

# DDR Clinical Evidence: Transforming Orthopedic Precision With Dynamic Imaging



**Dynamic Digital Radiography (DDR)** is evolving the standard of care in X-ray by moving beyond static imaging to capture the “physiology of motion.” This portfolio summarizes peer-reviewed research and clinical cases that demonstrate how DDR improves diagnostic confidence, surgical planning, and postoperative validation. With over a decade of research and a roadmap extending through 2026, DDR is no longer just a “novel” technique. DDR is a validated clinical and research tool for modern orthopedic practices.

## I. Quantifying the “Unseen”: Shoulder Kinematics and Scapulohumeral Rhythm (SHR)

Standard static X-rays and MRIs often fail to capture the dynamic relationship between the humeral head and the glenoid. DDR enables the quantification of Scapulohumeral Rhythm (SHR), providing a reproducible tool for complex pathologies.

Adhesive Capsulitis & Rotator Cuff Tears (RCTs): Research shows significantly reduced SHR in patients with massive RCTs and adhesive capsulitis, particularly during the initial phase of abduction.

Serratus Anterior (SA) Palsy: DDR serves as an objective tool to assess scapular winging and abnormal SHR caused by nerve compression, overcoming the limitations of traditional EMGs.

Posterior Instability: In cases where static imaging is inconclusive, DDR visualizes humeral head subluxation throughout the active range of motion.

## II. Surgical Excellence: Comparative Outcomes and Validation

DDR provides surgeons with objective data to compare surgical techniques and confirm the restoration of native biomechanics.

RSA vs. Tendon Transfer: For massive irreparable rotator cuff tears, DDR studies demonstrate that lower trapezius tendon (aLTT) transfer may better restore native shoulder biomechanics and SHR compared to Reverse Shoulder Arthroplasty (RSA).

Total Shoulder Arthroplasty: Studies comparing Anatomic (TSA) and Reverse (RSA) Arthroplasty found that while both improve function, DDR confirms they only partially restore coordination compared to healthy shoulders.

Complex Reconstructions: Postoperative DDR confirms humeral head concentric relocation and stability in complex cases, such as those involving Ehlers-Danlos syndrome or severe glenoid bone loss.

## III. Precision in Hand and Wrist Imaging

Subtle instabilities in smaller joints are often “motion-dependent,” making them prime candidates for DDR evaluation.

Wrist Instability: DDR videos demonstrate midcarpal bone dynamic motion before and after capsulorrhaphy, highlighting subtle lunotriquetral gapping that static deformity may miss.

Scapholunate Interval: Research indicates that DDR potentiates the visualization of interval widening during active radio-ulnar deviation.

Lumbar Spine: Emerging research for 2026 focuses on using DDR to diagnose motion-dependent abnormalities and segmental instability in the lumbar spine.

## IV. Efficiency through AI-Driven Automation

To integrate dynamic imaging into routine clinical workflows, Konica Minolta is leveraging machine learning to automate complex measurements.

Automated Scapula Dynamics: AI algorithms now allow for the automated analysis of scapular motion, ensuring high reliability and efficiency for the clinician.

Low Radiation Exposure: Despite providing high-frequency dynamic insights (e.g., 15 frames per second), DDR maintains low radiation doses suitable for repeated clinical use.

## V. General and Spine Imaging

DDR can aid in the detection of lumbar spine instability and motion-dependent abnormalities, conditions that are frequently missed by conventional static X-ray or MRI. By capturing the spine in active motion, researchers demonstrate that we can finally “see” the pain as it happens, particularly in complex cases of cervical and lumbar spine distress.

## I. Quantifying the “Unseen”: Shoulder Kinematics & Scapulohumeral Rhythm (SHR)

### ***Serratus anterior palsy as a Masquerader: Utilizing novel digital dynamic radiography for diagnosis and treatment response***

Sameer R. Khawaja; John M. Kopriva; Zaamin B. Hussain; Hayden L. Cooke; Michael B. Gottschalk; Eric R. Wagner *Journal of Shoulder and Elbow Surgery International*, Volume 8, Issue 3, pages 540-545, May 2024. DOI: [10.1016/j.jseint.2023.12.001](https://doi.org/10.1016/j.jseint.2023.12.001).

