Reverse Shoulder Arthroplasty: How to reach the back? A motion capture study to analyse glenohumeral strategies to perform functional internal rotation after RSA and in control cases

Authors:
Philippe COLLIN[1], Gabriel LEVY[2], Caecilia CHARBONNIER[3,4], Tiago MARTINHO[2,4], Hugo BOTHOREL[5], Anthony PERNOUD[5], Alexandre LÄDERMANN[2,4,6,7]

[1] American Hospital of Paris, 55 boulevard du Château - 92 200 Neuilly-sur-Seine, France

[2] Division of Orthopaedics and Trauma Surgery, La Tour Hospital, Avenue J.-D. Maillard 3, 1217 Meyrin, Switzerland

[3] Artanim, Medical Research Department, 40 chemin du Grand-Puits, 1217 Meyrin, Switzerland

[4] Faculty of Medicine, University of Geneva, Rue Michel Servet 1, 1211 Genève 4 Switzerland

[5] Research Department, La Tour Hospital, Meyrin, Switzerland.

[6] Division of Orthopaedics and Trauma Surgery, Department of Surgery, Geneva University Hospitals, Rue Gabrielle-Perret-Gentil 4, 1205 Geneva, Switzerland

[7] FORE (Foundation for Research and Teaching in Orthopedics, Sports Medicine, Trauma, and Imaging in the Musculoskeletal System), Avenue J.-D. Maillard 3, 1217 Meyrin, Switzerland

Aim & Background
Reverse shoulder arthroplasty (RSA) often restores satisfactory forward flexion and external rotation, but internal rotation with the hand behind the back (IR1), crucial for daily activities, remains unpredictable. This study explores the mechanisms enabling IR1, its anatomical correlations, and the minimal required amplitudes to achieve this motion.

Methods
A retrospective motion capture analysis of upper limbs was conducted. Control cases were assessed for humeral torsion, glenoid version, and scapular type. Maximal glenohumeral motions (flexion/extension [EXT], adduction [ADD]/abduction [ABD], and internal rotation [IR]) were measured and grouped by back-reaching strategies using k-means clustering. These strategies were correlated with anatomical features and compared between RSA and control groups. Strategies were further correlated with IR1 in the RSA group to identify optimal patterns.

Results
Among controls (n=40), four groups were distinguished by EXT, ADD/ABD, and IR:
Group A (n=16): EXT 26°±6°, ABD 3°±5°, IR 24°±7°
Group B (n=11): EXT 19°±7°, ADD 3°±7°, IR 42°±5°
Group C (n=6): EXT 26°±7°, ABD 17°±6°, IR 49°±7°
Group D (n=7): EXT 12°±6°, ABD 4°±8°, IR 63°±8°

Humeral torsion showed very weak correlations with EXT, ABD/ADD, or IR ($r<0.2$). Glenoid version correlated weakly with ABD/ADD ($r=0.37$) and very weakly with EXT and IR ($r<0.2$). Scapular type did not significantly affect motions, except for IR, which tended to be greater in type C vs. type B (48°±14° vs. 33°±14°, $p=0.098$).

In the RSA group, 4 out of 10 reached their back. Successful and unsuccessful groups did not differ significantly in EXT (16°±13° vs. 19°±10°, $p=0.914$) or ABD (15°±16° vs. 10°±4°, $p=0.761$), but successful patients tended to have greater IR (39°±25° vs. 22°±13°, $p=0.199$). Successful RSA patients exhibited motions resembling control group C, characterized by the highest EXT (26°±7°) and ABD (17°±7°).

Conclusion

Humeral torsion and glenoid version were not associated with ROM patterns. Scapular type C showed greater IR compared to type B. RSA patients achieving IR1 exhibited ROM patterns similar to controls with the highest EXT and ABD values. These last two amplitudes should be improved to regain IR1.