Flexibility – stretching the paradigm

by
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Functional Flexibility – "Every time you move you stretch!"

The challenge in considering *flexibility* is to be able to position it in the context of performance. Flexibility like strength or endurance, is an essential component of movement but too often it has been isolated from its functional role and even been seen in apposition to other capacities. For the last twenty years research and training about flexibility has been largely the preserve of the sport medicine fraternity that has conducted very effective educational programs. These have included promoting concepts indicating that "...failure to stretch (i.e. static stretching) particularly before training…increases the chances of being injured". In Australia this view has had a major impact on training programs, both in terms of how coaches and athletes perceive flexibility and how and when they use stretching techniques e.g. the mass inclusion of static stretching in warm-ups.

Rarely do practitioners take a broader view and look at functional flexibility as a component of movement in their sport. Efficiency of movement, sometimes in the guise of skill analysis, is the context in which flexibility requirements and problems need to be repositioned. This approach requires a mental and philosophical shift to a broader paradigm for many coaches and athletes. This emphasis focuses on the *development of efficient movement patterns* for the sport concerned, rather than on developing flexibility for injury prevention, or considering that flexibility is a separate and distinct component to strength, or speed or skill development. Strength and flexibility are complementary capacities and both are essential for movement to occur. Neither capacity exists in isolation and successful training programs develop these capacities concomitantly... Refocussing on the development of *efficiency of movement* will redefine the main role of flexibility training to be integral for improved performances, with the secondary role of flexibility training focussing on injury prevention.

Translating the Terminology OR What are we talking about?

Much of the confusion in this area has arisen from the use, and often misuse of terminology. While definitions may seem somewhat tedious they help to clarify and delineate the boundaries for discussion. Definitions for *flexibility* are relatively consistent, but those for *stretching* are varied. Comprehension by coaches and athletes of what stretching involves, is often limited by their understanding of what constitutes stretching and their selection of appropriate techniques to suit specific training requirements

What is Flexibility

Flexibility refers to the range of movement (ROM) around a joint. This varies markedly between joints, muscle groups and between individuals. Nonetheless, flexibility is regarded as one of the essential 5 S's of training and as such it is subject to all the basic principles of training. Flexibility requires development (overload), in a sport specific manner (specificity),

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recovery of the residual fatigue from flexibility training needs attention (recovery), and it needs practise to maintain normal functional ranges of movement (reversibility) *–use it or loose it*.

What is stretching?

Stretching refers to tissue elongation: i.e. any extension of a material or substance from its' resting length. This means that stretching can occur as a result of a minimal increase in length to a maximum increase in length, away from the resting state of the tissue.

Stretching is an essential musculoskeletal requirement for movement to occur. Stretching techniques are many and varied and the cause of much debate and confusion for coaches and athletes. Stretching taxonomies attempt to clarify the situation by classifying techniques into active, passive, assisted, dynamic etc but even here the terminology is inconsistent. The term *ballistic* for example, is described variously to mean either a single explosive movement, or repeated explosive movements (bouncing), and this may or may not be at full range of movement. Do all bouncing movements correspond to ballistic actions?

Rarely do these taxonomies identify *rate* of change from the resting length. And then there is PNF (Proprioceptive Neuromuscular Facilitation). There are many ways of applying PNF but interestingly enough the original work by Knott and Voss (1968) involved the contraction and extension of numerous muscle groups across multiple joints in functional directions i.e. stretching and strengthening concomitantly to retrain the neuromuscular system by rehearsing specific motor patterns.

Muscles and joints do not work in isolation. Yet, in contrast to the approach of Knott and Voss, few current stretching techniques replicate the functional roles of the muscles and joints being stretched. There is a noticeable lack of information about functional flexibility and this is reflected in the content of current *Stretching* and *Flexibility* books and manuals. How many provide information about active or dynamic stretching techniques? Or even how to assess functional flexibility? While there is a need to isolate some muscles and joints which have been identified for special attention, relatively little regard has been given to the development of functional or dynamic stretching techniques which prepare the athlete for sport specific actions.

