

MUSCULOSKELETAL DISORDERS IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD)

Abstract

Chronic obstructive pulmonary disease (COPD) is a long-term, inflammatory lung disease that makes breathing difficult. It is a progressive disease, which means that it worsens over time. COPD can lead to a variety of additional health issues known as comorbidities. Comorbidities include cardiovascular disorders, musculoskeletal disorders, depression and anxiety, nutritional issues, lung cancer, obstructive sleep apnoea, etc. Here, we are focusing on musculoskeletal disorders and COPD. COPD patients typically have muscular dysfunction, often known as skeletal muscle wasting, which causes muscle weakening, muscle mass loss, and functional issues. Muscle dysfunction lowers exercise ability and quality of life. People with COPD can manage their musculoskeletal complications and enhance their general health and well-being through the use of fall prevention strategies, medication, regular exercise, and proper nutrition. Similarly, by optimizing patient care and understanding COPD-related musculoskeletal problems, their causes, and appropriate therapy, healthcare practitioners can treat COPD's musculoskeletal issues and improve patients' well-being with a multidisciplinary approach. In this chapter, osteoporosis, osteoarthritis, muscle cramps, fatigue, chest wall deformities in severe COPD, major cytokines in muscular abnormalities, and multidisciplinary management of musculoskeletal disorders in COPD are discussed in detail.

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I. INTRODUCTION

People with chronic obstructive pulmonary disease (COPD) frequently experience musculoskeletal disorders (MSDs). COPD is a progressive lung disease characterised by persistent restriction of airflow, which causes respiratory symptoms such as coughing, shortness of breath, and wheezing. COPD primarily affects the lungs, but it can also have significant effects on the musculoskeletal system [1]. A common musculoskeletal disease in people with COPD is muscular dysfunction, often known as skeletal muscle wasting or muscle wasting syndrome. Muscle weakness, decreased muscle mass, and hampered muscle function are its hallmarks [2]. Systemic inflammation, physical inactivity, malnutrition, oxidative stress, and corticosteroid use are a few of the factors that lead to muscle dysfunction in COPD [1, 3]. Muscle dysfunction has negative effects on exercise capacity, dyspnea intensity, and quality of life. Pulmonary rehabilitation, exercise training, nutritional interventions, and targeted therapies are among the management techniques for muscle dysfunction in COPD. So there is a need of establishing correlation between musculoskeletal conditions and COPD.

II. OSTEOPOROSIS AND COPD

Compared to the general population, people with COPD are more likely to have osteoporosis, a condition marked by decreased bone mineral density and increased fracture risk [4]. Chronic inflammation, corticosteroid use, physical inactivity, vitamin-D insufficiency, and smoking are some of the variables that cause osteoporosis in COPD. Due to the fact that both osteoporosis and COPD individually raise the risk of fractures and functional impairment, coexisting with either condition presents a considerable difficulty [5]. Due to a number of respiratory condition-related factors, people with COPD are more likely to develop osteoporosis.

- 1. Inactivity and Decreased Physical Activity:** Breathlessness and exercise intolerance caused by COPD frequently lead to decreased levels of physical activity. Long-term inactivity and immobility can raise the risk of osteoporosis and contribute to bone loss.
- 2. Corticosteroid Use:** Systemic corticosteroids may be used for COPD management during exacerbations or as part of maintenance therapy. Increased bone loss and an increased risk of osteoporosis are linked to long-term or high-dose corticosteroid use [6].
- 3. Vitamin D Insufficiency and Malnutrition:** Patients with COPD may develop muscle atrophy and weight loss, which may be a result of insufficient dietary intake. Calcium and vitamin D deficiencies can deteriorate bone health and increase the risk of osteoporosis.
- 4. Chronic Inflammation:** The airways and lungs of people with COPD always have inflammation. Increased bone turnover and bone density loss can both be attributed to the inflammatory processes associated with COPD [7].
- 5. Consequences:** The prevalence of osteoporosis in people with COPD may have serious consequences:

- **Enhanced Fracture Risk:** Osteoporosis weakens bones, making them more prone to breaking, especially in the wrists, hips, and spine. People with COPD may experience further mobility problems and quality of life issues as a result of fractures.
- **Effect on Respiratory Performance:** In COPD patients, fractures, particularly those in the ribs and spine, can cause persistent pain and compromise respiratory function. Breathing problems can be made worse by painful fractures that restrict the movement of the chest wall.

