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Research Article

Shoulder Joint Osteoarthritis: Its Possible Neurosensory Impairments, Interactions and Postural Control Impacts

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Abstract

Osteoarthritis, a chronic joint disease induces high degrees of disability and health costs in all parts of the globe. Shoulder or glenohumeral osteoarthritis alone can be very disabling despite advanced surgical joint replacement availability, sophisticated diagnostic and remedial procedures. Discussed herein are data spanning 25 years of study 2000-2025 concerning shoulder osteoarthritis and its probable neuromotor pathogenic interactions and ramifications? A poorly studied topic, the data exploration process employed was designed to garner support for the idea that subnormal joint positional sense mechanisms and others involved in mediating or moderating shoulder movement and stability are an important shoulder osteoarthritis disease correlate and one worthy of efforts to detect this proactively, as well as to intervene accordingly to optimize and protect all shoulder neural structures and related somatosensory functions and avert injury.

Keywords: Glenohumeral Joint; Instability; Joint Position Sense; Neural Mechanisms; Osteoarthritis; Reflex Responses; Pain, Shoulder

Introduction

The disabling joint condition termed osteoarthritis remains a pervasive and intractable chronic health condition largely affecting older adults and persists despite years of study and investigation of the many possible causes thereof. Related research is, however, alluding to a highly important role for muscle as a disease precursor, modifier or mediator and in particular, implicates age related muscle wasting, as well as alterations in the desired muscle fat ratio that may expose the shoulder joint tissues and its cartilage lining to undue injurious impacts and forces and varying degrees of dysfunction. In addition, an intricate array of key mechanically sensitive nerve endings located in the shoulder joint capsule, tendons, ligaments and muscles, if injured, can severely disrupt the inherent ability of the individual to support the shoulder joint. At the same time, reactive muscle volume declines, possible decrements in shoulder joint stability and alterations in joint biomechanics, mobility, muscle recruitment, joint position sense, the sense of movement (kinesthesia) and the sense of force reproduction and functional wellbeing may develop incrementally and progressively [1-7].

Under normal conditions, the presiding or evoked joint neural network located at the shoulder that controls its motor functions and is designed to serve a functionally responsive and protective alliance may be subject to failure due to injury and aging. In this regard, ample data show this is especially challenging to address in the face of damage to those diverse neural receptors designed to interpret and convey mechanical messages to and from the joint tissues and muscles to the central nervous system even when assessed [6].

This situation is especially damaging at the shoulder joint, a somewhat unstable joint and where the presence of any impaired joint sensibility whether causative or not may continue to decline via internally located tissue damage, joint inflammation and pain, reactive muscle spasm, tendon attrition and a basic loss or waning of precisely modulated and functionally active hand or upper arm usage, muscle atrophy and possible muscle fatigue [5,7]. There may also be ongoing persistent and progressive

processes of subnormal bone remodelling, articular cartilage degeneration, soft tissue capsular, joint laxity, neural elemental, tendon and ligament alterations with subsequent deficits in their ability to integrate joint associated sensorimotor information rapidly and accurately, especially in the face of excess fat deposition or expansion in the shoulder muscles and tendons [9].

These possible interactive adverse neuromotor alterations, although theoretically reversible or preventable may well engender and account for further degrees of long term suffering if they impact the ability to place a joint accurately and thereby impose a state of progressive joint damage, muscle inflammation, as well as muscle alterations that may detrimentally impact muscle force sensibility and its reactivity, vibration sense, muscle tone and force generating activity, plus extensibility [10-12]. The affected person may consequently fail to be able to combat the development of muscle fibrosis, the emergence of excess or diminished joint range of motion, muscle fatigue and inflammation effects, plus varying degrees of progressive shoulder pathology [13-16].

