**INTRODUCTION:** Computer-assisted surgery is becoming more widely accepted for a wide range of orthopaedic procedures. Significant advances have been made at the hip and knee, and recently the shoulder has become of interest. One surgical procedure that could markedly benefit from a computer assisted procedure is reconstruction of the fractured proximal humerus via a hemiarthroplasty procedure. Currently, surgeons do not have the option of computer assistance, and rely on preoperative templating of radiographs, intraoperative instrumentation, and clinical experience to position the humeral implant. However it is particularly difficult to achieve proper implant placement, since most of the relevant anatomical landmarks have been damaged. The functional outcome of this procedure, including the ability to achieve sufficient range of motion, is related, in part, to the ability of the prosthesis to recreate normal anatomy and hopefully restore normal kinematics to the glenohumeral joint. Therefore, it is logical to postulate that computer-assisted hemiarthroplasty may produce a more accurate reconstruction, given the clinical challenges in recreating the proximal humerus using current techniques.

The purpose of this study was to assess the effects of a computer-assisted method of performing shoulder hemiarthroplasty, in comparison to traditional techniques, on glenohumeral joint kinematics during scapular plane abduction.

**METHODS:** This study utilized seven pairs of fresh-frozen cadaveric shoulders (mean age: 69 ± 12 years). One specimen from each pair was randomized to the computer-assisted technique, while the contralateral shoulder underwent a traditional hemiarthroplasty. A standard anterior deltopectoral surgical approach was employed. A simulated four-part proximal humerus fracture was created in each shoulder and a modular shoulder hemiarthroplasty system (Anatomical Shoulder Hemiarthroplasty System, Centrepulse Orthopaedics Inc, Austin, TX) was used for reconstruction.

The computer-assisted technique used CT data and computerized simulations of anatomical characteristics, including humeral head version, inclination, head center, humeral length, medial articulation point position, and greater and lesser tuberosity positions. From the preoperative CT analysis, the planned locations of the implant head and shaft were established. Intraoperatively, the surgeon’s goal was to align the planned locations with the actual features of the implant. An electromagnetic tracking device (Flock of Birds, Ascension Technologies, Burlington, VT), in conjunction with custom-written software (LabVIEW, National Instruments, Austin, TX), was used to enable real-time intra-operative feedback and track joint kinematics.

Passive glenohumeral abduction was conducted and motion was recorded using the tracking system. Coordinate systems, created on both the humerus and scapula from digitized anatomical landmarks, were used to compute humeral head translation. Statistical analyses were performed using one-way Analyses of Variance (ANOVA) and post-hoc Student-Newman-Keuls tests ($\alpha = 0.05$).

**RESULTS:** A significant difference was found between the operative techniques for the superior-inferior position of the humeral head ($p < 0.04$) (Figure 1), with the traditional approach resulting in a more inferiorly positioned humeral head at all angles of elevation. Differences were also found between the intact and traditional surgery ($p = 0.01$) states. There was no difference ($p = 0.3$) between the intact and computer-assisted surgery states. There was no overall difference in the anterior-posterior position of the humeral head ($p = 0.2$) (Figure 2).

**DISCUSSION AND CONCLUSIONS:** The similarities measured in the kinematics of the intact and computer-assisted repair states during passive abduction can be attributed to the similarities in the "anatomical" features of the reconstructed and intact states. Given that a previous study showed that only 3% of shoulder arthroplasty surgeries performed 10 or more procedures per year, the use of a computer-assisted approach may improve the accuracy of reconstruction, and by extension, the restoration of kinematics.

Strengths of this investigation include that it was a paired, randomized, controlled study, and a single surgeon performed all of the procedures. Limitations include the fact that only passive shoulder motion was evaluated.

This is the first known study to examine the kinematic effects of a computer-assisted method for performing shoulder hemiarthroplasty. While this technique requires further investigation and refinement, the current results show that the computer-assisted approach should more closely replicate the native glenohumeral joint kinematics, potentially resulting in improved patient function and greater longevity of the arthroplasty.

**REFERENCES:**