

Total Wrist Arthroplasty Alignment and Its Effect on Range-Of-Motion: Higher Volar Tilt and Shift are Associated with Higher Range-Of-Motion

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Background: Alignment of knee and hip joint replacement components strongly correlate with implant performance, and while malalignment is a known contributor to implant failure. There is a lack of standard quantitative parameters that describe the alignment of wrist replacement components, and more importantly, the effects of implant malalignment have not been studied. The aims goals of this retrospective study were (1) to define the alignment of total wrist arthroplasty (TWA) components in radiographic images and validate them using three-dimensional analysis and (2) to determine how if the alignment is associated TWA range of motion (ROM).

Methods: Six non-rheumatoid patients who received Freedom® wrist arthroplasties were recruited, and radiographic images and CT images were acquired. Volar-dorsal tilt (VDT), radial-ulnar tilt, volar-dorsal shift, and radial-ulnar shift alignment parameters were drawn from the posteroanterior and lateral view of the radiographs for both radial and carpal components. The radiographic measurements were validated with the three-dimensional models that were reconstructed from CT images. Biplanar videoradiography was used to compute the range-of-motion of the replaced wrist. Linear regression ($p < 0.05$) assessed the associations between alignment and ROMs.

Results: The high consistency between alignment parameters in radiographs and their corresponding 3D model parameters ($p < 0.03$ and $R > 0.67$) demonstrated their validity as standard measurements. Overall flexion-extension and radial-ulnar deviation were positively correlated with volar-dorsal tilt ($p = 0.047$ and 0.015) of the radial component demonstrating an increase of $3.7^\circ \text{ROM}/^\circ \text{VDT}$ and $1.6^\circ \text{ROM}/^\circ \text{VDT}$, respectively. There was no correlation between the carpal component's alignment and overall range of motions.

Conclusions: We demonstrated the volar tilt of the radial component is associated with a higher range of flexion-extension and radial-ulnar deviation motions in patients.