

PHYSIOTHERAPIST'S PERSPECTIVE TO IMPORTANCE OF PATHOPHYSIOLOGY OF SUPRASPINATUS TENDONITIS IN PROPER REHABILITATION OF PAIN AND DYSFUNCTION

Abstract

This article focuses on the physiotherapist perspective on the importance of pathophysiology of the Supraspinatus. Tendonitis is a very frequent cause of shoulder pain. The tendinopathy of supraspinatus most frequently affects people involved in various sports driven actions and above the head work in our daily living. It is thought to be caused by both intrinsic and extrinsic factors, but for simplification they were divided into Anatomical, Biomechanical, Vascularity, Activity related, Biochemical and Age-related factors. The following data-bases were searched for both published and unpublished studies in English language for the period of 1962 to 2022: PubMed, EMBRACE, MedLine, Web of Science, Scopus. The following terms were used to carry out the search: Shoulder, impingement, supraspinatus, pain, pathophysiology, physiotherapy implication, athletes, older adults. We conclude that it is important to have in-depth knowledge about these concepts of pathophysiology of pain in terms of all possible etiologies and the healing process which helps the physiotherapist to make wise decisions about the rehabilitation process.

Keywords: Supraspinatus tendonitis, Shoulder, Impingement, Pain, Inflammation, Physiotherapy, Supraspinatus tendinopathy, Tendon healing, Tendon injuries, Shoulder impingement syndrome

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I. INTRODUCTION

Supraspinatus is one of the most important muscles of Rotator cuff which is frequently involved in shoulder pain [1]. Shoulder pain is the third most common musculoskeletal complaint [2] and supraspinatus muscle tendon has been a frequent disturbance of major concern in humans including many activities with maximum activities related to work of daily living. Although various tissue injuries of the shoulder muscles have been involved in the problems within the shoulder, causing various events of plays like badminton, overthrow ball, volleyball. Moreover, it increases along with the aging involving the impact on more than 80% of the population over eighty years of age, with the impact over the supraspinatus tendon being one of the most commonly affected [3]. It takes origination nearly to the supraspinous fossa and the scapula and which is inserted towards the greater tuberosity of humerus bone. In its course it runs below the acromion process in the subacromial space and makes the supraspinatus tendon where it receives its neural and blood supply by the suprascapular nerve and anterior circumflex humeral and suprascapular arteries respectively [4]. The primary action of supraspinatus is in the first 15 degrees of shoulder abduction and in the rest it helps in abduction from 15-90 degrees [5]. Additionally it also stabilizes the glenohumeral joint by depressing the shoulder during abduction as the muscles force vectors bifurcated into components and largest component is compressive in nature but to date a various things of thinking In aspect of the association with pathology stays the same.[6] Although Supraspinatus tendinopathy have been a major portion I'm the understanding of degenerative complication which works on from their acute tendinitis, with various problem in tendinosis, and effectively working on orientation of the and partial or full thickness tendon tear [7]Moreover, in the current times works On the terms of tendinitis and tendinosis which is made to be avoided with making the word tendinopathy and various things to be preferred into the various parts of research defining what is with the minimal or no inflammatory cells in irritating tendon areas [8]. To date it appears that tendon disorders arise from a variety of different intrinsic and extrinsic etiological factors. We searched the following data-bases for both published and unpublished studies in the English language for the period of 1962-2020: PubMed, EMBRACE, MedLine, Web of Science, Scopus. The following terms were used to carry out the search: Shoulder, impingement, supraspinatus, pain, pathophysiology, physiotherapy implication, athletes, aging adults. The basic purpose in this study includes to simplify the pathophysiology and give physiotherapists perspective over the possible factors and solutions for this painful condition. We have divided the pathophysiology into Anatomical, Biomechanical, Vascularity, Activity related, Biochemical and Age-related factors.

II. MAIN BODY

- Anatomical Factors:** It takes origin from the actual portion of supraspinous fossa within the area of the scapula and gets inserted into the superior as of greater tuberosity of the humerus. In its course it runs below the acromion process in the subacromial space and makes the supraspinatus tendon where it receives its neural and blood supply by the suprascapular nerve and anterior circumflex humeral and suprascapular arteries respectively [4]. The structural work of the supraspinatus insertion within the surfaces of extracellular matrix composition which includes the categorized into various segments of four transition zones. The one zone is known as tendon proper which is constructed up of mostly type one involving collagen fibers and little amount of decorin. The

