POWER AND EXPLOSIVENESS: FIRST STEP(S)

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Power (along with Impulse) is arguably the most import characteristic for an athlete to develop. Power (particularly peak power) has strong relationships with sports performance such as lifting, throwing, sprinting, jumping and agility. Development of power is best accomplished by a progressive sequence that is characterized by successive phases that increased work capacity, muscle cross-section area, maximum strength and task specific power. Furthermore, evidence indicates that for power development, weaker athletes benefit as much or more from the development of strength through basic strength training than from power training.

KEYWORDS: strength, force & velocity, force development.

Three concepts will be discussed in this presentation: strength, explosive strength, and power.

Strength

Strength can be defined as an ability to generate force (Stone, 1993). Force is a vector and is created by the contraction of specific muscles. What we term technique is actually the application of force (direction and magnitudes) in specific tasks and is the product of motor control and strength. It is important to understand that strength generation has associated characteristics: Force application also has duration, a rate of development and produces a work rate. Thus strength is associated with impulse (FxT), explosiveness as rate of force development (RFD) and power (FxV).

Basic strength controlling mechanisms include:

Motor control/ neural related

1. Motor unit (MU) recruitment
2. MU activation frequency (rate coding)
3. Synchronization (ballistic movements)
4. MU activation pattern (intra-muscular activation)
5. Muscle action pattern (inter-muscular activation)
6. Neural inhibition
7. Use of elastic energy and reflexes as stretch-shortening cycle

Contractile/structural properties – muscle force production

1. Contractile elements
2. Elastic elements – titin, connective tissue, etc. (additional energy imparted to the cross-bridges by eccentric forces)
3. Tissue stiffness - stiffness of muscle-tendon complex (active and passive: affected by neural and structural aspects) – not lack of flexibility
4. MU type (muscle fiber type)
5. Muscle cross-sectional area

Biomechanical \ anthropometric factors

1. Limb length – moment arm
2. Joint angle (length-tension)
3. Tendon insertion point
4. Angle of pennation

The degree to which alterations can be made in these mechanisms producing increased sport performance depends upon several factors including. These factors include: physiological age, emotional and intellectual maturity, trained state, integration of the training process (appropriate stimuli at the right time and good fatigue management), perhaps most importantly having a good coach/sport scientist that understands and accounts for these factors.

Explosive Strength

Explosive strength has been defined as the use of maximum or near maximum RFD (Schmidtbeicher 1992; Stone 1993). Measurement can include both isometric and dynamic actions. RFD is associated with acceleration; as a result of Newton's 2nd law (F = ma). RFD is an important characteristic defining critical time periods for sport. For example, foot contact time for elite sprinters is approximately 90 ms, the greater the vertical force that can be applied in this time frame the faster the sprint (Mann and Sprague 1983)

Power

Power is work rate or F x V. Peak power is the highest power output noted within a range of motion and average power is the mean power over that range or the duration of a movement. Peak power has been strongly related to a number of "strength-power" sports (Borudin et al. 2010; Cormie et al. 2010) and is therefore a very important and necessary characteristic to develop for sport success. Development of power appears to be optimized using a series of sequential steps. These steps have both a theoretical/mechanistic underpinning (Figure 1) and a practical/training underpinning (Figure 2).

