E-Poster #129

Surgical Technique Impacts Kinematics and Outcomes of Hand-to-Back Motion After RSA

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Disclosures

- William Anderst
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Background

- Internal rotation (IR) is not reliably improved after reverse shoulder arthroplasty (RSA)[1-2].
- Surgical techniques and implant parameters are believed to be associated with IR after RSA[1-2] .
- There are no established *in vivo* shoulder kinematics during IR after RSA, and the relationship between *in vivo* kinematics and clinical outcomes is also unknown.

Aims & Hypothesis

Aim

- Determine the effects of surgical techniques and implant parameters on glenohumeral (GH) and scapular kinematics as well as arthrokinematics after RSA.
- Determine associations between kinematics and clinical outcomes after RSA.

Hypothesis

- Surgical techniques and implant parameters are associated with GH and scapular kinematics and arthrokinematics.
- Kinematics associated with surgical techniques and implant parameters will be associated with more favorable clinical outcomes.

Methods – Data Collection

Data Collection

- Patients who previously received RSA within 1-5 years consented to participate in this IRB-approved study.
- CT scans of the shoulder were collected at time of testing (Figure 1C).
- Lateralization, glenosphere size, implant type, and eccentricity were recorded from surgical notes, while humeral retroversion and glenosphere tilt were measured from the CT.
- Clinical outcome measures were collected at time of testing (ASES, DASH, CMS scores, and IR range of motion (ROM)).
- Participants performed 3 trials of hand-to-back motions (Figure 1A) while synchronized biplane radiographs of the shoulder were collected (Figure 1B).

Methods – Data Processing

Data Processing

- Scapular upward rotation, scapular tilt, scapular protraction, GH elevation, GH plane of elevation, and GH internal/external rotation were obtained (Figure 1E,F).
- A 3D CAD model of the humeral liner was matched to the humeral tray.
- The contact path was calculated from the projection of the humeral liner center to the glenosphere throughout the entire motion and averaged at corresponding percents of the movement cycle.
- Peak posterior contact path location, as well as the anterior/posterior and superior/inferior contact path locations at the end positions were determined.
- Average end position, kinematic ROM, and peak kinematic rotations were found.

