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Current concepts of scapular dyskinesia: Clinical implications and rehabilitation

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Abstract
Scapular dyskinesis ('dys'—alteration of, 'kinesis'— movement) is a collective term that refers to movement of the scapula that is dysfunctional-Multiple factors may cause dyskinesis. Bony causes include thoracic kyphosis or clavicle fracture nonunion or shortened mal-union. Joint causes include high grade AC instability, AC arthrosis and instability and GH joint internal derangement. Several authors have demonstrated altered muscle activity patterns in the scapular muscles in patients with shoulder impingement. These include altered muscular activity or strength, and changes in the timing properties of the serratus anterior (SA), the upper (UT), middle (MT) and lower (LT) portions of the trapezius. In particular, researchers consistently demonstrated a decreased strength in SA, hyperactivity and early activation of UT (resulting in a shrug excessive elevation of the shoulder girdle during arm elevation), and decreased activity and late activation of MT and LT.

Keywords: scapular dyskinesia, dyskinesia, scapula muscle, neck pain, scapula disorder

Introduction
Chronic neck and shoulder pain are among the three most prevalent musculoskeletal disorders in the general population, with more than 60% of individuals suffering neck/shoulder pain at some stage throughout life [1, 2]. There is a strong relationship between chronic neck and shoulder pain and dysfunction of the scapula. The scapula functions as a 'bridge' between the shoulder complex and the cervical spine and plays a very important role in providing both mobility and stability to the neck/shoulder region [3].

Scapular Dyskinesis
Knowledge regarding the role of scapula in shoulder function has been gradually accumulating. It has been difficult to track scapular motion because of the relatively deep position of the scapula, the overlying muscles and the potentially complex nature of the position and motion of the scapula during planar arm motions and functional tasks. Early studies of scapular motion in healthy individuals defined two-dimensional SHR Scapulo Humeral Rhythm [4, 5] Dyskinesis has been hypothesised to relate to changes in GH angulation, AC joint strain, subacromial space dimension, shoulder muscle activation and humeral position and motion.
Scapular dyskinesis ('dys'—alteration of, 'kinesis'— movement) is a collective term that refers to movement of the scapula that is dysfunctional. Scapular dyskinesis has been identifi ed by a group of experts as: abnormal static scapular position and/or dynamic scapular motion characterized by medial border prominence; or inferior angle prominence and/or early scapular elevation. or shrugging on arm elevation; and/or rapid downward rotation during arm lowering.5 However, static position and dynamic motion are two separate entities, so when describing the static appearance of the scapula and if an asymmetry is observed, it should be referred to as 'altered scapular resting position' rather than 'scapular dyskinesis'. Scapular dyskinesis is a non-specifi c response to a painful condition in the shoulder rather than a specifi c response to certain glenohumeral pathology. Scapular dyskinesis has multiple causative factors, both proximally (muscle weakness/ imbalance, nerve injury) and distally (acromioclavicular joint injury, superior labral tears, rotator cuff injury) based. This dyskinesis can alter the roles of the scapula in the scapula– humeral rhythm. It can be due to alterations in the bony stabilisers, alterations in muscle activation patterns or strength in the dynamic muscle stabilisers.

Causes of Dyskinesis
Multiple factors may cause dyskinesis. Bony causes include thoracic kyphosis or clavicle fracture nonunion or shortened mal-union. Joint causes include high grade AC instability, AC arthrosis and instability and GH joint internal derangement. Neurological causes include cervical radiculopathy. Long thoracic or spinal accessory nerve palsy. Soft tissue mechanisms for scapular dyskinesis involve inflexibility (tightness) or intrinsic muscle problems. Inflexibility and stiffness of the pectoralis minor and biceps short head can create anterior tilt and protraction due to their pull on the coracoid [6]. Soft tissue posterior shoulder inflexibility can lead to GH internal rotation deficit (GIRD), which creates a 'wind-up' of the scapula on the thorax with reduced humeral internal rotation and horizontal abduction. Alterations in periscapular muscle activation are related to scapular dyskinesis. Serratus anterior activation and strength is decreased in patients with impingement and shoulder pain, contributing to the loss of posterior tilt and upward rotation causing dyskinesis [7]. In addition, the upper trapezius/lower trapezius force couple may be altered, with delayed onset of activation in the lower trapezius, which alters scapular upward rotation and posterior tilt [8-10]. Altered scapular motion or

position both decrease linear measures of the subacromial space, increase impingement symptoms, decrease rotator cuff strength, increase strain on the anterior GH ligaments and increase the risk of internal impingement.