6. Treatment Strategies: The treatment of osteoporosis in COPD necessitates a complex strategy:

- **Bone Density Testing:** Performing routine bone mineral density (BMD) tests, such as dual-energy X-ray absorptiometry (DXA) scans, can assist identify people who are at risk for osteoporosis and direct the right interventions [8].
- **Calcium and Vitamin D Supplements:** Bone health depends on getting enough calcium and vitamin D in your diet. Supplementation might be required, especially if dietary consumption is inadequate [9].
- Encouragement of weight-bearing activities and regular physical activity can help maintain bone density, build stronger muscles, and enhance general health. Exercise may be incorporated into pulmonary rehabilitation programmes to improve both respiratory and bone health.
- **Methods for Preventing Falls:** The incidence of fractures in people with COPD and osteoporosis can be decreased by putting safety measures in place to prevent falls, such as home modifications, the use of assistive technology, and balance exercises.
- **Available Medications:** To lower the risk of fractures, doctors in some circumstances could think about prescribing osteoporosis drugs such bisphosphonates or other bone-strengthening drugs. The choice to begin pharmaceutical therapy should be made on an individual basis, taking into account elements like fracture risk assessment and general health status.

Patients with COPD should bring up concerns regarding osteoporosis with their medical professionals. It is feasible to lessen the effects of osteoporosis and maintain better bone health in people with COPD by comprehensive care, which includes lifestyle adjustments, suitable nutrition, and focused therapies.

III. OSTEOARTHRITIS AND COPD

Osteoarthritis, a degenerative joint disease is not uncommon in COPD patients, and the coexistence of these two conditions can present additional challenges in managing the overall health of the affected individuals. Patients with COPD, especially those who also have chronic bronchitis, may be less active because of breathing problems, which can lead to weight gain and put more stress on weight-bearing joints. Systemic corticosteroids can also raise the risk of osteoporosis, which could result in joint issues if taken for COPD

exacerbations. Osteoarthritis and COPD share a complex association that includes risk factors like age, obesity, inactivity, and systemic inflammation. Osteoarthritis may develop and advance due to COPD-related causes such as mechanical stress on joints brought on by a change in breathing mechanics, muscle dysfunction, and drug use.

Additionally, several research have hinted to a potential connection between osteoarthritis development or aggravation and the chronic inflammation seen in COPD. In those who are susceptible, the inflammatory processes associated with COPD may contribute to joint inflammation and cartilage degradation. A multidisciplinary strategy comprising both pulmonologists and rheumatologists or orthopaedic specialists is necessary for the therapy of osteoarthritis in COPD patients. Among the possible treatment plans are:

1. **Pain Management:** To treat joint pain, a doctor may prescribe non-steroidal anti-inflammatory medicines (NSAIDs) or other painkillers [10].
2. Exercise and physical therapy programmes can assist retain mobility, develop muscles to support injured joints, and enhance joint function.
3. **Weight Management:** Promoting weight loss in COPD patients who are overweight or obese helps ease the load on their weight-bearing joints and increase mobility in general.
4. **Pulmonary Rehabilitation:** By encouraging an active lifestyle, this programme can assist COPD patients in improving their ability to tolerate physical activity and lung function.
5. **Assistive Equipment:** Patients with COPD who experience mobility issues due to their joints may benefit from using canes, walkers, or other assistive devices.
6. **Lifestyle Changes:** Promoting patients' cessation of smoking and avoidance of other respiratory irritants can benefit both COPD and joint health.
7. Healthcare professionals must be aware of the possibility of osteoarthritis in COPD patients and adjust treatment strategies accordingly [11], addressing the distinct difficulties brought on by both disorders at the same time.

IV. MUSCLE CRAMPS, FATIGUE AND COPD

The cramping in the muscles and generalised weariness are common complaints in patients with COPD. These symptoms can be attributed to a variety of conditions, including decreased oxygen delivery to the muscles, higher energy expenditure brought on by respiratory problems, electrolyte imbalances, and physical inactivity. The amount of physical activity a COPD patient engages in, their functional status, and their general quality of life can all be greatly impacted by cramps and fatigue [5]. Optimising COPD management, addressing underlying reasons including hypoxemia and electrolyte imbalances, offering fitness training, and adopting ways to preserve energy and lessen tiredness are all part of management strategies.

