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Hand and Wrist Overuse Injuries in Flutists: Physical Causes and Prevention

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ABSTRACT

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In music, overuse injury is a common problem that is insufficiently addressed by many instrumentalists. Research has shown a significant number of flutists have suffered from overuse-related injuries. If flutists become cognizant of the anatomy, alignment, and function in their fingers, hands, and wrists, they will recognize how practicing wisely can prevent injuries. By incorporating informed, preventative measures into practice routines, the need for treatment is unnecessary or minimized. However, in current literature, there is a lack of research pertaining to physical causes and prevention of overuse injuries for this population and this issue.

In this dissertation, the author delves in to the mechanical organization of the flutists' hand and wrist to investigate how the anatomy of involved muscles and tendons work during flute playing. This is followed by an analysis of the physical causes of overuse injuries on these body parts. This project also introduces a framework for practice routines, which target every muscle group used for playing the flute, and suggests methods to improve hand and wrist strength and flexibility based on the training models of professional athletes. Through the combination of these aspects it is possible to lower the risk of flutists developing practice-related injuries.

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INTRODUCTION

In the music world, overuse injury is a common problem that is ignored among many instrumentalists. It is important to be knowledgeable of this issue, as it can negatively impact any musician's career if not addressed. Overuse injury is also known as Repetitive Strain Injury (RSI), "which is a stress-related, cumulative injury resulting from constant repetitive movements."[1] The symptoms are described as a collection of pain and discomfort that originates from tendons, muscles, nerves, and joints. RSI is driven by a variety of or combination of causes, including physical overuse, psychological stress, environmental discomfort, and social demand. The current literature evaluates how psychological, environmental, and social demand effect the development of injuries in musicians. For the purposes of this dissertation, I will focus only on the physical aspects surrounding overuse injury.

The human body can manage a certain amount of recovery naturally; it is capable of adapting to physical stress. Muscle tissue breaks down while the muscles are working and then recovers and rebuilds as the muscles are resting. For example, people normally feel sore after an intensive weightlifting session. The soreness is caused by the breakdown of muscle tissues; however, muscles recover themselves and become stronger after a few days of resting. If connective tissues are exercised for long periods without

[1] Robert M. Simon and Ruth Aleskovsky, *The Repetitive Strain Injury Handbook: An 8-Step Recovery and Prevention Plan* (New York: Henry Holt, 2000), 1.

sufficient rest time, and muscles continually endure this kind of strain, they begin to scar and shorten, which can potentially cause long-term damage. This process also produces lactic acid, a waste product of exercise that causes muscle fatigue.[2] When lactic acid accumulates, it irritates tendons, creating additional issues for the body.[3] Overuse injuries typically manifest because this process of tissues breaking down occurs more quickly than the body's natural recovery rate. The injured areas normally appear to be swollen and may be painful to use or feel numb. With enough rest for the affected muscle, the severity of the injury may lessen and will heal within days or months, but if not treated properly, the injury may even become chronic, meaning that it may continue to cause discomfort continuously over a long period of time.

According to the *Official Journal of the American Federation of Musicians of the United States and Canada*, "Most musicians will experience discomfort while playing at some time during their career. One of the most common causes of pain among musicians is an overuse injury. These often affect the wrists and arms or neck and shoulders."[4] Many world-renowned musicians have experienced overuse injuries, some of whom had to stop practicing completely for years to save their careers. An example of this is Korean violinist and educator Kyung Wha Chung. In an inspiring interview with Inge Kjemtrup, Chung talked about her career as a soloist and explained that her overused, swollen left index finger collapsed while she was busy preparing for recordings and concerts in 2005. This injury eventually put Chung's public performing career on hiatus

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[2] Jourdan Zaylee, *The Complete Idiot's Guide to Working Out at Home* (Indianapolis, IN: Alpha Books, 2001), 253.

[3] Simon and Aleskovsky, *The Repetitive Strain Injury Handbook: An 8-Step Recovery and Prevention Plan*, 20-21.

[4] Official Journal of the American Federation of Musicians of the United States and Canada, "Overuse: How to Avoid Injury," International Musician, http://internationalmusician.org/overuse-avoid-injury (accessed February 15, 2017).

for ten years.[5] In 2014, Violin virtuoso Hilary Hahn announced on her Facebook page that she had to withdraw from months of scheduled performances because of an inflamed muscle/muscle strain. Although the violinist did not specify the cause of her injury, it was highly likely triggered by overuse.[6] In addition, world-renowned pianist Lang Lang also announced through social media that he was forced to cancel performances from March to June in 2017, due to inflammation in his left arm, likely caused by overuse. Musicians cannot afford to be ignorant of this issue any longer. Understanding both the physical causes of overuse injury and the methods for its prevention can be extremely valuable to instrumentalists, including flutists like myself.

My motivation for researching this topic came from a painful and depressing personal experience that occurred in my first semester of graduate school. Like many other students, I wanted to excel in my first jury as a master's student. In an attempt to achieve this goal, I practiced seven or eight hours of scales every day for a week right before the final. During that week, I began to feel persistent pain and stiffness around my right wrist. In the past, the discomfort would normally dissipate after a night of sleep. Ultimately, I finished that semester with good grades; however, a week into the winter break, I suddenly started having an unbearable shooting pain in my right wrist. I did everything I could to rest the area: I purchased a thumb support mechanism to stabilize it; I massaged the area with medical balm; and I even ceased practicing for a whole month.

Unfortunately, the condition worsened when the next semester started, and many of my daily activities became unbearable to perform. The pain disrupted my sleep every

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[5] Inge Kjemtrup, "*The Return of Kyung Wha Chung*," Stringsmagazine.com, August 30, 2016, http://stringsmagazine.com/the-return-of-kyung-wha-chung (Accessed on April 30, 2017).

[6] Simon and Aleskovsky, *The Repetitive Strain Injury Handbook: An 8-Step Recovery and Prevention Plan*, 29.

night. I could not even hold a pen to take notes for my history seminar. My injury became so severe that at one point my wrist was too weak to simply turn a water bottle cap. In essence, I became temporarily disabled, as I could not do anything with my right hand. I went to see physician who did an MRI and many other examinations, but he could not find anything wrong. Finally, I was prescribed some anti-inflammation medication, handed a copy of a few hand stretch exercises, and told that I should immediately stop the activity that caused the pain. I followed the doctor's advice, but nothing improved. Eventually I withdrew from all my flute lessons, chamber music groups, and ensemble duties for the whole spring semester.

It pained me to see my colleagues practice and perform, especially since I did not know when I could start practicing or, even more devastatingly, if I would ever be able to play the flute again. That summer, I traveled back to China and found the best acupuncturist I could and spent three hours every other day in his clinic doing more than thirty treatment sessions. Finally, I felt like my right wrist and arm were becoming stronger. While I was happy about my right wrist regaining strength and flexibility and the pain subsiding, I was fearful to begin practicing again because I did not want to reinjure myself. I knew there was a correlation between the pain and my habit of over-practicing, but I was confused because I had always practiced eight hours a day in college without issue. It is now clear that I was missing key information about my body's limits and about healthy practice routines.

Research demonstrates that an astounding number of flutists have gone through similar strife and suffered from overuse-related injuries. For instance, in 1999, Cari Spence did a survey regarding how pain affects playing the flute at the National Flute

Association annual convention. The result indicated that "22.5% of flutists felt consistent pain in their right hand, 35% in the right wrist, and 25% in the right forearm."[7] It also shows that the hands and wrists are the most common areas for flutists to suffer from overuse injuries.

Focusing on this issue is critical to the success of many flutists, as most will have to address the potential for overuse injury at some point in their careers. When a non-musician suffers from overuse pain, he or she faces the difficulty of completing daily tasks. If a flutist's hand or wrist is injured, not only does he experience discomfort in daily life, but also his playing levels are likely affected. Due to the competitive nature of the music world, losing practice time could result in the termination of one's services or the inability to participate in a program. Unfortunately, many flutists choose to work through pain, a practice that could eventually cause lifelong damage to their bodies.

In light of my personal experience and other painful stories told to me by my flutist friends, I was eager to find out how my fingers, hands, and wrists work while playing the flute, what causes prevalent injuries in flute players, and if specific physical exercises designed for flutists can help strengthen hand and wrist muscles to prevent overuse injuries. Therefore, the purposes of this dissertation are to raise awareness about healthy music making, explore the physical causes of overuse injuries in the hands and wrists for flutists, and develop an ideal practice regimen that prevents these injuries while still maintaining a flutists' performance levels.

Chapter 2 outlines the current literature on these topics. Like many others who have suffered from this type of injury, I wish I had been advised about the causes and

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[7] Cari Spence, "Prevalence Rates for Medical Problems among Flautists: A Comparison of the UNT-Musician Health Survey and the Flute Health Survey," *Medical Problems of Performing Artists*16, no. 3 (2001): 99-102.

prevention of overuse injuries. If I had known more, I likely could have avoided much physical and mental pain. However, I learned in this process that there is a definite lack of research pertaining specifically to the physical causes and prevention of overuse injuries for flutists' hands and wrists.

Chapter 3 will focus on identifying every muscle or muscle group that is used while playing the flute to find the causes of overuse injuries. It will also apply previous research to study the ideal position for each finger, hand, and wrist on the flute to maximize a player's freedom of movement.

On many levels, flutists and athletes are similar. Athletes train to gain the efficient movements needed to consistently achieve goals, such as swinging the racket over and over in an accurate manner in order to perfect a tennis serve. In a comparable way, flutists strive for accuracy with micro-motion finger movements. Flutists improve their performance skills by working towards the same sort of perfection and accuracy that athletes do. However, just as athletes are prone to overuse because of their repetitive training habits, flutists place themselves at risk for physical health issues from repetitive fine movements. The difference for professional athletes is that they work with medical teams on a daily basis. Athletic teams have already developed a thorough procedure of prevention, diagnosis, treatment, and recovery. Unfortunately, flutists do not have this resource in the performance or education settings.

Therefore, in Chapter 4, I will combine a flute practicing regimen with the support of sports science to develop a unique training model that is much needed for today's flutists. In order to gather more professional insights from the field of sports science, upon the approval of Institutional Review Board (IRB), I interviewed Dr. Sara

A. Winges, a specialist in the area of neuromuscular control patterns of hand movements and how changes in the patterns of muscles could be applied to rehabilitation strategies for hand dysfunction. Dr. Winges is a faculty member in the School of Sport and Exercise Science at University of Northern Colorado, and her recent projects have focused on the control of skilled hand movements during piano and clarinet performance.

In my project, the practice routine will include how much time and what specific exercises a flutist should perform during warm-up and cool-down. It will also discuss an appropriate resting period. In addition, I will create a plan for finger, wrist, and arm strength as well as flexibility training for flutists. These training routines will use the findings in Chapter 3 to provide specific exercises that target and strengthen each muscle or muscle group used for playing the flute.

Finally, the conclusion will briefly sum up the results of all the examinations, analysis, and discussion from previous chapters. Furthermore, it will discuss the scope for future studies on this topic.

CHAPTER II

REVIEW OF LITERATURE

This chapter will review the influential injury prevention literature that begins to describe the physical causes and prevention of hand and wrist overuse injuries in flutists. This section mainly focuses on prominent publications and evaluates different organizations and research groups and the research they produce.

Techniques of Body Awareness

Alexander Technique

Since its establishment a century ago, Alexander Technique has benefited countless practitioners. In the book *Body Learning: An Introduction to the Alexander Technique*, author Michael Gelb mentions that Alexander Technique's "best formal definition is a means for changing stereotyped response patterns by the inhibition of certain postural sets."[8] In other words, Alexander Technique is a method that helps to improve posture and body movement in an effort to reduce physical and mental tensions. Its ultimate goal is to enhance general health and well-being.

The founder of Alexander Technique, Frederick Matthias Alexander, was born in Australia in 1869. Alexander was known as a successful play reciter who specialized in a one-man production of Shakespeare plays in Melbourne. Eventually, the high demand of his performance put great strain on his vocal cords and disparities that developed in his

[8] Michael Gelb, *Body Learning: An Introduction to the Alexander Technique* (London: Aurum, 2004), 1.

voice started to affect the quality of the show. Alexander sought the assistance of multiple doctors, but to no avail. Despite medical assistance, he continued to experience strain in his vocal cords. Alexander was determined to find the problem and discover solutions so that he could continue to recite plays. He noticed that his voice was fine when he spoke in a normal manner, but to act on stage made his voice hoarse. This continuous hoarseness ultimately led him to losing his voice.[9]

In his search for a solution, Alexander began to examine the specific step-by-step process of his reciting. He developed a breakthrough when he watched how he recited his act in a mirror. From this observation, he discovered that when he was reciting, he tended to pull his head back onto his spine with enhanced force. Noticing the obvious strain, he corrected this unconscious habit. This adjustment allowed him to recover his vocal talent.[10] Throughout the years, Alexander continued to build on his initial discovery and structured the key principles of the Alexander Technique. For example, "Misuse of the body often occurs habitually and unconsciously."[11] Alexander noticed in the mirror that his body acted differently when reciting than it did when speaking normally. He noted that "the body does not function as separate entities, but as a whole unit with every part affecting every other part."[12] Alexander's loss of voice was caused by the tension on his spine, not stress on the vocal cords themselves. This illustrates how apparent pain points may be caused by tension in other parts of the body. When the root of a problem is found and corrected, the body as a whole can return to its normal operations.

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[9] Richard Brennan, *The Alexander Technique Manual: A Step-by-Step Guide to Improve Breathing, Posture and Well-Being* (Boston: Journey Edition, 1996), 18-19.

[10] Ibid., 20.

[11] Ibid.

[12] Brennan, *The Alexander Technique Manual: A Step-by-Step Guide to Improve Breathing, Posture and Well-Being*, 21.

There are many musicians that practice this unique method to improve their body's balance and performance levels. Some music and arts schools even include the Alexander Technique in their curriculum. In his book, *The Alexander Technique Manual: A Step-by-Step Guide to Improve Breathing, Posture and Well-Being*, Richard Brennan specifically talks about the relationship between musicians and the Alexander Technique. He explains how to position an individual musician's body to reach peak performance with minimum effort and even uses a flutist's stance to demonstrate how poor posture might seriously influence the sound of the music and cause injuries to the player.[13]

Accomplished performing musicians and Alexander Technique experts Judith Kleinman and Peter Buckoke spent years researching and teaching music and Alexander Technique. In 2013, they published a book called *The Alexander Technique for Musicians*, which targets the usefulness of the technique for aspiring musicians.[14] In this book, the authors thoroughly explain why the Alexander Technique is helpful. The authors give examples of different factors that cause body damage, such as practicing long hours and developing bad practicing habits. Furthermore, they describe how to apply this technique to daily practice and improve performance. This book has exponential benefits for musicians who read it and take time to explore their individual needs in order to play healthily and productively. For instance, the authors introduce different exercises to practice the balance with and without the instruments. In order to improve efficiently, Kleinman and Buckoke also give suggestions about how to build a healthy relationship between students and teachers.

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[13] Brennan, *The Alexander Technique Manual: A Step-by-Step Guide to Improve Breathing, Posture and Well-Being*, 66-67.

[14] Judith Kleinman and Peter Buckoke, *The Alexander Technique for Musicians* (London: Bloomsbury, 2013), xi.

