REPRODUCIBILE REFERENCE FRAME FOR *IN VITRO* TESTING OF THE HUMAN VERTEBRAE

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Introduction

There is a consensus about the need for standardized reference frames [ISB, 2002]. Nevertheless, the literature on vertebrae is vague where it concerns a reference frame for *in vitro* applications. Many authors indicate that the vertebral body must be "horizontal" without specifying how such an alignment must be implemented. The aim of this study is:

- To define a reference frame for the human vertebrae, suitable for *in vitro* applications that: (i) relies on anatomical landmarks that are robust (e.g. are not affected by the presence of osteophytes, etc.); (ii) can be consistently applied by different operators.
- To assess its intra-operator and inter-operator repeatability.

Methods

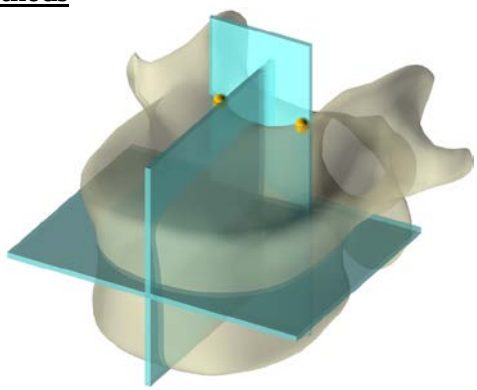

Figure 1: Definition of reference frame for the vertebral body.

The reference frame was designed to be applicable for both single-vertebrae specimens, and to three-adjacent-vertebrae specimens (where the central vertebra is the one under investigation). The reference frame is inspired on anatomical studies [Panjabi, 1992], which were extended by using the whole endplates (Fig. 1). Using a setup that allows for rotational adjustment in 3D, the specimen must be aligned in the following steps:

1. Anterior view: The right- and left-most points of both endplates must have an equal height for alignment (alignment in the frontal plane).
2. Lateral view: The most anterior and most posterior point of both endplates must have an equal height for alignment (alignment in the sagittal plane).
3. Superior view: Align the points defined by [Panjabi 1992] with a reference line (alignment in the transverse plane).

Four thoraco-lumbar specimens, consisting of three-adjacent-vertebrae were cleaned of soft tissues, with exception of the intervertebral discs. Five experienced operators did the alignment of each specimen three times.

Results

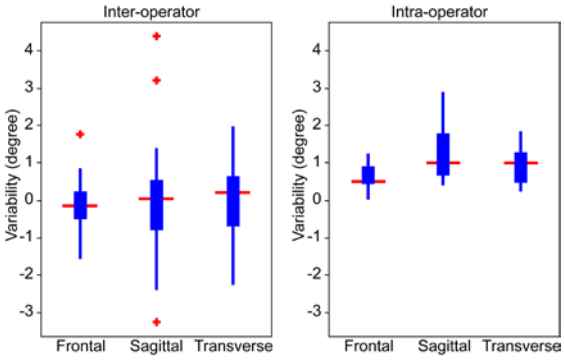

Figure 2: (a) Inter-operator and (b) Intra-operator repeatability for the three anatomical planes.

Discussion

Alignment in the frontal plane was most repeatable, while in the sagittal and transverse plane alignment was less repeatable. The inter- and intra-operator repeatability of the different angles were comparable (within ±2° for all planes, with some outliers) (Fig.2). This suggests that errors mainly depend on uncertainty in defining the landmarks. The main problems reported by the 5 operators were: bad visibility of the bone, anatomical differences, and the presence of osteophytes. Also the limited dimensions of the specimens play an important role in visual alignment.

References

ISB Standardization Committee, J Biomech, 35:543-8, 2002.

Panjabi *et al*, Spine, 17:299-306, 1992.