1. People with COPD frequently feel muscle cramps and exhaustion, which can drastically lower their quality of life. Numerous variables connected to the underlying respiratory illness may cause these symptoms to appear.
2. Weakness in the respiratory muscles, including the diaphragm and intercostal muscles, can be brought on by COPD. Due to this weakness, breathing may need more effort, which can wear down muscles and even cause cramping.

3. **Reduced physical activity:** Breathlessness and an intolerance to physical activity are hallmarks of COPD, which frequently results in lower levels of physical activity. Muscle weakness and fatigue can be attributed to inactivity and deconditioning.
4. **Side effects of medications:** Some drugs which are used to treat COPD, such as bronchodilators and corticosteroids, may cause muscle cramps or weakness.
5. **Electrolyte abnormalities:** People with COPD may develop electrolyte imbalances, such as low potassium levels (hypokalemia), which can make it more likely that they will experience cramps.

It takes a complete approach to treat muscle cramps and exhaustion in COPD patients, which may involve the following tactics:

1. **The rehabilitation of the lungs,** as part of pulmonary rehabilitation, engaging in an organised exercise programme can enhance physical fitness by enhancing muscle strength, endurance, and general health. By doing so, cramps may become less frequent and muscle tiredness may be reduced.
2. **Breathing exercises:** Using breathing exercises like pursed-lip breathing and diaphragmatic breathing [12] can assist improve the function of the respiratory muscles and lessen muscle fatigue.
3. **Medicine adjustments:** If a certain medicine causes muscle cramps or weakness, talking to your doctor about these symptoms may result in a dosage change or the recommendation of a different prescription.
4. **Adequate nutrition and hydration:** Maintaining a balanced diet and ensuring adequate hydration can support ideal muscle function and lower the risk of electrolyte imbalances.
5. **Stretching activities and relaxation methods:** Including regular stretching exercises and relaxation methods in daily routines will assist decrease cramping and ease muscle tension.
6. **Techniques for preserving energy:** Managing everyday tasks and doing so can assist prevent undue exhaustion. The ability to prioritise things, pace oneself, and use energy-saving strategies can all help one feel more energetic overall.

It is crucial for people with COPD to let their healthcare provider know if they experience any weariness or muscular spasms. In order to increase muscle function, lessen fatigue, and improve overall wellbeing in COPD patients, it is possible to treat these symptoms and put in place the right measures.

V. CHEST WALL DEFORMITIES IN SEVERE COPD

Severe COPD can lead to structural changes in the chest wall, resulting in chest wall deformities. The chest deformity with the largest anteroposterior diameter and flattest diaphragm is the most noticeable. These modifications may limit lung expansion, aggravate musculoskeletal pain, and reduce the effectiveness of the respiratory muscles. Pulmonary rehabilitation, breathing exercises, pain management, and, in extreme situations, surgical procedures are used to treat chest wall abnormalities in COPD.

1. **Abnormalities:** People with severe COPD may develop chest wall abnormalities as a result of a variety of chronic lung disease-related causes. Further, these abnormalities affect lung function, respiratory mechanics, and general respiratory health.

