Part II:

The Physiology of Hand, Wrist and Forearm Pain in Professional Musicians

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Introduction:

With no insult intended, as high-level and professional musicians, you are "*focal athletes*" who are often misunderstood and misdiagnosed by the well-established Sports Medicine community that usually sees and treats musculoskeletal problems. Though the underlying physiology is the same for everyone, your needs as musicians are very different from those of most other athletes.

Positioning your fingertips in space, often to within less than a millimeter of tolerance, and applying a precise amount of force within a fraction of a second, sometimes at a rate of over one hundred times per minute while holding the rest of your body in a rigid often uncomfortable position and repeating this with only brief rests over a two hour concert period often preceded by a rehearsal, is a **routine** accomplishment for you as a professional musician, yet because there is no apparent physical impact and it does not necessarily leave you gasping for breath or drenched in sweat, its **massive** demands usually go unappreciated not only by the general public but by most healthcare professionals, and since you are indeed a very small minority group, it is unlikely that this situation will change anytime soon.

Pushing the limits of muscle training will **inevitably** lead to some episodes of upper extremity pain throughout your career. About two thirds of all professional musicians (60-70%) experience some degree of chronic pain, about 40% in the upper extremities mostly associated with elements of sub-optimal muscle stretch or episodic muscle strain.

Understanding the physiology behind it (**IF** you also have understood the nature of pain as discussed at the end of Part I) will allow you to manipulate it more effectively, make the necessary changes to your technique and practice routines and hopefully reduce your fear and avoid the need for medical care. That is the goal of this part of the discussion.

Why are high-level musicians "focal" athletes?

A. They must develop extreme "*marathon-like*" endurance but isolated to a smaller, more localized set of muscles. This means that they:

1. Can't use systemic changes like rapid respiration, heart rate, or sweating to gage muscle fatigue or impending injury

2. They must rely on subtle local sensations of discomfort, fatigue or **pain**

B. They must develop near microscopic focus on small amplitude highly precise motions that appear superficially similar but in fact require a great variety of fine motor skills from a small number of highly coordinated intrinsic and extrinsic

muscles. These low amplitude, low impact gestures are often not perceived as athletic in nature simply because they are so discrete and focalized.

Classifying Upper Extremity Pain in Musicians:

TWO PRINCIPAL SOURCES of pain **MUST** be distinguished since each requires a completely different approach:

A. **<u>First:</u> Physiological Conditions**: those **directly caused** by the demands of playing your instrument - they may occur at any age, throughout your entire career. They are the topic of this discussion in Part II.

1. "*Physiological pain*" means it's **supposed to hurt** when we do certain things a certain way because **that's the way our bodies are made, not because there is something wrong!** It is crucial that you as musicians understand this distinction

2. These conditions nearly always begin with localized muscle fatigue, pain, weakness and cramping in specific muscle groups depending on your instrument and your unique method of play and represent a **normal** physiological response to forceful, prolonged or highly repetitive activity, especially in those muscles used **outside** the range of **optimal muscle stretch** (redo the demonstration in Part I!) The most **minor** positional changes can sometimes eliminate pain!

3. Anatomical variations among individuals can make certain positions or movements more difficult to accomplish or maintain for one person relative to another. In other words, you might experience pain while your colleague has none, even though you are both doing the same gestures

4. Symptoms from this source can almost always be prevented, modified or overcome through specifically directed changes in technique, practice habits and desensitization, especially if they are **addressed immediately** when they first occur. It is never "*convenient*" to make technique changes but it is "***crucial***"! (See also: "*It's easier said than done! Some practical suggestions*" below)

5. Some physiological conditions can eventually **become pathological** and can be career ending if ignored long enough (see Part III) but this is unusual and far from inevitable (which is why we are having this discussion! – beware of the fear mongers, they dominate the Internet!)

B. **Second: Pathological Conditions**: those typically caused by some disease process and **aggravated** or **made symptomatic** by playing your instrument. In other words, it isn't "*normal*" for it to hurt. Something else in your body needs attention

1. They usually become apparent in the 3rd, 4th and 5th decades of life, gradually increase in frequency and worsen throughout the remainder of your career

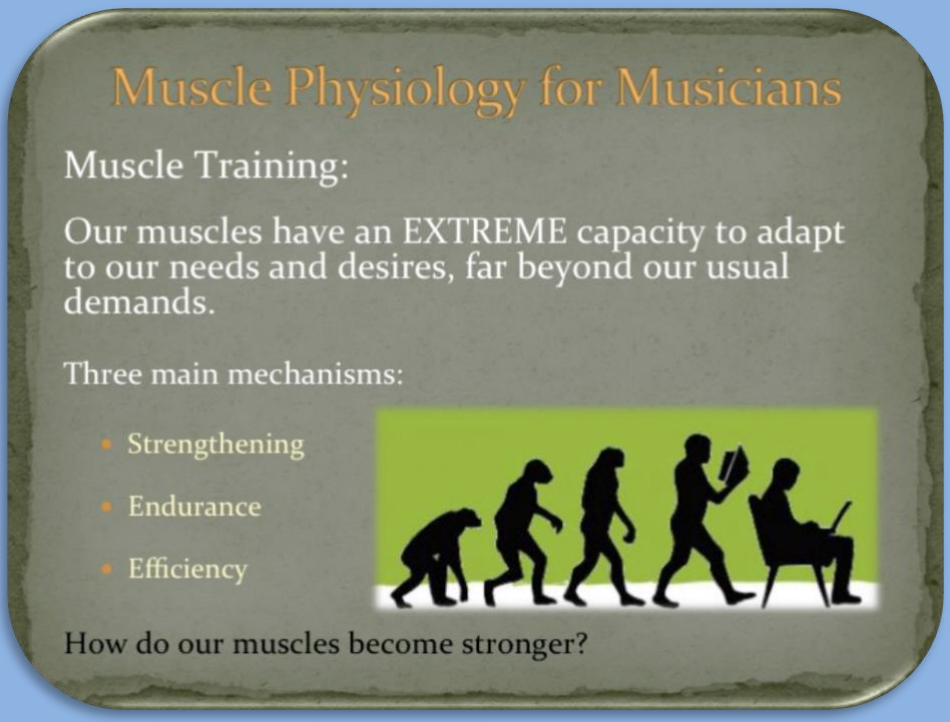
2. **Most** of these pathologies are **not more common** in musicians than they are in the general population (**contrary to what you are told!** – see Part III)

3. Some are diseases but many are an inevitable part of the aging process

4. They are however, more devastating to you than to non-musicians

5. They typically require some medical or surgical treatment, though not all of them **must** be treated or are **treatable.** They are the topic of Part III

Determining which of these two general categories account for your symptoms is not always simple and you may or may not be able to accomplish this yourself. You might need the help of a ***"musician-competent"*** physician or therapist (discussed in the next section, Part III). Making the distinction, however, is **crucial** to determining which measures are necessary for improvement. Understanding the nature of pain as we discussed in the last session and learning about muscle physiology which is our goal here, are essential to making this distinction.