Scapulothoracic motion is governed by a balance between periscapular muscles, such as the serratus anterior (SA), rhomboids and levator scapulae. Disruption of this balance, sometimes caused by SA palsy due to long thoracic nerve compression, can lead to scapular winging and abnormal SHR. Diagnosis of SA palsy can be difficult due to nonspecific symptoms and the limitations of traditional diagnostic tools like EMGs and static imaging. In this case report, a 55-year-old woman with SA palsy was successfully treated with a split pectoralis major tendon transfer, restoring scapular biomechanics. Preoperative DDR imaging revealed an SHR of 7.8, which was reduced to 2.7 postoperatively. This case illuminates the objective capabilities of DDR to assess scapulothoracic motion, enhancing diagnostic accuracy and surgical evaluation while overcoming the shortcomings of other imaging modalities.

### ***Digital dynamic radiography—a novel diagnostic technique for posterior shoulder instability: a case report***

Zaamin B. Hussain; Sameer R. Khawaja; Anthony L. Karzon; Adil S. Ahmed; Michael B. Gottschalk; Eric R. Wagner *Journal of Shoulder and Elbow Surgery International*, Volume 7, Issue 4, pages 523-526, July 2023 DOI: [10.1016/j.jseint.2023.02.015](https://doi.org/10.1016/j.jseint.2023.02.015).

Posterior shoulder instability is a challenging pathology to diagnose and treat due to its diverse presentations and limitations of static imaging modalities like MRI and CT scans, which fail to capture the dynamic nature of shoulder motion. This case report illuminates the application of DDR to visualize the relationship between the humeral head and the glenoid throughout active range of motion. It features a 28-year-old male with recurrent left shoulder dislocations following unsuccessful prior stabilizing surgeries. DDR imaging revealed severe posterior subluxation and ligament damage. While DDR's availability and lack of standardized grading systems pose limitations, its potential to improve the understanding and management of dynamic musculoskeletal pathologies marks a significant advancement in orthopaedic imaging.

### ***Variation in scapulohumeral rhythm on dynamic radiography in pathologic shoulders: A novel diagnostic tool***

Angel X. Xiao; Anthony L. Karzon; Zaamin B. Hussain; Sameer R. Khawaja; Beau M. McGinley; Adil S. Ahmed; Michael B. Gottschalk; Eric R. Wagner. *Journal of Shoulder and Elbow Surgery*, Volume 32, Issue 6, Supplement, Pages S123-S131, June 2023. DOI: [10.1016/j.jse.2022.12.023](https://doi.org/10.1016/j.jse.2022.12.023).

Traditionally, scapulohumeral rhythm (SHR), the relationship which reflects glenohumeral motion to scapulothoracic motion during arm abduction, was assessed using three-dimensional motion analysis or electromagnetic tracking. These approaches are resource-intensive and are not suitable for routine clinical use. DDR is an innovative technique with the capability to quantify SHR. This study analyzed SHR in patients with shoulder pathologies and healthy controls using DDR during arm abduction. Results revealed significantly reduced SHR in massive rotator cuff tears (RCTs), adhesive capsulitis and glenohumeral arthritis compared to controls, with the greatest decreases occurring in the initial phase of abduction. Small RCTs showed no significant difference. DDR provides dynamic insights into shoulder motion with low radiation exposure, offering a reproducible, efficient tool for assessing motion abnormalities. Future studies may validate DDR as a clinical and research tool for diagnosis, disease progression monitoring and postoperative rehabilitation.

### ***Functional shoulder radiography with use of a dynamic flat panel detector***

Sakuda K; Sanada S; Tanaka R; Kitaoka K; Hayashi N; Matsuura Y. *Radiological Physics and Technology*, Volume 7, pages 254–261, July 2014. DOI: [10.1007/s12194-014-0257-2](https://doi.org/10.1007/s12194-014-0257-2).

