Hyperplasia vs. Hypertrophy

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Ever since the pioneering work of Morpurgo in 1897, utilizing treadmill exercised dogs demonstrated that muscle fibers respond to exercise by hyper trophying without hyperplasia (an increase in muscle fiber number). Hypertrophy of muscle fibers has been the focus of many exercise programs and of a great deal of scientific research. However, treadmill-type exercise is usually considered to be an endurance-type exercise, quite different from strength or power-type training.

Within the last 20 years, numerous studies have demonstrated that the work induced growth process in skeletal muscle fibers is limited to an increase in cross-sectional area of the muscle fibers (hypertrophy) and not due to an increase in the number of muscle fibers (hyperplasia). In these studies the overload to the muscle examined was provided by surgically removing the muscle's synergists. If the growth process of a muscle is examined a prolonged period of time after the removal of the muscle's synergists, hyperplasia has been shown to have occurred. Recent animal studies have also demonstrated hyperplasia due to weight-lifting exercise without surgical removal of the muscle's synergists. Therefore, in laboratory animals it seems apparent that an increase in the size of a muscle is due not only to hypertrophy of existing muscle fibers but also due to an increase in the total number of muscle fibers due to hyperplasia.

What then is the stimulus for muscle hyperplasia? It has been demonstrated that for cats to lift increasingly heavier weights the amount of tension developed and the rate of tension development must both increase (i.e., the cat must not only be stronger but also more powerful). One manner in which a muscle can become stronger is for the entire muscle to hypertrophy, via all of the individual muscle fibers hypertrophying. However, it has been demonstrated in cats that it is possible for the contraction time of a muscle to increase due to high resistance training. An increase in contraction time leads to a less powerful muscle. This increase in contraction time could be due to a shift of the muscle fibers towards slow twitch fiber type characteristics. However, analysis of cat muscle trained with high resistance shows no such shift towards slow twitch fiber type characteristics. Thus, it appears that the increase in contraction time may be due to individual muscle fiber hypertrophy in a manner which is, for now, unclear. This line of evidence suggests that hypertrophy of the entire muscle due to hypertrophy of only the existing muscle fibers may increase strength, but that the possible accompanying increase in contraction time may lead to a less powerful muscle.

Another mechanism by which hypertrophy of the entire muscle can be accomplished is by increasing the total number of muscle fibers via hyperplasia. In cats, it has been demonstrated that high resistance exercise can increase the number of fibers by 20.5 percent when compared to a control group or to a low-resistance trained group and also cause hypertrophy of existing muscle fibers. In this same study, there also was a decrease in the time required by the high-resistance trained cats to perform each repetition of the weight lifting exercise. This indicates that hypertrophy of the entire muscle accomplished by some hypertrophy and also hypertrophy of existing muscle fibers may lead to a decrease in contraction time of the muscle. Therefore, not only will the muscle be stronger, but it will also be more powerful.

To the authors' knowledge, no concrete evidence of muscle hyperplasia in humans has been reported in the scientific literature. However, it has been reported that elite female swimmers have significantly smaller muscle fibers in their deltoid muscle than those of age-matched controls. This finding of smaller muscle fibers in the relatively larger deltoid muscle of the swimmers as compared to the controls indicates a need for development of new muscle fibers due to the swimmers training process. Following the same line of reasoning applied to the aforementioned cats, it is possible that the need for strength as well as power in the upper extremity of swimmers may have resulted in hyperplasia in the deltoid muscle of these swimmers. This same line of evidence also indicates that if the aims of a weight training program are to increase the strength of the athlete and also the power of the athlete, power type exercises must be incorporated in the training process.

In conclusion, scientific research indicates that hyperplasia takes place in high resistance trained laboratory animals and that hyperplasia may take place in humans. Also, for optimal increases in strength and power of a muscle, the gross hypertrophy of the entire muscle should be accomplished via hypertrophy of existing muscle fibers as well as increasing the total number of muscle fibers via a hyperplasia mechanism. For this hyperplasia to take place, power type exercises may need to be incorporated into the weight training program.

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References