Aspects of performance and prophylaxis related muscle function

Andreas Schlumberger[1], Patrizia Durjak[2]

[1] EDEN Reha, Rehabilitation Clinic, Donaustauf, Germany [2] P.u.L.Z., Freiburg, Germany

INTRODUCTION

Manipulation of muscle function in terms of improving sports specific performance and reducing injury rate has traditionally been an important part of the athletic trainers work. In this context, the concept of muscular dysbalances is frequently used as a tool to assess the actual state of muscle function.

Muscular dysbalances are assumed to occur when a particular agonist is relatively stronger than its antagonist (i.e. when the agonistic-antagonistic-strength-ratio is increased) or when one or the other is abnormally shortened or stretched. The basic notion behind this description is that changes in length and tension alter muscle pull which, in turn, may induce overload in terms of repetitive microstress to several passive structures (like cartilage, ligaments, tendonds, etc.). Therefore, limitations in performance may occur and risk of injury may increase.

With respect to labeling a distinct state of muscle function as positive, normal („balanced"), negative or abormal („dysbalanced") the basic problem is that until now we have no clear definitions which situation represents a balanced situation (4, 8). Therefore, the assessment of a distinct state of muscle function as „dysbalanced" is not well founded.

Fig.1: Quantification of knee flexor-extensor-ratio with an isokinetic system

MUSCLE FUNCTION IN TERMS OF STRENGTH

Specific loading of prime movers in sports usually results in specific strength profiles. I.e. Osternig et al. (1986) observed higher hamstring-quadriceps-ratios (see fig.1) in sprinters compared to distance runners indicating a relatively higher use of hamstrings in sprinting. Whereas dominant activity of one extremity (like a preferred kicking leg) in the lower extremity does not seem to induce generally side-differences in strength of agonistic muscles (11), dominant activity in the upper extremity (like a throwing arm) seems to lead to significant strength differences between sides (14). Consequently, each sports discipline may create a more or less pronounced state of muscle function representing an adequate solution or balance with respect to the optimization of performance.

The most decisive question is now if specific strength ratios or side-differences deviating from the respective values of non-active subjects predispose an athlete to injury. Female athletes exhibit lower flexor-extensor ratios in the knee joint compared to male athletes (1). At the same time, risk for serious knee injury seems to be many times higher in female athletes (5). The question is now, if the female ratio is "normal" because it is common in females or it is "not normal" due to lower values compared to males in combination with a higher risk of injury. Interestingly, a prevention program in female basketball players [stretching, plyometrics (including training of landing technique) and strengthening] reduced the incidence of knee injury (7). At the same time, flexor-extensor ratios increased to values comparable to the ratios of men. However, mechanics of landing changed dramatically (reduction of peak landing forces i.e. by a decrease in knee adduction and abduction moment) suggesting a complex nature of changes in muscle function related to the decrease of injury rate.

MUSCLE FUNCTION IN TERMS OF MUSCLE ACTIVITY PATTERNS (EMG)

Optimizing athletic performance and decreasing risk of injury may depend on the degree of stabilizers function of joints and/or the extremity axis. The function of the stabilizers like the M. multifidus or M. transversus abdominis muscles are usually assessed by measuring their electro-myographic activity in several static or dynamic postural tasks since unidirectional strength measurement techniques seem not to allow adequate assessment of stabilizer function (3, 13). Consequently, ratios of trunk flexors and trunk extensors are also not able to reveal quality o segmental stabilization.

It has been shown that individuals free of low back pain show a pre-activation of M. transversus abdominis (actually considered an importan segmental stabilizer of the lumbar spine) in weightlifting tasks of the upper extremity compared to primary mobilizers (like the M.deltoideus) whereas low back patients fail to demonstrate this activity pattern (13). Therefore specific movement analysis based on EMG-measurements may help in detecting deviations of normal muscle activity patterns and should be considered. Such knowledge of an unbalanced muscle activity may assist in detecting mechanisms of injury genesis in the future.

MUSCLE FUNCTION IN TERMS OF FLEXIBILITY/STIFFNESS

An important aspect of athletic performance seems to be flexibility (maximal range of motion (ROM)). High flexibility as well as low flexibility values seem to be a typical adaptation to sports-specific training. I.e. in gymnastics high flexibility is a necessary prerequisite for success and can frequently be observed. On the other hand, a lot of soccer players show low flexibility (i.e. short hamstrings limit knee and hip joint ROM). Interestingly, both conditions, high as well as low flexibility values are supposed to increase the risk of overload or injury. A high flexibility-condition may be associated with lax passive stabilizers altering physiological alignment (i.e. disturbance of segmental orientation in lumbar spine). A low flexibility condition is supposed to limit normal joint kinematics and thereby predisposing an athlete to joint instability and/or injury. Despite this frequent assumptions, scientific evidence substantiating a higher risk for injury in abnormal flexibility conditions is scarce (9). In this sense, the question if a flexibility training reduces the risk of injuries remains also debatable (6).

Another important aspect of flexibility considerations concerns the passive mechanical properties of muscles, i.e. expressed as stiffness (see fig.2). Despite the fact, that a stiff muscle obviously hinders normal joint alignment (i.e. a stiff tractus iliotibialis limits physiological movement of the patella in knee movements [12]), the meaningfulness of stiffness values with respect to risk of injury is controversial (Magnusson 1998). Furthermore, a distinct expression of stiffness seems to be a necessity for success in some sports. I.e. high stiffness values of the lower extremity seem to correlate with a good running economy in endurance runners (2).

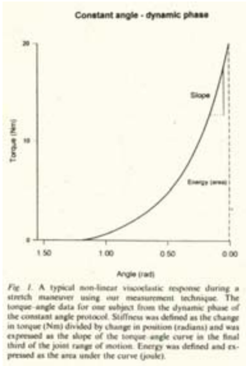

Fig.2: Quantification of muscle stiffness (in 9)

CONCLUSION

The main purpose of the concept of muscular dysbalances is to assess if a distinct muscle function expression is disadvantageous in terms o limiting performance or increasing risk of injury. Since i.e. injury genesis seems to be multifactorial with respect to muscle function (5), a simpl relation of one factor like altered strength (i.e. an uncommon strength ratio) and injury occurrence can hardly be described. Therefore, it i difficult to assess if strength is in balance or not. In addition, because optimization of muscular performance in high-performance athletes is dynamic process over years a balanced situation of muscle function representing a "right solution" is difficult to describe. It may be mor appropriate to use a complex approach by describing if the several muscle function aspects represent adaptation, deadaptation or compensatior indicating if sensorimotor and/or tendomuscular function limit joint/joint chain/ whole body mechanics or not.

REFERENCES