fibrocartilage zone is the second zone consisting of mainly occupy types 2 and 3 collagen tissues in abundance with various important types - 1, 9- and X - collagen in small amounts. The other one zone being fabricated from fibro cartilage which occurs with containing ty pe - 2 collagen which is largely type X collagen and aggrecan. Within the Fin ally, the fourth zone is bone having most ly, type 2 - collagen. [9] With painful pathology of the tendon of supraspinatus muscle depends upon the anatomy of the tendon. It was found using 3-D shape analysis that the shape depends whether it is atrophy, retraction or tear with retraction with helps in making decision about the requirement of surgical intervention. According to this study tear with retraction need surgery but tear with atrophy can be treated conservatively but is a major cause of pain and difficulty in Activity of Daily living [10]. According to a study it was found that actually supraspinatus is divided into two main parts anterior and posterior. Additionally, the structural portion of the posterior aspect of the tendon, which is more flat, was discovered to have a more tubular form in the anterior part of the tendon.. Anterior part being larger than the posterior. These parts are further divided into superficial, middle and deep portions having varied pennation angle (PA) [11]. This was further justified by a study where it was explained thst the PA also influences the effects of tendon itis within the tensile force generated by the whole muscle efforts for vector sum of force parts offering parallel to the line of tendon. Therefore, as the angle of PA increases, tensile component of contraction within a force decreases [12]. Now in this study it was found that the anterior medial part of the muscle had less PA than the lateral part so, the lateral part will produce less tensile force and there will be a difference in the force production within the muscle, which will eventually create shear forces. Also, within the larger area of the anterior parts with the region of muscle parts of supraspinatus structure within the impacts over the informed muscle which may cause an forceful impact over produced by this region. With this result , we are having an important variation in the anterior tendon that may undergo greater stress and causes over the other impact on posterior tendon work during contraction. This could be a reason for higher involvement over the front segment of tendon rupture [13]. Hence, at the time of healing it becomes extremely important to give rest to the tendon in the form of immobilization to avoid these shear stresses.

Importance of immobilization can be explained on the basis of a study which said that non traumatic supraspinatus tendonitis or tears depends upon the blood supply to the tendon which gets occluded sometimes because of increased sarcomere length. Optimal sacromere length being 2.13 μm . He found out that gravity causes increase in the sarcomere length by traction to the supraspinatus which eventually results in decreased force production and compression to the microvessels which occludes the blood supply, and the region becomes ischemic . This ischemia eventually causes inflammation of the tendon hence, Immobilization at 45 ° can counteract the gravity [14]. The morphology of the acromion process was found to be a factor responsible for impingement to develop. There are three main shapes of the acromion namely flat, curved and hooked. The hooked shape is mostly responsible for the mechanical impingement [15,16]. Following this a study was conducted in continuation to the previous study which showed a difference in the acromion physiology over the morphology within the effect over the patients with degenerative supraspinatus tears and those from the stressful tears. They work with that shoulders and from the degenerative wear and tear showing pathological changes with their effective narrowing of various spac from the background from lateral effects in the

lengthening of extension over an angulation where few aspect of the acromion gets Z-tears [17]. So, if the morphology of the anatomic structure is the cause for impingement then it better to refer the patient for surgery if it is causing major symptoms rather than trying to treat it conservatively.

2. **Biomechanical Factors:** Biomechanics of shoulder joint was seen on a cadaveric study using MRI, Within the various arms from the effective position from the change with the neutral, 45 °degree external and 45 degree within internal rotations at 0 degree ; 30 degree, and 60 °degree within of gleno humeral abduction. Measurements from various anterior, middle, and posterior portions of the tear from tendon were take with the structure. And from the outside was found that abduction over 30 degree without the ° shortened form the entire structural supra spinatus tendon [18]. It was effectively noted that the employees within the Jobs involving the high rates of supra spinatus symptoms performed over thr with arms from the external parts of rotation from the others with the employees in job within the proper the low shoulder injury occurrence rates. When tension is put on the tendon, it exhibits axial rotational motion within the tendon into a form that can reduce perfusion [19]. The anterior side of the tendon experiences a peak stress and peak within the strain at the beginning of motion, which is between 0 and 30 degrees. The anterior segment of the thas stretches from other areas as ER from the effective observable change. By adding elevations from where the tendon bends the other way, the posterior portion is able to contain variations in peak stresses from strains, which causes the magnitude from the other side of the anterior portion to increase significantly.[20]. The various differences our the shoulder mechanics involves form the studied in which it was objectively the found that Critical shoulder angle (CSA) is having plays an important parts of effective with the role in obtaining the forward occurrence of supra psi stud tear. It has been seen look after the in line subtended within the parallel over the anatomical acromion area processes, and another line across the inferior-lateral edge of our glenoid to the inferior-lateral side. The alternative case scenario is where CVA is less than 3 degrees from then osteoarthritis join from the effects over of the gleno-humeral will prevail if CVA has a value greater than that of 35 with the rotator cuff tear with it.[21].Using this information, another study was carried out and it was discovered that the mean Critical shoulder angle (CSA) of 38° degree is to Matching controls with intact rotator cuffs have a mean CSA of just 33 degrees, in contrast to the chronic supraspinatus muscle injuries that have been observed in these people. The variation within the CSA caused the over-deltoid line of action to be directed efficiently and frequently with more superiorly to the frontal plane with decreased variable compressive and increased shear loading pressures, which resulted in a large disassociation in joint forces.. In order to achieve the same levels of stability in terms of various shear and compressive forces leading to various Improvement over level of abduction, additional supraspinatus force was needed in the worst examined case of I a larger size of CSA, (ii) high large deltoid muscle activity within the relative to the supraspinatus, and (iii) 40° degree abduction. [22].Exercise regimens should be planned to change the RC tendons' load tolerance while also enhancing their ability to better manage humeral head depression. People with RC tendinopathy may benefit from having a variety of workouts prescribed in order to first prevent loading them into fatigue. Additionally, based on the various recovery rates of >6 hours, it may be wise to restrict RC strengthening exercises to no more than one session, inclusive, each day, or even longer intervals in the early stages of rehabilitation [24]. Additionally, it was discovered