The purpose of this study was to develop a functional form of radiography and to perform a quantitative analysis for the shoulder joint using a dynamic flat panel detector (FPD) system. The authors obtained dynamic images at a rate of 3.75 frames per second (fps) using an FPD system on three patients and five healthy controls using a clinically established frontal projection, with abduction of the arms. The arm angle, glenohumeral angle (G-angle), and scapulothoracic angle (S-angle) were measured on dynamic images and the ratio (GSR) of the G-angle to

the S-angle was quantitatively evaluated. In normal subjects, the G-angle and S-angle changed gradually along with the arm angle with the G-angle approximately twice as large as the S-angle, resulting in a GSR of 2 throughout the abduction of the shoulder. Changes in G-angle and S-angle tended to be irregular in patients with shoulder disorders. The GSR of the thoracic outlet syndrome, recurrent dislocation of the shoulder joint, and anterior serratus muscle paralysis were 3–7.5, 4–9.5, and 3.5–7.5, respectively. The GSR of the anterior serratus muscle paralysis improved to approximately 2 after orthopedic treatment. Preliminary results indicated that functional radiography by FPD and computer-aided quantitative analysis is useful for diagnosis of some shoulder disorders, such as the thoracic outlet syndrome, recurrent dislocation of the shoulder joint and anterior serratus muscle paralysis. The technique and procedures described comprise a simple, functional shoulder radiographic method for evaluation of the therapeutic effects of surgery and/or rehabilitation.

## Selected Conference Presentations

### I. Segmental Instability: Diagnosis and Treatment

Clerk O. Presented at ASSR 27th Annual Symposium, Las Vegas NV, Feb 2024.

### II. Scapulohumeral Rhythm Changes in Serratus Palsy and Scapular Dyskinesia: A Matched, Controlled Dynamic Radiography Study

Hussain Z, Khawaja S, Karzon A, Stewart T, Cooke H, Gottschalk M, Wagner E. Presented at BESS, Newport Wales UK, June 2023.

### III. Quantitative Changes in Scapulohumeral Rhythm in Adhesive Capsulitis – A Matched, Controlled Study Using Dynamic Digital Radiography

Hussain Z, Xiao A, Khawaja S, McGinley B, Adil A, Karzon A, Gottschalk M, Wagner E. Presented at BESS, Newport Wales UK, June 2023.

### IV. Poster 153: Dynamic Radiographic Evaluation of Scapulohumeral Rhythm in Patients with Massive vs Small Rotator Cuff Tears

Xiao A, McGinley B, Ahmed A, Gottschalk M, Wagner E. Orthopaedic Journal of Sports Medicine. July 2022. [Abstract link](#).

## II. Surgical Excellence: Arthroplasty & Reconstruction

### ***Lower Trapezius Tendon Transfer versus Reverse Shoulder Arthroplasty for Massive Irreparable Rotator Cuff Tears: An in-vivo Scapulohumeral Rhythm Dynamic Radiography study***

Zaamin B Hussain; Sameer R Khawaja; Musab Gulzar; Hayden L Cooke; Ozair R Khawaja; Krishna N Chopra; Michael B Gottschalk; Eric R Wagner. Journal of Shoulder and Elbow Surgery, Volume 34, Issue 11, pages e1043-e1052, November 2025. DOI: [10.1016/j.jse.2025.02.029](https://doi.org/10.1016/j.jse.2025.02.029).

Reverse shoulder arthroplasty (RSA) and arthroscopic-assisted lower trapezius tendon (aLTT) transfer are both treatment options for massive irreparable rotator cuff tears (MIRCTs) without glenohumeral arthritis. However, their indications remain debated. While RSA provides robust reconstruction, aLTT transfer may better restore native shoulder biomechanics by preserving joint motion and improving scapulohumeral rhythm (SHR). Through a comparison of SHR and shoulder biomechanics evaluated through clinical DDR imaging, findings from this study show that aLTT transfer is associated with increased SHR compared to RSA in patients with nonarthritic MIRCTs by demonstrating a higher glenohumeral contribution compared to scapulothoracic contribution.

