

Opinion Article

Sarcopenia and falls in patients with adult scoliosis

Petros Aftzoglou

Physiotherapist, Athens, Greece

All published work is licensed under Creative Common License CC BY-NC-SA 4.0 (Attribution-NonCommercial-ShareAlike)

Abstract

The present article is an opinion paper referring to adult scoliosis, sarcopenia and their relation. There is a presentation of adult scoliosis and sarcopenia as a whole including their classifications, aetiopathogenesis, clinical picture and evaluation, therapy options and complications, risk factors and consequences. The most important part is how sarcopenia and adult scoliosis can coexist and how this relation can lead to secondary problems for the patient as falls. Treatment options, for the elimination of all the above pathological conditions, are introduced in order to improve patient's life and his ADL.

Keywords: Adult scoliosis, Sarcopenia, Falls, Complications, Treatment

Introduction

There are two types of scoliosis: structural and non structural. The second one includes hysterical, inflammatory, postural, compensatory and sciatic scoliosis.

On the other hand structural scoliosis can be divided in idiopathic, congenital, de novo, neuromuscular, iatrogenic and traumatic types among others¹.

Adult scoliosis is a spinal deformity with an angle of Cobb higher than 10° in the coronal plain². This refers in a skeletally mature patient. There are two main categories of adult scoliosis: progression of childhood scoliosis or degenerative scoliosis³. Fast degeneration in disc and facet of the spine in middle age is the characteristic of De Novo scoliosis which results in generalized spondylosis².

Classification of adult scoliosis

Adult scoliosis is classified in:

- **Type I:** de novo scoliosis: Characteristics of this type of scoliosis are the protrusion of lower lumbar curves, changes due to advanced degeneration and minimal vertebral structural deformities as a result of facet joints and disc asymmetric degeneration and fractures due to the disease of osteoporosis.
- **Type II:** refers in the progressive idiopathic deformity which gives signs before maturation of the skeleton and the symptoms are obvious in adult life. Cervical and thoracic spine is involved in this type of scoliosis and the onset is in childhood or adolescence with progression in adulthood.
- **Type III** secondary degenerative scoliosis is caused as a result of idiopathic or different forms of scoliosis or due

to pelvic obliquity because of differences in leg length, a lumbo-sacral transitional anomaly or hip pathology. On the other hand secondary degenerative scoliosis can be caused due to metabolic diseases of the bones like osteoporosis².

Clinical presentation

The manifestation of adult scoliosis can vary from asymptomatic to great pain and disability. Most of the patients have no symptoms in the beginning but at the time the symptoms appear patients suffer from moderate pain on the back with no symptoms of radiculopathy to increased back pain with symptoms of neurogenic claudication, radiculopathy and gait inability. A complete history and physical exam are important for patient assessment³.

Clinical evaluation

Patient's medical history is a major part of clinical evaluation. In details, patients will be asked about their symptoms, treatment sessions and family anamnesis regarding of scoliosis. If operative intervention is necessary

The author has no conflict of interest.

Corresponding author: Petros Aftzoglou, Miaouli 16, Lykovrissi Attica, 14123, Athens, Greece

E-mail: petroslyk@yahoo.gr

Edited by: Yannis Dionyssiotis

Accepted 27 October 2017

to be done it is important to consider for coexisting medical comorbidities. Patients should be asked and examined for changes in body habitus, in gait pattern and presence of axial or radicular pain. Also standing evaluation should be done to evaluate trunk shift or presence of shoulder or pelvis asymmetry as well as the overall coronal and sagittal balance. Sagittal imbalance can cause extension of the hips and knees and retroversion of the pelvis to compensate the lumbar lordosis' loss. Observation patient's stance and mobility during flexion and side bending is also crucial. Any leg length discrepancy or pelvic obliquity should be noted along with any knee or hip contractures evaluated through palpation of sacroiliac and trochanters.

Osteoporosis is also considered significantly in patients being prepared for surgery. Bisphosphonates contribute in increasing of bone density but require a lapse period. Prediction of osteoporosis preoperatively can be done through DXA scan which shows low spinal or femoral neck T-Score. According to the results it would be necessary for these patients the application of instrumentation to achieve better surgical results because of deformity or instability³.

A complete neurological examination should be also taken place for evaluation of reflexes, balance and motor testing referring all muscle groups and sensory testing of the back, chest and lower extremities. Also gait examination, heel walking, toe walking, heel to toe walking on a straight line and hopping on one foot is used for assessment of strength and balance. Sensory abnormalities to light touch along the spine and the back give a sign of a spinal syrinx causing the scoliosis. Reflexes should be also included in our evaluation such as deep tendon reflexes of upper and lower extremities and the Babinski Test. Finally, abdominal reflexes could be examined and abnormal examination may show an intraspinal disease such as syringomyelia⁴.

