KINETIC ANALYSIS OF THE SHOULDER JOINT DURING PUSH-UP WITH A SWISS BALL

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INTRODUCTION

Clinically, doing exercise on an unstable surface is often used to increase muscle activation in stabilizing muscles as well as increasing the proprioceptive balance demands on a patient. In strength training program, compared to conventional exercise programs, an exercise with the use of Swiss balls will result in an increased need of core muscles to improve spinal stability or balance [1, 2]. Several fitness literatures have asserted that performing push-ups from different hand positions may better isolate either the pectoralis major or the triceps. However, very little published research has studied the shoulder joint kinetics during push-up exercise with the leg on the unstable support surface. Therefore, the purpose of this study is to investigate the joint loading of the upper extremity in push-up exercise on the floor and on unstable surface with the use of Swiss ball.

METHODS

Eleven male subjects were recruited in this study. Push-up exercises were performed by each subject. There were four different leg-supporting conditions, feet on the floor (FOF), feet on ball (FOB), shank on ball (SOB) and thigh on ball (TOB). A 65-cm Swiss ball was used. Twenty six reflective markers were placed on selected anatomic landmarks of the trunk and the upper extremities bilaterally. The VICON 612 motion analysis system was used to collect the trajectories of reflective markers at 120 Hz to calculate the joint movements of the shoulder joint. The subject's hands were asked to place on two AMTI force platforms and perform 12- repetitions push-up. The ground reaction forces and moments were recorded at 960 Hz. A set of customized MATLAB program was used to calculate the joint forces and joint moments of the upper extremity using inverse dynamic method. Three trials of each testing condition were recorded. There were two-minute rest between trials and 3-minute recovery between sessions to avoid fatigue. One-way ANOVA with repeated measure was used to compare the difference between different conditions.

RESULTS AND DISCUSSION

Shoulder joint force and moment were shown in Figure 1. FOB and FOF had significantly greater anterior and lateral forces than SOB, which had significantly greater anterior and lateral forces than TOB ($p<0.05$). TOB had significantly greater medial force than FOB, SOB and FOF ($p<0.05$). Compression showed significantly different between each conditions (FOB>SOB>FOF>TOB, $p<0.05$).

FOB and FOF had significantly greater adductor and flexor moments than SOB, which had significantly greater adductor and flexor moments than TOB ($p<0.05$). FOB and SOB had significantly greater internal rotator moment than TOB, which had significantly greater internal rotator moment than FOF ($p<0.05$).

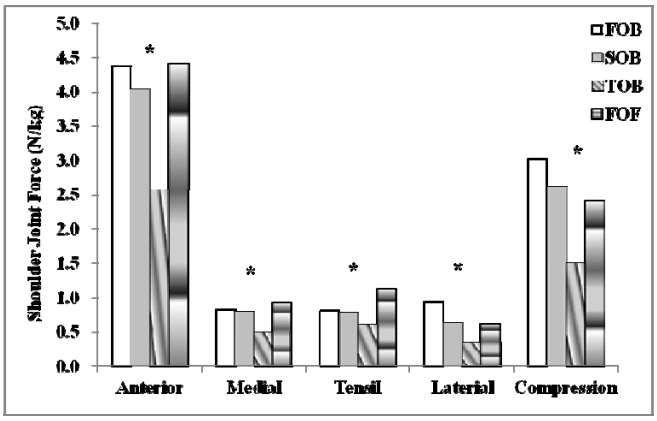

Figure 1: The shoulder joint forces during push-up in different leg-supporting conditions. *ANOVA, $p<0.05$.

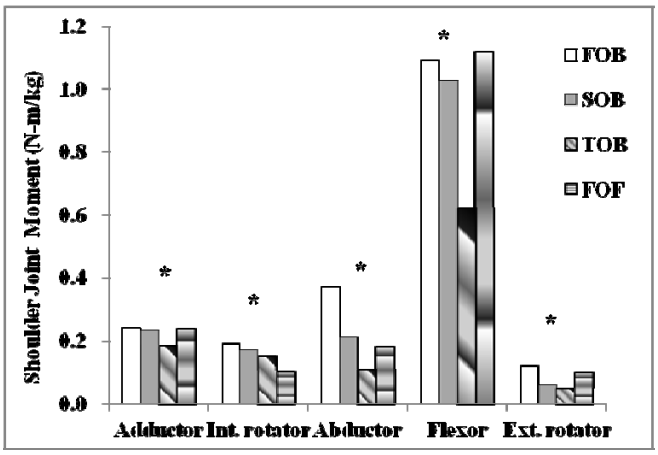

Figure 2: The shoulder joint moments during push-up in different leg-supporting conditions. *ANOVA, $p<0.05$.

CONCLUSIONS

The results showed that leg-supporting surfaces substantially affect the shoulder joint loading during push-up. Compared to feet on floor (standard push-up) and other ball conditions measured in this study, feet on ball had the highest shoulder joint loadings. The findings of this study suggested that doing push-up with the feet on Swiss ball would induce more shoulder force and moment and thus produce more effect on joint impact and muscle strengthening than standard push-up.

REFERENCES

1. Lehman GJ, et al, *Manual Therapy*, 13: 500-506, 2008.
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