Some Myths and Misconceptions

1. Stretching prevents injury, therefore performing static stretching in the warm-up will prevent injuries during training and competition.
2. Strength training and hypertrophy training lead to a reduction in flexibility.
3. PNF is the best stretching technique to use.

What do the Sport Scientists tell us?

Does stretching prevent injury?

The strongest support for this hypothesis, that stretching reduces injury risk, comes from prospective cohort studies (Ekstrand & Gillquist, 1983; Lysens et al. 1989). While cohort studies provide useful prognostic information about injury risk, they do not provide strong

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evidence of a causal relationship between stretching and injury risk. Until recently there had been no published randomised trials examining the prophylactic effect of stretching. In 1998 two large-scale randomised trials were undertaken in Australia to determine if conventional stretching programs reduce injury risk in an *at-risk* population of army recruits (Pope et al. 1999).

The first study involved 1093 male recruits, and the second 1538. All subjects were undertaking 12 weeks of intense military training. Recruits were randomly allocated to stretch (static stretches) or control (no stretch) groups. Pre and post screening for injuries and flexibility assessment were conducted for both studies. All injuries were recorded during the 12-week period. Results showed no significant effect of pre-exercise stretching on injuries sustained. However, fitness was a strong predictor of injury risk; with the least fit subjects being 14 times more likely to sustain injury than the fittest subjects. The authors concluded that, "…a typical muscle stretching protocol performed during pre-exercise warm-up does not produce clinically meaningful reductions in risk of exercise-related injury…" (1999).

Interestingly, a similar American study also using military trainees (Hartig et al.1998) has provided supportive evidence. Subjects were divided into control and intervention groups with both groups performing the same static stretches before training. The intervention (experimental) group performed static stretches before lunch, dinner, and bedtime i.e. static stretches were also performed after exercising. Results showed that static stretches prior to exercise did not prevent lower extremity overuse injuries, but additional static stretches after training and before bed resulted in 50% fewer injuries occurring.

In 1989 static stretching was removed from warm-up drills for the soccer squad at the Australian Institute of Sport, with active movements and specific foot and bodywork drills used during the warm-up instead. Until that time stretching had not been undertaken in the warm-down so static stretches were included in warm-down activities post-training and post-game three times a week. Training injury rates fell significantly (calves, shins, hamstrings, groins) and hip flexibility measuring extension and flexion, improved by an average of 20^{o} over a four month period (Calder & Sayers, 1992).

Stretching the paradigm here, involves identifying the link between flexibility and injury.

Flexibility is a critical component for movement but with reduced functional flexibility the efficiency of movement is compromised and this compromise increases the risk of mechanically induced injuries. The argument that stretching prevents injury is a misrepresentation and an over simplification of the logic underlying the relationship of flexibility for movement efficiency, and the fact that **inefficient** movements are a major contributor to training injuries, not flexibility per say.

Another assumption underlying this myth is that static stretching is **the** technique by which appropriate flexibility is achieved. While static stretching can increase passive flexibility there is no research to demonstrate its correlation with the dynamic flexibility required in sporting actions. In addition the idea that static stretching in the warm-up will prepare muscles for action is fallacious.

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When a passive muscle is stretched it does not behave like a simple elastic structure. (Proske et al., 1999) A few cross-bridges between actin and myosin are still present even after apparent muscle relaxation following contraction. . About 1% of cross-bridges in a muscle fibre are still formed randomly during passive stretching. This results in an initial stiffness when a static stretch is applied. The presence of these cross-bridges and the resultant stiffness in these muscle fibres produces a degree of *slack* in the myofibrils when they are stretched. As a result of this *slack*, the tension response to stretch shows a delayed rise as movement takes up the *slack*. In coaching terms this means that the contraction rate of muscles following static stretching is slower. Is this appropriate preparing the muscle before training?

