Part III:

Common Pathologies of the Hand, Wrist and Forearm

In High-Level Musicians

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Introduction:

As professional musicians, about 60-70% of you will experience some degree of chronic pain and 15-25% of you will end your careers early due to health issues. Many of these will involve the upper extremities. Your physical demands are **much more extreme** than those of many other people and as elite focal athletes you must maintain a rigorous training schedule for decades beyond other professional athletes, and deal with the normal degenerative body changes that occur with aging. At some point, those demands will exceed your physical capabilities. Because of your special demands as musicians, conditions that cause motor or sensory deficits in the hands, wrists and forearms that might be minor enough to go unnoticed in the activities of most other people, are often sufficient to end your careers. All of this makes it **intuitively obvious** that you, as professional musicians, **must be** more prone to injury and illness than other members of society. In fact, you are bombarded on the Internet with claims of your vulnerability and given endless reasons to **fear** being overwhelmed by Repetitive Strain Injury (RSI) and focal dystonia. This important issue is discussed in the "*Zoom Video Intro*" on this website and in Part II of this document.

One of the most important things to learn about ourselves as humans is that our intuitions are often wrong, since they are based on our evolution over millennia in conditions and contexts very different from those in which we find ourselves today. By our nature, we also have a tendency to manipulate information to help us confirm what we already **believe to be true** (confirmation bias). It is something we **all** do but being aware of our shortcomings, using actual data and analyzing it honestly can help us compensate for our intuitive errors.

According to U.S. Social Security Administration statistics, over 20% of **ALL** early retirees **from all walks of life** report health issues that interfere with their work as the cause, about the same percentage as professional musicians. How can this be if your physical demands are much more extreme?

If you have read Part I and Part II of this document, you will already have understood that our bodies are highly adaptive and capable of responding effectively to almost any demands we place on them as long as they are made progressively and we diligently maintain our training levels. We have excellent and highly effective repair mechanisms to heal our injuries and with innate adaptive behaviors and some contextual help, we can compensate extremely well, even for some formidable physical deficits. So, why are we surprised that professional musicians don't retire at a younger age than others and can compensate quite well for the increased physical demands and the gradual degenerative changes that occur with aging?

The answer goes back to our misunderstanding of the nature of pain. Professional musicians, on average, have significantly more chronic pain than others and if you continue to believe that this is an objective indication of a higher incidence of injury or illness, then you cannot make the distinction between hurt and harm and will likely suffer throughout your career. If the beginning of this paragraph makes no sense to you, read or re-read Part I: "*Sensation - The Nature of Pain*". This being said and hopefully understood, you are still subject to injuries and illnesses just as is every other human being, and because of your special needs as professional musicians, understanding the physiology behind some of the common conditions ("*pathologies*") that may impact your career is well worthwhile and is the topic of this section.

"*Pathological*" conditions in the upper extremities are those that are usually caused by disease processes or physical injuries and are either aggravated or made symptomatic by playing your instruments. Only a few of these do or might have a higher incidence in musicians OR may be preventable and they are highlighted in **RED.** The important thing to note is that treatment strategies should be carefully customized to fit your special needs as professional musicians. You should discuss this issue openly with your providers and seek treatment for upper extremity problems from **"*musician-competent*"** specialists when possible. Ignoring the difference between physiological and pathological conditions leads to wrong diagnoses and inappropriate treatment that could hasten the end of your career.

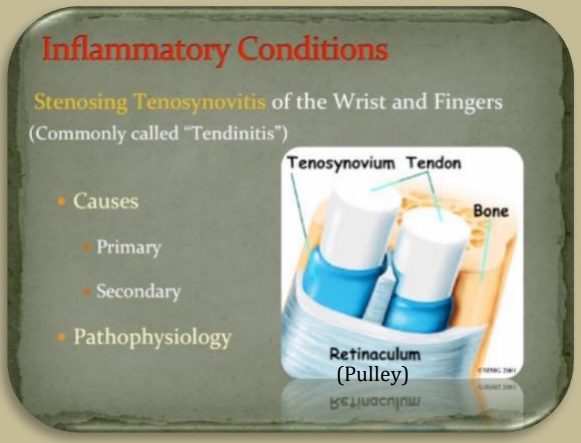
Common conditions that affect play have been included here but there are obviously many more that could be discussed, making the list and the classification somewhat arbitrary. Those chosen have been divided into four general categories: **Inflammatory, Neurological, Degenerative and Congenital/Hereditary**. For each condition we will discuss: Typical Presentation (general information and the common things people feel when they have it), Causes/Aggravating Factors, Pathophysiology/Epidemiology (some of the reasoning behind why it occurs and how common it is), Prevention, and possible Treatments.

Part I and Part II of this website were written specifically to give you the background knowledge necessary to understand the physiology behind these various conditions and if you have not read them, you will be at a significant disadvantage and much of this material will be incomprehensible unless you already possess a scientific background. While an effort has been made to give abbreviated explanations here for each condition, you will often be referred back to these previous sections for a more comprehensive and understandable explanation. You will likely find it tedious to try to read through all of these conditions and unless you find it somehow interesting and enjoyable, I don't recommend it. If you read the introduction to each of the four categories and skim through the conditions you can identify which areas may interest you now and save the others for reference material in the future. You may also wish to skip ahead to "**Tips for finding a musician-competent physician**".

Inflammatory Conditions:

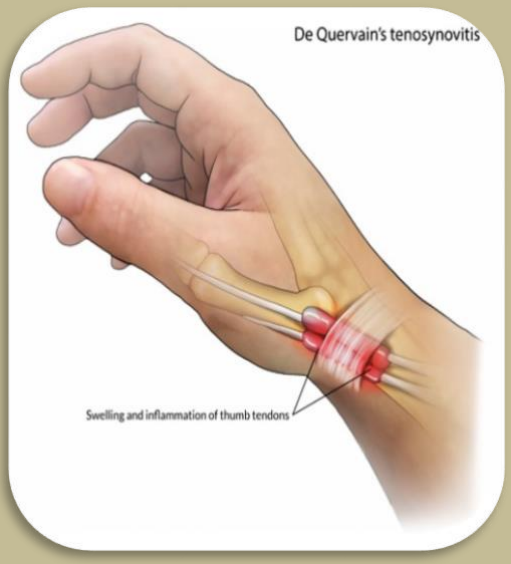
Painful motions of the wrists or fingers characterize these conditions but unlike most physiological problems (see Part II), they also include **swelling, redness and warmth**. These are the classic signs of inflammation and they are **aggravated** when you play your instrument. The origin of most of these conditions is uncertain and their onset can only very rarely be traced back to a specific incident or injury. Our natural tendency however is to assign a "*cause*" related to some "*overuse*" activity and most will try diligently to convince themselves and others of the validity of their intuitive assumptions. Unlike physiological conditions, inflammatory problems will not usually respond to changes in technique. Fortunately, they are often transient and can resolve on their own. These conditions are also **very common** in the general public and there is no clear evidence that they are more prevalent in musicians. There are two main categories:

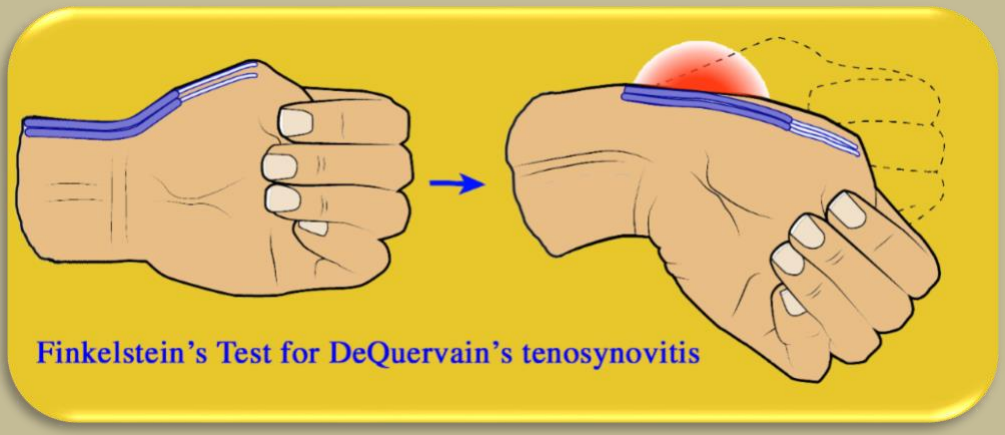
A. **Localized: "***Stenosing Tenosynovitis*" (commonly called **tendinitis** - though this is a misnomer in that the inflammatory process does not usually involve the tendon itself as much as the membrane that surrounds it – the tenosynovium) "***Tendinitis*" is unfortunately often used as a "catch-all" diagnosis** (just like RSI!) when the source of pain is uncertain. These conditions are found in **very specific anatomical locations** where tendons must glide through rigid pulley systems. The important basic concepts were described in Part I



1. Typical presentation (**these observations apply to all of the sub-groups**)
   a) Usually occurs in people over the age of 35-40 years and the incidence slowly **increases with age** – it is **the** most common hand/wrist pathology in **all** people, not just musicians
   b) If it occurs in young people before the age of 30, some underlying illness such as systemic inflammatory disease or metabolic disease **should be questioned and investigated** (these are diseases like rheumatoid arthritis and diabetes and are discussed under B. "*Systemic Inflammatory Diseases*"). If you are young and **truly** have tendinitis, your doctor will need to order some blood tests
   c) You begin to feel mild aching pain either in the wrist or the palm that is **present even at rest**
   d) The pain gradually worsens over a period of several days and becomes more localized
   e) You begin to notice **swelling, redness and warmth over the most painful area**
   f) It is usually worse in the mornings when you first get up
   g) You may feel an abrasive "*sand-paper*" like feeling or a catching or popping sensation with motion of the wrist or fingers
   h) Playing your instrument becomes very difficult or even impossible due to the pain and the decreased range of motion
   i) Almost **all** activities of daily living become painful and difficult

2. Different common types and locations
   a) **Wrist**
      1) **DeQuervain's *"disease"***: this is the most common site for wrist tenosynovitis
         (a) Pain is localized to the thumb side of the wrist ("*1st extensor compartment*") and it affects those tendons that control separating the thumb away from the hand ("*extension*" and "*<u>ab</u>duction*" of the thumb)
         (b) Holding the thumb flexed into the palm causes **extreme** pain with wrist motion and this is a reliable diagnostic test ("*Finkelstein's test*"):





(c) It is more common in people with diabetes and systemic inflammatory conditions as well as during pregnancy and just after giving birth ("*post-partum*"), possibly due to hormonal changes

(d) Once symptoms begin, they usually worsen when playing your instrument

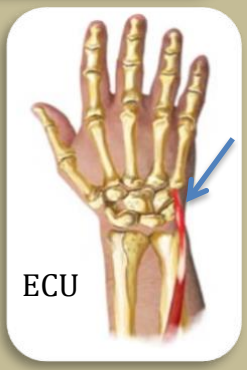
2) **Intersection syndrome**

(a) Pain is located in the forearm above the wrist also on the thumb side (top edge of the "*2nd extensor compartment*") with **pronounced swelling –** more than in other forms of tenosynovitis

(b) All motions of the wrist are painful

(c) In contrast to DeQuervain's disease, motion of the thumb alone is less painful

3) **ECU tenosynovitis** ("*6th compartment - **E**xtensor **C**arpi **U**lnaris tendon*")



(a) Little finger side of wrist otherwise similar to DeQuervain's

(b) Little or no pain with isolated motion of the thumb

b) Fingers

1) ***"Stenosing tenosynovitis"*** (finger tightness)

(a) Pain and swelling in a finger or thumb **and** in the palm along the digit

(b) Aching tightness in the finger or thumb, worse with motion

(c) Finger or thumb held in a slightly bent position compared to other digits

(d) Excruciating sharp **pain if you try to completely straighten the finger**


"Trigger"

2) **"*Trigger* finger"** (catching finger)
   (a) Same symptoms as above but the finger or thumb gets stuck in the palm after a full fist is made - any digit may be involved not just the index finger – hold your hand as shown in the picture, now turn it with the palm down. You will see the "*trigger*"
   (b) It is often especially painful in the morning when you first get up
   (c) If you pull hard enough you can straighten the finger or thumb but with a painful, sometimes audible "*clunk*" – **don't panic**! It doesn't signal the end of your career!

3. Causes /Aggravating Factors (applies to all of the above variations)
   1) **Idiopathic** (unknown) This is the primary cause – Not overuse
   2) More common in people with diabetes, hypothyroidism, systemic inflammatory disease etc. but **anyone** may develop symptoms
   3) It has always been **assumed to be caused** by repetitive use but recent studies **do not support** this – **think about it:**
      (a) Minor trauma is possible as a cause but can **rarely** be identified in patients with tenosynovitis – less than 10% of people can recall a specific incident or an unusual activity that preceded symptoms
      (b) Remember that the **weakest link** in the muscle-tendon unit is the **muscle** itself and its attachment to the tendon, and microscopic tears (strains) are possible with a sudden increase in use (these were discussed in the section on physiological pain in Part II)
      (c) The tendons are **much stronger** than the muscles and have been gliding freely through the pulley system in your wrists and fingers since before you were born
      (d) **IF** inflammation occurs with "overuse" it should be at the muscle **not** the tenosynovium
      (e) **IF** you have been practicing in a similar fashion for many years, why would you suddenly develop inflammation around the tendons unless some process within your body was causing an increased inflammatory response? Once inflammation begins, it is then **aggravated** by hand usage

(f) Many adults with no known diseases seem to experience periods of increased inflammation in various body parts quite routinely and the incidence of tenosynovitis in musicians does not appear to be any different than in the general population – ***there is no convincing reason to suspect overuse*** as causative except our intuition

4. Pathophysiology/Epidemiology
   a) It is three to four times more common in women than in men
   b) As we learned above in Part I, long tendons attached to powerful muscles must often **change their direction of pull** as joints move
   c) To prevent "*bowstringing*" they must be held in place by a rigid pulley system through which they must glide freely (if this is unclear re-read Part I)
   d) They are surrounded by a membrane that nourishes and lubricates them called the "*tenosynovium*"
   e) If this membrane becomes inflamed it swells and increases the pressure inside the pulley causing even more irritation, more inflammation and more swelling

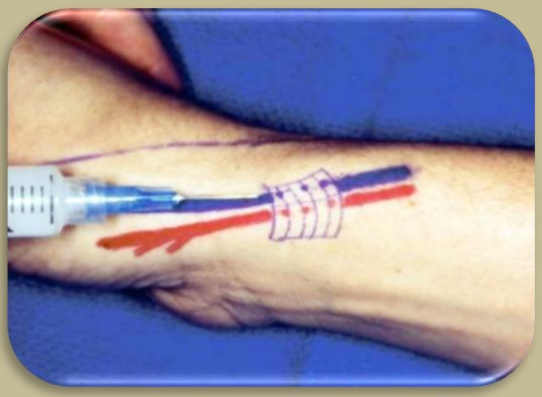
   f) This vicious circle can maintain the inflammation and pain
   g) If the membrane thickens enough, it can "*bunch-up*" and get stuck at the entrance to the pulley causing a "*clunk*" ("*triggering*") as it is forced through
   h) Treatment **must** involve either shrinking the membrane or making the pulley bigger

