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Velopharyngeal Insufficiency In A Clarinet Player: A First Hand Case Study

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VELOPHARYNGEAL INSUFFICIENCY IN A CLARINET PLAYER: A FIRST HAND CASE STUDY

BY

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Abstract

The purpose of this study is to describe how Velopharyngeal Insufficiency (VPI) presented in a professional woodwind player and the corrective measures that were taken to fix the problem. In addition, this project examines the issue from two perspectives, how SVPI and VPI can be found in other musicians and how they are treated. The project will also give a general overview of how to handle the physical and musical challenges in musicians with this problem.

Introduction

This project will provide information on VPI and the way it was presented in a twenty-year-old female musician. Typical presentation of VPI in a wind player is SVPI; however, after an original diagnosis of SVPI, further testing combined with a familial history of cleft palate led to specific tests revealing an anatomical/structural deficiency. The information provided in this project includes treatment options such as, speech therapy, reassessment and correction of clarinet fundamentals, and surgery. This paper also addresses my personal experience, including when and why I developed VPI, the testing process, the treatment, and recovery.

Thesis Statement

Velopharyngeal Insufficiency in a woodwind player can be a career-ending or career-preventing problem. While there is some research into SPVI and VPI in musicians, no personal account of the diagnosis, surgical treatment, recovery, and the return to playing has been found in literature. I will provide a first-hand account of each while specifically focusing on the recovery through speech therapy and my return to professional clarinet playing.
Related Literature

There are many articles that describe VPI as a medical problem in people with physical problems with their palate, but there are few articles that discuss VPI in musicians. There is some research that discusses SVPI in musicians.

There was a survey done by Dr. Deonne Malick and her team at the University of Iowa discussing the effects of SVPI in musicians. The paper, *Stress Velopharyngeal Incompetence: Prevalence, Treatment and Management Practices*, includes the definition of SVPI and the way it presents in musicians. Additionally, there are charts and data determining the intraoral pressure associated with playing each instrument.

Dr. Chris Gibson, Associate Clarinet Professor of Music at Northwest Missouri State, has done extensive research into the problem and solutions of SVPI in woodwind musicians. He suffered from this problem and was able to correct it non-surgically. His work was the catalyst that led to finding out what my problem was and where to start looking for solutions.

For information regarding Velopharyngeal Insufficiency, there are a few sources that help identify and define symptoms and causes. Articles by the Seattle Children’s Hospital help give an overview of exactly what VPI is, symptoms and diagnosis, and treatment options. Additionally there are references to Velopharyngeal function and SVPI in wind players found in *Cleft Palate Speech* by Peterson-Falzone. This book also describes the endoscopic procedure that was used in my original diagnosis.

My particular speech treatment plan was created by Dr. Julie Stierwalt and Dr. Toby Macrae of The Florida State University. Dr. Stierwalt devised a plan using “Case 43 Douglas: A Novel Combination Approach to Treating Apraxia of Speech” found in *The Communication*
Disorders Casebook. Case 43Couglas involved treatment for a stroke victim. The plan was modified to fit my particular needs.

Further examination on the acoustic and perceptual analysis pre, post, and final evaluation allowed for exact measurements of speech growth. That coupled with the human analysis of my speech provided by Dr. Stierwalt and her assistant, Sarah Haas, provided a clear insight to my recovery. Treatment and measurements focused on words containing post-vocalic /r/ (r following a vowel). Additional perceptual analysis was conducted by Dr. Macrae with the assistance of his classes for reference of perception of a speech by a Standard American English speaking person and one with a strong foreign accent. The purpose of this experiment was to determine the human perception of my speech pre and post therapy.
Contributions

I hope to provide information on the signs of SVPI and VPI, the steps to correct the problem, and my experience with during the testing, treatment and recovery processes. In addition, I hope to give insight on the benefits of speech therapy in the recovery process to both the music and scientific world.
Chapter I
SVPI and VPI in Musicians

1.1 Summary of Related Literature in Musicians

“The term Stress Velopharyngeal Incompetency was coined by Weber and Chase (1970) in their case presentation of a 24-year old woman with a 6-year history of nasal/snorting sounds while playing the oboe.”\(^1\) Dr. Malick and her team describe Stress Velopharyngeal Insufficiency (SVPI) and Velopharyngeal Insufficiency as potentially career-ending or career-preventing problems.\(^2\) Additionally, another study done by Schwab and Schultze-Florey defined VPI in woodwind and brass musicians as a “well-known phenomenon, manifested in various anatomic and functional disorders arising from the interaction between the soft palate muscles and the pharyngeal walls. It usually develops as a result of various neuromuscular illnesses, secondary to deformities (i.e. cleft palate), or after an operation.”\(^3\)

SVPI occurs due to the high intraoral pressure required to play woodwind and brass instruments, which can be up to 30 times greater than the intraoral pressure associated with normal speech.\(^4\) Due to the competitive nature and the long hours required to be a professional musician, a breakdown of the velum and pharynx under the stress of playing creates the

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dysfunction. It is important to note the word “stress” in the definition because it explains that this particular leak occurs in what would be a normal functioning area.⁵

“Velopharyngeal Insufficiency (VPI) is a disorder resulting in the improper closing of the Velopharyngeal sphincter (soft palate muscle in the mouth) during speech, allowing air to escape through the nose instead of the mouth.”⁶ While VPI is most commonly found in children, it can affect adults. The symptoms of SVPI and VPI while playing a wind instrument are the same but the underlying causes are different.