Muscle Physiology for Musicians:

A. **Muscle Training: Adaptive Changes that Occur with Usage**

1. **Strengthening**:
   a) Increase in cell size and volume ("*Hypertrophy*"), not cell number ("*muscles get bigger*")
   b) Strength is proportional to the cross-sectional area of a muscle at **optimal**

stretch, thus, usually, the bigger the muscle the stronger it is though other factors in its configuration may also play a role – muscle size/strength clearly increases with training!

2. **Endurance**: What changes?
   a) An increase in the blood supply to the muscles by making extra blood vessels (called "*neovascularization*")
      1) Brings more nutrients
      2) Removes more waste materials faster
   b) Increase in the size and number of "*mitochondria*" (these are energy producing organelles in the cells)
   c) Increase in the proportion of Type I ("*slow twitch*") muscle fibers

3. **Efficiency**: fine tuning of any repetitive process (Musicians!)
   a) Refinement of neuron connections between all active brain modules (learning and practice)
   b) Reduction in **unnecessary** muscle contractions (***"tension"***) – less energy needed and finer control possible (see demos in Part I)
   c) Reduced tendency for muscle strain

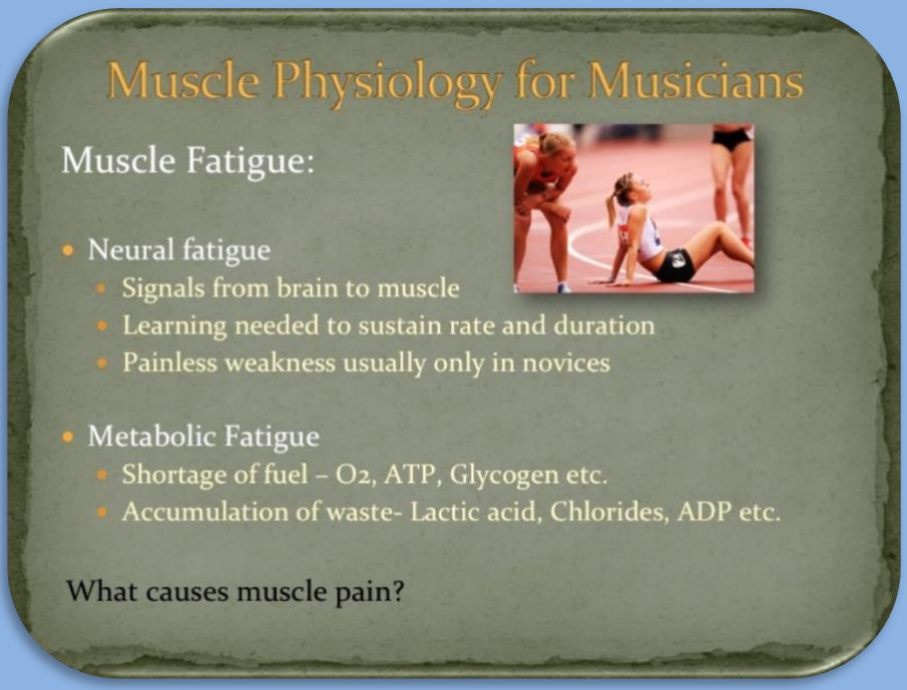
4. Remember that our bodies are **made to adapt to our needs** and are usually capable of meeting our demands **If** this physiological process is gradual and well directed! Slow gradual improvement is always possible

B. Muscle fatigue : Neural fatigue vs. Metabolic fatigue

1. Neural fatigue: a "*flow*" of motor nerve signals from brain to muscle
   a) Rate of firing and the duration of the signal controls how forcefully or how repetitively the muscle contracts up to its maximum capacity

b) Novice players may not be able to sustain this "*flow*" and may initially feel **painless weakness**
c) This improves steadily with training by strengthening appropriate neural connections
d) Unless there is neurological disease, this type of muscle fatigue does not cause persistent problems in high-level musicians

2. Metabolic fatigue: (the most common source of fatigue)
a) Shortage of fuel ("*substrates*") needed for muscle contraction, i.e., ATP, glycogen ("*can't get enough nourishment quickly enough*")
b) Accumulation of waste materials ("*metabolites*"), i.e., lactic acid, chloride, ADP ("*can't get rid of the waste products, "toxins", fast enough*")

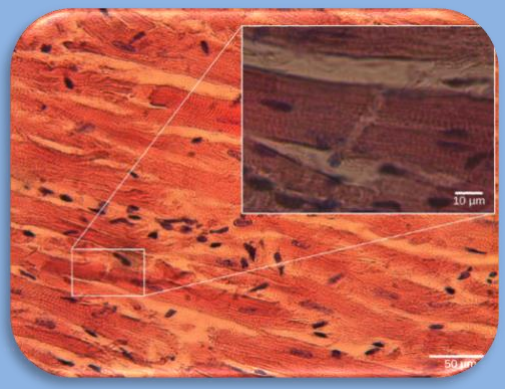


C. Exercise-induced Muscle Pain and Muscle Strain:

1. **Pain without strain** - consequences of metabolic fatigue:
a) Pain is caused by stimulation of sensory nerve endings by a decreasing pH (acid and waste build-up in the tissues) and muscle function declines rapidly
b) Occurs during and shortly after exercise (**comes on much more rapidly with sub-optimal muscle stretch!**)
c) Resolves within minutes or hours with reduced activity or rest (recovery)
d) May be aggravated by reduced blood flow ("ischemia") – i.e., postural - **thus may improve or recover with even minor position changes!**

e) **No actual damage** is caused to the muscle units
f) Repeating the process multiple times leads to **adaptive strengthening** and refinement of the action ("*efficiency*")
g) Gradually force, coordination and endurance are increased making the muscle unit less prone to injury
h) **Constant maintenance** of this "*training*" process is required or the beneficial effects will gradually fade and vulnerability will return

