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Review Literature

STRENGTH TRAINING RESTORES MORPHOLOGICAL CHANGES OCCUR DURING AGING

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ABSTRACT:

Human skeletal muscle mass constitutes the major body proportion and essential for their functional independence. Aging is the strange phenomenon which is the main rationale for decreasing the skeletal muscle mass by causing a variety of morphological changes in the form of declining of myofiber cross sectional area and satellite cells content during the years. Satellite cells are known as the stem cells of skeletal muscles which play a very important role in skeletal muscle growth. They give rise new myonuclei in response of any stimulus, which provides genetic material for the purpose of protein synthesis. Though in aging process, number of myonuclei is not decreased but still they need any threshold or stimulus that is required for their functionality. Currently, strength training is considered as one of the best available valid and reliable methods for countering aging process. Strength training provides the certain threshold which is necessary for satellite cell activation and proliferation and for the restoration of functional capability of myonuclei. Strength training has the ability to restore morphological changes occur during the aging process. It is equally effective in elderly is as well as in young adults. In this review, we will elaborate how strength training is effective for restoration of the morphological changes occur during aging process.

Keywords: Aging, muscle mass, satellite cells, strength training

INTRODUCTION:

There are many challenges of aging process in human life; decline in muscle mass, muscle strength, functional capacity and independence are few of them[1]. American government consuming lot of money on dealing health care issues related to the elderly people and sarcopenia is the prime issue in elderly population, which can affect badly their daily life activities[2]. First spoke about Sarcopenia by Rosenberg, in 1988 in a meeting in Albuquerque; New Mexico[3]. "Sarcopenia is the generalized, involuntary progressive loss of muscle mass and muscle function as a result of aging process". Muscle mass is very essential for maintaining muscle action and ultimately functional independence, carrying daily life activities and healthy life[4, 5]. Collectively, the skeletal muscle mass comprised of fiber cross sectional area, length of myofiber and number of myofiber found in that particular muscle [6]. Modulation is very significant feature of skeletal muscles by which they can change themselves in case of any stimulus i.e. strength training[7, 8]. By virtue of modulation, skeletal muscles can enhance their muscle mass by increasing both the cross sectional area[9, 10] and length of individual myofibers, while decline in muscle mass mainly occurs in case of disuse/decline in physical activity by decreasing the individual cross sectional area [11] and length of myofiber. Researcher[12] studied aging effect on 43 healthy subjects of 15-87 year of age and found that muscle atrophy begins at the age of 25 and this process of atrophy is boasted with

increasing age. The decline in muscle mass may be due to one or more factors. Damage to myofibers or neural de-nervations with increasing age are silent factors for atrophic changes in skeletal muscles [6].

Satellite cells are mono-nucleated cells first described in frog skeletal muscles by Mauro in 1961[13, 14, 15]. They are known as satellite cells due to their location as they are found between basal lamina and plasma membrane[13, 14]. They play vital role in skeletal muscles repair, regeneration and growth[15, 16]. In case of pathological/ physiological demand as trauma/ injury or overload stimulus, they repair/ grow the skeletal muscles by proliferation[17, 18] and give rise to new myonuclei, which help in protein synthesis[9]. Theoretically, myonuclear domain is that area which controlled and ruled by single myonuclei[19]. The myonuclear domain remains same in case of increase in myofiber cross sectional area as new myonuclei addition are pre-requisite for skeletal muscle growth and hypertrophy[9,14]. There are numerous morphological changes takes place in skeletal muscles as a result of aging process like decline in the number of myofiber[20] especially type II[21], muscle mass[22] cross sectional area[11, 23], frequency of satellite cell[24, 44] and myonuclear domain[25] are some of them. Moreover, there is increase in fat content and connective tissue as a result of aging[26, 27].

There are lot of instruments that can be used for restoration of changes occur during the aging process. Hormonal therapy, diet therapy and exercise are few of them. Endurance or strength training can be used but resistance exercise is thought a handy way to deal with these changes by decreasing fat content/ connective tissue, increase muscle mass, frequency of satellite cell, number of myofibers and myonuclear domain. In this review, we will elaborate how strength training can restore these changes and what kind of morphological changes occurred during the aging process.

