From the Department of Molecular Medicine and Surgery Section of Orthopaedics and Sport Medicine

Assessment of 3D movements in the Lumbar and Cervical spine with a new CT based method

AKADEMISK AVHANDLING
som för avläggande av medicine doktorsexamen vid Karolinska Institutet offentligen försvaras i Psykaulan, Löwenströmska sjukhuset

Fredagen den 18 november 2011, kl 09:00

av
Per Svedmark
MD

Huvudhandledare:
Professor Lars Weidenhielm
Karolinska Institutet
Institutionen för molekylär medicin
Och kirurgi
Sektionen för ortopedi

Bihandledare:
Med dr Henrik Olivecrona
Karolinska Institutet
Institutionen för molekylär medicin
Och kirurgi
Sektionen för ortopedi

Professor Gunnar Németh
Capio group,Stockholm

Med dr Tycho Tullberg
Stockholm Spine Center

Fakultetsopponent:
Professor Björn Strömqvist
Lunds Universitet
Institutionen för kliniska vetenskaper,lund
Avdelningen för Ortopedi

Betygsnämnd:
Docent Leif Ryd
Karolinska Institutet
CLINTEC

Docent Paul Gerdheim
Karolinska Institutet
CLINTEC

Docent Johan Wikstrom
Uppsala Universitet
Institutionen för radiologi, onkologi samt strålnings vetenskap

Stockholm 2011

ABSTRACT

Background: Numerous methods for measuring segmental motion in spine have been described. However, because of the inaccessibility of the spine and the complexity of segmental movements, most of the noninvasive methods in use today have low accuracy or are unable to detect movements in all three cardinal axes. Almost all in vivo methods used for analysing segmental motion are based on twodimensional (2D) radiographic examinations. Radiostereometris Analysis is so far the most accurate method to detect three-dimensional (3D) motion.

Specific aim: To develop and evaluate a non-invasive method for motion analysis of the spine using computed tomography (CT).

Methods: We studied segmental motion in a custom-made spine model, healthy subjects, and a small series of patients operated with total disc replacement. The subjects and patients were examined in flexion and extension on a fourth generation spiral CT unit. Analyses of the segmental movements in lumbar and cervical spine were done with a in-house developed software tool.

Results: In the lumbar spine the accuracy was 0.6 mm for translation and 1 degree for rotation in the model study. Movements of more than 1 mm could be visual detected. The repeatability on healthy subjects was 2.8 degrees in rotation and 1.8 mm in translation in vertebral segment. The mean facet joint 3D movement was for the right 6.1 mm and for the left 6.9 mm in L4-L5 segment and for the L5-S1 segment for the right facet 4.5 mm and 4.8 mm for the left. Mean rotation in the sagittal plane was 14.3degrees in L4-L5 and 10.2 degrees in L5-S1. In patients with total disc replacement the mean rotation in the sagittal plane at the operated level (L5-S1) was 5.4 degrees before surgery and 6.8 after surgery. In the adjacent level (L4-L5) the mean rotation (degrees) was 7.7 before and 9.2 after surgery. The 3D translation in the operated level the left facet was 3.6 mm before and 4.5 mm after surgery and for the right facet joint 3.4 mm before to 3.6 mm after surgery.In the cervical spine the accuracy was 0.7 degrees in rotation and 0.5 mm in translation in the model study. The repeatability on the model was 1.1 degrees in rotation and 0.3 mm in translation. The repeatability on patients was 2.3 degrees in rotation and 1.4 mm in translation. The median movement for the patient was in the sagittal plane for rotation 6.28 and translation 0.1mm, coronal plane 1.68 and 0.6 mm, and for the transverse plane 1.38 and 0.6 mm in translation

Conclusion: We have developed a non-invasive CT based method to study the 3D segmental movement in the spine. It has been tested in a model study, on healthy subjects and on patients with total disc replacement in cervical and lumbar spine. We believe that this method for detecting movements in the spine is useful both in research and for clinical use.