Imaging evaluation

In posterior-anterior radiograph (if scoliosis is suspected) the curve of the vertebral column is examined as well as the vertebral bodies. True scoliosis is also a rotational deformity. If there is a scoliotic curve without any rotation patient should be examined for body tumors like osteoid osteoma, nerve root irritation or intraspinal pathology like syringomyelia and masses. If pain on the back is also existed, lumbosacral region should be examined by a lateral radiograph for spondylolysis, spondylolisthesis infection or bony destruction. For scoliotic patients with back pain, MRI test and also a bone scan should be included in further imaging evaluation⁴.

Surgical treatment

Pain irradiation to the legs and recurrent claudication are indications for surgery. This pain irradiation in degenerative scoliosis is caused mainly by foraminal stenosis which includes disc space narrowing at the concave-side and compression of nerve roots as there is subluxation of the vertebral body laterally. Goal of this surgery is improvement

of claudication and radiating pain, relieve back pain and deformity correction. This goal can be achieved by using many surgical options such as fusion, decompression and or correction of deformity. By using long level fusion including deformity correction may minimize excessive blood loss and prolonged surgery time which can lead to more postoperative complications. It is important for the surgeon to understand the symptoms, indications, advantages, disadvantages and complications of a specific surgical option so he will be able to select the right surgery for widening of disc space and lateral subluxation correction⁵.

Postoperative complications

Excessive blood loss could be considered as an important complication during the surgery of spinal deformity in adults and it occurs in extended fusion level and longer operation time. Preoperative antifibrinolytic administration, autologous blood donation and blood salvage are important to be done for minimizing blood loss during surgery.

Adjacent segment disease is considered as late complication and it appears with proximal junctional kyphosis and spinal stenosis. The incidence of adjacent segment disease is high when there is a sagittal imbalance, facet joint injury or the patient is older.

Another complication, pseudarthrosis, can occur at L5-S1 when fused to the sacrum but it can also take place at the thoracolumbar junction. Risk factors of pseudarthrosis is older patient, thoracolumbar kyphosis is more than 20°, decreased lumbar lordosis and sagittal imbalance.

Finally, there could be instrumentation failure by loosening of screws and rejection at the superior part and the most distal part of fixation. In details screw loosening occurs when there is imbalance in sagittal plane especially in the long level fusion. It is possible to avoid and reduce screw loosening by cement augmentation on the proximal screws. The most common screw loosening is on L5 level referring to patients with imbalance in sagittal plane. In that case fusion must be extended to the sacrum⁵.

Sarcopenia

The definition of sarcopenia was given firstly by Irwin Rosenberg in 1989 as the age-related loss of muscle tissue which can cause a decline in functional capacity⁶. Special Interest Group of the European Sarcopenia Working Group in 2010 defined sarcopenia as the "progressive loss of muscle mass and strength with a risk of adverse outcomes such as disability, poor quality of life and death". This term distinguishes the loss of muscle mass from neurological damage or immobilization⁷.

Aetiopathogenesis

Risk factors for sarcopenia are age, gender and level of physical activity as well as obesity, osteoporosis, type 2 diabetes and insulin resistance. Sarcopenia is important to

be distinguished in two categories: primary and secondary sarcopenia. Primary sarcopenia is related to aging itself, on the other hand secondary sarcopenia exist when one or more causes are obvious. Etiology of sarcopenia in elderly people is multifactorial and is characterized as a geriatric syndrome with many facets. It has been shown that low intake of energy and protein is connected with reduce of muscle mass and function. Co morbidities can cause a reduction of physical activity and also a rise of proinflammatory cytokines generation that play an important role for proteolysis⁸.

Risk factors of sarcopenia

- Age and sex, low birth weight, are factors which can influence the sarcopenia predominance. Also many genetic factors can influence metabolism of the muscles along the lifespan.
- Through ageing there is muscle modification which is expressed by raising of catabolic stimuli and reducing of anabolic stimuli. Also hormonal dysregulations (especially, growth hormone, insulin-like growth factor 1 axis and testosterone) are associated with reduction of muscle mass as they have been described with ageing and changes in neural input.
- Factors of higher risk of sarcopenia include decreased food intake (especially proteins) with low physical activity during lifespan and use of alcohol and tobacco.
- Immobilization, bed rest for a long time as well as low weight has shown to contribute to decrease of muscle mass.
- Finally, many chronic diseases as diabetes, cognitive impairment, end-stage organ diseases and mood disturbances have been shown to relate with a loss of muscle mass and strength⁹.