### ***Is pre-morbid scapulohumeral rhythm restored with anatomic or Reverse Shoulder Arthroplasty for cuff-intact osteoarthritis? An in-vivo Dynamic Radiography Study***

Zaamin B. Hussain; Sameer R. Khawaja; Musab Gulzar; Jaden C. Hardrick; Krishna N. Chopra; Anna Gorsky; Victoria A. Conn; Michael B. Gottschalk; Eric R. Wagner. Journal of Shoulder and Elbow Surgery International, Volume 9, Issue 6, pages 2053-2061, November 2025. DOI: [10.1016/j.jseint.2025.06.008](https://doi.org/10.1016/j.jseint.2025.06.008)

Glenohumeral osteoarthritis can be treated with two different total shoulder replacement surgeries—anatomic total shoulder arthroplasty (TSA) or reverse shoulder arthroplasty (RSA)—but their effects on shoulder function and scapulothoracic compensation remain poorly understood. This study used DDR to compare scapulohumeral rhythm (SHR) between TSA and RSA in patients with glenohumeral osteoarthritis and intact rotator cuffs. DDR images and manual measurements of glenohumeral and scapulothoracic angles were taken at 0°, 30°, 60°, 90° and 120° of abduction. This enabled calculation of SHR as a measure of shoulder function. Results from this study showed both surgical techniques improved function from preoperative levels. There was no difference between postoperative SHRs for both techniques. Both partially restored coordination between the glenohumeral and scapulothoracic joints, although not to the extent of normal healthy shoulders.

### ***Do Shoulder Kinematics Change After Reverse Shoulder Arthroplasty?***

Itaru Kawashima; Eric R. Wagner; Joseph J. King; Zaamin B. Hussain; Sameer R. Khawaja; Jaden C. Hadrick; Krishna N. Chopra; Michael B. Gottschalk; Scott A. Banks; Thomas W. Wright. *Journal of Shoulder and Elbow Surgery International*, Volume 9, Issue 4, pages 1357-1364, July 2025. DOI: [10.1016/j.jseint.2025.04.025](https://doi.org/10.1016/j.jseint.2025.04.025).

RSA is believed to alter shoulder kinematics, yet it is unclear whether these changes are surgery-induced or preexisting, or if preoperative SHR predicts postoperative outcomes. This study aims to evaluate kinematics in RSA cases using DDR and a novel 3D-to-2D registration method. Scapular and humeral kinematics, including SHR, upward rotation, posterior tilt, and internal/external rotation, will be analyzed during scapular plane abduction. These findings may provide insight on the unique kinematic adaptations and patient-specific outcomes associated with RSA.

### ***Glenoid Bone Grafting During Primary Reverse Shoulder Arthroplasty: A Learning-Curve Analysis***

Hussain Zaamin B.; Khawaja Sameer R.; Gulzar Musab; Cooke Hayden L.; Chopra Krishna N.; Roundy Robert S.; Gottschalk Michael B.; Wagner Eric R.; *Journal of Bone and Joint Surgery* [Open Access, Volume 10, Issue 2, e24.00125, April-June 2025](https://doi.org/10.2106/JBJS.OA.24.00125). DOI: [10.2106/JBJS.OA.24.00125](https://doi.org/10.2106/JBJS.OA.24.00125).

Reverse shoulder arthroplasty (RSA) with bone grafting is an effective intervention to address significant glenoid bone loss. This study examines the number of cases needed for optimal learning for this surgical technique. This study found a linear relationship between the number of cases completed and operation duration without decreased outcomes or complication rates. As part of outcome assessment, range of motion was evaluated using DDR. The learning curve analysis reported offers data for future studies on improved surgical procedures to manage glenoid bone loss.