Body Mapping

Body mapping has been a topic of interest for the past thirty years. "Body Mapping is the process of discovering one's personal body map. Individuals then use this material to consciously start working to correct any mistakes found in their map in order to produce efficient, graceful, and coordinated movements."[15] Barbara Conable's pioneering book introducing this technique, *What Every Musician Needs to Know about the Body,* is the realization of Alexander's educational plan and has influenced many scholars and musicians to explore the healthy relationship between body mapping and playing. In the theory of body mapping, every physical action requires the coordination of the whole body. This can be applied to the simplest motions such as standing up as well as more complicated body movements such as playing an instrument. To finish tasks in the best physical condition and move effectively without extra unnecessary tension and stress, people should have a conscious idea of the functions of each body part in their individual body map. The understanding of one's body map should be as detailed as possible.

Many music institutions also list body mapping as an elective course. It is common for professors on this subject to ask students to draw their own body maps to illustrate how little they understand how their bodies work. For example, when playing the flute, a person usually focuses most on the processes of fingering, breathing, and expressing the music. The flutist might not be aware of where his neck, arms, back, and legs are or what they are doing while he is playing the flute. In this case, the map this flutist draws probably does not reflect the actuality of what happens during flute playing.

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[15] Stephen Caplan, *Oboemotion: What Every Oboe Player Needs to Know about the Body* (Chicago: GIA. Publications, 2009), 4.

Through this exercise, the player becomes familiar with his own body map and thus is able to visualize his movements and make consistent and intelligent bodily decisions while playing. This practice also enhances the connection between the body and the instrument to achieve the best practicing results.

Stephen Caplan's book *Oboemotions: What Every Oboe Player Needs to Know about the Body* is also inspired by body mapping theory. Although this book focuses on oboists, all instrumentalists could benefit from his research on body balance, effective practice, and body movement awareness training. For example, the author specifically analyzes how arms and fingers work during oboe playing to demonstrate the relationship between the player's body and oboe. This examination details which muscle or muscle groups are involved in which movement. Caplan uses the real stories of injured and confused oboists to make the theory more practical and convincing. The simple structure and comprehensive information taken from this book are not only valuable for oboists, but also for flutists and other instrumentalists. For example, the effective practicing methods, balance between body and mind, and practicing without an instrument can be helpful and applicable to all musicians who want to improve their playing.

In 2006, Lea Pearson wrote a book called *Body Mapping for Flutists: What Every Flute Teacher Needs to Know about the Body*, which applies the concepts from Conable's book to flute playing. Pearson, who is a flutist and educator herself, wrote one of only a few publications dedicated specifically to flutists. In her book, she points out the importance of understanding and utilizing body mapping to help form balanced playing techniques. She asserts that "every sound that musicians make is created by movement: tone, rhythm, technique, and musicality are all created by subtle and complex movements

that take years to refine."[16] Taking the relationship between tone quality and the movement of breathing as an example, in order to produce a rich sound, flutists need to coordinate the body movements while providing support from the lips, lungs, ribs, and diaphragm. This book also includes a brief analysis of the structures of the arms, hands, head, and neck to teach good playing postures. Another valuable asset of this book is the last chapter in which the author encourages educators to help students progress as musicians by providing them the knowledge of their own individual body maps.

The unifying concept of Alexander Technique and Body Mapping is constant awareness of the human body's natural movement. The resources mentioned above provide useful information about these techniques in general, but the application of these techniques to daily practice for flutists is still largely undefined. Undeniably, it is helpful for a flutist to have a general understanding of where his fingers, hands, and wrists are both at resting state and on the instrument. However, the next step, which lacks any current research, should be to know in great detail where each flute-playing muscle, muscle group, and joint are located and how to realize each component's prime performance. This will be the main focus of my project. The more completely flutists understand how their hands and wrists operate, the less likely they will be to suffer from injuries. Therefore, in this project, I will approach prevention, suggesting the balanced and ideal posture for flutists. Additionally, I will include a collection of detailed exercises meant to improve both flexibility and strength, a topic which none of the above sources includes.

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[16] Lea Pearson, *Body Mapping for Flutists: What Every Flute Teacher Needs to Know about The Body* (Columbus, OH: Flutibia, 2006), 1.

Performing Arts Medicine

The field of performing arts medicine provides some further insights into hand and wrist overuse injuries. Written in 1993, Richard Norris's book *The Musician's Survival Manual* addresses the causes, treatments, and prevention of musicians' overuse injuries. It summarizes the physical issues musicians face from day to day and offers solutions that are efficient and helpful. In this short but comprehensive book, there is even a section dedicated specifically to flutists. The author boldly states that the flute as an instrument is not user-friendly, and that holding it for a long period of time can cause neck dysfunctions. He also discusses the ergonomic design of both the thumb rest and the finger rest, which many flutists use.[17] Norris's research is valuable for musicians and explains some of the physical complications that may arise from playing an instrument. This book provides readers different viewpoints, which demonstrate that the flawed design and mechanism of the flute lead flutists to face overuse injuries. At the same time, the author promotes the development of more efficient manners of flute playing.

According to Howard Bird, the author of the book *Performing Arts Medicine in Clinical Practice*, "In the case of musical instruments, a major problem is that in general musical instruments come in standard shapes and sizes whilst performers differ in size and body build."[18] He also points out that the flute has a problematic design compared to the rest of the woodwind family. Holding it requires "contorted positions of both arms for long periods. The left forearm is often hyper-extended and the left wrist deviated

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[17] Richard Norris. "*The Musician's Survival Manual: A Guide to Preventing and Treating Injuries In Instrumentalists*," Musicianssurvivalmanual.com, 2011. http://musicianssurvivalmanual.com/Download_Book_files/Final%20master%20MSM.pdf (accessed on December 12, 2017).

[18] Howard. A. Bird, *Performing Arts Medicine in Clinical Practice* (Cham: Springer, 2016), 9.

radically, which in turn is a recipe for compression neuropathy."[19] Although the author mainly focuses on injury caused by the awkward position of the left wrist, both wrists and hands could possibly suffer from injury if they are not placed in neutral positions. This will be explained further in chapter 3. In this book, Bird discusses the relationship between medicine, musicians, and dancers. Chapter 8 is specifically written for overuse syndromes, which are the main causes of flutists' injuries. Bird lists a few extrinsic factors that contribute to the overuse injuries among athletes: excessive load on the body, training errors, and poor equipment.[20] The physical causes of overuse injuries will also be discussed in Chapter 3 in this project. The last part of the book talks about future trends and the development of performing arts medicine in the UK in recent years. For example, with the founding of the British Association for Performing Arts Medicine, special clinics now focus on performing artists. Most importantly, the Royal College of Music started a project that "unites eight of the most important music conservatories in the UK in a large study of the effects of music making on musicians' health and wellbeing."[21] The researchers in this project will monitor the participants' training for health, injury, and psychological impact when practicing music. This program is a beneficial source for professional musicians and music students, as it encourages knowledge of efficient practice and injury prevention.

These two books list several different causes for hand and wrist injuries, but they lack a detailed solution to prevent injuries. It is true that the weight of the flute and the asymmetrical playing posture are troublesome. Since the redesigning of the instrument is

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[19] Bird, *Performing Arts Medicine in Clinical Practice*, 9.
[20] Ibid., 94.
[21] Ibid., 167.

not really a feasible solution to avoid injury, this project aims to be practical and realistic in identifying injury prevention solutions by giving flutists a detailed understanding of the hand and wrist mechanisms that will promote natural and uninhibited motion.

The renowned Australian plastic surgeon, researcher, and lecturer Dr. Hunter John Hall Fry has published numerous articles on overuse injuries in musicians in both medical and music journals. In "Prevalence of Overuse (Injury) Syndrome in Australian Music Schools", Fry interviews instrumental performance students from seven music schools in Australia. He then examines injured students individually and privately. His findings suggest that thirteen percent of woodwinds players experience pain caused by overuse, and half of the affected students had hand and wrist pain. This article also identifies woodwind players as one of the groups most affected by overuse. Fry includes causes and prevention suggestions at the end of his article. He then points out that various degrees of depression appeared in all the students who experienced severe injuries.[22] Although his research is investigates music students in Australia only, overuse issues in musicians are universal.

Depending on the severity of overuse injuries, Fry classifies them into Grades 1-5 in the article *How to Treat Overuse Injury: Medicine for Your Practice*. He states that three common causes of the injuries are increasing practice duration and intensity, genetic differences among individuals, and technique and energy efficiency. He also points out that besides the repetitive movements musicians do with their fingers, sustaining the body in one position for a long time could also cause overuse issues. This supports the idea that holding the weight of the flute over a long period of time can lead

[22] Hunter J. H. Fry, "Prevalence of Overuse (Injury) Syndrome in Australian Music Schools," *British Journal of Industrial Medicine* 44, no. 1 (1987): 35-40. JSTOR (accessed March 13, 2017).

to injuries. Based on the principle of Alexander Technique, practicing helps to relax and balance the body, and to prevent further overuse injuries. Fry suggests that one of the best ways to prevent injuries is through education. From a medical doctor's perspective, he suggests that it is critical that music educators and medical specialists work together to provide a healthy and positive environment for music students.[23]

Playing Without Pain: Strategies for the Developing Instrumentalist by Northwestern University professor of orthopedic surgery William J. Dawson identifies three key factors as the main causes of overuse pain. These factors are exceeding the body's physiological limits, misuse, and hypermobility or double-jointedness. He also describes in detail the conditions, symptoms, diagnosis, and treatment of overuse. Dawson proposes a few practical tips for preventing overuse injuries, such as practice modifications that focus on effectively planning out practice and break times, and adequate hydration to keep the body in a healthy working condition. At the end, the author emphasizes the importance of education on both healthy practice and pain management.[24]

Former professional orchestral cello player Janet Horvath uses her own unfortunate experience with overuse injury to start her book *Playing (Less) Hurt: An Injury Prevention Guide for Musicians*. Although this book does not focus on the flute, Horvath provides a lot of practical and useful tips that could be applicable for all musicians. She particularly discusses the causes of overuse injuries and, most importantly, provides useful means to protect musicians from getting injured. Instead of

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[23] Hunter J. H. Fry, "How to Treat Overuse Injury: Medicine for Your Practice," *Music Educators Journal* 72, no. 9 (1986): 46-49. JSTOR (accessed February 25, 2017).

[24] William J. Dawson, "Playing Without Pain: Strategies for the Developing Instrumentalist," *Music Educators Journal* 93, no. 2 (2006): 36-41. JSTOR (accessed March 25, 2017).

"No pain, no gain," Horvath prefers "No brain, no gain."[25] This statement opposes the ultimately detrimental method of non-stop practicing.

In addition, several dissertations and other research documents examine hand and wrist overuse injuries in woodwind players. The bulk of Teresa Lynn Mitchell's doctoral dissertation *Alternative Methods of Resolving Hand and Wrist Pain in Woodwind Players* is a review of literature. She focuses on looking for various treatments for musicians who have injured hands and wrists. The author reviews medical journals that clearly define and diagnose hand problems and offers various alternative methods of treatment such as massage, acupuncture, Tai Chi, Pilates, and yoga.[26] This dissertation is informative and well-organized; however, the author fails to explain how each treatment is related to or beneficial for musicians' hand and wrist recovery. Moreover, some of the Eastern regimes she mentions lack validity regarding the scientific method.

In 2009, Sandra Elaine Cox wrote her doctoral dissertation entitled *Recognition, Evaluation, and Treatment Options of Performance-related Injuries in Woodwind Musicians*.[27] The author's review of literature includes different medical resources for treating musicians' injuries. However, most of her references are outdated since they are from twenty or thirty years ago, and medical advancements have continued since then. She does include the various kinds of performance disorders in different body parts and

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[25] Janet Horvath, *Playing (Less) Hurt: An Injury Prevention Guide for Musicians* (New York: Hal Leonard Books, 2010), 177.

[26] Teresa Lynn Mitchell, "Alternative Methods of Resolving Hand and Wrist Pain in Woodwind Players," DMA diss., University of Miami, 2003. ProQuest Dissertations & Theses Global. (accessed March 25, 2017).

[27] Sandra Elaine Cox, "Recognition, Evaluation, and Treatment Options of Performance -Related Injuries in Woodwind Musicians," DMA diss., University of Memphis, 2009. ProQuest Dissertations & Theses Global (accessed March 25, 2017).

their treatments. Overall, a deeper and more thorough investigation is needed in order for the research to be reliable and useful for woodwind players.

Several organizations formed recently have also contributed to the body of literature on musician injuries. Since the annual Symposium on Medical Problems of Musicians started in 1983 in Aspen, Colorado, various similar associations have developed rapidly around the world.[28] For example, Performing Arts Medicine Association (PAMA) is a Colorado-based nonprofit professional organization that aids physicians and other professionals who are involved in treatment and/or research in the field of Performing Arts Medicine. Also, the International Society for Study of Tension in Performance (ISSTIP) was founded and established in 1980 by world-famous piano professor and pedagogue Carola Grindea from the Guildhall School of Music in London. Over the course of its existence, the ISSTIP has educated countless musicians to overcome the stress and physical discomfort that often comes with playing an instrument regularly through its conventions and publication. The ISSTIP has also held clinics where they offer to help musicians with these issues. The Dutch Performing Arts Medicine Association (NVDMG) and Australian Society for Performing Arts Healthcare (ASPAH) are both organizations that consistently review related medical research to help the well-being of performing artists. The year 2017 marks the thirtieth year of their official publication *Medical Problems of Performing Artists*, which is the world's first clinical medical journal to provide a global forum for professionals involved in practice and research related to performing arts medicine.

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[28] Richard J. Lederman, "An Overview Of Performing Arts Medicine," *American Music Teacher* 40, no. 4 (1991): 14. JSTOR (accessed March 25, 2017).

Sports Medicine

Publications about music medicine can be traced back to the eighteenth century. Yet, while performing arts medicine and its clinical practice have progressed greatly in the past three decades, current research on medical care for injured musicians still falls far behind that of athletes. Because this dissertation will explore hand and wrist injury causes and prevention for flutists, not simply injury management as these previous documents and organizations have done, it is also necessary to turn to the literature available in the field of sports medicine. The following sources related to sports injures are valid references for this study on flutists.

In *Everyday Sports Injuries: Diagnosis, Treatment, and Prevention*, Jones and Wilson analyze the causes, prevention, and recovery of overuse sports injuries for different body parts. Their experience comes from years of efficient sports training programs. For example, during the rehabilitation stage, the book advises the athlete to "always warm up and cool down, and make sure you use the correct technique, and build up gradually–don't try to do too much, too soon."[29] This book provides athletes with an effective and healthy model for daily training, but because the same basic principles of daily training can be applied to musicians, this book also can provide a guide for serious instrumentalists.

Although this dissertation will only focus on physical causes and prevention, Gabrielle Hopkins's discussion on the role of psychological stress in predicting and preventing sport injuries in *Sports Injuries: Prevention, Management and Risk Factors* is helpful for musicians to have a broader understanding of injuries. In the fourth chapter,

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[29] Gareth Jones and Ed Wilson, *Everyday Sports Injuries: Diagnoses, Treatment, and Prevention* (New York: Dorling Kindersley Publishing, Inc, 2010), 13.

he writes, "Psychological research has shown athletes play an active role in the process of becoming injured. The key psychological factor related to sport injury occurrence is the stress response."[30] When musicians experience overuse injuries, recovery efforts are usually focused on the injured physical parts; however, Hopkins indicates that stress also contributes to the overall likelihood of injury by affecting decision making and causing muscle tension. In order to combat this effect, one may need to have a psychological intervention to reduce injuries. This shows that musicians must also develop a healthy mindset as a part of injury prevention.