Probably not. Recent research by physiotherapists at the Australian Institute of Sport (Purdam, et al.1999) has compared the effect of static and ballistic stretching on hamstring strength. Results indicated that static stretching produced a significant reduction in eccentric hamstring strength of the order of 7% whereas concentric strength was unaffected by either static or ballistic stretching. The authors concluded that prolonged static stretching has the propensity to depress strength in the immediate post-stretch period.

In coaching terms what does this mean? Another challenge to the paradigm that flexibility means static stretching. Consequently it is important to be selective in choosing the appropriate stretching technique for different aspects of the training program. Warm-up or preparatory components of training require the use of techniques that prepare both the neuromuscular system and the mental state of the athlete for ensuing action. Warm-downs or recovery components require techniques to recover normal resting states, including muscle lengths and functional joint mobility; while separate training sessions should be programmed to focus solely on developing and improving flexibility. It's horses for courses rather than the same nag (static stretching) for all events.

Does strength or hypertrophy training, reduce flexibility?

There is a common belief in some circles that large or strong muscles are less flexible. i.e. the cartoon images of body builders with bulging bodies and Neanderthal-like postures. The determinants limiting flexibility here are not the development of the muscle strength or size, but the way the muscle has been trained.

Research indicates that the range of movement undertaken during an exercise is a strong determinant of flexibility. The concept of *muscle memory*, or thixotropy, is not new, and is based on the experiences of muscle fibres and elastic filaments in connective tissue (Proske, et al., 1999). If an exercise is performed through a narrow range of motion, or a joint is immobilised for a short time, even a few hours, then flexibility will be reduced. If however, actions are performed through a full range of movement, and / or flexibility exercises are added post training, then both flexibility and strength performances are enhanced (Wilson, et al., 1992). Wilson used combinations of static and active stretches post training to improve flexibility in powerlifters, and also demonstrate a corresponding significant increase in strength.

Muscle strengthening through eccentric loading is a common practice. In current studies at Monash University eccentric exercises are being used as a strategy for protection against hamstring injury (Brockett, et al., 1999). The rationale behind this research is that the damage resulting from an initial bout of eccentric loading produces damage to muscle fibres. This results

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in an increase in the number of sarcomeres laid in series so that during future eccentric exercise, the muscle fibre is longer and can stretch with the descending limb without experiencing as much damage. It takes about 6-7 days for additional sarcomeres to form. (Proske pers comm.)

Stretching the paradigm here indicates that if strength or hypertrophy training is undertaken through a full range of movement and accompanied by post exercise stretching, both static and active, then flexibility will not be compromised. In fact there should also be a corresponding improvement in performance. Similarly the selective use of eccentric loading can help to increase muscle length and strength and provide protection for muscles which often compromised during explosive actions. Translated into coaching terms, this means that muscles remember what happens to them. So what athletes do with their muscles and joints in and out of training situations will affect their functional flexibility for their sporting performances.

Is PNF the best stretching technique to use?

There have been a number of studies comparing the effectiveness of different stretching techniques. Research about static stretching (slow speed, passive movement to place a muscle on stretch) indicates that stretches held from 12 – 18 seconds increases flexibility as much as stretches held for up to two minutes (Madding et al.1987; Taylor et al. 1990). Proske has suggested that 6 seconds is sufficient to gain stretch in muscle fibres (pers.comm.1999). Comparisons of ballistic and static stretching techniques indicate that both are equally effective in gaining range, (Lucas & Koslow, 1984) but static techniques are regarded as safer having no detrimental physiological effects. (Moore & Hutton, 1980; Osternig, et al. 1990).

