Scapholunate instability (SLI) remains the most common carpal instability, accounting for approximately 5% of the wrist sprains. The diagnosis of SLI is often missed. Even when diagnosed and treated, surgical outcomes remain less than ideal. In large joints such as the knee and the shoulder, the diagnosis of instability and surgical decision-making largely depends on dynamic clinical assessments. Despite a large amount of literature on carpal malalignment in SLI, the in vivo kinematics is poorly understood. Dynamic computed tomography (4D CT) enables an in vivo dynamic assessment of the wrist. The aim of this thesis was to define the objective dynamic changes of SLI compared to the healthy wrist using 4D CT, to better understand the in vivo kinematics in SLI.

Nineteen 4D CT scans of healthy wrists and 19 SLI wrists were assessed during wrist ulnar to radial deviation and extension to flexion. The radius, scaphoid, lunate, and capitate were segmented and converted to 3-dimensional (3D) models. The carpal displacements were calculated using a registration algorithm. The outcome measures were the radiocarpal angular and linear displacements, midcarpal angular displacements and the helical axis of motion (HAM) of the scaphoid and lunate.

Compared to the normal wrist, the SLI wrist had following significant findings in the arc of motion: The arc of radial angulation was greater, and the arc of flexion was less in the SLI scaphoid during wrist radial deviation beyond 10°. While the normal scaphoid had more out of plane motion during wrist radial deviation, the SLI scaphoid had more in-plane motion. The arc of flexion of the SLI lunate was less during wrist ulnar to radial deviation. During the wrist motion from 70° to 40° extension, the arc of flexion of the SLI scaphoid was greater; The arc of flexion of the SLI lunate was less.

Compared to the normal wrist, the SLI wrist had following significant findings in the radiocarpal angles: The radioscaphoid angle was more flexed for the SLI wrist from wrist extension to flexion and from ulnar deviation to neutral position. The radiolunate angle was more extended for the SLI wrist, during wrist flexion and radial deviation. The SLI scaphoid was more internally rotated in all wrist position.

Comparing the motion distribution between the radiocarpal and midcarpal joints, the scapho-capitate joint was found to be the dominant articulation in the normal wrist during radial deviation. In the SLI wrist, the dominant articulation was the radioscaphoid joint. During wrist 70° to 40° extension, the radial column of the SLI wrist had more radiocarpal flexion than the normal wrist; the central column of the SLI wrist, had more midcarpal flexion than the normal wrist.

The HAM of the normal scaphoid and the lunate underwent sequential changes in the orientation and location as the wrist moved from ulnar to radial deviation. The SLI scaphoid HAM remained similar throughout. The SLI lunate had sequential changes in the orientation of the HAM but, of a lesser magnitude. The change in the orientation of the HAM from maximum ulnar to maximum radial deviation, was significantly greater in the normal wrist compared to the SLI wrist, in all three planes for the scaphoid and the lunate.

SLI result in increased ‘in-plane’ motion and reduced ‘out-of-plane’ motion of the scaphoid. There was an accompanying reduction of lunate ‘out-of-plane’ motion. The significant changes were evident mainly during wrist radial deviation. This is associated with multiple objectively measurable kinematic abnormalities in 3 dimensional radioscaphoid and radiolunate angles, which supports a diagnosis of a ‘kinematically abnormal wrist’. The kinematic changes may occur in a spectrum in SLI.

The clinical implications of the findings are partly diagnostic and enable understanding of the 3D kinematics of SLI. In addition, the sequential changes in the HAM of the scaphoid and the lunate are suggestive that a single-bundle tendon reconstructions are unlikely to recreate normal kinematics in SLI.