Consequences of sarcopenia

Sarcopenia through frailty could be the reason of dangerous consequences such as: multiple and various trauma, falls, loss of function and disability, recurrent emergency department visits, cross-infections, hospital admissions, nursing home admission, decrease of independence, poor quality of life and eventually death⁹.

Sarcopenia and adult scoliosis

The loss of muscle mass related to the age can cause disruption of the balance between extensors and flexors muscles of the spine. This imbalance along with all the alterations take place in different parts of the spine, might have a consequence of degenerative scoliosis and might be the beginning of general spine disorganization¹⁰.

Lumbar kyphosis is an example of disorganization of the spine due to muscle loss. A specific myopathy of the paraspinal muscles which causes a forward bending of the trunk is believed to be connected with lumbar kyphosis. It was found muscle changes as type 2 muscle fiber atrophy in the innermost, multifidus and shortest of paraspinal muscles.

On the other hand musculoskeletal system is able

to restore stabilization of the spine and compensate for muscular degeneration. In previous study, it was observed that there was no a relationship between isometric strength of the muscles and their cross-sectional area. An atrophic phenomenon of the muscles of the trunk due to age, in patients with pain on the back and a control group with no symptoms were included in the study. The muscle strength testing results, were better in symptomatic patients with muscle degeneration than asymptomatic patients with an identical degree of muscle degeneration. The authors concluded that those muscles which present atrophy secondary to pain restrictions, use the remaining muscle mass more effectively than those muscles whose atrophy is due to sedentary lifestyle with no clinical symptoms.

In conclusion, paraspinal muscles' degeneration can lead to a disturbed balance between the two antagonists and subsequently the kyphotic result in the lumbar spine or scoliotic deformations¹⁰.

Kyphoscoliosis

The term of kyphoscoliosis is used to explain a condition in which there is an abnormal curve of the spine in both a coronal and sagittal plane. Kyphosis and scoliosis are combined. The causes of kyphoscoliosis can vary and may be present from birth due to congenital abnormalities. In some cases, keeping an abnormal and fault posture for a long period can lead to fault curvature of the spine. Also vertebral tuberculosis or general tuberculosis and osteochondrodysplasia can cause the disease of kyphoscoliosis. Kyphoscoliosis can also occur in patients above 50+ years suffering from osteoporosis or osteoarthritis. Sometimes a traumatic injury leads to the development of the disease. Finally, genetic factors are also suspected to cause kyphoscoliosis.

Signs of kyphoscoliosis are: a) abnormal shape of spine like S or C, b) difference in arms and leg lengths, c) associated disorders like hypertension and neurological disorders and d) abnormal gait.

On the other hand, a patient with severe kyphoscoliosis can develop fatal respiratory failure. The impairment in that case is associated with the degree of scoliosis and decrease of vital capacity due to the normal aging process. There is an increase airway resistance as a result respiratory restriction and obstruction. In previous studies, bronchial torsion has been also described¹¹.

A case report from a previous study also shows that the deficiency of vitamin D can also develop kyphoscoliosis. Vitamin D plays a crucial role in homeostasis of calcium as a result good skeletal health. Vitamin D enhances the absorption of calcium from the small intestine and the absorption of phosphorus from the distal small bowel. Both absorption of calcium and phosphorus are crucial for the mineralization of the bone. Vitamin D is also concerned in maturation of the osteoclasts. Decrease levels of vitamin D leads to rickets in children and in osteomalacia in adults. Patients with osteomalacia can experience chronic muscle pains.

The case report of this study refers to 30 year old obese female patient who has difficulties in walking and standing up from sitting position. She also suffers from pain in chest and the limbs and she has to crawl in the house to do her ADL. Through examination it was found tenderness in ribcage, pelvic girdle and thigh area and through muscle strength testing there is muscle weakness in the shoulder girdle 3/5 and in the pelvic girdle 2/5. She also suffers from mild dorsal kyphosis which forced her to walk in stooped position. X-ray examination of the spine shows us the image of anterior wedging of thoracic vertebrae and osteoporosis with anterior wedging is detected through CT scan of the spine. The diagnosis was deficiency of vitamin D which causes osteoporosis. Therapy with the proper dose of injectable and oral vitamin D was prescribed and after 6 weeks of therapy there was improvement in muscle strength to 4/5 in the shoulder and pelvic girdle. There was also reducing of pain and improvement in walking with support¹².