Alter (1988) has argued for the inclusion of ballistic stretching in training because the dynamic demands placed on the muscle are similar to sporting demands. This is despite the debates about whether it is potentially dangerous because it may evoke the stretch reflex. Many recent articles in popular training magazines are also promoting the inclusion of more active and dynamic stretching techniques for use in warm-up activities. However examples of what these activities may be are not so frequently provided.

The notion that it is important for muscles to be in a relaxed state to achieve intramuscular connective tissue elongation have been challenged by studies which have looked at PNF techniques. Although Knott and Voss (1968) used a variety of PNF techniques in their clinical work there are two predominant PNF techniques used in sporting contexts. The one most commonly taught and used in Australia is the Contract Relax technique. Contract Relax (CR) involves passive movement to the onset of muscle stretch, and a maximal voluntary contraction performed against resistance before passively moving further into range. Reciprocal relaxation (RR) is where the agonist produces the stretching force on the opposite muscle (antagonist). Combinations of these two techniques are sometimes used and this procedure is referred to as the Contract Relax Antagonist Contract (CRAC) format.

A number of studies have indicated that PNF (proprioceptive neuromuscular facilitation) techniques result in greater gains in range than those for passive stretching techniques, (Sady et al., 1982; Wallin et al., 1985) In a recent review of the literature Hutton notes that Static and CRAC techniques have yielded similar acute improvements in ROM, but adds that most studies focusing on long-term (chronic) gains in ROM have mixed results (Hutton, 1992). Despite these

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varied results Hutton states that "…the CRAC PNF procedure has often been shown to produce the greatest absolute gains in ROM over other stretching procedures."

The effectiveness of PNF is paradoxical in view of the belief that muscles must be in a relaxed state in order to achieve intramuscular connective tissue elongation. In reality all the PNF techniques increase electromyographic (EMG) activity, an indication that the muscles being stretched are not relaxed (Hutton 1992).

Stretching the paradigm here involves challenging the notion that any one stretching technique is paramount and superior to all other techniques. The challenge for a coach or athlete is twofold. First to establish ***why*** they want to undertake stretching activities including the relevance of these for the training program, and secondly to be able to choose the technique or techniques, most suited to achieve this. For example, the stretching techniques for a warm-up will probably be quite different to those for the warm-down. There are increased requirements for active and ballistic activities in the preparatory component of the training session, while more passive and light static stretching techniques may be more suited in recovery at the end of training. The rationale underlying the selection of techniques will relate to producing acute flexibility gains with a functional focus for either preparation or recovery. In contrast, the choice of stretching techniques for the development of long-term flexibility, i.e. chronic gains, will be different. The choice of techniques relates to the principle of Specificity and is well suited to the use of PNF techniques, long held static stretches and even some eccentric loading. There is no **one** technique which is better than another – it all depends on what you want to achieve by the stretching procedures you undertake.

Current Problems; OR What is holding us back?

Some of the misconceptions about flexibility and stretching stem from the application of poor logic to known information. For example, biomechanists tell us that an athlete needs to be flexible and strong enough to perform movements efficiently.(This is logical) Physiotherapists and biomechanists tell us that if athletes are inefficient or have poor mechanics/skill/technique due to poor flexibility they are more at risk of injuries than an efficient performer of the same calibre.(This is also logical) These logical concepts have been married and translated into coach education programs to read that static stretching in the warm-up will prevent injuries in training. (This is stretching the truth). This illogical thinking pattern has permeated training stretching philosophies in Australia for over twenty years and it is very difficult to change.