Another informative source for this project is Chapter 3 of Norris's *Sports Injuries: Diagnosis and Management*. Here, Norris dedicates an entire chapter to the hand and wrist area of the body. He details both the structures of bones and tendons in the hand and wrist as well as the functions that these serve. He then gives a few examples of common hand and wrist injuries along with some popular exercises for prevention.[31]

Semyon M. Slobounov's book *Injuries in Athletics: Causes and Consequences* is a well-written database for athletic injuries. The information he provides is easy to understand even for non-athletes. The author includes a chapter that specifically talks about overuse injuries from the students' points of view. It gives examples of different sports overuse injuries and suggests that scientific training methods, which are applicable to musicians, will prevent overuse injuries as well.[32]

If flutists become aware of how the muscles and tendons are supposed to work in their fingers, hands, and wrists, they will recognize how practicing wisely can prevent

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[30] Gabrielle Hopkins, *Sports Injuries: Prevention, Management and Risk Factors* (New York: Nova Publishers, 2015), 87.

[31] Christopher M. Norris, *Sports Injuries: Diagnosis and Management*, 2nd ed. (Edinburgh: Butterworth-Heinemann, 1998), 454-468.

[32] Christopher M. Norris, *Sports Injuries: Diagnosis and Management*, 2nd ed., 93.

injuries. Subsequently, no treatment would be needed because injury has been prevented through informed practice routines. This dissertation will delve deeper in the mechanical organization of flutists' hand and wrist areas, design a practicing routine that targets every muscle or muscle group used for playing the flute, and suggest methods to improve hand and wrist strength and flexibility based on the training models of professional athletes. Through the combination of these aspects it is possible to lower the risk of flutists developing practice-related injuries.

CHAPTER III

PHYSICAL CAUSES

In order to learn the physical causes of overuse injuries, it is important to know the physical structure of the flutist's hand. This chapter will start with identification of the most common overuse injuries in the flutist's hands in flute-holding position. An examination of each finger's function during flute playing will follow. Finally, the last section of this chapter discusses the physical causes of overuse injuries, including training errors and physical inefficiencies.

There are two types of injuries: acute injuries and overuse injuries. "Acute injuries occur suddenly, and have a clearly defined cause or onset."[33] For example, an acute injury could be a concussion incurred during a football game or a broken bone caused by falling off a bicycle. An injury caused by overuse can be difficult to identify, diagnose, and treat, because it often appears gradually over time and typically starts when repetitive movements put stress on certain part of the body. In the early stages of overuse injury, the tissue involved in the repetitive movement adapts to the tension by strengthening and thickening. However, "if the applied stress becomes too great and the body's system is not able to recover and adapt quickly enough, this overload to the system leads to microtraumatic injuries, which cause inflammation of the affected area

[33] Roald Bahr and Sverre Mæhlum, *Clinical Guide to Sports Injuries* (Champaign, IL: Human Kinetics, 2004), 3.

and can result in an overuse injury as a direct response."[34] Since the buildup of an overuse injury often hides in these typical bodily reactions, flutists can easily overlook the strain on their bodies until the injury causes significant damage. It is also important to be aware that a very serious and complicated possibility may involve both types of injuries: an acute injury superimposed on a chronic developing injury.

In order to learn the physical causes of hand and wrist overuse injuries, a brief anatomy of these areas should be studied and discussed, along with how the muscles and tendons of the hand and wrist work in flute playing.

Brief Anatomy of the Hand and Wrist

The human hand and wrist consist of a system of bones, ligaments, tendons, and muscles. Tendons attach the bones to the muscles. Muscles create movements by contracting, working in pairs.[35] When one muscle is contracting; its opposite muscle is relaxing. To be more specific, an extensor is "a muscle that straightens out (extends) a joint to full length."[36] Its opposite muscle is called a flexor and is "a muscle that bends (flexes) a joint."[37] Tendons are "fibrous bands attaching a muscle to a bone."[38] Tendons are most susceptible to overuse injury.[39] In fact, tendon related pain is most often caused by repetitive movements, which is why it is common for flutists to suffer from overuse injuries. Therefore, it is helpful to locate and recognize the different tendons in the hand and wrist areas active during flute playing.

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[34] Hermann O. Mayr and Stefano Zaffagnini, *Prevention of Injuries and Overuse in Sports: Directory for Physicians, Physiotherapists, Sport Scientists and Coaches* (Heidelberg: Springer, 2016), 29.

[35] Paul Mason, *Improving Flexibility*, 1st ed. (New York, NY: Wayland, 2011), 10.

[36] Biagio John Melloni, *Mellonis Illustrated Dictionary of the Musculoskeletal System* (New York, NY: Parthenon Publ. Group, 1998), 169.

[37] Ibid.

[38] Ibid., 239.

[39] Bahr and Mæhlum. *Clinical Guide to Sports Injuries*, 11.

The following two figures show both the dorsal view and palmar view of the right hand in flute holding position with participating tendons diagramed in black (see figure 3.1 and figure 3.2).

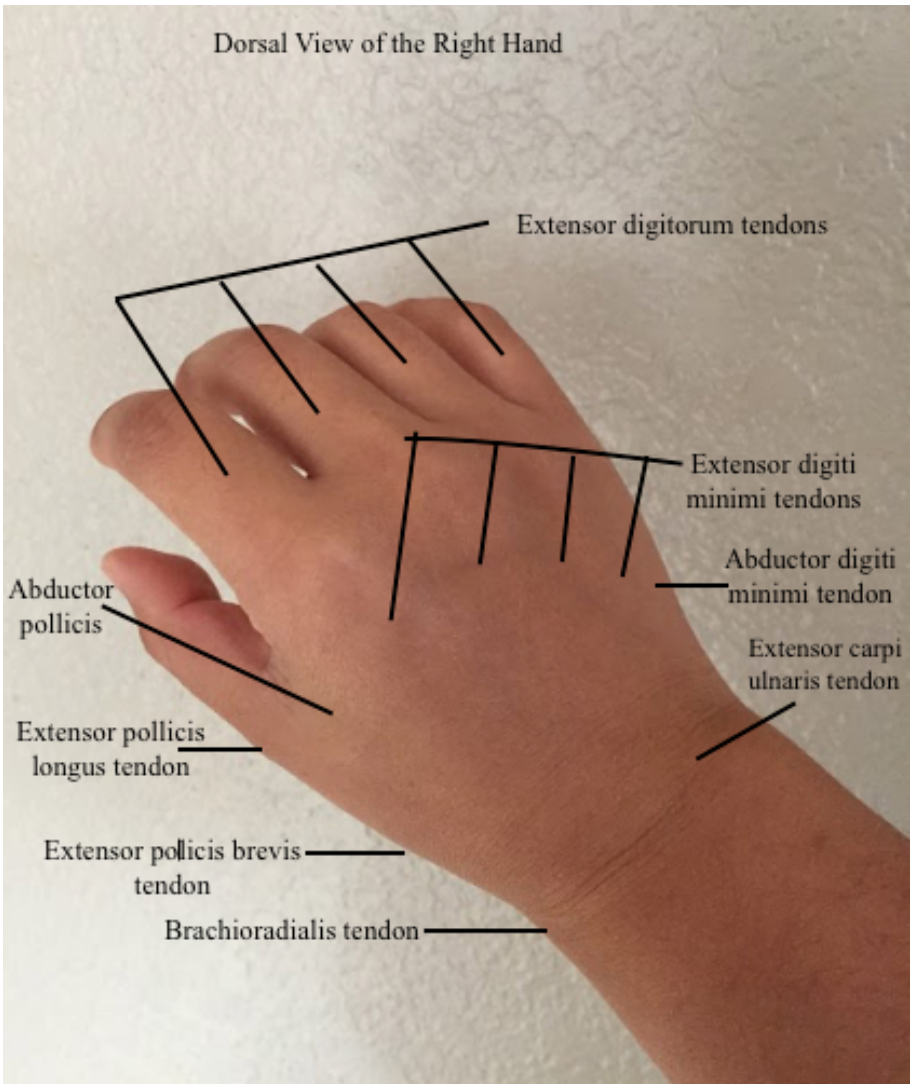

Figure 3.1. Dorsal view of the right hand in flute holding position

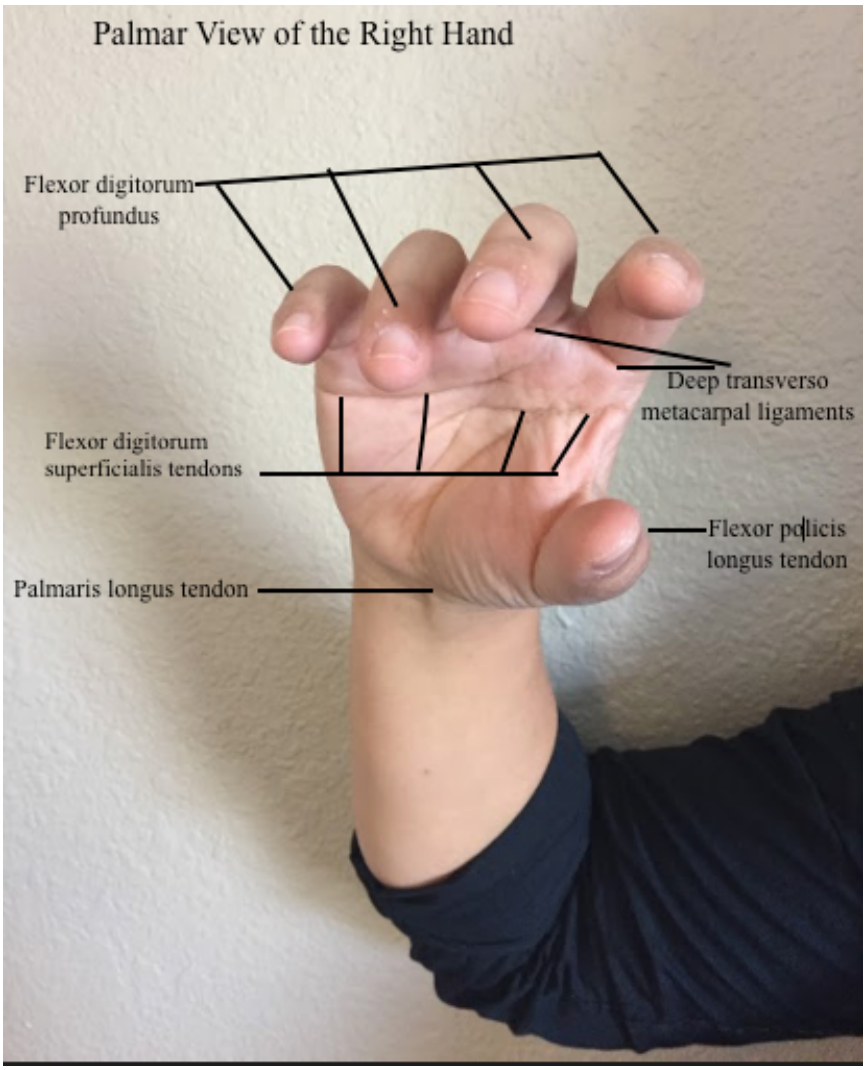

Figure 3.2. Palmar view of the right hand in flute-holding position

Functions of Each Finger During Flute Playing

Simply being able to identify the anatomy of the hand and wrist is insufficient in helping flutists trace the causes of their overuse injuries. In order to study overuse injuries thoroughly, it is necessary to understand how hands and wrists function specifically during flute playing, and to know what muscles and tendons are involved in playing each particular note.

Since both hands have different positions and functions in flute playing, the following section will explain the function of each hand and wrist separately.

Right Hand and Wrist

The right wrist and thumb should be placed comfortably in a neutral and stable position (see figure 3.3 and figure 3.4). However, keeping these muscles in one place for extended periods of time can sometimes lead to an overuse injury around the extensor carpi ulnaris tendon. The flute's weight relies heavily on the right thumb, and indirectly affects the brachioradialis tendon located between the end of the thumb and wrist.

Figure 3.3. Side view of right hand holding the flute

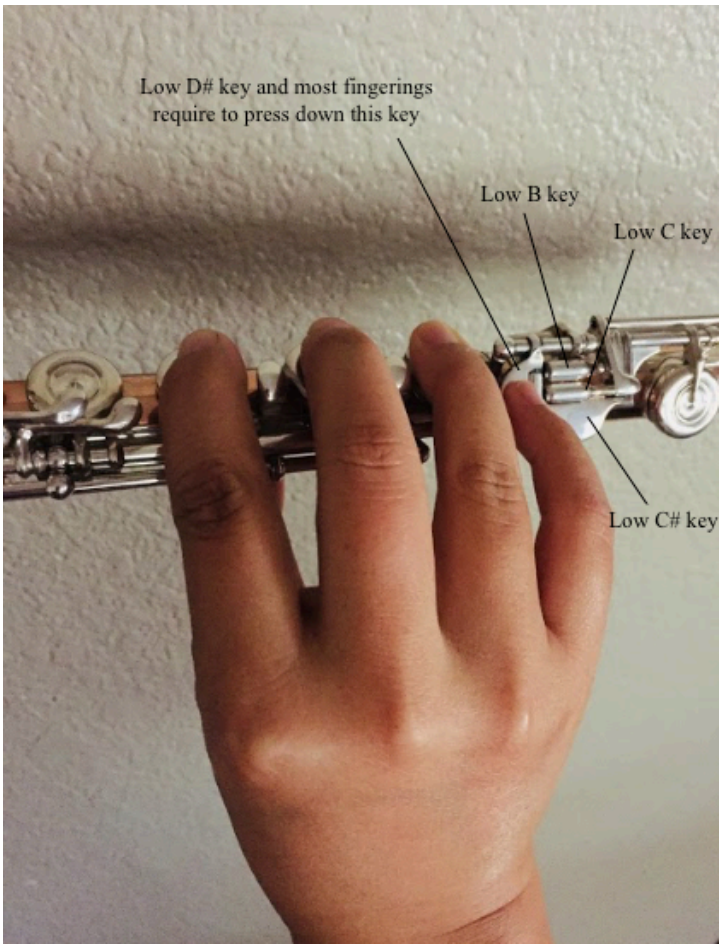

Figure 3.4. Bird's eye view of the right hand holding the flute

In current fingering charts, there are only a few notes (for example, D and high E) that do not require pressing down the right little finger. Thus, in addition to correct fingerings, the right little finger also plays a major role in keeping the instrument balanced. Gradual stiffness, pain, or injury can result if the right little finger sustains tension by squeezing the flute or stays in the same position for a long time. The common cause is the overuse of the abductor digiti minimi tendon, located on the right side of the hand.

Moreover, the right little finger is also the busiest finger of all, because it is in charge of four separated keys in order to play low B, low C, low C#, and low D# (see

figure 3.4). However, the little finger is naturally the weakest finger on the hand with the least flexibility and dexterity of all fingers when finishing a task independently. Actions like practicing in the low register on an E major scale requires the right little finger to move both horizontally and vertically in order to press down and lift up. Over practicing these low notes can also cause overuse of the abductor digiti minimi tendon.

