HUMAN EARCANAL DYNAMIC MOTION:
A discrete approach to study the size and shape variations with head, face and jaw movements

Michel Demuynck, **Aidin Delnavaz**, **Jérémie Voix**

École de technologie supérieure, Université du Québec, Montréal, QC, Canada

To harvest the maximum in-ear compression energy, a harvester should preferably be placed after the 1st bend of the earcanal, on its anterior wall.

CONTEXT

Several studies proved that a significant amount of energy can be harvested from movement. Although they have already evaluated the power capability of earcanal dynamic motion, none of these studies aimed at predicting the precise locations where the energy capability of the earcanal is maximum.

Objective:
To assess size and shape variations of the earcanal with different activities to identify the in-ear region that could provide the highest amount of mechanical deformation energy.

METHODS

1

18
Healthy subjects

33%
Women

33,5 [31;39] years
Median age

5 activities
CM: Closed mouth
MO: Mouth opening
THL: Turning head left
RE: Raising eyebrows
SM: Smiling

2

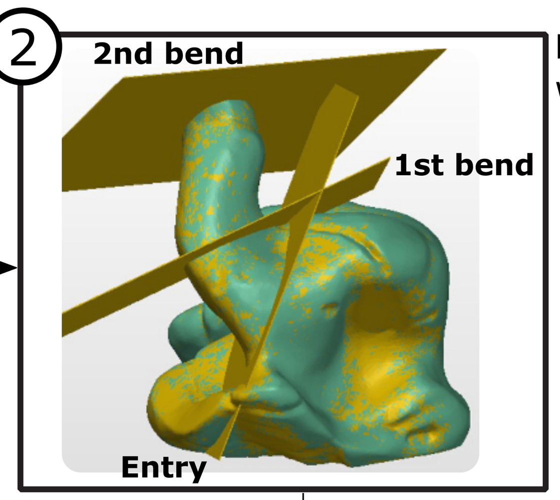

Fig. 1: Earmold numerical model with the 3 reference planes

4

(1) Area
(2) Circularity
(3) Tortuosity

3

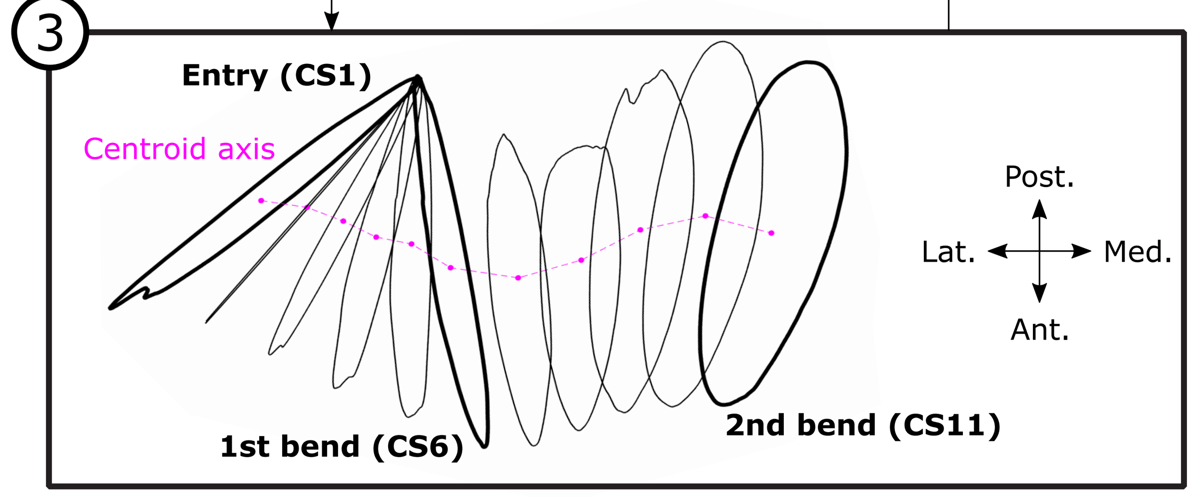

Fig. 2: Earcanal discretization with 11 cross-sections (CS) and centroid axis.

CONCLUSIONS

MO and SM show the highest differences in size and shape. The transition between first and second bend looks like a turning point as deviations change sign. By placing an energy harvester at this location, MO and SM should provide a significant amount of energy resulting from contraction and expansion of the earcanal.