5. Prevention – **none known –** don't be intimidated by what you read online

6. Treatments
   1) Active rest and **NSAIDs** (see Appendix I) are the early treatments of choice
   2) "*R.I.C.E*" (Rest, Ice, Compression and Elevation) may be tried and in combination with NSAIDs, may sometimes be effective (active, not complete rest)
   3) Reduce practice schedules drastically but **do not stop playing completely** for more than a few days if you can manage it
   4) If combined with NSAID's, it is possible that splinting an affected digit in full extension (completely straight) may be helpful by keeping the

tenosynovium confined inside the pulley system, thus **reducing swelling**. The splint must extend up over the hand and keep **all** of the finger joints straight, including the knuckle, to be effective. This is initially very painful but pain improves rapidly once you get it fully straight! Use the splint at night but remove it periodically during the day and continue gentle active range of motion

5) Splinting of the wrist (or thumb and wrist in DeQuervain's) does reduce pain when you are active but is less effective in compressing the tenosynovium than it is in the fingers. You should wear a splint **at night** if it helps you sleep but, as with the finger, remove it often during the day for gentle range of motion. Night splinting is always safe because you don't normally move extensively during sleep anyway
6) Long-term splinting for any of these conditions is not only ineffective, it is harmful! The immobilization and decreased stimulation lead to hypersensitivity, increased swelling, adhesive scarring, loss of coordination and muscle wasting ("*atrophy*"), all of which foster chronic pain (see Part I), stiffness and functional deterioration
7) If symptoms don't improve beyond about 10 days or recur every time you resume your normal activities you will need medical help
   (a) If **any** physician tells you that surgery is the **only** option, get another opinion from a musician-competent provider (you might still need surgery eventually but other things should be tried first)
   (b) Systemic steroids (oral prescription medications - pills) may be used sometimes with good success and should be tried if your physician agrees. There may be side effects but they are usually mild with short-term use (see Appendix II)
   (c) Local steroid injections (see Appendix II) are **by far the safest, most effective and least disruptive** treatments for these conditions if full range of motion is commenced immediately (these measures can shrink the membranes very rapidly breaking the vicious circle)



(1) Return to unrestricted activity can safely be done very rapidly if pain resolves (often within a few days and nearly always less than 2-3 weeks)

(2) **Once the injection is done**

1. Move the wrist, finger or thumb as much and as often as possible. This will distribute the steroid and numbing medication along the tendon sheath, rapidly decrease pain, and improve its effectiveness while reducing complications
2. Desensitizing of an area of active inflammation is not very effective and can aggravate the inflammation itself however, once the inflammation is subsiding, typically within 24-48 hours of the injection, desensitization (stimulation and massage of the **most** painful areas) can be **very** helpful in reducing pain rapidly allowing a return to normal activities

(3) An injection may be safely repeated, if necessary, provided that:

1. Three months or more have elapsed between episodes
2. Meticulous efforts are made by the treating professional to avoid injecting into the substance of the tendon
3. Motion is begun immediately – This is helped by a long-acting local anesthetic (numbing medication) that is mixed with the steroid
4. Using these criteria, local steroid injections are **extremely** safe. Over a period of 30 years, I gave thousands of these injections without a single major complication

(4) Success with injections can be as high as **90%** so if these conditions interfere with your career, **control your fear and get the shot!** This is the reason why bypassing the conservative measures and going directly to surgery is not the best plan!

(d) Surgery - if symptoms are persistent in spite of these measures or you experience multiple recurrent episodes, then surgery is the only

reasonable treatment (see Appendix III for observations on: "*Upper Extremity Surgery in Musicians*")

(1) Surgery makes the pulley bigger and breaks the vicious circle. It is a way of bypassing the underlying problem and is essential in those people whose inflammation is not transient but is chronic. Surgery almost always gives permanent symptom relief

(2) Appropriate rehabilitation with early range of motion and rapid return to play to avoid adhesive scarring is **critical** in professional musicians and should be discussed with your surgeon early on

(3) The complication rate with these surgeries is low and they are usually well tolerated by professional musicians

8) Typically, these localized inflammatory conditions are **not** career-ending (unless you cannot overcome your **fear**) and no matter what treatment is required, return to professional play is fully expected

B. Systemic (whole body) inflammatory diseases

A. Typical presentation

1. Examples
   a) Rheumatoid arthritis
   b) Lupus
   c) psoriatic arthritis
   d) Crohn's disease
   e) There are **many** others that are more subtle and can be difficult to diagnose
2. Early symptoms may involve generalized fatigue, low-grade fever as well as pain and swelling in several joints
3. Morning stiffness is very common, making it difficult to get out of bed and begin your activities
4. Rashes and changes in skin color may occur
5. Loss of appetite and unexplained weight loss are common
6. In Crohn's disease early symptoms may involve abdominal pain, diarrhea and bloating

7. **If untreated**, systemic inflammatory diseases can cause pain and severe deformities of the hands and wrists that will often end your career over a period of months or years
8. Diabetes is **not** an inflammatory disease but a "metabolic" one, which means it involves the body's chemical regulation rather than the immune system. It is mentioned here only because it is **associated with a higher incidence of tenosynovitis** in the wrist and hand

B. Causes /Aggravating Factors
   1. Unknown but **not related to overuse**
   2. Some hereditary influence
   3. These conditions **cannot** either come from or turn into **osteoarthritis**

C. Pathophysiology/Epidemiology
   1. These are "**autoimmune"** diseases, meaning that the immune system mistakenly attacks some of the body's own cells. They may begin either in childhood or early to mid-adulthood, 30s and 40s, rarely after age 55
   2. They affect 8% of the population, women 3 times more often than men
   3. They increase the likelihood of stenosing tenosynovitis and triggering (see the section above under "*Localized Inflammatory Conditions*")
   4. The immune system fails to recognize certain cell types as part of its own body and attacks them as if they were "*invaders*"
   5. This triggers an immune response that can be extensive and destructive to these cells causing chronic inflammation
   6. Joint cartilage, ligaments, synovial (and tenosynovial) membranes are usually involved causing tissue damage, laxity, and progressive deformities
   7. There is no known cure as yet but many promising avenues are opening at the time of this writing

D. Prevention – none known

E. Treatment
   1. These conditions usually require the long-term use of medications to keep them inactive (in "*remission*")
   2. These include "*anti-inflammatories*" and "*immunosuppressors*"
   3. Fortunately, many new and effective medications that are available today can often keep these diseases in check and they may allow you to continue to play through a normal career!

Neurological Conditions:

Pathological conditions affecting the motor and sensory nerves as they travel to and from the extremities (the "*peripheral nervous system*") and those that affect the nerves that are found within the brain and spinal cord (the "*central nervous system*") have very different symptoms and very different treatments and thus make a very basic and important distinction in their classification.

Conditions affecting the peripheral nerves are typically felt as numbness, tingling or muscle weakness and are usually caused by a nerve being squeezed or pinched ("*nerve compression*") by some internal or external mechanical force.

Those affecting the central nervous system however, are usually felt as a loss of coordination or voluntary control, sometimes accompanied by muscle tightness, twitching or spasm. They usually have more complex causes at a cellular level in the brain or spinal cord.

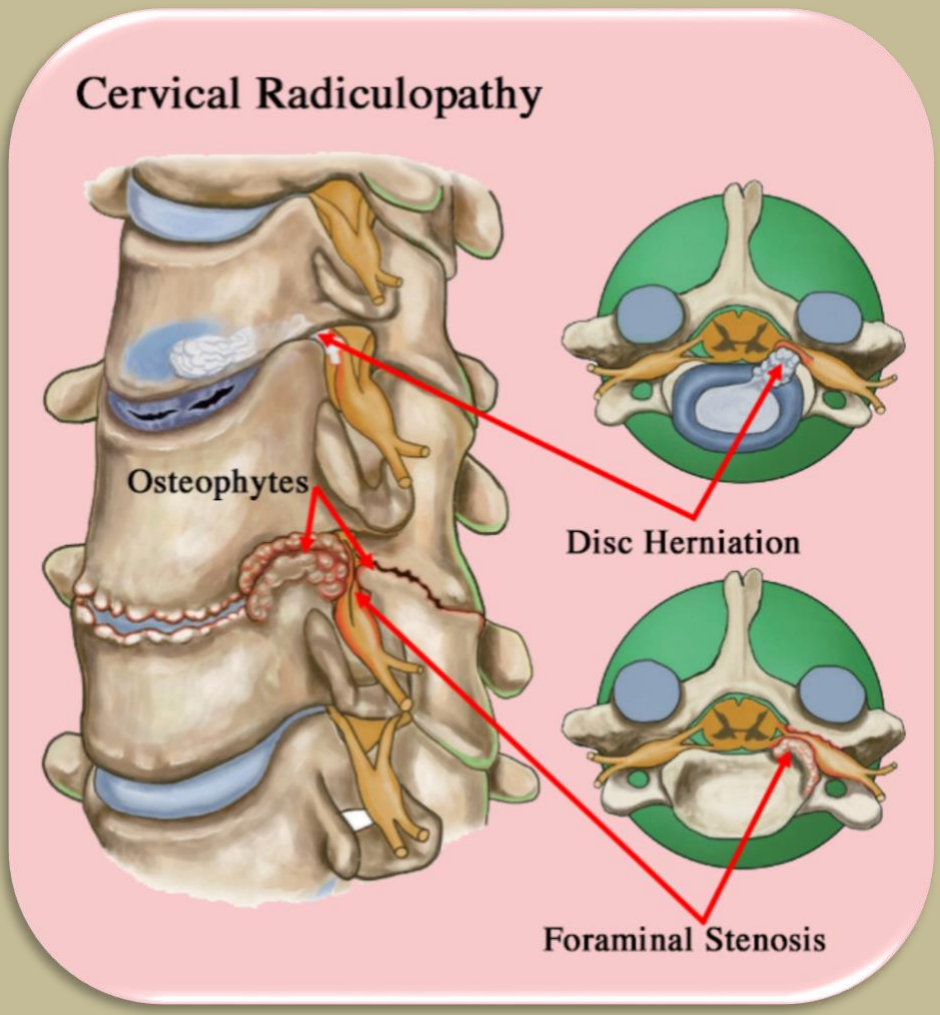
Peripheral nerve conditions often require surgical treatment since they are caused by mechanical problems whereas central nervous system conditions usually require medical treatments or in some cases, no effective treatments are available.

A. **Peripheral nerves** – pinched nerves *("compressive neuropathies"*)
   1. **Neck**: "*Cervical Radiculopathy*" involves pressure on a nerve in the neck that travels between the spinal cord and the arm and hand, typically as it exits the spine ("*vertebral column*"). "*Cervical*" means in the neck, "*radiculo*" means pertaining to a segment of nerve close to the spinal cord, and "*pathy*" means an abnormality, in this case the pinching of the nerve
      a) Typical presentation
         1) The problem is in the neck but the symptoms are often felt more in the arm, forearm and hand
         2) It usually occurs in people over the age of 40, often over the age of 50
         3) It may begin with neck or arm pain and/or numbness and tingling that travel ("*radiate*") into the hand. It almost always involves **only one side** (is "*unilateral*")
         4) It can sometimes be mistaken for carpal or cubital tunnel syndrome (discussed below)
         5) The onset may be sudden or gradual and it can sometimes feel like an electric shock that seems to occur randomly
         6) In more severe cases it may be associated with weakness in the shoulder, arm or hand
         7) If you pay close attention, you will often find that it feels either better or worse with different positions of the neck (usually worse looking up toward

the sky or turning the head fully to one side and better looking down at the floor or turning the head to the opposite side)

8) It may worsen over time but the most common scenario is that it gradually improves spontaneously and symptoms may disappear completely though the process may take months or years. So, it may not require treatment

b) Causes/Aggravating Factors



1) Most commonly it is due to the aging process or some previous minor injuries causing gradual changes in the spine that decrease the size of the exit passage ("*foramen*") causing pressure on the nerve

   (a) In some cases, the pad ("*disc*") between two of the bones of the spinal column can break ("*rupture*") allowing some of the softer internal substance ("*nucleus pulposus*") to push out and press on the nerve ("*disc herniation"*)

(b) In other cases, the joints between two of the bones may wear from loss of congruence (see Part I) either due to the aging process ("*osteoarthritis*" - by far the most common) or to previous minor injuries ("*post-traumatic arthritis"*) causing damage to the cartilage surfaces, allowing the bony portions of the joints to come into contact with one another. This in turn causes bone spurs (called *"osteophytes*") to form at the joint edges and thus decrease the size of the nerve passage ("*foraminal stenosis")*

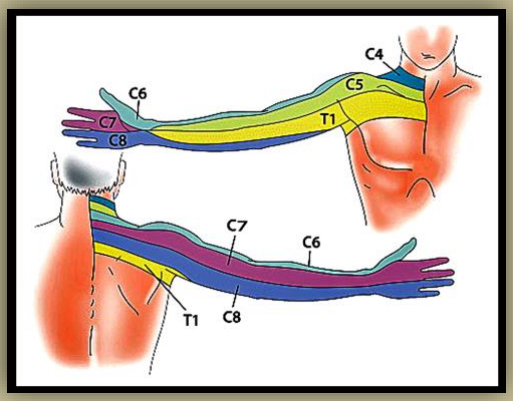
(c) In both cases, the conditions are classified as "*degenerative*" because they involve gradual deterioration that comes normally with age and usage

2) A sudden ("*acute*") onset of symptoms may occur when mechanical forces are applied to the neck such as in a minor car accident or a chiropractic manipulation, causing a sudden disc rupture ("*acute herniation*") or the displacement of existing bone spurs, and be severe enough to cause weakness or even paralysis but this is very unusual. Pre-existing degenerative changes are almost always present when this occurs

c) Pathophysiology/Epidemiology

1) Incidence is 107/100,000 people/year in men and 63/100,000 in women, thus 1.7 times more common in men than women
2) Occurs more frequently in white people and smokers
3) Symptoms and signs are different depending on which nerve root is affected. The nerves are numbered from 1 to 8 in the C-("*Cervical*") spine. C7 is the root most commonly involved, followed by C6, then C8. Numbness, when it occurs, may be felt in the areas of skin shown below
4) In 70-90% of people, symptoms either become mild or resolve completely over a period of **2-4 years**. Unfortunately, as a professional musician, the degree of finesse required to play your instrument may be such that the minor motor and sensory deficits that often go unnoticed in most people, combined with the very long recovery time, could be enough to end your career though this is not very common

Sensory areas affected by nerve root compression:



5) The diagnosis is often made by the history and clinical exam but neck imaging (x-rays, MRI etc.) and nerve testing (EMG) is typically done to help quantify the involvement and rule out other issues

d) Prevention – None known

e) Treatment

1) Often conservative with medications (NSAIDs or steroids – see Appendix I & Appendix II)
2) Physical therapy may be helpful
3) Early use of traction and/or a neck brace can sometimes reduce symptoms dramatically but these are not long-term solutions
4) **IF** there is significant weakness involved and a **very** recent sudden onset, sometimes surgery is considered to decompress the nerve but this is rare