Lack of soft tissue flexibility

With respect to soft tissue inflexibility, tightness of the m pectoralis minor and posterior glenohumeral capsular stiffness has been established in relation to abnormal scapular position. Increased scapular internal rotation, as well as increased anterior tilting, has been demonstrated in healthy individuals with a short m pectoralis minor [11-12]. Subjects with posterior shoulder stiffness (evaluated by measuring the passive glenohumeral internal rotation range of motion) have been found to have greater scapular anterior tilt compared to subjects with the normal glenohumeral internal rotation range of motion.13 These alterations in scapular position are similar to the scapular deviations, established in patients with impingement symptoms [14-18]. Tyler *et al* [19] quantified posterior shoulder tightness and motion loss in patients with shoulder impingement. The authors also found that correction of posterior shoulder tightness was associated with symptom resolution in patients with impingement symptoms.[20] In addition, posterior shoulder and pectoralis minor stiffness have been identified as a possible risk factor for chronic shoulder pain in overhead athletes. In summary, evidence suggests a significant association between stiffness of soft tissue surrounding the scapula, scapular dyskinesis and chronic neck/shoulder complaints. However, stiffness of other structures possibly altering scapular kinematics, such as the m levator scapulae, m latissimus dorsi, the glenohumeral external rotator muscles and the m rhomboidei, has not yet been quantified, but could possibly contribute to motion restriction of the scapula, based on scapular dyskinesis.

Lack of muscle performance

Several authors have demonstrated altered muscle activity patterns in the scapular muscles in patients with shoulder impingement. These include altered muscular activity or strength, and changes in the timing properties of the serratus anterior (SA), the upper (UT), middle (MT) and lower (LT) portions of the trapezius. In particular, researchers consistently demonstrated a decreased strength in SA, hyperactivity and early activation of UT (resulting in a shrug excessive elevation of the shoulder girdle during arm elevation), and decreased activity and late activation of MTand LT [21-22]. [23-26] Most studies investigating axioscapular muscle function in neck pain have focused on UT. Changes in the behaviour of UT during typing or other similar upper limb tasks have been shown in patients with both insidious onset and traumatic onset neck pain in clinical [27-31] as well as in experimental pain studies.Zakharova-Luneva *et al* and Wegner *et al* evaluated the behaviour of all three portions of trapezius muscle in patients with chronic mechanical neck pain. During a typing task, the neck pain patients generated greater activity in the middle trapezius and less activity in the lower trapezius compared to the control group, whereas during isometric shoulder abduction and external rotation significantly greater levels of LT electromyography (EMG) signals were observed in the patient group and no changes in UT and MT. Recently, some studies have also demonstrated altered activity of SA in patients with cervical disorders, during different arm elevation tasks using surface EMG and mfMRI. Helgadottir *et al* demonstrated a significantly delayed onset of muscle activation and less duration of muscle activity of SA on both sides during arm elevation. O'Leary *et al* demonstrated a different activation pattern between the upper and lower parts of SA during elevation in a healthy control group, which was not different in subjects with mechanical neck pain. Scapular dyskinesis has been identified not only in patients with shulder pathology, but also in healthy overhead athletes as a sport specific adaptation [32-35]. Some studies demonstrate sport-specific adaptations in favour of scapular stability, showing stronger scapular muscles and favourable scapular positioning and movement patterns, whereas others demonstrated scapular abnormalities, possibly increasing the risk for chronic shoulder pain in this population, for instance, a lack of upward rotation or decreased flexibility of the m pectoralis minor muscle. On the level of muscle strength, recent studies indicate a relative weakness of the stabilising muscles of the scapula (in particular, MT and LT) compared to the prime movers (UT) in adolescent overhead athletes. These data might help the clinician to identify the possible risk factors for shoulder pain and develop preventive training programmes.