The sequences of kyphoscoliosis are: structure or alignment deviation and cardio respiratory, neurological and balance problems or back pain. Patients with spinal deformity as kyphoscoliosis can also develop cardio vascular problems indicated for surgery. These patients tend to suffer from decrease physical capacity and exercise tolerance which lead to difficulties in perform ADL. According to literature surgical intervention is necessary as physical capacity and exercise tolerance improve, so patient has better quality of life. The evaluation of the changes in exercise tolerance and physical capacity for patients who had a surgery for correction of kyphoscoliosis, is done through modified Borg scores and six minute walk test. After surgery patient with high levels of severity improve their condition but it has to be mentioned that there was no connection between the degree of correction and the change in parameters assessed. It is obvious that in kyphoscoliotic patients the decrease of physical capacity due to less number of exercises, low self-confidence, plays an important role and lead to deficiencies. Finally strengthening exercises in order to improve physical conditioning and respiratory exercises can help these patients to improve their general conditioning¹³.

It is worth to mention that if there is an increase spinal deformity as a result the spinal cord compression, extensive surgical level has to be done. Thus, transposition of the spinal cord is most efficient surgical method. According to a clinical case in previous study severe kyphoscoliotic abnormalities can be improved by surgical intervention uses the combined anterior posterior approach. The result will be improvement of spinal canal shape, decrease of compression of spinal cord and also reduce of the neurological deficits. Decompression of the spinal cord through vertebral instrumentation can lead to improvement of trunk balance, elimination of deformity progression and achievement of successful instrumentation¹⁴.

On the other hand treatment of degenerative scoliosis and of adult scoliosis can also include orthotic intervention.

In some cases degenerative deformations and pain exists and a back brace has to be placed. Nowadays, orthoses are biomechanically adapted to the patient and can reduce the pain. Orthotics also support and help the spine by optimization of the body statics in three dimensional adapted designs and it can be used from the patient to perform specific activities or permanently.

Previous published reports show that the combination of physiotherapy sessions and the use of elastic or solid braces are also effective.

To get the wanted results from an orthotic application, an orthosis must be adapted in accuracy; patients should be informed for the side effects of the use of the orthosis until the use of the brace becomes a habit. Several sessions for adaptation of the orthosis should be take place in the beginning.

Orthotic treatment of patients with degenerative deformations of the spine and so for kyphoscoliosis is very helpful as it decreases the pain and helps the patient to improve his mobility. Specifically, report cases, in which individualized torso orthoses were used, have shown that these type of orthoses are more effective in reduce pain for patients with degenerative disorders of the spine in sagittal plane and can be used in acute as well as in temporary or permanent treatment for outpatient care. Of course, physiotherapy sessions are an integral part of the rehabilitation of the patient in order to get the best possible results¹⁵.

Interventions for sarcopenia

As it was mentioned above people who have low physical activity are more likely to face reduce of muscle mass and strength and are also in a high risk of sarcopenia.

Aerobic activity such as running, swimming and walking has been shown to improve endurance capability and cardiovascular fitness. Aerobic exercise helps to increase the cross sectional area (CSA) of muscle fibers. It has been shown that aerobic exercises less contribute to muscle hypertrophy. Also, after aerobic exercise there is a raise in the mitochondrial volume and enzyme activity which shows an improvement of protein synthesis and the quality of muscles independently of age. Finally, aerobic exercises cause a decrease of body fat including intramuscular fat as a result improvement of muscle functional role.

In addition resistance exercises seem to better improve the muscle mass and strength and eliminate the risk of sarcopenia. According to the literature there is an improvement in muscle CSA by 11% as well as improvement in muscle strength after high resistance exercise training in 12 week period program in older men.

In most recently studies an improvement in muscle size and strength in older people after moderate resistance exercise training program can be compared to muscle strength in younger individuals. It has been approved that a program of resistance exercise training of 6 months in people

of 65-75 years has similar results of gaining in muscle CSA with those in younger age between 20-30 years.

According to a Cochrane review in which 121 randomized controlled trials of Progressive Resistance Training (PRT) in older people were included, showed that there was an improvement in balance, gait speed, physical function by performing PRT 2 to 3 times every week and the most important was muscle strength progress in training groups of high intensity¹⁶.

Again it has to be mentioned the crucial role of the high intensity of the resistance exercise program in order to achieve improvement in muscle strength.

Resistance exercise training program has shown a high incident in falls prevention. Especially, by resistance exercise there is an achievement of increasing of muscle CSA as well as type 2 (fast twitch) muscle fibers and through that a general improvement in muscle power and physical functioning. Patient is able to carry out his ADL as there is a prevention of functional reduction and disability¹⁷.