2. **Muscle fiber microscopic tears** or partial ruptures (**strain**) may occur with continued intense muscle activity in the absence of reduction or rest
   a) This triggers an inflammatory response that aids in the healing process but causes pain with a delayed onset of about 24h with the maximum around 48h (the pain you feel the next day after an unaccustomed heavy workout)
   b) Pain is slow to resolve (typically 5-10 days – healing process)
   c) As long as the muscle is allowed to recover fully with reduced activity or relative rest, pain resolves, scar tissue forms, remodeling and muscle regeneration occurs and **adaptive strengthening continues**
   d) Muscles become rapidly resistant to additional strain by the **same level** of exercise



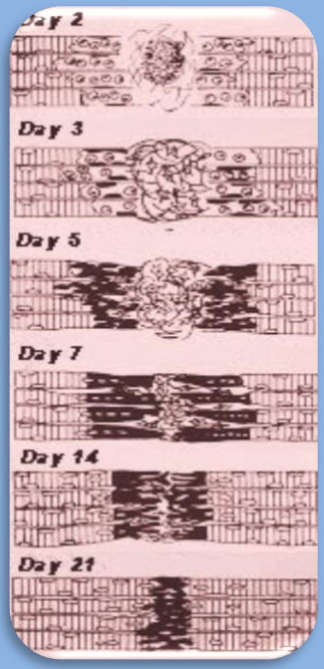
   e) Some studies suggest that some "*micro-damage*" to muscle fiber architecture **may be necessary** to take full advantage of adaptive strengthening

3. **Cramping**: involuntary contraction, muscle spasms
   a) May occur with additional forceful or repetitive use causing decreased available oxygen (local "*hypoxia*"), electrolyte imbalance and reduced ATP (the molecule that brings energy to cells)
   b) Worsened by **suboptimal muscle stretch** and/or dehydration
   c) Sudden onset, often **extreme** pain
   d) Usually resolves within minutes **if** the muscle is passively stretched to or slightly beyond optimal length
   e) Often forceful enough however to cause more severe muscle fiber tears, increased inflammation and prolonged pain

f) Healing proceeds normally as above in 5-10 days and adaptive strengthening still occurs

4. **Recurrent muscle injury** may occur when muscle fiber tears are caused repeatedly in **already damaged** muscle **before** recovery has occurred
   a) This causes additional inflammation, lengthens the healing process further, forms additional scar tissue and causes continued and prolonged pain
   b) This also **may disrupt the adaptive strengthening process** keeping the muscle unit weak and chronically vulnerable to re-injury
   c) **This is the only physiologically valid use of the term "*Repetitive Strain Injury*"** (RSI) as a diagnosis. **Unfortunately, it is almost always misused**. This will be discussed further below.
   d) **Even this injury always heals** without permanent consequences with active rest but because the adaptive strengthening process has been disrupted and must start over, retraining can restart this vicious circle unless it is **gradual** and thus **prolonged**
   e) It is **essential** that you understand that recurrent or persistent **pain from any source can become chronic** if misinterpreted, even if the original injury is fully healed as we saw in our discussion on the nature of pain in Part I!

D. **Muscle Healing** occurs in three phases:



1. Destruction phase: from injury to about 3-5 days
   a) Bruising ("*hematoma*" formation)
   b) Damaged cells die ("*tissue necrosis*")
   c) Initiation of the inflammatory process = redness, swelling and more pain
2. Repair phase: begins about day 3 and peaks about 10 days post injury
   a) Removal of dead ("*necrotic*") tissue and hematoma by immune cells
   b) Regeneration of muscle cells
   c) Simultaneous production of connective scar tissue
   d) Growth of new blood vessels (capillaries)
   e) The scar becomes stronger than the adjacent normal muscle tissue by approximately day 10
3. Remodeling phase: overlaps with the repair phase and extends out several months (up to 1 year) depending on the severity of the injury and variations in each person's physiology – it is **not disrupted by activity – NO restrictions are necessary! In fact, normal activity guides this process!** (See Part I)

a) Maturation of muscle fibers
b) Reorganization of scar tissue and scar contracture
c) Gradual return of **normal** muscle function

E. Swelling ("Edema")

1. What is it?
   a) For our discussion here, it is an increase in the size (volume) of the hand, wrist or forearm beyond its "*normal*"
   b) It usually represents an accumulation of fluid expanding the tissues causing an increase in the pressure you feel inside the hand
   c) Full motion of a swollen hand feels "*tight*" (as if under pressure), uncomfortable and sometimes painful, regardless of the source of swelling
2. Let's begin with a **Demonstration:**
   a) Next time you go for a long walk (30 minutes or more) leave your arms hanging down at your sides with your elbows straight
   b) Holding nothing in your hands, relax them completely and just let your shoulders swing gently as they do normally when you walk. Don't try to make a fist or use your hands in any way
   c) Enjoy your walk and after about 30 or 40 minutes, concentrate on your hands and be attentive to any tightness or swelling
   d) Now try to make a fist and you will notice some stiffness, resistance to motion and perhaps even some discomfort or mild pain the tighter you squeeze. You may notice some visible swelling of your fingers
   e) Keep walking with your arms in exactly the same position but **alternately** open and close your fists **very** tightly (the first few times may be quite uncomfortable but do it anyway) holding the tight fists for about 5 seconds then stretching your fingers out completely for 5 seconds, etc.
   f) Compare the swelling and tightness after about 5 minutes of doing this with how it felt when you first began. Chances are your hands feel considerably better but are not completely back to normal
   g) Now hold your elbows bent as you walk so your hands are above your heart (the position that most joggers use when they run) letting your shoulders swing gently as they did before
   h) Again, compare how your hands feel after a few minutes of this
   i) To understand this demonstration, we need to discuss sources of swelling
3. **What causes swelling?** Some of these elements are always present and part of our **normal** physiology whereas others are "*pathological*" and occur when something goes wrong. Understanding this is crucial to our discussion
   a) Gravity
      1) We often forget that all things in our environment including us and the fluids we contain are constantly pulled toward the center of the Earth

