A Re-evaluation of Isometric Strength Training

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In the last ten years it has been common practice by many physical education teachers and athletic coaches to promote regimens of isometric exercise on the premise that such exercise will increase the strength of the muscle and delay the onset of fatigue. It is thought that this type of training increases the "level of performance" in the individual concerned.

In the main, most of the research pertaining to isometric training concerns changes in strength. Evidence is scarce in relating gains in strength with fatigue, speed of muscle movement, reaction time, co-ordination, etc. However, many broad and sweeping claims have been made on the effectiveness of a single short isometric contraction. Much of the theory of this work has been adapted to training procedures without adequate evidence. Thousands of physical education students, professional and amateur athletes have undergone and are undergoing, isometric training based upon contradictory and questionable research.

There is much evidence to indicate that regimens of isometric exercise will lead to gains in strength (Hettinger & Muller 1953; Hettinger 1955 and 1958). As early as 1925 (Petow & Siebert) there was evidence that an increase in the intensity of work above that previously demanded of a muscle is the stimulus for an increase in muscular strength. The amount and duration of such exercise necessary to increase strength is still unknown today.

The factors involved in determining the capacity of a muscle to continue work at a given level are complex and not well understood. It is theorized that the increase in strength is triggered by the amount of oxygen deficit in the muscle during contraction. Researchers contend that the oxygen deficit resulting from a partial occlusion of circulation in the contracting of muscles is responsible for causing an imbalance of the bio-chemical depletion-replenishment mechanism. It is thought also that the amount and duration of stretch resulting from the contraction itself of the elastic muscle elements provides the stimulus for strength increase. In support of this theory (Hettinger & Muller 1953), it was found that a work load less than 1/3 of maximal force had no training effect. Further, it was shown that the training load had to be above this level in order to bring about an oxygen deficit in the muscle fibre and thereby cause a training effect. A maximum rate of strength increase was

achieved by using as little as 40-50 per cent of the maximum isometric strength as a training load. Increasing the load did not give a faster training result. When 20-30 per cent of maximal strength was used no observable increase in strength was found. It was concluded that 40-50 per cent of an isometric contraction was sufficient to produce the maximum training effect possible. Provided it is held long enough and repeated often enough, a 5 per cent increase in strength results.

However, others (Royce 1958) believe that this critical level is too low. It has been shown that the region where the muscle pressure and the blood pressure are inferred to balance each other is at approximately 60 per cent maximal force. It is concluded therefore, that loadings greater than 60 per cent of maximal strength would be necessary to evoke a deficit in the replenishment mechanism, thereby producing a maximum training effect.

Recently it was found (Start & Graham 1964) that when intramuscular tension becomes sufficient to cause intramuscular vascular occlusion, isometric endurance is related to strength. When tension produces only partial occlusion, the relationship of endurance to strength becomes less, until with very light loading the factors causing fatigue bear little relationship to strength. It is therefore necessary to determine each individual's pre-training strength plus subsequent increases in strength as training progresses. This is vital in order to keep the contractions above the 60 per cent level which will change in proportion to gains made in maximal strength. Because there is evidence (Muller & Rohmert 1963) to indicate that individuals already close to their theoretical maximal strength level gain little from isometric exercise, measurement of pre-training strength is essential.

During a maximal isometric contraction the blood flow to the muscle is occluded temporarily. The flow of blood remains occluded until the maximal force is reduced to approximately 60 per cent; beyond this point circulation is re-established, resulting in an increased amount of oxygen to the muscle fibre. It is theorized that the increase in strength is due to the amount of oxygen deficit in the muscle during contraction. There is no evidence (Kroll 1968) to indicate that stronger muscles fatigue faster than weaker muscles. The same factors responsible for muscular fatigue are not operating at different levels of isometric strength.

One of the consequences of a maximum strength increase may be that more muscle fibres are brought into play since the muscles contract more forcefully. This may result not only in more biochemical fatigue products, but may interfere with the nature of the skilled movement. There is little known with regard to the effect that isometric training may have on various kinds of movements, such as controlled, rapid controlled, and ballistic. A target-directed skill like pitching a baseball involves one kinesiological pattern when performed slowly, and an entirely different pattern when performed rapidly. It is a possibility that the increased speed of muscle movement brought about as a result of isometric training could interfere with the individual's present skill pattern.

One problem to which every coach should give considerable thought is the effect that isometric training may have on the developing structures of the body. Most of the major epiphyses in the long bones of boys do not close until seventeen to nineteen years of age, and other structures such as muscles, ligaments and tendons, are still in a state of rapid growth prior to and during these years. There is evidence (Robson 1970) to show that

weight training in young people can result in injuries to the vertebral column (such as prolapsed discs) and to the pectoral muscles and knee musculature (such as ligament and tendon strains). Therefore, it is recommended that such training be avoided during the elementary and junior high school years. Needless to say extreme caution should be used when prescribing training regimens for the adolescent athlete; excessive and irresponsible training programmes could interfere with normal growth patterns.

Do individuals (already at or close to their maximum strength level) really increase in static strength? Is better athletic performance really related to such an increase? These are questions that are still unanswered.

A re-evaluation of the influence of isometric training on strength and fatigability in the skeletal muscle is vital in order to formulate a valid basis for the establishment of rational training programmes on the athletic field and in the physical education class. Such information will also be valuable in furthering understanding and eliminating the ignorance and apathy that has gained a foothold in training programmes.

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