Conclusion

Adult scoliosis is a spinal deformity which in progression can lead to pain, decrease of mobility, imbalances, instability. There are also secondary problems as degenerations, deformations, claudications and neurological deficits. According to literature there is a relation between adult scoliosis and sarcopenia. The loss of muscle mass related to the age can cause disruption of the balance between extensors and flexors muscles of the spine. This imbalance along with all the alterations take place in different parts of the spine, might have a consequence of degenerative scoliosis and might be the beginning of general spine disorganization.

From all the above it is important for the patient to deal with the sarcopenia and to regain the previous muscle loss. Medications and physiotherapy are the first options for conservative treatment in adult scoliosis. Certainly, surgery is the only option when the non surgical measures have no effect or do not promise any relevant long term help. So, it is important for the patient to follow all medical and physiotherapy prescriptions referring to his problem in order to deal with scoliosis and sarcopenia thus he will be able to improve his life by improvement activities of daily living.

References

1. Silva FE, Lenke LG. Adult degenerative scoliosis: evaluation and management *Neurosurg Focus* 28(3):E1, 2010.
2. Kotwal S, Pumberger M, Hughes A, Girardi F. Degenerative Scoliosis: A Review. *HSSJ* 2011;7:257-264.
3. Youssef JA, Orndorff DO, Patty CA, Scott MA, Price HL, Hamlin LF, Williams TL, Uribe JS, Deviren V. Current Status of Adult Spinal Deformity. *Global Spine J* 2013;3:51-62.
4. Janicki JA, Alman B. Scoliosis: Review of diagnosis and treatment. *Paediatr Child Health* 2007;12(9):771-776.
5. Cho K-J, Kim Y-T, Shin S, Suk-I. Surgical Treatment of Adult Degenerative Scoliosis. *Asian Spine Asian J* 2014;8(3):371-381.
6. Rolland Y, Czerwinski S, Abellan Van Kan G, Morley JE, Cesari M, Onder G, Woo J, Baumgartner R, Pillard F, Boirie Y, Chumlea WM, Vellas B. Sarcopenia: its assessment, etiology, pathogenesis, consequences and future perspectives. *J Nutr Health Aging* 2008;12(7):433-450.
7. Ali S, Garcia JM. Sarcopenia, Cachexia and Aging: Diagnosis, Mechanisms and Therapeutic Options. *Gerontology* 2014;60(4):294-305.
8. Santilli V, Bernetti A, Mangone M, Paoloni M. Clinical definition of sarcopenia. *Clinical Cases in Mineral and Bone Metabolism* 2014;11(3):177-180.
9. Cruz-Jentoft AJ, Landi F, Topinkova E, Michel J-P. Understanding sarcopenia as a geriatric syndrome. *Current Opinion in Clinical Nutrition and Metabolic Care* 2010;13:1-7.
10. Sukthankar A, Nerlich AG, Paesold G. Age-Related Changes of the Spine In: Boos N, Aebi M, editors. *Spinal Disorders Fundamentals of Diagnosis and Treatment*. Berlin Heidelberg New York: Springer-Verlag; 2008; 112-113.
11. Al-Kattan K, Simonds A, Chung KF, Kaplan DK. Kyphoscoliosis and Bronchial Torsion. *Chest* 1997;111:1134-36.
12. Singhai A, Banzal S. Severe Vitamin D deficiency causing kyphoscoliosis. *J Fam Med Primary Care* 2013;2:384-6.
13. Patil PC, Rathod AK, Borde M, Singh V, Singh HU. Effect of Surgical Curve Correction on Exercise Tolerance and Physical Capacities in Patients of Severe Spinal Deformity. *Journal of Clinical and Diagnostic Research* 2016;10(12):RC05-RC08.
14. Novikov VV, Vasyura AS, Lebedeva MN, Mikhaylovskiy MV, Sadovoy MA. Surgical management of neurologically complicated kyphoscoliosis using transposition of the spinal cord: Case report. *International Journal of Surgery Case Reports* 2016;27:13-17.
15. Gallo D. Case reports: orthotic treatment of adult scoliosis patients with chronic back pain. *Scoliosis* 2014;9:18.
16. Liu CJ, Latham NK. Progressive resistance strength training for improving physical function in older adults. *Cochrane Database Syst Rev* 2003;CD002759.
17. Burton LA, Sumukadas D. Optimal management of sarcopenia. *ClinInterv Aging*. 2010;5:217-228.