(a) Gravity causes our body fluids to accumulate in areas that are below the level of the heart ("*pooling*")

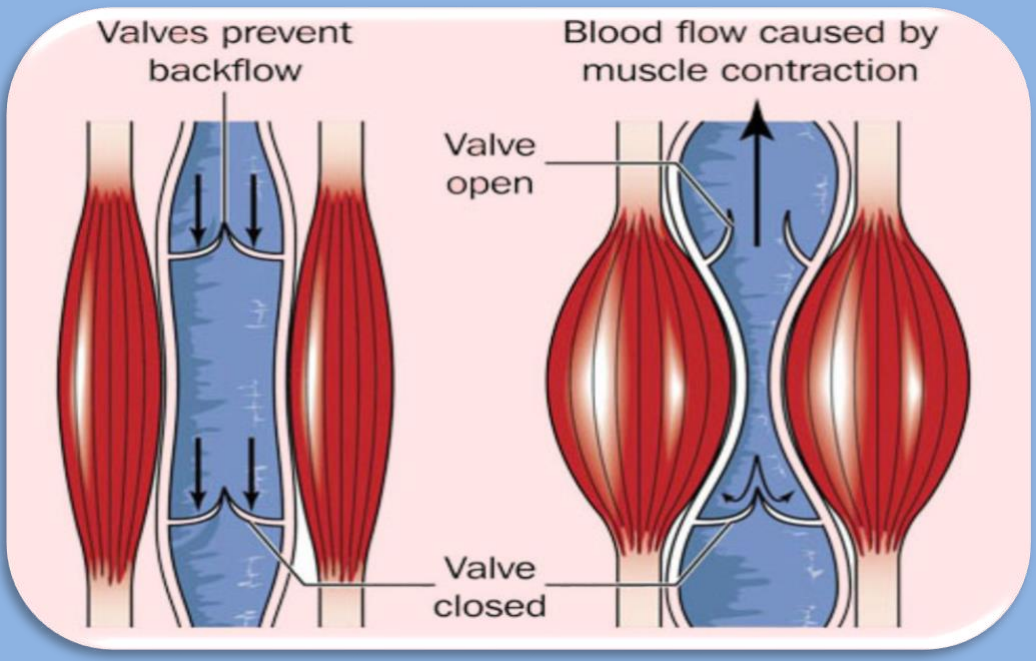
(b) Since we spend much of our time in an upright position, our legs and feet, and to a lesser extent our arms and hands, are held below heart level and thus are prone to accumulating fluid

2) Much of our physiology evolved to counteract this constant force but we need only discuss a few elements here for our purposes

(a) Blood pumped through the arteries by the heart is under **high pressure** and easily overcomes the force of gravity

(b) Blood returning to the heart through veins however is under **very low pressure** and gravity has a **profound** effect but we have evolved some special ways to help us compensate for this:

(1) Veins in our arms and legs have one-way valves built into them allowing blood to move **only towards** the heart and thus away from the pull of gravity decreasing "*pooling*":



(2) Some additional force however is still needed to overcome gravity and this comes from contractions of our muscles which "*squeeze*" the veins thus pushing blood back toward the heart, further preventing fluid accumulation in the extremities (see above)

(c) Other fluids surrounding our cells but outside the blood vessels also accumulate in areas below heart level and are returned to the circulation through the "*lymphatic*" system. This is also heavily

dependent on **muscle contractions** "*squeezing*" the tissue compartments

(d) Our body deals with gravity in this and many other ways that are beyond the scope of our discussion here. It does so every minute of every hour of every day of our lives without us typically being aware of these processes as long as we are "*normally*" active

(e) In the demonstration above when you alternately open and close your hands, muscle contractions force blood back towards the heart reducing the amount of fluid that has accumulated in your hands reducing any swelling and relieving the sensation of pressure

(f) When you bend your elbows and keep your hands **above** your heart you reverse the effects of gravity making it help reduce swelling rather than cause it

b) Inactivity

1) Since gravity is inescapable (unless you are an astronaut in space) complete rest or inactivity, especially in a standing or sitting position, **causes or worsens swelling** in the extremities

2) Without periodic muscle contractions to generate the energy required to overcome gravity, fluid progressively accumulates as illustrated in the demonstration above

3) Most people are aware of some swelling in their feet at the end of the day if they have been inactive while standing or sitting with their feet on the ground

4) If you have ever seen a person who has had a stroke and cannot move one of their hands ("*hemiplegia*"), you may have noticed that the hand that cannot move is swollen compared to the other side, even though the stroke itself did not cause any injury to the hand (see image below). This

Hand swelling due to motion loss from stroke

occurs because of the combined effect of the lack of muscle contraction (the paralysis) and the typical convenient positioning of the hand in the lap (below the level of the heart – this is no longer seen as often as it once was since preventive measures are now used routinely). In Part I, you saw a very similar picture of a person's hands who has CRPS ("*complex regional pain syndrome*") on the right side. There was very visible swelling of the involved hand even though there was no recent injury. **If your fear is so extreme that you consciously avoid all motion and contact with a painful hand, the swelling will be equivalent to someone with paralysis!**

5) Thus, even though we remain typically unaware of their contribution, motion and activity are our body's primary means of compensating for the effects of gravity that are otherwise inevitable in our environment

c) Injury
   1) Injuries differ greatly in character and severity but almost all involve some degree of bleeding into the tissues, sometimes in only microscopic proportions (bruising or if severe; "*hematoma*")
   2) Damaged blood vessels continue to "*leak*" fluids into the tissues surrounding them increasing swelling
   3) The effects of gravity become even more noticeable when normal fluid exchange is disrupted by injury and more fluid is present outside the blood vessels
   4) Swelling due directly to the injury is usually mild but becomes rapidly worse as the next cause, inflammation, adds its effects
d) Inflammation
   1) Blood cells, debris from the outside world or from injured cells, bacteria, and a multitude of other factors potentially present in tissues after an injury, trigger a complex "*inflammatory process*"
   2) It begins within minutes of an injury and worsens over about 72 hours (or longer under certain conditions)
   3) Inflammation is an **essential and normal** part of the healing process. It protects us from infection and prepares the tissues for scar formation
   4) The many mechanisms involved in inflammation are beyond the scope of our discussion but **all** cause the accumulation of cells and fluid around the injury site and the amount of swelling can sometimes be massive
e) Other causes
   1) "*Edema*" is an enormous topic about which much is known, even down to the molecular level
   2) There are **many** other sources of swelling that we need not discuss here