To this end, this brief specifically examines whether: a) in addition to a subnormal muscle fat ratio, ongoing alterations in the neural or mechanoreceptor system supplying the arthritic shoulder joint capsule, ligaments and muscles warrant attention as far as remediation goes, b) possible insights from shoulder proprioception-related studies that may hold promise as far as resolving its role in influencing the widespread clinical problem of disabling shoulder arthritis in the older adult population and its solutions. It was believed this information might be of interest to orthopaedic clinicians as well as those who contemplate surgical solutions for osteoarthritis in general and specifically at the shoulder joint, where considerable suffering commonly prevails, but few options for its relief are evidenced. It was anticipated the literature would reveal limited numbers of studies highlighting the potential impact of proprioception as its focal point or any mention as to its impact on muscle fibrosis and atrophy, joint attrition and inflammation that can arise in the face of joint injury and/or aging and can possibly determine the degree of any ensuing pathology and surgical need and outcomes [12]. Neural integration and sensibility was selected as a theme for this review because among the most challenging aspects of the condition may be varying degrees of tears in the shoulder rotator cuff tendons, a site associated with sensory Golgi tendon organs and muscle contractile inputs that can currently accompany shoulder osteoarthritis and present enormous treatment challenges if these disrupt the ability to generate muscle forces and responses that protect against injury and tendinopathy. It was also selected because osteoarthritis is strongly associated with obesity and a youth study has shown obesity, to be associated with a lower than desired degree of proprioceptive acuity [9]. As well, in the face of pain and fears of moving the joint, weight gain may ensue inadvertently with unanticipated sensory ramifications. Taken together if unrelieved, one can predict possible unwanted increases in muscle atrophy and changes in the mechanisms and distribution of joint loads, cartilage viability, muscle fat infiltration and fibrosis [8].

Drawn largely from the PUBMED database, the largest medically oriented database, the overview builds on others that have aimed to provide the interested reader a general view of past as well as current trends and gaps as well as opportunities in this regard.

The focus was on shoulder osteoarthritis, now the third most common site and which may occur independently as a separate health condition or in conjunction with one or more chronic health conditions. Little studied when compared to the knee and hip joints, a shoulder that is constantly painful and weak is an enormous activity obstacle and deterrent to successful aging goals due to its many adverse impacts on life quality and functioning, including immense socioeconomic losses that may not be remedied readily in the older adult. While the world awaits a possible antidote in this regard, mounting evidence points to a possible role for the presence of proprioceptive as well as muscle fat and its expansion post injury as possible remediable interacting factors. In addition, the rationale for examining proprioception as a shoulder osteoarthritis determinant relates to its potential influence on the perpetuation of abnormal movement patterns and responses that may generate micro injuries and severe disability that demands excess health resource usage and unwanted public health costs.

This idea is not fanciful but one that has a long history of support showing motor control is dependent on the viability of a very complex neural network wherein one or more components of the the broad array of distinct neural sensory pathways surrounding and embedded in shoulder joint tissues and blood vessels are involved in governing its movement precision and quality, reflexive responses, sensibility and monitoring functions. In particular, it is assumed that when functioning optimally, the three specialized receptors found in the shoulder joint, termed Type 1, 2 and 3 receptors work in harmony to subserve position sense, movement patterns and desired muscle forces in the face of changing stimuli [7]. Under normal conditions, these synergistic well timed and modulated actions help protect the joint against excess damage due to sudden perturbations or excess

loading under dynamic conditions, but they do not heal readily or reverse any ongoing or emergent dysfunction once apparent.

These receptors are hence very vital to protect, not only are they more vulnerable to injury with age, but have a significant bearing on multiple inputs and outputs lodged in the shoulder bone-cartilage interfaces and their neurovascular components that house many pain receptors. However, despite the enormous mobility implications of having great limits placed on their upper arm usage in the presence of osteoarthritis pain, clinical research in this realm is limited with the exception of a widespread focus on youth studies and shoulder surgery, rather than on understanding the sources of the condition and disabling pain in the older adult population. However, we propose this is a topic of great import to pursue given that shoulder disabled adults who exhibit subnormal degrees of sensory awareness and reflex responsiveness may also pose multiple post operative challenges in a significant proportion of cases, regardless of age.

