

DOS BEST PHD 2022

Distal radioulnar joint kinematics assessed by dynamic radiostereometry

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List of Studies

- I: **Thillemann JK**, de Raedt S, Jorgensen PB, Romer L, Hansen TB, Stilling M. Distal radioulnar joint stability measured with radiostereometry during the piano key test. *Journal of Hand Surgery European Volume*. 2020 Nov;45(9):923-930. DOI: 10.1177/1753193420934689.
- II: **Thillemann JK**, de Raedt S, Hansen TB, Munk B, Stilling M. Distal radioulnar joint stabilization with open foveal reinsertion versus tendon graft reconstruction: an experimental study using radiostereometry. *Journal of Experimental Orthopaedics*. 2021, 8: 10. DOI: 10.1186/s40634-021-00329-y
- III: **Thillemann JK**, de Raedt S, Petersen ET, Puhakka KB, Hansen TB, Stilling M. Normal values of distal radioulnar joint kinematics during a dynamic press test. *Journal of Wrist Surgery, e-publication December 2021*. DOI: 10.1055/s-0041-1740486
- IV: **Thillemann JK**, de Raedt S, Petersen ET, Puhakka KB, Hansen TB, Stilling M. Kinematics of the distal radioulnar joint before and after open reinsertion of the foveal triangular fibrocartilage complex in comparison to normal joints performing the hand press test. *Manuscript accepted to Acta Orthopaedica, June 2022*.

The PhD thesis is available at ortopaedi.dk/videnskab/afhandlinger/

Summary:

Ulnar sided wrist pain after falling on the extended wrist or torque loading in work injuries is common and often related to lesion of the triangular fibrocartilage complex (TFCC). Traumatic lesions of the radioulnar ligaments of the TFCC can lead to distal radioulnar joint (DRUJ) instability as these structures are the main contributors to DRUJ stability. In clinical examination of DRUJ instability the observer manually feels and subjectively quantify the anterior posterior translation of the DRUJ, but the method has limited reproducibility. Likewise, imaging methods such as computer tomography scans and magnetic resonance scans have inadequate specificity and sensitivity for TFCC injuries. Therefore, the gold standard diagnostic method of TFCC injuries is arthroscopic evaluation. However, it is not feasible to operate patients to get a diagnosis. Thus, a valid objective tool to diagnose TFCC injuries and grade DRUJ instability before and after surgical treatment is warranted. Radiostereometry (RSA) is a very precise and accurate method, which has been used for decades to evaluate hip and knee implant migration with repeated imaging over time in a static setting. Dynamic RSA has been used for experimental as well as clinical evaluation of joint kinematics with high precision, but never before for evaluation of the DRUJ.

The focus of this PhD thesis was TFCC injuries and application of static and dynamic RSA as an objective measure of DRUJ stability and kinematic mapping.

In Study I, the feasibility and precision of AutoRSA for analysis of RSA imaging of DRUJ translation was demonstrated experimentally. Lesion of the distal and proximal insertion of the TFCC to the ulna styloid and ulna fovea, led to increasing DRUJ translation during static RSA examination during a Piano key test.

In Study II, a surgical treatment with foveal reinsertion of the TFCC or Adams TFCC reconstruction was compared in a randomized experimental study. The Piano key test applied to induce DRUJ translation, which was recorded by static RSA at end-points. A stabilizing effect was demonstrated by foveal TFCC reinsertion, whereas the variation in the stabilizing effect of Adams TFCC reconstruction was large and did not prove a statistically significant reduction of DRUJ translation.

In Study III, the feasibility and precision of a AutoRSA for analysis of dynamic RSA imaging during a Press test was demonstrated in a clinical study. DRUJ kinematics during an active Press test was recorded in participants with asymptomatic clinical stable non-injured DRUJs and classified as "normal DRUJ kinematics". Using a DRUJ position ratio was recommended to take individual sigmoid notch size into account.

In Study IV, DRUJ kinematics during a patient active Press test was recorded with dynamic RSA and a paired comparison was done between the patients asymptomatic non-injured DRUJ and the symptomatic DRUJ with an arthroscopically verified foveal TFCC lesion. A statistically significant difference of the DRUJ position ratio in foveal TFCC injured DRUJs compared to the asymptomatic side was demonstrated as the ulnar head center translated 10 percent points more volar in the sigmoid notch with foveal TFCC injury. Surgical treatment with open foveal TFCC reinsertion was performed and postoperative clinical and dynamic RSA imaging showed a stabilizing effect on the DRUJ stability towards normal values at 6-month and 1-year follow-up. Surgery did not normalize grip strength and AROM to the level of the non-injured contralateral side, but PROMs (QDASH, PRWE, and pain during activity) were improved to the level of minimal clinically important differences (MCID).

In conclusion, this thesis documented static and dynamic RSA imaging and AutoRSA analysis to be a feasible and precise method for evaluation of DRUJ stability and kinematics. The studies contributed with precise estimates of DRUJ kinematics and improved the understanding of normative DRUJ kinematics, and the kinematic impact of TFCC injuries. This inspires to further explore the DRUJ kinematic patterns using clinically relevant and more complex DRUJ exercises that mimic the situations in which patient's report symptoms and DRUJ instability. Furthermore, dynamic RSA imaging and AutoRSA analysis of the DRUJ now makes it possible to evaluate the stabilizing effect of existing and new surgical treatments for DRUJ instability.