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that the tensile load on the tendon varies depending on the anatomic sites and that the muscle experiences various tensile loads depending on the position of the arm. When the supraspinatus muscle is reduced to a 10 mm broad strip due to overuse, the tendon will fail at a steady crosshead AC movemental speed in 25.4 mm. When compared to the midsubstance location, the insertional point showed the most signs of degradation. [25]

3. **Vascularity:** Vascularity of the tendon also plays a major role in the occurrence of the disorder. Blood supply (BS) is received by anterior circumflex humeral and suprascapular arteries [4]. The concept of avascular zone or critical zone came in 1990, when it was found that there are certain areas in the tendon where the blood supply of the tendon is low. Supraspinatus tendon gets inserted on the greater tuberosity of humerus. A few centimeter from its insertion it has the maximum chances of getting impinged. This area is called the critical zone because the tendon has the least amount of blood vessels present in this region hence, more prevalent to ischemia [4]. The critical zone is found to have slightly higher strains than the midsubstance, while the insertion point has higher stresses [20]It points to the need for a lengthier recuperation period. According to a study done fluoroscopically, the mean Changes in the baseline functional impacting the capillary density within was 106.13 ± 13 cm/cm², and the Changes over the mean capillary diameter was in. 10.07 m in the area of the unaffected impact on tendon insertion. While the variation over the diameter of the vessels generating an alteration that were present did not change, the effective functional capillary density was insignificantly seen in. lowered to 20 ± 14 cm/cm². [26]
4. **Activity Related:** Forward head posture and increased kyphosis also results in instability of the scapulothoracic mechanism which can lead to impingement as described by Herberts in his study on heavy load carrying laborers [27]. People who show extreme elevation positions due to an effect full occupational requirements needs, such as individuals engaged in physically demanding occupations that include significant overhead lifting, such as those in the construction industries. They may also achieve these positions if their scapular upward rotation is restricted, as this acknowledges the requirement to adjust for changes in the elevation of the glenohumeral joint. Rehabilitation targeted at enhancing scapular upward rotation to lessen supraspinatus tendon tension when in elevation may help this shift in the population in a variety of ways. While motion over the inferior translation greatly increased the impact of the stress and strain on the tendon leading through the range of motion, alterations over the superior humeral head tended to diminish it.[28]. From a clinical aspect, a patient with shoulder pain may translate their humeral head inferiorly in an effort to lessen the pain they might feel from high-elevation impacts. However, this motion actually increases the strain on the supraspinatus tendon, aggravating the problem. These findings might suggest that patients with shoulder pain thought to have its source in the supraspinatus minimize the amount of time they spend in extreme glenohumeral elevation [20].Bonde examined the psychological aspects of shoulder diseases associated with the workplace as well. They discovered that alterations associated with poor recovery from physical job exposures were strongly observed as people aged. At the time the shoulder issue was identified, their perception of demands, control, and social information support were also linked to a delayed recovery [29]. A study was done on the various sleep positions and their impact on the supraspinatus perfusion and subacromial pressure effect because tendon perfusion is essential for tendon-to-bone healing during the postoperative changes on physical

therapy afterward the rotator cuff reconstruction and for prevention overhead of additional damage to healthy on to the impacts over the already torn cuffs. They discovered that the supine posture, followed by the prone position, has the lowest pressure effect. In the side-lying posture, there was shown to be the greatest pressure effects and lowest perfusion. Therefore, sleeping ergonomics is a crucial and inevitable factor for the tendon's pain reduction and recovery, which is sometimes overlooked by physiotherapist [30].