The index finger, the middle finger, and the ring finger are normally curved slightly and naturally to gently press down the keys. In flute playing, most notes are realized by cooperating movements by these three fingers on both hands. The most commonly used extensor digiti minimi tendons are located at the back of both hands. Since pressing down the keys requires extension of these extensor tendons, the longer and more intense work these tendons perform, the higher the risk of incurring an overuse injury in this area.

Left Hand and Wrist

Like the right wrist, the left wrist should be comfortably placed in a stable and in neutral position (see Figure 3.5).

Figure 3.5. Side view of left hand holding the flute

Figure 3.6. Bottom view of the left hand holding the flute

The left thumb is in charge of two keys, yet it is not required to move frequently. Overuse injury around the extensor policis brevis and the brachioradialis tendon can most likely be caused by playing a B-C trill or switching between B and Bb (see figure 3.6).

The left index finger, the middle finger, and ring finger's functions on the left hand are similar to their counterparts on the right hand. They should be curved naturally, resting gently on the keys when not actively playing (see figure 3.7).

The little finger on the left hand is not used as often as the little finger on the right. There are only two common notes (Ab and Eb) that require pressing down this finger. Due to its weakness, this finger still has the possibility of suffering overuse injury. Practicing trills between G and Ab, which requires the little finger to move in an up-and-

down motion independently and repeatedly, is a possible cause of an overuse injury (See figure 3.7).

Figure 3.7. Bird's eye view of the left hand holding the flute

From feeling discomfort to losing the ability to perform adeptly, there are different stages of overuse injuries based on the severity of overuse. "Signs of overuse or inflammation include swelling, warmth, redness, or impaired function of the body part."[40] It is strongly recommended that flutists consult with a medical professional if these symptoms show.

In order to help flutists build healthy practice habits and avoid overuse injuries, the causes of these types of injuries should be identified, analyzed, and understood. In general, there are two main causes of overuse injuries: overuse/ training errors and physical inefficiency.

[40] Mayr and Zaffagnini, *Prevention of Injuries and Overuse in Sports: Directory for Physicians, Physiotherapists, Sport Scientists and Coaches*, 29.

Possible Practice Habits and/or Tendencies that Contribute to Overuse Injuries

Overuse/Training Errors

Overuse injury caused by overuse and training errors "tend to involve a rapid acceleration of the intensity, duration, or frequency of an activity. They are especially associated with specialization."[41] Therefore, the hands and wrists of flutists are at high risk of sustaining overuse injuries due to the nature of holding the instrument and repeating finger movements during consistent practice. The following factors can contribute to overuse injuries:

Intensity

The sudden increase of fingering movements in each practice session. For flutists particularly, this may mean the practicing of fast passages or the same scale patterns for long periods of time without proper hand warm-up. For example, a flutist's right little finger requires a lot of movement when playing an E major scale, especially during the following three notes: low B, low C#, and low D# (see figure 3-4). These intense and repetitive uses of the right little finger could cause an overuse injury around the abductor digiti minimi tendon.

Duration

The sudden increase of the length of each practice session. An example of an overuse injury related to this factor would be the return to consistently practicing for four hours a day after taking two weeks off from practicing. The sudden increase of workload from zero to four hours a day could shock the related muscles and tendons and cause overuse injuries.

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[41] Andrews and Yaeger, *Any Given Monday: Sports Injuries and How to Prevent Them for Athletes, Parents, and Coaches: Based on My Life in Sports Medicine*, 11.

Frequency

An increasing the number of practicing sessions without enough break or rest between each session. For instance, consider a flutist who is used to having two one-hour practice session everyday, one in the morning and one in the afternoon. If he decides to add two hours of practice between each session with little or no break after each hour, this decision might put him at risk of an overuse injury.

Physical Inefficiency

Physical inefficiency mainly involves poor posture during flute playing. (The reasons for poor posture can be traced down to positional and structural faults. However, this paper will only study the positional faults caused by overuse.)

Utilizing the body inappropriately by using poor posture causes an imbalance in the way that muscles are built and leads to uneven amounts of pressure being placed on tendons and ligaments. This instability causes a reduced efficiency in participating muscles during flute practicing.[42] Worst of all, "when an imbalance between strength and flexibility occurs, the injury patterns for overuse injuries increases rapidly."[43] In this case, even if a flutist is not practicing with long duration or intensity, the risk of suffering from overuse injuries increases.

The following figures compare and evaluate the ideal flute-playing posture with a few common poor postures during flute playing (see figure 3.8 and figure 3.9).

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[42] Pete Magill, Thomas Schwartz, Melissa Brever, and Diana Hernandez, *Build Your Running Body: A Total-Body Fitness Plan for All Distance Runners, from Milers to Ultramarathoners Run Farther, Faster, and Injury-Free* (London: Souvenir Press Ltd, 2015), 290.

[43] Andrews and Yaeger, *Any Given Monday: Sports Injuries and How to Prevent Them for Athletes, Parents, and Coaches: Based on My Life in Sports Medicine*, 11.

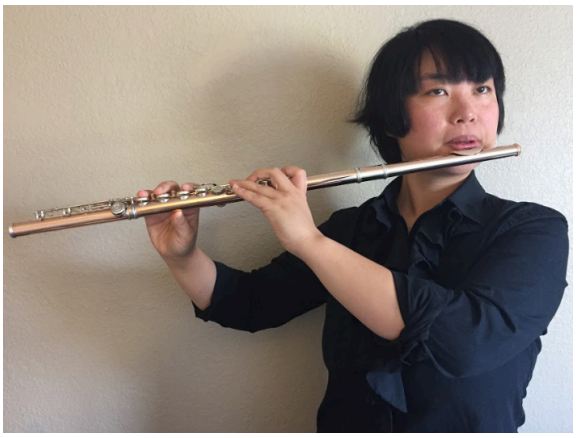

Figure 3.8. Ideal posture

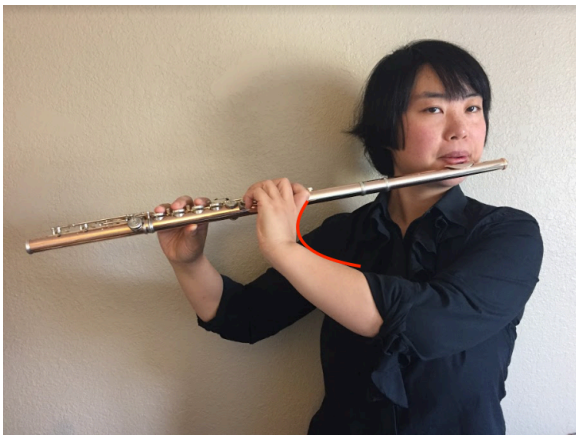

Figure 3.9. Poor posture for left wrist

In an efficient flute-holding position (see figure 3.8), the left arm generates most of the power. When the wrist is placed in a neutral position, it helps to transfer the strength from stronger and bigger arm muscles to the relatively weaker and smaller muscles around the wrist. This way, the flute can also be better balanced and remain stabilized.

However, if the left arm is weak, in other words, when one link in the kinetic chain is weak, the left wrist will have to contribute the strength to hold the flute. Not only could this result in excessive pressure around the wrists, but it could also cause poor playing position, leading to misuse and overuse of the wrists over time. To be more

specific, the left wrist is hyper-extended (see the angle marking in figure 3.9) which is causing strain that can lead to an overuse injury on the extensor carpi ulnaris tendon in the left wrist area.

Figure 3.10. Poor posture for right thumb

When the right hand is placed like it is in figure 3.10, the right thumb stretches out to support the instrument. This thumb hyperextension can cause tension in the left side of the right thumb and especially on the right wrist, potentially leading to injuries to the extensor pollicis brevis tendon and brachioradialis tendon.

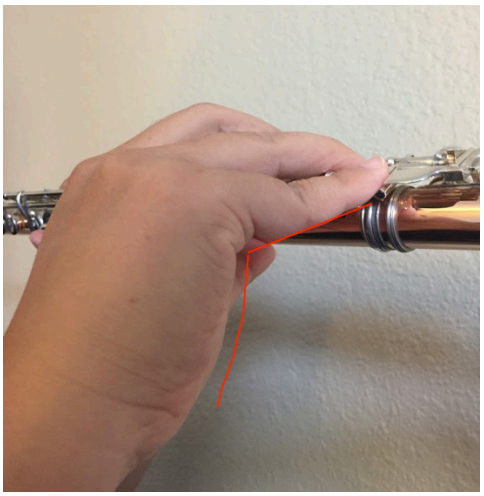

Figure 3.11. Poor position for right little finger

In figure 3.11, the right little finger is straightened out to press down the key, resulting in the little finger and palm creating nearly a ninety-degree angle. In this case, tension is created on the right side of the palm and outside of the right wrist. Since all the fingers work best when they are relaxed and moving as a whole system, this strained position of the right little finger could negatively affect the movement of the index finger, middle finger, and ring finger. When holding the flute for a long time in this position, the risk of overuse injuries for the abductor digiti minimi tendon and wrist is increased.

When one part of the body is weak, the other, stronger body parts naturally compensate to help finish a physical task. In flute playing, this situation often causes imbalanced posture. Studying Alexander Technique and Body Mapping helps one understand and visualize human balance physically and mentally; however, to improve poor posture caused by uneven strength and limited flexibility and to prevent overuse injuries, one should practice the exercises in the following chapter.

In conclusion, the examination and understanding of the wrist, hand, and each finger's anatomy and natural movement during flute playing will help the flutists to visualize the cause and process of overuse injuries. Overuse injuries are not solely caused by sudden increased intensity, duration, and frequency in practice, but can also be triggered by physical inefficiency, which is mainly related to poor posture.

CHAPTER IV

PREVENTION

The goal of modern sports medicine has shifted from treatment to prevention. This consists of injury prevention, developing stronger and healthier bodies, and developing more efficient techniques for practicing and competing.[44] As discussed in previous chapters, a flutist's use of his whole body, especially his fingers, hands, and wrists is similar to an athlete's use of his muscles both in frequency and duration. Both flutists and athletes are prone to overuse injuries if they do not take caution while practicing and training. However, there is good news. Based on research in sports medicine, "at least 60 percent of overuse injuries can be prevented simply by employing a little common sense – and even more by taking just a few safety precautions."[45] The prevention of overuse injuries in professional sports has developed into a comprehensive field, and flutists could benefit tremendously by learning more from athletes' injury prevention programs. For example, consider a professional athlete's warm-up and cool-down session. A flutist could mimic those athletes' injury prevention programs, tailoring the context to muscles used for flute playing. This chapter is designed with this principle in mind.

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[44] Bruce Graham, *Any Given Monday* (New York, NY: Dramatists Play Service, Inc., 2013), 17.
[45] Ibid., 3.

The human body has the ability to adapt to physical stress after continuously built-up exercise. The stronger and more flexible the upper limbs are, especially in the wrist area, the less likely a flutist is to suffer from an overuse injury. The key is to integrate strength and flexibility exercises into day-to-day practicing for injury prevention. The focus of this chapter will be to design injury prevention programs specific to flutists based on anatomy and physiology, analysis of physical causes in the previous chapter, and resources gathered from professional athletes' training programs.

"It is widely accepted that both warming up and cooling down are beneficial for athletes. Raising the body's core temperature, activating muscles, and getting the blood flowing are essential before any physical activity. Slowing down the heart rate, reducing the incidence of muscle soreness, and reducing the effects of lactic acid are all good reasons to cool down."[46] While a flutist's practice may not be as physically intense as a tennis player sprinting and hitting the ball, proper warm-up and cool-down sessions before and after flute practice could help a flutist prevent overuse injuries.

Warm-up sessions focus mainly on tendon, muscle and joint flexibility. "Flexible joints and muscles allow ideal joint alignment, making good technique easier to achieve and more efficient."[47] Studies have also found that warming up prior to physical activity significantly lowers the risk for traumatic and overuse injury.[48] When muscles and joints have established a healthy range of motion, not only is there reduced risk for injury, but accuracy and overall performance of the muscle is enhanced, which improves flute playing in the long term.

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[46] Bruce Graham, *Any Given Monday*, 205.

[47] Paul Mason, *Improving Flexibility*, 27.

[48] Mayr and Zaffagnini, *Prevention of Injuries and Overuse in Sports: Directory for Physicians, Physiotherapists, Sport Scientists and Coaches,* 41.

In order to effectively and healthily perform the following injury prevention program, individual fitness and flexibility levels must be taken into consideration. These programs are not meant to be competitive. Some people have a natural aptitude for flexibility, therefore it would be unhealthy to compare with one another. Doing so could result in strained muscles or tendons and would defeat the purpose of these prevention programs.

Based on a professional athlete's practicing model and the participating tendons studied in chapter 3, this chapter's prevention routine is designed for the efficient flutist.

Warm-Up

The goal of warm-up for flutists is to elevate body temperature and to improve the muscles' flexibility, especially to prepare the muscles and joints around the fingers, hands, and wrists for a practice session. This part includes two stages of exercises: light movements to raise the temperature of participating muscles and dynamic stretch.

Light-Movement Exercises

When muscles are not warmed up properly, they can lose flexibility, a factor that could contribute to overuse injury. The surrounding temperature also largely affects the muscle's flexibility. For example, in cold weather, a muscle's range of motion is smaller than it is in a warm environment.

It is suggested to "always warm-up first to get your blood circulating throughout your body and especially in the muscle groups. A warm-up should be slow and rhythmic, addressing the larger muscle groups first before moving onto the smaller muscles."[49] The nature of flute playing is dynamic; therefore, light dynamic warm ups are ideal for flutists

[49] Adam Weiss, *StretchSmart: Dynamic Stretching to Improve the Way You Feel and Move*. (n.p.: Adam Weiss, 2016), 15.

to warm up the whole body first. With limited time, flutists could focus on the upper limbs. Engaging these light movement exercises helps the following stretches to gain efficacy. This is because the blood is flowing to the muscles more quickly, and the synovial fluid inside the joint has become freer moving.[50]

In the order to work from larger muscles to small muscles, there are several mild activities flutists could do at the beginning of the warm-up session. When possible, these exercises done in the morning benefit the individual for the rest of the day.

1. Gently rotate the shoulders a few times.

Figure 4.1. Shoulder rotation

[50] Paul Mason, *Improving Flexibility*, 14.