SVPI is the breakdown of the soft palate due to the high intraoral pressure from playing a wind instrument and VPI is an anatomical problem most commonly associated with a history of cleft palate or submucous cleft palate.⁷

Symptoms include an air leak from the nose, nasal snorting, and pressure. The symptoms can occur from the initiation of playing an instrument to after an extensive practice sessions.⁸ Those with VPI can have these symptoms occur while speaking in addition to playing an instrument. Further testing is necessary to determine the cause of the leak.

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⁷ Seattle Children’s Hospital, Velopharyngeal Insufficiency (VPI).

1.2 Severity and Possible Causes

According to an experiment conducted by Dr. Moon, Dr. Malick, and Dr. Canady, there could be a variety of etiologies for SVPI and VPI in musicians, ranging from family history, to the stress on the anatomical mechanism from extended playing with instruments requiring higher intraoral pressure. With the exception of the clarinet, instruments that have been reported as requiring higher intraoral pressure (i.e. tuba, oboe, horn, trumpet and bassoon and clarinet) during instrument play have also been reported in case studies of SVPI.

“SVPI symptoms were reported at some point in time by 41.67% of the respondents who played the clarinet, 78.95% (15/19) English or French Horn, (64.29% 9/14) bassoon (60% 3/5) or oboe (41.67% 5/12).” Statistically, there is no concrete evidence to associate surgical or medical history associated with SVPI. However, in their experiment, 2 of 3 musicians with positive history of cleft or sub mucous cleft palates reported systems of SVPI. Further reports revealed that those who have a repaired palate were more susceptible to palate fatigue even while speaking and therefore increasing the potential of SVPI in musicians (where playing an instrument can place up to 30 times greater muscular demand than speaking) with repaired palates. Furthermore, 50% of those who reported having gone through an adenoidectomy reported symptoms of SVPI and 36.36% of musicians who had reported undergoing a tonsillectomy reported signs as well.

10 Malick, Stress Velopharyngeal Incompetence: Prevalence, Treatment and Management Practices, 430.
11 Malick, Stress Velopharyngeal Incompetence: Prevalence, Treatment and Management Practices, 430
1.3 Testing Information

There are two primary tests than can determine the location and extent of a leak in the velopharyngeal port: a nasal endoscopy or a videofluoroscopy. Both are relatively simple procedures, the former uses a scope to examine the nasal passages at the point of closure to determine the location and approximate size of the leak. Typical signs include bubbling in the area when it should be tightly sealed either for speech or while playing the instrument. An endoscopy is a procedure that uses a scope complete with an eyepiece and camera in addition to a high – intensity light source. “Endoscopes can be passed through body openings and pathways to reach internal organs, including the velopharyngeal area that cannot otherwise be directly visualized….The endoscope permits observation of the velum and the pharyngeal walls as they move in relationship to one another for speech and swallowing.”

The latter is a slightly more complicated procedure. Videofluoroscopy is a dynamic x-ray, which allows examination of structures during function and/or movement. In order to visualize structures during the procedure, barium sulfate is used to coat the nasal and palatal area, thus enhancing soft tissue contrast. While the structures are coated, individuals are asked to complete speech and performance (instrument playing) tasks to examine velopharyngeal closure (Appendix D).

In addition to having picture taken of my velopharyngeal port at rest and while speech, I also was asked to play my clarinet during both procedures. The endoscopy results are located in Appendix F and the fluoroscopy results are located in Appendix D.

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1.4 Treatment Plan

There is still little known about SVPI and VPI in musicians since research has been documented primarily through case studies. Dr. Chris Gibson, associate music professor at Northwest Missouri State University, has had encounters with SVPI and has Some of the methods Dr. Chris Gibson, offers based on his research, for methods of treating the condition include changes to physical aspects of playing the clarinet. He first suggests that the instrumentalist re-evaluate the physical aspects of his/her playing such as posture, breathing, and embouchure.16 Releasing tension can allow the body to move more fluidly and help the velum function normally. Breathing fully from the diaphragm can also alleviate tension during play. In addition, a too-resistant mouthpiece, reed, or a combination of these factors can create additional stress of the velopharyngeal muscles. Evaluation of the embouchure is also needed to make sure the musician is not biting or adding unneeded pressure during practice or performance. Dr. Gibson placed emphasis on a structured and carefully-planned warm-up. This allows stress to gradually be added to the velopharyngeal area. If these steps prove unsuccessful, it is possible that medical intervention may be necessary.

Dr. Gibson suggests that should non-medical interventions be unsuccessful, evaluation of the leak may need to be performed by an ENT. The ENT will conduct a re-evaluation of basic techniques and, based on the results of the testing and the severity of the leak, provide several treatment options. Testing, diagnosis and treatment can also be obtained by a speech pathologist and craniofacial surgeon at a craniofacial clinic, which specializes in the correction of VPI. The least invasive treatment option is to pursue treatment from a speech-language pathologist.