Alternately, if found to be influential in any way, interventions to enhance favourable neural responses and protect the joint may provide one avenue that is reasonably practical for purposes of securing the well-being of the aging shoulder osteoarthritis sufferer. This is increasingly so in the case of the chronic pain suffered by many older adult that live in the community and desire to be independent, as well as public health costs of housing 'otherwise' healthy older adults.

This work is also significant because the ability to minimize osteoarthritis severity is currently of the highest import in attempt to control narcotic use, especially among those older adults who want to remain productive and mobile. It aimed to specifically examine the value of conceptually viewing joint sensibility as a key form of joint protection or a network of adaptive organs designed to minimize the risk of acquiring and suffering from progressive bouts of micro injury and osteoarthritis pain compounded by declines in muscle volume and increases in muscle fat mass [16]. Its second aim was to offer recommendations for future consideration by clinicians and researchers in the field based on these findings.

Materials and Methods

To examine our line of inquiry we elected to employ the PUBMED, PubMed Central and Google Scholar data bases largely using 'best match' and 'most current' prompts and covering data published largely between January 2000-August 31, 2025, using the key words: osteoarthritis, shoulder and proprioception. Only articles focusing on osteoarthritis and some form of neurosensory association with joint function and dysfunction in shoulder osteoarthritis were selected for review. Described in narrative form, are some general ideas and results of the diverse array of current studies directed towards establishing how proprioception protects the shoulder joint and points made are those that have emerged over time and comport with the author's 25 years of research showing high degrees of neuromotor and joint sensor related causes of pain in cases with disabling hip and knee osteoarthritis.

It was felt this realm of exploration might prove insightful in understanding arthritis manifestations at the shoulder and especially in efforts to counter its progressive disabling presence.

Accordingly, discussed first is some general evidence that alludes to the key influences of shoulder sensory receptors or responses in shoulder joint stability. This perspective was chosen as it may have a bearing in the author's view on pain and the related hallmark of osteoarthritis, namely cartilage shock absorbing tissue degeneration changes and destruction, the presence or encroachment of fat into the muscles of vulnerable joints which atrophy and heighten injury risk and induce many functional disadvantages. Second, some emerging evidence of a key role for preventive health behaviors and injury prevention as a mediating or moderating pathogenic factor in this respect is alluded to. Third, clinical implications and future research ideas are presented.

It was assumed, afferent inputs from shoulder based mechanoreceptors types 1-3 located in the shoulder joint and its overlying skin, muscles, joint capsule, ligaments and tendons have the potential to impact local muscle function, muscle composition, strength and joint stability [7, 10, 11, 17]. It was further assumed aging, macro/micro injury, being overweight, using the upper arm repeatedly and non physiologically, injections, poor muscle endurance, fatigue, unresolved joint inflammation and surgery may foster possible alterations in one or more shoulder sensorimotor structures and their integration processes that are not readily reversible. Consequently, it was assumed unwanted joint functional outcomes and pain provoking adaptations both before as well as after surgical joint replacement or nerve blocks or both may be observed in the face of a breakdown of

sensorimotor mechanisms that may generate pain in its own right while heightening osteoarthritis risk, progression and disability. A recent review offering in depth analyses of shoulder proprioception implications is that by Fox, et al., [30].

Global Findings

Despite a dedicated search for potentially relevant data and after a careful examination of the PUBMED data base contents, it was clear most publications on shoulder osteoarthritis were generally not based on prospective or targeted studies of the older adult with shoulder osteoarthritis and most were observational studies using dubious unproven measurement tools and instrumental methods with unknown properties or cadaver related samples. These were also generally non uniform in multiple design realms that is even more apparent if one takes into account studies on adolescents were not included, but that osteoarthritis is said to be an emerging epidemic condition in the elderly.