- **Hyperinflation:** Severe COPD results in hyperinflated lungs, which enlarge beyond their typical size. The shape and structure of the chest wall may change as a result of this hyperinflation, [13] giving the chest a barrel-like appearance. There may be little movement during breathing, giving the chest an inflated, spherical appearance.
 - **Weakening of Respiratory Muscles:** Severe COPD may cause the intercostal and diaphragm muscles, as well as other breathing muscles, to weaken. The shape and contour of the chest wall may change as a result of this weakening, resulting in abnormalities such as limited chest expansion or paradoxical breathing.
 - **Skeletal changes:** The ribs and thoracic spine may be affected by COPD's long-term hyperinflation and greater work of breathing. A flattened rib cage or increased thoracic kyphosis (forward curving of the upper spine) are two anatomical abnormalities of the chest wall that can develop as a result of these skeletal alterations throughout time.
 - **Muscle wasting and weight loss:** Severe COPD can cause the muscles in the chest wall, as well as other muscles, to waste away. This muscle mass loss may contribute to weakened chest wall integrity and aggravate abnormalities of the chest wall.[3]
2. **Consequences:** The following consequences may result from severe COPD patients having chest wall deformities:
- Lung function and respiratory mechanics may be further hampered by chest wall abnormalities. When the chest wall is less mobile, the lungs may be unable to expand and contract as efficiently, adding to the labour required to breathe and contributing to respiratory inefficiency.
 - **Exercise Intolerance:** Chest wall abnormalities may make it difficult to engage in strenuous physical activity, which exacerbates the deconditioning and intolerance to exercise that are frequently present in people with severe COPD.
 - **Worsened Respiratory Symptoms:** In people with severe COPD, deformities of the chest wall can make respiratory symptoms including dyspnea (shortness of breath), wheezing, and coughing worse. An all-encompassing strategy is required to treat severe COPD-related chest wall deformities:
 - **Pulmonary Rehabilitation:** Taking part in a pulmonary rehabilitation programme can help improve the mobility of the chest wall and exercise tolerance while maximising respiratory muscle performance.
 - **Breathing Exercises:** Practising and learning breathing techniques, such as diaphragmatic breathing and pursed-lip breathing, can help to improve the mechanics of breathing and maximise the performance of respiratory muscles.
 - **Supportive Devices:** In some circumstances, the use of supportive devices such as braces or vests may be considered to provide external support to the chest wall and

improve respiratory mechanics. Adequate nutrition, including appropriate calorie intake and protein consumption, can help prevent weight loss and muscle wasting, which may indirectly support chest wall integrity.

Work together with healthcare team, including pulmonologists and respiratory therapists, to create a personalised management strategy if one have severe COPD and chest wall abnormalities. This strategy should attempt to improve respiratory function and general health while addressing the unique problems caused by the chest wall abnormalities.

VI. INTERACTING CYTOKINES IN MUSCULAR ABNORMALITIES AND COPD

A recent study [15] ascribes that myokines and osteokines, such as IL-6, irisin, myostatin, RANKL, osteocalcin, etc., may be involved in muscle-bone crosstalk in COPD. Myostatin, a myokine belonging to the TGF-B superfamily, is a significant negative regulator of skeletal muscle growth and development that can prevent muscle cells from proliferating and differentiating as well as expedite muscular atrophy. In response to muscle contraction, skeletal muscles may also produce a significant amount of interleukin (IL)-6, which is released into the blood stream during exercise and is therefore also regarded as a myokine. Irisin is a newly discovered myokine, mainly produced from skeletal muscles. Evidence [16] suggest that COPD had lower levels of serum irisin compared to healthy controls, and irisin levels had a beneficial impact with physical activity. Personalised therapy for COPD comorbidities may be feasible with the recognition of important molecules in the pathophysiology of musculoskeletal conditions. The mechanisms underlying the muscle-bone relationship in COPD is still under study and needs further investigation.

VII. MULTIDISCIPLINARY MANAGEMENT OF MUSCULOSKELETAL DISORDERS IN COPD

A comprehensive approach is necessary for the management of musculoskeletal issues in COPD. In order to increase musculoskeletal function, exercise tolerance, and general quality of life, pulmonary rehabilitation is essential. The prevention of muscle wasting requires proper nutrition, which includes consuming enough protein. Drugs used to treat osteoporosis and pain should be individualised for each patient. Musculoskeletal issues may be relieved by physical therapy methods such joint mobilisation, stretching, and strengthening exercises. Collaboration amongst medical specialists, such as pulmonologists, physiotherapists, dietitians, and rheumatologists, is essential to ensure that people with COPD and musculoskeletal diseases receive thorough and individualised care.

VIII. CONCLUSION

Musculoskeletal disorders are common comorbidities in COPD, significantly impacting the overall health and quality of life of affected individuals. Understanding the various musculoskeletal disorders associated with COPD, their underlying mechanisms, and effective management strategies is crucial for optimizing patient care and improving outcomes. By implementing a comprehensive and multidisciplinary approach, healthcare professionals can address the musculoskeletal aspects of COPD and enhance the overall well-being of individuals living with this chronic respiratory condition.

Conflict of interest: Authors declare no competing interest.

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