

Pianists' Injuries: Movement Retraining is the Key to Recovery

Thomas Carson Mark

1 Introduction

Repetitive stress injuries bring misery to many pianists. They are very common, and the pain they cause can be dreadful. The list of famous pianists with injuries is much longer than most people think – it includes Gary Graffman, Leon Fleisher, Wanda Landowska, Artur Schnabel, Alexander Scriabin, Ignaz Friedman, Sergei Rachmaninoff, Clara Schumann, Glenn Gould, Michel Beroff, Richard Goode and many others. In most cases the injury did not end the career, but it forced cancellations of concerts or tours, or restriction of repertoire. This is a tragic situation, since injuries are preventable and curable. Unfortunately, the literature I have seen on pianist's injuries does not clearly explain how injuries are caused, and some of the most commonly recommended "cures" are band-aids: they are good in themselves and helpful up to a point but they do not remove the cause of the injury. In this paper I shall briefly describe the causes of pianists' injuries and then indicate what has to happen to permit an injured pianist to recover. I believe that every pianist and teacher should have this information, since injuries can lead to permanent damage if left untreated.

Injuries are caused by stressful movement

Our hands and arms can move in many ways, but some ways of moving put extra stress on the tendons and other soft tissues. If a person moves in a stressful way, and does this repeatedly over a long period of time, the vulnerable structures may be injured. In this paper, I shall use the terms "efficient movement" or "stress-free movement" to refer to ways of moving that can be used even in highly repetitive tasks without causing injury. Which ways of moving are "efficient" or "stress-free" in this sense is a matter of anatomical fact, not of conscious awareness. Conscious awareness tells us whether a particular movement hurts right now, but it does not tell us whether that same movement repeated millions of times over a period of years would lead to injury. Note also that the stressfulness of a movement is not just a matter of position or outward appearance. A movement can appear right without being right (because of underlying tensions that the eye cannot see); conversely (but less often) it can look wrong without being stressful.

2 Four Causes of Injury

Co-contraction

Our arms and hands are moved by muscles. Muscles exert force only when they contract, so each muscle can exert force in only one direction. To move a body part in two directions requires two muscles or two sets of muscles, one to move it one way and one to move it the other way. When one muscle contracts, the opposing muscle must release and lengthen to permit movement. If this does not happen – that is, if the opposing muscle remains tense – then both muscles are contracting simultaneously, which is called *co-contraction*. Co-contraction inhibits movement and can cause injury.

Awkward positions

A muscle attaches to the bone it moves by means of a tendon, and the tendon passes over a joint (or several joints). The relative position of the bones will influence the efficiency of the tendon in transmitting the muscular force to the part moved, especially in cases like the fingers where the tendon passes over several joints. Awkward or extreme positions of the wrist and hand stress these tendons, making movement more difficult and also weaker. The mid-range position of the wrist, with the wrist in a straight line with the arm, gives the greatest mechanical advantage to the fingers. Deviating from this position sideways or up and down results in a loss of grip strength; in extreme positions grip strength is reduced by 25 % or more. Awkward positions make movement stressful and can cause injury.

Static muscular activity

Typically, when a muscle exerts force to move a body part, the muscle contracts and decreases in length as the part moves. When the part moves the other way, the muscle releases and lengthens. Thus, the muscle alternately gets shorter and longer. This kind of activity is called *dynamic*. But if the muscle exerts force without changing in length, the activity is called *static*. This is the type of activity used in isometric exercise. Static muscular activity is more stressful than dynamic activity. Dynamic activity permits circulation of the blood, whereas static activity inhibits blood circulation, causing the muscle to become fatigued and making it prone to injury.

Excessive force

Obviously, stress to the muscles, tendons and other vulnerable structures varies according to the amount of force used: more force is more stressful than less force. But this does not make clear how damaging excessive force can be. According to some studies, doubling the force multiplies stress on the tendons not by two but by five. Pushing down keys on the piano does not require much force; the standard touch weight for a well-regulated piano is only fifty grams, about the weight of ten U.S. five-cent pieces. It is easy to fall into the habit of using more force than needed, and because of the extremely high levels of repetition involved in piano playing, excessive force is potentially injurious.

