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REVIEW ARTICLE

The Management of Atraumatic Shoulder Instability

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ABSTRACT

The definition of atraumatic shoulder instability is 'abnormal motion or position of the shoulder that leads to pain, subluxations, dislocations and functional impairment.... Without any history of a significant preceding injury'.

Atraumatic shoulder instability can be a severely disabling condition resulting in reduced quality of life, even simple daily tasks such as reaching for a glass may lead to subluxation and pain.

The management of ASI remains a challenging and under-researched area. This is in part due to the multiple potential underlying causes which can co-exist in each presentation, and the strong association with psychosocial co-morbidities that can negatively impact engagement with treatment and post-operative outcomes.

This review will detail the anatomical and biomechanical basis of ASI, the essential considerations in clinical assessment and investigation, as well as the current evidence and ongoing controversies regarding management.

Keywords: Shoulder, glenohumeral, atraumatic, instability, dislocation, multidirectional

Introduction

The definition of atraumatic shoulder instability (ASI) is 'abnormal motion or position of the shoulder that leads to pain, subluxations, dislocations and functional impairment.... Without any history of a significant preceding injury' [1]. Atraumatic shoulder instability can be a severely disabling condition resulting in reduced quality of life, even simple daily tasks such as reaching for a glass may lead to subluxation and pain [2]. There are many potential causes including, but not restricted to, aberrant muscular activation, altered proprioceptive and motor neural pathways and capacious capsular volume.

The management of ASI remains a challenging and under-researched area. This is in part due to the multiple potential underlying causes which can co-exist in each presentation, and the strong association with psychosocial co-morbidities that can negatively impact engagement with treatment and post-operative outcomes. Non-operative management, with a specialist upper limb rehabilitation programme, is the mainstay of treatment and there is growing evidence for its efficacy in this condition. Surgical intervention should be reserved for cases with defined structural pathology, that have failed conservative measures and have had mental and social co-morbidities optimized.

This review will detail the anatomical and biomechanical basis of ASI, the essential considerations in clinical assessment and investigation, as well as the current evidence and ongoing controversies regarding management.

Classifications, Anatomy and Biomechanics

There are numerous classifications and terminologies used to describe the clinical entity of ASI. Neer and Foster first described multidirectional instability (MDI) of the shoulder as anterior and posterior instability with inferior subluxation or dislocation [3, 4]. This definition was then refined by Neer as instability in 2 or more directions with minimal or no structural damage [4]. Shoulder instability that occurs due to aberrant and unbalanced activation of the rotator cuff and periscapular musculature can also be known as functional shoulder instability (FSI) [5]. Functional shoulder instability can be further described according to the direction of instability, whether controllable or non-controllable, and whether positional instability (during movement) or non-positional instability (in neutral position) [6]. Alternative terms subsequently used to classify shoulder instability are Traumatic, Unilateral, Bankart lesion, Surgery (TUBS) AND Atraumatic, Multidirectional, Bilateral, Rehabilitation, Inferior capsular shift (AMBRI) [7].

The relationship between these different forms of glenohumeral joint (GHJ) instability can be understood as a spectrum comprising the polar groups of the Stanmore classification [8]. Type I—traumatic with associated structural defects, Type II—atraumatic with an absence of bony structural defects and Type III—secondary to muscle patterning [8]. Type II and III shoulder instability come under the umbrella term 'atraumatic shoulder instability' which is estimated to account for 4% -10% of shoulder instability cases [9,10]. Atraumatic shoulder instability is a dynamic condition and repetitive trauma to the GHJ from subluxations and dislocations can result in structural defects over time. Atraumatic shoulder instability may not be multidirectional but in cases where MDI is identified the pathoanatomy is most frequently increased GHJ volume due to redundant capsule [11]. This increased capsular volume can lead to symptomatic subluxations and/or dislocations which may be anterior-inferior with posterior subluxation, posterior-inferior with anterior subluxation or global dislocation [3].

There is growing evidence that the proprioceptive and motor neural pathways of patients with ASI are altered. Howard et al [12] used functional MRI (fMRI) to assess the brain activity of patients with ASI during forward flexion and abduction compared to age matched controls. They found significantly greater activity of the primary motor cortex, supramarginal gyrus, inferior frontal gyrus, precentral gyrus and middle frontal gyrus suggesting that these patients were 'working harder' to maintain motor stability. Poor scapular control, leading to downward rotation, winging and forward tilt on arm elevation, can also contribute to ASI by reducing GHJ congruency [13,14]. Nyiri et al [15] confirmed with biomechanical analysis that patients with MDI had significantly altered kinematic parameters and muscle activity compared with healthy controls.

