ied, further investigation is needed to determine whether these relationships have meaningful implications in more functional movements. If these relationships prove to be a common finding among subjects with shoulder pathology, future prospective studies that investigate various treatments applied to this population would be useful to assist in developing more specific protocols designed to correct dysfunction.

References


Commentaries

Following are two commentaries on "Electromyographic Activity of Selected Shoulder Muscles in Commonly Used Therapeutic Exercises"

Ballantyne and colleagues collected data to support the argument that patients with glenohumeral joint pathology demonstrate a different pattern of electromyographic (EMG) activity of some shoulder muscles during selected movements as compared with asymptomatic subjects. The authors concluded, therefore, that an imbalance may exist in the pattern of muscle activation during some shoulder movements in patients with shoulder pain. We believe, however, that there are several issues related to the design of this study that need to be considered when interpreting the meaningfulness of the authors' conclusion. Our queries to the authors relate to what appears to be an unclear rationale for subject selection and, most importantly, to the development of a theoretical argument for explaining the meaningfulness of the results.

The method of patient selection appears to be unclear for two reasons. First, the subjects in the patient group were found by the authors to have a variety of impairments, which may have indicated the presence of numerous pathologies. The heterogeneity of the patient sample is an important issue because the authors in their discussion attempt to explain some of their results based on an impairment (glenohumeral joint instability) that they felt existed in only four of their subjects. Given a more homogeneous sample, the authors may have been able to better explain their results.

Second, the reliability of measurements used for subject inclusion is suspect. The authors required that subjects in the patient group had unilateral weakness of the abductors and lateral (external) rotators but used a method of muscle testing that has no demonstrated evidence of reliability within the grade range used. There are data and theoretical arguments to support the notion that manual muscle test judgments above the grade of Fair are unreliable.2,3 We are curious as to why the authors chose not to use an instrument such as a hand-held dynamometer to identify patients with weakness. There are some data to support the reliability of measurements of the shoulder obtained with a hand-held dynamometer.5,6

Many of the other examination procedures used for describing the patient
group (see Tab. 1 in the article) have no demonstrated evidence of reliability (eg, instability tests, impingement tests). We would argue that classifying patients as having an instability or an impingement syndrome does not appear to be sound, based on the methods used by the authors. Other examples of unclear procedures used to select patients can be found in the article. For example, the authors restricted admission of subjects with "signs of acute inflammation" but did not define what they meant by this term.

We have addressed measurement issues and other theoretical issues related to patient selection because we believe that a complete description of the subjects tested is necessary for future research in this area. Given the lack of reliability and the heterogeneity of the sample, we do not believe this study is replicable.

An issue directly related to subject selection is the theoretical construct for the meaningfulness of the question asked in this study. If the purpose of the study was to compare subjects with and without shoulder pathology to determine whether a pathologic pattern of myoelectric activity can be observed, then we are not sure what theoretical or empirical model was being used to explain the results. Why should physical therapists be interested in whether patterns of EMG activity are similar or different when these two groups are compared? Are the authors interested in developing the EMG technique used in this study as a diagnostic tool? We believe the potential impact this report will have on practice rests with the theoretical argument for the usefulness of the question.

The introduction began by discussing the importance of shoulder muscles working in groups to produce "well-coordinated" motion. The authors then discussed those studies that attempted to determine which exercises produce the greatest electrical activity in specific muscles. We are not sure how these two concepts (coordinated activity of muscle groups and optimal EMG activity of a given muscle during an exercise) relate to the authors' question. We hope the authors can clarify for us the theoretical construct that explains why their question is clinically important.

Although there were no formal hypotheses stated in the introduction, the authors implied they had a hypothesis that explained the relationship between the amount of myoelectric activity in the two groups. The authors hypothesized in the "Data Reduction" section of the report that if between-group differences existed, the differences would be most apparent when the greatest demands were placed on the muscle. The authors, however, found that one of the two between-group differences occurred in the supraspinatus muscle during the prone lateral rotation (PLR) exercise, an exercise that did not place the greatest demand on the supraspinatus muscle. The other between-group difference was found to occur in the infraspinatus muscle during the PLR exercise. The patient group had significantly higher EMG activity during this exercise. However, the infraspinatus muscle's EMG activity during the PLR exercise was no different than that found during the sidelying lateral rotation (SLR) exercise in the patient group. There was no difference in infraspinatus muscle EMG activity between the two groups during the SLR exercise. These findings would appear to conflict with the hypothesis implied by the authors.

The authors claimed that the difference between groups in supraspinatus muscle EMG activity during the PLR exercise was due to positional factors. The supraspinatus tendon was said to be more vulnerable to impingement during the PLR exercise and therefore may have demonstrated a "pain-inhibited response." The authors did not define what they meant by the term "pain-inhibited response." In addition, the authors provided no data to support the notion that the position of the limb during the exercise resulted in the differences that were found. The authors did not report whether the subjects reported pain during the exercise sessions.

One of the articles referenced by the authors to argue for the importance of the study was the article by Glousman and colleagues. Ballantyne and colleagues further claimed that their results are consistent with those of Glousman et al.