In short, pianists' stress injuries are caused by

1. co-contraction,
2. awkward positions,
3. static muscular activity, and
4. excessive force.

These factors, alone or in combination, are the source of virtually all the pain and discomfort experienced by pianists.

Although stressful movements are the cause of injury, there are other factors that contribute to the body's resistance to injury and its ability to recover. A person's general health is one factor, physical fitness is another. Rest is also important; someone who gets adequate rest will be more resistant. Another factor is age: resistance to injury decreases as we get older. This is why some pianists play for years without problems, and then, in their thirties or forties, they develop an injury. They are not playing differently, but their body's ability to withstand the strain is less.

3 How Injury Develops

Power to move our fingers, hands and arms comes from muscles, which are attached by tendons to the parts they move. Some tendons are quite long. For example, since the muscles that move the fingers are mostly in the back of the forearm, the tendons to the fingers extend through the wrist and hand. Tendons are like long fibrous cords. They are made of collagen, they are not very elastic and they are very strong. They slide back and forth as we move our arms and fingers; some by as much as 2 inches. To facilitate the back and forth movement, tendons may be enclosed in sheaths for part or all of their length. These are the synovial sheaths, which secrete a fluid (synovial fluid) that acts as a lubricant. Circulation of blood in the tendons is limited, which means that if a tendon becomes injured, recovery is slow.

For pianists and others who engage in repetitive motion, the tendons are the weak link in the system, the structures especially prone to stress injury. Most stress injuries of the hand, wrist, arm and shoulders involve the tendons. To be sure, muscles can also be injured, but they recover more quickly. The four causes of injury listed above are dangerous because they increase stress on the tendons. (One important pianist's injury which does not primarily affect muscles and tendons is dystonia, a neurological condition in which the brain's ability to control movement is impaired. See <http://pianomap.com/dystonia.html> for more about dystonia.)

Tendons become injured because of repeated tensing or from rubbing on nearby ligaments and bones. Subjected to constant stress, tendons may fray or tear apart, or become thickened and bumpy. The injured area may calcify. The tendon sheath is also vulnerable; it may produce excess fluid, causing swelling. The tendon may become "locked" in the sheath and move jerkily; the sheath may become inflamed and press on the tendon. Inflammation and swelling in the restricted space of the carpal tunnel can put pressure on the median nerve, leading to the tingling and numbness of the thumb and second finger which often indicate carpal tunnel syndrome. All this starts to sound like a catalogue of medieval tortures, and for pianists who have been injured it might

as well be just that. Symptoms include aching, tenderness, tingling, soreness – in short, pain. The pain can be so severe as to prevent not only piano playing, but everyday actions as well. One pianist (now fully recovered and playing beautifully) says that when suffering from acute tendinitis the mere lifting of a paperback book was excruciating.

4 Cure of Injury

Dreadful as all this is, the good news is that we can be cured. Our bodies have an amazing capacity to repair themselves. Injuries will heal, provided that they have not been allowed to progress to the point of permanent damage. Even the tendons, despite their limited blood supply, will recover in time. In the acute phase of an injury, treatment may involve rest, anti-inflammatories to reduce inflammation and swelling, and massage, which can stimulate circulation (producing some of the benefits of exercise without actually having to work the injured structure). What these "treatments" really do is to provide conditions in which the body's own healing powers can do their job.

Unfortunately, in far too many cases the cure is only temporary because the person returns to the same activity as before and performs it in the same stressful way, causing re-injury. **A permanent cure requires *identifying and removing the cause of the injury***. Now, we know that piano playing *need* not be injurious, since many people, including some fabulous virtuosos, do it without ever injuring themselves. Therefore, the fact of someone being injured does not prove that piano playing is dangerous in itself. What it does prove is that there was something in the technique that was stressful, something that with constant repetition over years of playing, resulted in injury. The person must learn to play the piano using non-stressful movements to perform the tasks that were formerly performed with stressful movements. **In short, a permanent cure for pianist's injuries requires *movement retraining***.

