movements involved in sports.[10] This technology can be used to (*a*) identify muscles that are activated and (*b*) assess the extent of activation of each muscle relative to that muscle's maximum capacity to perform work.[9 10] Information obtained from functional MRI measurements can be used to compile individual databases of each athlete's muscle activation patterns when he or she is at peak performance. This information can be valuable if the athlete is injured or if there is a pronounced decline in peak performance. Functional MRI measurements of identical exercise obtained under such conditions, when compared with information from the athlete's database, could provide insight into injury induced changes in muscle activation patterns. Functional MRI may also be used to monitor an athlete's recovery from an injury. As with MRS, MRI provides a measure of an athlete's physical conditioning at a specific point in time.

In summary, it is possible that, by combining MRI and MRS with more traditional methods, we may create an organised training and evaluation tool capable of elevating human performance to a new level. At this level we would be able to (*a*) minimise instances of overtraining and therefore reduce overtraining injuries, (*b*) optimise event readiness thereby reducing injuries that are associated with fatigue during an event, and (*c*) optimise injury recovery programmes so as to reduce the incidence of reinjury. These reductions could make a significant impact on sports related injuries in elite and professional athletes.

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Stretching before exercise: an evidence based approach

Clinicians are under increasing pressure to base their treatment of patients on research findings—that is, to practice evidence based medicine.[1] Although some authors argue that only research from human randomised clinical trials (RCTs) should be used to determine clinical management,[2] an alternative is to consider the study design (RCT, cohort, basic science, etc) as one of many variables, and that no evidence should be discarded a priori. In other words, the careful interpretation of all evidence is, and has always been, the real art of medicine.[3] This editorial explores these concepts using the sport medicine example of promoting stretching before exercise to prevent injury. In summary, a previous critical review of both clinical and basic science literature suggested that such stretching would not prevent injury.[4] This conclusion was subsequently supported by a large RCT published five months later.[5] Had the review relied only on previous RCT data, or even RCT and cohort data, the conclusions would likely have been the opposite, and incorrect.

Was there ever any evidence to suggest that stretching before exercise prevents injury? In 1983 Ekstrand *et al*[6] found that a group of elite soccer teams randomised to an intervention of warming up and stretching before exercise, leg guards, special shoes, taping ankles, controlled rehabilitation, education, and close supervision had 75% fewer injuries than the control group. There was one other RCT and a quasi-experimental study that also supported this conclusion,[7 8] both using at least warm up as a co-intervention.

Clinical evidence suggesting that stretching before exercise does not prevent injuries has also been reported. van Mechelen[9] published an RCT showing that the intervention had no effect, but many subjects were non-compliant. If we look at "less strong evidence", both Walter *et al*[10] and Macera *et al*[11] published cohort studies that suggested that stretching before exercise was not beneficial, and there have been several cross sectional studies as well.[12 13] Of course, there were significant limitations to all of these studies.

In summary, the RCTs could easily be interpreted to suggest a probable effect using strict evidence based medicine guidelines. The use of cohort studies may weaken the conclusion, but would be unlikely to reverse it. Understanding the basic scientific research allows one to put this clinical evidence into perspective and explain results that may appear contradictory.

Firstly, some people believe that a compliant muscle is less likely to be injured. From the basic science research, we find that an increase in tissue compliance due to temperature,[14] immobilisation,[15] or fatigue[16 17] is associated with a decreased ability to absorb energy. Although this is not the equivalent of stretching, no basic science research shows that an increase in compliance is associated with a greater ability to absorb energy. Secondly, most injuries are believed to occur during eccentric contractions,[18] which can cause damage within the normal range of motion because of heterogeneity of sarcomere lengths.[19–22] If injuries usually occur within the normal range of motion, why would an increased range of motion prevent injuries? Thirdly, even mild stretching can cause damage at the cytoskeletal level.[23] Fourthly, stretching somehow increases tolerance to pain—that is, it has an analgesic effect.[24–26] It does not seem prudent to decrease one's tolerance to pain, possibly create some damage at the cytoskeletal level, and then exercise this damaged anaesthetised muscle. Of note, there is no basic science evidence to suggest that stretching would decrease injuries. Fifthly, there are some basic science data to suggest that a warm up may help to prevent injuries.[27] Understanding these principles, we can now explain the apparent contradiction in the clinical literature. Re-examining the RCTs that support stretching before exercise, one finds that all of them included at least one other effective co-intervention—for example, warm up, leg guards, etc.[6–8] Therefore it is not surprising that these RCTs found less injuries in the intervention group. On the other hand, the cohort studies,[10 11] and the RCT by van Mechelen *et al*,[9] controlled for these co-interventions in the analysis stage. Therefore, although formally a "weaker design", the studies suggesting that stretching before exercise is not beneficial should be weighted as stronger because the analysis was more appropriate. However, this was only recognised because the basic science was reviewed.

In conclusion, the strength of any literature review can be gauged by its ability to predict what future research studies eventually show. The inclusion of all the evidence available led to a conclusion that was supported by a subsequent, well conducted, large RCT. Had the evidence in the review article[4] been limited to only RCTs as proposed by some authors, the conclusion would have probably been different, and inaccurate. This may be one reason why many meta-analyses fail to predict the outcome of future large RCTs. Further, we must remember that much of medicine in general, and sport medicine in particular, is based on historical precedent. When historical precedents are based solely on hypotheses that have more recently been proved incorrect, the clinician must choose to (*a*) continue treatment on the basis of a known incorrect idea of pathophysiology or (*b*) change to a treatment based on current knowledge of pathophysiology and pathobiology. Of course, the potential side effects of any new treatment (likely to be unknown) must also be weighed against the potential side effects of the historical treatment (more likely to be known). The art, and even science, of medicine then becomes the ability to weigh all the available information at hand without discriminating a priori, and to be able to judge which is most appropriate for the patient seated across the desk.

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