Glousman and colleagues compared the shoulder muscle EMG activity of two groups of skilled baseball players during the pitching motion. One group consisted of healthy subjects, whereas the other group consisted of subjects with surgically confirmed glenohumeral instability. Glousman and colleagues found significantly greater infraspinatus muscle EMG activity in the patients during the early cocking phase of throwing, a position Ballantyne et al argue is similar to the position attained during the PLR exercise. However, this difference between the groups during the early cocking phase was not reported by Glousman et al to be statistically significant.

It would also appear that the late cocking phase, as defined by Glousman et al, most closely corresponds to the end-range position of the PLR exercise (interval 3) studied by Ballantyne et al. In the late cocking phase, Glousman et al found, unlike Ballantyne et al, that the infraspinatus muscle activity of the asymptomatic subjects exceeded that of the patient group, although not significantly. Also of interest is the fact that Glousman et al found that the supraspinatus muscle activity of the patients during the late cocking phase was significantly greater than that of the healthy subjects. This finding would also appear to contradict the results of Ballantyne et al, who found that supraspinatus muscle activity of the asymptomatic subjects was significantly greater than that of the patients when in a similar position (interval 3). The data of Glousman et al appear to suggest that EMG activity of the supraspinatus and infraspinatus muscles in the two groups is not dependent on the position of the shoulder in the same way as that reported by Ballantyne et al.
The apparent paradox between the results of Ballantyne et al and those of Glousman et al may be more presumed than real. The types of movements studied and the methodologies of the two studies differed in many ways and probably provide adequate justification to restrict direct comparison. For example, Ballantyne et al studied a homogeneous group of patients with surgically confirmed instability, whereas Ballantyne et al studied a patient group that appeared to have a large variety of diagnoses. These two studies, however, provide most of the basis for assessing the usefulness of EMG data in identifying differences between healthy subjects and patients with shoulder pathology during defined movements. At this point, the data would appear to us to be inconclusive.

Ballantyne et al reviewed literature in the introduction that examined which exercises produced the highest EMG activity in specific muscles. We expected to find a stronger argument in the introduction for why differences in EMG activity between healthy subjects and patients during specific exercises might be useful when determining treatment. We are unclear as to how this information would be useful for therapists designing exercise programs for their patients.

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References

I would like to compliment the authors on an interesting and informative preliminary study, and I encourage them to pursue this topic further.

The authors have identified, through electromyographic (EMG) analysis, a characteristic pattern of muscle activity during three commonly performed rehabilitative exercises. In addition, they have noted in their symptomatic shoulder group a significant alteration in the magnitude of the EMG activity of the supraspinatus and infraspinatus muscles during prone lateral (external) rotation (PLR). The authors have reported in this group greater EMG activity in the infraspinatus muscle and a decrease in EMG activity in the supraspinatus muscle when compared with the control group. They have suggested that this is an imbalance in the activation of the posterior rotator cuff muscles during specific movements when the shoulder exhibits instability or impingement.

There are several points I would like to discuss regarding this study. The authors have equally divided the subjects into two groups, one consisting of subjects with symptomatic shoulders and the other of subjects with asymptomatic shoulders. It is not clear, however, as to exactly what type of shoulder pathology these individuals exhibited. In Table 1, the distribution is such that 8 out of 20 subjects with shoulder pathology exhibited anterior instability, and an additional 5 subjects exhibited a positive impingement sign, but what diagnosis did the remaining subjects in this group exhibit? Also, for the subjects exhibiting impingement, was this a primary or secondary pathology due to instability. I feel it is important to delineate the clinical conditions, such as impingement or instability. The primary pathology should be identified because of the possible alterations in normal glenohumeral joint kinematics and specific muscular imbalances. Such an example exists with patients who have stage II impingement, as described in this report. We have identified that this type of patient exhibits a reverse capsular pattern, whereas medial (internal) rotation is restricted more than elevation, which is limited more than lateral rotation. Several authors have noted that posterior capsular tightness can lead to altered glenohumeral kinematics and may cause the humeral head to migrate anterosuperiorly during arm movements above the horizontal plane. This anterosuperior migration of the humeral head can cause impingement on the coraco-humeral ligament or the anterolateral surface of the acromion, and thus cause a painful arc.

This may help to explain the decrease in EMG activity of the supraspinatus muscle during PLR in subjects with impingement. The alteration in EMG activity was not noted during the other two movements.

Additionally, ~40% of the subjects with symptoms exhibited anterior glenohumeral instability. None had a history of subluxation or traumatic dislocation; therefore, these individuals can be classified as having atraumatic instability and probably exhibited a degree of excessive laxity. Often individuals with excessive laxity of the shoulder who complain of recurrent pain without gross instability are actually silent subluxators. Jobe and colleagues state that the most sensitive means for detecting silent subluxations of the glenohumeral joint is the use of an apprehension test followed by a relocation test. In younger populations (ages 18-27 years), this subtle clinical condition can lead to im-