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Shoulder Pain: Mechanism, Effect and Treatment

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ABSTRACT: ***S****houlder pain generally occurs when rotator cuff tendons become stuck beneath the bony area, resulting in inflammation or injury. The rotator cuff is a musculotendinous complex with four muscles: the supraspinatus, infraspinatus, teres minor, and subscapularis. Rotator cuff tendinopathy includes subacromial impingement syndrome, tendonitis, tendinosis, partial rotator cuff rupture, and subacromial bursitis which caused by intrinsic, extrinsic, and central mechanisms. Intrinsic mechanisms include changes in age-related degenerative disorders and alteration of the mechanical properties of the tendon. Extrinsic mechanisms are caused by anatomical factors and the biomechanical factors that compress the structures under acromial. The central mechanism involved the central nervous system in the pathology. Shoulder pain can cause symptoms including stiffness, clicking, and grinding. It is recorded as the third most prevalent musculoskeletal symptom among adults. Treatments may include surgery, medication, electrotherapy, manual therapy, therapeutic bandages, dry needle techniques, and therapeutic exercises.*

Keywords: *shoulder pain; rotator cuff; tendinopathy; glenohumeral; range of motion.*

I. INTRODUCTION

The most common cause of shoulder pain occurs when rotator cuff tendons become trapped under the bony region, causing inflammation or damage (Rees et al., 2021). The rotator cuff is a musculotendinous complex comprising four muscles: the supraspinatus, infraspinatus, teres minor, and subscapularis. The insertion of the tendons forms a continuous cap that wraps around the proximal part of the humerus. Together, they play the most critical role in the active stabilization of the shoulder and cause a compressive force on the glenohumeral joint.

This compression is critical during arm elevation movements when they must oppose translations of the humeral head, such as the superior translation caused by the powerful deltoid (Sharkey & Marder, 1995). Although their role has been described as dominating in mean ranges of motion, Labriola et al. (2005) showed that the rotator cuff muscles are indeed active at the end of amplitude, whereas superior and anterior translational forces are predominant.

Rotator cuff tendinopathy is a general term for subacromial impingement syndrome, tendonitis, tendinosis, or partial rupture of the rotator cuff and subacromial bursitis (Papadonikolakis et al., 2011). These conditions are believed to be primarily caused by inflammation or degeneration of the soft tissues in the space between the coracoacromial arch and the upper surface of the humeral head. When the upper limb is in elevation, there are tablets between the coracoacromial arch and the humeral head.

Several mechanisms can cause the appearance of rotator cuff tendinopathy and the consequent pain. They can be divided into intrinsic and extrinsic mechanisms. The intrinsic mechanisms refer to tendons' histological, mechanical, and physiological properties, while extrinsic mechanisms refer to factors external to the tendons. Although mechanisms are presented separately, they can occur at the same time and can influence each other. In addition, a central nervous system component can also influence the course of the condition and the signs and symptoms.

II. MECHANISM OF SHOULDER PAIN

2.1. Intrinsic Mechanism

Intrinsic mechanisms mainly include changes in age-related degenerative disorders, alteration of the mechanical properties of the tendon, alteration of tendon vascularization, and the imbalance between degeneration and synthesis of the tendon extracellular matrix. The role and properties of a tissue are defined by its composition and the organization of its components. The predominant collagen fibers are type I. They are strong and bonded together in a sturdy way to withstand tensile forces. Age is an essential factor in modifying the properties of the tendon. More particularly, a decrease in elasticity and maximum tensile strength was shown (Seitz et al., 2011). These changes would be associated with the development of fibrocartilage within the tendon (Vogel, 2003), a decrease in the concentration of glycosaminoglycans and proteoglycans (Riley et al., 1994), and an increase in the proportion of college type III, which has a lower tensile strength and whose fibers are arranged more irregularly (Kumagai et al., 1994).

