EVALUATION OF THE INFLUENCE OF DIFFERENT ARMS POSITION ON SAGITTAL SPINAL ALIGNMENT USING VIDEO-RASTERSTEREOGRAPHY

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• Despite x-rays is the gold standard to assess three-dimensional spinal alignment, video-rasterstereography represents a valid and reliable technique, based on light emission.

• Besides being radiation-free, video-rasterstereography could allow to overcome technical difficulties arising from standard radiographic assessment, especially concerning the sagittal plane evaluation. Indeed, lateral radiographs require the arms not to be positioned along the body, in order to correctly visualize vertebral bodies.

• Different arm positioning, however, influences sagittal spinal measurements.

In order to correctly interpreter the results from an instrumental assessment of sagittal plane of the spine we need to know how much the amount of shoulder flexion imposed to patients during the measurement influences the spinal parameters.

The aim of the present paper was to evaluate by means of video-rasterstereography the influence of different arm positioning on sagittal alignment of the spine in a population of healthy volunteers.
30 patients enrolled in the study.

Each subject has been consecutively evaluated in normal standing position, with arms along the body, then with active arms elevation in 30°, 60°, 90°, and 120° position.
To collect data, the patients underwent video-rasterstereography, a non-invasive device which uses an optical-electronic technique without involving exposure to ionizing radiations.

- Parallel white light lines are projected on the back surface of the patient by a slide projector.
- Anatomical landmarks are automatically captured by assigning concave and convex areas to the curved light pattern. With these anatomical fix points, the system is able to calculate a three-dimensional model of the human spine.
These evaluations were performed three times for each subject and the mean of the three measures was considered for each subject.
The following parameters have been considered in order to evaluate **sagittal alignment**:

- Trunk inclination VP-DM
- Flèche cervicale
- Flèche lombaire
- Kyphotic apex KA
- Lordotic apex LA
- Inflection point ITL
- Inflection point ILS
- Kyphotic angle ICT-ITL (max)
- Lordotic angle ITL-ILS (max)
- Pelvic inclination (dimples)
Values for each test position were compared within subjects using repeated measures ANOVAs.

One two-tailed ANOVAs were used to compare differences in each variable between the 5 test positions.

Tukey post hoc test were used to identify specific differences between test positions.

The position with arms along the body represented the mean value for control.

30 subjects were enrolled in the study:
- Mean age: 27.5 years
- Mean height: 173 cm
- Mean BMI value: 23.58
## RESULTS (2)

<table>
<thead>
<tr>
<th></th>
<th>30°</th>
<th>60°</th>
<th>90°</th>
<th>120°</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FLÈCHE CERVICALE</strong></td>
<td>6,95 mm</td>
<td>16,7 mm*</td>
<td>23,73 mm***</td>
<td>31,35 mm***</td>
</tr>
<tr>
<td><strong>FLÈCHE LOMBAIRE</strong></td>
<td>-13,62 mm**</td>
<td>-22,20 mm***</td>
<td>-24,79 mm***</td>
<td>-27 mm***</td>
</tr>
<tr>
<td><strong>KYPHOTIC ANGLE</strong></td>
<td>-0,3°</td>
<td>-0,5°</td>
<td>2,28°</td>
<td>8,85° *</td>
</tr>
<tr>
<td><strong>LORDOTIC ANGLE</strong></td>
<td>-1,2°</td>
<td>-2,43°</td>
<td>-3,95°</td>
<td>-4°</td>
</tr>
<tr>
<td><strong>KYPHOTIC APEX</strong></td>
<td>-17,87</td>
<td>-34,70 mm**</td>
<td>-40,88 mm***</td>
<td>-24,64 mm*</td>
</tr>
<tr>
<td><strong>LORDOTIC APEX</strong></td>
<td>-13,611 mm**</td>
<td>-22,2 mm***</td>
<td>-24,79 mm***</td>
<td>-28 mm***</td>
</tr>
<tr>
<td><strong>TRUNK INCLINATION</strong></td>
<td>3° ***</td>
<td>5,18° ***</td>
<td>5,83° ***</td>
<td>5,8° ***</td>
</tr>
</tbody>
</table>

Mean differences from normal standing position (0 value) in sagittal parameters during each of 4 experimental positions.

*p<0.05, **p<0.01, ***p<0.001
DISCUSSION (1)

A review of methods for evaluating the quantitative parameters of sagittal pelvic alignment

The spine can be considered as a mobile unit that ensures a correct balance between the head and the pelvis, which represents the foundation of the spine; therefore the harmony among spinal and pelvic parameters is of significant importance. This harmony can be maintained with an optimal lordotic position of the vertebrae among an optimal position of the pelvis.


Standing Lateral Radiographic Positioning Does Not Represent Customary Standing Balance

Since there are compensatory mechanisms that act on this postural equilibrium, in order to better comprehend and analyze the sagittal alignment, we have to understand the compensatory relationship between the spine, the pelvis and the lower limbs.

DISCUSSION (2)

Three spinal parameters are hardly influenced by arms positioning:

1. *Trunk inclination*
2. *Lordotic angle*
3. *Flèche cervicale*

This is probably due to the **compensatory trunk extension which counterbalances arms elevation in order to maintain the Center Of Mass (COM) over the base of support.**

- **Kyphotic angle**, however, is less influenced at minor degree of arms elevation and it significantly modifies only at 120° position, probably due to the shoulder joints’ biomechanics. Indeed gleno-humeral joint contributes to active flexion of the shoulder only up to about 120°, while the remaining 60 ° are due to the abduction and lateral rotation of the scapula.
- **No significant changes** were observed in the other parameters.
None of the authors has any potential conflict of interest