3) The take-home message when it comes to swelling of the hand is that though multiple sources may contribute to the final result, it must ultimately be resolved by those mechanisms that the body uses to pump fluids from the extremities back towards the heart, **the most basic of which are muscle contractions and movement**

4. Why are these concepts important?
   a) Unfortunately, most people believe that the **only** cause of swelling is injury and subsequent inflammation. So, just as they are afraid of pain, they are **afraid of swelling**, equating it to tissue "*damage*"
   b) They wrongly believe that moving a swollen hand must cause additional injury and they are often even told by medical professionals to use only ice and elevation and to wait for swelling to subside before moving or using it
   c) Swelling is thus always seen as a negative or worrisome experience in spite of it being an integral part of the **normal** healing process
   d) By removing one of the body's principal means of pumping fluid out of the hand (by keeping it immobile), we worsen the swelling, increase pain and delay the recovery process. As mentioned in the discussion on pain, our ancestors could not have survived if they had to immobilize swollen limbs in order to heal!
   e) When people reason that they should wait for the swelling to subside before trying to move their hand it is similar to the reasoning that they should wait in a dark room until the sunlight will not hurt their eyes. It simply creates an impossible dilemma
5. This misinterpretation of swelling **reinforces and significantly worsens the vicious circle of pain** described in Part I under "*Sensation: The Nature of Pain*". It is worthwhile for you to go back and re-read this section if you do not have a clear recollection of its contents

F. The Role of Rest in Recovery

1. **Complete** rest and **immobilization**
   a) **With what you know now, let's think about it for a minute.** In the early days of medicine, it became clear that massive injuries with severe blood loss required complete rest to survive and some fractures needed to be immobilized in order to heal. So, complete rest and immobilization were justified in cases of severe injury where the victim would have otherwise perished and certainly many lives have been saved by

these interventions. The problem arose when we erroneously but instinctively concluded that if rest and immobilization were good for severe injuries, they must be good for **all** injuries! When we discovered nociceptors and concluded that pain was an indication of ongoing injury, it followed naturally that chronic pain should also be treated with rest and immobilization. In spite of almost every improved medical and surgical outcome over the past 125 years being associated with increased activity and motion, we have been unable to overcome these self-destructive and erroneous assumptions

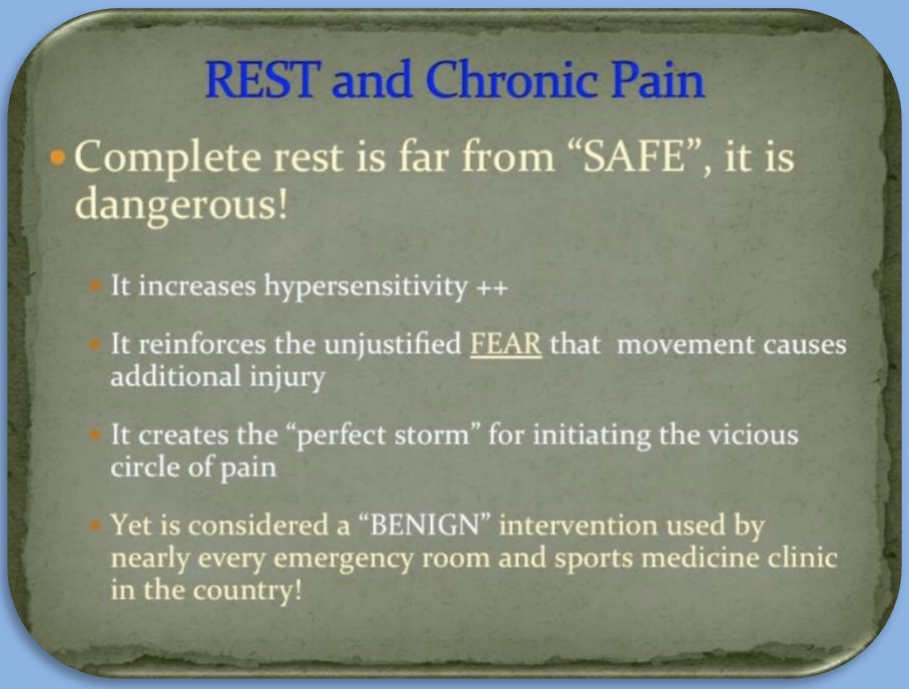
b) When **complete** muscle fiber ruptures occur (almost **never** in musicians unless a piano falls on you!) complete rest or immobilization **may** be beneficial in reducing the size of the tear gap and the volume of the hematoma

c) Even in severe injuries, however, the duration of immobilization should be **no more than 3-5 days**

d) After that period, motion and gentle stretch **improves** the remodeling process and reduces the fibrosis that occurs with scarring

e) Also, what might be appropriate for another athlete whose principal requirements are stability and power is inappropriate for you who require mobility and finesse!

f) Prolonged immobilization or complete rest leads to swelling, adhesive scarring, stiffness, loss of strength and coordination as well as chronic pain – beware! – As a musician, it is the beginning of the END of your career!



2. **Active or Relative** rest – relative reduction in intensity of activity
   a) All that is required for muscle strains – most musician's injuries
   b) **Significant** reduction in intensity of play and practice time for 7-10 days
   c) You can be creative however if pain is mild by using modified practice **as therapy**
   d) Participate in other forms of mild exercise not related to your instrument while you are recovering
   e) **Gradual** return to normal play should begin after day 7 **incorporating changes** in technique and practice routines

