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Acquisition of accurate temporomandibular joint disc external shape and internal microstructure

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State of the art

The temporomandibular joint (TMJ) is composed of:

- the temporal bone,
- the mandible’s condyle,
- the TMJ disc.

The TMJ disc is:

- a fibrocartilage,
- composed mainly of water, collagen type I and proteoglycans,
- associated with TMJ disorders.

Objectives of this study:

- Understanding the mechanical behaviour of the TMJ disc.
- Building up experimental database.
- Numerical investigation to determine mechanical properties.
- Identification of disc’s geometry, thickness and internal microstructure to implement them in numerical joint models.

Data concerning the disc’s thickness (t) are crucial to process experimental measurements but are not straightforward to obtain.

Complete TMJ discs and condyles are extracted from pig’s head.

Optical 3D scan

- Atox Compact scan system (GOM, Germany)
- Two measuring techniques
  - Disc placed on condyle
  - Disc maintained in holding system (4 hooks)
- Postprocessing with CloudCompare and GomInspect to evaluate thickness

MRI imaging

- Image acquisition with disc placed on a 3D printed condyle within physiological solution (NaCl 9g/L)
- 1.4 T vertical superconducting magnet; Avance III 600 Wide Bore (Bruker, Germany)

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Results and Discussion

Optical scan allows reconstruction of the disc’s surfaces and measurements of its thickness on areas (method I: mean 3.24 ± 0.63 mm, n = 18):

- Different thickness measurement techniques lead to consistent results.

MRI acquisition allows insight into the disc’s volume. In the sagittal cut, the biconcave shape of the disc can be observed. Thickness measurements for three sagittal cuts resulted in t = 2.75 ± 0.75 mm (mean ± STD, n=9).

The transversal cut depicts the antero-posterior orientated microstructure.

Outlook

The authors would like to thank Mrs. S. Hatton (Sokli-Ced, Woippy, France) for the support and help in the 3D scan and the Société de Biomécanique for financial support to participate at the WCB 2018.