Cause–Consequence relationship between scapular dyskinesis and neck or shoulder pain

There is no consensus about the cause–consequence relationship between scapular dyskinesis and shoulder or neck pain. Several mechanisms can potentially contribute to alterations in scapular kinematics. These include pain, soft tissue stiffness, muscle activation or strength imbalances, muscle fatigue and thoracic posture. It is unclear whether the alterations found in scapular kinematics are compensatory or contributory to neck/shoulder pathology. Recently, a first prospective study was published showing that scapular dyskinesis, based on visual observation, is a risk factor for shoulder pain during the season in professional rugby players [36]. Possibly, scapular dyskinesis predisposes the subject to develop neck/shoulder pain, but once the abnormality presents, scapular dyskinesis may be exacerbated by paininhibition mechanisms. The latter is often found in clinical practice. Bilateral scapular abnormal positioning and movement patterns (suggesting the primary cause for shoulder pain) are frequently observed during clinical examination, but to a worse degree on the painful side (suggesting scapular dyskinesis being exacerbated by pain). To support this observation, experimental pain studies have demonstrated that pain may directly contribute to the initiation of altered behaviour and function of the axioscapular muscles. According to a new theory of pain adaptation, it is suggested that during episodes of pain, there is a redistribution of activity within and between muscles, which may have some benefit in the short term (protection from further pain or injury), but there is the potential for adverse long-term mechanical consequences to pain-sensitive tissues.

Scientific rationale for a scapular rehabilitation programme

Recently, several studies have examined the effectiveness of a scapula-based rehabilitation programme. Vande Velde *et al*

showed that a 12-week scapular training programme resulted in a significant increase in isokinetic scapular muscle strength in healthy adolescent swimmers, and from a study of Merolla *et al*, strength increase in the glenohumeral external rotators was apparent after a 6-month training programme in volleyball players with scapular dyskinesis. The latter study is of particular importance since it showed that scapular training improved glenohumeral muscle function, specifically the external rotators which are highly stressed during overhead activities. However, both the studies mentioned were performed on healthy non-injured overhead athletes. Recently, De Mey *et al* showed that after 6 weeks of training according to the method described by Cools *et al*, overhead athletes with impingement symptoms showed improved scapular muscle recruitment. In this study, surface EMG activity was recorded from the four major scapular muscles before and after the training programme. The main result was that the relative muscle activity for UT during arm elevation significantly decreased compared to the pretraining test and compared to the other scapular muscles. In view of the assumption that UT is often overactive in patients with impingement, a decrease in activity implicates a more efficient scapular recruitment pattern. In addition, SPADI scores showed significant functional improvement and less pain after completing the scapula-based exercise programme. A few randomised controlled trials confirmed the value of scapular exercises in the treatment of shoulder impingement. In general, these studies show better results regarding functional outcome, strength and patient satisfaction if a scapular approach is implemented in the treatment protocol. However, further research is required to show that restoring scapular control directly influences shoulder and neck pain.

Conclusion

In summary, there is evidence of scapular kinematic alterations associated with shoulder and neck pain. There is also evidence of altered scapular muscle recruitment patterns in these patients, with respect to changes in strength, flexibility, motor control and timing of the surrounding muscles. In particular, lack of flexibility, in combination with muscle dysfunction of SA and LT, might be the clinical base for a treatment programme given to these patients. The available evidence in clinical trials supports the use of therapeutic exercise in the rehabilitation of these patients; however, future studies should be performed to confirm the effectiveness of these exercise protocols.

Summary

Summary

The scapula functions as a bridge between the shoulder complex and the cervical spine.

- Although the association between abnormal scapular positions and motions and glenohumeral joint pathology has been well established in the literature, studies investigating the relationship between neck pain and scapular dysfunction have only recently begun to emerge.
- Overall, scapular rehabilitation guidelines decent for both patients with shoulder pain as well as patients with neck problems are lacking.
- A science-based clinical reasoning algorithm with practical guidelines is provided which may help the clinician to put the rehabilitation of scapular dyskinesis into a precise perspective of the thorough treatment of shoulder and/or neck dysfunction.

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