16 Gibson, Current Trends in Treating the Palatal Air Leak.
The purpose of speech therapy is to strengthen the velum. Such treatment would only be implemented for musicians who simply have stress related dysfunction, as they have adequate closure of the mechanism. For those with a physical or anatomical deficiency the only feasible option is surgery in order to create a mechanism that can fully close under situations of high pressure. Surgeries employed to correct VPI, regardless of etiology, in musicians include: Posterior Pharyngeal Wall Augmentation, Push-Back Palatoplasty, Pharyngeal Flap, Sphincter Pharyngeoplasmy and Palatal Adhesion.\textsuperscript{17}
Chapter II

My Case

2.1 SVPI and VPI

My air leak began my junior year of high school as I increased the amount of hours of practice for upcoming competitions and undergraduate auditions. My family and early teachers had associated the leak with upper respiratory illnesses (as that seemed to be when the leak occurred the most). Once I began my undergraduate studies at The Florida State University, the demands increased and once again I found myself practicing hours a day, only to realize that the air leak was becoming not only a distraction for myself but for my audience. In fact, during one of my juries, two of our woodwind faculty pointed out the severity of the leak and the possibility of getting it fixed.

That summer my mom began to research what my professors called a “glottal leak” and eventually discovered an article by Dr. Deonne Malick about SVPI in musicians. My mom contacted her and that June I had a nasal endoscopy. During the procedure, Dr. Malick had me read the “grandfather passage” (Appendix A) and had me play the clarinet with the endoscope placed in my nasal passages to examine velopharyngeal closure. Dr. Malick found that while I had no air leak during speech production, the leak while playing the clarinet was significant. She diagnosed me with SVPI.

In addition to the distracting aspect of the leak, SVPI has severe consequences if not treated. SVPI symptoms, while playing, can be quite painful and would often cause extreme pressure in my nose. Additionally, the amount of air escaping through my nose created
hypernasality (nasal resonance) and the decreased airflow through my mouth made it difficult to be loud enough, resulting in me placing extra tension on the vocal folds just to create an adequate speech signal. Even more detrimental than those, was the fact that I was losing a large amount of air while playing. Air is the key to any wind player, so a lack of air pressure made the performance of a wind instrument that much harder. Articulation speed was especially difficult. It became apparent that for me to continue my career as a musician, I needed to find a solution for this problem.

It was evident at that point, due to the size of the leak, that a surgical repair would be the only way to fix the problem. Through Dr. Julie Stierwalt, (Speech Therapist and Professor at FSU), my case was presented to Dr. Bill Williams, speech pathologist, of Shands Hospital at the University of Florida-Gainesville. He agreed to take my case, and in February of 2011 I had a video fluoroscopy. The results revealed that my soft palate was two standard deviations too thin and three standard deviations too short (Appendix D). Essentially, my soft palate could not withstand the intraoral pressures related with playing the clarinet. The anatomical structure did not reach the pharyngeal wall. During normal speech this was not a problem, however the extreme pressures of the clarinet revealed the structural deficiencies causing a leak through the nasal passages. This information coupled with my family history of cleft palate changed my diagnosis from SVPI to VPI.

As I stated earlier, because of the size of the leak and my family history, surgery was the only option to fix my case of VPI. The surgeon decided that a pushback with a pharyngeal flap would be the best suited surgery (Appendix E).
Chapter III
Recovery

3.1 Physical

In this section, I will discuss the physical portion of the recovery post-surgery addressing dietary concerns, pain, unexpected occurrences and development of speech distortion.

Following my surgery, one of the most difficult aspects of my recovery was diet. I was on a strict liquid diet from the day of surgery for two weeks and then soft foods for the following four weeks. Due to the fact that I had reconstruction of the area connecting the hard and soft palates, I was very sensitive to the temperature of the liquids. This also contributed to the issue of receiving proper nutrition, which slowed the process of healing at the surgical site.

Something else to be expected was the pain that came with this particular surgery. I was prescribed Roxicet (a liquid mix of acetaminophen and oxycodone) for the pain in addition to an antibiotic to prevent infection. While it took away the pain, it also left me very sleepy and not cognizant for the majority of the two weeks following the surgery. I relied heavily on the help of my family and friends for simple tasks from getting food to using the restroom. In addition to difficulty eating, I had significant trouble communicating. Originally, I was communicating through a white board. As I slowly began to be able to speak, it was very painful. In fact, I could only say “juice” and “potty,” the two things that were most important to me at that time. Over the next couple of weeks, the development of my speech came from what my mom described as, “an orca whale with marshmallows in its mouth” to sounding like I had severe speech distortion and eventually progressing to sounding like speech with a British accent, which I will describe in further detail in the next chapter.
Interestingly, I was unable to hear the change in speech that I developed during this process. My neighbors and family members would often comment on the change but I did not hear a difference until my parents recorded me and played the recording back. As a side note, I believe due to the difference in the intraoral structure, I had no sense of where to place my tongue, helping to create the illusion of a British accent. I could hear words in my head the way I wanted them to sound but producing them was challenging and really unattainable most of the time. In my opinion, this also translated into my clarinet playing. Prior to surgery, I had a strong concept of what I wanted to sound like as a clarinetist and was able to emulate that sound with ease. Following surgery, I struggled with grasping how to create the sound I wanted. I will talk more about this part of the recovery in the next chapter.