      1) How gradual this must be will vary from injury to injury and from person to person
      2) Work diligently on attaining **optimal muscle stretch**
      3) Being attentive to your pain **without fear** is your best indicator of how far to push (pushing harder isn't "*dangerous*", it's just less effective!)
      4) ***Short frequent practice sessions are better than longer, fewer sessions***
      5) Mild pain that improves or resolves rapidly between sessions is okay, keep with it – **massage and stimulate painful sites!**
      6) **Percussive massage guns**
         (a) These hand-held devices have become popular and may be significantly beneficial if used properly
         (b) Massage guns can provide a reliable and controllable source of local stimulation which, as we have seen, can significantly reduce pain
         (c) They have been shown to improve flexibility and range of motion when applied to tight muscles without reducing the force of contraction
         (d) The most effective use is by application of the gun to the area of maximum tenderness and gradually increasing the force applied
         (e) While usage does not replace optimal muscle stretch in preventing recurrence, it can help reduce existing pain
   f) **Always** try to understand the factors that caused the strain and modify accordingly! If you don't know why it happened, returning to your normal routine **without modifying anything** is **unlikely to succeed**

g) If there **is** improvement by 7-10 days of active rest **but** every time you return to play your pain returns:
   1) Reduce your practice session to **just less than** the time it takes to generate pain (do whatever it takes – reduce to 1 minute if necessary!) then rest, then repeat as often as you can without or with minimal pain
   2) **VERY GRADUALLY** increase your practice duration 1 minute at a time until you reach a level acceptable for you
   3) You may have to limit the duration of individual practice sessions permanently – **recent research in learning effectiveness suggests this is desirable in any case!**

h) If pain **does not significantly improve** or resolve by 7-10 days of active rest, some process other than muscle strain may be involved and continued rest will **probably not offer a solution**
   1) Don't panic! Fear is your worst enemy
   2) Try NSAID's (see Appendix I – not everyone can use NSAID's safely) and continue to work on **optimal muscle stretch** and **desensitization** (actively massage the **painful** site!) for another 7-10 days
   3) If still **no** improvement, it's time to see a musician-competent physician (we will discuss this in Part III)

It's Easier said than done! Some practical suggestions

"It's easy for a non-musician to talk about modifying technique but our instruments don't allow us to make changes and still play well!"

1. This is a completely understandable statement but it is only partially true. You were indeed taught to play in very precise positions and developed your own modifications over hundreds or thousands of hours of practice. That means that it has become second nature for you to position yourself **exactly** the same way each time. It is part of your "*efficiency*", allowing you to concentrate your attention on elements of finesse rather than basic positioning

2. Fortunately, your muscles are highly adaptable and **usually** respond extremely well using the mechanisms described above to strengthen and become more efficient so that you can play without pain even though you may not have achieved optimal muscle stretch, **but** with age and perhaps in some cases **too**

much postural relaxation, muscles that are not under optimal stretch may begin to "*complain*" or even go on to cause severe pain

3. **Major** positional or postural changes are indeed prohibitted by the nature of your instuments but **minor changes abound** even though they may not be obvious to you! Unfortunately, **every** change no matter how small, involves a huge amount of effort and commitment on your part and so is inherently "*too much hassle"*

4. It is important to understand however that even the most **minor change** may be enough to significantly improve or resolve your pain completely! Only you can evaluate how much you are willling to invest in trying to remove a source of pain

5. From a **practical standpoint**, what can you do?

   a) Each instrument as well as each person and his or her training is **so** different that no single measure is widely applicable but we can discuss some examples to give you the "*flavor"* of things you can try in order to improve physiological pain

   b) Begin by taking stock of what things you **can change** and still play your instrument. Be creative because there are **many more** than you can initially imagine, especially if you remember that even extremely subtle changes may be effective, **including those that seem unrelated or at a distance from the painful site**

      1) Posture is often a major source of pain specifically because our tendency is to unconsciously relax postural muscles progressively the more we play, in order to save energy – a negative aspect of becoming more "*efficient*". Gravity never gives you a break however, so it can influence muscle stretch even if you thiink you haven't changed anything! Re-evaluate your posture frequently, especially neck, back and shoulders
      2) Sitting position
         (a) Precisely **where** you sit on a chair or bench relative to its shape and center has a profound effect on how you balance your body and this distributes forces differently to different muscle groups
         (b) Using support aids such as the back of a chair or a small pillow with precise positioning can be helpful in some circumstances and detrimental in others. Only you can determine what is best for you but if you have pain, consider **changing** whatever you do now!

(c) The height of your chair is **crucial** (pianists take special note because you have the luxury of usually having a precisely adjustable chair though it typcally has no back!)

(1) We do not all have the same leg length or height so it is absurd to think that one chair fits all!

(2) The position of your hips and knees profoundly affects your balance which in turn affects your back, neck, shoulder, elbow and wrist positions. Cushions or shims of precise thickness under chair legs can be a nuissance but extremely helpful. If you play in an orchestra, consider buying a chair or modifying your chair to fit your personal needs – radical but potentially effective in reducing physiological pain

(3) Pianists, raising your chair even a half an inch higher than what you have previously established as your "*optimal*" position makes you extend your elbows very slightly and can sometimes reduce or completely relieve forearm pain, though it means pedal use is more awkward until you adapt to the new norm

3) Shoulder, elbow, wrist and finger positions

(a) These are less easily adjustable because of the rigidity of your instruments but minor changes are very possible and should be considered

(b) A musician-qualified hand therapist may be able to fabricate a discrete splint that limits motion slightly in a given joint thus avoiding positions that generate pain (see "*Ligamentous hyperlaxity*" near the end of Part III). If you are early in your career you may only need the splint as a training device until your muscles learn the desireable excursions

(c) Pressure points can be reduced or positions changed slightly by applying a soft discrete pad to certain instruments (mainly woodwinds and brass)

c) ETC., ETC. – These by necessity are only examples but at least illustrate that you must be creative and interested in improving pain

d) Many musicians, once they understand that **physiological pain is not harmful to them,** are able to reduce their fears, desensitize painful sites, and simply modify their practice schedules so they no longer interpret their pain in the same way and thus no longer suffer. Remember that pain is an interpretation of a specific context and not an objective sensation! Never underestimate the extreme effectiveness of the contextual effect! (If this makes no sense whatsoever to you, read or re-read "***Sensation: The Nature of Pain***" at the end of Part I)

e) In either case, understanding the concepts and experimenting with the many factors you **can** change are the keys to bringing physiological pain under control

If it's "normal" physiology, why do we have pain?