5. **Biochemical Factors:** Cytokines are identified as pro-inflammatory markers. There has been evidence which supports increased level of cytokines and apoptotic genes in rotator cuff tears and tendinopathy, especially supraspinatus tendinopathy. Which suggests that these can play a role in tendinopathy. And could be made a target for management [31]. In histochemical study there are three chemical mediators which are namely interleukin-1, interleukin-6, and matrix metalloproteinase-1 are found (VEGF R-1), and increased tendon stress brought on by cyclical loading is caused by connective tissue that has been arranged over tissue growth factor (CTGF), which may also be a part in the early vascular changes that precede tendinosis. The largest cell densities and changes in all three proteins were seen in the loaded tendon's outer region, where the enthesis are situated [33]. Another study showing the changes was done in which the possible role of Glucose amino glycans (GAG's) and Harmonin- interacting, ankyrin inclusion of the various repeat containing proteins (HARP) are seen and analyzed. Total sulfated GAG levels were discovered to rise after 4 weeks of misuse and to be steady for up to 16 weeks. After two weeks, there was an increase of the mRNAs and proteins for the proteoglycans (PGs) decorin, versican, and aggrecan, as well as the PG mRNA for biglycan. While the mRNAs for the various collagen-2, collagen-3, collagen-6, and the transcription factor Sox9 were significantly enhanced at 2 weeks, the important collagen-1 transcript had reduced [34]. A microarray analysis was carried out in 2006 to investigate the genetic causes of tendon pathology. In that study, it was shown that variations in glutamate appeared to produce and responsively prompt a proapoptotic impact upon the cultured tendon cells. This finding is comparable to the "exit-toxic" reaction of cells in the central nervous system that changed after becoming overstimulated. Which may also alter to least change in the partial changes over the overuse changes in the tendon tissue that cause deterioration and enable the development of therapies or "prehibitation" regimens that change over time [35]. Earlier it was believed that the tendon has only tenocytes which are capable of repairing the tendon. It has been recently found that tendons have specialized cells known as tendon derived stem cells which are capable of tendon repair and regeneration [36].
6. **Age Related Factors:** In the earlier studies deposition of lime salts has been attributed to be one of the reasons for degenerative process of the musculoskeletal region. Authors have learnt constant impingement below the acromion as the most probable reason for lime salts deposition. In these cases internal rotation and abduction will be more restricted. Major emphasis should be on regaining these movements [37]. In rare cases deposition of calcium salts in the supraspinatus tendon can result in subacromial stenosis and coracoid impingement. Sometimes large subacromial cyst have also been found in the subacromial area as a result of excessive calcium deposition [3]. These calcium deposits are mostly seen at the "critical zone" or the avascular zone therefore, treatments like extracorporeal shockwave therapy should be target to these areas for better treatment

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results [38]. Increase in the glutamate level is also found to be responsible for the disease. It is also said that various Glutamate and its involved glutaminergic system effects work on an important role in painful human tendon tears occurring frequently. But study did not find any strong correlation between the substance up-regulation and clinical outcomes [39]. Infraspinatus and supraspinatus are highly correlated in terms of tendon pathology. In a study it was found that impact in the substantial the fatty looking changes in the input infiltration of the injury occurrence infraspinatus was look after the strike seen over seen It was associated with worsening severity over the effective damage in conjunction with supra-spinatus tear lesions and atrophy, even in the absence of an enlarged tear. Thus, developing the external rotators is just as crucial as developing the supraspinatus [40].

III. CONCLUSIONS

Supraspinatus being the most commonly involved tendon in shoulder pain pathologies. It becomes very important to identify the exact mechanism behind the pathology which can take place in a variety of pathological forms. Causes could be Anatomical, biochemical, Vascular, work related, biomechanical, Genetical, or age related. Accordingly, demonstrated in a variety of ways clinically. Although putting blame for the condition on the acromion structure and posture remains primary but this study helps us to see the diversity of causes that could be involved in the evolution of the disorder. As every etiology takes a different course its management also cannot be defined by one particular protocol. We can make out from this information that there is not one particular way of seeing and treating a pathology hence, all the possible causes should be assessed and treated accordingly.

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V. LIST OF ABBREVIATIONS

PA- Pennation Angle

CSA- Critical Shoulder Angle

RC- Rotator Cuff

BS- Blood Supply

VEGF- Vascular Endothelial Growth Factor

VEGFR-1- Vascular Endothelial Growth Factor Receptor -1 gene

CTGF- Connective Tissue Growth Factors

GAG- Glucose Amino Glycans

HARP- Harmonin- interacting , ankyrin repeat containing protein

PG's-Proteoglycans

AUTHOR'S CONTRIBUTION

Karishma Chawla*- Major role in literature writing, data collection and idea of the research topic

Zainy Khan- Helped in conceptualization and guiding the process of the research paper writing

Nitin Dhar- Helped in statistical analyses and result conceptualization.

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