### ***Structural bone grafting with reverse shoulder arthroplasty for osteoarthritis with severe glenoid bone loss: outcomes using a long post***

Zaamin B. Hussain; Sameer R. Khawaja; John M. Kopriva; Haley M. McKissack; Robert Roundy; Anthony L. Karzon; Ujjawal Savani; Hayden L. Cooke; Michael B. Gottschalk; Eric R. Wagner. *Journal of Shoulder and Elbow Surgery*, Volume 34, Issue 4, Pages 1061-1070, April 2025. DOI: [10.1016/j.jse.2024.06.025](https://doi.org/10.1016/j.jse.2024.06.025).

Reverse shoulder arthroplasty (RSA) with angled humeral head autographs provides an effective solution for severe posterior glenoid bone loss, and the integration of DDR offers enhanced evaluation of shoulder mechanics. In this study, 24 shoulder cases with glenoid bone loss and retroversion greater than 30° underwent RSA with angled autographs, with DDR used preoperatively to assess scapulohumeral dysfunction and postoperatively to confirm functional improvements. Patients demonstrated significant gains in range of motion and high patient-reported outcome measures. DDR complemented static imaging by providing real-time insights in shoulder mechanics, confirming the graft's effectiveness in restoring version, lateralizing the center of rotation and enhancing shoulder function. These findings underscore the potential of DDR as a critical tool in optimizing and monitoring outcomes in complex shoulder reconstruction.

### ***Pedicle Pectoralis Major Transfer for Axillary Nerve Palsy and Greater Tuberosity Nonunion***

Khawaja, Sameer R.; Gulzar, Musab; McQuillan, Thomas J.; Cooke, Hayden L.; Hussain, Zaamin B.; Gottschalk, Michael B.; Wagner, Eric R. *Journal of Bone and Joint Surgery: Case Connector*, Volume 14, Issue 4, e24.00244, October-December 2024. DOI: [10.2106/JBJS.CC.24.00244](https://doi.org/10.2106/JBJS.CC.24.00244).

This case study describes a 46-year-old male patient presenting with shoulder pain, limited range of motion and loss of sensation for a year after undergoing hemiarthroplasty for a proximal humerus fracture. Workup demonstrated a greater tuberosity nonunion and deltoid paralysis secondary to upper trunk brachial plexopathy. A PM transfer for deltoid and rotator cuff insufficiency successfully restored shoulder stability and biomechanics, and resolved pain without requiring any subsequent intervention. Dynamic radiography demonstrates enhanced fluidity of shoulder kinematics with improved scapulohumeral motion, shoulder abduction and flexion in this case.

## ***Dynamically rebalancing the unstable shoulder in Ehlers-Danlos syndrome: latissimus dorsi transfer for posterior shoulder instability***

Sameer R. Khawaja; Zaamin B. Hussain; Hayden Cooke; Elinor Stern; Anthony Karzon; Michael B. Gottschalk; Eric R. Wagner. Journal of Shoulder and Elbow Surgery International, Volume 8, Issue 5, pages 954-962, September 2024. DOI: [10.1016/j.jseint.2024.05.008](https://doi.org/10.1016/j.jseint.2024.05.008).

Hypermobile Ehlers-Danlos Syndrome (hEDS) is a connective tissue disorder characterized by joint hypermobility and recurrent instability, with the shoulder being one of the most affected joints. Standard stabilization procedures often fail in hEDS due to poor soft tissue integrity, leaving limited surgical options. This case report presents a novel surgical approach combining an arthroscopically assisted latissimus dorsi (LD) tendon transfer and pectoralis minor (PM) release to address recurrent posterior shoulder instability in a 14-year-old female with hEDS. The LD tendon was transferred to the greater tuberosity to dynamically stabilize the shoulder by rebalancing force vectors, while the PM release corrected scapular dyskinesia contributing to instability. The patient achieved significant pain relief, functional improvement and stable shoulder mechanics, with no recurrence of instability at 2.9 years postoperatively. Postoperative DDR imaging confirmed humeral head concentric relocation and stability, which contributes to improvement in glenohumeral motion. This dynamic stabilization strategy offers a promising alternative for managing complex posterior instability in patients with connective tissue disorders.