During the healing process, the surgical site slowly recovered. Dissolvable stitches began falling out and I could accomplish small tasks such as brushing my teeth. As I would clean the surgical area, discolored pieces of tissue would fall out that were later determined to be “scabs” of a sort within my mouth.

Something else that I found particularly frustrating was the recovery time. The doctors anticipated that I would have full recovery in three weeks and could begin attempting to play the clarinet after six weeks (assuming my six week examination went well, which it did.) However, my palate took closer to seven weeks to fully heal and at the end of June, I was still dealing with infection, which left scarring in my hard palate. My first lesson, and the first time I began to play was on June 24th, almost two full months following the surgery.

Something to note is that this surgery is usually performed in young children in whom recovery time is significantly faster than that of an adult, and being a musician significantly
complicated the recovery in the sense that the surgeons, my professors, and I were unsure as to how long the exact recovery time would take, which added to my frustration when I wasn’t ready when I thought that I should have been.

I present all of this information, not to scare anyone, but to prepare others who must go through this experience with the information and knowledge that was unavailable to me. This process was extremely emotional. The surgery and recovery were difficult, but the musical recovery was much longer and more emotionally challenging for me. Once I began playing again, I had to start from the very beginning and I was blessed to have the finest instruction. Looking back, I was very lucky to begin re-learning my instrument from the very beginning with one of the best teachers in the country. The process took much longer than I anticipated and it was difficult to watch others progress while I felt like I was moving backwards. However, I think this whole process will make me a better teacher because I had the opportunity to learn from the beginning for a second time at the age of twenty.
3.2 Clarinet Recovery: Return to Clarinet Playing

In this section I describe my personal account of the musical recovery, both physically and mentally. Dr. Deborah Bish, my clarinet professor, had no mold to follow and we took each week with caution. My physical abilities and my ability to trust my body played a great role in how we proceeded.

Technically, the very first time I played my clarinet post-surgery was June 10, 2011; a month and a half after the procedure. My surgeon had given me the go ahead to try and play a few notes in his office at my post-surgical consult). He was a fan of Mozart, so I played a portion of the Mozart Clarinet Concerto as a thank you to him. When I played, nothing felt right. The entire shape of my mouth was different and I didn’t trust my palate to hold up with the pressure of playing.

I consider the beginning of this part of my journey as the first time I met with Dr. Bish. I told her of all my concerns and how truly difficult it was for me to play. We devised a plan where I would start with Rico 2 ½ reeds and only mouthpiece and barrel for 5 minutes a day to reduce the amount of pressure. We did not use articulation for the first week either. The second week we incorporated light legato articulation into the daily practice time without changing anything else from the previous week.

The third week, I put the whole clarinet together. All we did that day was play open g’s, the note with the least amount of resistance. We worked a good deal with a mirror, talking about the correct embouchure, tongue position, and airflow. At this point, I was still feeling a large amount of discomfort and pain. I was accustomed to having the majority of air escape from my nose and great pressure extending to either side of my nose. I didn’t know whether this was the
“normal” back pressure that “normal” people feel, or if it was pain from the surgical area. Either way, we decided to continue to limit the amount of time I spent playing. Dr. Bish never pushed me in any way and we had to trust that I would know when it was “ok” to push forward. That became difficult as I was in constant fear of “breaking” my palate.

With the beginning of the fourth week I began testing the limits of my reconstructed palate and would play notes from the chalumeau c to the throat tone g. All of this had been unarticulated, because that’s when I felt the least amount of pain.

Following the first month, I began switching between Rico 2½ reeds and Rico 3 reeds depending on how strong I was feeling that day. By this point we were beginning to work on finger evenness and scales. This was one of the most frustrating things I experienced during the playing portion of my recovery. Prior to surgery, finger evenness came naturally to me. When I began playing, I truly sounded like what I was, a beginner. It was at this point that I had to accept where I was and how long the journey was ahead.

For inspiration, Dr. Bish thought that working on a piece would not only be a great way to motivate me, but also a great tool to measure how far I had come. We chose Adagio and Tarantella by Ernesto Cavallini. The piece had a good mixture of fundamentals including long lines to work on air stream, articulation, and runs.

At this point, I met with Dr. Stierwalt and she was able to give more insight into the actual recovery my body had undergone. She assured me that the reconstructed structure would not tear. She compared my surgery to a recovery of an athlete after an injury. Essentially the soreness, or what I had interpreted as pressure/pain, was equivalent to an athlete stretching
injured muscles. The stretching may be uncomfortable but the structure had healed, it was stable and would not break down.

School started and the piece we chose to focus on for the fall semester in addition to the Cavallini, was *Première rhapsodie* by Claude Debussy. The challenges of this piece required a complete centered tone, fast fingers, and a strong concept of style. These two pieces combined with continuous etude study and immersion into fundamentals made for a tough semester.

I never realized quite how long this process would truly take. I honestly thought I would have surgery, take a few weeks off, pick the clarinet back up and in a couple of weeks be auditioning for chair placements four months after surgery. However, even in January, eight months after surgery, I was still having problems with endurance. It was not until April of 2012, a year after surgery, that I felt my tone and endurance had returned to that of my sophomore year and I was finally able to progress and improve my skills rather than working towards just getting back to where I was.