The challenges faced by older adults with shoulder osteoarthritis that have been examined for some time although not at all current, largely fail to update the enormous disease impact on functional independence, social and occupational deficits a sufferer may incur and that may make the nursing home the only viable late life venue.

In this regard, past research shows that many aging adults who have a high risk of incurring shoulder joint injuries as well as age related muscle mass losses and parallel disturbances in proprioception interactions and related strength declines, often go on to manifest severe osteoarthritis. But very few discuss the disease etiology and a role for targeted interventions to minimize joint dysfunction and attrition in consideration of its multi dimensional neural networks and sensory receptors that may be violated or subject to subnormal stresses. A disease with enormous disabling features in its own right and one often linked to rotator cuff tendinopathy and tears, calcific tendinitis, adhesive capsulitis, glenohumeral instability and acromioclavicular disorders this painful condition is clearly especially disabling in multiple life affirming respects and only a concerted effort to delineate its risk factors will likely help to mitigate this downward spiral, as is borne out in numerous surgical follow up studies.

Among these is the potentially highly significant role of sensorimotor feedback processes that normally emerge from a diverse intrinsic sensory receptor network that links joint tissue biology and desired adaptive inputs to the central nervous system and thereby to the generation of the most optimal and functional biomechanical and stabilizing features of the joint. They play a key role among other factors in generating timely sensorimotor reflex responses, micro and macro injury prevention and provide the brain with inputs that serve to accurately estimate arm position [12-15]. A recent investigation has clearly shown this afferent system to consist of varying degrees of free nerve endings and three types of sensory corpuscles that may be disrupted in the face of trauma and aging and that vary in relative density and spatial arrangement among the shoulder joint tissues [10]. Joints from subjects suffering chronic shoulder pain may however show a reduction in the presence of some sensory corpuscles.

Further Findings

While not widely documented, nor universally applied to a degree commensurate with its diverse pathogenic disease ramifications, proprioceptive attributes, feedback control processes and their associations with muscle do appear to potentially explain and may predict diverse aspects of shoulder osteoarthritis progression as well possible surgical challenges. It is also reported that current reports should be viewed with caution because they do not commonly provide sufficient data to reliably back up their conclusions especially about adverse events and harm to joint replacement or repair strategies for rotator cuff tears. A fair focus however, is placed on exercises to advance proprioception that suggests it is a recognized system that controls movement including muscle force and joint position perceptions and one that has multiple implications for joint loading, joint protection, joint stability, mobility and pain, muscle imbalances, deforming muscle contractures, varying degrees of muscle spasm, immobility and subnormal vector influences [14,19]. Affecting numerous neuromuscular functions including functional changes in muscle kinematics, biochemistry and muscle size that may have a unique or collective bearing on cartilage viability proprioception at the shoulder should be assessed and findings followed up accordingly to avert pain, possible fears of moving due to pain, and/or shoulder dislocation, plus the inability of the injured joint tissues to heal or regenerate [3,4,14,15,18].

Centralization or enhanced pain sensitivity possibly indicative of subnormal sensory inputs, abnormal glenoid wear and excess tendon degeneration do indeed appear important in determining and explaining surgical management outcomes and possibly conservative care as well [16-20,25]. Moreover, without due or carefully construed care, the affected individual may continue to show signs of a gradually diminishing joint range of motion, an increasing degree of joint stiffness, a subnormal degree of muscle

strength and endurance capacity and motor mechanics that hasten an ongoing cycle of disordered joint destruction processes, inflammation and pain [18, 22].

In this regard, a pervasive array of adverse conditions may follow as well as dejection and despair since upper arm use is a prerequisite for most daily functions including use of a walker or assistive device. Since age alone is clearly not the universal shoulder osteoarthritis determinant, any degree of persistent shoulder pain or worsening pain, should be addressed as early as possible to offset or mitigate those factors that may involve or implicate neurosensory trauma, plus disease associated subnormal neural and muscle metabolic states, muscle mass losses, increasing bouts of sedentary behaviors and a deficit in loads needed for muscle and cartilage regeneration [21,24,26]. Moreover, attention is warranted to avert any emergent unwillingness on the part of the affected adult to move to counter increasing pain and stiffness, alongside abnormal movement patterns, muscle mass declines, inflammation and capsular thickening [23,24,27].

