INTRODUCTION
Cervical kinematics has been the subject of many studies [1-4] investigating the influence of some factors (age, sex, lifestyle, work …) on it. However none of these studies has looked at extensively analyzed the link between the speed of execution of movements and cervical kinematics.

METHODS
Cervical kinematic was recorded using the optoelectronic VICON system.

Clusters were placed on the chest (sternum, acromion, Th2, Th6) on the face (zygomatic arch, tragus) and a helmet with four markers on the head (figure 1).

The main movements (flexion-extension, lateral bending, rotation) and coupled movements were studied in healthy subjects. Subjects (n = 32, age 31±10years) performed movements in two modalities: the best possible (BEST) and as quickly as possible (FAST). For each movement, two trials were performed.

Subjects were seated on a stool to let the thoracic spine free because thoracic spine mobility directly affects cervical mobility [5-6].

Data were processed using a program written in Matlab. For each movement, maximal motion range, amplitude of coupled motions and motion velocity were computed and compared using ANOVA.

RESULTS
FAST movements displayed significantly higher speed compared to BEST movements (figure 2).

BEST movements showed similar amplitudes to those found in the literature [1]. Amplitudes were higher for each movement (p = 0.0007 for flexion-extension, p = 0.000007 for lateral flexion, p = 0.004 for rotations) when movements were performed as quickly as possible (movements made in the BEST modality showed amplitudes of 95% compared to movements carried out in the FAST modality).

Average data are summarized in table 1. Concerning coupled movements there was only an increase in rotational movements coupled to lateral bending during FAST movements (figure 3).

DISCUSSION
Results are shown in table 1. An important increase of speed (p<0.001) was observed for each movement. Concerning extension we did not find difference of amplitude between movement modalities (the difference observed for the flexion-extension movement is just due to the important
increase of flexion amplitude). This may indicate that the increase of motion observed for the other movements is not only due to speed increase, but that other factors may interfere as well.

CONCLUSION
It appeared that the speed of movement has an effect on cervical kinematics. The amplitudes found in the literature correspond to motion ranges made during a modality resembling the BEST situation in our study. For the movements made as quickly as possible amplitudes were higher than those found in the literature.

Further studies are needed to study more precisely this relation between speed and kinematics. It would be interesting to investigate the effect of age and pathology.

![Figure 3: Rotational movement coupled to lateral bending (right rotation is positive)](image)

Table 1: Mean (SD) of cervical motion speed (°/s) and amplitude (°)

<table>
<thead>
<tr>
<th></th>
<th>Flexion</th>
<th>Extension</th>
<th>Lateral Bending Right</th>
<th>Lateral bending Left</th>
<th>Rotation Right</th>
<th>Rotation Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPEED</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BEST</td>
<td>143 (35)</td>
<td>149 (35)</td>
<td>115 (36)</td>
<td>115 (37)</td>
<td>361 (262)</td>
<td>348 (61)</td>
</tr>
<tr>
<td>FAST</td>
<td>371 (100)</td>
<td>362 (86)</td>
<td>328 (96)</td>
<td>308 (76)</td>
<td>625 (239)</td>
<td>609 (226)</td>
</tr>
<tr>
<td>Increase (%)</td>
<td><strong>260%</strong>*</td>
<td><strong>243%</strong>*</td>
<td><strong>285%</strong>*</td>
<td><strong>267%</strong>*</td>
<td><strong>173%</strong>*</td>
<td><strong>175%</strong>*</td>
</tr>
</tbody>
</table>

| AMPLITUDE |         |           |                       |                     |               |               |
|           | BEST    | FAST      |                       |                     |               |               |
| Flexion   | 68 (9)  | 76 (15)   | 55 (11)               | 56 (17)             | 45 (5)        | 50 (6)        |
| Extension | 102%    | 49 (10)   | 50 (6)                | 50 (6)              | 49 (10)       | 77 (6)        |
| Increase (%) | **112%** | **111%*** | **109%*** | **104%** | **103%** |

ANOVA results: *: p<0.05 **: p<0.01 ***: p<0.001

REFERENCES