INTRODUCTION

• Previous studies have utilized EMG (Electromyography) to investigate muscles in the tennis serve and have measured intensity of muscle activation as a percentage of maximal voluntary isometric contraction. These studies measured muscle activation in the various phases of the serve and have found that each of the muscles were active during all phases of the serve at varying levels of intensity.

• This study provides greater detail of the muscle activity during the serve by investigating patterns and sequencing of muscle activation. Specific patterns of activation are established and a clearer picture of how coupled activations accomplish the motions and positions of the arm in the tennis serve is given. In addition, guidelines for goals and content of rehabilitation and conditioning programs are suggested.

METHOD

Patterns of muscle activation were observed during the tennis serve motion.
• The serratus anterior (–287 ms before ball impact) and upper trapezius (–234 ms) were active in the early cocking phase, while the lower trapezius (–120 ms) was activated in the late cocking phase just before the acceleration phase.
• The anterior deltoid (–250 ms) was activated in early cocking, while the posterior deltoid (–157 ms) was activated later. The teres minor (–214 ms) was activated early in the cocking phase. The supraspinatus (+103 ms) was activated in late cocking.
• The infraspinatus (+47 ms after ball impact) was activated in follow-through. All muscles except infraspinatus were activated in duration of more than 50% of the service motion.

CLINICAL IMPLICATIONS

• One of the goals of a conditioning program is to optimise muscle activation and one of the goals of rehabilitation is to restore optimal muscle activation. This study suggests some guidelines towards those goals. As different parts of the same muscle (upper and lower trapezius, anterior and posterior deltoid) are activated at different times, and for different durations, during the service motion, they can act as separate muscles. Conditioning or rehabilitation exercises must be directed at activation of each part of the muscle in their proper position and function.
• Second, as the muscle activations start at the scapular stabilisers and proceed towards the rotator cuff, conditioning and rehabilitation exercises should adhere to the same progression. They should emphasise scapular stability and control as a basis for rotator cuff activation, and should integrate the training of the muscles along kinetic chain principle. Eccentric activation of the scapular stabilisers, the anterior deltoid and the posterior deltoid should be implemented, and plyometric or stretch/shortening activities with medicine balls or tubing should be emphasised. A stable scapular base is required for maximal rotator cuff activation, so rotator cuff emphasis should be delayed until adequate scapular control is achieved.
• Third, most of the muscles are activated for a high percentage of the duration of the tennis serve motion. This implies that part of the training of these muscles should involve endurance exercises. The early activation of the serratus anterior in the cocking phase shows that this muscle should be rehabilitated as a scapular external rotator. The patient can progress to rotator cuff exercises after scapular control is regained.

CONCLUSION

This study demonstrates that there are patterns of activation of muscles around the scapulohumeral articulation in the normal accomplished tennis serve. Rehabilitation and conditioning programs for tennis players should be structured to restore and optimize the activation sequences (scapular stabilizers before rotator cuff), task specific functions (serratus anterior as a retractor of the scapula, lower trapezius as a scapular stabilizer in the elevated rotating arm) and duration of activation of these muscles.

REFERENCES