## ***Arthroscopic Pectoralis Minor Release After Reverse Shoulder Arthroplasty: A Novel Consideration of Postarthroplasty Pain***

Stern, Elinor; Karzon, Anthony L.; Hussain, Zaamin B.; Khawaja, Sameer R.; Cooke, Hayden L.; Pirkle, Sarah; Bowers, Robert L.; Gottschalk, Michael B.; Wagner, Eric R. Journal of Bone and Joint Surgery: Case Connector, Volume 13, Issue 2, e22.00804, April-June 2023. DOI: [10.2106/JBJS.CC.22.00804](https://doi.org/10.2106/JBJS.CC.22.00804)

Neurogenic thoracic outlet syndrome (nTOS) is a challenging condition to diagnose. This case study describes a 74-year-old man with persistent anterior shoulder pain and paresthesia following RSA, anterior cervical discectomy and fusion (ACDF). These interventions failed to provide long-term improvements in shoulder function and pain reduction. After four years of unsuccessful attempts, the patient underwent a pectoralis minor release, brachial plexus neurolysis and suprascapular nerve release. Immediately following the procedure, pain, paresthesia and functional limitations were completely resolved and sustained for years following the operation. In this case study, digital dynamic imaging served as evidence to demonstrate that there were no apparent complications with prosthesis implantation following the patient's RSA. This case serves as a cautionary tale to demonstrate that while difficult to diagnose, consideration of nTOS as an etiology for persistent anterior shoulder pain and dysfunction is important to identify appropriate treatment plans and limit unnecessary invasive procedures that will not obtain complete symptom relief.

## **Selected Conference Presentations**

### **I. Lower Trapezius Tendon Transfer vs. Reverse Shoulder Arthroplasty for MIRCTs**

Khawaja SR, Hussain ZB, Gulzar M, Khawaja OR, Cooke HL, Gottschalk MB, Wagner ER. SOA. Miami Beach, FL. July 20, 2024.

### **II. Can We Restore Premorbid Scapulohumeral Rhythm with Anatomic or Reverse Shoulder Arthroplasty for Cuff-Intact Osteoarthritis: An In-vivo Dynamic Radiography Study**

Khawaja SR, Hussain ZB, Gulzar M, Hardrick JC, Chopra KN, Cooke HL, Conn VA, Gunawardana, Gottschalk MB, Wagner ER. Annual Meeting of the American Society for Surgery of the Hand. October 9-11, 2025.

### **III. Does Shoulder Arthroplasty Restore In-vivo Scapulothoracic Biomechanics in Glenohumeral Osteoarthritis? A Comparison Between Reverse and Anatomic Prosthesis Using Dynamic Radiography**

Khawaja SR, Hussain ZH, Gulzar M, Chopra KN, Hardrick JH, Conn VA, Seilern J, Gottschalk MB, Wagner ER. The American Orthopaedic Society for Sports Medicine. Nashville, TN. July 11, 2025.

### **IV. Lower Trapezius Tendon Transfer versus RSA for MIRCTs: An In-vivo Scapulohumeral Rhythm Dynamic Radiography Study**

Khawaja SR, Hussain ZH, Gulzar M, Khawaja OR, Cooke HL, Chopra KN, McQuillan T, Gottschalk MB, Wagner ER. American Academy of Orthopaedic Surgeons. San Diego, CA. March 2025.

### III. Precision in Hand, Wrist and Spine Imaging

#### ***Arthroscopic Volar-Dorsal Scapholunate and Lunotriquetral Ligament Capsulorrhaphy for Midcarpal Instability: A Case Report***

Gillis, Julianne W.; McQuillan, Thomas J.; Cooke, Hayden L.; Hardrick, Jaden C.; Suh, Nina; Wagner, Eric R. JBJS Case Connector, Volume 16, Issue 1, e25.00219, January-March 2026. DOI: [10.2106/JBJS.CC.25.00219](https://doi.org/10.2106/JBJS.CC.25.00219).