To summarize

We can avoid injury by maintaining good physical health and fitness, getting sufficient rest, and – by far the most important – eliminating stressful movements, those involving awkward positions, co-contraction, static muscular effort and excessive force. We can cure injury the same way.

5 Why Many Pianists Do Not Recover

To say that to cure an injury we must remove its cause sounds too obvious to require emphasis, but in fact movement retraining, which is the way to accomplish this, very often does not happen. There are several reasons why injured pianists often do not get the retraining that would cure their injuries.

Many injured pianists don't understand the need for retraining or don't believe in the possibility of moving differently to play the piano. After all, they play the piano the way they always have done, the way they were taught to play. Rather than admit shortcomings in their technique they (or their teachers) may insist that the injury has "nothing to do" with piano playing but has some other cause (this is almost never true). Consequently, when first injured they rarely

look for someone to analyze their technique, identify the technical problem and find a solution. Instead they resort to transparently poor strategies like denial, wishful thinking, or "toughing it out." They say "I'll rest over the weekend and it will be better on Monday," or "I guess I just overdid it, I'll take it easy for a while." Sometimes the first symptoms are even welcomed, and people say "I must really be making progress in my practicing, I can feel it in my arms" (the "no pain no gain" fallacy). Or else, misled by discussions in the literature, they say "I just tried to do too much without proper warm-up; I'll be careful always to warm up from now on," or "I guess I need to exercise and develop strength in my fingers." As the injury persists and they become desperate, they go to doctors, physical therapists, chiropractors, accupuncturists, nutritionists, massage therapists – the list is endless. All of these professionals can help, especially in treating the acute condition, but only to a limited extent. They are not trained to do what is really necessary, namely teach the person how to play the piano without danger of re-injury.

This brings us to a point that it is vital for pianists to recognize: pianists' injuries are rarely *medical* problems, they are *movement* problems. An injury would count as a medical problem if it were caused by illness or trauma. Occasionally this is the case; carpal tunnel syndrome, for example, can be caused by diabetes, and arm pain can be caused by a fracture or sprain. These conditions are appropriately treated by medical science. But (according to some authorities) such cases account for only about 5 percent of pianists' injuries. It follows that roughly 95 percent of pianists' injuries are not medical problems; they do not come from illness or trauma but from the way the person habitually uses his body. This explains why health care professionals are rarely of much help to pianists who seek a permanent cure. An injured pianist does not need a *doctor*, he needs a *teacher*, and the solution to the near-epidemic of pianists' injuries will come not from therapy but from education.

Becoming injured can be emotionally devastating for a pianist. If a person's thoughts, aspirations, and, perhaps, very livelihood center around the piano, then to be unable to play one's best, unable to play without pain, perhaps unable to play at all, is a dreadful experience. Injured pianists often become deeply depressed and discouraged. The injury can become a stigma and the injured pianist feels isolated, rejected, inadequate, and humiliated. Depression and a sense of hopelessness can themselves be obstacles to recovery. An injured pianist desperately needs emotional support and understanding from friends, relatives, colleagues, and teachers.

Unfortunately, many colleagues and teachers, though well-intentioned and sympathetic, can offer only limited help. Typically, they offer moral support, which is essential, but few have a clear understanding of the causes of injuries or the conditions for recovery; few have the information they need to prevent injury in their students or show an injured pianist how to recover. What I described a few paragraphs back as "transparently poor strategies" are the ones most often invoked by teachers and pianists at all levels. This is understandable; after all, the required information is not part of most music curricula, pedagogy classes, or conservatory programs. On the assumption, natural enough but usually mistaken, that the problem is a medical problem, not a movement problem, teachers and colleagues may send the injured pianist for medical treatment or therapy. Such treatment rarely produces a complete, permanent cure, so teachers and colleagues feel helpless, frustrated and anguished along with the injured pianist.

