Anatomic Total Shoulder Replacement Reduces Compensatory Spine and Trunk Movements During Hairbrushing And Drinking Tasks

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INTRODUCTION:

Glenohumeral arthritis is one of the most prevalent upper extremity pathologies with increasing incidence in the aging population. GH arthritis is known to reduce range of motion (ROM) of the shoulder, forcing patients to compensate with altered biomechanics that may increase cervical and low back pain. Despite this, no research has evaluated the impact of arthroplasty on restoring anatomic biomechanics and reducing compensatory motion in the lumbar spine and pelvis.

METHODS:

The present study evaluated 26 patients with GH arthritis during hairbrushing and drinking tasks that emulate activities of daily living (ADLS) both before anatomic total shoulder replacement (aTSA) and again at 6 weeks (n= 26), 2 months (n = 26) and 6 months (n= 11) post-operatively. Motion capture evaluated range of motion of the shoulder as well as compensatory movements via motion analysis of the lumbar and cervical spine and pelvis (Figure 1). Shoulder ROM and compensatory movements were compared pre- and post-operatively.

RESULTS:

Six months following aTSA, patients required significantly less ROM of cervical side flexion and rotation, less lumbar flexion, and less pelvic obliquity and anterior pelvic tilt during the hairbrushing task compared to pre-operatively (Figure 2, Table 1). This was accompanied by increased shoulder flexion and rotation. During the drinking task, patients required significantly less cervical rotation and lumbar rotation 6 months following aTSA as well as less pelvic obliquity, rotation, and anterior pelvic tilt (Figure 3, Table 2), which was similarly accompanied by increased shoulder flexion and rotation.

DISCUSSION AND CONCLUSION:

Anatomic TSA reduces the need for compensatory movements of the cervical and lumbar spine and trunk during ADLs by increasing ROM of the previously arthritic shoulder. A primary goal of arthroplasty is to relieve pain and restore function in an arthritic joint. To our knowledge, this is the first study to quantify improvement in global motion and function during ADLs following shoulder arthroplasty. Prior research has identified a "cone of economy" for the spine and trunk that minimizes effort and joint load during ADLs, with evidence suggesting that patients who fall outside the cone of economy may experience increased forces through the spine and trunk, predisposing them to pain and injury[1]. Future research is needed to investigate if the reduction of compensatory motion of the lumbar spine and pelvis allows them to maintain this cone of economy, improves pain, and/or reduces effort during ADLs in patients with concomitant pathology in shoulder and   lower   back.

Figure 1. Motion Lab analyses of activities of daily life. Snapshots of video with artificial intelligence skeletonization of a human subject performing drinking task (left) and hairbrushing task (right).

Figure 2. Comparison and Shoulder Range of Motion to Hairbrushing Task Following Anatomic Total Shoulder Replacement

Figure 3. Comparison and Shoulder Range of Motion to Hairbrushing Task Following Anatomic Total Shoulder Replacement
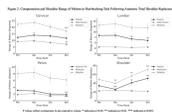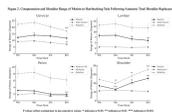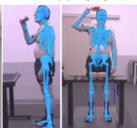
Table 1: Kinematic compensation range of motion and shoulder range of motion during Hairbrushing task.

Table 2: Kinematic compensation range of motion and shoulder range of motion during Drinking task.