2. Carpal tunnel syndrome (CTS)

a) Typical presentation

1) Usually occurs in people over the age of 35, even more often over the age of 50, and progresses over many years – it is the **most common** form of nerve compression
2) Compression typically begins months or years **before** you notice any symptoms
3) The median nerve is gradually squeezed at the wrist where it passes from the forearm and into the hand
4) This causes progressive (slowly increasing) numbness and tingling in the **thumb, index, long, and half of the ring finger** (the purple area in the illustration)
5) It may sometimes also cause aching pain in the hand, wrist and forearm
6) Symptoms are usually worse at night (often awakening you from sleep) and when you first get up in the morning, gradually improving during the day and with activity (contrary to popular belief)
7) You often begin to feel the same symptoms beginning in the other hand though not as pronounced initially (involves both hands >50%)
8) At first, symptoms often disappear when you play your instrument but get worse in between long practice sessions or again at night

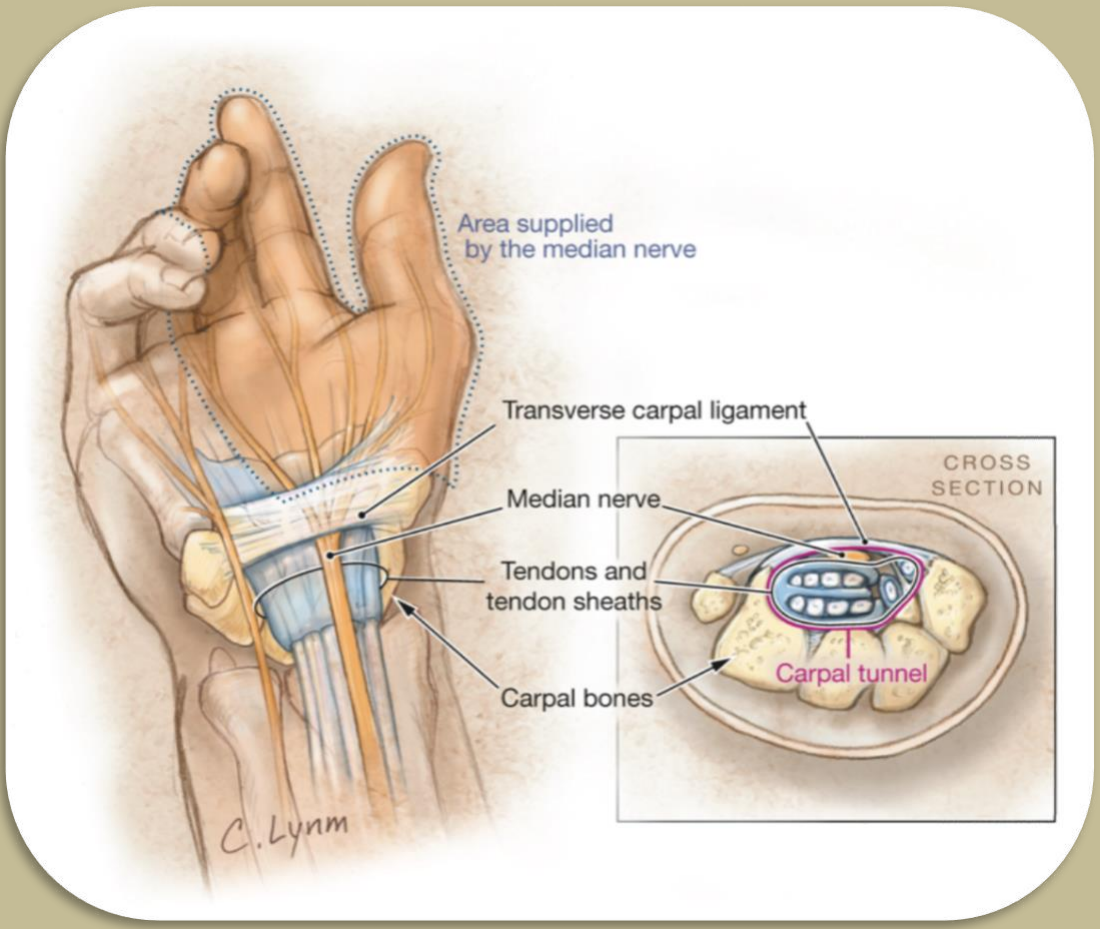
9) Your playing quality deteriorates gradually as sensation (feedback) becomes impaired. Deterioration may go completely unnoticed in some non-musicians
10) In severe cases, weakness of thumb opposition (see Part I) occurs and is especially noticeable in pianists and string players. The intrinsic muscles at the base of the thumb gradually waste away ("*atrophy*") from lack of stimulation as the nerve becomes more and more compromised

11) Grip strength and lifting strength are **not** directly impaired contrary to popular belief, because they come from "extrinsic" muscles (see Part I) that are unaffected by **CTS**
12) If left untreated it will eventually end your career, but it may take 5-20 years or more depending on your rate of progression and which instrument you play. Brass players for example, may be able to tolerate the deficits better than others

b) Causes/Aggravating Factors
1) Primary - The vast majority of **CTS** is "*primary*" or "*idiopathic*". This means that we don't yet completely know and understand the underlying causes
2) Secondary - A small percentage of carpal tunnel syndrome is "*secondary*" to other underlying conditions that may cause thickening of the tenosynovium such as (to name only a few):

(a) Rheumatoid arthritis (or other forms of systemic inflammatory disease i.e., lupus, Crohn's disease etc. – all usually seen in younger people)
(b) Diabetes (risk of **CTS** reaches 85% after 54 years of type 1 diabetes)
(c) Pregnancy ("*gestational CTS*"), usually during the last 3 months
(d) Hypothyroidism
(e) Gout
(f) It may be transient and resolve with the underlying condition (i.e., after receiving thyroid supplements, giving birth etc. – gestational **CTS** is very common and almost always recovers fully after the birth of the baby)

c) Pathophysiology/Epidemiology in "*idiopathic*" **CTS**
1) Approximately 10% of **all** people will develop symptoms at some point during their lifetime, women about 3 times more often than men, usually beginning over the age of 45 years (prevalence in the adult population at any given moment is 2.7-5.8%)
2) Since its description just after the World War II, it has been **empirically assumed by all** that **CTS** is **caused by** some form of **repetitive overuse** of the hands and wrists and researchers have struggled to try to prove this intuitive assumption since then (Like everyone else, we doctors don't like to feel that we were wrong!)
3) More recent scientific literature **does not support this conclusion**
4) It has a strong hereditary tendency – if several of your family members had it, your chances of getting it are higher, but remember you are an individual
5) Though it appears **not to be caused** by repetitive use of the hands, it may either become symptomatic or **symptoms may be worsened** by forceful or repetitive activities, **especially** in extreme positions of the wrist. This is the source of the mistaken assumption about causation. Remember that correlation does not imply causation!
6) Because, as professional musicians you represent less than 0.02% of the population of the United States, we do not have reliable statistics about your specific group but there is **no convincing evidence to suggest that you are more likely to develop CTS** than anyone else – about 1 out of 10 of you will develop it in your lifetime
7) **CTS** is overwhelmingly the best candidate for the ***"most erroneous information available on the Internet"*** and it is very unfortunate that you should continue to be told that you face imminent danger as musicians or that you should perform rituals to prevent it!
8) The carpal tunnel is a **closed and rigid space** that forms the "*pulley*" that prevents your flexor tendons from "*bow-stringing*" away from your wrist when it is fully flexed (see an illustrated discussion in Part I)



9) The median nerve travels through the tunnel along with the 9 tendons that allow you to flex your fingers and grasp objects
10) They are surrounded by membranes ("*tenosynovia*") that nourish and lubricate them
11) These membranes gradually thicken ("*hypertrophy*") with age and/or with diseases or conditions that affect them
12) As long as there is enough space in the tunnel to accommodate the thickening there is no problem and no **CTS.** The size of the space is largely determined by your heredity
13) If there is not enough space, then the thickening increases the pressure inside the tunnel, squeezing the nerve and reducing its blood supply until it cannot function normally (= "***too much stuff in too little space***")
14) It occurs gradually and progressively over a period of many years (2 to 25 approximately) becoming stable when the nerve is no longer functional
15) The diagnosis of **CTS** is made by an appropriate history and a set of clinical signs and symptoms – a nerve test (EMG) may **help** confirm **BUT**:
    (a) **The diagnosis <u>cannot</u> be made by a nerve test alone!**
    (b) Nerve compression may exist for many years before symptoms begin

(c) The nerve test indicates that compression exists but **NOT** that it is the source of symptoms. Though it has not been studied in the general population, about 20% of diabetic patients who have nerve compression on EMG have no symptoms of CTS. That corresponds with my own observations of the entire patient population I saw over 30 years. It takes a trained and experienced practitioner to accurately make the diagnosis, **not just a test result**

(d) **This distinction is crucial if surgery is to be successful in relieving symptoms. If** surgery is done on the basis of **test results alone**, about 20-30% of patients will not get significant symptom relief and an even higher percentage will be dissatisfied with their result, gaining only partial relief because other concurrent conditions are very often present

(e) This is why a diagnostic local steroid injection is desirable and should be considered before surgery (see below) - If there is **good temporary relief** of symptoms with the injection, surgery **will** give permanent relief in almost every case

d) Prevention

1) For primary CTS– **NONE KNOWN**
2) For secondary CTS – treat the underlying condition unless it's temporary i.e., pregnancy, then treat only the symptoms

e) Treatment – **only 2 options are possible** for "*too much stuff in too little space*": make the "*stuff*" smaller (shrink the membranes) or the space bigger (increase the size of the tunnel)!

1) Shrink the membranes
   (a) Sometimes NSAIDs or systemic steroids can shrink the membranes slightly especially if there is inflammation present but they are usually only minimally helpful and work only on a temporary basis (see Appendix I and Appendix II)
   (b) **Local steroid injection** in the carpal tunnel shrinks the membranes **reliably** and can serve as a diagnostic test and an **excellent short-term treatment**
      (1) It can fully relieve symptoms during pregnancy
      (2) It can buy time when there is a reason to put off surgery

(3) Unfortunately, this is **only temporary** and the membranes return to their previous thickness over time (usually 3-6 months but varies widely)

(4) It may be repeated at 3–6-month intervals **if** the goal is only to reduce symptoms and **not to cure** the condition, but sensory and motor **deficits will continue to slowly develop** even though patients tolerate their symptoms better on a long term

2) Increase the size of the tunnel

(a) Wearing a brace +/- (doesn't **increase** tunnel size but **prevents decreases**)

(1) Bending the wrist to either extreme makes the tunnel slightly smaller and can make symptoms worse if held for a period of time

(2) Wearing a brace that holds the wrist straight **<u>at night</u>** can help prevent you from waking up with symptoms but it is usually only temporary and the night symptoms gradually recur even with the splint

(3) Wearing a brace or splint during the day is **not beneficial** and may be counterproductive by causing loss of strength and coordination

(4) Wearing a splint on a long term **cannot cure CTS** though it may serve to help a person **adapt to the deficit** and to accept it over time

(5) Thus, except at night, it is **not an appropriate treatment** for a professional musician. The deficits will still compromise your career

(b) Surgery (see Appendix III)

(1) Increasing the size of the tunnel permanently is the **only** possible **<u>cure</u>** for worsening primary **CTS regardless of what you read on the Internet –** decreasing symptoms **does not cure** the problem!

(2) **All other treatments** that may indeed help reduce symptoms, involve adapting to and tolerating the deficits that continue to progress gradually and this path will typically **end your career** in any case

(3) It is reasonable to put off surgery if your ability to play is not yet compromised and you foresee your retirement soon approaching anyway, but surgery after you retire is still the best solution

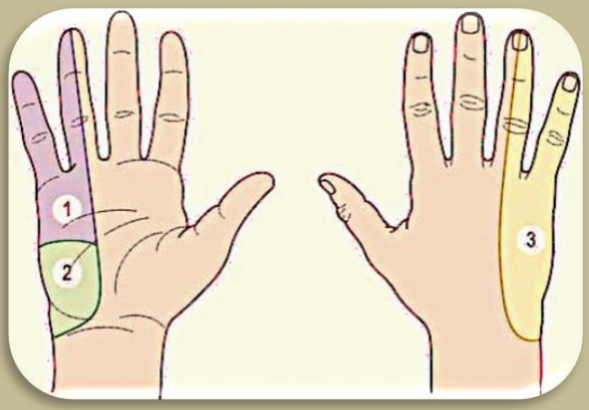
(4) The results of surgery are **immediate if** it is done **before** your ability to play is compromised – if done after, expect it to take up to **1-2 years** before you fully regain or surpass your prior level of play

(5) Carpal tunnel surgery is one of the least invasive and best tolerated interventions for a musician and should be **seriously considered when indicated**

3. Cubital tunnel syndrome

a) Typical presentation (13 times **less** common than carpal tunnel)

1) May occur in people as young as their 20's but is more common in people in their 50s and 60s



2) Often begins with a vague aching pain on the inside of the elbow especially when it is fully bent ("*flexed*") or laying on a flat hard surface

3) You may then begin to feel numbness and tingling in the **ring and small fingers** often in the morning when you first get up or towards the end of a long practice session. It is almost always felt in all three colored zones marked on the illustration because the compression site is almost always at the elbow and the remarks here apply to that variety. If the numbness is limited to **only** one of the 3 zones it may be due to other rare compression sites outside the realm of our discussion

4) Initially it goes away when you are active and you may not think about it for several days at a time

5) It gradually becomes more prominent until you realize that you have some aching numbness constantly in the ring and small fingers, often associated with some deep aching pain on the inside of the elbow

6) You begin to miss notes off and on

7) You may start to notice that your hand feels fatigued after only short periods of practice and you may experience muscle cramping in the hand

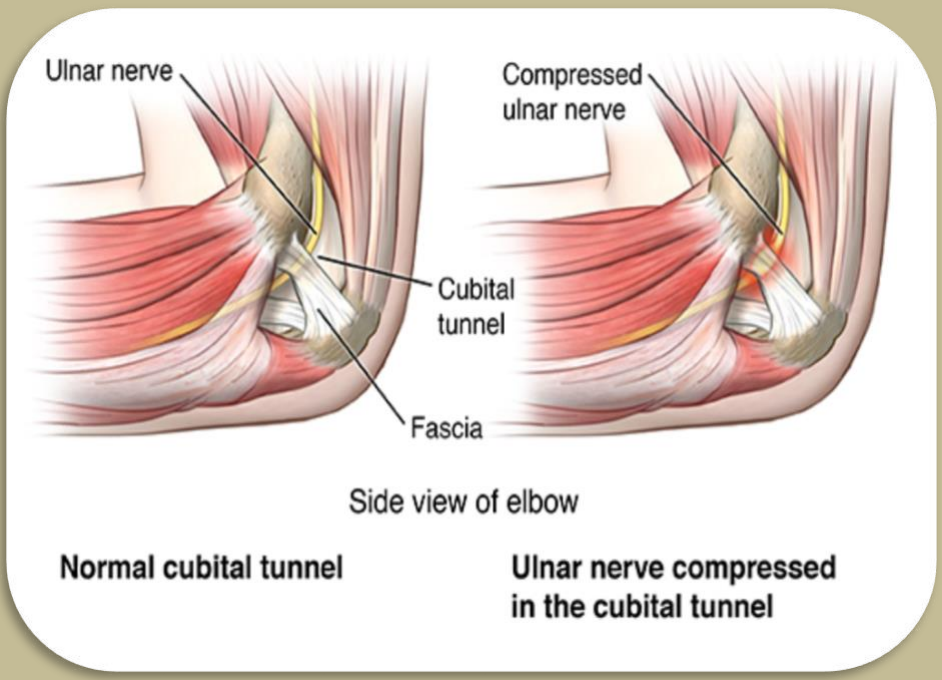
8) In late stages you will find that your reach is compromised and you will begin missing notes that are played in extreme positions

