Assessment of Spinal Balance and Range of Motion Using the Kinect Motion Analysis System

Site: University of California, San Francisco	
Site Director: Jeffrey Lotz, PhD (UCSF)	
PI and Co-PI name(s): Shane Burch; Jeff Lotz	**Proposed Budget:** **(including 10%** indirects): ≤ $40,000
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Need and Industrial Relevance:

Sagittal balance is an important clinical parameter significantly associated with high health related quality of life scores. Loss of global balance occurs during aging as lordotic lumbar segments become neutral or kyphotic through the degenerative cascade. Realignment of the spine through osteotomies, interbody cages and posterior spinal fusion can be extremely effective at restoring global sagittal balance. Realignment procedures are being performed more frequently and despite their effectiveness these procedures are expensive and revision rates remain high. Loss of alignment through reciprocal kyphosis and weak hip extensors contribute to failures of these procedures. Assessment of global and segmental range of motion of the thoracic-lumbar-hip axes is critical to the success of spinal realignment procedures. Although static angular normal parameters have been well established there is limited data on how these parameters perform in the dynamic setting in the older patient. Furthermore data on soft tissue balancing of the spine is limited because range of motion parameters are not routinely measured objectively through Xray, CT or MRI. Laboratory based motion analysis techniques (eg. Vicon motion analysis system) have become the gold standard to quantify spine motion. Recently, a low-cost system that uses depth cameras to measure three-dimensional motion (Microsoft Kinect) has emerged as a potential alternative to the gold standard laboratory based motion analysis systems that can be used in a clinical setting.

Improved understanding of the dynamic alignment of the spine as a patient stands may introduce insights into better implant designs or surgical strategies to fit the biomechanical demands of a patient with spinal pathology.

Project Aims (including Hypotheses):

We hypothesize that a low cost depth camera system (Kinect) is able to measure angular motion along the thoracic-lumbar-pelvis and hip sagital and coronal axes to better identify forces (moment arms) at the cervical-thoracic junction, the thoraco-lumbar junction and at the lumbar-sacral junction in patients with spinal pathology.

Aim 1: To measure the static and dynamic relationships of the thoracic-lumbar - pelvis and hip axes in a standing and sitting position. Correlation of the measurements from the Kinect system will be correlated to plain 3 foot standing xrays in patients with spinal stenosis

Aim 2: To measure the excursion of the thoracic and lumbar spine from a neutral vertical axis during flexion and extension to assess the relationship of the thoracic and lumbar spine during flexion and extension in patients with adult degenerative scoliosis.

Aim 3: To measure the excursion between the pubic symphysis and the sternum during flexion and extension compared to neutral in patients with adult degenerative scoliosis.

Methods:

IRB approval has been obtained to measure sagittal and coronal alignment of healthy active volunteers (n=20) and patients with spinal disorders (n=60) in both the sitting and standing positions. Three cohorts will be chosen. Patients with degenertative conditions with less than 3 level disease (n=20), patients with adult degenerative scoliosis / kyphosis without fusion (n=20) and patients with adult degenerative scoliosis / kyphosis with fusions from the thoracolumbar junction to the pelvis (n=20). Patients will be imaged sitting and standing (static) and with image capture also occurring during the transition from sitting to standing (dynamic). Angular measurements in the sagittal and coronal plane between nodes (reference points) at the thoracic-lumbar, pelvis and femoral axes will be captured using a MATLAB interface. Similarly the excursion from a vertical reference axis will be determined for each spinal node. Measurement of the change in distance between the pubic symphysis and sternum will also be recorded. Comparisons between static full standing films will be made against a vertical sagittal and coronal axis for each cohort.

Milestones (must include):
IRB Approval - complete

Finish MATLAB / Kinect user interface– Oct 15, 2015

Finish control measurements – Oct 31, 2015

Finish cohort measurements – March 31, 2015

Finish data analysis – May 31, 2015

Deliverables (must include):
Quarterly presentation updates:

- *December 2015 – conference call*
- *Spring 2015 – Spring Symposium @ UT (conference call option for UCSF teams)*
- *June 2015 – conference call*
- *September 2015 – Fall Symposium @ UCSF (conference call option for UT teams)*

Final written report including results - October 31, 2016
Specific work product (e.g. protocols, material, device, database)

General Budget Outline:

Personnel	$	25,000
Supplies	$	11,000
Total Direct	$	36,000
Indirects (10%)	$	3,600
Total	$	39,600

Start Date:	End Date:
(October 2, 2015	September 30, 2016

Please limit this document to 2-3 pages and email it to PuiYee.Law2@ucsf.edu by August 14th.