The Comprehensive Assessment of Atraumatic Shoulder Instability

A thorough history of the nature, onset and timing of symptoms is essential. In those patients with hyperlaxity symptoms may have commenced following a minor injury or event. Involvement of other joints should be considered. The history should detail the occurrence and direction of subluxations and dislocations, apprehension with movement and position, the quality and distribution of any pain, the presence of neuropathic pain or neurological disturbance, functional limitations and general health including psychosocial comorbidities [16].

Examination findings specific to instability include the direction of instability and whether this occurs at rest or on movement. Abnormal muscle patterning can be identified on examination. The lower trapezius, infraspinatus, supraspinatus and deltoid may be underactive whereas the latissimus dorsi and pectoralis major may be overactive [17,18]. This disordered muscular function may occur due to muscular deconditioning

and weakness, avoidance pain, altered proprioception or as a fear-avoidant strategy [17]. It should be noted whether the neutrality of pelvis, trunk and neck on arm movement is maintained. The arm may assume a position of excessive internal rotation and hyperextension of the elbow on elevation of the GHJ . Any aberrant positioning of the scapula, arm or body should be corrected by the examiner and the movements repeated to assess improvement in symptoms [17].

Hypermobility is a common aetiology in ASI which can complicate management and rehabilitation, a Beighton score should be undertaken to quantify the degree of laxity [19]. The 2017 Ehlers Danlos Syndrome (EDS) diagnostic criteria can be applied to diagnose Joint Hypermobility Syndrome. (JHS) and hypermobility spectrum disorder (HSD) [20,21]. If laxity affects only the glenohumeral joint this is considered a localized HSD [20,21]. The history may reveal non-musculoskeletal symptoms of JHS such as autonomic dysfunction, vascular disorders, gastrointestinal disturbance and chronic fatigue [17, 22].

Imaging and Diagnostics

Investigation should begin with plain radiographs, these may identify glenoid dysplasia or hypoplasia, glenoid or humeral bone loss [23]. Bony defects can be further quantified by a computed tomography (CT) scan in axial and coronal planes [23].

For soft tissue evaluation a magnetic resonance imaging (MRI), or preferably MR arthrography (MRA), is recommended. An MRA including standard and abduction/ external rotation (ABER) images, can identify pathology of the labrum, rotator interval (RI) and glenohumeral ligaments. The most common finding is increased GHJ volume and RI dimension, without or without the presence of attritional labral tears. Schaeffler et al [24] found that on MRA the combination of a 'crescent sign' - enhancing layer between the humeral head and anterior-inferior glenohumeral ligament with 'triangle sign' - enhancing triangular space between the humeral head, anterior-inferior glenohumeral ligament and glenoid, had good sensitivity and specificity for MDI. Moroder et al [25] assessed FSI patients with fluoroscopy and MRI, the most common findings were glenoid flattening and glenoid dysplasia with soft tissue compensation.

Indications for Management in Tertiary Care

Certain patient groups should be identified early and referred to a specialist tertiary unit. The British Elbow and Shoulder Society (BESS) patient care pathway for ASI stipulates that onward referral is necessary for those with a PainDETECT score of greater than 19, those under the age of 18 who have been absent from more than 20% of schooling or over 3 months of work, patients that report persistent dislocation or subluxation and those frequently attending emergency departments for shoulder relocation should be referred early to a tertiary unit [1]. In part these guidelines reflect the significant economic burden that ASI in young working age patients can represent. Van der Linde et al [26] found the combined cost of productivity loss and healthcare utilization per patient was € 6914, € 5284 and € 4061 for the first, second and third or following dislocation, respectively.

Factors which can negatively influence outcomes and compliance with treatment also require referral to tertiary units. Psycho-social comorbidities should be identified and, if significant, treatment at a tertiary center is advised to permit involvement of psychology services from an early stage. Cho et al [27] demonstrated that patients exhibiting depression pre-surgical treatment of rotator cuff injuries had increased post-operative pain scores and disability. Lebe et al [16] carried out a study to date assessing the prevalence of depression and its association with disability in ASI patients. In this study 64 symptomatic patients with ASI completed a self-reported questionnaire including Disability of the Arm, Shoulder and Hand score (DASH), Stanmore Percentage of Normal Shoulder Assessment (SPONSA) and Becks Depression Inventory II (BDI – II). The results found a statistically significant between the overall DASH score and the overall BDI score ($F(1,62) = 12.78$, $P < .001$). Nineteen patients (29.7%) reported a history of self-harm and 11 patients (17.2%) had attempted suicide on at least one occasion [16].

Other factors which have been shown to negatively influence post-operative outcomes may not warrant tertiary referral but should be noted- this includes female sex, smoking, and workers' compensation status [28]. Raja et al identified predictive factors for failure of surgical management in patients with Type II instability. These were age under 30 and female gender. Of note hypermobility was not found to be predictive of postoperative recurrence [29].