I also believe that the kinesthesia of the mouth played a large role between my speech and musical recovery. As I began to understand how my body needed to move to produce certain sounds on the clarinet, I also began to understand how to move my mouth to produce my pre-surgical speech pattern.
Chapter IV

My Observations

As I began working to correct my speech and my clarinet playing I began to notice amazing similarities between the two. For example, during my lessons Dr. Bish would play a passage and I would have to imitate. I constantly asked her, “Where should my tongue be?” or “Does this sound right?” I had the same experience with speech therapy. Dr. Stierwalt would present a word such as “jar” and I would have to try and reproduce it the best I could. Again, I would ask, “Where is your tongue when you say that?” She would choose not to answer. This process was about me learning how to use the modified structure in my mouth.

I also found that as my speech progressed, I progressed with my playing. As my body began responding to the aural commands given, whether from speech or music, the kinesthetic response translated almost simultaneously to the other. As the process continued, I began to understand that I had a good mental image of what I was supposed to sound like, both through speech and through my clarinet, however I could not reproduce the sound due to the anatomical differences my body had undergone.

Both my speech therapist and my clarinet teacher advised me to use my ears to help me create a sense of what I wanted to sound like. For speech therapy, I tried to talk to family members as much as possible so that I could create a familiar speaking environment, in hope of reproducing words in my natural speaking tone. For clarinet, I would listen to recordings of clarinet players with the tone that I wanted, again hoping to recreate that sound. In many cases I could visualize myself speaking a word the way I used to, or playing with the tone that I had
worked so hard to develop but physically being unable to produce what I had a concept of was one of the biggest challenges of this process.
Chapter V
Speech Therapy

5.1 Therapy/Homework

My speech therapy case was unique in the fact that, prior to surgery, I had a normal speech pattern. Following surgery, my speech pattern assimilated that of a British-speaking individual. My mouth had undergone significant anatomical changes and the vocal chamber no longer resembled the same shape I had while learning how to speak. While my muscles remembered how to speak, the chamber in which the sound was produced was entirely different causing the British accent.

Dr. Stierwalt modified a treatment plan that had been used for stroke victims, an example of which is found in Case 43 from The Communication Disorders Casebook Learning by Example. Treatment occurred at an on-campus facility and was monitored by Dr. Julie Stierwalt and her assistant graduate student clinician, Sarah Haas as well as Dr. Toby Macrae and his graduate students Sara Phillips and Shannon Rielly. Dr. Stierwalt and Sarah Haas, designed and implemented the actual correction of my speech and Dr. Macrae and his graduate assistants took the speech recordings and analyzed the speech production.

During speech production, problems were most noticeable on the consonant /r/ when it followed vowels (postvocalic /r/), however there were additional issues with some of the vowels. The therapy focused predominately on twenty target words that contained a postvocalic /r/. At the beginning of each session, speech productions on the target words were rated on a scale of 1 to 5; 1 indicating a delayed target sound and 5 representing a natural, immediate, accurate
production. This measure provided an index of motor learning of the stimuli without the benefit of practice.

During the sessions there were three main components: The target productions were elicited following a “clinician model”, “without a model,” and “embedded in contextual practice.” Following the clinician model provided by the speech therapist, I was asked to provide four productions of the same word with an imposed delay between each attempt. The delays allowed me to listen and evaluate my production and think about how I might change it. Following my final production I was provided a model for the last time and feedback was given about how close to the target my productions were. This was repeated until all twenty words were completed. Refer to Appendix B for a complete list of words.

Continuing with the “no model” portion of the therapy, I would attempt to produce the word four times without the clinician model, but with the delay, again each time modifying to production if needed to try and achieve the target sound. Following my last attempt, I was given a model and then repeated the word. Again, I received immediate feedback.

The final stage, Contextual Practice, incorporated a sentence with the target word embedded (Appendix C). I was again provided a model and produced a replica three times. Immediate feedback was given. Additionally, I was given each of the twenty words on flashcards to take home and practice. I was also encouraged to speak with people in my natural environment, such as my parents, and try and imitate the way they sounded so as to restore my speech back to its original production patterns.

The following graph shows my progression and analysis by Dr. Stierwalt and Sarah Haas over my six treatment sessions (note: all sessions were not consecutive). The first week, my
average production on the twenty target items was a 2.05 indicating elongated production. Weeks two and three were indicative of distortion of the target. Weeks four and five were very close to natural immediate accurate production eventually culminating in week six when I was scored all 5s.

Of interest to note, was the fact that Dr. Stierwalt and Dr. Macrae felt that my recovery was more rapid than is typical due to my musical training. In private lessons, often a teacher will perform a passage and the student must imitate it as closely to the example as possible. The same is true for speech therapy, the teacher (or therapist) would provide a model and I would have to imitate as closely as possible.
5.2 Results

Figure 1.

![Graph showing retention measure with average ratings on the y-axis and time points on the x-axis.](image-url)

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Chapter VI

Perceptual Analysis

6.1 Formants and Measurements

In addition to the actual therapy, Dr. Toby Macrae, with the assistance of Sara Phillips and Shannon Rielly, provided acoustic analysis of the /r/ formant measures, corner vowel, and perceptual ratings. Further analysis included the relationship of formant three to formant two. The perceptual ratings were employed to help better understand the severity of the speech distortion and the pre/post treatment results.