Research in this area is also fraught with problems associated with the testing and assessment of flexibility, but this is a world wide phenomena not just a problem in Australia. Comparisons of research data are made difficult because reliability problems arise due to the variety of assessment and testing procedures employed. In addition there are major concerns about the validity of what is being measured. In this regard flexibility has much in common with the problems associated with the measuring and assessment of strength

The classic example of this problem for flexibility is the use of the *Sit and Reach Test* as a measure of hamstring flexibility. But what does it really measure? Arguments against the inclusion of this test in Talent Identification programs, or as a measure of hamstring flexibility, are rejected by proponents of the Test. They argue that despite it's questionable validity the test

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is useful because it is reliable. Eg "*It has been used for so long it is too difficult to change to another test!"* Or *"Large volumes of data have been collected using it and these data provide benchmarks for comparative studies."* Or *"To change to another test and establish new benchmarks would take a long time!"* Unless the test is conducted by knowledgeable clinicians who can tease out the intricacies of lumbar, neural and hamstring flexibility reflected in test results, then the data it provides are extremely limited. It tells us nothing about movement and is a questionable predictor of injury potential.

Consequently there is a need to identify appropriate measures that are both valid and reliable indices of flexibility for sporting movements. An excellent attempt at this was undertaken by the Australian Institute of Sport about four years ago when it established a Task Force of leading sport physiotherapists from around Australia, to identify and compile a set of standardised testing and screening protocols. This information was published earlier this year (AIS, 1999). These protocols have standardised testing regimens to facilitate the comparison of data from athletes who undergo musculoskeletal screening and testing at a variety of state and national training centres by different physiotherapists. So the question of reliability has been addressed.

But where are we with establishing validity for flexibility tests? The answer is not so clearcut or so positive. There is no question that the screening and testing protocols identified by the sport physiotherapy group provide an excellent assessment of an athlete in a static state, but where is the data to support a direct or even strong correlation between static and dynamic flexibility. In fact information about functional and dynamic assessment is woefully lacking. Gait analysis using treadmills has been introduced as a means to address this situation but these assessments fail to replicate true sporting movements. For example, walking is altered considerably by the treadmill environment, and running is affected even more. These analyses are poor predictors of on-court, or on-field performances, the very environments where athletes perform.

The best methods for analysing movement and identifying problems in flexibility involve the use of digital cameras, and for some high-tech analyses, high speed video. Until recently the use of these has been the preserve of biomechanists and a few skills coaches. However with the introduction of improved technologies including the increased availability of digital cameras, and movement analysis programs on the internet, coaches are now able access excellent technology to obtain detailed information about their athletes movement and flexibility problems. The challenge is for coaches to be able to interpret what they see on screen and translate this back into the training situation.

Current and future trends for the assessment of functional flexibility do not lie in laboratory environments with the sport scientist but rather with in-situ performance analysis of the required sporting movements by the coach. The future role of the applied sport scientist is to upskill coaches in the use of the technology and the interpretation of data, and to act in a consultative role as a *sounding board* for ideas, advice or explanations. This new technology is a tool to enhance coaching observations (the science of coaching) but how the coach interprets and uses that information is still very much an art. Great coaches are not only knowledgeable they are also great artists.

Stretching the paradigm here means that we need to take our assessment of functional flexibility into the training environment. In future more coaches will evaluate skill and technique in

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performance settings using small portable computer aided video analysis systems. These analyses will highlight the flexibility requirements or problems for an athlete, as well as provide information to evaluate the effectiveness of any developmental stretching programs. In some sports, particularly those of a cyclic nature, there needs to be more emphasis on monitoring technique and skill throughout the whole training session even during the warm-down. It is pointless for an athlete to undertake large volumes of training if any component of that training is not monitored for efficient technique.

Integrating flexibility and stretching into the training program

Before training begins, identify what you are working with.

If flexibility is such a critical component of movement then the first task for a coach is to develop a clear understanding of its importance for his/her sport. Before any training is undertaken each athlete is assessed and screened using a musculoskeletal (static) protocol and a functional (sport specific movements) protocol. This should be complemented by other physiological tests including relevant applied strength and power testing. Any deficiencies can be identified and training programs individualised to address these areas. A blanket approach to prescribing the same exercise to all athletes is inappropriate even for non-elite performers.

