Model studies on segmented heter det segmental? movement in lumbar spine using a semi-automated program for volume fusion

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**Introduction:** Spinal segments motion analysis is a three-dimensional problem. However, because of the inaccessibility of the spine and the complexity of segmental movements most of the noninvasive methods in use today do not have the proper accuracy or the ability to detect movements in all three cardinal axes. Almost all in vivo methods used for analysing segmental motion are based on two-dimensional (2D) radiographic examinations. We have therefore developed a new CT based method for detecting three dimensional (3D) segmental movements. In a model study the validity and repeatability of the method has been assessed and the method has been applied on patients that underwent disc arthroplasty surgery in lumbar spine. In patients we have also analysed the facet joint 3D movement in the adjacent level before surgery and 2 years post operative in provocations CT scans.

**Materials and Methods:** One hundred and four CT volumes were acquired of a phantom incorporating three lumbar vertebra. Lumbar segmental translation was simulated by altering the position in all three cardinal axes of one vertebra between acquisitions. The CT volumes were combined into 64 case pairs, simulating lumbar segmental movement up to three millimeters between acquisitions. The relative movement between the vertebra was evaluated visually and numerically using a volume fusion image post-processing tool. Results were correlated to direct measurements of the phantom. 10 patients with low back pain that were selected to L5-S1 disc arthroplasty surgery underwent a low dose CT (0.8 mS) with provocation in flexion and extension. CT was performed before and two years after surgery.

**Results:** In the model visual inspection, translation of at least one millimeter or more could safely be detected and correlated with separation between the vertebra in 3D. Numerically, the accuracy limit for lumbar segmental translation in 3D was The accuracy limit for all the CT measurements of 3D translations was 0.56 mm (median 0.12, range -0.76 to +0.49). The accuracy for the sagittal axis was 0.45 mm (median 0.10, range of -0.46 to +0.62), the accuracy for the coronal axis was 0.46 mm (median 0.09, range of -0.66 to +0.69) and accuracy for the axial axis 0.45 mm (median 0.05 range -0.72 to +0.62). Preliminary results from patients show that translation between the vertebra of at least one millimeter or more could safely be detected on visual inspection and adjacent levels facet joints movements decreases from pre operative to two years follow up.

**Discussion:** The accuracy of this non-invasive method is better then today’s routine methods for detecting segmental movements. The method allows both visual and numerical evaluation of segmental movement. Preliminary data from the patient study shows that this method could be used to detect in vivo 3D segmental movements in patient that has been difficult to detect with other methods.