COMPARISONS AMONG DIFFERENT TYPES OF HEARING AIDS

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CONTENT

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INTRODUCTION

BACKGROUND

- Hearing aids are used to amplify collected sound for people with hearing loss.

- Different types of hearing aids are designed for specific demands.
  - Behind-The-Ear (BTE) aids,
  - In-The-Ear (ITE) aids,
  - In-The-Canal (ITC) aids,
  - Completely-In-The-Canal (CIC) aids.

(Different hearing aids ® Siemens)

LITERATURE REVIEW

Fit evaluation of hearing aids

- Fit evaluation has been studied for various ergonomics designs, such as shoes (Au&Goonetilleke, 2007) and chairs (Helander&Zhang, 2010).
- Most of fit studies focused on ear anthropometry (Jung&Jung, 2003; Chiou et al., 2016), auditory performance (Rallapalli et al., 2019; Vroegop et al., 2018), and cognition (Convery et al., 2019).
- Evaluation methods:

  - Computer Aided Design (CAD) simulation;

  - Virtual reality;

  - Mock-up evaluation;

  - Prototype evaluation.

RESEARCH AIM

Research gap:

- The association between anthropometric data and design patterns of hearing aids has not been sufficiently evaluated.
- To address the design problem, there is a need to evaluate the fit for various hearing aids.

Aim:

- This paper aimed at comparing sizes and shapes among the widely-used types of hearing aids, including BTE, ITE, and ITC aids, based on the user experience of fit and comfort.
- As a work-in-progress study, the findings can be useful to study fit evaluation of hearing aids in future research.

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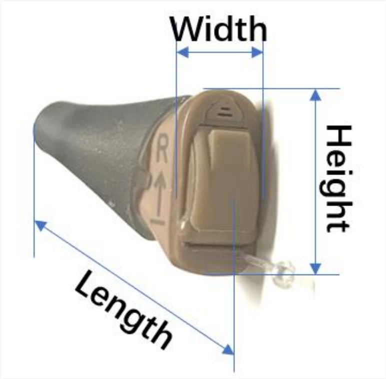
METHODS

PRODUCT MEASUREMENTS

- In the study, BTE Fun P, ITE Vibe Mini 8, and ITC Vibe Nano 8 aids (Siemens®) were selected.
- Product parameters, including length, width, height, and weight, were measured to evaluate the product, which were compared with anthropometric data to seek proper fit.

BTE

ITE



ITC

PRODUCT TEST

- Participants were asked to wear each hearing aid for 5 minutes.
- Fit and comfort perception of the participant was recorded with a Likert-Scale questionnaire.
- Contact area with the human ear was marked for further discussion on association between anthropometric data and product design.

BTE (Siemens®) ITE (Siemens®) ITC (Siemens®)

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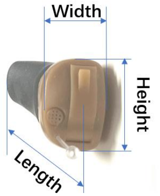
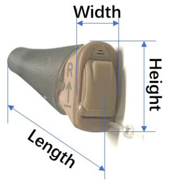
RESULTS AND DISCUSSION

DIFFERENCES AMONG COMMERCIAL HEARING AIDS

- Selected commercial product were measured for product length, width, height, and weight.