9) If you look for it carefully, you will eventually notice a sunken spot between your thumb and index finger on the top of your hand (muscle "*atrophy*") and your ring and small fingers may not fully straighten when you actively try to flatten your hand

10) If left untreated, it will typically end your career over a period of about 2-10 years depending on what instrument you play

b) Causes/Aggravating Factors
   1) This **may be one of the conditions that is more common in professional musicians** but since it is quite common in the general public, **this is uncertain**
   2) Anatomical variations (genetic components) may play an important role but there is no way to know if you might be more susceptible unless a family member has or had this condition
   3) It may be caused by and is almost certainly aggravated by:
      (a) Holding the elbow in a fully flexed position for prolonged periods, as in sleeping positions and/or in your case, playing positions
      (b) Frequent or prolonged pressure applied to the inside of the elbow by resting it on a hard surface i.e., table, desk, recliner, instrument, etc.

c) Pathophysiology/Epidemiology
   1) The nerve travels from the arm to the forearm on the back inside of the elbow through a groove in the humerus (people call this groove the "*funny bone*" because bumping it stimulates the nerve causing a sensation of electric shock!)
   2) The nerve is stretched to its maximum length when the elbow is fully flexed – this "*pulls*" the nerve against the hard bony surface of the humerus



3) If the nerve is flexible enough and there is enough space in the groove, nothing happens and the syndrome will not develop
4) With age, tissues become less flexible and stretching the nerve by holding the elbow fully bent may reduce its blood supply ("*ischemia*")
5) Even though the nerve is usually protected from impact by the bones that protrude on either side of the groove, applying pressure over the groove compresses the nerve, reducing its blood supply even further
6) Less than 0.5% of people will experience cubital tunnel syndrome, so it is uncommon
7) It will involve both arms in about 20% of people who have it

d) Prevention
1) Learn to **sleep without fully flexing your elbows** – even in musicians **sleeping positions** are often the most significant factor! You may get away with it when you are young but your risks increase as you get older
2) Avoid sleeping on your stomach ("*prone*") since that usually requires you to keep your elbows completely bent ("*flexed*")
3) Mild flexion up to about 70 degrees is fine and is usually most comfortable
4) **Do not** sleep or sit for long periods in a recliner unless you have extra-soft pillows behind your elbows
5) Pay close attention to posture – remember that optimal muscle stretch usually means playing in positions that are close to "*neutral*", so the elbow should be about in its middle range or slightly extended to less than 90 degrees – attention cellists: reduce your left arm flexion whenever you can!

6) Pianists adjust your bench height higher so that your elbows are slightly straighter
7) Remember that the **tiniest adjustment** in position can sometimes make a world of difference! (see Part II)
8) If your instrument requires you to use significant elbow flexion, take frequent short stretch breaks and get in the habit of resting your arms with the elbows extended when you are not playing
9) Pay close attention to your habits, we do lots of things we're not aware of! Resting positions are often critical

e) Treatment
1) Activity/position modifications – all of the preventive measures mentioned above work **extremely well** for treatment if addressed early when symptoms first begin. **Unlike CTS**, if you are diligent, and catch it early enough you may be able to **reverse this process and avoid surgery!**
2) If you keep waking up with your elbows completely bent and can't seem to train yourself:
   (a) Get an extra pillow and just before going to sleep slip your arm inside the pillow case with the pillow at the front of your elbow
   (b) This still allows elbow motion but prevents full flexion
   (c) Continue this every night for at least a month and repeat it periodically if you start slipping back into your old habits
   (d) If you still can't train yourself and keep finding the pillow on the floor, wrap a big soft bath towel around your elbow before going to sleep and tape it loosely above and below your elbow – this is soft enough to still allow you to flex comfortably but prevents full flexion

   (e) Do **whatever it takes** to adopt a sleeping position with your elbows in a slightly extended position (not completely straight) – there are many, many commercial braces available but it just usually isn't necessary to spend the money on them – do it however if you can't manage otherwise

(f) If you have symptoms and ignore this step, you are doomed to failure!

3) Surgery (see Appendix III)
   (a) If you cannot reverse the progression with the above measures, the only option for a cure is surgery. Remember that progression will almost certainly end your career so living with the deficit is usually not a good option anyway
   (b) Surgery makes more space for the nerve by opening the tissues over the groove and/or re-routes the nerve towards the front of the elbow to shorten its trajectory so it isn't stretched against the bony epicondyle

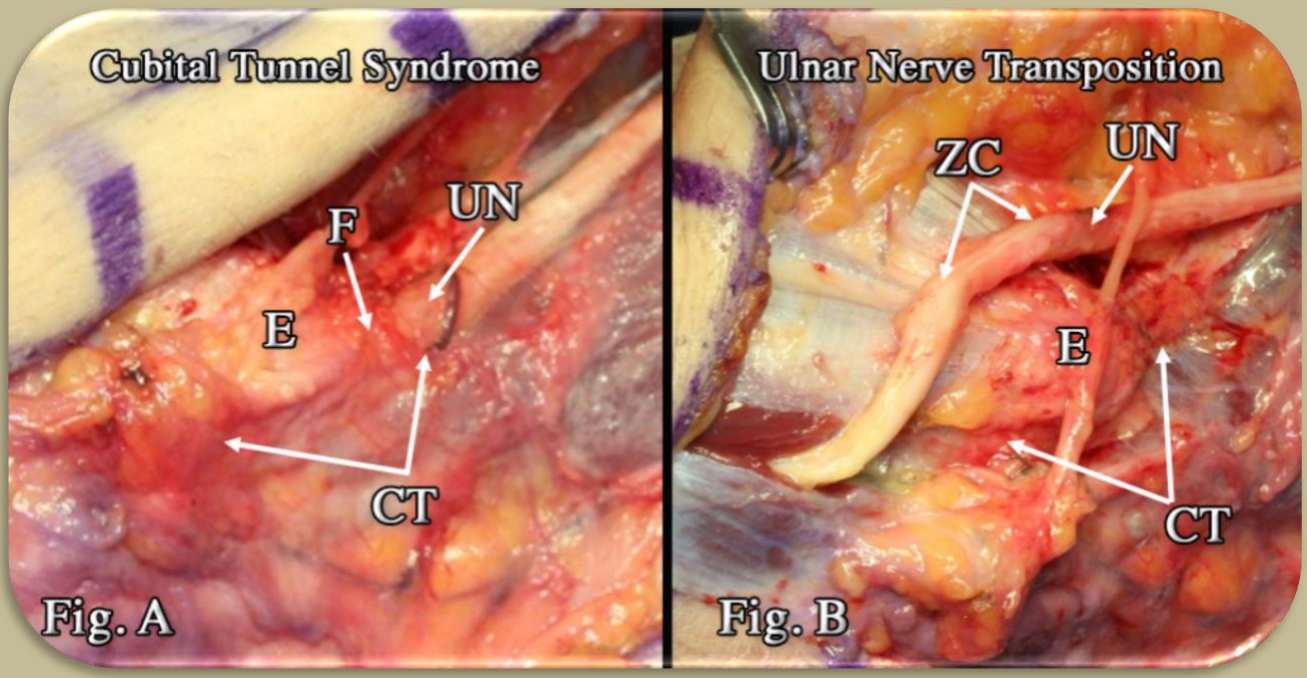
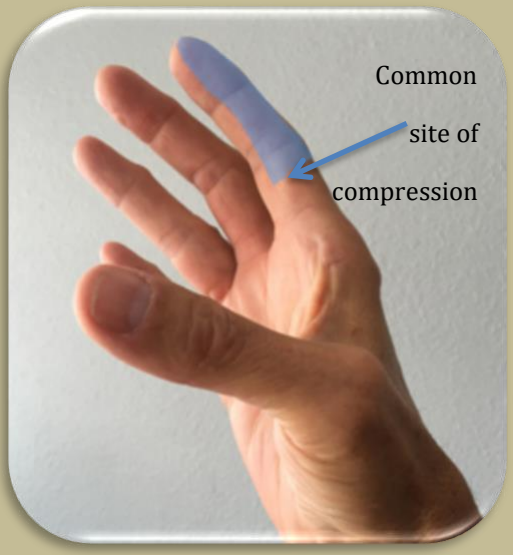


Fig. A, Before decompression: The ulnar nerve (UN) is shown at the top ("*proximal*") edge of the cubital tunnel (CT) just as it goes beneath the thick tissue ("*fascia*") (F) that covers and limits the space in the tunnel. The epicondyle (E) is the bony prominence you feel on the inside of your elbow just in front of your "*funny bone*", the ulnar nerve. Fig. B, After decompression: The fascia (F) has been opened and the ulnar nerve (UN) has been freed from the cubital tunnel (CT) and transposed in front ("anterior") to the epicondyle (E). Notice that the nerve is flattened and has a pink discoloration in the zone of compression (ZC) where it was chronically "*squeezed*". The nerve trajectory is now shorter so the nerve is no longer pulled against the epicondyle when the elbow is fully bent ("flexed"). E and CT are in identical locations in the two pictures, allowing you to compare the outside and inside of the cubital tunnel. Prior to surgery, the ulnar nerve (UN) was tethered and squeezed in the groove behind the epicondyle (E).

   (c) This is a more significant surgery than carpal tunnel but may still allow you to return to professional play
   (d) Full recovery can **only** be expected if you intervene **before** a significant muscle deficit occurs and even sensory deficits take up to 2 years to recover
   (e) Younger musicians will do better than older ones

4. **Digital nerve compression** – this is one of the only pathologies actually **caused** by your playing and not a disease process that is aggravated. It also **may be more common in musicians**. If ignored for a very long period it could lead to a permanent deficit but usually does not.

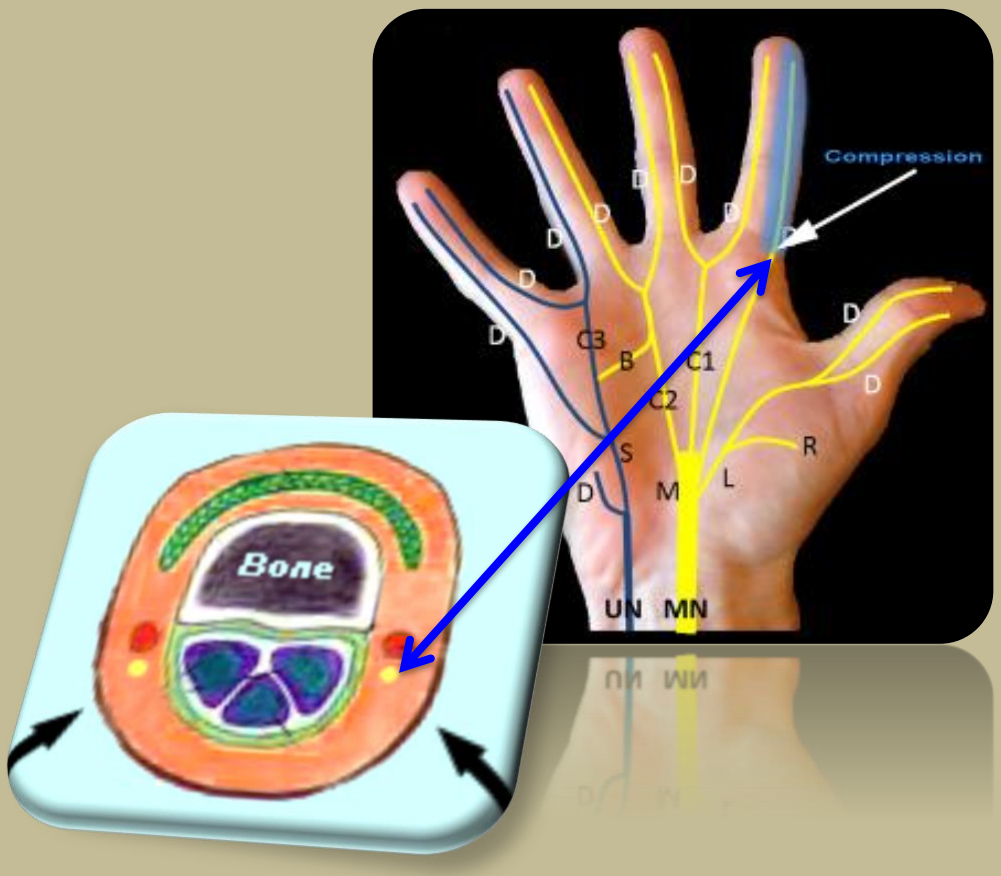


   a) Typical presentation
      1) May happen to anyone at any age but is more common in younger musicians who are still learning techniques - attention trombonists!
      2) **One half of a finger** tingles off and on while you are playing. It is most often the index finger or the thumb but any finger could be involved depending on the site of compression
      3) It goes away when you stop playing and you forget about it for awhile
      4) Gradually it starts to occur more and more often
      5) The tingling turns into partial numbness and begins to persist for several hours after you stop playing
      6) You begin to notice some constant numbness in that half of your finger that does not go away

   b) Causes/Aggravating Factors
      1) Repeated or prolonged external pressure at **precisely** the same site along a digital nerve
      2) Almost always related to an aspect of technique

   c) Pathophysiology/Epidemiology
      1) Each digital nerve is round and about the size of a #2 pencil lead
      2) It gives sensation to one half of one finger
      3) It usually rolls from side to side when you try to press on it but is tethered at its extremes of motion by the tissue ("*fascia*") that surrounds it
      4) If pressure is repeatedly applied and/or held for a long period when the nerve is tethered and cannot roll away, its blood supply is reduced ("*ischemia*") which initially causes tingling
      5) If this is repeated often enough or long enough, some of the nerve axons will be damaged and will degenerate causing constant numbness ("*neurapraxia*") over the entire area served by that nerve ("*Wallerian degeneration*") all the way to the fingertip

6) You can find the precise site of injury by tapping along the palmar side of the half of the finger that is numb. When you tap the affected spot, it will give you



a small "*electric shock*" sensation (Tinel's sign)

(a) This is the spot where pressure is being applied

(b) Mark the spot with a pen and hold your instrument

(c) Something will be pressing on the finger at that site

(d) If it is not your instrument, it is some other device or activity i.e., scissors, bowling ball etc.

7) This damage is **almost always reversible** when your technique is changed and the compression stops but full recovery usually takes **several months**

d) Prevention - Be attentive to areas of constant pressure where you hold your instrument

e) Treatment

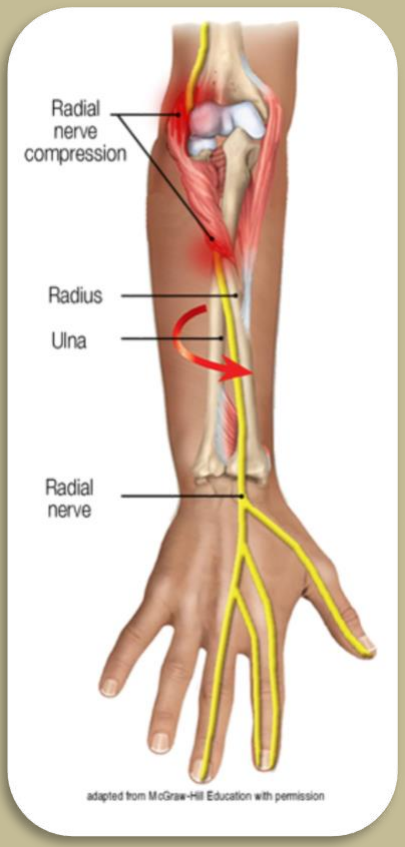
1) Don't panic!