This report details a 20-year-old man who had previously undergone ulnar shortening osteotomy and triangular fibrocartilage complex (TFCC) repair after left wrist injury, presenting with wrist pain, clunking sensation with motion and clinical evidence of midcarpal instability on exam. Management included all arthroscopic dorsal and volar capsulorrhaphy centered around the lunotriquetral (LT) and scapholunate (SL) ligaments to tighten the radiocarpal and midcarpal joints. In young active patients with the desire to preserve motion, arthroscopic treatment of midcarpal instability offers a promising alternative to restore native wrist biomechanics and reinforce volar and dorsal extrinsic stabilizers. In this case report, DDR videos of wrist motion demonstrate midcarpal bone dynamic motion pre- and post-operative.

#### ***Front-to-Back Arthroscopic Repair of Complete Lunotriquetral Ligament Injuries: A Case Presentation and Algorithm for Arthroscopic Management of Intercarpal Ligament Injuries***

Spencer B. Chambers; Eric R. Wagner. Journal of Hand Surgery, Volume 50, Issue 2, page 242.e1 - 242.e9, February 2025. DOI: [10.1016/j.jhsa.2024.10.015](https://doi.org/10.1016/j.jhsa.2024.10.015).

A case study and algorithm for arthroscopic management of intercarpal ligament injuries is presented. Compared to scapholunate ligament injuries, injuries to the lunotriquetral intercarpal ligament (LTIL) are not as well-understood. They are believed to be the result of falls on a radially deviated, flexed and pronated wrist, or through to ulnar impaction. The authors describe arthroscopic repair of the volar and dorsal LTIL and propose a treatment algorithm for the arthroscopic treatment of these uncommon injuries. Dynamic digital radiography is used to show subtle lunotriquetral gapping with radial deviation prior to static deformity.

#### ***Total Wrist Arthroplasty as a Motion-Sparing Option for Distal Radius Malunion in a Patient of Advanced Age: A Case Report***

Hayden L. Cooke; Christine V. Schaeffer; Andrew M. Gabig; Anthony Karzon; Ujjawal Savani; Michael B. Gottschalk; Eric R. Wagner. JBJS Case Connector, Volume 13, Issue 3, e23.00167, July-September 2023. DOI: [10.2106/JBJS.CC.23.00167](https://doi.org/10.2106/JBJS.CC.23.00167).

A case report of a 62-year-old woman presenting with wrist pain secondary to a distal radius fracture malunion four months prior. After unsuccessful nonoperative treatment, she underwent total wrist arthroplasty (TWA). The woman reported significant improvement in both pain and function at a 14-month follow-up assessment. The authors report that dynamic digital radiography enables continued and long-term assessment of wrist motion in total wrist arthroplasty patients.

### IV. Efficiency Through AI-Driven Automation

#### **I. Dynamic Digital Radiography in Musculoskeletal Imaging: Development Of Novel Techniques, Experience In Clinical Practice And Future Development Potential.**

Joshua Huang, Christian Boivin, Sarah Koles. Presented at the 2022 Canadian Association of Radiologists (CAR) Annual Scientific Meeting. Abstract 1195604. The project emphasized that static X-rays often miss functional pathologies. By using DDR, the authors demonstrated:

- Functional Instability: Identifying ligamentous laxity in the wrist (like Scapholunate Dissociation) that only appears under stress.
- Shoulder Mechanics: Visualizing the relationship between the humerus and scapula during abduction to diagnose impingement syndromes.
- Spine Assessment: Measuring the degree of vertebral slippage (spondylolisthesis) during active flexion and extension.