Joensen et al. (2009) have also shown an association between the increase in the thickness of the tendons of the rotator cuff and the presence of a Symptomatic rotator cuff tendinopathy. More recent tendinopathy could undergo thickening due to the ongoing healing process (Malliaras et al., 2010), while chronic tendinopathy may show thinning associated with degeneration (Seitz et al., 2011). On the contrary, neovascularization was shown in the regions where the tendons showed signs of degeneration or rupture (Levy et al., 2008). Again, these discrepancies could be explained by the evolution of the rotator cuff tendinopathy.

Levy et al. (2008) showed that tendinopathies could show signs of hypervascularity in the acute phase, while in the chronic phase, signs of hypervascularity. When a tensile force is applied to a tendon, its cells react to produce an extracellular matrix and thus adapt to the demand. In the long term, it results in superior mechanical capabilities called mechanotransduction (Paluch et al., 2015). If intensity and frequency are too high and exceed the capacity of the cells to produce an extracellular matrix or repair the damage imposed on the tendon effectively, it will damage the structure’s integrity (Magnusson et al., 2010). If the balance is not recovered, tendinopathy, partial or complete rupture may occur. To sum up, the intrinsic mechanisms make the tendon vulnerable when subjected to tensile forces whose intensity and frequency are too great to adopt.

2.2. Extrinsic Mechanism

Extrinsic mechanisms can be represented by anatomical factors and the biomechanical factors that contribute to the compression of the structures under acromial (Seitz et al., 2011). Anatomical factors that may contribute to the compression of structures beneath the acromial are the shape of the acromion and the presence of bony outgrowths under the acromion in the lower part of the acromioclavicular joint or ligament coracoacromial. Impaired scapular control has been identified in individuals with rotator cuff tendinopathy (Seitz et al., 2011). These individuals usually show a decrease in posterior tilt (Endo et al., 2001), a decrease in superior rotation (Su et al., 2004), and an increase in lower rotation (Ludewig & Cook, 2000). These deficiencies would limit the elevation of the coracoacromial arch relative to the humeral head during arm elevation, which would contribute to the compression of subacromial structures (Ludewig & Cook, 2000).

Weaknesses or decreased serratus anterior and trapezius muscle activation have also been observed in individuals with rotator cuff tendinopathy (Cools et al., 2003). Although several variations in the position or control of the scapula were observed, no clear causal link has been established between these deficiencies alone and the onset of rotator cuff tendinopathy (Ratcliffe et al., 2014). Another biomechanical factor that can be considered an extrinsic mechanism in the development of rotator cuff tendinopathy is the excessive superior translation of the humeral head during arm-raising movements (Royer et al., 2009). Individuals with rotator cuff tendinopathy exhibit decreased strength (Tyler et al., 2005) and activation of muscles of the CR (Diederichsen et al., 2009).

2.3. Central Mechanism

Although rotator cuff tendinopathy is considered a mechanical pathology, several studies have demonstrated the involvement of the central nervous system in the pathology (Coronado et al., 2014). Examples are the sensitization of neurons that conduct pain in the spinal cord, the alteration of pain inhibition systems, and the modification of the cortex. It has been shown that unilateral rotator cuff tendinopathy could present a lower pain threshold on the healthy side or far from the rotator cuff tendinopathy than individuals without rotator cuff tendinopathy (Coronado et al., 2014). Ngomo et al. (2015) also demonstrated an asymmetry between the two cerebral hemispheres regarding the excitability of neurons innervating the infraspinatus was present (Ngomo et al., 2015). The affected side, the hemisphere opposite the painful shoulder, showed lower excitability than the healthy side. Moreover, this reduction in excitability was positively associated with time since the onset of symptoms. Changes in the excitability of motor neurons can have several causes, including prolonged pain (Farina et al., 2003).

