SCAPULOHUMERAL RHYTHM: RELATIONSHIP BETWEEN MOTION VELOCITY AND RHYTHM

Kazuomi Sugamoto
Department of Orthopedic Surgery, Osaka University, Medical School
sugamoto@ort.med.Osaka-u.ac.jp ,

INTRODUCTION

Inman et al initially analyzed scapulohumeral rhythm and suggested that normal rhythm is fixed and that the ratio of glenohumeral and scapulothoracic motion is almost 2.0. However, we hypothesized that the scapulohumeral rhythm of a healthy person are not fixed with different conditions of motion. The effect of motion velocity on scapulohumeral rhythm was studied to evaluate the components of shoulder motion under conditions of the most simplified motions.

METHODS

Nineteen shoulders of 10 healthy volunteers (all men, 24-30 years of age) were examined. Bilateral upper arms were abducted or adducted symmetrically in the scapular plane to avoid spinal movement. Shoulder motions were observed using an image intensifier combined with a video system. High definition images 1024 x 1024 matrix at high speed 7.5 frames per second were displayed dynamically on the films without a blur. Fluoroscopy was done with each subject standing on the platform facing the fluoroscopic table at an angle of 30 deg. anterior to the frontal plane so that the plane of abduction was parallel to the plane of the radiograph. Each frame was digitized to measure the arm (A), glenohumeral (GH), and scapulothoracic (ST) angles. ΔGH/ΔST ratio was calculated from the gain of GH and St angle from a frame to the next in the abduction, and it was also calculated from the loss of GH and St angle from a frame to the next in the adduction. The effects of two types of motion velocity on scapulohumeral rhythm were studied. High- and low-speed motion consisted of 2 and 4 seconds per cycle from abduction to adduction, respectively. Each motion was performed three times to confirm its uniformity.

RESULTS AND DISCUSSION

Figure1 shows changes in ΔGH/Δ ST ratios of one subject at low speed, where the ratios were fixed and almost 2.3 at an angle greater than 40 deg.during abduction and adduction. These waves show that scapulohumeral motion is stable.

Figure2 shows changes inΔGH/ΔST ratios of the same subject at high speed. The waves were reproducible, but ratios were not fixed, and differed from the results obtained at low speed. These also resulted in stable scapulohumeral motion. Ratios were high at the beginning of abduction or adduction at an abduction angle greater than 40 deg., then decreased according to the arm movement. Glenohumeral motion at high speed was more dominant at the beginning of abduction or adduction except in the setting phase, then declined according to the arm motions compared with low speed. The overall results showed that: (1) the waves of scapulohumeral rhythm were not fixed under different conditions (at high speed and low speed); (2) ΔGH/ΔST ratios were highly reproducible under certain types of motion, even at high speed, showing the uniformity or dynamic stability of scapulothoracic motion on each participant; and (3) scapulohumeral rhythms at high speed completely differed from those at low speed. ΔGH/ΔST ratios at low speed were fixed at 2.4 on average during abduction or adduction except in the setting phase. Glenohumeral motion at high speed was more dominant at the beginning of abduction or adduction except in the setting phase and decreased according to the arm movement compared with that at low speed.

SUMMARY

Nineteen shoulders of 10 healthy individuals (all men, 24-30 years of age) were analyzed using an image intensifier and a high-resolution digital video system. High- and low-speed motion consisted of 2 and 4 seconds per one cycle, respectively, from abduction to adduction in the scapular plane. ΔGH/ΔST ratios were fixed at low speed. Ratios at high speed were not fixed and differed from those at low speed. Ratios were high at the beginning of abduction or adduction, then decreased according to the arm movement. Glenohumeral motion at high speed was more dominant at the beginning of abduction or adduction, then became less dominant according to the arm movement, compared with the motion at low speed.

REFERENCES

Inman VT et al (1944). *J Bone Joint Surg* **26**: 1-30.