Non-Operative Management of Atraumatic Shoulder Instability

The literature suggests that 80% of ASI will improve with physiotherapy led strengthening exercises alone [30]. Physiotherapy should include education on the condition and exercise prescription focusing on proprioception, recruiting dynamic shoulder stabilisers and strengthening shoulder musculature in order to compensate for lack of passive stability. A systematic review of the evidence for conservative management of posterior shoulder instability found a rehabilitation programme focusing on scapular stabilization followed by progressive deltoid and rotator cuff strengthening resulted in the best PROMS with lowest rates of recurrence [31]. The BESS patient care pathway recommends that if improvement is evident after 12

weeks of physiotherapy then a further 3-6-month course should be undertaken [1].

Douglas et al [32] carried out a prospective follow up of 104 patients with ASI managed with specialist physiotherapy. The mean Oxford Instability Score (OIS) and SPONSA scores improved significantly by 6 months compared with pre-treatment results (18 to 27, 43% to 67% respectively) and this improvement was sustained at both 12 and 24 months [32]. Burkhead and Rockwood found the Rockwood Instability program resulted in good to excellent Constant scores in 87% of patients included in their study [33]. Similarly, Watson et al found a 12-week course of structured physiotherapy resulted in significant improvement in both the Western Ontario Shoulder Instability Index (WOSI) and Oxford Instability Shoulder Score (OISS) on short-term follow-up [34]. Scott et al [35] assessed the PROMS of 85 patients with ASI managed with physiotherapy alone and found significant improvements at 12-72 month follow up (median OISS improved from 21 to 39, median WOSI improved from 1117 to 485). Similarly, Bateman et al [36] found a statistically significant improvement in OISS and WOSI following 4.5 months of their target led physiotherapy protocol (16.67 point and 36.76% improvement respectively, p< 0.001).

Griffin et al [37] carried out a systematic review to compare physiotherapy treatment programs for ASI and from the available evidence could not identify one specific programme as superior to others. Among the nine treatment programs identified from their review there were six common components: education, movement re-education, static posture correction, shoulder muscle strengthening, functional training and adjuncts [37].

To date only one randomized controlled study has been carried out to assess the efficacy of this treatment for multidirectional ASI, Warby et al compared two 24-week (12 session) physiotherapy programmes (the Watson Multi-Directional Instability rehabilitation programme and Rockwood Instability programme) [38] and found the Watson MDI programme resulted in a statistically significant and clinically important improvement in the Melbourne Instability Shoulder Score (MISS) and Western Ontario Shoulder Index (WOSI) outcome scores by the 24-week mark[38]. Potential reasons for the success of the Watson MDI programme include progression of exercises to achieve task and position specific functional gains, improvement in proximal scapular stability and focus on motor control training of periscapular muscles [38].

Those patients that are resistant to physiotherapy treatment alone require assessment and management by a multidisciplinary team ideally including surgeons, specialist upper limb physiotherapists, occupational therapists, rheumatologists, paediatricians, pain services, neurophysiologists and psychologists [1].Once surgical targets have been excluded, the focus of treatment should be to develop strategies within a biopsychosocial framework to enable the patient to manage their symptoms.

The high prevalence of psychological co-morbidities in this cohort, as evidenced by Lebe et al [16], makes the involvement of psychologists from the outset of treatment ideal. Jaggi et al [39] introduced a nurse led psychiatry clinic in parallel to the complex instability clinic at their tertiary center. Following initial mental health screening 26 of the 51 patients involved in the study met the criteria for invitation to the psychiatry clinic. Patients were then offered appropriate psychological support to optimize their ASI management (talking therapies, commencement of antidepressants, referral for attention deficit hyperactivity disorder/ autistic spectrum disorder assessment) [39].

Further non-operative interventions which can be of benefit include botulinum toxin injections of the pectoralis major +/- latissimus dorsi to reduce tonic activity which can contribute to persistent dislocation , although affects could be temporary and may not alter central processing or address the primary driver for the abnormal muscle activity [40]. Moroder et al assessed the efficacy of 'shoulder pacemaker' treatment using an electrical muscle stimulation-based therapy protocol to address abnormal muscle activation in patients with PP-FSI, they found all clinical outcomes significantly improved by the end of treatment with all participants able to achieve stable shoulder motion [6]. Electromyography (EMG) biofeedback has been used with good results to enhance posterior deltoid recruitment as part of treatment for patients with posterior shoulder instability [41, 42].