III. EFFECT OF SHOULDER PAIN

Although nearly 65% of rotator cuff sufferers are asymptomatic (Minagawa et al., 2013), the pain in the symptomatic rotator cuff tendinopathy is not negligible. In a qualitative study, Minns Lowe et al. (2014) reported that participants described their pain intensity as very important. A decrease in painless range of motion (Delgado-Gil et al., 2015), with a painful arch between 60° and 120° (Park et al., 2005), and a decrease in muscle strength (Tyler et al., 2005) have been reported. These characteristics of rotator cuff tendinopathy can lead to decreased function (MacDermid et al., 2004), a decrease in quality of life (MacDermid et al., 2004), work incapacity (Østerås et al., 2008), and sleep disorders (Tekeoglu et al., 2013).

Shoulder pain have significant effects on the person's life. They can decrease the ability to perform daily routine activities, leading to difficulties during sleeping or overhead activities such as styling hair or dressing. The shoulder pain can lead to symptoms such as pain, stiffness, clicking, and grinding. Rincón-Hurtado (2018) states that the rotator cuff pathology strongly indicates poor physical health and quality of life. Chronic impingement of the shoulder has been demonstrated to cause severe functional impairment and a decrease in quality of life (Sahoo et al., 2020). As with hypertension, congestive heart failure, diabetes mellitus, and clinical depression, shoulder pathology can affect an individual's impression of the quality of life. Shoulder injuries cause an average of 6.5 weeks of missed training and competition, making them the most significant cause of absence from sports compared to the other time losses reported in the research (Jakobsen et al., 2018).

Rotator cuff tendinopathy is the leading cause of shoulder discomfort in adults, making it the third most prevalent musculoskeletal symptom (Rahimi et al., 2018). The long head of the biceps tendinopathy, subacromial bursitis, and shoulder impingement syndrome (SIS) are all subacromial shoulder diseases that fall under the umbrella term of rotator cuff tendinopathy (Desmeules et al., 2016). Shoulder ailments forced 40 percent of English First League professional male players to miss training or take time off (Jurkojć et al., 2017). Because of the prevalence of shoulder injuries, injury prevention techniques are urgently required (Asker et al., 2018). A change in eccentric external-rotator (ER) strength, a decrease in concentric internal rotator (IR) strength, and a change in the ER: IR ratio are all associated with the onset of glenohumeral internal-rotation deficit (GIRD).

EQ-5D health-related quality of life (HRQOL) includes mobility, pain/discomfort, anxiety/depression, and the capacity to care for oneself and carry out routine tasks when players with present shoulder pain post-retirement report considerably lower Tegner activity levels. Measured activity level, quality of life (QOL), and general health status using the Tegner Activity Level Scale (Collins et al., 2011), the EQ-5D, and the VAS on a sample of 108 NBA players (Szende et al., 2014). Athletes' vulnerability to game-related injuries is increased because of the high physical exertion required to compete at the professional level (Lewis, 2018).

As a result of their frequent leaping, pivoting, and overhead movements, NBA athletes are at risk of sports-related injuries (Lewis, 2018). Even though the most common sports-related injury occurs in the knee in the upper extremity, the highest proportion of injuries occur in the hand, of which acute injuries are reported more commonly than overuse injuries (Park & Woo, 2015). Tendinopathies differ from acute injuries, which intrinsic factors play a more significant role (Kvist, 1994).

IV. TREATMENT OF SHOULDER PAIN

Several modalities can be used to treat rotator cuff tendinopathy. The surgery is preferred in the event of failure of conservative treatments, which may include pharmacology, electrotherapy, manual therapy, therapeutic bandages, dry needle approaches, and therapeutic exercises. If conservative treatments prove ineffective, surgery is considered (Mauro et al., 2012). The procedures of the various surgeries performed aim to decrease compression in the subacromial space either by thinning the acromion, removing part or all of the bursa, or by resecting the coracoligament acromial or a combination of the three (Donigan & Wolf, 2011). A recent systematic review evaluated the efficacy of surgery in rotator cuff tendinopathy and concluded that surgery, regardless of the approach used, is as effective as exercises alone (Toliopoulos et al., 2014). They recommend a conservative approach since it is safer and less expensive.

