the Journal of Bodywork and Movement Therapies, for giving us the opportunity to participate in this discussion.
REFERENCES

Anonymous 1988 Randomised trial of intravenous streptokinase, oral aspirin, both, or neither among 17,187 cases of suspected acute myocardial infarction: ISIS-2. ISIS-2 (Second International Study of Infarct Survival)