Methods

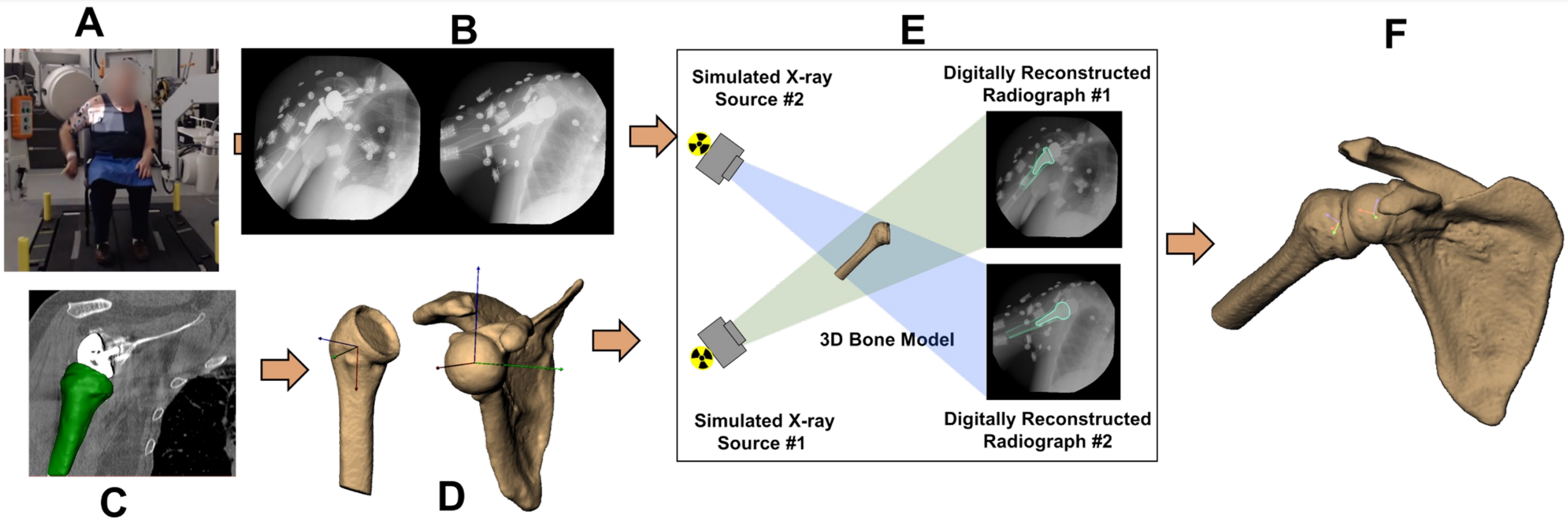

Figure 1: Biplane radiography data collection and processing. (A) *Participants performed 3 hand-to-back movements while* ***(B)*** *synchronized biplane radiographs were collected for 2 seconds at 50Hz (90kV, 50mA, 2ms pulse width).* ***(C)*** *CT scans (0.47x0.47x0.625mm) were collected and* ***(D)*** *used to create 3D humerus and scapula bone models.* ***(E)*** *3D GH kinematics were determined using a validated CT model-based tracking process[4].* ***(F)*** *Six degree-of-freedom kinematics were calculated.*

Methods

Data Analysis

- Multiple linear regression was used to determine associations between implant parameters/surgical techniques and kinematics/arthrokinematics.

- Pearson's correlations were used to determine associations between kinematics/arthrokinematics and ROM/PROs with significance set at $p < 0.05$.

Results

- 34 participants (72 ± 7 years, 17 M) completed testing an average of 2.5 ± 1.2 years post surgery.
- More inferior glenosphere tilt was associated with less peak abduction (Table 1), which was associated with less IR ROM ($p = 0.025$).
- More inferior glenosphere tilt was associated with greater peak scapular upward rotation (Table 1), which correlated with favorable ASES scores ($p = 0.047$).
- Larger glenosphere size was associated with more scapular tilt ROM, which was correlated to favorable DASH scores ($p = 0.047$).
- No other associations were found between surgical parameters and kinematics/arthrokinematics.

Results

Table 1: Glenosphere tilt and size associations with kinematics and arthrokinematics

More Inferiorly Tilted Glenosphere		
Kinematic/Arthrokinematic Variables	Beta	p-value
Less Peak Abduction	0.389	0.035
More Peak Upward Rotation	-0.371	0.018
More Upward Rotation ROM	-0.308	0.026
Less Peak Protraction	0.797	0.007
More Peak Adduction	-0.499	0.005
More Peak Posterior Plane of Elevation	-1.068	0.008
More Anterior Plane of Elevation Endrange	-1.135	0.005
Less Peak Scapular Posterior Tilt	0.374	0.014
More Peak Scapular Retraction	-0.574	0.003
Less Endrange Protraction	0.791	0.009

Results

Table 1 (cont.): Glenosphere tilt and size associations with kinematics and arthrokinematics

Larger Glenosphere Size		
Kinematic/Arthrokinematic Variables	Beta	p-value
More Peak Adduction	1.076	0.042
More Scapular Tilt ROM	1.151	0.019
Less Endrange Abduction	-1.778	0.011
Less Endrange Rotation	-1.995	0.012
Less Peak Posterior Contact	-0.658	0.003