A formant is a resonating chamber in the vocal tract. When producing vowels and /r/ sounds, the vocal tract becomes divided into different sections. When dividing the vocal tract into different chambers each chamber has a specific resonance. Changes in tongue position or lips, as the tongue and lips are the articulators, in combination with vocal tract shape are associated with a particular pattern of resonance. Dr. Macrae and his team were able to use the recordings of my treatment sessions to complete formant measurements and compare them to Standard American English for pre and post treatment and at the follow-up.

Pre-treatment acoustic analysis revealed a mean postvocalic /r/ (r following a vowel) third formant (F3) frequency of 2873 Hz, which is much higher than the frequency for an adult female American English speaker. According to Kent and Read (2002) the average frequency

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reported for /r/ in adult American English female speakers is 1700-2200 Hz.\textsuperscript{22} The consonant /r/ has the lowest F3 frequency of all English consonants, which is an important perceptual cue for /r/ in Standard American English. Since the participants frequency was much higher than average this would have contributed to the perception of an “accent.” \textsuperscript{23}

Post-treatment, the F3 measure of postvocalic /r/s was found at 2342 Hz, which was much closer to Standard American English however it was still higher than the average reported by Kent and Read. Following two months of treatment, I returned home in the hope that being in a normal environment would be the last step in reacquiring my typical pre-surgical speech pattern, additional measures were collected. The follow-up measures indicated that the average F3 measure was 2008 Hz, which was well within the range of Standard American English as reported by Kent and Read.

In addition to the postvocalic /r/ production, there was also vowel distortion adding to the illusion of an “accent,” especially vowels /i/ and /\textipa{\oe}/. The vowels measured were, /i/, /\textipa{\oe}/, /u/ and /\textipa{\oe}/. As evident in Figure 4, the vowels pre-treatment are farther from that of Standard American English. The surgery affected the back portion of the oral cavity where vowels /a/ and /u/ are produced; vowels /i/ and /\textipa{\oe}/ are front vowels. The most significant changes were made to vowels /i/ and /\textipa{\oe}/.

In this study, there were 5 perceptual ratings; a rating of 1 represented Standard American English and a 5 would indicate a Strong Foreign Accent. In a graduate course of Clinical Phonetics that Dr. Macrae was teaching, he asked class members to rate samples of my speech pre- and post-treatment. In addition, there were samples of another speaker repeating the

\textsuperscript{22} Kent, Raymond D., and Charles Read, \textit{Acoustic Analysis of Speech 2\textsuperscript{nd} ed.} Albany,NY: Singular, 2002.
\textsuperscript{23} Macrae, “Speech Disturbance Following VPI Repair: Acoustic and Perceptual Analysis”
same words to serve as a control comparison. Participants in the study were unaware of the purpose of the study. All audio examples were randomly ordered. Students were asked to listen to recordings and then rate what they heard, either 1 or 5 or something in-between. The results of the perceptual task revealed that listeners rated my productions post-treatment speech as significantly different than that of pretreatment in the direction of Standard American English. In addition, there were comparisons of pretreatment samples to the control. The control was rated significantly different than my pre-treatment examples. Finally, a third comparison was comprised of post-treatment from my speech samples and the control; no significant differences were found (Figure 2).
6.2 Results/Graphs

Figure 2.

Perceptual Ratings

<table>
<thead>
<tr>
<th>Rating</th>
<th>Pre</th>
<th>Control</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
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</tr>
<tr>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Frequency

24 Macrae, Toby, “Speech Disturbance Following VPI Repair: Acoustic and Perceptual Analysis”
Figure 3.

/r/ Formant Measures Across Time

Figure 4.

Pre- and Post Treatment Corner Vowel Formants

Macrae, Toby. *Speech Disturbance Following VPI Repair: Acoustic and Perceptual Analysis*. 25

Macrae, Toby. *Speech Disturbance Following VPI Repair: Acoustic and Perceptual Analysis*. 26
Conclusion

The purpose of this study was to provide information to both the musical and scientific communities about Velopharyngeal Insufficiency in musicians, from a first person standpoint. With little published research, I hope that this paper will serve as an accessible resource for musicians who suffer from Stress Velopharyngeal Insufficiency and Velopharyngeal Insufficiency and particularly to those who need a surgical repair in order to correct VPI.

I hope that my journey inspires others to persevere and offers direction for how to treat this potentially career-ending problem. My journey wasn’t easy, and part of the difficulty was in trying to find a diagnosis. I want to encourage those who are currently suffering from this disorder, that even though VPI and SVPI are difficult issues for musicians to deal with, both physically and emotionally, in many cases they can be overcome. I am currently fully healed. I have normal speech and have been able to successfully audition for graduate school to continue my dream of becoming a professional clarinetist.
Bibliography


Appendix A

Paragraph’s used for measuring formants pre and post treatment

My Grandfather

You wish to know all about my grandfather. Well, he is nearly 93 years old, yet he still thinks as swiftly as ever. He dresses himself in an ancient, black frock coat, usually minus several buttons.

A long, flowing beard clings to his chin, giving those who observe him a pronounced feeling of the utmost respect. When he speaks his voice is just a bit cracked and quivers a trifle. Twice each day he plays skillfully and with zest upon a small organ.