RESULTS

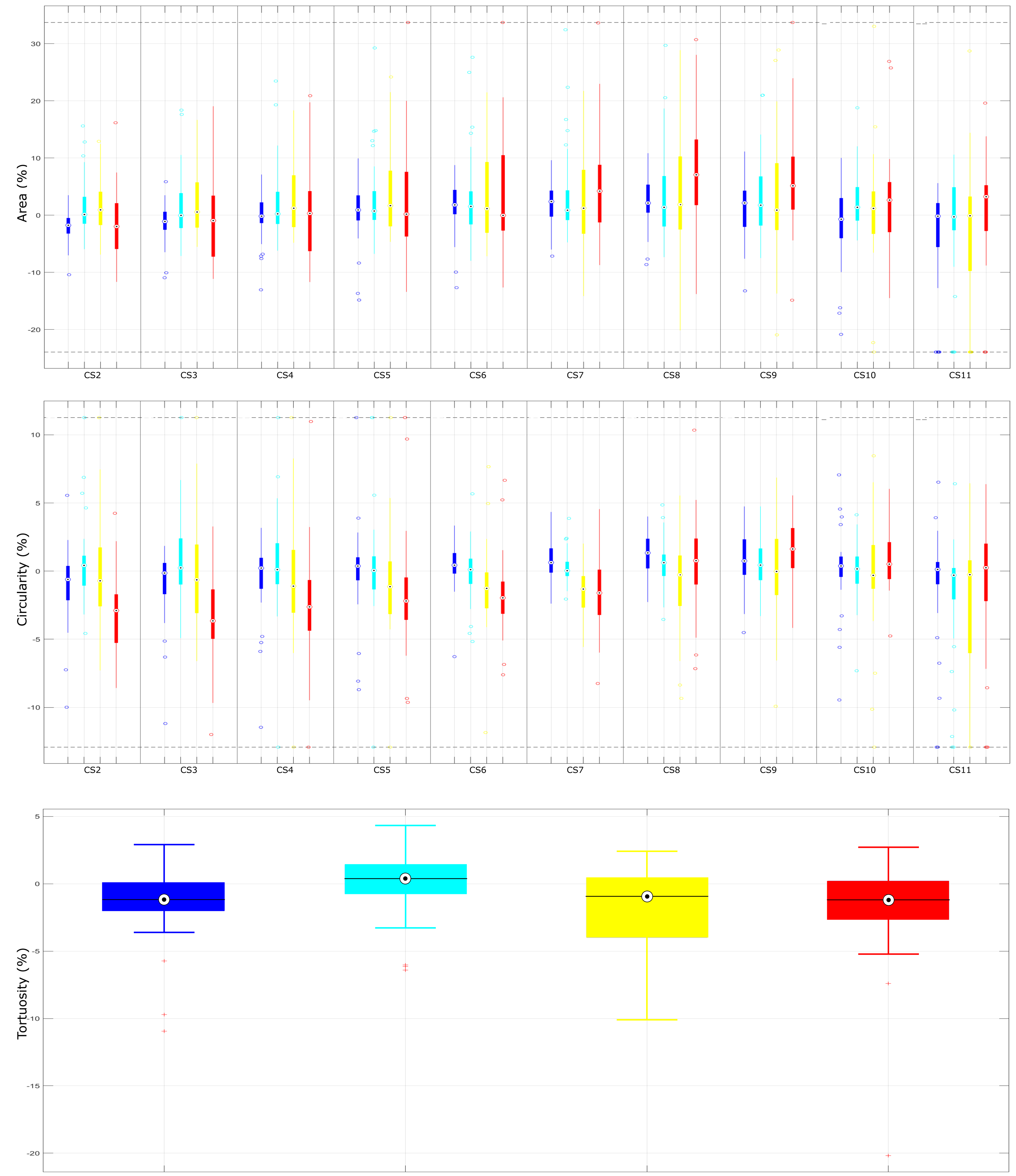

Fig. 4: Distributions of Area (top), Circularity (middle) and Tortuosity (bottom) deviations for MO (blue), THL (light blue), RE (yellow) and SM (red) with respect to CM.

- MO and SM contracts earcanal (EC) at the entry but then only MO tends to expand EC from first bend.
- Only MO contracts EC significantly (%ΔAmin = -1.75% [-3.21;-0.48] at CS2, $p<0.001$), while MO (%ΔAmax = 2.39% [-0.25;4.31] at CS8, $p<0.005$), THL (%ΔAmax = 1.75% [-1.80;6.79] at CS10, $p<0.05$) and SM (%ΔAmax = 7.07% [1.77;13.25] at CS8, $p<0.001$) expand EC significantly.
- RE tends to expand EC from entry to 2nd bend (%ΔAmax = 1.86% [-2.50;10.28] at CS8, $p>0.05$).
- THL and RE don't change CS shape much until first bend, while MO (%ΔCmin = -0.61% [-2.14;0.38] at CS2, $p<0.05$) and SM (%ΔCmin = -3.65% [-4.97;-1.34] at CS3, $p<0.001$) makes CS significantly more elliptical.
- MO makes CS more circular until the second bend but only significantly at the transition between the two bends (%ΔCmax = 1.34% [0,20;2.38] at CS8, $p<0.001$), while RE (%ΔCmin = -1.32% [-2.68;-0.36] at CS7, $p<0.001$) and SM make CS significantly more elliptical in this region.
- Only SM makes CS significantly more circular close to the second bend (%ΔCmax = 1.62% [0,22;3.16] at CS9, $p<0.005$).
- MO (%ΔTI = -1.15% [-1.98;0.01], $p<0.001$) RE (%ΔTI = -0.91% [-3.98;0.45], $p<0.005$) and SM (%ΔTI = -1.18% [-2.64;0.21], $p<0.005$) make EC significantly more tortuous.
- Only THL makes EC straighter (%ΔTI = 0.39% [-0.74;1.41], $p>0.05$) but not significantly.

Michel DEMUYNCK
mdemuynck@critias.ca
@BioMickeynist
/in/mdemuynck

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