Select appropriate stretching techniques

Understanding the role of the warm-up, and warm-down segments of a training session, enables the coach to identify the techniques which best suit those components. Activities to prepare the body physically, neurologically, and psychologically involve movement. Recovery components may also involve movement but some passive techniques may also be appropriate. The critical notion with these stretching techniques is that they are undertaken to assist with the preparation or recovery of the athlete.

The need to enhance or develop existing flexibility requires special attention, and except for the artistic sports, is best undertaken as a separate training session with the sole purpose of flexibility development. Stretching techniques to enhance long-term flexibility require careful preparation, even though such sessions may not be particularly long in duration. I believe that most of the non-artistic sports need one developmental session a week, of about 20 – 60 minutes duration. It is best to plan such sessions for the end of the day as the techniques involved result in considerable neuromuscular fatigue. It is advisable for athletes to rest afterwards and avoid exercising till the next day.

In Australia in recent years the need to develop functional flexibility has been recognised and concepts and techniques from movement therapy have started to influence athlete conditioning programs. Some of these have concepts akin to PNF and focus on reprogramming of neural pathways and retraining of functional movement patterns. Invariably these techniques develop functional strength and flexibility concomitantly. The Pilates Movement Therapy founded for ballet in the 1920s is an example of the new breed of exercises that have been introduced to Australian sport in the last eight years.

There is one Pilates practitioner at the AIS who integrates core strength and flexibility exercises with body awareness programming for swimming. The subtle differences between these

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techniques and the core stability exercises currently popular in the fitness industry relates to the development of body awareness and its transfer into the specific performance environment so that an athlete can become self correcting. Intercostal extensions and strengthening, together with expansion and retraining of the diaphragm whilst maintaining a stable core, are integrated into exercises both on the land and in the water. The transfer of these exercises to the performance environment is paramount. There is no point for a swimmer to be the best performer in the gym if that does not translate to great pool performances.

Plan to evaluate movement performance

In addition to pre season screening and testing, the annual plan should include monitoring and evaluation points to assess athlete progress. Functional tests may be programmed several times a year depending on the sport and level of development of the athletes concerned. Artistic sports will undoubtedly be monitoring athlete movement and skill on a daily basis albeit maybe not always with camera and computer analyses. Evaluation of technique in cyclic sports is far less frequent and may occur only two or three times a year.

Selling the message to the athlete, Or Stretching should not be Boring

Athletes frequently undervalue stretching programs because they find stretching exercises monotonous. Educating athletes about the various stretching techniques and designing sport specific warm-ups reduces the monotony of tedious repetitive techniques. The use of *small sided* games and sport activities as warm-up strategies whilst excluding traditional static stretching exercises is common in a number of elite teams in Australia.

Other methods I have used at the AIS have required the athletes to conduct their own post training stretching routines as a team. In the AIS soccer program each player is trained to teach two static stretches from a repertoire of 32. After training each player directs the other team members to do those two stretches during the warm-down. Post-game stretching can continue the day after the game with active stretching in a shallow pool. This is especially common with all the football codes in Australia and teams in the national basketball League.

Perhaps the best selling point for an athlete is to understand that flexibility is an integral part of movement and we stretch every time we move. Refocussing the athlete's view of stretching as a means to improve performance is far more marketable than trying to sell the negative message associating stretching with injury prevention.

Conclusion

My message is simple. From a training and coaching perspective we need to reposition flexibility with movement and sports performance where it belongs. This will require a conceptual shift for many coaches and sport medicine specialists who have been conditioned to think of flexibility, and stretching in particular, as a process to prevent injury. The question we need to explore and emphasise is: "*How can we train athletes to perform efficiently?"* Rather than focus primarily on: "*How can we prevent athletes from getting injured?"* The two statements are not mutually exclusive and to some of you this rephrasing may seem like *splitting*

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hairs. But the rationale underpinning each statement is significantly different. To appreciate this we need to broaden our views on flexibility and ***Stretch the paradigm***.

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