2) This only requires a modification in technique or in some cases a small piece of padding applied to the instrument or your finger at the site of contact

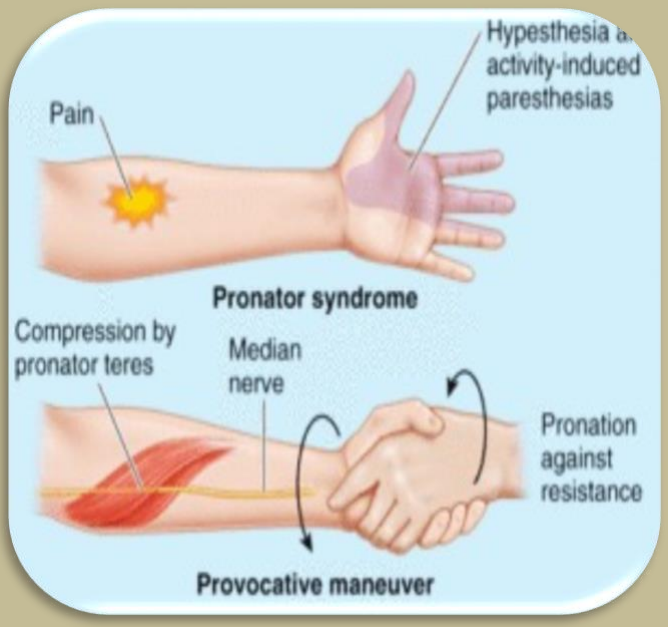
3) It will go away completely after you have corrected the problem (whether or not you allow yourself to be scared during the few months it takes!)

4) You can monitor its progress by tapping along the nerve every few weeks and you will see the Tinel's sign ("*electric shock*") gradually move toward the tip of the finger and then disappear as sensation returns to normal
5) As long as you have addressed the pressure site that caused it and you begin to feel gradual improvement, you do not need any other type of care

5. **Radial Tunnel Syndrome and Pronator Syndrome** – these pathologies are quite rare but there is a logical mechanism where they **might** occur more commonly in musicians. They are not frequent enough however for any valid studies to determine this and no conclusions can be drawn. Even the diagnoses are subjective and no definitive tests exist to clearly confirm their presence. Only an experienced musician-competent physician can make these diagnoses.
   a) Typical presentation (similar with minor variations for both conditions)
      1) You begin to experience a vague aching pain in the forearm after variable periods of play
      2) The location of pain is difficult to pinpoint but often begins near the elbow and extends down to the wrist
      3) It is associated with a sensation of generalized fatigue in the forearm and hand and you may feel that you are unable to continue to play
      4) Pain and fatigue subside quickly after you stop playing and at first are gone within a few minutes
      5) The symptoms seem to begin more rapidly and take longer to go away as time goes on
      6) You may experience some tingling or vague numbness in the hand mainly in the thumb, index and long fingers, on the top side in radial tunnel and on the palm side in pronator syndrome
      7) Because these conditions are rare and the diagnoses are elusive, you will usually be told that you have tendinitis or repetitive strain injury, given a brace or splint, and told to rest



      8) You will likely see multiple physicians before a diagnosis is made and even then, it will be somewhat uncertain since no clear diagnostic tests are available



b) Causes/Aggravating Factors
   1) Unknown "idiopathic" but some hypotheses below
   2) Thought to be "*Dynamic*" nerve compression in the forearm - here, "*dynamic*" simply means that the compression is only present when the muscles are in forceful active use and not when they are at rest
      (a) In "*radial tunnel syndrome*" it is the nerve on the top side of the forearm that sends signals to the muscles that extend your wrist and fingers and those that turn your palm upwards, that is squeezed near the elbow
      (b) In "*pronator syndrome*" it is the nerve on the palm side of your forearm ("*median nerve*") that signals muscles to bend ("*flex*") your wrist and fingers and turn your palm downward, that is involved

c) Pathophysiology/Epidemiology
   1) Radial tunnel and pronator syndrome are extremely rare and affect less than 0.1% of the population so don't be too frightened that you have it
   2) Muscles are contained within compartments in the forearm that are surrounded by a strong fibrous tissue called "*fascia*" that is very resistant to stretch or expansion.
      (a) This helps us counteract the effects of gravity in several ways, one allowing muscle contractions to squeeze the veins and push blood and fluids back towards the heart (see Part II: "Swelling/*Edema*")
      (b) While these muscle compartments can expand very gradually to accommodate the strengthening of large groups of muscles as seen in body builders, small isolated muscle groups that are strengthened independently may meet with greater resistance to expansion and their bulk, when they contract, may put too much pressure locally on one of

these nerves as it passes through the compartment, squeezing it and reducing its blood supply causing ischemia which in turn causes pain and weakness

(c) Alternatively, the enlarged muscle as it contracts may tighten a fibrous band over the nerve causing compression ischemia that then ceases when the muscle is relaxed

(d) The size of a given compartment is largely hereditary as is the exact configuration of fibrous tissue in an individual

(e) This suggests that the syndrome may have a congenital component but this cannot be known or predicted in a given individual

(f) Musicians, as "*focal athletes*", would be expected to adaptively strengthen (increase muscle volume - see Part II) **selectively** in certain forearm muscles adjacent to the nerves potentially setting these mechanisms in motion

3) This is only speculation and whether this could be an actual cause in musicians or only a theoretical cause is unknown

4) Remember that identical symptoms will occur if you suddenly or rapidly increase your physical demands when playing due to muscle fatigue (see Part II) so if this comes on only when you are intensely preparing for a critical audition, don't panic, just slow down and let the strengthening process catch up to your demands. Also, this condition is often confused with the more common "*tennis*" and "*golfer's*" elbow described below

d) Prevention – None known except good regular practice habits and maintenance of **optimal muscle stretch (see Part I)**

e) Treatment

1) Modification of technique and practice routines is the best and most effective treatment early on. Shorter but more frequent practice sessions are better for many reasons as discussed in Part II

2) Though it isn't usually possible, depending on your specific instrument, it may help greatly if you can change even slightly the degree of rotation of your forearm when you play (palm up vs palm down)

3) There may be some mild swelling in the forearm and if it is only intermittent NSAIDs (see Appendix I) or steroids (see Appendix II) should be tried

4) **Local steroid injection** can be both diagnostic and beneficial by reducing any local inflammation in the compartment but also by **causing shrinkage of muscle and/or fat** ("atrophy" **-** volume reduction - see Appendix II)

5) Surgery for decompression should be considered **only** if excellent and complete but temporary relief is obtained with local steroid injection

B. Central nervous system

1. **Task Specific Focal dystonia** ("*Musician's Cramp*": "*Focal*" = localized, "*Dys*" = abnormal, "*tonia*" = muscle tension)
   a) Typical presentation

   1) May begin in many different ways but is usually first perceived as a sensation of "*awkwardness*" while playing your instrument, missing notes unexpectedly especially during complex repertoire
   2) Initially it may just seem like fatigue and you may not notice it when you first begin to play but as time goes on it comes on more and more rapidly and becomes more severe
   3) It may initially be associated with a specific passage in a particular piece of repertoire but may then generalize to other pieces
   4) Your frustration increases and at first you try to compensate by practicing even harder but you quickly find that it simply comes on faster with increased practice it may progress rapidly over a period of days or weeks
   5) You begin to feel that your hand or mouth takes on positions that you can't control and you may experience cramping or sometimes trembling
   6) It is **usually not painful** at first but may become so if actual cramping ("*muscle spasm*") is a prominent feature
   7) If you play two instruments your ability with one may be completely unaffected while the other becomes impossible to play
   8) In almost every case, symptoms resolve as soon as you stop playing your instrument and they **rarely interfere with other aspects of your life,** though they may be triggered by motions similar to playing your instrument such as trying to drink from a plastic bottle in brass players with "*embouchure dystonia*" (discussed below)
   9) Your neurological examination is **entirely normal** and you may be made to feel by some healthcare professionals or coleagues that it is psychiatric in origin. You begin to wonder about your own sanity because you have never experienced that kind of loss of control before
   10) It becomes not only frustrating but very embarrassing as even picking up your instrument or positioning your hands to play may trigger uncontrollable motions that others perceive as bizarre
   11) You become frightened, desperate and consumed by a feeling of helplessness and often guilt. At this point you become highly vulnerable and ready to

follow anyone who promises a miracle cure, but your only real hope of some form of resolution is through knowledge and understanding

b) Causes/Aggravating Factors
   1) Unknown ("*idiopathic*"), but some hypotheses are discussed below
   2) There is a **significant hereditary component**. Up to 60% of cases have a family history of some form of dystonia
   3) It is strongly associated with **extensive practice** of highly detailed, very precise motor skills in **susceptible individuals** ("*endophenotype*") – meticulous, perfectionist, anxious - but these things are **not** "*causative*"

c) Pathophysiology/Epidemiology
   1) The incidence is highest between the ages of 28 and 45 and it affects males 75-80% of the time, thus **four times more common in men** than women
   2) The most common form in non-musicians is "*writer's cramp*" though that may be changing as handwriting skills are being replaced by keyboard use
   3) Among musicians the highest risk appears to be in pianists, guitarists and woodwind players, though any may be affected
   4) Approximately 1:100 musicians will develop focal dystonia in their lifetime compared to 1:7000 in the general population, thus **70 times more common in high-level musicians**
   5) Of those who do develop it, it will be **career-ending in almost all** cases. It rarely develops before 10,000 hours of practice and usually requires more than 10 years of play
   6) Involvement is often instrument-specific: pianists usually right hand, violinists usually left hand, woodwind and brass players mouth, tongue and facial muscles ("*embouchure dystonia*"). In spite of these general similarities,

every single case of focal dystonia is **unique to that individual** in its precise manifestations

7) Due to the complexity, diversity and rarity of this condition, the average time from the onset of symptoms to diagnosis in professional musicians is 2.1 years
8) Most recent studies suggest that it involves abnormal learned connections especially in the "*basal ganglia*" of the brain. "*Maladaptive plasticity*" – that is, recruiting adjacent areas of cortex usually used for other functions, has also been implicated, but **all of this is too complex to be helpful to musicians at this stage of our understanding**
9) Though it is speculative and not a scientific explanation, I have found a computer analogy to be useful in helping my patients understand one of the **probable** mechanisms of focal dystonia
   (a) Whenever massively large data sets are manipulated, that is, retrieved, possibly modified in some way and then stored again, the process itself is never perfect. There is always a possibility and in fact a **high probability**, that occasional **random** errors will occur (as an aside, this is also the basis for the evolution of life on Earth but that is a bit beyond the scope of our discussion!)
   (b) On a computer, if the error involves only the data itself it may simply be transcribed and the process will continue normally. The error may be found and corrected on a future pass or it may be minor enough to remain unperceived
   (c) If the error occurs in the program code however, the processor is directed to a wrong address. If at that address it is sent back to the error site, it forms an "*infinite loop*" where the same segment of code just runs over and over again with no possible endpoint: the screen freezes! Your only recourse is to restart the computer, which downloads a back-up, error-free copy of the program code
   (d) Remember from Part I that we have over 100 billion neurons in our brains that make over 100 trillion connections with other neurons. We constantly refine those connections with practice and repetition. With each run-through of a musical phrase for example, you make minor modifications that you expect to remember and reproduce the next time you play it. The countless repetitions and the massive amount of data processed in this way over a period of years exposes you (and **any** other high-level artisan in **any** domain who is constantly practicing and "*tweaking*" details of their performance) to **many more opportunities** for a random connection error to occur

(e) If a small group of neurons that control a very precise motion in a segment of muscle erroneously create a **connection back to themselves** that becomes strong enough to automatically make them fire again, a loop is formed just as in the computer. Since we don't have a back-up copy and can't restart the brain (at least for now), each repetition made in an effort to correct the error actually strengthens the abnormal connection. Whenever that pathway is activated that small muscle segment is stimulated repeatedly in a vicious circle making it consciously uncontrollable. It contracts abnormally and repetitively causing a tremor, tightness, cramp or spasm

(f) Since that pathway is **only** activated from **within** a highly precise and very specific behavior, in this case you playing your instrument, it doesn't affect other activities (unless they closely mimic the way you play your instrument)

(g) Under this theoretical model it would be entirely predictable that studies would show a positive correlation with personality traits such as anxiety, perfectionism and meticulousness. Those individuals who have those traits would be **expected** to do far more practicing and tweaking than anyone else!

10) The most encouraging news is that extensive research is underway and it is possible that we will see some progress in the years to come

d) Prevention

1) "*If anxiety, meticulousness and perfectionism are correlated with a higher incidence of focal dystonia, doesn't that mean that if I can somehow avoid those traits that I can reduce my chances of getting it?*" **Unfortunately, absolutely not!**

(a) Our intuitions often preclude our understanding of statistics. They **do not apply** to individuals, **only to groups**! Your individual risk might be less than 1:1,000,000 or more than 1:10!

(b) Correlation does not imply causation. If you read and understood the computer analogy above, the most likely cause of focal dystonia is a coding error, a **random** event similar to winning the super lottery jackpot. While it is true that among a very large group of people playing the lottery, those that play the most would have a greater statistical chance of hitting a jackpot, you are not a group and your **individual** chances **do not improve** the more you play! This is one of many gambler's fallacies that are blindly encouraged by our intuitions. It simply doesn't work that way

(c) Thus, while reducing your stress level and anxiety may be **extremely beneficial** to your health and well-being and even prolong your life (see

Part I, "*The Placebo Response/Contextual Effect*"), it is unlikely to reduce your risk of developing focal dystonia

(d) There is some debate about to what extent you can change your personality traits such as perfectionism or meticulousness but there is no dissention in saying that **if** it is possible, it is **extremely difficult,** and if you succeeded, while it would be very unlikely to change your chances of developing focal dystonia, it would **almost certainly** make you a worse musician!