Except in the winter when the snow or ice prevents, he slowly takes a short walk in the open air each day. We have often urged him to walk more and smoke less but he always answers, "Banana oil!" Grandfather likes to be modern in his language.

The Rainbow

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. A rainbow is the division of white light into many beautiful colors. These take the shape of a large, round arch, with its path high above and its two ends apparently beyond the horizon.

There is, according to legend, a boiling pot of gold at one end. People look but no one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow.
## Appendix B

### Target Words

<table>
<thead>
<tr>
<th>Cigar</th>
<th>More</th>
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</thead>
<tbody>
<tr>
<td>Steer</td>
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<tr>
<td>Car</td>
<td>Lurk</td>
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<tr>
<td>Tear</td>
<td>Door</td>
</tr>
<tr>
<td>Far</td>
<td>Search</td>
</tr>
<tr>
<td>Radar</td>
<td>Stir</td>
</tr>
<tr>
<td>Guitar</td>
<td>Deter</td>
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<tr>
<td>Spear</td>
<td>Turn</td>
</tr>
<tr>
<td>Near</td>
<td>Learn</td>
</tr>
<tr>
<td>Bar</td>
<td>Mourn</td>
</tr>
<tr>
<td>Year</td>
<td>Torn</td>
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<tr>
<td>Jar</td>
<td>Lurch</td>
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<tr>
<td>Deer</td>
<td>Jerk</td>
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<tr>
<td>Scar</td>
<td>Burn</td>
</tr>
<tr>
<td>Cheer</td>
<td>Corn</td>
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<tr>
<td>Ear</td>
<td>Turk</td>
</tr>
<tr>
<td>Fear</td>
<td>Born</td>
</tr>
<tr>
<td>Star</td>
<td>Boar</td>
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<tr>
<td>Hear</td>
<td>Soar</td>
</tr>
<tr>
<td></td>
<td>Fern</td>
</tr>
</tbody>
</table>
### Appendix C

**Target Sentences**

<table>
<thead>
<tr>
<th>I smell the cigar</th>
<th>It is near campus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steer the bicycle</td>
<td>I went to the wine bar</td>
</tr>
<tr>
<td>I don’t have a car</td>
<td>I love the New Year holiday</td>
</tr>
<tr>
<td>I tear up at sad movies</td>
<td>I don’t need help opening the jar</td>
</tr>
<tr>
<td>The house is not far</td>
<td>Uh oh, that is going to leave a scar</td>
</tr>
<tr>
<td>The radar is cutting edge</td>
<td>The deer walked into the woods</td>
</tr>
<tr>
<td>I love the sound of an acoustic guitar</td>
<td>A cheer came from the stadium</td>
</tr>
<tr>
<td>He tossed the spear at midfield</td>
<td>I got it stuck in my ear</td>
</tr>
</tbody>
</table>
Appendix D

Clinical Report Following Video Fluoroscopy

e-mail: williams@dental.ufl.edu

Clinic Report: Videofluoroscopic assessment of the velopharyngeal port during function for speech

Re: Kensley Behel
Dental No.:  
Medical No.: 1890030

This 20 year-old white female was seen on February 4, 2011 for a videofluoroscopic assessment of her velopharyngeal port during function for speech. Medical history is significant for an Uncle with Cleft Lip and Palate. Ms. Behel was cooperative and her speech samples were judged by herself and her mother to be representative of her usual manner of production. Nasopharyngeal structures were coated with a thin barium sulfate to aid in enhancing soft tissue contrast. Records were obtained in the lateral and frontal planes. Dr. Bill Williams was asked to review this film and to offer his opinion as to the underlying cause of Ms. Behel’s velopharyngeal insufficiency and to suggest a possible treatment plan. Although Dr. Williams is retired he agreed to this request on a volunteer basis with no remuneration.

Detailed analysis of the fluoroscopic film revealed the following conditions:

1. During physiological rest, while breathing through her nose, Ms. Behel's velum maintained a normal resting configuration resulting in an open velopharyngeal port of 10+ mm, as measured from the lateral view, an opening well within normal limits. Ms. Behel and her mother report her speech to often be hypernasal at the end of the day or when she is fatigued. During today's fluoroscopic assessment there was no evidence of VPI during speech or while she played her clarinet.

2. While speaking, Ms. Behel's soft palate is actively mobile with a movement pattern appropriate to the several speech samples assessed. The velum elevates to the level of the palatal plane with a consistent closure against the bottom margin of a small protruding adenoid pad.

3. The depth of Ms. Behel's nasopharynx, as measured along the palatal plane from the posterior margin of the hard palate to the posterior pharyngeal wall is 21 mm. This compares to the norm of 24.25 mm ± 1.9 mm±1SD, revealing her nasopharyngeal depth to be within normal limits, although at the shallow end of the 2nd SD.

4. The length of Ms. Behel's soft palate, as measured at physiological rest from the posterior margin of the hard palate to the tip of the uvula, is 30 mm. This compares to the norm of 34.5 mm ± 1.6 mm±1SD revealing her velum to be into the 3rd SD of being short.

