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Acquisition of accurate temporomandibular joint disc external shape and internal microstructure

L.K. Tappert¹, A. Baldit¹, C. Laurent², M. Ferrari³, P. Lipinski¹

¹ Université de Lorraine, CNRS, Arts et Métiers ParisTech, LEM3, F-57000 Metz, France; ²Université de Lorraine, CNRS, Arts et Métiers ParisTech, LEM3, F-54000 Nancy, France; ³LEMTA ENSEM - 54505 Vandoeuvre, France;
lara-kristin.tappert@univ-lorraine.fr

State of the art

The temporomandibular joint (TMJ) is composed of:
• the temporal bone,
• the mandibula’s condyle,
• the TMJ disc.

Modified from: Michael Kaz: Temporomandibular Joint Problems

The TMJ disc is:
• a fibrocartilage,
• composed mainly of water, collagen type I and proteoglycans,
• associated with TMJ disorders.

Example of porcine TMJ disc; different anatomical disc zones are indicated.

Objectives of this study:
• Understanding of disc’s geometry, thickness and internal microstructure to implement them in numerical joint models.

Material and Methods

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
• Atos Compact scan system (GOM, Germany)
• Two measuring techniques
  I. Disc placed on condyle
  II. 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)
• 1.5 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 ± standard error: 3.24 ± 0.063 mm, n = 18).

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.

→ Different thickness measurement techniques lead to consistent results.

Outlook

The authors would like to thank Mr. S. Hatton (Soki-Cad, Woippy, France) for the support and help in the 3D scan and the Société de Biomécanique for financial support to participate at the WSB 2018.