While more data are indicated here, additional data show position sense declines three years after shoulder surgery that could be causative or reactive or both and may entail degenerative changes in the tendons of the aging rotator cuff [25,29]. As well, those cases displaying atrophic muscle weakness disruptions may show declines in muscle force capacity, force estimation sensations, as well as responsiveness with dire ramifications even if reconstructive surgery appears to restore some of these proprioception characteristics [30,31]. One additional recent noteworthy finding here is that careful coordination of the muscles cros sing the shoulder is needed to maintain the delicate balance between the joint's mobility and stabilizing functions. Based on experimental evidence it was concluded that the stretch reflexes within shoulder muscles are modulated based on the aggregate activity of muscles crossing the joint, not just the activity of the muscle in which the reflex is elicited and reflect the important role in coordinating this through neural coupling in the face of environmental perturbations [32]. Indeed, based on this finding and others it can be argued possible impairments in joint proprioception along with central processing mechanistic changes may further serve to amplify the pain and dysfunction attributable to the local condition even after surgery and especially in the absence of salient timely targeted intervention that embrace efforts to mitigate pain inputs, obesity and possible shoulder muscle fatty tissue infiltration and deposition [16,35]. This idea accords with those expressed in a well articulated histological study where it appeared any disruption of the shoulder joint labrum or the ligaments induced by trauma or surgery can deprive the shoulder of mechanical stability and may cause a decrease in proprioception because of the loss of these afferent neural receptors [37]. These associations were clearly quite complex and showed the presence of two morphological types of mechanoreceptors and free nerve endings in the ligaments, the coracoclavicular and coracoacromial ligaments, glenoid labrum and the subacromial bursae that may all be subject to structural and functional alterations.

Other data confirm that with regard tothe shoulder joint capsule and glenoid labrum, embedded corpuscular mechanoreceptors appear to play an important role in joint control by fostering protective reflex actions desired in the presence of extreme or abnormal movements. Their density in distinct areas of the shoulder joint capsule appears to be related to zones that are subjected to increased biomechanical stress during physical activity [15].

Discussion

Building on almost three decades of inquiry it is clear shoulder osteoarthritis, common in older adults, can greatly impair function and overall life quality. In this regard, this overview was designed to urge researchers and clinicians to go beyond traditional disease understandings and beliefs and focus on possible disease influences that include neurosensory deficits as related to the disease manifestations of pain, muscle atrophy, muscle fat infiltration, tendon tears and fibrosis and rotator cuff muscle degeneration. This was predicated on the impact of subnormal proprioception on the ability to control muscle forces as well as joint stability and its influence on inherent muscle or joint tissue regenerative potential.

Indeed, in contrast to the pain transmitting free nerve endings in the joint tissues, the role of the proprioceptive sensors is to provide information on actual motor performance and foster reflexes, joint stability, joint congruity and muscle power; that can protect the joint as well as enhancing the inherent capacities for repair and remodeling of the musculoskeletal tissues [35].

However, if joint sensibility is impaired in some way, muscle imbalances as well as degeneration may be hastened, fatty tissue and muscle abnormalities, for example fibrosis, may prevail and the rotator cuff tendons can degenerate and/or tear from the greater tuberosity of the humerus which is associated with several anatomical, physiological, biochemical and molecular changes

in tendon, as well as muscle immunobiological responses and neural network responses and transmission abnormalities or damage. The role of proprioception as a neuromuscular shoulder joint stabilizer and its bearing on degeneration of the joint and surgery outcomes alongside abnormal reactive muscle forces may strongly influence structural joint changes plus pain and disturbances in the length-tension relationship of the posterior rotator cuff inducing or perpetuating degradation of the shoulder or glenoid cavity cartilage [28,32-36].