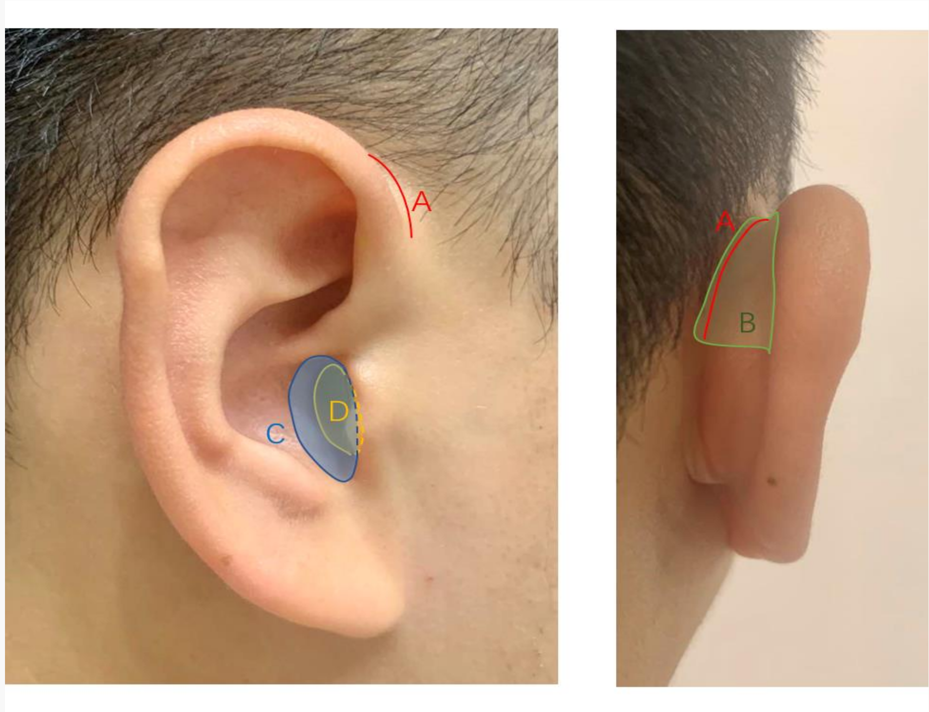
Type	Hearing aids	Components contacting with human ear	Size	Weight
BTE		Round earplug in soft plastic material; Tubing contacting the ear root.	Earplugs were designed with selectable sizes.	7.16g
ITE		Special shape in direct contact with ear concha.	Width:8.71mm Height:12.97mm Length:19.88mm	1.42g
ITC		Special shape in direct contact with ear canal.	Width:5.72mmg Height:12.52mm Length:17.28mm	0.97g

DIFFERENCES AMONG COMMERCIAL HEARING AIDS

- Wight and size: BTE aids > ITE aids > ITC aids.
- Users' satisfaction on fit and comfort perception: BTE aids > ITE aids > ITC aids.
- As for the product weight, load analysis can be conducted in specific ear region for the specific type of hearing aids.
- The parameters were difficult to compare directly, considering different aids need to fit with distinct ear region. Hence, there is a need to associate the product dimensions with anthropometric data to examine the comfort and fit.

ANTHROPOMETRY FOR HEARING AID DESIGN

- Based on the contacting area, BTE, ITE, and ITC aids should be designed to match with specific ear regions individually.



Ear reference area for designing hearing aids:

Ear root (A) and back part of the ear (B) associated with BTE aids;

Ear concha (C) associated with ITE aids;

Ear canal (D) associated with ITC aids.

ANTHROPOMETRY FOR HEARING AID DESIGN

- To seek proper fit, anthropometric data were essential for designing distinct types of hearing aids.
- According to definitions of ear dimensions in the literature (Lee et al., 2018), different dimensions were chosen for specific hearing aids.

  - ear protrusion and pinna flare angle can be used for designing BTE aids;

  - cavum concha length, center of concha to incisura intertragic length, and ear canal entrance circumference can be valuable for designing ITE aids;

  - ear canal entrance height, ear canal entrance width, ear canal entrance to 1st bend length, and ear canal 1st bend circumference can be applied in ITC aid design.

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CONCLUSION AND FUTURE WORK

CONCLUSION

- This pilot study tried to compare the shapes and sizes of different hearing aids, and examined the application of ear anthropometry in hearing aid design from comfort and fit perspective.
- Generally, BTE aids have the largest size and weight but the highest fit and comfort perception, while ITC have the smallest size and weight but the lowest fit and comfort perception.
- Different contact areas on the external ear were recorded with diverse types of hearing aids. Accordingly, anthropometric dimensions were selected for different hearing aids based on the literature.

FUTURE WORK

- With the preliminary findings in the study, next step is to apply CAD simulation to examine the fit of different hearing aids, and use prototypes to explore the users' experience.
- Future research can be conducted with larger sample size and more hearing aids in different markets to improve the fit of ear-related products with the use of CAD simulation technique.

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Thank You !