2. Gently swing the arms a few times to loosen the muscles around the shoulders and arms.

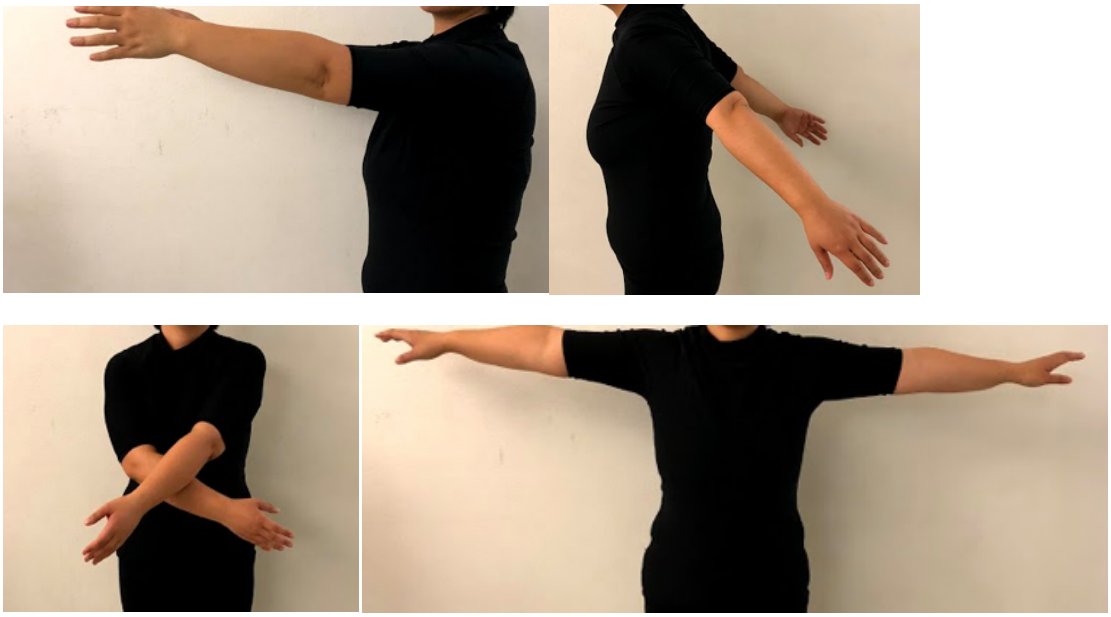

Figure 4.2. Arm swing

3. Slowly do a few wrist circles first clockwise, then counter clockwise. This movement warms up tendons around the wrist, such as the brachioradialis tendon and extensor carpi ulnaris tendon.

Figure 4.3. Wrist rotation (clockwise)

4. Gently massage one hand with the other from the palm to each fingertip. This helps the blood flow to both hands and warms up the hands and fingers.

Figure 4.4. Hand and finger massage

Please note, when the surrounding temperature is low, for an effective warm up, take extra time to do the above activities, especially for those muscles that are about to be stretched.

Playing the flute requires each finger to move individually at times. An exercise that addresses this is resting the wrist and hand on a flat surface in a neutral position, and slowly lifting each finger 10-20 times, or until the fingers are warmed-up, followed by dynamic stretches (see figure 4.5).

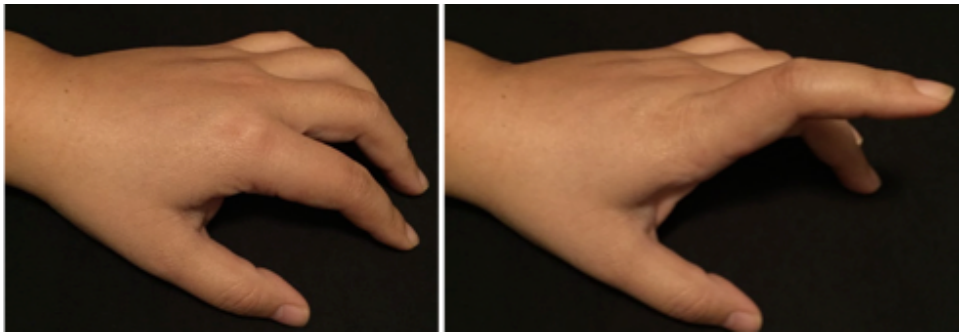

Figure 4.5. Finger lifting

Dynamic Stretches

There are two types of stretches: dynamic stretches and static stretches. They use different stretching techniques and serve different purposes. "Dynamic stretching consists of controlled movements to increase a particular body part's range of movement."[51] It is

[51] Craig Ramsay and Jerry Mitchell, *Anatomy of Stretching: A Guide to Increasing Your Flexibility* (San Diego, CA: Thunder Bay Press, 2012), 10.

"the best way to increase range of motion pre-workout."[52] Not only does this type of stretching prevent overuse injuries, it also enhances performance.

On the other hand, static stretching is what most people practice and are familiar with. This "consists of stretching a muscle to its farthest point and then holding that position."[53] In the book *Strength Training*, the author Lee Brown suggests performing static stretches during the cool-down period.[54] While the muscles are still warm from the workout, static stretches help the muscles to recover, reduce the soreness, and gain flexibility. This type of stretch will be discussed later as a part of cooling down in this chapter.

The following dynamic stretches are good warm-up exercises that every flutist could easily do before practice. Please note that a critical point for any stretch is adequate breathing. Some people focus so much on the stretching part and forget about breathing naturally and relaxing the whole body. Dr. Winges suggests starting these movements with less extension and gradually increase the extension as you repeat the motion, making sure that the hands are warm. Start with full hand movement, be sure to take ten to fifteen seconds on thumb extension, and shake the hands off and relax.[55]

First, make a fist, then spread the fingers as wide as possible and then bring them together to make a fist. This movement helps to warm up all the tendons that participate in flute playing (see figure 3.1 and figure 3.2). Repeat this movement 10-20 times or until the muscles around the fingers are warm.

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[52] Pete Magill, *The Born Again Runner: A Guide to Overcoming Excuses, Injuries, and Other Obstacles for New and Returning Runners* (New York: The Experiment, 2016), 75.

[53] Ramsay and Mitchell, *Anatomy of Stretching: A Guide to Increasing Your Flexibility*, 10.

[54] Lee E. Brown, *Strength Training*, 2nd ed. (Champaign, IL: Human Kinetics, 2017), 149.

[55] Sara A. Winges, interview by author, Greeley, CO, November 30, 2017.

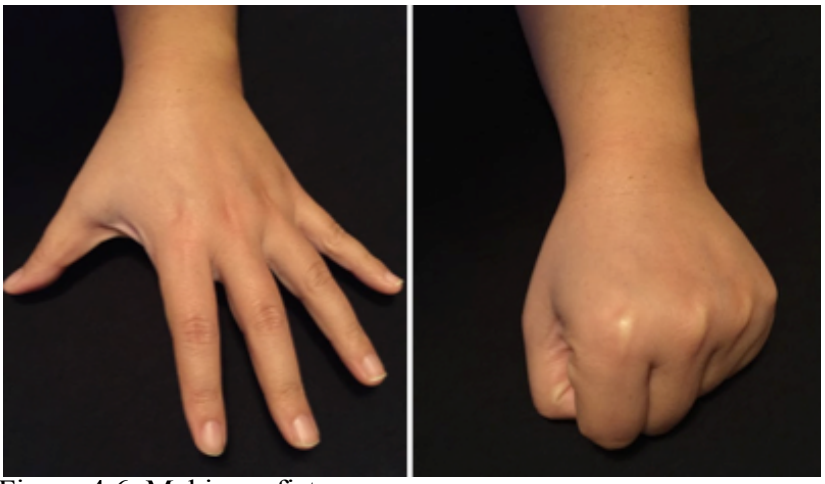

Figure 4.6. Making a fist

The second exercise is to make a fist first, then rotate the wrist both clockwise and counterclockwise slowly a few times. This rotation will also cover the light dynamic stretch in the thumb extension (see figure 4.3).

Rest During Practice Session

Losing practice time causes anxiety and stress for musicians, especially when important performances are approaching. Although every minute of practice is valuable, rest is also irreplaceable. Based on previous studies, a lack of rest during practicing is one of the major causes of overuse injuries.

In the sports world, "exercise and rest need to be considered as a unit when designing a training program."[56] Set a timer as a reminder to take breaks during practice. Muscles need time to recover from any workout. Setting a timer to rest after practice protects those muscles in prolonged contractions from holding the instrument in a posture with little variance or specific finger work for too long. Those who are unaware of time

[56] Mayr and Zaffagnini, *Prevention of Injuries and Overuse in Sports: Directory for Physicians, Physiotherapists, Sport Scientists and Coaches*, 88.

passing during practice can set a timer to take a five-minute break for every twenty minutes of practice. There are a few things flutists could do during rests.

Hydration

During training, athletes drink water frequently to replace the water lost through sweat. Flutists should be aware of hydration, especially when practicing in hot or dry weather. Hydration keeps the brain and muscles functioning properly: "once 2 percent of an athlete's body weight has been lost through dehydration, their performance starts to decline. At 4 percent, the ability of the muscles to work decreases."[57] Although flute practice is not as intense as many types of athletic training, hydrating during breaks enables flutists to let their muscles recover, and furthermore enables their bodies to function properly and stay healthy.

Light Massage

Apply light massage around fingers, hands, arms, and shoulders. For example, after twenty minutes of practice, the muscles around the hands, arms and shoulders might be slightly stiff and sore. A self-massage around these working areas would help the tendons relax and perform better upon resuming practice.

Cool Down

The purpose of cooling down is to remove lactic acid built up during practice and reduce subsequent muscle soreness. On the days that flutists practice, this post-practice static stretch is the final step for overuse injury prevention. At this stage, "everything is warmed up. It is a good idea to do the same movements you do in the warm-up. You could also include some static stretches as well, to capitalize the warmness of the

[57] Paul Mason, *Improving Flexibility*, 24.

muscles."[58] This must be done while the muscles are still warm; otherwise, stretching may increase the risk of tears, strains, and pulls.[59] However, Dr. Winges suggests not performing any stretches if one is fatigued from practice or if a body part is already irritated because stretching on exhausted muscles may cause tendon pain and injury.[60]

It is recommended to "hold each stretch for 30 seconds, with a total of two sets per stretch, and a 10-second break between sets."[61] Ideally, ten to fifteen minutes on post-practice stretching and exercises can lower the odds of suffering injuries.[62]

Since musicians often have back-to-back rehearsals or one obligation after another, time is a major factor. This is why utilizing short but effective stretches becomes important for time management. The following stretches are tailored to flutists in particular, covering all the participating hand and wrist tendons discussed in the previous chapter. Each person is different in flexibility and fitness levels, so most of the stretches provided below have three difficulty levels for different individuals.

This section includes two parts: static stretches of the wrist and static stretches of fingers.

Wrist Static Stretches

The wrist is capable of six basic motions (three sets) based on its natural movements. The following preventive stretches are designed for all these motions. Each pair of motions works on contrasting muscles, and it is recommended to practice these stretch pairs to achieve the best results.

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[58] Sara A. Winges, Interview by author, Greeley, CO, November 30, 2017.

[59] Karina Inkster, *Foam Rolling: 50 Exercises for Massage, Injury Prevention, and Core Strength* (New York: Skyhorse Publishing, 2015), 47.

[60] Sara A. Winges, Interview by author, Greeley, CO, November 30, 2017.

[61] Ramsay and Mitchell, *Anatomy of Stretching: A Guide to Increasing Your Flexibility*, 21.

[62] Pete Magill et al., *Build Your Running Body: A Total-Body Fitness Plan For All Distance Runners, From Milers To Ultramarathoners Run Farther, Faster, and Injury-Free*, 287.

Wrist Extension vs. Wrist Flexion

Wrist extension is a movement in which the palm is bent down towards the body. Conversely, a wrist flexion requires raising the palm up and pointing away from the body (see figure 4.7).

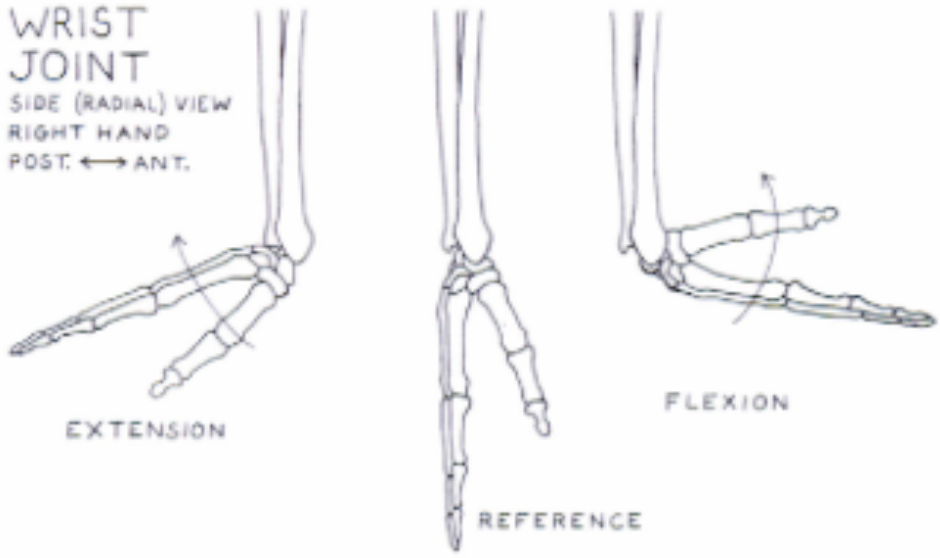

Figure 4.7. Wrist extension and flexion[63]

Wrist Extensor Stretch

Target tendons: Extensor pollicis longus, extensor digitorum profundus, and extensor carpi radialis, brachialis, extensor carpi ulnarism, and palmaris longus.

Beginner wrist extensor stretch (see figure 4.8 and figure 4.9).

Technique: Extend both arms forward in front of your waist at a forty-five degree angle. Interlock the fingers and push your palms out and away from your body until you feel a gentle stretch in your forearms.

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[63] Eliot Goldfinger, *Human Anatomy for Artists. The Elements of Form*. New York, NY: Oxford University Press, 1991, 49.

Figure 4.8. Beginner wrist flexor stretch 1

The following stretch (figure 4.9) is another wrist extensor stretch for beginners.

Technique: Extend one arm with the palm facing up. Gently stretch the tendon by placing the opposite hand in a pulling motion at the base of the fingers until your hand is parallel to your body. This stretch will be felt in the wrist and forearm area.

Figure 4.9. Beginner wrist extensor stretch 2

Intermediate wrist extensor stretch (see figure 4.10).

For the next level of wrist extensor stretch, rely on the floor to increase the extension felt in the wrist extensor during the stretch. To achieve the best result, carefully and gently put some of body weight on both hands.

Technique: Kneel on the floor and keep hands shoulder-width apart. Create a 90-degree angle with the palms and arms by laying both palms flat on the floor, fingers pointing towards the body. The arms should be fully extended (completely straight), with elbows facing the body.

Figure 4.10. Intermediate wrist extensor stretch

Advanced wrist extensor stretch (see figure 4.11).

Once a level of comfort is reached with the previous two stretches, it may be appropriate to move to the next step. Take the position of the intermediate wrist extensor stretch and proceed by slightly leaning back to the heels so that your hand and arms form an angle. This will create a longer wrist extension as shown below in Figure 4.11.