As such the data reveal why it is not easy to reverse shoulder osteoarthritis especially if this involves the shoulder rotator cuff muscles. Moreover, almost all articles on shoulder osteoarthritis muscles refer to a role for fat infiltration that may arise from proprioceptive and related pain manifestations but do not translate this into most clinically oriented intervention discussions.

Moreover, what we know is not only affected by a lack of data, but what is indicated may not be reliable or valid for generalization purposes. In particular, muscle stress protection that seems crucial is not discussed to any degree in older adult contexts of care, thus potentially placing the osteoarthritis shoulder joint at risk for further disease progression. As well, although a recent practitioner oriented study discussed some modes of intervention assumed of benefit to the shoulder osteoarthritis patient this was largely based on knee and hip studies and clinician not patient opinions even though both have a shared role in achieving the goals of a rehabilitation program [38,40]. This may include-

- Strengthening exercises [40]
- Proprioceptive neuromuscular facilitation [41,42]
- Combinations of proprioceptive and strengthening exercises [43]
- Motor control retraining where it is argued the induced improvement by this form of exercise treatment will linger on even after one month of follow-up assessments [44]

Here Wu, et al., conclude that compared to non-specific exercises, specific exercise programs moderately alleviate shoulder pain symptoms, with shorter interventions demonstrating marginally superior outcomes [45]. However, efficacy varies by exercise type, emphasizing the need for individualized prescriptions. Zhu, et al., further conclude facilitating joint proprioception can help cases with scapulohumeral periarthritis, pain and shoulder weakness and dysfunction [46]. In addition, they argue for the importance of fostering a sound psychological state and one conducive to fostering the recovery of a persons' former health status. This is important because in the clinical realm, it is argued, medical staff should pay attention to the psychological state of patients with shoulder pain that can be disabling in the older adult population in its own right.

One novel suggestion that appears promising is early intervention with motor imagery for purposes of resting and reducing functional pain, excess joint range of motion and edema [47]. Another suggests Integrative Korean medicine treatment is a potential option for reducing pain severity and improving function and health-related quality of life in patients with shoulder osteoarthritis and a future series of this line of inquiry using prospective randomized designs would prove helpful here [48].

Encouraging healthy as well as symptomatic older adults to take care at all times to avoid overexertion, muscle fatigue and repetitive upper arm movements, may avert the probability of an impairment of muscle reflexes from emerging and that can foster an array of muscle deficits and pain [18].

Alternately, it appears that shoulder osteoarthritis cases may suffer in part due to associated altered levels of subnormal neurosensory functions and actions, including its role in mediating muscle spasm and pain. Another set of studies points to possible perceptual control losses of joint sense and force control as well as arm position perception, muscle and strength losses that may impair muscle force generating capacity and its stabilizing role while fostering possible kinesiophobia or fears of moving the arm as well as persistent tendon inflammation, declines in the perception of force signals required for weight discrimination, muscle fat infiltration as well as muscle atrophy and nerve entrapment, often with devastating mobility, psychological and functional results [15,16,36-39,49,50]. By contrast, it appears well designed long term sensorimotor rehabilitation will yield benefits if coupled with clinical efforts to protect damaged joints and mitigate muscle and nerve disturbances and accords with the nature of any possible neural based deficit [47,49,50-55]. Meantime, it is shown that the decisions regarding the best individual treatments are highly diverse at best and non uniform and deserve more unifying forms of meticulous carefully controlled study [56,57].

In addition, Duzgun, et al., reiterate that the glenohumeral joint, which is a mechanoreceptor-rich joint, may fail to respond to

treatment if one or more interventions are not design specific and overlook the important role of the surrounding musculature as well as proprioceptive functions in the maintenance of joint homeostasis and muscle timing [52]. This may render desired upper arm functions of daily living unattainable without help, while provoking distress and possible health declines if sleep is disrupted [53].