Results

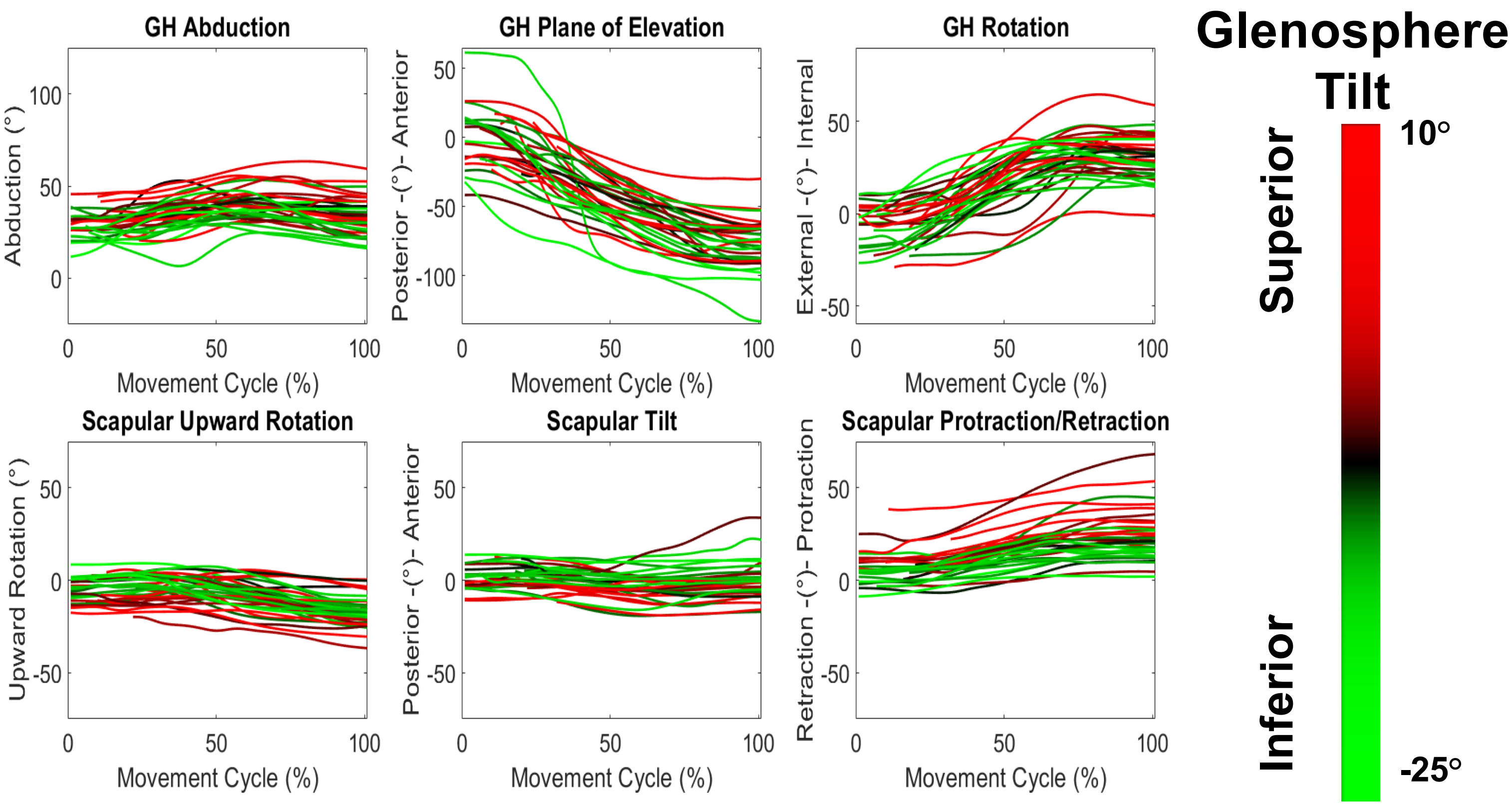

Figure 2: GH and scapular kinematics. *Scapular protraction, rotation, and tilt as well as GH rotation, abduction, and plane of elevation throughout the progression of the hand-to-back motion.*

Discussion

- Glenosphere tilt and size may be the most influential surgical technique and implant parameter affecting internal rotation, and the resulting kinematics may impact patient satisfaction.
- Less inferior tilt was associated with more IR ROM suggesting modifications to tilt may be a significant parameter for IR performance.
- Contrary to previous findings, greater lateralization was not associated with improved kinematics.

Clinical Significance

- **Altering glenosphere tilt and size to increase peak abduction, peak upward rotation, and scapular tilt ROM in IR may lead to improved outcomes.**

References

1) Berhouet, et al., (2013). *JSES*.

2) Werner et al., (2021). *JSES*.

3) Bey, et al. (2006). *J Biomech*.

- This work was funded by NIH Grant: R03AG064417

National Institute on Aging

This work is supported by NIH R03: AG064417