2) While you will see **extensive advice** on how to "*prevent*" dystonia on the Internet, it is **entirely anecdotal and speculative** with no scientific data available to suggest that these measures have **ANY** effect whatsoever
3) These "*warnings*" and various prescriptions, as well-meaning as they might be, serve only to generate fear in musicians and this anxiety and stress may have a negative effect on your well-being, while doing nothing to change your chances of developing the condition
4) The **nature** of your work as a musician involves the repetition of highly demanding, extremely precise and detailed tasks. This is a **necessary** part of attaining the skills required to play professionally. Any modification of this scenario **even if it could** actually help you prevent dystonia, **would also prevent you from gaining these skills and becoming a professional musician!**

e) Treatment
1) At present, **there is no reliably successful treatment for focal dystonia, especially in professional musicians**
2) Be wary of the "*miracle*" cures you find on the Internet – focal dystonia leaves you desperate and you become easy prey for those who are unscrupulous or whose knowledge is flawed or incomplete, **even if** they have the best intentions
3) Some medications and injections have been helpful in certain cases **but**:
(a) Botulinum toxin injections can temporarily weaken muscles that are overpowering others but these are also muscles that you need to finely control to play at a professional level. Weakening the cramped muscles does nothing to restore control
(b) If indeed the underlying problem is due to a feedback loop as suspected, **any** intervention that still allows you to play your instrument in the same way you have always done, would continually strengthen the erroneous connection and would thus be doomed to failure

(c) These injections are much more successful in individuals with lesser demands rather than professional musicians. In those musicians who do respond well, the diagnosis of focal dystonia **was probably wrong**

4) In some musicians "*sensory tricks*" such as touching or stimulating an area adjacent to a zone of abnormal muscle contraction or wearing a soft cotton glove to change the character of the sensory input signals have been helpful in avoiding the feedback loop, but these are anecdotal and **unlikely to work except in a very small minority of individuals**
5) As might be expected, the **most successful interventions** in musicians involve relearning to play their instruments using slightly different neurological pathways (techniques) so that the faulty neuronal connections are bypassed and not triggered but as a high-level professional musician, re-learning to play your instrument as a beginner is simply not a feasible solution

f) In Summary:

1) Focal dystonia **is <u>not</u> a disease and is <u>not</u> a psychiatric condition!**
2) Until or unless we gain a better understanding of its underlying causes, presenting focal dystonia as a disease that requires some form of prevention only generates unnecessary anxiety and stress, which we know to be detrimental to our health and well-being (see Part I, "*The Placebo Response/Contextual Effect*")
3) By the nature of your profession, you have about a 1:100 lifetime chance of developing focal dystonia. If you are an American, you also have about a 1:107 lifetime chance of dying in a traffic accident. It is important to put things in perspective
4) **For now, ignoring focal dystonia altogether is your best and safest route.** Either you will get it or you will not! **It isn't worth a life of fear!**
5) That said, **if you are** the 1 person out of 100 who develops the condition, none of these observations will offer you any comfort. If the limited treatment options discussed above are not successful, you will be faced with a difficult decision. It has been my experience, especially with solo performers, that you will feel that if you can't play then you also can't effectively teach others to play. With what you **now know** about focal dystonia, it is time for you to understand that you are a victim of chance, give up the feelings of embarrassment, inadequacy and guilt, and realize that if you put in the years, perhaps decades, of meticulous practice that may have contributed to the development of this condition, you also possess a wealth of finesse, and invaluable, irreplaceable knowledge that you **can** impart to

others if you so desire. I would respectfully ask you to read or re-read the section near the end of Part I: "*Learned Optimism*"

2. **Multiple sclerosis (MS)**: mentioned only for differentiation from **focal dystonia**
   a) No convincing evidence that **MS** is more common in musicians
   b) **MS** is now about 3 times more common in women than in men
   c) Average age at onset is 34 years, in general slightly younger than in focal dystonia
   d) Symptoms at onset are more commonly tingling ("*paresthesias*"), numbness and problems with equilibrium, speech and vision rather than decreased muscle control and cramping, though these may also occur
   e) It is more common to have involvement of the lower extremities and areas of the body not involved in playing your instrument
   f) Symptoms **do not go away** when you are not playing

3. **Parkinson's disease**: mentioned for differentiation from **focal dystonia** and **MS**
   a) No convincing evidence that Parkinson's disease is more common in musicians
   b) Average age at onset is 60 years, only 10-20% of people are under age 50 years at onset
   c) Occurs more commonly in males at a ratio of 3:2 with females
   d) Often presents with tremor and rigidity or slowness of movement ("*bradykinesia*") beginning in one hand, spreading gradually to lower extremities and to the other hand
   e) Tremors are worse at rest and often improve during intentional use of the hands
   f) Other involuntary motions may occur as they do in focal dystonia but they are **not associated** with a specific activity such as playing your instrument
   g) Speech and facial expressions gradually become uniform and monotonous

Degenerative diseases

These conditions are almost all related to the aging process at vulnerable sites throughout the body. Occasionally, some may be due to an acute injury but this is the exception, not the rule. The distribution is often hereditary though it may also be due to a previous injury causing either joint incongruency (see Part I, under "*Movement – Motor function*") or tissue breakdown in an area where the blood supply is poor. These conditions may and often do exist **without pain**. Though they are usually progressive and sometimes

cause deformities, they **DO NOT automatically** lead to loss of function. When they are painful, **activity and stimulation often reduce pain**!

A. **Epicondylitis** (often called "*Tennis"* and *"Golfer's"* elbow: "*Epi*" = upon or outermost, "*condyle*" = a prominent bump at the end of a bone, in this case the "*humerus*" at the elbow, "itis" = inflammation of)
   1. Typical presentation
      a) At first, aching pain at the elbow going into the forearm and worsening gradually over several days
      b) Pain gradually becomes sharper, more intense and **more localized** to either the outside or inside of the elbow and is **very painful to the touch**
      c) You may or may not feel warmth and notice swelling and redness over the area that hurts the most
      d) Lifting becomes very painful and is much worse depending on whether your palm is turned up or down
      e) Stretching your elbow out completely straight hurts a lot and you will try to avoid it
      f) The aching may keep you awake at night or pain may awaken you suddenly when you move in bed
      g) You become very scared and miserable!

2. Lateral (Tennis Elbow)
    a) Outside ("lateral") surface of the elbow
    b) Origin of a muscle group called the "*extensor-supinator*" muscles – **pain** is most intense with:
        1) Extension (straightening) of the wrist and fingers
        2) "*Supination*" – turning the palm **up** against resistance
        3) Lifting objects with the palm down

3. Medial (Golfer's elbow)
    a) Inside ("*medial*") surface of the elbow
    b) Origin of the "*flexor-pronator*" muscles – **pain** most intense with:
        1) Flexion (bending) of the wrist and fingers
        2) "*Pronation*" – turning the palm **down** against resistance
        3) Lifting objects with the palm up

4. Causes/Aggravating Factors
    a) Caused by a tear in the fibrous tissue near the muscle origin. The tear itself is typically very small while the entire muscle attachment is very large so it has no mechanical significance at all in muscle function. There is no loss of muscle strength except that caused by our response to the pain
        1) Degenerative
            (a) Some of the tissue changes seen with aging weaken the muscle origin and may allow minor tears to occur
            (b) Most commonly seen over the age of 45-50
            (c) It may occur spontaneously with no change in your normal routine
        2) Traumatic
            (a) Even though a specific incident may not always be identified, it likely occurs while lifting or pulling something from an awkward position
            (b) Whether it affects the inside or outside of the elbow often depends on the rotation of the forearm at the moment of the injury
            (c) In a musician it is more likely to occur when you are lifting or pulling heavy objects (chairs, stools or other furniture, your instrument if it's a piano, harp or bass! etc.) rather than with playing your instrument
            (d) When traumatic it's usually in younger patients but is rarely seen prior to age 30
    b) The source of pain is likely tension on the tear itself but intermittent inflammation is often present throughout the healing process
    c) It is second only to carpal tunnel syndrome for the ***"most erroneous information available on the Internet"***

5. Pathophysiology/Epidemiology
    a) As we saw in Part I, muscle attachments have an "*origin*" on one side of a joint and an "*insertion*" on the other side. When the muscles contract they cause the joint to either bend ("*flex*") or straighten ("*extend*") depending on their location. Muscles may span, and thus have an effect, on more than one joint
    b) Several muscles may share a common origin and at the elbow, as noted above, they control flexion and extension of the wrist and fingers and rotation of the forearm. Since each group has an opposite effect, they are known as "*antagonists*" and often must contract against each other in order to counteract the effects of gravity and control the positions of the fingers, hands, wrists and forearms in space. This means that epicondylitis is painful with almost any motion from the elbow to the tips of the fingers!
    c) The muscle origin is a "*tendon-like*" fibrous tissue that attaches muscle to the very hard smooth surface of bone and the tear occurs within this tissue. It is different from muscle strain because it involves this different tissue type with very different healing characteristics
    d) The main problem in this condition is the poor blood supply at this interface with the hard and dense bone surface, making healing a **very slow** process compared to muscle or skin
    e) An analogy I often used with my patients to help them understand this condition is that of a paper cut on the top of your knuckle:
        1) Every time you bend your knuckle, you pull the cut open slightly and it tears a little bit of the new scar tissue that is healing the wound, causing pain
        2) It isn't dangerous in terms of the function of your finger and no matter how much you use your hand, the cut will still go on to heal normally as long as you avoid infection
        3) Using your finger normally during the healing process slows it down **but** it also instructs the scar tissue on what your needs are for healing at that location (see Part I: "*Sensation: The Nature of Pain*")
        4) Moving and using your finger during the healing process also **desensitizes** it so that even if it hurts terribly at first, the pain subsides rapidly with normal use and only comes back suddenly off and on when you exceed the amount of motion to which you are accustomed
        5) The only difference between the paper cut and epicondylitis is the tissue type. Your skin heals extremely well within 7-10 days but probably because of its poor blood supply, the muscle origin takes several months!
    f) At any given moment, 1-3% of the population suffers from epicondylitis (that means between 3-11 million people in the US)

g) It has been speculated that all people from every walk of life have about a 50% chance of experiencing at least one episode of epicondylitis at some point in their lifetimes.
h) It is well documented that epicondylitis is **self-limited and spontaneously heals**, though very slowly. Pain resolves 90-95% of the time within 12 months **regardless of whether any treatment is applied**
i) Because it is mechanically insignificant and is not a variant of muscle strain, it does not prevent muscle strengthening and does not cause **any** long-term disability **except that due to chronic pain.** Thus, the only thing that needs treatment is the pain itself!
j) It is "*the perfect storm*" however, to generate a vicious circle of chronic pain because people (**including most healthcare professionals**) mistakenly believe that it represents some risk or danger to them if it is left untreated (see "*Sensation -The Nature of Pain*" in Part I")
k) Fear is your worst enemy in this condition. **UNLESS YOU LET IT, EPICONDYLITIS WILL NOT END YOUR CAREER**!

6. Prevention – **no known reliable preventive measures**

7. Treatment
   a) **Intermittent** NSAID's for episodes of painful warmth and swelling (see Appendix I)
   b) Desensitization (If you learned anything in Part I, apply it to this condition!)
      1) Local **stimulation, massage and pressure** on the area of maximum tenderness **(the spot that hurts the most!)** is highly effective on both short and long term – if you just touch around it, and avoid the painful spot, it doesn't work! Using a massage gun may be extremely helpful! Start very gently with a soft impact head at very rapid speeds. Press harder and decrease the speed gradually as your tolerance improves
      2) Modify technique and practice sessions if you must, but **keep playing**!
      3) Remember that the hurt you feel **does not indicate harm**. Don't forget the "*contextual effect*" we discussed in Part I! A less fearful attitude will help you re-interpret and modify the pain (sensory re-education)
   c) R.I.C.E. (active Rest, Ice, Compression and Elevation), moist heat or contrast (heat followed by ice or vice versa) at the end of the day may help
   d) Physical therapy, iontophoresis (steroids delivered through the skin) – may be helpful if you can't desensitize on your own - but **if you can't control your fear, this will fail**
   e) **Local steroid injection** – for rapid pain relief in extenuating circumstances i.e., upcoming audition or major performance - (effect is usually temporary but

excellent – it lasts for a period of several weeks to several months). Even a saline injection without steroid may actually stimulate the local tissues to heal faster though it won't give the same immediate pain relief

f) Surgery
   1) Absolute last resort, not recommended in professional musicians
   2) Mediocre to poor results because **pain syndromes are typically not cured by surgery –** remember that chronic pain becomes its own disease! Even amputating a chronically painful arm **does not cure pain!** (See Part I)

g) **Many, many, many** other treatments of limited value – counterforce brace (tennis elbow forearm strap) is **very often used** but does not perform much better than placebo and can cause other more serious problems if worn incorrectly

8. **In summary,** epicondylitis is a physically benign problem that is nearly always self-limiting, but our fear of pain often makes this a devastating condition that fosters the formation of a vicious circle of hypersensitivity. Overcoming our fear of ongoing injury and desensitization are the keys to recovery

B. Osteoarthritis (Primary) (sometimes called "*osteoarthrosis*")

1. Typical presentation
   a) You have reached the age of 50 and you notice some aching pain in the joints of your fingers or at the base of your thumb – very rarely it could involve the wrist
   b) It may be aggravated and become sharper during certain passages as you play but if you push through the pain, it often improves only to return sporadically
   c) The pain comes and goes in an unpredictable way and some days are worse than others
   d) You can often correlate changes in the weather with your symptoms
   e) If your pain is at the base of the thumb, you may feel severe pain off and on with forceful pinch – removing a lid from a jar may become difficult or impossible
   f) If you compare your hands with those of a younger person's you see some bumps and deformities around many of the small joints. It may be painful if you press directly on one of these bumps
   g) Sometimes when you feel aching pain at rest, you notice redness and swelling in the joints (inflammation) but this is sporadic – comes and goes
   h) When you first get up in the morning or when you have been inactive for a few hours you may feel stiffness in the joints but pain is usually worse with beginning activity rather than at rest
   i) You may only notice the deformities and **never experience any pain at all** (**in fact, this is the most common scenario in the hand!**) – look at the hands of the oldest professional players you know, especially those whose playing you

respect the most, and you will find that they have many of the deformities shown here yet continue to play their instruments beautifully!

j) Osteoarthritis is perceived differently by different individuals – **the more afraid and attentive you are to the deformities the more they hurt!**

2. Causes/Aggravating Factors

a) Osteoarthritis is primarily a hereditary condition that occurs with advancing age

b) In the absence of trauma, our hands will have about the same pattern of osteoarthritis as those of our parents and grandparents **regardless of our activities** in life and unrelated to our burning desire to blame "overuse"!

c) It is progressively more common in **older** people thus the "*incidence*" is constantly reported as "*increasing*" as life expectancy increases in modern societies

d) There is no reason to believe that people today do more physical labor than their parents and grandparents (the opposite is more likely) suggesting that the increasing incidence is due to other factors!

e) In the fingers, by age 65, there is x-ray evidence of osteoarthritis in about 60% of men and 75% of women with the **majority** of them **unaware** and without significant pain.

f) Repetitive or forceful usage has **always been assumed** to be the cause because it is intuitive but this is **not supported** by objective studies except as defined below under "*post-traumatic*" arthritis

g) Osteoarthritis is **not in any way** related to rheumatoid arthritis or any other systemic inflammatory disease and **cannot "*become*"** one of these more severe conditions!

h) Osteoarthritis is a fact of life and entails no inherent "*danger*" to you and **REST will not stop its gradual progression but will INCREASE stiffness and chronic pain!** (Read that sentence again!)

3. Pathophysiology/Epidemiology

a) Osteoarthritis is **not more common in musicians** though as with other conditions, it may have a greater impact on a musician's career because of greater demands

b) Women are affected or at least symptomatic, almost twice as often as men, 3-4 times more often for the base of the thumb ("***C**arpo**M**eta**C**arpal: CMC arthritis*")

c) In genetically susceptible individuals the collagen in the cartilage of certain joints becomes more disorganized with age leading to its gradual destruction
d) Inflammation is not a routine feature of osteoarthritis but it does occur off and on possibly due to "*wear particles*" in the joint and when present, it is a source of pain
e) As cartilage wears away, bone spurs ("*osteophytes*") often form at the joint edges and irregular wear leads to crooked joints ("*angular deformities*")
f) Joint motion gradually becomes reduced and can eventually make reaching extreme finger positions on your instrument difficult – this occurs slowly enough however that musicians can usually unconsciously adapt and continue playing!