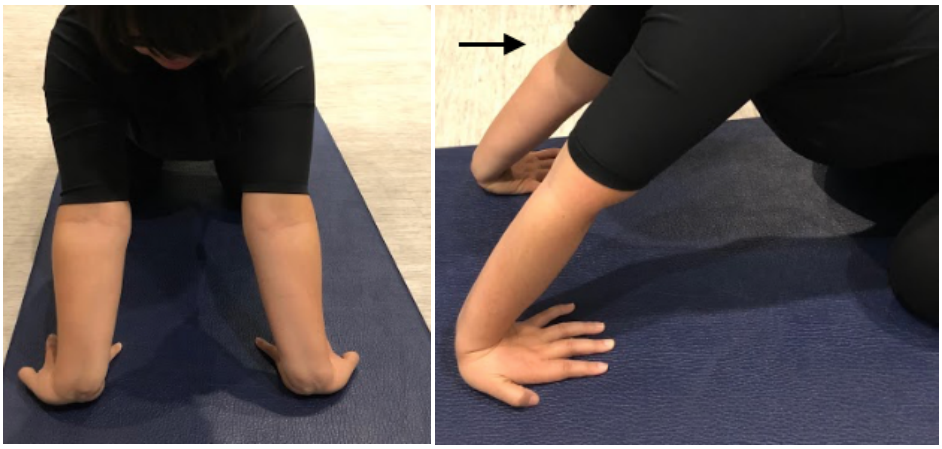

Figure 4.11. Advanced wrist flexor stretch

Wrist Flexion Stretch

Target tendons: Flexor digiti minimi, flexor digitorum communis, flexor carpi radialis longus, and flexor carpi ulnaris

Beginner wrist flexor stretch (see figure 4.12).

Technique: Straighten one arm with the palm facing down and inward. Place the opposite hand at the base of the knuckles and gently pull the fingers towards the body. As you pull you should feel a stretch on top of the wrist extending down your forearm.

Figure 4.12. Beginner wrist flexor stretch

Intermediate wrist flexor stretch (see figure 4.13).

Technique: Kneel on the floor and keep hands shoulder width apart extending the arms downward. Slowly place the back of the hand on the floor with fingers pointing toward the body. Be careful not to place too much body weight into the stretch at first, as it can result in injury. This stretch will also be felt on top on the wrist and extend further up the forearm.

Figure 4.13. Intermediate wrist flexor stretch

Advanced wrist flexor stretch (see figure 4.14 and figure 4.15).

Technique: Begin with the formation in the intermediate wrist flexor stretch, then slightly lean back to heels and keep the back of hands on the floor until a stretch is felt.

Figure 4.14. Advanced wrist flexor stretch 1

One can also perform another form of advanced wrist flexor stretch as figure 4.15 shown below.

Technique: Kneel on the floor, and bridge your body forward by placing your hands down in front of you shoulder-width apart. Lay the back of your hands on the floor, fingers pointing towards each other. Keep the arms straight and elbows facing away from the body. Gently shift your body weight on the hands and wrist to the right, ensuring that the back of the hand stays flat on the floor. Return to the middle, and then complete the stretch on the left. Always return to the middle prior to completing this stretch to avoid injury.

Figure 4.15. Advanced wrist flexor stretch 2

Radial Deviation vs. Ulnar Deviation

Radial deviation describes the movement of bending the wrist sideways in the direction of the thumb. Ulnar deviation is bending the wrist sideways in the direction of the little finger (see figure 4.16).

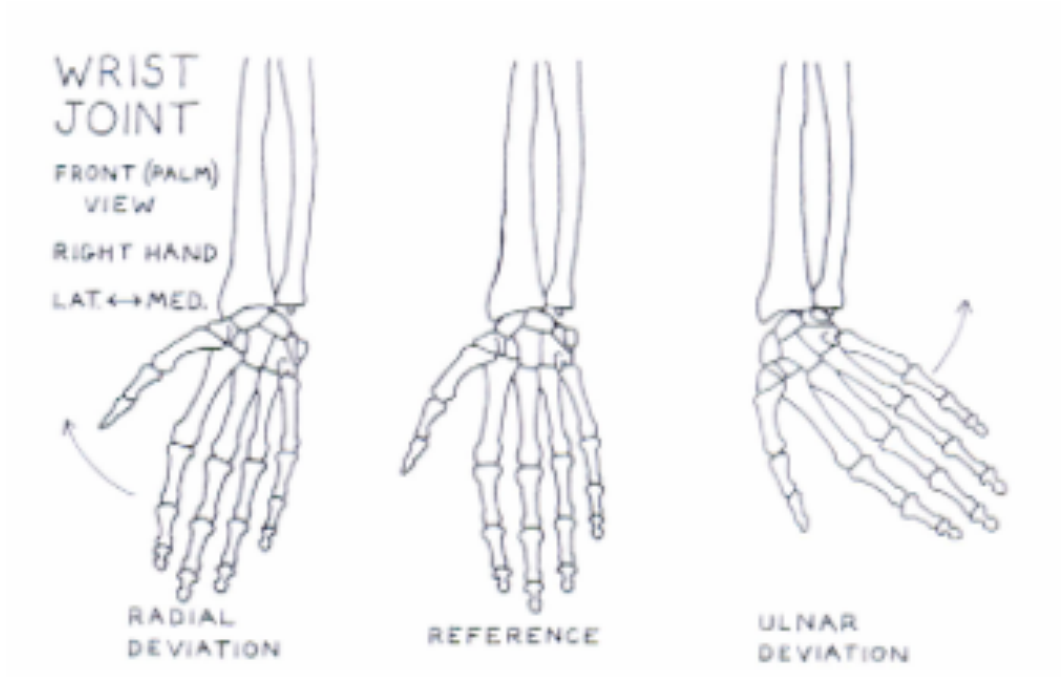

Figure 4.16. Wrist radial deviation and ulnar deviation[64]

Compared to the variety of wrist extensor and flexor stretches, there are fewer radial deviation and ulnar deviation stretches due to the wrist's ranges of motion when moving side to side. Therefore, this section will start introducing one basic stretch for radial deviation and ulnar deviation each, then provide a few more exercises combining radial deviation and ulnar deviation with wrist extensor stretches and flexor stretches for better efficiency.

[64] Eliot Goldfinger, *Human Anatomy for Artists* (New York, NY: Oxford University Press, 1991), 49.

Radial Deviation

Target tendon: Flexor carpi radialis, extensor carpi radialis longus, flexor digiti minimi brevis, and abductor digiti minimi

The following stretch is commonly used for improving the flexibility of radial deviation.

Beginner wrist radial deviation stretch (see figure 4.17).

Technique: Extend out one arm in from of the body palm down. Keeping this hand level, wrap the opposite hand's fingers over the top of the stretching hand, and pull inwards towards the body. This stretch will be felt on the side of the hand running down from the little finger finger.

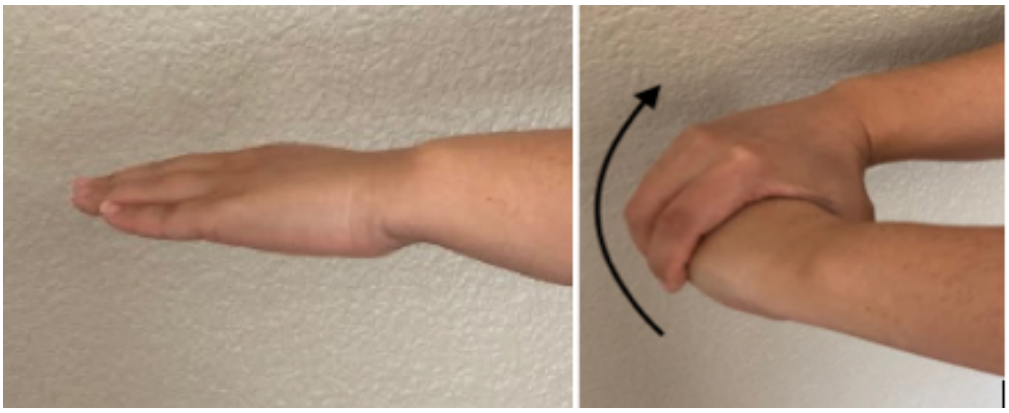

Figure 4.17. Beginner wrist radial deviation stretch

Advanced wrist radial deviation stretch (see figure 4.18).

This stretch combines radial deviation and an extensor stretch. This stretch targets the tendons used for both radial deviation and extensor stretch. It works well when one has a good flexibility and limited time to stretch.

Technique: From the kneeling position extend into a bridge by placing your hands palm down on the floor. Turn your arms inward fully extended and spread your fingers,

spacing as much as possible between each finger. You should feel this stretch in your fingers, hands, and slightly in your forearm.

Figure 4.18. Advanced wrist radial deviation stretch

Ulnar Deviation Stretch (see figure 4.19)

Target tendons: Flexor carpi ulnaris and extensor carpi ulnaris

Beginner wrist ulnar deviation stretch (see figure 4.19).

Techniques: Extend the hand you intend to stretch out as if you are about to shake hands with someone. With the opposite hand place your four digital fingers against the stretching hand's index finger; the thumb of the opposite hand should be rested as the bottom of the stretching hand's palm. With the opposite hand, gently pull towards the body. You will feel this stretch from the outside of the thumb down the forearm.

Figure 4.19. Beginner wrist ulnar deviation stretch

Intermediate wrist ulnar deviation and flexor stretch (see figure 4.20).

The next stretch works the best when it is alternated with wrist extensor stretches. One can feel both stretches pulling on the contracting muscles and tendons. This stretch particularly helps to relax the lower arm, wrist, and tendons connected by the little finger.

Technique: Stand or sit up straight. Lift both arms to shoulder height with palm facing the floor. Make a fist with four fingers wrapped around thumb for each hand, then bend wrists downward until a stretch is felt. This stretch helps to relax the tendons in between the little finger and the elbow.

Figure 4.20. Intermediate wrist stretch radial deviation and flexor stretch

Advanced wrist ulnar deviation stretch 1 (see figure 4.21).

Technique: From the bridge position straighten your arms, palms down and fingers pointing away from your body. Expand the space between your fingers as much as possible to feel a stretch in the forearms, hands, and fingers.

Figure 4.21. Wrist ulnar deviation and extensor stretch

Advanced wrist ulnar deviation stretch 2 (see figure 4.22).

Technique: While on your knees, place your hands down in front of you in a bridging position. Place the back of your hand flat to the floor, elbows facing away from your body. Close the distance between the bases of the wrists on both hands so they touch. Open the fingers outward while on the floor to intensify the stretch.

Figure 4.22. Advanced wrist ulnar deviation and flexor stretch

Wrist Supination vs. Wrist Pronation

Wrist supination describes the motion when the forearm rotates into a palm up position. In contrast, wrist pronation is when the forearm rotates into a palm down position (see figure 4.20).

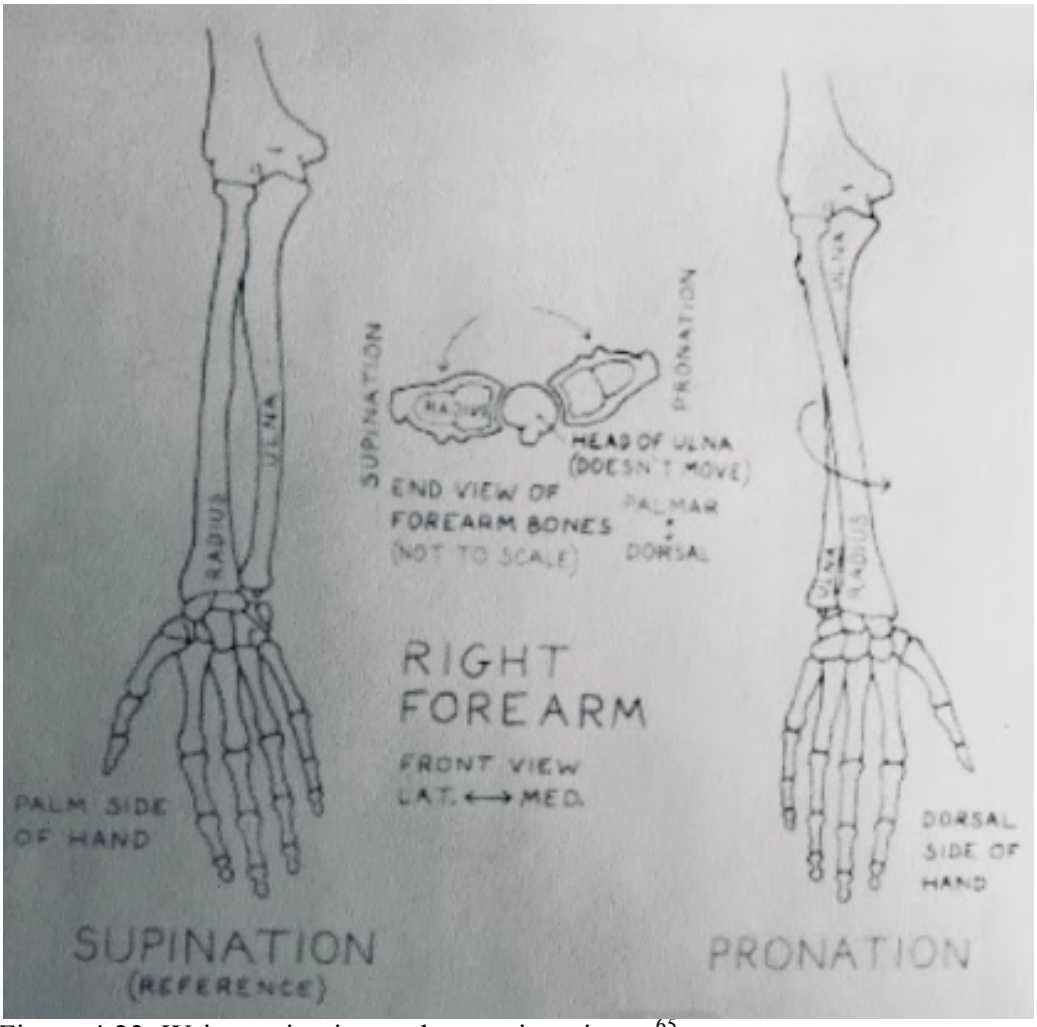

Figure 4.23. Wrist supination and pronation picture[65]

Wrist Pronation Stretch

Target tendons: Extensor carpi ulnaris, flexor digitorum superficialis, extensor pollicis, and extensor pollicis brevis

[65] Goldfinger, *Human Anatomy for Artists*, 51.

Beginner pronation stretch (see figure 4.24).

Technique: Extend the arm parallel to the ground, palm facing up, with the thumb away from your body. Support the other hand with both palms facing up by grabbing your palm between the thumb and index finger, and stretch pulling your thumb down toward the floor.

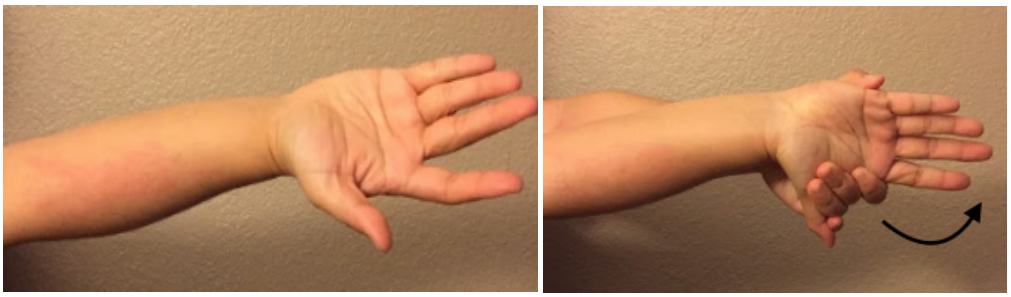

Figure 4.24. Wrist pronation

Advanced pronation stretch (see figure 4.25).