#### **II. Analysis of Shoulder Kinematics and Determination of Scapulohumeral Rhythm Using a Machine Learning Algorithm and Dynamic Digital Radiography Images**

Sabol JM, Hussain Z, Khawaja SR, et al. Presented at the 109th Scientific Assembly of the Radiological Society of North America, Chicago IL, November 2023. <https://www.auntminnie.com/clinical-news/digital-x-ray/article/15659341/deeplearning-model-measures-shoulder-kinematics-on-ddr>

### III. Artificial Intelligence Analysis of Scapula Dynamics Using Dynamic Digital Radiography

Hussain Z, Khawaja SR, Sabol JM, Yamamura T, Xiao A, Karzon A, Cooke H, Gottschalk MB, Wagner ER. Presented at the 54th Annual Meeting of The Eastern Orthopaedic Association, Charleston SC, October 2023.

### IV. Artificial Intelligence Analysis of Scapula Dynamics Using Dynamic Digital Radiography

Hussain Z, Khawaja SR, Sabol JM, Yamamura T, Xiao A, Karzon A, Cooke H, Gottschalk MB, Wagner ER. Presented at the 40th Annual Meeting of The Southern Orthopaedic Association, Miramar Beach, FL, July 2023.

### V. Artificial Intelligence automated analysis of scapula dynamics using dynamic digital radiography: Initial reliability study

Anthony Karzon, Zaamin Hussain, Sameer Khawaja, John Sabol, Angel X. Xiao, Takayu Yamamura, Michael B. Gottschalk, Eric R. Wagner. Presented at the 2023 Annual Meeting of the American Association for Hand Surgery, Miami, FL, January 2023. [Abstract link.](#)

### VI. Artificial Intelligence Automated Analysis of Scapula Dynamics Using Dynamic Digital Radiography: A Validation and Reliability Study

Hussain Z, Khawaja S, Sabol JM, Yamamura T, Xiao A, Karzon A, Cooke H, Gottschalk M, Wagner E. Presented at BESS, Newport Wales, UK, June 2023.

### VII. Poster 173: Using Dynamic Digital Radiography to Measure Variation in Scapulohumeral Rhythm of Pathologic Shoulders

Angel Xiao, Beau McGinley, Michael Gottschalk, Eric Wagner. Orthopaedic Journal of Sports Medicine. July 2022. DOI: [10.1177/2325967121S00734](https://doi.org/10.1177/2325967121S00734).

## V. General and Spine Imaging

### I. Dynamic Digital Radiography and Lumbar Instability

Sadiq UM, Sabol JM, Brittany T, Nolte L, Carcary K, Clerk O, American Roentgen Ray Society Annual Meeting, Pitts. PA, Apr. 2026.

### II. Use of Dynamic Digital Radiography in Diagnosing Motion-Dependent Abnormalities of the Lumbar Spine

Sadiq UM, Sabol JM, Brittany T, Nolte L, Carcary K, Clerk O, American Roentgen Ray Society Annual Meeting, Pittsburgh PA, April 2026. Annual Scientific Meeting, Montreal PQ Canada, April 2026.

### III. Dynamic Digital Radiography in Musculoskeletal Imaging: Development Of Novel Techniques, Experience In Clinical Practice And Future Development Potential”

Joshua Huang, Christian Boivin, Dr Sarah Koles, “Dynamic Digital Radiography in Musculoskeletal Imaging: Development Of Novel Techniques, Experience In Clinical Practice And Future Development Potential” Canadian Association of Radiologists (CAR) Annual Scientific Meeting, Montreal PQ Canada, April 2026.

### IV. Dynamic Digital Radiography: A Novel Imaging Technique to Investigate Patients with Cervical Pain

Cellina M, Ce M, Rabaiotti FL, et al. Presented at the 110th Scientific Assembly of the Radiological Society of North America, Chicago IL, November 2024. [Presentation link.](#)

### V. Dynamic Digital Radiography (DDR): Developing Musculoskeletal Techniques

Koles SL. Presented at the American Roentgen Ray Society Annual Meeting, Boston MA, May 2024