4. Prevention
   a) None known (Repeat: None Known)
   b) In spite of widespread claims and a **multi-billion-dollar industry** worldwide, there **is no** supplement or medication of **any** kind so far that has been shown to prevent the onset or progression of osteoarthritis beyond that of placebos (read that sentence once again – it may save you thousands of dollars over a lifetime!)
   c) **The placebo response** (see Part I) is impressive in osteoarthritis since symptoms come and go sporadically. This is why it is so easy to take people's money. **ANY** intervention or context, from magnets to royal jelly to chondroitin supplements, will "*give relief*" about 75% of the time. If you're sure it isn't harmful, you don't mind spending the extra money and you feel that you can truly **believe** in something – go for it! If you are a person that understands and can manipulate the contextual effect that we discussed in Part I, you can achieve the same effect for free!
   d) Some studies suggest that weight reduction in obese persons might reduce the progression of knee osteoarthritis but even this is uncertain

5. Treatment
   a) **None** of the changes that occur with osteoarthritis represent **any danger** to your general health or **automatically require treatment of any kind!**
   b) Aside from the deformities mentioned above, typical osteoarthritis does **not cause** long-term disability **except that due to chronic pain** and in a few cases due to decreased range of motion (there is a severe hereditary form of the condition that causes severe deformities and disabilities but it is very rare)
   c) Thus, treatment of osteoarthritis is **directed entirely at pain relief**
      1) Inflammation, when it is present episodically, may respond extremely well to NSAIDs (see Appendix I) but chronic use has significant side effects that may generate health issues of its own

2) Local steroid injections (see Appendix II) give **excellent pain relief** on a short term (a few months) but **when combined with desensitization may be highly effective on a longer term as well**
3) Acetaminophen (Tylenol – see Appendix I) can help reduce pain but only for several hours with no anti-inflammatory or long-term beneficial effects. Chronic use also has potentially serious side effects
4) Again, as with all other chronic pain, **rest is ineffective** as a treatment though it continues to be recommended routinely – **multiple studies have shown moderate exercise to be beneficial in reducing pain and improving function.** Thus, playing your instrument is your best treatment!
5) As with epicondylitis and other benign conditions, our misunderstanding of the nature of pain has taken a terrible toll on the well-being of countless individuals who were told and convinced that pain is equivalent to injury. If there is one thing that you glean from this document, make sure that you read and understand the section in Part I entitled: "*Sensation – The Nature of Pain*". It has the potential to help you improve the quality of your life immeasurably!

C. **Post-traumatic arthritis** (a form of **Secondary Osteoarthritis**)**:** differentiation with primary osteoarthritis
1. The same process occurs but in response to a previous injury
   a) Direct joint injury
      1) Usually from a serious impact that causes a fracture in a joint and/or damage to the cartilage surface that results in an **uneven** (incongruent) surface (see Part I)
      2) This irregularity wears into the adjacent surface damaging the cartilage further
   b) Chronic instability
      1) An injury that damages the ligaments around a joint allows it to move abnormally (laxity – see the "*spoons*" demonstration in Part I)
      2) Congenital laxity (see below) if severe enough or ignored in certain conditions may lead to degenerative changes but this is unusual
      3) Non-matching surfaces come into contact wearing away joint cartilage
2. Localized to the joint or joints that sustained the injury
3. For many years **all** osteoarthritis was assumed to be "*post-traumatic*" but there is **no evidence that "*overuse*" of a normal joint constitutes a "*trauma*" or causes these degenerative changes!**
4. Once established, post-traumatic osteoarthritis acts and is treated in the same way as primary osteoarthritis

Congenital Abnormalities and Hereditary Conditions

Congenital abnormalities are usually present at birth though some may only appear in adolescence during the growth spurt. They are typically associated with anatomical differences that affect how a person holds or plays their instrument. They usually do not change or worsen over time unless they are ignored when learning to play the instrument. Then, painful areas of local pressure may develop and/or increasing deformity ("*hyperextension*") can lead to "*locking*" (see below). These conditions typically cause poor postures or positions that prevent optimal muscle stretch. In these ways they may generate chronic pain. If left uncorrected over several years, joint irregularities ("incongruence") may cause abnormal wear patterns and secondary osteoarthritis (see above).

Other hereditary conditions may only express themselves and become evident later in life. "*Dupuytren's disease*", also known as "*Dupuytren's contracture*" is the example that will be discussed here. In almost all conditions where the abnormalities are not present at birth or during the adolescent growth spurt, environmental factors likely play a role in determining the age of onset of symptoms and/or their severity. Unlike congenital abnormalities, once they become expressed, they usually worsen progressively over time without a fixed endpoint. These conditions are also typically influenced by the interaction of multiple genes "*polygenic inheritance*" and so have a highly variable expression. Thus, not all family members who inherit the genes actually express the trait. It also means that a certain small percentage of people with the condition do not have a family history and these cases are called "sporadic".

One could make the case that osteoarthritis, discussed above under "*Degenerative Conditions*", is more accurately a hereditary disease but because of its extremely high prevalence and because of our intuitive belief that it must be due to "overuse", it has never been classified this way. As we learn more about the origin of various diseases and conditions however, and are able to delineate the importance of these different interactions, it is very likely that the size of this category will increase!

A. **Ligamentous Hyperlaxity** (often called "***double-jointed***" in non-medical terms)

1. Typical presentation
    a) Fingers or thumb bend backwards ("*hyperextend*") when pressure is applied
    b) Symptoms occur much more frequently in novices than in professionals
    c) A musician may begin to feel frequent aching pain in the forearm or hand when playing

d) Over a more extended period they may begin to feel pain directly over a hyperextended joint or in adjacent joints
e) After playing for a prolonged period a musician may note that a finger seems to "*lock*" in an extended position until flexion is initiated with the other hand – this is because the hyperextension itself changes the direction of pull of the tendons. In the illustration below, the long finger is "stuck" open as the person tries to bend it. This is corrected in the ring finger by limiting its extension

In the image on the left, the first joint of the right thumb ("***i**nter**p**halangeal*" - **IP**) joint is bent backwards ("*hyperextended*") due to laxity of the ligaments. Over time this will create a pressure point that may become painful, and it prevents the antagonistic muscles from attaining optimal stretch which can also generate forearm pain. In the image on the right, the middle joint of the ring finger ("***p**roximal **i**nter**p**halangeal*" – **PIP**) is hyperextended making it impossible to bend without outside help. The metal figure-of-eight ("*extension block*") splint on the ring finger allows the finger to bend ("*flex*") fully and allows it to straighten almost completely but blocks hyperextension. It can be fitted by a Hand Therapist and can correct both of these problems!

2. Causes/Aggravating Factors
   a) Hereditary
   b) Special demands
      1) When we are young our ligaments are still "*stretchy*" allowing us to adapt to special demands that we place or are placed upon our bodies
      2) This flexibility allows us to increase the degrees of motion of any joint if we diligently practice stretching it or lose motion in any joint if we don't move or use it. If the pattern is maintained over a long period, it determines our individual "*normal*"

Same problem as above, but this time with hyperextension at the middle joint of the thumb ("***m****etacarpo****p****halangeal*" – **MP**). The same "*figure-of-eight*" concept was used to fabricate an "*extension block splint*" which can serve either as a training device, or if long-term use is necessary, as a piece of "jewelry" used when playing.

3) An example is a young ballerina or gymnast that learns to do the splits, but anything we do regularly that is out of the ordinary but constantly repeated can have this effect
4) A very young student who is taught an incorrect technique in learning to play a musical instrument, can also create an undesirable joint laxity that may be a source of pain if they continue to play over many years
5) As we get older, the ligaments become stronger and less stretchable, thus corrections become more difficult

c) Trauma
1) A sudden force applied to joint, especially one that causes a ligament to tear completely can allow a joint to move abnormally on a long term (seen more commonly in the shoulder, sometimes in an elbow or finger)
2) Usually more significant in a younger person
3) In most cases with only a partial tear and especially in adults, the opposite occurs with scarring causing a reduction in joint motion
4) If laxity persists on a long term, it can cause degenerative changes and pain (see the discussion of ligaments and the demonstration in Part I

3. Pathophysiology/Epidemiology
    a) The incidence of loose ligaments ("*ligamentous laxity*") in the general population is hard to quantify because it is hard to define. Attempts place it at anywhere from 5% to 50% which is not very helpful but somewhere in the middle, about 30% is probably realistic if we are considering all causes
    b) Lax ligaments around a joint offer less passive support than normal allowing increased motion
    c) This allows joints to take abnormal positions
    d) This is painless and "*normal*" for some people and usually causes no problems as long as joints are used in neutral positions – **optimal muscle stretch**
    e) Rigid musical instruments when held or played may encourage holding joints in hyperextended positions for prolonged periods
    f) This means using antagonistic muscles outside their range of optimal stretch which causes aching pain
    g) Pressure is also often applied to the prominent portion of the hyperextended joint itself rather than to the softer surfaces and this can cause local pain
    h) Prolonged, forceful and repeated hyperextension stretches the ligaments further aggravating the problem
    i) Over-extended joints "*lock*" or resist flexion because muscle contraction simply pulls the joint together instead of bending it **until** it is pushed into slight flexion externally and suddenly "*pops*" as the direction of pull is restored – this can be avoided if hyperextension is prevented either consciously or with splinting
    j) If ignored over several years this laxity can foster degenerative arthritis as described in Part I
4. Prevention
    a) As long as positions of optimal muscle stretch are respected in the musician's technique, no problems develop
    b) Teachers and coaches should be particularly attentive to this issue
    c) Anytime a student shows abnormal positioning of a joint, it should be addressed immediately either by technique changes, if possible, or referral to musician-competent physician or practitioner that can have a corrective splint fabricated if feasible
    d) If this is not possible, consider recommending change to a different instrument before the student's time commitment and investment becomes too great
5. Treatment
    a) Same as recommendations for prevention
    b) If the musician is unable to correct the hyperextension with conscious modifications of technique, a hand therapist can fabricate or fit an extension-block splint to be worn when playing until the new positions can be learned and the brace is no longer needed

c) These can often be made to look like sophisticated jewelry and are not always unsightly (see the illustrations above)

B. "*Radioulnar fibrous synostosis*" (Limitation of forearm rotation)

1. Typical presentation
   a) Forearm motion is limited and it must be held rotated to its maximum in order to play an instrument in the standard way (left hand in the illustration below)
   b) The novice musician often doesn't realize this and if the teacher does not, it goes initially unnoticed. The person in the illustration, for example would have great difficulty as a pianist
   c) The musician begins to feel forearm pain with play

This student can rotate her **right** forearm normally, easily turning her palm completely up ("*supination*") and palm completely down ("*pronation*") without forcefully contracting the muscles of her forearm. On the **left** side however, while she is able to almost fully turn her palm up comfortably, she cannot turn her palm down completely, even while forcefully contracting her forearm muscles. It is not shown here, but she compensates for this in normal life by simply "*abducting*" her left shoulder (bringing her elbow away from her body) completing the rotation. Since she was born this way, it may have gone completely unnoticed. It is important for music teachers to recognize this and orient these students toward instruments that can be played comfortably.

2. Causes/Aggravating Factors - Hereditary

3. Pathophysiology/Epidemiology
   a) The two forearm bones, the "*radius*" and "*ulna*", have joints at both the wrist and elbow that allow them to rotate around each other and thus allow us to turn the palm up ("*supination*") or down ("*pronation*"). It is a very important motion that we don't think of very often

b) The ligaments that hold these joints together usually allow us to put our hand flat on a table with the palm either up or down without having to move our shoulder to accomplish this but with "*radioulnar fibrous synostosis*":
   1) The bones of the forearm are incompletely separated during development
   2) A fibrous remnant ("*synostosis*") acts as a tether that reduces rotation in one or both directions
c) It is quite rare in the US population affecting only about 1 in 10,000 individuals, but minor forms often go unnoticed so this probably underestimates the true incidence significantly
d) Either side may be involved and it occasionally involves both sides ("*bilateral*")
e) It may be as minor as a sensation of significant tightness at full rotation or a very severe loss of rotation with the forearm almost fixed in one position
f) Forearm rotation is forced to maximum during play if the palm must be rotated to an extreme position
g) This applies force to the fibrous synostosis sometimes generating local pain
h) It precludes optimal muscle stretch without some modification and requires much more energy to constantly force against the tether while playing

4. Prevention
   a) Of the condition – none known
   b) Of symptoms when playing an instrument
      1) Change instruments at the novice level to one that does not require extreme positioning
      2) Teachers should be sensitive to this and detect it early
5. Treatment if already fully committed to an instrument
   a) Position modification or instrument modification may be tried but is not usually feasible
   b) If this is not possible, shorten practice sessions and use local stimulation and desensitization to reduce pain. Remember, if you know you are not causing any permanent damage to your body you may be able to modify your perception of the pain and thus reduce its effects (see Part I: "*Sensation – The Nature of Pain*")
   c) Surgery is **NOT** usually indicated in professional musicians since it is not reliable enough in either increasing motion or in relieving chronic pain

C. "Dupuytren's Disease" or "Dupuytren's Contracture"

1. Typical Presentation
   a) You are about 50 years old when you notice a painless lump in your palm right around the skin crease at the base of your ring or small finger
   b) You may initially think you are developing a callous but can't think of any activity that might be causing it and you forget about it for awhile

c) Several months go by and the lump doesn't seem to have changed except it is perhaps very slightly larger and a "*dimple*" has formed in the skin. Sometimes you feel the lump pushing into your palm if you grasp something forcefully

d) You notice it at one point when you are visiting your mom and mention it to her. She says: "Oh yeah, your dad had that in his hands but it never really bothered him. Don't you remember?"
e) You have no recollection of ever noticing it and your father never mentioned it to you. You forget about it again for several months
f) You are pushing against a large flat surface and you realize that you can't completely flatten your hand against it because you ring finger won't straighten completely
g) It doesn't hurt until you get frustrated and try to force it straight. Then you have some pain in the palm and the knuckle that resolves in a few days
h) The lump begins to look more like a small cord under the skin and you may see additional dimples forming in the area adjacent it. The skin may look wrinkled and deformed. If it is your left hand, you can no longer wear your wedding ring. You begin to notice similar lumps developing in your other hand

i) The finger contracts gradually more and more into the palm making it difficult to slide your hand into your pocket or into any narrow space
j) At some point, the middle joint ("***p****roximal* ***i****nter****p****halangeal*" – PIP) begins to bend as well and you notice that your little finger in same hand is beginning to show the same signs and progression as the ring finger
k) Depending on your instrument, it may begin to interfere with play at some point in this progression
l) **Remember**, it typically does **not hurt**, so if your main issue is pain, the lump you feel either isn't Dupuytren's disease, or you happen to have 2 problems at the same time. It is not uncommon at all to see "*stenosing tenosynovitis*" and even trigger finger in a digit that shows signs of Dupuytren's disease (see Inflammatory Conditions above). If the wrong condition is treated, the results are usually poor and you will be dissatisfied!
m) In non-musicians, because it is painless, it is easy to forget about it until the lack of finger extension begins to interfere with their activities of daily living. If you are a trombonist, it may not interfere at all with your playing and it would be your other activities that would determine if you need treatment