Technique: While kneeling, place one hand on your knee and extend the other down to the floor in a slight lean. The hand should be placed with the palm facing the floor, fingers and elbows directed toward the middle of the floor. Straighten the arm slightly to feel the stretch in the wrist. This stretch will place a lot of pressure on the tendons running up the wrist. Be sure to ease into this stretch.

Figure 4.25. Wrist pronation and extension stretch

Wrist Supination

Wrist supination is in a slightly awkward position compared to some of the other stretches above. This is due to the movement needed to pull the thumb (see figure 4.26). It is a great stretch for improving the thumb's flexibility.

Target tendon: Flexor digitorum superficialis, pronator quadratus, and flexor pollicis longus.

Technique: Extend your hand with the palm facing outward and thumb towards the floor. With the opposite hand reach over and grab the thumb. Making sure that the stretching arm remains extended, pull the thumb up towards the ceiling rotating the hand.

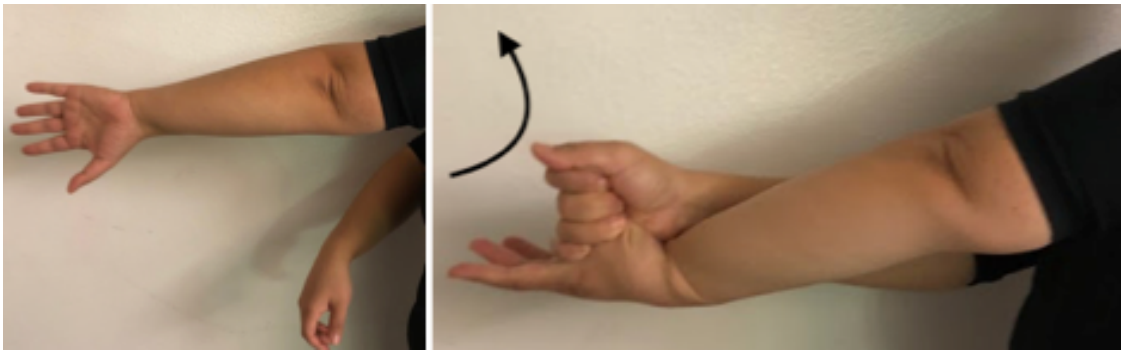

Figure 4.26. Wrist supination stretch

Finger Static Stretches

Due to structural and motional differences between the thumb and other four fingers, the next part will discuss their stretches separately (see figure 4.27).

Thumb Static Stretches

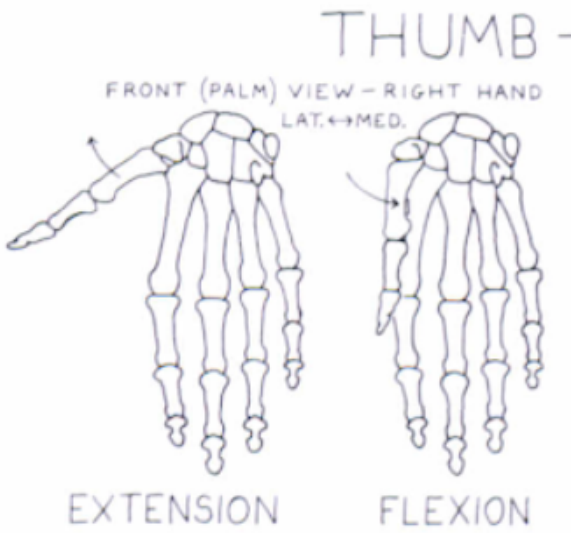

Figure 4.27. Thumb extension and flexion[66]

Thumb Extension

Target tendons: Extensor pollicis brevis, brachioradialis, and extensor pollicis longus

Beginner thumb extension (see figure 4.28)

Technique: Make a fist while tucking the thumb into the four clasped digital fingers. Stretch by moving the knuckles of the fist toward the ground.

Figure 4.28. Beginner thumb extension

[66] Goldfinger, *Human Anatomy for Artists,* 51.

Advanced thumb extension (see figure 4.29).

Technique: Make a fist while tucking the thumb into the four digital fingers. Stretch by moving the fist toward the ground; in other words, the knuckles face the ground. Extend this stretch by supporting with the opposite hand, clasping the fingers over the fist and pulling downward to the ground.

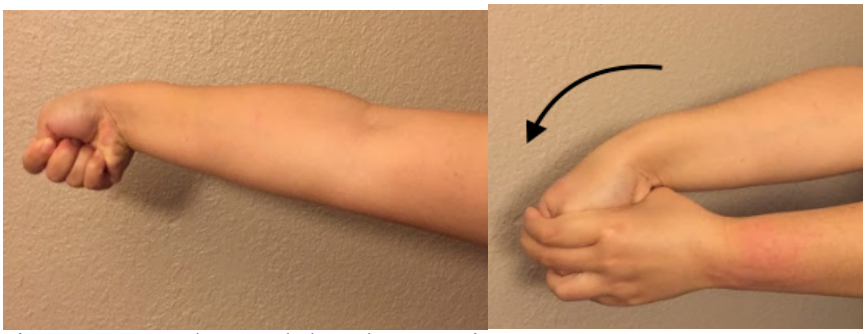

Figure 4.29. Advanced thumb extension

Thumb Flexion (see Figure 4.30)

Technique: Extend the thumb towards the little finger finger, running it across the palm as far as possible without straining to gently stretch the tendon.

Target tendon: flexor pollicis longus and brachioradialis

Figure 4.30. Thumb flexion

Other Four Fingers Static Stretch

Finger Extensor

Target tendon: Extensor pollicis longus, extensor digitorum brevis, extensor carpi ulnaris, extensor carpi ulnaris, extensor digiti minimi brevis, and palmaris longus

Beginner finger extension (see figure 4.31).

Technique: With your palm facing down towards the floor take each finger and pull it up and back toward the body with the opposite hand. Repeat on each finger.

Figure 4.31. Beginner finger extension

Intermediate finger extensor stretch (see figure 4.32).

Technique: Sit or stand up straight. Extend the forearm in front with elbow at a 90-degree angle. Place the palm facing outward and fingers up. With the opposite hand, pull back all fingers except the thumb toward the body. You will feel this stretch at the bottom of your wrist and forearm.

Figure 4.32. Intermediate finger extensor stretch

Finger Flexor Stretch (see figure 4.33 and figure 4.34)

Target tendon areas: flexor carpi ulnaris, flexor carpi radialis longus, flexor pollicis longus, flexor digitorum communis, and flexor pollicis brevis.

Technique: Sit or stand up straight. Extend the forearm in front with elbow at a 90-degree angle. Place the palm facing up and bend the fingers toward the body. Put the other hand on the back of the fingers and slightly pull in towards the forearm.

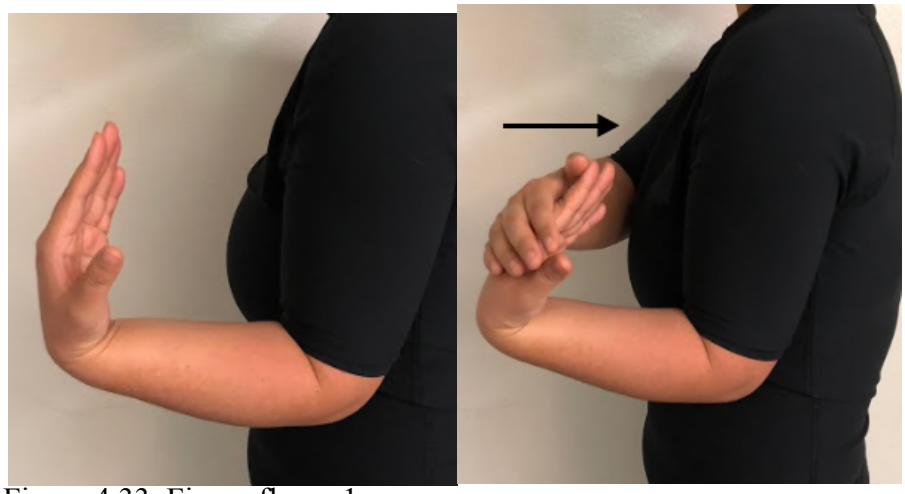

Figure 4.33. Finger flexor 1

One can also stretch each finger separately as figure 4.34 shows below.

Technique: Extend out your hand with your palm facing the floor. With the opposite hand, grasp each finger (except the thumb) and pull the finger back towards the body.

Figure 4.34. Finger flexor 2

Finger Stretches Work the Muscles on the Side of Fingers (see figure 4.35)

Technique: Face the palm away from the body, and using the thumb, index, and middle fingers of the opposite hand between each finger to stretch the muscles.

Target tendon areas: flexor digitorum superficialis, abductor digiti minimi, extensor digiti minimi, flexor pollicis longus, and flexor pollicis brevis.

Figure 4.35. Figure stretches work the muscles on the side of fingers

Flutists who are new to hand and wrist stretches should do them with caution, being sure to focus on using proper technique. Never force the stretch or make it painful. "The key rule for working on flexibility is that if any stretch becomes even slightly painful, you should stop immediately."[67] It is best to perform a pain-free range of slow motion movements in a controlled manner in order to promote healthy muscle development.

Although static stretches are beneficial for flutists, Dr. Winges particularly emphasizes not doing them during the actual practice session but rather during the cool-down session. Finding a separate time for these exercises is also recommended.[68]

Strength Exercises

More and more musicians go to the gym and lift weights regularly to stay fit and healthy. Being physically strong can also prevent overuse injuries. Having a strong upper body, arms, and wrists can benefit flute playing tremendously. The wrist is an essential link between the arm and hand. For the flutist, the wrist supports the majority of the flute's weight.

Based on the discussion in chapter 3, maintaining a correct posture requires the muscles to be strong and flexible. Therefore, flutists can avoid poor posture by strengthening the participating muscles. There are a few easy and lightweight training exercises for wrists and hands that could benefit flute playing.

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[67] Mason, *Improving Flexibility*, 14-22.
[68] Sara A. Winges, Interview by author, Greeley, CO, November 30, 2017.

Lower Arm and Wrist Strength Training

Free Weights Strength Training

While building strength around the wrist, extra caution is recommended as the wrist muscles are relatively short and weak compared to the muscles in the arms. Therefore, start the following strength exercises with low and/or comfortable weights, then gradually increase the weight as you build more muscles around the wrists.

Rest the arm on a bench or on your knee in a neutral position. Make sure to slowly reach full range of the wrist while doing the following wrist exercises. At the same time, relax the muscles around the wrists and keep the stretches as fluid as possible. Apply this common weight training routine: repeat each movement ten times, rest one minute between each set, and finish with three sets.

Wrist Extension (see figure 4.36)

Target tendons: abductor pollicis longus, flexor carpi radialis, extensor carpi radialis longus, and extensor carpi radialis brevis.

Technique: Using a light dumbbell weight while seated, hold the weight vertically. Slowly tilt the dumbbell towards the floor as far as possible, and then slowly bring the weight back up in a similar motion.

Figure 4.36. Wrist extension with dumbbell

Wrist Curl (see Figure 4.37)

Technique: In a seated position, support your arm on your knee from the elbow. Starting with the dumbbell horizontal and the wrist curled down, isolate the movement to the wrist and lift the dumbbell upward. Then slowly return the weight down to the starting position.

Figure 4.37. Wrist curl with dumbbell

Wrist Curl Reverse (see figure 4.38)

Technique: In a seated position with your arm supported by your knee, extend your arm outwards, holding a dumbbell palm down. You hand should start curled towards the floor. Isolate the movement to your wrist and lift the weight up, raising the top of your hand up until it is even with your forearm.

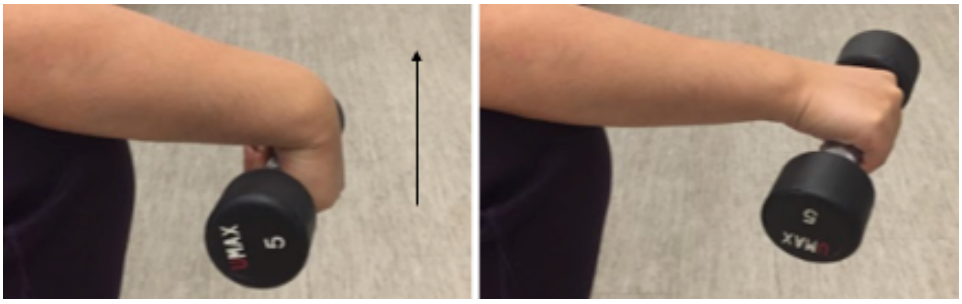

Figure 4.38. Wrist curl reverse with dumbbell

Rubber Band Wrist Strength Training

Compared to lifting free weights, stretching the wrists and hands using a band creates less strain on the muscles and joints because it offers a range of more flexible movements. When one stretches a rubber band, it creates a resistance. The resistance changes based on how much of the band is pulled. The longer it is stretched, the more force will be pulled on the hand and wrists. Normally, these bands have various colors representing different thickness of the bands that indicate different levels of resistance. It is best to start this training by choosing a band with comfortable level of resistance.

Before the following wrist exercises, make sure to secure the ends of the band under the foot matching the side of the wrist you are exercising. Stabilize your elbow on your thigh, move your wrist upward, and slowly return.

Wrist Extension with a Rubber Band (see figure 4.39)

Technique: From a seated position with the forearm supported by the knee place the exercise band under the foot on the side you intend to exercise. With a fist, grasp the exercise band, palm facing the floor horizontally. From the downward position pull the wrist up in an isolated movement until it is even with the forearm.

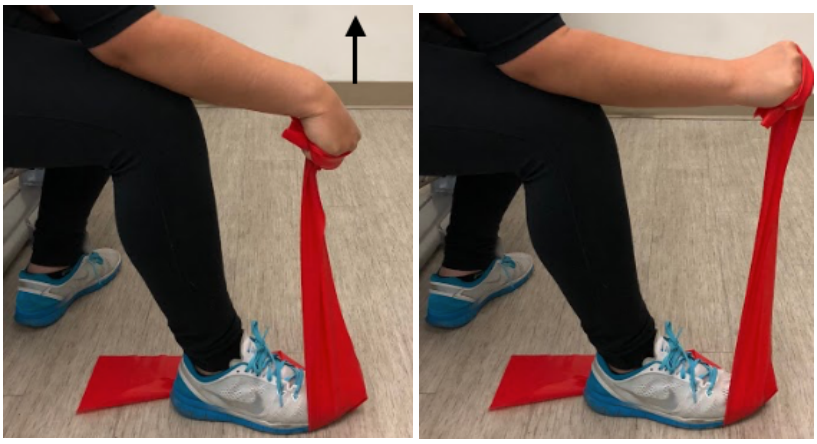

Figure 4.39. Wrist extension with a rubber band

Wrist Flexion with a Rubber Band (see figure 4.40)

Technique: From a seated position, support the forearm on your knee. Grab the band with your fingers clenched, making a fist horizontally. Extend from the hand downward. With the palm facing outward, pull upward in an isolated movement with the wrist. This will look similar to the "flexing position" people typical use to show their biceps, but isolated in the wrist.