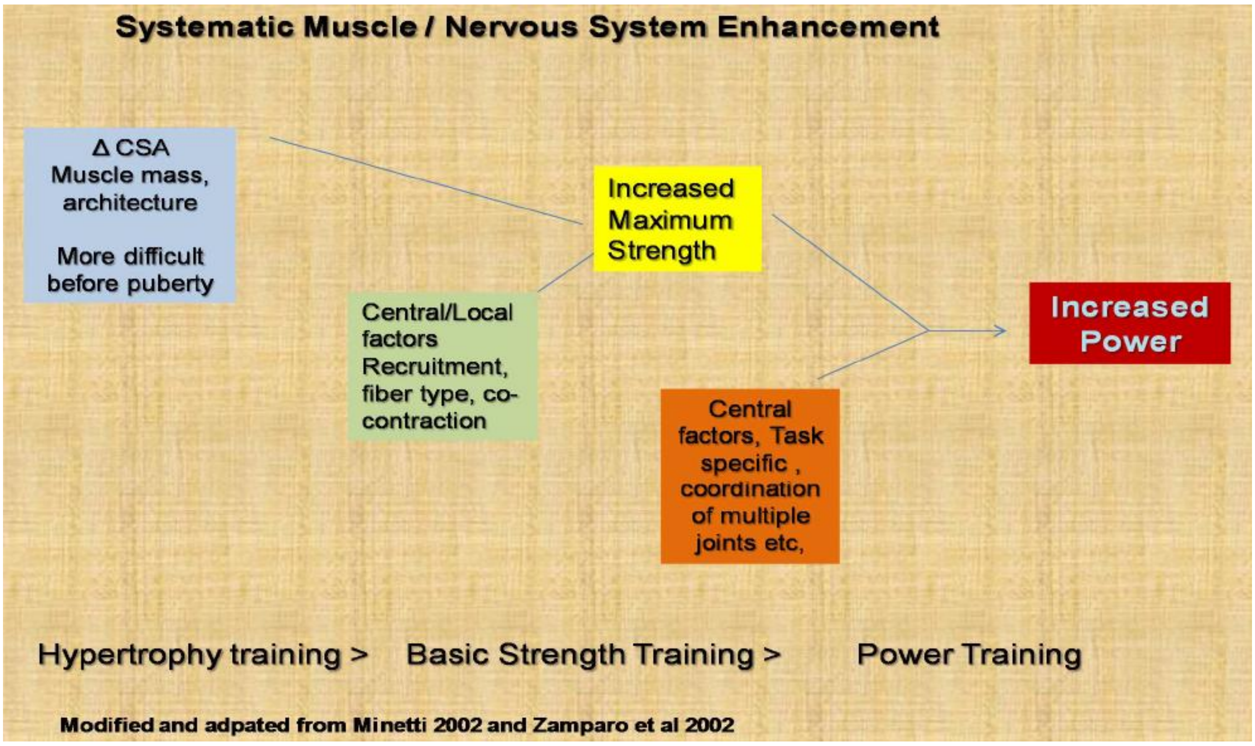

Figure 1: Theoretical Aspects of Power Development

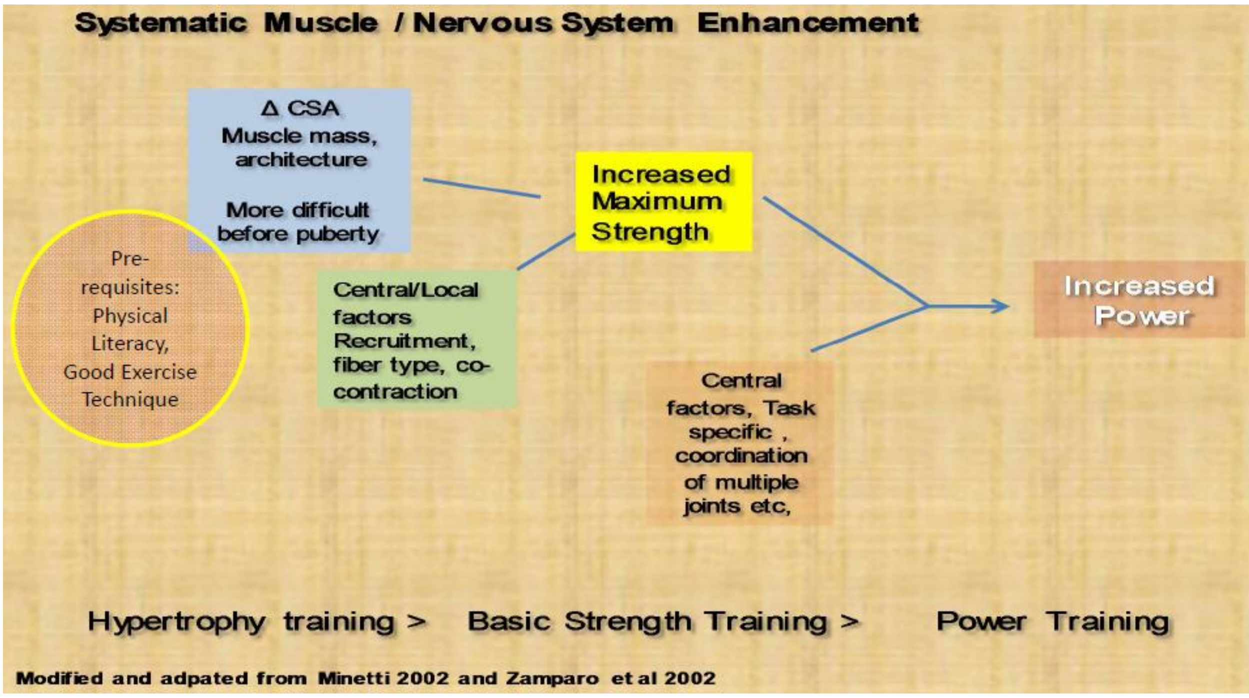

Figure 2: Practical Aspects of Power Development

It appears that the development of maximum strength is a key for the development of power. Maximum strength levels dictate both the range of loads over which power can be produced, and to an extent, the upper limit of peak power production (Cormie et al. 2010b; Stone et al. 2003a; Toji et al. 1995; Toji et al. 1997; Toji and Kaneko 2004). Stronger athletes have a more "favourable" neuromuscular profile to serve as a basis for creating increased power. Among novices a first step(s) in increasing power output would be to increase specific work capacity and maximum strength. Indeed among weak athletes, strength training is as beneficial (or greater) as power training for power development (Cormie et al. 2010a; Cormie et al. 2010b; Cormie et al. 2007, Harris et al. 2000; Stone et al. 2013). Although, maximum strength gains can increase power output, further increases in power and sport performance require a well-planned approach for targeting high power outputs in specific activities.

CONCLUSION: Power development appears to be best accomplished by a progressive sequence characterized by successive phases of training that, increase work capacity, muscle cross-section area, maximum strength and task specific power. Additionally, evidence indicates that for power development, weaker athletes benefit as much or more from basic strength training than from power training.

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