1. Musicians **must** continuously strengthen and maintain appropriate muscles if they hope to keep the level of endurance required to play professionally. It's easy to get behind then overdo it trying to "*catch-up*"

2. Adaptive strengthening **only** occurs when muscle-tendon units are pushed to and possibly slightly beyond the limits of their comfort zones creating the signals that trigger this process (the origin of the sometimes-disputed adage: "*no pain, no gain*"). Just as you would expect to have some pain the next day after an unusual workout in the gym, you can expect to have some the day afer you push beyond your usual practice routine. Don't let it scare you. You now know how to proceed if you have read this section

3. Pushing these limits but still stopping short of creating recurrent muscle strain that may instead interfere with strengthening is a fine line that may be a difficult distinction for **all** athletes

4. Musicians as "*focal*" athletes are at an additional **disadvantage,** having to use more discreet and subtle cues to determine optimal training levels and thus may be even more prone to strain

5. Musical instruments are historical, not flexible, and are not easily modified to suit human physiology so musicians must adapt to their instruments, not the other way around (See "***It's easier said than done! Some practical suggestions***" above). It may not be possible for you to achieve optimal muscle stretch, meaning that you may have to choose between dealing with some pain ("*hurt*" without "*harm*") and giving up your career!

6. Musicians and their instructors may be resistant to modifying classically successful techniques that seem to initially work well for them but begin to generate pain

7. Most musicians do not have fully predictable careers with uniform demands but are subject to **sporadic periods of intense preparation** for upcoming performances

8. The stresses associated with public performance are well known to musicians and these can significantly affect their judgment especially when it comes to pain, during last minute preparations

9. Musicians typically pursue their careers for decades beyond other athletes and "graduate" into the many degenerative changes that are inevitable with the normal aging process. While these are gradual enough that most musicians can adapt and compensate for several years, they typically will become the determining factor for your retirement

10. **ETC., ETC**. – these are only a very few of the **many** reasons why a musician's normal physiology **will** periodically cause painful problems in his or her upper extremities! I am certain that you can think of many more!

Misuse of the term "*Repetitive Strain Injury*" (RSI) (or "*Overuse Syndrome*", "*Cumulative trauma disorder*" and several others):

A. This is **one of the most common "*diagnoses*"** given to musicians with symptoms of upper extremity pain (this and the equally misused diagnosis of "*tendinitis*" discussed in Part III!)

B. The widespread misuse and misunderstanding of this "*diagnosis*" has led to it becoming a **"*catch-all*" phrase** for **chronic pain** in an athlete or production worker (or musician) **regardless** of its source.

C. Our intuition and folk wisdom tell us that any pain that recurs with activity **must** be due to overuse and **must** be causing some long-term "harm" to our bodies, but forty years of searching meticulously for some objective damage to muscles that have undergone "*repetitive strain*" has yielded no "*pathological*" diagnosis and thus no objective chronic "*injury*". Repetition as a cause for injury remains only a satisfying intuitive assumption that is tied to our past errors in understanding the nature of pain. It has not been able to find a respectable scientific basis

D. In this context, it is **not** a "*diagnosis*" but rather a generic label that says **nothing** about the cause or origin of symptoms thus excluding it from the realm of science – only conjecture is possible allowing **anyone** to reveal "***The Truth***" about it based on their suffering – these conjectures require **NO** scientific knowledge and there is no shortage of sufferers willing to share their "*medical*" opinions and their stories of woe! **Remember that ANY source of pain can become chronic and debilitating depending on its context** (see Part I)

E. As a "*catch-all*" it **does not** distinguish physiological from pathological sources of pain and is therefore **of no value** in counseling individual high-level musicians - so it is rarely used by "*musician-competent*" healthcare professionals.

F. Its use often means that a detailed history and physical examination was **not carried out** and the need to be **more specific** was either not appreciated or was ignored. It is often used as a substitute for saying "*I don't know what's wrong*"

G. This widespread misunderstanding too often leads to the **simplistic and erroneous** approach that **"*rest*"** is **the answer**, which we have learned is not, by itself, a useful treatment or a long term "*solution*" for a professional musician.

H. As we discussed above, the body's **normal** response to muscle strain (and to almost all other injuries) is healing and adaptive strengthening, **not** chronic pain! If pain persists**, other, more complex issues exist** and should be evaluated and addressed. Pharmaceutical and surgical interventions **DO NOT** effectively treat chronic pain!

I. Be **very** critical of what you read on the Internet, even from what seem to be reputable sources. **Opinions** on the subject are **rampant** and outdated while knowledge-based information is sparse and most professionals still misunderstand the nature of pain and endorse the use of extensive rest following classic protocols

Summary of some take-home thoughts for musicians: (now that you know some basic physiology it's time to repeat some important concepts!)

A. You **WILL** have physiological upper extremity pain off and on throughout your career but in most cases, it will come from sub-optimal muscle stretch and can be resolved without muscle strain if perceived early and corrected

B. Sadly, rest, immobilization and narcotic pain medications are considered benign interventions used by nearly every emergency room and sports medicine clinic in the country. These interventions have the potential to rapidly end your career

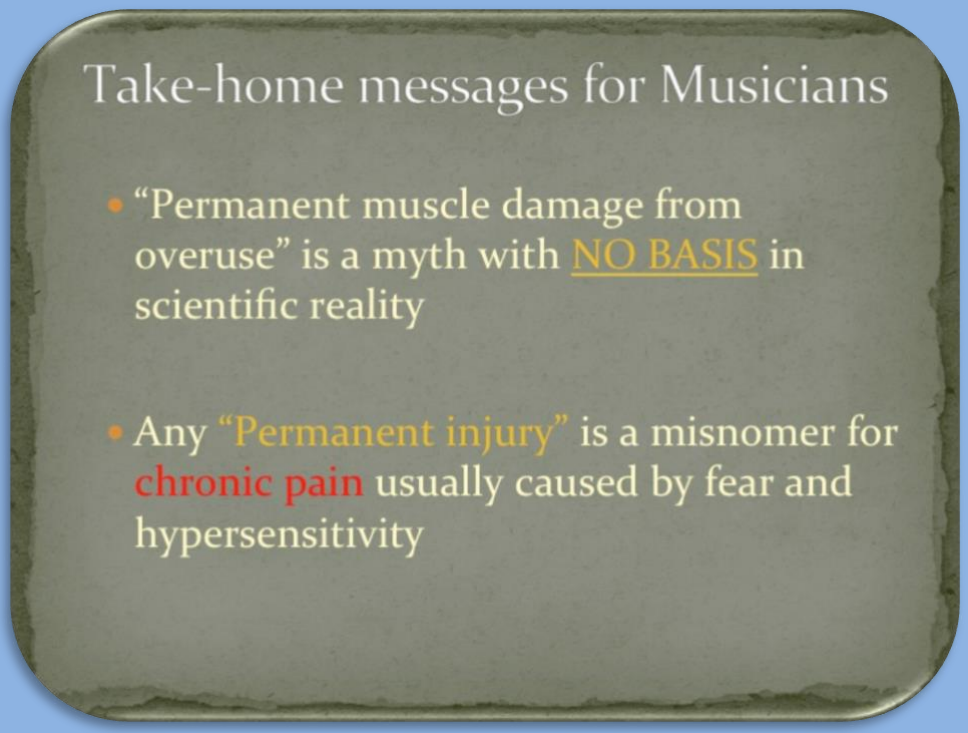
C. When muscle strain occurs periodically it is part of **normal** human physiology and includes a natural and very effective recovery process that only requires **active rest** and activity modification