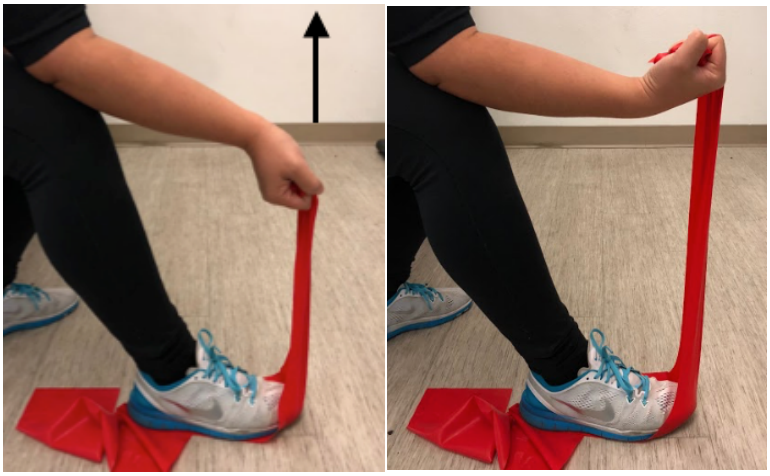

Figure 4.40. Wrist flexion with a rubber band

Radial Deviation with a Rubber Band (see figure 4.41)

Technique: Position your palm facing inward and your elbow by your side with your thumb pointing forward. Extend your hand downward and hold the exercise band at a 45-degree angle with a fist. Move your wrist backwards and slowly return. Double loop the exercise band to make more resistance if needed.

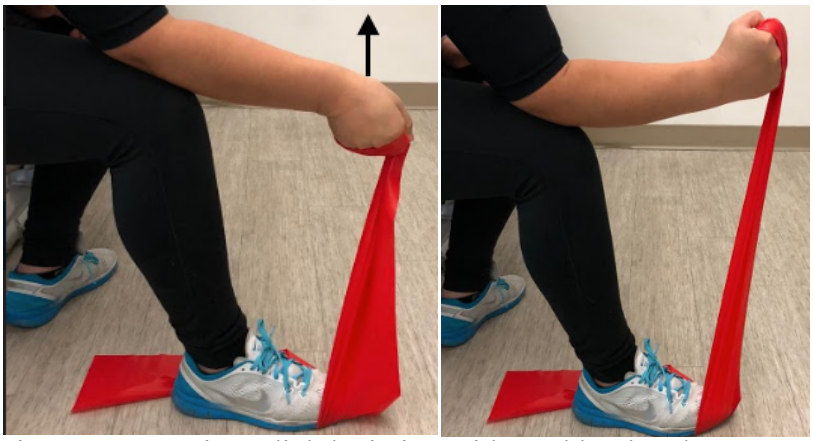

Figure 4.41. Wrist radial deviation with a rubber band

Ulnar Deviation with a Rubber Band (see figure 4.42)

Technique: Hold the exercise band in a fist with your palm facing your body and your wrist in a naturally relaxed position. Pull the band downward as far as possible.

Figure 4.42. Wrist ulnar deviation with a rubber band

Finger Strength Training

Flute playing does not require a lot of finger power while pressing the keys. In fact, pressing keys with too much strength could cause squeezing the instrument, which can lead to tension around the fingers, hands, and wrists. Due to the fact that the right thumb needs to support the weight of the instrument, strengthening the muscles around

the right thumb is also necessary. Moreover, strength training on every finger benefits flutist's overall balance around the hand and wrist.

Tennis Ball Squeeze (see figure 4.43)

Technique: Squeezing a tennis ball with a comfortable level of strength for five to ten seconds and then release, allowing the hand to relax. Repeat the above movement three times.

Figure 4.43. Tennis ball squeeze

Although squeezing a tennis ball is an effective and efficient exercise, Dr. Winges recommends the next two exercises for individual finger strength training since playing the flute requires fingers to move independently.[69]

Table Pressing for Fingers (see figure 4.44)

Technique: Place the tip of your thumb on the edge of a table. Gently push downward to feel the stretch. Practice this exercise on every finger.

[69] Sara A. Winges, Interview by author, Greeley, CO, November 30, 2017.

Figure 4.44. Table pressing for fingers

Finger Pull with a Rubber Band (see Figure 4.45)

Technique: Using an exercise band make a fist and extend out your index finger. Wrap the band around this finger and pull backwards with the opposite hand. Practice this exercise on every finger.

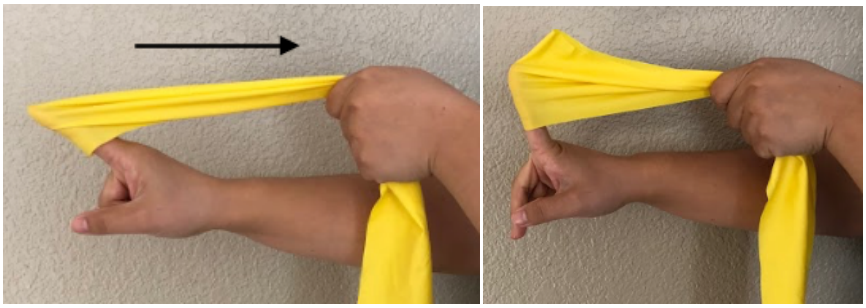

Figure 4.45. Finger pull with a rubber band

After accomplishing the previous three finger strength exercises, you may consider use a dumbbell to practice finger curls for higher intensity.

Finger Curl (see Figure 4.46)

Technique: From a seated position, support your arm on your knee. Place your arm tilted downward at a comfortable angle. Hold the dumbbell at the proximal interphalangeal joint (PIP joint, the middle knuckle of the finger). Isolate the movement to the fingers and lift the dumbbell upward executing the finger curl.

Figure 4.46. Finger curl

Preventive Training Recommendations Based on Causes of Overuse Injuries

Maintaining a consistent training schedule for the promotion of flexibility and strength benefits flutists and all musicians. However, every exercise discussed in this chapter needs to be performed with caution.

Rules for Designing a Training Plan

The following rules would help someone to design a training plan based on his or her own fitness level and amount of free time.

1. Start with easy stretches that are short in length, and then slowly add more time.

2. Start with low and /or comfortable weight, then slowly increase the weight to build up strength.

3. Do not practice stretches on the same areas of muscles every day. Consider stretching every other day or every third day to avoid overuse injuries from stretching too often.[70]

[70] Sara A. Winges, Interview by author, Greeley, CO, November 30, 2017.

4. Schedule stretches and strength training on different days. Make sure to do a few dynamic stretches of the target areas to warm up the muscles before beginning the official stretching and strength training session.

One may find certain exercises are easier or more effective than others. Keeping in mind the differences in each individual's fitness and flexibility levels, the stretching and strength exercises in this chapter can be performed in a myriad of different types of routines.

All the exercises mentioned in this chapter are for injury prevention purposes only. These programs are not designed for individuals who are currently experiencing pain or injuries. Please consult a physical therapist or other healthcare professional for treatment if you are injured.

Suggestions for Avoiding Mismanagement of Frequency, Duration, and Intensity

The causes of overuse injuries in Chapter 3 include the mismanagement of frequency, duration, and intensity during practice. In other words, "overuse injuries are due to doing too much, too often, too quickly, and with too little rest."[71] The following strategies are used to avoid these causes.

In general, have a long-term goal when it comes to weekly lesson, juries, competition, recitals, concerts, or other big performances. This way, one can avoid last-minute cramming practice, which often leads to overuse injuries.

First, avoid sudden increase of frequency. For example, if one must add an extra practice session, plan more rest time in between.

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[71] Bahr and Mæhlum, *Clinical Guide to Sports Injuries*, 5.

Second, avoid sudden increase of duration. There is a common rule in sports training: the increasing rate of time duration should not exceed ten percent from the previous week. For example, if a flutist practices one hundred minutes daily for week one and he wants to add more time in daily practice, his practice time in the following week should not exceed ten percent of the prior week. In this case, the new daily practice time would need to be no more than one hundred and ten minutes to be considered a safe increase.

Moreover, avoid sudden increase of intensity. Flutists could try to alternate between different musical passages when practicing. Different passages have different notes, tempi, and dynamic marks, requiring different fingering combinations, air control, and mental focus. By switching between practicing fast and slow passages, certain fingers in the fast section that require high intensity do not get overused as quickly.

Suggestions on Poor Posture Causing Overuse Injuries

Different flutists have different hand sizes and shapes as well as diverse body types and capabilities, but, unfortunately, flutes come in only one size. Thus, it is difficult to come up with a universal posture that works perfectly for everyone.

Based on the analysis in the previous chapter, there are two important tips that could be used as guidance for preventing hand and wrist overuse injuries. When seeking to prevent misuse caused by poor posture, the first step is to keep the wrists and hands in a neutral position: neither extended nor flexed. Avoid hyperextending the left wrist and the flexion of the right wrist. The second step is to keep in mind that the right thumb and fingers should curl slightly and avoid squeezing the keys.

Although this project does not focus on preventive solutions from the Alexander Technique and Body Mapping perspectives, these techniques could be useful for exploring and visualizing one's personalized body map. They could serve to improve one's posture by relying on natural and comfortable strength from the body, and eventually, through using these techniques, one could develop his own balanced posture to lower the risk of overuse injuries caused by unnatural positions.

Based on the analysis in this chapter, one can conclude that overuse injury prevention consists of a series of precautions. First of all, sport-inspired flute practice routine (warm-up, cool-down, and training) should be applied in general or daily practice for flutists. Secondly, hand and wrist strength training aids in developing more power and endurance while holding the instrument, which helps the flutists to balance the flute efficiently without having one particular muscle overcompensate. Last but not least is to prevent overuse itself by avoiding sudden increase of frequency, duration, and intensity in practice, and poor postures.

Finally, education through private instruction is another means through which overuse injuries can be prevented. Flute teachers usually work with students in weekly one-on-one lessons. Not only do these professionals teach their students how to improve their playing, but they also teach them healthy and effective practice habits. It would be very beneficial for the students if their teachers could help them come up with personalized practice routines.

Despite these preventive measures, there is no guarantee against overuse injuries since each individual has his own body type, capacity for stretching, and threshold for discomfort. Moreover, variables such as age and how long and/or often flutists practice

also affect the way the body reacts to overuse, injury caused by overuse, and measures of overuse injury prevention. Ultimately, however, the precautions discussed in this chapter will lower the risk of suffering from overuse injuries.

CHAPTER V

CONCLUSION

In this project, the first two chapters focus on how overuse injuries can negatively impact a flutist's health and career. The project then demonstrates the necessity of a study that targets the physical causes and prevention of hand and wrist injuries to flutists caused by overuse. This is necessary not only because the current documentation and research is lacking in this area of study, but also because hand and wrist overuse injuries are among the most frequent injuries for flutists.

The third chapter begins with locating and identifying specific tendons utilized in a flutist's hand and wrist during flute playing, then delves into an examination of the possible overuse injuries that may affect each flute-playing tendon. Since the training of an athlete and the practice of a flutist share the need for repetitive movements in muscles and tendons, the author designs a healthy practice model for flutists' hands and wrists influenced by the training routine of a professional athlete with the purpose of preventing overuse injury in chapter 4. This practice model includes warm-up, rest, and cool down during practice sessions, and strength training around hands, wrists, and lower arm as additional support for overuse injuries prevention.

Therefore, this dissertation fills the void of understanding surrounding overuse injuries in flutists' hands and wrists. However, this is not the end to overuse injury studies. With continued development in technology and medicine, there will undoubtedly be more resources available for the musicians to learn this specific matter in the future.

Based on the conclusions drawn in this dissertation, this remaining chapter will briefly discuss potential future studies focused on overuse injuries for flutists.

Studies on the body parts that participate in flute playing are possible topics. Physically, overuse injury is a series of complicated chain reactions. For example, if a flutist practices with his wrist hyperextended, which places his arm in an unnatural position, eventually his neck or upper back might feel stiff, sore, or in pain after an extensive practice session. Thus, continuous studies on overuse injuries in flutists' shoulders, necks, or other areas are possibilities for the future.

Overuse injury caused by other non-physical reasons could also be studied. For example, one could study the relationship between the psychological factors and overuse injuries, how different diet plans affect the results of flute practice, or how different sexes react to overuse injuries.

Based on the studies of overuse injuries in sports, "the psychological factors of self-blame and hyperactivity are considered to be risk factors for overuse injuries in athletes."[72] Normally, muscles get tense or stiff if one is under a lot of mental stress, and based on the research in chapter 3 of this dissertation, stiff muscles or tendons have higher risk of suffering from overuse injuries. Therefore, the relationship between different psychological conditions and a musician's physical performance could be a possible way to approach overuse injury prevention.

Chapter 4 demonstrates that having strong arms and wrists helps to lower the possibility of overuse injuries for the flutists. Lightweight training of the upper body is a good way to gain the strength one needs to support the instrument. However, being

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[72] Mayr and Zaffagnini, *Prevention of Injuries and Overuse in Sports: Directory for Physicians, Physiotherapists, Sport Scientists and Coaches*, 33.

physically fit and psychologically healthy are also related to healthy diet and balanced nutrition. Due to the fact that everyone has a different body, it is impossible to generalize one ideal diet. There are many existing books and studies that focus on the topic of diet and human health. For future studies, the relationship between different diets and a musician's performance could be an interesting topic.

Based on sports injury studies, "male athletes seem to have a higher risk of severe sports-related injuries, while women are more affected by overuse injury than men."[73] There are physical and psychological differences between sexes; researching overuse injuries in the different sexes among flutists could be an interesting approach.

As mentioned in chapter 1, all musicians are prone to suffer from overuse injuries. Therefore, the structure of this dissertation could be applied to study overuse injuries on other musicians as well.

In conclusion, not only does this project fill in the gaps of detailed study surrounding the physical causes and prevention of overuse injuries for flutists' hands and wrists, but it also provides a research structure for further analysis of other overuse injuries. With further development in technology and medicine, it is possible that there will be more resources available for musicians to study overuse injury in the future. The understanding, prevention, and treatment of overuse injuries are topics worth all musicians' continuous attention throughout their careers.

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[73] Mayr and Zaffagnini, *Prevention of Injuries and Overuse in Sports: Directory for Physicians, Physiotherapists, Sport Scientists and Coaches*, 32-33.

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APPENDIX

INSTITUTIONAL REVIEW BOARD APPROVAL

UNIVERSITY OF
NORTHERN COLORADO

Institutional Review Board

DATE:	October 19, 2017
TO:	Xin Jing
FROM:	University of Northern Colorado (UNCO) IRB
PROJECT TITLE:	[1139897-1] Hand and Wrist Overuse Injuries in Flutists: Physical Causes and Prevention
SUBMISSION TYPE:	New Project
ACTION:	APPROVAL/VERIFICATION OF EXEMPT STATUS
DECISION DATE:	October 18, 2017
EXPIRATION DATE:	October 18, 2021

Thank you for your submission of New Project materials for this project. The University of Northern Colorado (UNCO) IRB approves this project and verifies its status as EXEMPT according to federal IRB regulations.

Thank you for the succinct, clear and thorough IRB application for your dissertation research.

All protocols and materials are verified/approved exempt. You may begin participant recruitment and data collection.

Best wishes with your research.

Sincerely,

Dr. Megan Stellino, UNC IRB Co-Chair

We will retain a copy of this correspondence within our records for a duration of 4 years.

If you have any questions, please contact Sherry May at 970-351-1910 or Sherry.May@unco.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance|with all applicable regulations, and a copy is retained within University of Northern Colorado (UNCO) IRB's records.