



Sensorimotor control deficiency in recurrent anterior shoulder instability assessed with a stabilometric force platform

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Background: Deficiencies in both afferent proprioceptive information and efferent motor responses have been independently reported in patients with recurrent anterior shoulder instability. We used a validated force platform method to analyze the association between the stabilometric parameters of the upper limb as representative of the shoulder's sensorimotor control and clinical glenohumeral joint instability.

Methods: We enrolled 32 patients with unilateral recurrent anterior post-traumatic shoulder dislocation, on the dominant side in 13 patients (DIG) and the non-dominant side in 19 patients (NDIG) and 16 healthy nonathletic subjects (CG). Displacements of the Center of Pressure were measured by a Win-Posturo® Medicauteurs force platform in the upper limb weight-bearing position with the lower limbs resting on a table up to the anterior superior iliac spines. The association between stabilometric values and clinical shoulder instability was analyzed by side-to-side comparisons and comparisons to a control group.

Results: For CG and NDIG, there were no side-to-side differences. For DIG, stabilometric values were significantly higher on the dominant pathological shoulder side than on the healthy contralateral non-dominant side ($P < .01$). The percentage of side-to-side differences was higher in DIG than CG ($P < .01$).

Conclusion: Sensorimotor control deficiency was associated with recurrent anterior shoulder instability, especially in patients with the pathological shoulder on their dominant side. Using a force platform to assess sensorimotor control of the shoulder is feasible in patients with shoulder instability, and can allow assessment of the global sensorimotor control deficiency present in unstable shoulders.

This study was exempt from IRB Ethical Committee approval.

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The glenohumeral joint is the most mobile, but also the most frequently dislocated articulation in the human body.³ Anterior dislocation caused by trauma is by far the most common diagnosis of shoulder dislocation. The recurrence of dislocation is frequent, especially in athletic patients 15-30 years of age (50-90%), which can lead to incapacity or handicap in professional, social, sporting and/or daily life.³ Its precarious stability is ensured by a delicate relationship and fine balance between static and dynamic stabilizers.^{3,5,11,12,17,24} Moreover, the sensorimotor system plays an integrative role by mediating these static and dynamic stabilizers.¹¹⁻¹³ Sensory or proprioceptive information (afferent) from the mechanoreceptors present in the static (especially capsuloligamentous) and dynamic (musculotendinous) structures travels to the central nervous system where it is integrated to elicit the necessary neuromuscular control (efferent motor responses) that allows shoulder stability and coordinated movement patterns.^{11-13,15} Precise sensorimotor system function is necessary for effective motor program development and to optimize the constant feedback-adjustment interplay required during complex motion, especially in order to maintain the humeral head permanently centered in the scapular glenoid. Glenohumeral recurrent anterior instability typically occurs with deficiencies in bony, soft tissue (capsuloligamentous) or the dynamic muscular restraint that prevents translation of the humeral head on the glenoid.^{3,5,25} Recurrent anterior instability can also occur in cases of a deficiency in the sensorimotor system.

Deficiencies in both the afferent proprioceptive information and efferent motor responses have been reported in patients with recurrent anterior glenohumeral instability. Several studies have reported proprioceptive deficits in patients with recurrent anterior instability regarding both the joint position sense and kinesthesia.^{8,17,18,25} Accompanying the disruption of the static stabilizing structures, damage to the capsuloligamentous structures could lead to proprioceptive deficits by decreasing mechanoreceptor stimulation as a result of tissue deafferentation and/or increased tissue laxity.^{13,18} Neuromuscular control deficits have also been reported in patients with recurrent anterior instability who presented muscle weakness in the shoulder^{4,5,17,21,23} and/or alterations in their coordinated muscle activation patterns.^{7,9,10} These results suggest that sensorimotor deficiencies are associated with recurrent anterior instability. However, to our knowledge, no data are available for global shoulder sensorimotor assessment in patients with recurrent anterior instability because there was no method available to do this satisfactorily.

It has been suggested that shoulder proprioception, muscle coactivation and joint stability are promoted by close kinetic chain exercises using an upper limb weight-bearing position^{11,13,22,24} and that the sensorimotor control of lower limbs can be assessed by postural control analysis using a force platform.¹ Following these ideas, Edouard et al⁶ suggested that using a force platform to assess shoulder sensorimotor control would be both feasible and reliable. This assessment procedure has been validated in a homogenous population of healthy subjects. A force platform provides the opportunity to monitor the displacements of the center of pressure (CoP) which incorporate corrective muscular actions.¹⁶ Any deficiency of the sensorimotor system (eg, ligamentous and capsular deficiency [afferent], central inhibitions [central]), strength or coactivation (efferent) in patients with glenohumeral joint instability could be highlighted by some variations of CoP. Our hypothesis was that there is an increase of CoP displacements.

Using this validated force platform process method we proposed to analyze the association between shoulder sensorimotor control and glenohumeral joint instability in recurrent anterior instability on nonoperated patients.

Materials and methods

Population

Two groups were constituted for this observational controlled study. Patients with recurrent anterior post-traumatic glenohumeral instability (patient group = RAIG) were selected prospectively and consecutively from a physical medicine and rehabilitation outpatient unit (from 2010 to 2011) together with a matched control group of nonathletic healthy subjects (control group = CG).

Inclusion criteria for the RAIG were as follow: patients with symptomatic recurrent unidirectional anterior glenohumeral dislocation, with post-traumatic onset, scheduled for stabilizing surgery with a healthy, stable contralateral shoulder, no associated injury (rotator cuff injury or bone injury with the exception of Hill-Sachs lesions or bony Bankart lesions on computer tomographic [CT] arthrography), no prior participation in upper-limb sports such as those involving throwing or swimming, and no contraindications to isokinetic testing.² Patients with voluntary instability, rotator cuff disease, neurological disorders, musculoskeletal injury or pain, and/or a history of back, wrist and/or elbow pain, were excluded. The diagnoses of shoulder instability were established by the same surgeon (non-author)

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