D. Contrary to popular belief, **"*permanent muscle damage from repetitive strain*" is a myth and has <u>NO basis</u> in scientific reality**.

E. Scar tissue forms following injury and muscle function is **not** permanently impaired by overuse alone. Any **"*permanent injury*"** is a misnomer for **"*chronic pain*"** that is typically caused by fear, hypersensitivity and in some cases undiagnosed pathological issues

F. **Almost** all physiological problems can be prevented or treated effectively when first perceived but they will also **require some modification** in your routine

G. **None** will **automatically** lead to pathological conditions though some may, if unaddressed for long periods (these will be discussed in Part III)

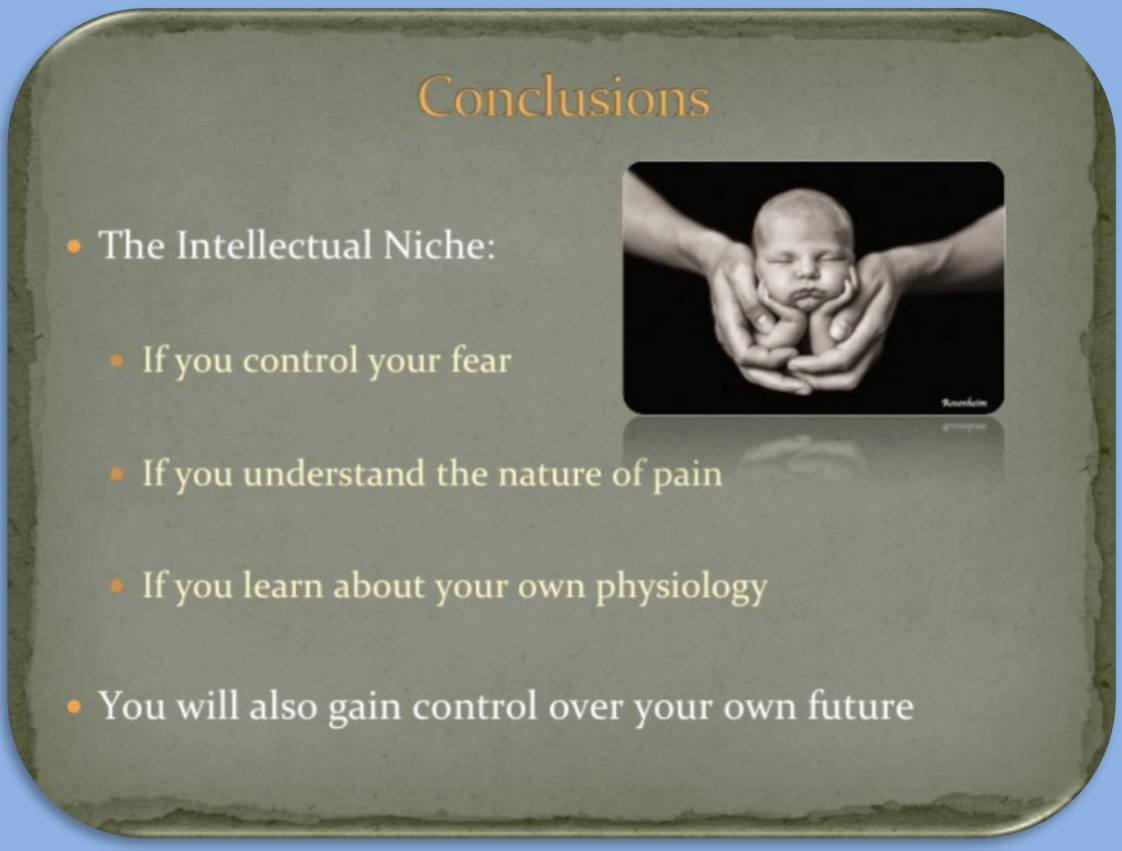


H. Due to the "*focal*" nature of your demands, sometimes even the **slightest modification** in technique, posture or practice routine can lead to a **complete** resolution of symptoms. In other words, if you can get that one little muscle that is complaining into a position of optimal stretch, your pain **may go away completely**

I. The unyielding nature of your instrument combined with your physiology may not allow you to play without some degree of pain, but if you know that it cannot cause any permanent injury and are unafraid, you may be able to desensitize it and modify its character (sensory re-education), making it only a nuisance rather than a cause for suffering or a reason for you to end your career

J. **If you control your fear**, understand the physiology and the pitfalls, use good judgment, and remain attentive to your body's signals, you can usually resolve these issues with your own ingenuity combined with advice from teachers and colleagues rather than relying on the medical community

K. **If you truly have RSI – you don't need a physician!**



**This material is intended ONLY as an educational resource for understanding the physiology of the hand and wrist as it applies to high-level and professional musicians in the 21st century. Some of the more recent concepts discussed are not yet part of mainstream medical practice though hopefully they will be in the years to come. It is not intended and should not be used as a substitute for professional medical care or as a justification for ignoring medical advice. Though I AM a retired physician and surgeon, I am not YOUR physician or surgeon and thus cannot be aware of the nuances of your individual circumstances. Once you have a professional that you trust, I STRONGLY recommend following her or his advice to the letter. You may and should however, openly discuss the concepts you glean from this document. D.G*

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