5. The thickness of the velum, as measured at the midpoint of her velar length is 6 mm which compares to the norm of 8.8 mm ± 0.6 mm±1SD revealing her velum to be greater than 3SD's thin.
6. The adenoid pad which begins at the level of the palatal plane and extends to a height of 19mm along the height of the posterior pharyngeal wall. The thickness of the pad both at its base where the elevated velum approximates and at its midpoint is 5mm. It is our opinion that with loss of this adenoid tissue there will be an increase of nasal pharyngeal depth of approximately 5 mm resulting in an overall depth of 26 mm. (norm = 24.2 ± 1.9). It is our opinion that this depth is greater than Ms. Behel will be able to close.
7. An anterior-posterior view revealed symmetrical lateral wall function with a pattern within normal limits. During speech both sides move towards the midline by 50 -75 from physiological rest to function.

8. In an attempt to create a condition of VPI, Ms. Behel blew on her thumb to create a high level of intraoral air pressure and at levels apparently greater than that produced while she played her clarinet the velopharyngeal closure broke down resulting in the loss of air through the nasopharynx. From an oral exam, Dr. Seagle reported finding neither a bifurcated uvula nor a notching of the posterior nasal spine, conditions often associated with a submucous cleft palate. However, the fluoroscopic findings of a significantly thin soft velum, as well as velar length 2.5 SD's short suggest an anatomical variant (possibly a submucous cleft palate) of the velum that could account for Ms. Behel's VPI.

In summary, Ms. Behel and her mother report that over the past year, there exists a condition of inconsistent hypernasality for speech and while she plays her clarinet. During this assessment, VPI was not observed under either condition. The closure pattern of the velum to the posterior pharyngeal wall is remarkable in that the elevated velum makes contact/closure with the base of the protruding adenoid pad. It is our opinion that with any loss of the adenoid pad, there is the likelihood of a more consistent condition of an opening through the velopharyngeal port in which the velum will fail to make contact/closure with the posterior pharyngeal wall.

As there is good and appropriate velar movement and as the nasal pharynx is of normal dimension, and as the soft palate is significantly thin and on the short end of the normal range, it is our opinion that surgical management of the velar port should initially consider the condition of a submucous cleft palate. If a submucous cleft palate exists it is our recommendation it be corrected with the Furlow double opposing-z palatoplasty technique. However, if a submucous cleft palate is ruled out, it is our opinion that the optimal surgical technique is a palatal pushback with a pharyngeal flap lining.

If I can be of any further assistance in the interpretation of this film please call (352) 334-0228.

W.N. Williams, PhD
Dr. Brent Seagle, PO Box 100286
Ms. Ginny Dixon-Wood, PO Box 100296

Julie A.G. Stierwalt,
PhD
Associate Professor
Communication Sciences and Disorders
FSU
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Appendix E

Operative Report

DATE OF SURGERY: 04/28/2011

PREOPERATIVE DIAGNOSIS: Velopharyngeal insufficiency

POSTOPERATIVE DIAGNOSIS: Velopharyngeal insufficiency

OPERATION PERFORMED: Palatal push back and pharyngeal flap.

SURGEON: Seagle

ANESTHESIOLOGIST: Berger

ASSISTANT: GANZY

ANESTHESIA: General anesthesia

DESCRIPTION OF PROCEDURE: The patient was brought to the Operating Room, placed supine, anesthetized, prepped and draped. A time-out was done. IV antibiotics were given. The Dingman mouth gag was inserted into the oral cavity. The palate was inspected. The soft tissues of the hard and soft palate along with the posterior pharyngeal wall were infiltrated with 0.5% Xylocaine mixed with 0.25% Marcaine. After vasoconstriction occurred, a moderately wide superiorly based pharyngeal flap was incised and elevated. Hemostasis was achieved with electocautery. We then incised the V-Y push back type of incision in the hard palate and we undermined the mucoperiosteum back to the posterior border of the hard palate, exposed and
preserved the greater palatine neurovascular bundles on each side. Further elevation was done from the anterior layers of the soft palate from the nasal layer for about 5mm posterior to the posterior border of the hard palate. We removed the boney rim of the greater palatine ostium on each side with a chisel. I then incise through the mucosa into the nasopharynx and did further blunt dissection to the retrodisplace the palate tissues. After an adequate push back was attained, we brought the pharyngeal flap up and sutured it to the posterior border of the hard palate. I then sutured the flap itself to the raw surface of the retro displaced palatal tissues using 4-0 Vicryl for all the sutures. We then repaired the V-Y push back incision and suctioned the stomach, terminated the procedure, awakened and took her to Recovery in good condition.
Appendix F

Examination Report Following Nasal Endoscopy

H Lee Moffitt Cancer Center: Examination Report

Patient Info
Last Name: Behel
First Name Middle Initial: Kensley

Exam System Info - General
Exam Original Date: Tue Jun 08, 2010 09 30 21
Examining Facility: AM
H Lee Moffitt Cancer Center - Order
#48325

4:04:16 (50.1) – Velopharyngeal Port left side. Note tissue irregularity on PPW at midline

12:15:08 (15:1) – Velopharyngeal Port right side note tissue irregularity on PPW

16:00:11 (53:1) – Velopharyngeal Port left side during clarinet play air leakage right and left of PPW projection

12:03:00 (49:1) Velopharyngeal Port right side during clarinet play air leakage right and left of PPW projection