INTRODUCTION
The mechanisms that lead to the development of rotator cuff tendinopathy, specifically subacromial impingement syndrome (SAIS) are not well understood due to the complex nature of the disorder. SAIS is theorized to be caused by extrinsic and intrinsic mechanisms. Extrinsicly, the rotator cuff tendons are compressed due to narrowing of the subacromial space; intrinsically, the rotator cuff tendinopathy degrade due to factors related to tendon overload, aging, vascularity and changes in tendon histology and mechanical properties.[1]

Treatment of SAIS with exercise has been shown to be helpful in reducing shoulder pain, but not for all patients. Potentially this is because the exercise program does not adequately load the rotator cuff to promote remodeling of the tendon and muscle. An exercise program focused on eccentric loading of the rotator cuff during shoulder external rotation exercises has been shown to reduce shoulder pain.[2] Scapular plane elevation (scaption) exercises are commonly used to strengthen the supraspinatus in rehabilitation. Scaption exercises are performed with the shoulder in internal rotation (empty can) or in external rotation (full can). Both positions have been shown to produce maximal activity of the supraspinatus. A prior study in subjects free from shoulder pain has shown that the empty can elevation exercise produced altered scapular kinematics of decreased scapular posterior tilt and external rotation.[3] These same altered scapular positions have been found in patients with SAIS, and theorized to increase external impingement. The effects of the EC dynamic strengthening exercise has not been examined in patients with shoulder pain, to determine if altered scapular kinematics are present.

Better understanding of the effects of the empty can (EC) as compared to the full can (FC) exercise on scapular kinematics will assist in recommending eccentric strengthening exercises for SAIS. This study characterized scapular kinematics during EC and FC exercises in subjects with SAIS.

METHODS
Subjects (n = 28, 10 females, age = 37.9±14.3 years, height = 172.8±11.4cm, mass = 74.1±15.1Kg) participated. All subjects had pain with resisted arm elevation or external rotation, and 3/5 positive SAIS tests: painful arc, pain or weakness with resisted external rotation, Neer, Hawkins, and Jobe tests. All subjects provided informed consent prior participation. The IRB of the Virginia Commonwealth University approved this project.

Three dimensional scapular and clavicular positions were determined using the Polhemus 3Space Fastrak electromagnetic-based motion capture system (Polhemus, Colchester, VT) and Motion Monitor software (Innovative Sports Training, Inc, Chicago, IL) following ISB recommendations.[3] Electromagnetic sensors were placed over the T3 spinous process, posterior acromion and distal humerus. Scapular and clavicular positions data were collected during 5 consecutive arm elevation motions in the plane of the scapula. Scapular upward rotation (UR), scapular internal rotation (IR), and scapular posterior tilt (PT), clavicular elevation (ELE) and clavicular protraction (PRO) were calculated at 30°, 60°, 90° and 120° of humeral elevation.

A three-way repeated measures ANOVA (arm position x arm elevation phase x arm elevation angle) was used to test for statistical differences of the dependent variables between EC and FC arm position, with significance set at p≤0.05.

RESULTS AND DISCUSSION
Figures 1-5, display the scapular and clavicular position by arm elevation angle. Significant differences were found between EC and FC arm positions and the ascending and descending phases.
During arm elevation in the FC position the scapular was in less UR (p<0.001, mean difference [MD]=2.4°), greater PT (p=0.026, MD=1.9°), the clavicle was less ELE (p<0.001, MD=1.6°) than during elevation in the EC position. The arm position by elevation angle interaction for IR was significant (p<0.001), the scapula experienced an IR rotation during EC and an external rotation during the FC arm elevation. No difference was seen in clavicular PRO (p=0.065) between the EC and FC positions. The scapula was in greater UR (p=0.009, MD=1.3°), IR (p=0.003, MD=1.5°) and PT (p=0.005, MD=2.5°) and the clavicle was in greater ELE (p=0.001, MD=0.7°) and less PRO (p<0.001, MD=1.67°) during the descending phase than the ascending phase.

In a similar study in subjects without shoulder pain Thigpen et al [3] reported an increase in IR of 1.4° and a decrease in PT of 1.96° during arm elevation in the EC position. In the current study in subjects with SAIS we found that the EC position had a greater effect on scapular and clavicular motion than what was reported by the earlier study in subject without shoulder pain. In the current study subjects with SAIS experienced increased IR during the ascending phase in the EC. This suggests that the use of the EC for eccentric loading the rotator cuff may increase the impingement of the rotator cuff due to the decreased PT and increased IR. Future studies should examine the activity of the scapular stabilizers musculature during EC and FC exercise.

REFERENCES