MATERIALS & METHODS:

Resistance/ Strength training:

Resistance training has very dramatic effect on increasing muscle mass, strength and power in elderly population which results in improvement in physical functioning, mobility and independence. Resistance training can be introduced in elderly in different regimen like progressive resistance exercise (PRE), high resistance training (HRT), low intensity resistance training, short and long duration resistance training are few of them. There are lot of studies [1, 9, 11, 28, 29, 30], which reflect the practicability and usefulness of resistance training in older adults. Nelson et al. (1994) [28], studied effect of high intensity resistance training (HRT) in 40 post-menopausal women of 50-70 year of ages. They had participated in the long term (one year) duration of high intensity resistance training and found significant improvement in muscle mass, strength and power after the completion of training in postmenopausal women. Fiatarone et al. (1994) [1], studied the effect of high intensity resistance training (HIPRT) in elderly people for 10 weeks. The subjects were residents of old care home and voluntarily participated in the study. All were more than 70 year of age and can walk minimum 6 meter. After training period there was remarkable increase in muscle strength (113±8%) and muscle mass (2.17±1.8%). More interestingly, they found these changes were independent of age and gender. Many other studies [9, 11, 29] had found similar results in the form of improvement in muscular strength and decrease in fat content [31] after introducing of strength training.

RESULTS:

Strength training and fiber type distribution:

Strength training have remarkable improved the distribution of fast fibers [32] while others studies [33, 34, 35, 36] had showed positive but not statistically significant response in fiber type distribution modification. Whether more or less, all researcher had demonstrated positive trend in increment in numbers of fast type of myo-fibers and similar decrement in type I fiber.

Strength training and myo-fiber area:

There are different studies[9, 11, 18, 26, 35, 36, 38, 39] which had demonstrated the effectiveness and validity of strength training in elderly people. Marked and significant improvement in muscle size was observed after introducing strength training in elderly. Yong adults respond more to strength training as compared to elderly. Though there was not statistically significant difference in response between the young and elderly adults[4]

Strength training and satellite cell frequency:

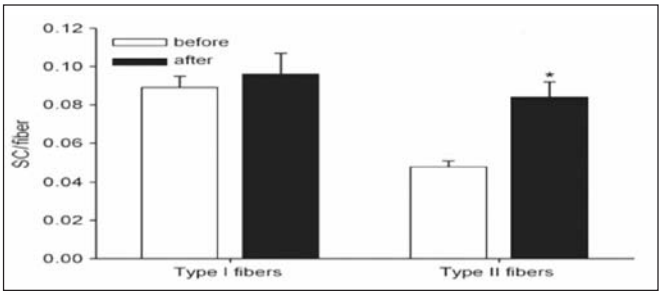
Different studies [9, 10, 11, 14, 41, 42, 43] had demonstrated that, strength training have remarkable ability to increase satellite cell in elderly. 10 weeks of strength training in nine female showed remarkable responses in term of satellite cell contents satellite cell contents increase from 3.7 to 5.4 % [9]. In other study [14] they had demonstrated significant increment after 30 and 90 days of strength training. There were 19% and 31% addition of satellite cell contents after 30 and 90 days of strength training.

In other study by Verdijk et al. (2009)[45] had shown that type II fiber shows more positive response to strength training as compared with Type I fibers.

Strength training and number of myonuclei and myonuclear domain:

Researchers [10, 11, 18] demonstrated that significant response in number of myonuclei after 16 weeks of strength training. There was no difference in response of strength training in elderly and young people[11]. Number of myonuclei increase from 2.08 to 2.27 in young ones while 2.23 to 2.38 in elderly people. Similar results were found by Kadi & Thornell (2000) [9], after ten week of strength training, the number of myonuclei increased from 2.1 to 3.6. There is no declension in number of myonuclei [44, 46] with increasing age, but fiber size decreased with aging process [11, 12, 23], so the myonuclear domain decreased with aging. Recently, number of

FIGURE 1.
Satellite cells/ fiber in type I and type II fibers before and after strength training. * p<0.05 [45].



studies[9, 11, 26, 35, 36, 37, 38, 48] demonstrated that, strength training increase in myofiber cross sectional area significantly.

DISSCUSSION:

This study focused on evaluating the effect of resistance training on myo-fiber distribution, cross sectional area, satellite and myonuclear content and myonuclear domain in elderly adult's skeletal muscles. The prime important finding was strength training is capable to restores the morphological changes occur with increasing age in human skeletal muscles.

