Embouchure Assistive Device

MEGAN JONES, PATRICK CASSIDY, VIVIAN CHEN
CLIENT: ELON ROTI ROTI (DEPT. OF OBSTETRICS/GYNECOLOGY) **ADVISOR:** JOHN WEBSTER, PH.D. (DEPT. OF BME)

ABSTRACT

Bell's palsy is a nervous disorder that may develop into synkinesis. Patients suffering from synkinesis experience involuntary muscular movements accompanying voluntary movements [1]. The client suffers from facial synkinesis, which affects her ability to play the clarinet. However, she wishes to be able to play semi-professionally, which requires playtime to be extended to at least 30 min. Therefore, the aim of this project is to develop an assistive device that would help the client to maintain a proper clarinet embouchure.

BACKGROUND

Bell's Palsy

- Paralysis of facial muscles due to dysfunction of cranial nerve VII
- Nerve inhibition because of inflammation
- Specific cause for inflammation is not known
- Treatments available: steroids and physiotherapy, etc.
- Good prognosis even without treatment

Synkinesis

- Result of misdirected nerves after trauma

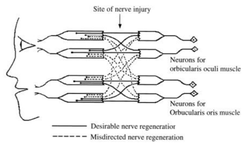

Figure 1: Misdirection of neurons to wrong motor endplates [1].

- Most often affects muscles around mouth
- Treatments available: surgery, facial retraining, biofeedback, mime therapy, and Botox

Embouchure

- Embouchure: shape of mouth while playing instrument
- Main muscles engaged are zygomaticus, buccinator, orbicularis oris

Figure 2: Clarinet embouchure [2].

Design Criteria

- Extend practice time to at least 30 min.
- Easy to use/clean
- Lightweight
- Help maintain pressure on mouthpiece
- Must not restrict playing
- Lightweight
- Reduce air leakage at corner of mouth
- Low cost
- "Headgear"

TESTING

Figure 8: Force simulation on client's face with fingers applying approximately 22.2 N force.

Figure 9: Ring prototype; capable of applying 8.9 N force.

Pros
- Lightweight
- Comfortable
- Slight improvement in tone
- Easy to use

Cons
- Insufficient force
- Straps not robust
- Obstructs ear
- Difficult to adjust

Figure 10: Coil prototype; capable of applying 6.7 N force.

Pros
- Improved aesthetics
- Simple
- Slight improvement in tone
- Easy to use

Cons
- Unstable
- Static
- Insufficient force

PREVIOUS DESIGN

- Headgear design
- Device is secured to head using straps
- Inner ring rotates freely within base
- Set screw affixes slider on track
- Force arm rotates to apply inward pressure on cheek

Figure 3:Previous prototype created last semester

- Disadvantages:
  - Bulky
  - Ear contact
  - Multiple adjustments
  - Pressure application
  - Aesthetics

FINAL DESIGNS

Ring Design

Figure 4: Ring prototype on client's head

Figure 5: Ring prototype

- Device sits over left ear
- Device is secured to head using head straps
- Sliding track allows for correct placement of force arm on cheek
  - Provides additional forward force
- Force arm made of 1095 spring steel
  - Force arm preset to apply inward pressure on cheek
- Beveled base and curvature of force arm allow better accuracy in force application

Coil Design

Figure 6: Back view of coil prototype

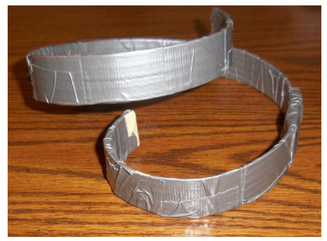

Figure 7: Front view of coil prototype

- Device coils around head
- Device made of 1095 spring steel
- Preset to smaller curvature than head which stabilizes device on head
- 0.0048 m iron bar stock reinforces cantilever and curvature
- Device lined by grip tape to provide more friction between device and head

CONCLUSION

Accomplishments:
- Two functional prototypes
- Able to apply force on face
- Mount easily on head
- Adjustable with one hand
- Low cost, budget of ~$200

FUTURE

- Surface EMG
  - Measure muscle contractions on unaffected or compensating side of the face with & without prototype
- Improve adjustability
- Inelastic straps for Ring design
- Reinforce Coil with lighter bar stock
- Reconstruct Ring design precisely out of aluminum
- Aesthetic improvements

REFERENCES

[1] Nakamura, K., Toda, N., Sakamaki, K., Kashima, K., & Takeda, N. (2003). *Biofeedback Rehabilitation for Prevention of Synkinesis after Facial Palsy*. Otolaryngology -- Head and Neck Surgery, 128(4): 539-543

[2] http://www.clarinet-now.com/poor-clarinet-embouchure.html

ACKNOWLEDGEMENTS

- Dr. John Webster (Dept. of BME)
- Elon Roti Roti
- Brian Anderson
- Jacklyn Diels
- Brooke Takac
- Trevor Hunt
- Andy LaCroix