A simplistic linear applied solution to improve shoulder motor control seems elusive though given that the existence of a reflex arc from the mechanoreceptors within the glenohumeral capsule to muscles crossing the joint, plus muscle spindle and tendon complexes that may all engender possible disturbances in adjusting the upper arm to perturbations in the face of low levels inputs and coordination deficits [61-63]. This situation, if unresolved, may markedly reduce the ability of the individual to function physically. Joint biomechanics may also be progressively impaired as well as cartilage and one or more soft tissue structures. Joint shock absorption mechanism may fail and the resultant accumulation of bone micro impacts may induce marked degrees of discomfort and pain, joint inflammation and stiffness and movement limitations.

Realms of possible interest to pursue here are: the roles of (1) the shoulder joint peripheral sensory receptors, (2) peripheral pain processing or 'nociception' mechanisms and (3) the location of any receptor damage and how these factors might contribute to the variability in the clinical presentation, the diagnosis and the treatment of shoulder pain [30, 65]. In the interim it appears shoulder proprioception can likely both contribute to and be caused by shoulder pathology. To avoid overlooking this potential cycle of impairment, it is recommended patients with rotator cuff tears, glenohumeral osteoarthritis and shoulder instability be carefully assessed and their proprioception deficits targeted accordingly [30,38,43,58-65].

Conclusion

In line with the above discourse and despite its limitations, we conclude:

- Older adults and those at risk for excess reactive or age associated neuromotor declines may suffer in multiple ways if they incur injury sufficient to invoke an array of neural disruptions and subnormal shoulder joint motor outputs and cartilage impacts
- While not definitive, mechanoreceptors appear highly important to acknowledge and preserve, for example in surgical realms, as well as in occupational protection arenas and use of neural blocks
- Preventing and ameliorating the magnitude and extent of deficient sensori motor functions in those with shoulder osteoarthritis may offer one pathway that can mitigate disabling shoulder osteoarthritis and its severity even in cases that undergo joint replacement surgery

Moreover, unless addressed, it appears most clinical researchers will continue to assume sensory disturbances as well as muscle problems of some sort underlie and impact osteoarthritis shoulder pain and if minimized or normalized will prove beneficial, but this is not only unproven, but overlooks the magnitude of the diverse innervation pathways subserving the shoulder that could be implicated. More specific lab as well as clinical exploration should help enormously however, in our estimation, as cited by most current shoulder anatomy and researchers who study as well as conduct joint replacement surgery especially at the shoulder joint. In particular, helping younger and vulnerable aging adults to avoid repetitive eccentric muscle forces plus nonphysiological repeated joint impacts is strongly advocated. However, it is equally vital especially in the older adult to avoid adopting a sedentary lifestyle, thus educating them about the impact of excess body weight and joint impacts on their wellbeing and need for possible joint protection, environmental and lifestyle adaptations, plus their participation in exercises to build strength is highly indicated as well and should not be neglected. In the future, it is possible the use of artificial intelligence generated innervation mapping procedures may further help pinpoint nerve pathways and any structurally relevant disease features as well as remedial opportunities. Augmented reality for operative care and postoperative rehabilitation using immersive technologies for shoulder surgery is another realm that remains underexplored and presents an opportunity for future research as well as practice. In the interim, we assert that despite a lack of solid data, the associations between a progressive decline in joint sense as well as skeletal muscle mass and function cannot be ignored in efforts to tease out the etiology of disabling shoulder osteoarthritis in later life as well as its perpetuation. Moreover, a failure to appreciate and understand the importance of identifying, tracking and examining neurosensory as well as muscle factors in general in the realm of both osteoarthritis research and the design of optimal shoulder osteoarthritis rehabilitation plans may be shortsighted at best and certain to fail.

Conflict of Interests

The authors declare that there is no conflict of interest related to this study.

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