The use of pharmacological interventions, such as taking anti-nonsteroidal inflammatory drugs (NSAIDs) and corticosteroid injections, are used every day in the treatment of rotator cuff tendinopathy. Prescribed NSAIDs are described mainly in two groups: noninhibitors selective cyclo-oxygenase inhibitors (NS COX inhibitor) and selective cyclo-oxygenase inhibitors oxygenase 2 (COX-2 inhibitor) (Paoloni et al., 2009). Boudreault et al. (2014) conducted a systematic review with meta-analysis to assess the effect of NSAIDs in treating rotator cuff tendinopathy and conclude that in the short term, NSAIDs are more effective than a placebo in reducing pain. Moreover, both groups of NSAIDs presented would be of similar efficacy in the short term.

Electrotherapy modalities can be used to decrease pain and reactivate the healing process of the tendon. Traditionally, therapeutic ultrasound is used to treat tendinopathies in physiotherapy. However, Andres and Murrell (2008) conducted a systematic synthesis on this subject and concluded that little evidence supports its use to decrease pain and increase function in individuals with rotator cuff tendinopathy. Only the study from Ebenbichler et al. (1999) concluded that ultrasound is more effective than a placebo in individuals with calcifying tendinopathy in reducing the size of the calcification, decreasing pain, and increasing function (Ebenbichler et al., 1999).

Manual therapy is an intervention modality used in physiotherapy. In a recent systematic review, Desjardins-Charbonneau et al. (2015) include joint mobilizations, manipulations joints, soft tissue techniques (massage, transverse friction), neuromeningeal mobilizations, and mobilizations with movement (MWM) such as manual therapy techniques. These techniques can be applied to the shoulder complex and vertebral spine to treat rotator cuff tendinopathy. Manual therapy alone or in addition to other modalities may decrease rotator cuff tendinopathy-related pain but would have little impact on function (Desjardins-Charbonneau et al., 2015). For the problems of the rotator cuff, its use aims to decrease pain and increase function by correcting the posture and or by facilitating the activation of specific muscles to normalize the patterns of scapulothoracic and glenohumeral movements. Non-elastic taping may effectively correct posture and improve the active range of motion (Lewis et al., 2005). However, its use, alone or in addition to multimodal interventions, would not benefit pain and function in the medium and long term (Desjardins-Charbonneau et al., 2015).

The use of dry needles is gaining popularity in physiotherapy due to myofascial trigger points (Dunning et al., 2014). On the contrary, acupuncture is based on a theoretical concept of meridians containing predetermined needle insertion points. Moreover, it has been noted that among 255 anatomical points known to develop myofascial trigger points frequently, 238 corresponded to insertion points of traditional acupuncture (Dorsher, 2008). Arias-Buría et al. (2017) evaluated the effect of adding from inserting dry needles into myofascial trigger points to exercise therapies. The intervention group (exercises and dry needles) showed a more significant increase in function than the control group (exercises only). However, the decrease in pain was similar. It is common practice to recommend physical therapy for those who have had rotator cuff injuries, especially its effect on strength, range of motion (ROM), and patient-reported outcomes, yet its impact on in vivo joint kinematics remains little understood. Physical therapy enhanced pain/function ratings and increased range of motion (Baumer et al. (2016). However, high failure rates of non-operative therapy for full-thickness rotator cuff tears, together with the prevalence of rotator cuff illness, highlight the need for better non-operative care for rotator cuff injuries (Miller et al., 2016).

V. CONCLUSION

Shoulder pain has significant effects on the person's life. They can decrease the ability to perform daily routine activities, leading to difficulties during sleeping or the performance of overhead activities. Pain is among the significant symptoms accompanying shoulder injuries. The symptoms include pain in the arms when raised, pain or discomfort in the shoulder or arm that is worse at night, popping or clicking noises or sensations when moving the arms, weakness in the shoulders, and difficulty lifting objects. The treatments may include surgery, pharmacology, electrotherapy, manual therapy, therapeutic bandages, dry needle approaches, and therapeutic exercises.

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