Musculo-skeletal models of the spine can help in clinical practice. For example, the effect of thoracic kyphosis on spinal loads and trunk muscle forces can be studied. However, due to the lack of a coherent dataset, such models require combining musculo-skeletal data from different cadavers. As a result, models may contain musculo-skeletal systems that are not anatomically realistic [1].

We dissected the elements and digitized their data from different cadavers. We obtained a complete and coherent anatomical dataset for musculo-skeletal modeling of the entire human spine.

We dissected the elements and digitized their attachments by using NDI Hybrid Polaris spectra tracking system. Subsequently, we measured morphological muscle parameters for each element [2,3]:
- fiber length
- optimal-fiber length (OFL),
- tendon length (TL),
- physiological cross-sectional area (PCSA),
- mass,
- and pennation angle.

An average sarcomere length (SL) for every muscle was calculated by using the laser diffraction method (Fig. 1c) [3]. Furthermore, we graphically estimated wrapping surfaces from the geometry of the spine and measured point clouds over the structures that muscles wrap.

Full spinal CT images were segmented into STL geometry files. Finally, iterative closest point algorithm was used to register muscle attachments with the CT images. After registration, attachment sites measured with respect to local reference frames were transformed to the global reference frame defined by the CT scanner (Fig. 1d).

We obtained a complete and coherent anatomical dataset for the entire human spine. This dataset includes segmented bone surfaces, three-dimensional coordinates of muscle attachment sites, and the morphological muscle parameters from a single male cadaver.

An apparent difference in muscle architecture was noted in the transversospinal muscles. They had their tendons running from their origin to insertion where their fibers either spanned the full length of the tendon (Fig. 3c) or partially spanned (Fig. 3b).

Anatomical variability was found in terms of muscle attachments with the bones. Results were consistent with other anatomical studies and included new data for several muscles.

The complete musculo-skeletal data was recently published in these articles:

References

Table 1. Range of values in measured morphological parameters.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCSA (cm²)</td>
<td>0.09</td>
<td>18.5</td>
</tr>
<tr>
<td>SL (µm)</td>
<td>2.1</td>
<td>3.91</td>
</tr>
<tr>
<td>OFL (cm)</td>
<td>0.6</td>
<td>25.1</td>
</tr>
</tbody>
</table>

Discussion & Conclusions
We obtained a complete and coherent anatomical dataset for the entire human spine.

This dataset includes segmented bone surfaces, three-dimensional coordinates of muscle attachment sites, and the morphological muscle parameters from a single male cadaver.

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