2. Causes/Aggravating factors
    a) Heredity
        1) About two thirds of the time there is a clear family history but since it may skip generations and may also be mild enough to go unnoticed, that number is likely much higher
        2) Those with ancestors from northern and western Europe have a higher incidence (it is sometimes called "*Viking's disease*" in non-medical circles), but the condition may still be found in any ethnic group though it usually means a northwestern European found his or her way into the genetic line
        3) Keep in mind, that just because a family member has it, even if it is severe, it does **NOT** mean that **you** will develop it as you get older and even if you do, it could be mild enough to be just a curiosity and have no effect on your career! Try not to panic if it runs in your family!
    b) Alcohol/Smoking
        1) Several studies have shown a correlation between levels of alcohol consumption and smoking and the incidence and severity of Dupuytren's disease
        2) It is postulated they influence or facilitate some part of the inheritance complex discussed above
        3) The condition is still quite common in non-smokers and in abstainers so it is unlikely that there is a significant causal relationship
    c) Trauma
        1) For a long time, "*microtrauma*" or repetitive injuries were thought to contribute to the development of this condition but remember that this is an intuitively tempting assumption that we can't seem to resist
        2) A few studies suggested that the incidence was higher in workers exposed to vibrating tools
        3) The prevailing opinion however, is that like alcohol and smoking, it may aggravate the condition if you have the genetic predisposition, but it probably does not cause it
        4) Diabetes
            (a) The prevalence of Dupuytren's Disease in patients with diabetes can be up to 3 times higher than in non-diabetics
            (b) Diabetes affects the microscopic blood vessels and may enhance the deposit of waste materials in the palmar tissue affected by the condition, but detailed mechanisms are still unknown
            (c) The highest incidence of all is found in diabetic smokers and drinkers
            (d) Again, diabetes is not thought to be causative but rather is an aggravating factor

3. Pathophysiology/Epidemiology
    a) The Culprit
        1) The structure involved in this condition is the layer of connective tissue just beneath the skin called the "*palmar fascia*" or "*palmar aponeurosis*"
        2) Its job is to anchor the skin to your palm and to provide a protective layer over the important delicate structures beneath it (nerves, blood vessels and tendons). We grasp and hold things in our palms
        3) Notice the differences in the skin on the top of your hand compared to the palm. It is very thin and glides back and forth freely over the tissues beneath it. We would injure our hands constantly if our palms were made the same way
        4) The fascial cords are intertwined with but do not directly involve or "*stick*" to the tendons, nerves or blood vessels that supply the fingers **unless** there has been a previous penetrating injury or intervention
    b) The process
        1) For reasons still uncertain, the cells that create the fascia ("*fibroblasts*") begin to multiply ("*proliferate*") and produce extra "*collagen*", the substance that increases its volume and forms the lumps in the palm
        2) As they slowly get larger and consolidate, the lumps get bigger and form "*nodules*"
        3) "Collagen" is also used in forming scar tissue and part of its job is to contract to close wounds in the normal healing process. As the nodules unite and contract they form "cords" that begin to pull the finger down toward the palm
        4) The process continues at a pace that is different for each person
    c) Observations
        1) Though it varies somewhat by location, the word-wide prevalence of Dupuytren's Disease is 8.2% according to a comprehensive meta-analysis (combining and analyzing the results of multiple studies) done in 2020. It's prevalence in the US is 4-6%, 400-600 cases/100,000 people
        2) It is about 3 times more common in men than women but if one looks only at those cases that are severe enough to require treatment, about **85% are men**
        3) Other than anecdotal reports, there is **no evidence** to suggest that Dupuytren's disease is more common in professional musicians!
        4) The earlier it starts in life (30's and 40's) the more severe it typically is, but remember you are an individual and not a statistic, so this may not be so for you!

5) Most commonly the ring and small fingers are affected with occasional involvement of the long finger. The thumb and index are rarely affected and if they are, involvement is usually less severe
6) The severity varies tremendously from a tiny, barely perceptible lump to contractures so severe that they interfere with many important activities of daily living
7) Progression of the disease is **unpredictable** and may involve months or years of minimal change or it may worsen rapidly over a few months
8) Only 30-50% of people who have the disease ultimately require treatment, though we would expect that percentage may be slightly higher in professional musicians given the minimal possibilities of modifying their instruments
9) It involves both hands (is "*bilateral*") in about half of the people affected (30-80%) but the severity may be very different in each hand
10) Remember that Dupuytren's disease is not dangerous and for half the people who have it, it is only a nuisance!

4. Prevention
   a) No reliable prevention known
   b) It is reasonable to assume that if you stop or reduce smoking and alcohol consumption and keep your diabetes carefully controlled, that you will at least eliminate some of the factors that may **aggravate** the condition, but at least for now, you cannot intervene genetically to remove the most important cause
   c) Stretching or splinting to try to prevent worsening of the contracture is **ineffective and may be harmful.** Intuitively it sounds attractive but it doesn't work!

5. Treatment
   a) To date, there are no medications that can either stop the progression or reverse the effects of Dupuytren's disease, no matter what you read on the Internet
   b) As noted above, splinting is ineffective and potentially harmful
   c) Because the limitations are mechanical, the solution must also be mechanical. Three different interventions (many more with some modifications) have been widely used and continue to be valuable
      1) Needle fasciotomy (or "*aponeurotomy*") – the suffix "*otomy*" means to cut open
         (a) Can be done in a physician's office
         (b) The skin is numbed with a local anesthetic
         (c) A needle is used as if it were a tiny scalpel to cut the tight cords at the sites where the tethering is most severe

(d) The finger is then forcefully straightened, separating the severed portions of the cords and tearing some of the lesser attachments

2) Collagenase injections
   (a) Can also be done in a physician's office
   (b) Collagenase is an enzyme that the weakens collagen bonds. When injected into a fascial cord it weakens it enough that it can be torn
   (c) The process is similar to needle fasciotomy except that instead of cutting the cords where they are most severe, these sites are injected with the enzyme which then takes about 24 hours to weaken the bonds
   (d) The next day, the finger or fingers are forcefully straightened tearing the cords at the injection sites along with the lesser attachments

3) Sub-total palmar fasciectomy (the suffix "*ectomy*" means to remove or "*excise*")
   (a) This is done in a hospital or an outpatient surgery center
   (b) The whole arm is numbed or general anesthesia is used
   (c) Incisions are made in a zig-zag pattern along the **entire** length of each of the involved digits and up through the palm, almost to the wrist
   (d) The involved palmar skin is carefully separated from the fascia, leaving connections with the adjacent normal skin tissue to help maintain the blood supply to the skin
   (e) The fibrous cords along with **all** visualized **normal fascia** is removed in its entirety allowing the finger/s to be extended
   (f) The wounds are closed with sutures

d) Observations on the **difficult** process of choosing which procedure is right for you

1) The least invasive approach
   (a) Choosing the simplest and least invasive approach seems like a no-brainer if all available procedures achieve the same mechanical goal – in this case, straightening the finger/s.
   (b) The early results for all procedures are good but not identical
   (c) Average correction of the contracture is about 50-70% for needle fasciotomy and collagenase injection but reaches 70-90% for fasciectomies

2) If you read about the pathophysiology above, you know that this disease deposits collagen in the fascia progressively with no specific endpoint
   (a) Wouldn't it be naïve to think that dividing the cord without removing any of the fascia would stop the progression of the disease and prevent recurrence?
   (b) What are the average recurrence rates at 5 years?
      (1) For fasciectomies, 5% to 40%, average around 15%

(2) For collagenase injections, 20% to 50%, average around 35%
(3) For needle fasciotomies, 20% to 70%, average around 45%

3) The most invasive approach
   (a) Choosing the more extensive intervention then seems like a no-brainer if
      (1) It potentially offers a better correction
      (2) It removes the underlying tissue affected by the disease
      (3) It has a lower recurrence rate
   (b) But what about complication rates and recovery times?
      (1) Average complication rates
         1. For fasciectomies, 10% to 40%, average around 25%
         2. For needle fasciotomies, 5% to 15%, average around 10%
         3. For collagenase injections, less than 5%
      (2) Average recovery times
         1. For fasciectomies, several weeks to several months
         2. For collagenase injections and needle fasciectomies, a few days to about 2 weeks
4) So, then starting with the least invasive procedure and then moving on to the more extensive one if it becomes necessary a few years down the road, is a no-brainer. Right?
   (a) Collagenase injections and needle fasciotomies both generate scar tissue in the palm that causes the diseased fascia to adhere to the vital structures beneath (nerves, blood vessels and tendon sheathes)
   (b) This increases the risk of damaging one of these structures if surgery is required as a secondary procedure
   (c) One study showed a 10% increase in the complication rates for fasciectomies if previous collagenase injections or needle fasciotomies were done
5) So, there is **no** "***best***" treatment. Each intervention has significant positive and negative aspects that must be carefully considered for each individual patient
6) All of these treatments are complex procedures and large variations exist in the techniques used by different surgeons and in their post-operative protocols

e) Some conclusions about treatment for Dupuytren's disease
   1) This is a complex condition that requires an extremely high level of expertise to achieve the best possible results. If you are told that there is only one form of treatment, you should seek another opinion
   2) You need not only a fellowship-trained and experienced Hand Surgeon but also ideally one that has some expertise or specific interest in treating

professional musicians (see "***Tips for finding a musician-competent physician***" below)

3) In choosing the treatment that is best for you, carefully consider your priorities and special circumstances and discuss these with your surgeon. The more knowledgeable you are, the more fruitful your discussion will be. Some examples:
   (a) If you are young and healthy and hope to play professionally for many more years, the more complicated fasciectomy may be your best choice
   (b) If you have less than 5 years before you plan to retire and don't feel that your retirement would suffer by some recurrent contracture, fasciotomy, either needle or collagenase, may be best for you
   (c) If you suffer from other important medical conditions, such as diabetes and heart disease, the simplest procedure possible may be best

Tips for finding a musician-competent physician:

A. Your healthcare needs as professional musicians relative to the musculoskeletal system require special considerations (discussed extensively in Part I and Part II) – sports medicine specialists abound but are not automatically equipped to deal with your special needs

B. Since you make up such a small percentage of the population, most physicians have **never** treated a professional musician in their careers

C. Except to prescribe anti-inflammatory medications or give you an appropriate referral, your family physician (with a few exceptions) **will not** be able to help you with your problem and may cost you valuable time or cause you unnecessary worry

D. Do your homework and look for a **specialist** with either documented post-specialty training in treating professional musicians **or** at least 15 years of clinical experience and an interest in musician's clinical problems. She or he will typically be associated with a university. If you have to travel, do it

E. The practitioner should be a board-certified specialist (either in Orthopedic, Plastic or General Surgery) **and** a member of a sub-specialist society (i.e., the American Society for Surgery of the Hand - ASSH) since this assures sub-specialist accredited training – specifically through a Hand Fellowship – a one or more year apprenticeship in an accredited Hand Center after they complete their specialty training. Any physician can claim to be a specialist or sub-specialist regardless of their actual qualifications

F. If your practitioner does not question you specifically about your instrument or ask you to bring it to an appointment (unless you are a pianist, harpist or percussionist, etc.!) before deciding on a treatment, he or she might not possess the expertise you need

G. The practitioner should ask you detailed questions about your general health, the nature of your symptoms as well as specific details of your practice routines, playing positions and technique

H. He or she should take the time to talk to you and examine you in detail as well as give you precise explanations for possible diagnoses – if you do not understand the explanations, **ask for clarification**. If it still isn't clear and you don't feel confident, consider finding another practitioner

I. Be wary of the generic diagnoses of "*overuse syndrome*" or "*repetitive strain injury*" unless a detailed investigation has been undertaken and is otherwise **normal** – then treatment should only involve technique modifications and possibly NSAID's

J. If the prescription is **complete rest** for more than 7-10 days or immobilization for more than 3-5 days with no other intervention such as a modification in your technique or practice routine or a targeted rehabilitation program, get a good explanation or find another physician. **Remember that prolonged periods of casting, splinting and rest are not only ineffective, but they can reliably end your career!**

K. If your physician diagnoses a pathological condition, he or she will also propose a treatment plan for that condition and should outline clearly what special considerations are involved due to your profession. Individualized rehabilitation protocols with a Certified Hand Therapist are usually required, are highly beneficial, and should be explained to you. If your physician tells you that he/she doesn't use a Certified Hand Therapist in their practice, seriously consider finding one who does

L. If you are told that surgery is your ONLY option **before** any other treatments are tried, get another opinion

M. If your physician says that he/she does not use local steroid injections as a treatment option, consider using another physician who does (see Appendix II)

N. Once you find a professional who is well qualified and that you feel is knowledgeable and attentive to your needs, stick with them and **don't** keep shopping around or you **will** ultimately be diagnosed with and treated for multiple conditions that **you don't**

have. As physicians, we detest saying "*I don't know*" or "*I'm not sure*" but those who are capable of doing so at appropriate times will often serve your needs better

O. **Inappropriate treatment is almost always worse than no treatment at all!**

P. It is entirely appropriate to discuss things that you have learned online or from this document but once you are satisfied with the explanations and are committed to a treatment plan, follow your practitioner's instructions to the letter. You are seeing a specialist for a reason. Respect his/her expertise and don't try to second guess it or you will compromise your results

The take-home messages for musicians with hand problems:

A. If you have been fully evaluated by a "*musician-competent*" physician and she or he feels that you **do not** have an underlying **pathological** condition that needs treatment but yet you have chronic pain, be **ENCOURAGED** not discouraged!

1. It means that your problem is typically within the spectrum of **normal physiology** and therefore still has the potential to resolve or significantly improve without medical or surgical intervention and that continuing your career in spite of your pain **will not be harmful** or **dangerous** to you!

2. It means that it is the **pain itself** that requires treatment – If you become familiar with the nature of pain and can overcome your fear, you can overcome your pain, or at least modify it so that it becomes tolerable (see Part I, "*Sensation: The Nature of Pain*"). Our misinterpretation of the nature of pain makes us unable to distinguish between hurt and harm and condemns many people to chronic suffering

3. It means that knowing your pain is not harmful, "***desensitization"***, the deliberate and aggressive stimulation of painful sites, is by far the safest and most effective means of breaking the vicious circle of hypersensitivity

4. It means that you, your teachers and your colleagues are in a **better** position to "*treat*" this condition than is the medical community and you should continue each day to make subtle modifications in your technique and/or your training schedule until you find the answer

B. The concept of **optimal muscle stretch** is central to preventing and treating chronic muscle pain and should be your top priority

C. If your "*musician-competent*" physician does find a pathological problem that needs medical or surgical attention, take the time and expend the energy necessary to understand the problem from a physiological standpoint and discuss it intelligently with your provider so that you can both identify and address those special issues and challenges that you will face as a professional musician. If you ignore these issues, it may end your career

D. While the **majority** of professional musicians will experience significant upper extremity symptoms during their careers, only a **small minority** of them will have their careers ended by injury **if** they understand basic physiological principles and are able to benefit from **appropriate** medical care.

**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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