Evaluating the Reliability of Radiograph Parameters in Detecting Prosthetic Overlengthening During Radial Head Arthroplasty

Jacob M Welsch¹, Harshavardhan Bollepalli, Matthew Van Boxtel, Feras Qawasmi, Steven I Grindel¹, Connor W Sullivan ¹Medical College of Wisconsin

INTRODUCTION:

Radial head arthroplasty (RHA) is the procedure of choice for complex radial head and neck fractures where open reduction and internal fixation is not a possibility. Complications arise with RHA when the native anatomical dimensions of the radius are inaccurately restored, either by insertion of an overlengthened prosthetic stem or a radial head that is increased in diameter. Insertion of an overlengthened prosthetic during RHA alters elbow kinematics, accelerates capitellar wear, and increases the risk for prosthetic failure. Although selecting an appropriately sized prosthetic during RHA is crucial, there is a notable absence of established intraoperative landmarks to assist in prosthetic dimensioning. Radiographic landmarks, such as the lateral ulnohumeral joint space (LUHJ) and the proximal edge of the lesser sigmoid notch (SN), are two intraoperative parameters utilized to evaluate for radial head overlengthening. This study aims to evaluate the reliability of the (LUHJ) and (SN) as radiographic parameters to assess radial head prosthetic overlengthening. We hypothesize that the SN is a more reliable radiographic mark compared to the LUHJ for diagnosing prosthetic radial head overlengthening.

METHODS:

Two fellowship-trained upper extremity surgeons implanted radial head prosthetics into 9 fresh-frozen cadaver upper extremities at 0, +2, +4, and +6 mm of overlengthening. AP radiographs were obtained at each length with the cadaver positioned at 45° flexion and full extension. The radiographs were randomized and presented twice to 4 fellowship-trained upper extremity orthopaedic surgeons to evaluate for prosthetic overlengthening. Following data collection, inter-rater and intra-rater reliability of the two radiographic parameters at each position was calculated with a Fleiss and Cohen's Kappa calculation. Kappa scores were categorized based on values \leq 0 as indicating no agreement, 0.01–0.20 as none to slight, 0.21–0.40 as fair, 0.41– 0.60 as moderate, 0.61–0.80 as substantial, and 0.81–1.00 as almost perfect agreement. RESULTS:

A total of 144 radiographs were presented to 4 upper extremity surgeons. The inter-rater reliability (Table 1) of the SN was greater than the LUHJ at both full extension (K=0.55 vs 0.43) and 45° flexion (K=0.24 vs 0.19), consistent with a moderate to fair level of agreement for the SN and a slight to moderate level of agreement for the LUHJ. Intra-rater reliability (Table 2) was higher for the SN than the LUHJ at both full extension (0.54 vs 0.48) and 45° flexion (0.3 vs 0.28). Kappa scores for the SN were consistent with fair to moderate reliability at 45° flexion (K=0.30) and full extension (K=0.54). The LUHJ had fair to moderate intra-rater reliability at 45° flexion (K=0.28) and full extension (K=0.48).

DISCUSSION AND CONCLUSION: This cadaveric study assesses the reliability and reproducibility of the SN and LUHJ space as radiographic landmarks utilized to evaluate radial head prosthetic overlengthening. Both radiographic landmarks, taken alone, are not reliable enough to adequately assess radial head prosthetic overlengthening and have decreased reliability when the elbow is flexed, underscoring the need for surgeons to properly position the elbow and consider multiple factors during radiographic evaluation of prosthetic length. This study contributes to the growing body of knowledge regarding radial head prosthetic overlengthening, highlighting the importance of selecting a reproducible and valid radiographic landmark during prosthetic overlengthening evaluation.