Embouchure Assistive Device

Megan Jones, Andy LaCroix, Patrick Cassidy, Vivian Chen
Client: Elon Roti Roti **Advisor:** Amit Nimunkar, Ph.D.

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 minutes. 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

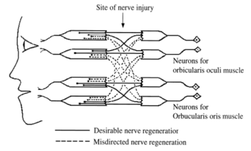

Figure 1: Misdirection of neurons to wrong motor endplates [1].

- 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 minutes
- Easy to use/clean
- Lightweight
- Help maintain pressure on mouthpiece
- Must not restrict playing
- Reduce air leakage at corner of mouth
- Low cost
- "Headgear"

Testing

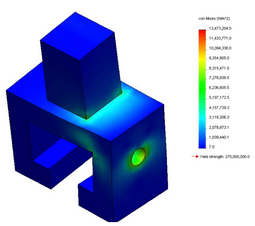

Figure 8: Strength testing of sliding piece. Maximum stress is 12.5 MPa with 10 lb force. ABS yields a factor of safety of 4.

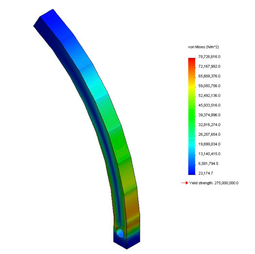

Figure 10: Strength testing of force arm. Maximum stress is 78.7 MPa with 10 lb force. Aluminum yields a factor of safety of 3.5.

Strength Testing

- SolidWorks was used to test the strength of each component
  - Von Mises stresses
- Forces applied: 10 lbf
- Materials (yield strength)
  - Simulation: 6061 Aluminum (275 MPa)
  - Prototype: ABS (48 MPa)

Outcome

- Only arm would fail if made of ABS
  - Changed to zinc plated copper tubing
- ABS prototype constructed with a factor of safety of 3

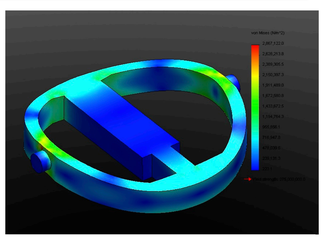

Figure 9: Strength testing of inner ring. Maximum stress is 2.7 MPa with 10 lb force. ABS yields a factor of safety of 18.

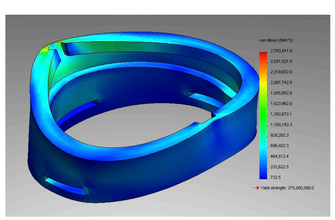

Figure 11: Strength testing of base ring. Maximum stress is 2.8 MPa with 10 lb force. ABS yields a factor of safety of 17.

Final Design

- Headgear design
- Device sits over left ear
- Device is secured to head using head straps
- Inner ring rotates freely within base
  - Allows for correct placement on cheek
- Sliding track affixed with set screw provides forward force on cheek
- Set screw allows adjustment of force arm
- Force arm rotates to apply inward pressure on cheek
- Beveled base and curvature of force arm allow better accuracy in force application

Figure 3: Force simulation on client's face with fingers.

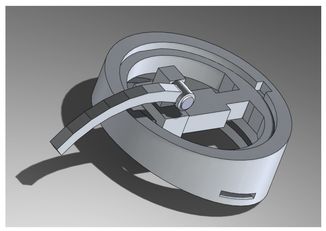

Figure 4: SolidWorks representation of device.

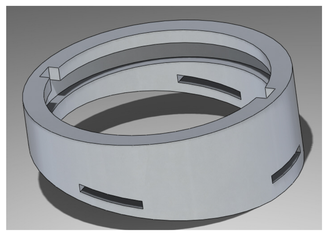

Figure 5: SolidWorks representation of base ring.

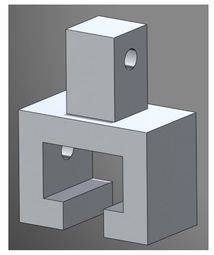

Figure 6: SolidWorks representation of sliding piece.

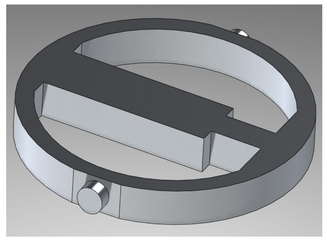

Figure 7: SolidWorks representation of inner ring.

Conclusion

Figure 12: Client trying on prototype.

Accomplishments

- Construct semi-functional prototype with headgear design
- Able to precisely put arm on face
- Mounts easily on head
- Low cost, budget of <$100

Future

- User testing with client
  - Efficacy of force application
  - Ease of use and comfort
  - Playing time
- Surface EMG
  - Measure muscle contractions on unaffected or compensating side of the face
  - With and without the prototype
- Design Modifications
  - Make set screws easier to use with one hand
  - Mold padding to the curvature of the user's head
  - Construct additional force applicators that include different sizes, materials and possibly heat depending on the client's preference
- Reconstruct design precisely out of aluminum

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

- Amit Nimunkar
- Elon Roti Roti
- Brian
- Jacklyn Diels
- Brooke Takac
- Trevor Hunt