Muscle activity during shoulder dislocation

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EMG activity from eight shoulder muscles in parallel was recorded from 4 patients with generalized joint laxity. During external rotation of the humerus in 45° abduction, humeroscapular dislocation occurred in 2 patients and subluxation in the 2 others. The activity level in the subscapularis was low, and the activation speed was slow. The low muscle activity and delay in activation of the subscapularis muscle may contribute to the instability.

Multidirectional instability of the humeroscapular joint presents a difficult problem, as the results of surgery are confusing (Neer and Foster 1980, Rowe et al. 1973). Electromyographic (EMG) studies on shoulder muscle activity and coordination in normal controls and in patients with instability problems have demonstrated a changed muscular activation pattern in patients with generalized joint laxity and instability (Kronberg et al. 1988).

We report the patterns of shoulder-muscle activity and coordination before and during humeroscapular dislocation in 4 patients with joint laxity.

Methods

EMG activity was recorded from eight muscles simultaneously during standardized loaded movements with a technique described by Kronberg et al. (1988). In this paper only EMG activity during external rotation with the arm in 45° abduction will be presented because this was the movement when dislocation occurred. The movement was loaded with 35 N in men and 25 N in women using a pulley apparatus.

EMG activity was recorded from the pectoralis major, the anterior, middle, and posterior part of the deltoid, the supraspinatus, the subscapularis, the infraspinatus, and the latissimus dorsi muscles. Flexible bipolar surface Ag-AgCl electrodes were used for superficially located muscles. The electrodes were attached to the skin with a center-to-center distance of 3 cm in the main direction of the muscle fibers over the belly of the muscle. Intramuscular nylon-coated, bipolar fine-wire electrodes, with a diameter of 0.025 mm, were used for the supraspinatus, infraspinatus and subscapularis muscles (Nemeth et al. 1988). The electrodes were placed in a hypodermic needle and inserted into the posterior axillary line. With this method, activity from the deeply located muscle can be recorded without overflow from superficially located muscles. The position of the electrodes was checked with computed tomography.

The EMG signal was preamplified (Devices AC 8, Neurolog NL 104, 703)—full-wave rectified, low-pass filtered, and time averaged—using a time constant of 0.2 seconds (Spaulding and Robinson 1984) and fed to an 8-channel chart recorder for graphic display.
To quantify the muscular activity and to be able to compare activity between different patients and different muscles, the EMG was normalized. The activity recorded during the investigated movement was divided by the activity recorded during a reference voluntary contraction (RVC), i.e., an isometric maximum voluntary muscular contraction (isometric MVC). The normalized EMG was calculated every 10th percentile during the rotation. Raw EMG was simultaneously visualized on an oscilloscope to reveal unwanted artefacts. The test situation was videotaped to allow measurements of the angular position of the arm and for synchronization of the video-tape and EMG recordings. A digital time indicator panel visible on the video pictures was used.

Results

During external rotation, 2 patients experienced subluxation of the humeral head throughout the movement (Figure 1). A complete forward dislocation requiring reposition was observed in the other 2 patients. One occurred during the external rotation at the 60th percentile and the other during internal rotation at an almost neutral position.

During the rotation movement the rotator cuff muscles as a group were more activated than superficially located muscles. There was a high activity in the infraspinatus muscle in all the patients during external rotation, with a peak value in the middle part of the external rotation movement.
The supraspinatus muscle was activated to a medium and almost constant level throughout the entire movement cycle in all the patients. In the 2 patients with subluxation of the humeral head, the subscapularis muscle was activated to a level of about 30 percent. In the other 2 patients, before luxation occurred, the subscapularis was very little activated: namely, less than 15 percent during the entire movement cycle. In both patients, there was immediately after luxation a rapid increase in activity to a high level in the subscapularis. After reposition of the humeral head, the activity decreased and returned to the previous base level.

The activity in all the other studied muscles was low during the entire movement cycle.

Discussion
Owing to the limited number of patients, interpretation of our results should be made with caution. With the exception of the subscapularis, shoulder-muscle activity in our 4 patients was very similar to that previously recorded in other patients with generalized joint laxity (Kronberg et al. 1988). When compared with healthy subjects, the activity level in our 4 patients was higher in both the supraspinatus and infraspinatus muscles (Kronberg et al. 1988). In previous studies on shoulder-muscle activity during loaded movements, we have demonstrated high activity in both agonistic and antagonistic muscles, especially in the rotator cuff muscles. This reflects the important stabilizing function of the rotator cuff (Basmajian and Bazant 1959, Ovesen and Nielsen 1985, Turkel et al. 1981). EMG findings in the present study accord with those of previous studies and especially point to the very important stabilizing function of the subscapularis muscle. In both patients who experienced shoulder subluxation, subscapularis activity was increased to a constant level, whereas in the other 2 patients it was increased to a very high level when total dislocation occurred. In spite of this high activity, dislocations occurred during external rotation when the subscapularis is an antagonist (Ovesen and Nielsen 1985). Further, the high activity observed after dislocation was too high to be explained only by muscle-fiber stretching secondary to the dislocation. Thus, the high activity can be interpreted as an attempt to increase stability, but the activation was too slow to prevent the dislocation. The slow activation might be due to impaired muscle proprioception and/or an imbalance between shoulder muscles in these patients with shoulder instability and generalized joint laxity. The poor results of surgical treatment with soft-tissue repair in such patients could thus be explained, and, instead, we propose that a physiotherapy program aimed at improving muscle proprioception and coordination might be the treatment of choice.

References

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