Strength training and fiber type distribution:

Numerous changes take place in fiber type distribution with aging. Slow (oxidative types of fibers; Type I) and fast (glycoltic type of fibers; Type II) composition and distribution varies in elderly as compared with younger adults. Strength training showed varied response in elders but strength training has always positive effect on fast type of fibers. Canepari et al. (2010) [21], demonstrated that, there are reduced number of fast type of fibers in elderly people, while parallel increment in number of slow type of myofibers. Strength training is capable to reverse the changes occur because of aging process. Some researcher [32] had demonstrated that, the ten (10) weeks of strength/ resistance training in thirty women showed significant improvement in number of fast type of fiber, while there was no significant improvement in fast fiber distribution with other (endurance, coordination) training programme. Campos et al. (2002) , studied effect of progressive strength training on thirty two (32) men for eight (8) weeks and positive response in term of increment of type II fibers (28.5-32.2%) , but this increment was not statistically significant. Though, IIAB increment was significant (5.8-12%). Similarly in one study, researcher [34] had found similar result after ten (10) week of progressive resistance training in young and old subjects. Both age groups showed increment (not significant) in number of type II fiber. In young age group, there was increase in type II fibers (32-37) and in old age group, type II fibers increase from 35 to 44% but there was not statistically difference between the response of young and old men. In other study [35], they found similar results (increase type II fibers from 24.5-29.1) after sixteen weeks of strength training (twice per week). It is interested to note that all studies show positive increment in Type I fibers and in the same ratio decrement in type I fibers. The more interesting thing is to note that female respond more positively to strength training than men in term of fiber type alteration in distribution.

Strength training and myofiber area:

Strength training is considered as better tool to deal with age related morphological changes occur as a result of aging process. Kadi & Thornell (2000)[9], studied effective of strength training on nine female. They had found significant increment in fiber cross sectional area. In other study [35] after sixteen weeks of strength training in elderly, they had found remarkable change in fiber size area. In type I fiber area increase 45% from baseline and 34% in Type IIA and 52% increment in Type IIB. Similar results were found by in other studies [26, 36, 39] that strength training shoed positive changes in myo-fiber size. . Other scientist [11, 37], had studied effect of strength training in young and elderly. Petrella et al, (2006) [37], take 26 old adults and 26 young adults. After sixteen week of strength training, they had found 17 % increment in fiber cross sectional area (CSA) in elderly and 27% increment in fiber cross sectional area in young adults. Similarly, Hikida et al. (1998) [11], had showed same trend in increment in fiber cross sectional area. In elderly, there was 18% increment and 25% in young adults after sixteen week of resistance training.

Strength training and satellite cell frequency:

Satellite cells are stem cells of skeletal muscles and essential for skeletal muscle growth. Satellite cell content even increased after single bout of exercise. Crameri et al. (2004) [42], had taken eight sedentary subject and performed one leg resistance; eccentric exercise, while other leg was taken as control. They had found increment in satellite cell content after single bout of exercise but marked changes were seen after 4 and 8 days of strength training. Similar result was demonstrated in another study [43], they had demonstrated 36% increment after two days and 80% increment after three days of strength training. Olsen et al. (2006) [10], had demonstrated that combination of strength training and protein diet is more effective than strength training alone. Mostly studies [47] had showed that there was no statistically significant difference in fiber specific satellite cell frequency but other study [41] had showed that Type II fiber are more prone to changes in response of aging. So, it seems that fast type of fibers are more responsive to strength training and shows greater changes in distribution, size, satellite cell content, myonuclei contents and myonuclear domain.

Strength training and number of myonuclei and myonuclear domain:

There is lot of studies [44, 46] that explained that myonuclear content is not reduced during aging process. As the number of myonuclei is not lost or reduced in number in elderly, but why they are unable to synthesis new protein? It may be their functional ability reduced due to aging process or might be threshold is required which is essential for the functioning of them. The physical activity level reduced in elderly people, so it might be it is one of the reasons for their functional failure or incompetence. Strength training provides stimulus for myonuclei functional activity restoration and enhancement in their number as well. By improving the fiber size, the myonuclear domain will restored, so strength training is an effective way in restoring the myonuclear domain.

CONCLUSION:

In short, strength training is the best available intervention which is capable to restore the morphological changes occurs during aging process. Strength training in elderly restores myofiber type composition, myofiber cross sectional area, satellite cell frequency, myonuclear content and domain.

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