Surgical Intervention

In cases where non-operative measures have failed surgical management can be considered however literature on the outcomes is inconsistent and the studies largely of low quality. The lack of robust evidence is in part due to great heterogeneity in both the procedures performed and outcome measures used. Surgical intervention for ASI should be individualized to address any specific pathology contributing to the presentation and as such there are several possible surgical treatments.

In cases of capsule-ligamentous or labral insufficiency, an open or arthroscopic capsular shift/ plication or thermal capsular shrinkage can be performed however recurrence rates and outcomes quoted in the literature vary. Jaggi et al [43] carried out a single centre randomised placebo-controlled trial of arthroscopic capsular shift stabilization vs diagnostic arthroscopy in 68 patients with atraumatic shoulder instability. The Western Ontario Shoulder Instability Index (WOSI) improved by over 40% by 6 months post operatively in

both arms, there was not a statistically significant difference between the outcomes for each intervention suggesting no additional benefit of stabilization [43]. Raja et al performed a retrospective analysis of 2-year outcomes for 72 shoulders in 70 patients with Type II instability undergoing arthroscopic inferior capsular shift in their tertiary unit [29]. Their results found 8% required revision surgery whilst 39% experienced recurrent symptoms, most commonly subluxation. Despite high recurrence rates patient-reported functional outcomes were improved at both short and medium-term follow-up [29].

Chen et al [44] carried out a meta-analysis assessing the effectiveness of surgical management for MDI. The rates of recurrent instability following open capsular shift and arthroscopic capsular shift were found to be 9.9% and 6.08% respectively with risk of reoperation approximately 5% for both procedures. The meta-analysis performed by Lebe [45] comparing surgical with conservative management of MDI found recurrence rates of 16% for arthroscopic capsular plication, 11% for open capsular shift and 28.31% for thermal capsulorrhapy. Arthroscopic capsular plication conferred the greatest improvement in functional outcome scores with lowest re-operation rates (3.76%) suggesting this procedure could be considered the gold standard [45]. Biomechanical studies have demonstrated that capsular shift with post-operative physiotherapy can restore the normal muscular activity and rotational centres of the GHJ on movement for up to 4 years [46].

Additional procedures to address redundant capsular volume include thermal capsular shrinkage, arthroscopic capsulorrhapy and rotator interval closure. Chen et al found that thermal capsular shrinkage had a high recurrence rate of 23.9% and as such concluded this procedure should be avoided for MDI [44]. Rotator interval closure has not been found to improve recurrence rates of functional outcomes [44].

Bony procedures to address ASI, by increasing the static stability of the GHJ, are not routinely performed and evidence for their efficacy is limited. Walch et al [47] first proposed combining capsular shift and latarjet procedures for the management of hyper lax shoulders. Ropars et al [48] reported excellent or good results with a stability rate of 95% following open latarjet procedures with Neer capsulorrhaphy in their series of 77 patients with anterior shoulder instability and anterior capsular redundancy. Boileau et al performed a retrospective evaluation of 30 shoulders in 28 young athletes with recurrent anterior instability and hyperlaxity who were managed with arthroscopic capsular plication and the trillat procedure, a closed wedge osteotomy of the coracoid tilted inferiorly, posteriorly and medially and affixed to the glenoid neck above the subscapularis with screw or suture button [49]. Their cohort had good outcomes with 80% reporting good or excellent Rowe scores, 86% of patients returning to participation in sports and a 10% recurrence rate [49].

Conclusion

Atraumatic shoulder instability is a complex condition which requires a holistic management strategy tailored to the patients' individual presentation and pathology. Non-operative management, with a specialist upper limb rehabilitation programme, is the mainstay of treatment and there is growing evidence for its efficacy in this condition. Surgical intervention should be reserved for cases with defined structural pathology, that have failed conservative measures and have had mental and social co-morbidities optimised. Patients and surgeons must remain mindful that evidence indicates surgery for ASI can have variable outcomes, significant rates of recurrence and may even exacerbate symptoms.

The management of ASI is an under-researched field with several potential avenues for further investigation. Through a greater understanding of the pathology underpinning ASI new treatment strategies could be adopted. For example, the increased prevalence of ASI in female patients suggests a possible link between hormonal imbalances and abnormal soft tissue and muscular development, increasing laxity and predisposing to instability. Good quality evidence regarding the role of surgical intervention is also required. To date there are no studies comparing non-operative intervention with surgical outcomes.

There is a growing understanding that a 'biopsychosocial approach' is key in the management of ASI, involving psychological services from the outset to support treatment. For those patients that are resistant to conventional non-operative management and surgical intervention a holistic approach is essential. In recalcitrant cases it may be necessary for clinicians to support the patient in living with this chronic condition and its effects on both physical and mental health.

Conflict of Interest:

The authors have no conflicts of interest to declare

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