The general problem will be solved only when sound information is part of every pianist's training. When teachers have the information and students, from the very beginning, are taught the principles of stress-free movement, pianists' injuries will no longer occur.

Piano periodicals and books on technique are not generally very helpful to the injured pianist. Few discussions of pianists' injuries emphasize movement retraining and the strategies they do recommend are not especially effective, either for avoiding or for curing injury. These include "building endurance," "developing strength," taking frequent breaks, warming up, "pacing ourselves," and the like. In themselves, I have no quarrel with any of these suggestions; all are good things to do, and they may contribute to our ability to resist injury. But they are not the full answer; someone can do all of them and still be injured. For example: suppose my way of playing octaves involves forcefully flexing my wrist. There are anatomical reasons why repeated forceful flexion of the wrist is dangerous; it is, in fact, one of the common causes of carpal tunnel syndrome. Therefore, if that is how I play octaves I am risking injury. Even if I take breaks, warm up before practicing, and so on, it will still be true that with every octave I play I will be stressing the tendons in my wrist. If I use stressful movements to play octaves, then telling me to avoid injury by warming up before practicing the Sixth Hungarian Rhapsody is like telling a smoker to take some deep breaths before lighting up in order to avoid lung cancer. Warming up and deep breathing are great, but they don't remove the cause of the problem. Just as lung cancer is caused by smoking, not by failure to do lung exercises, so pianists injuries are caused by stressful movement, not by failure to warm up, take breaks, and so on.

How does it come about that a good pianist may play in a way that stresses the body? I think there are two principal reasons. First, most people's technique is not deliberately chosen. That is: the person does not analyze the movements needed to play a passage and practice those movements. Instead, the person just finds a way, by hook or crook and trial and error, to get by the right notes. With constant repetition the movements become habits. Sometimes, movements acquired this way will be efficient. But there is no guarantee. Our bodies can become used to inefficient movements as well as efficient ones, and when we are used to them, the inefficient ones feel "natural." I have heard pianists with techniques full of potentially injurious movements describe their technique as "natural" and "relaxed."

The second way in which people come to move stressfully is that they are *taught* stressful movements. No teacher would knowingly teach harmful movements. But too few teachers understand the principles of efficient movement, and some ways of moving that are dangerous to our health are firmly established in traditional pedagogy. I shall give only one example: playing with "curved fingers."

The expression "curved fingers" is vague, so let us be more precise. When we hold our hands in a relaxed position hanging at our sides, the fingers assume a gently curved position. I shall call this the "natural curve" and it is indeed the appropriate position for the fingers in playing the piano. But some methods instruct students to bend the two end joints of the fingers, resulting in a more pronounced curve than the "natural" one. I shall call this *curled* fingers, and it is potentially injurious. The reason curled fingers are dangerous is that the two end joints of the fingers are moved by the flexor muscles on the lower side

of the forearm. Holding the fingers curled requires maintaining the contraction of the flexor muscles. Lifting of the fingers, on the other hand, is accomplished by contracting the extensor muscles on the top of the forearm. Therefore, if I lift my fingers while maintaining the "curl" of the two end joints, I am using flexor muscles and extensor muscles simultaneously; in other words, I am co-contracting. Co-contraction is one cause of injury; there are pianists who have suffered injury from playing with curled fingers (see Beth Tomassetti's story in *Oregon Musician*, Fall, 1995).

That playing with curled fingers is stressful is not just an opinion for people to accept or reject as they choose. It is a fact of anatomy. There is no way, anatomically, to lift our curled fingers without co-contracting. No amount of practice, no exercises aimed at "finger independence" or "strengthening the fingers," no amount of telling ourselves to "relax" – none of these will change the way our bodies are made. The anatomical fact is that if we play in this position we are risking injury. Yet playing with curled fingers is not only tolerated, it is advocated by some piano methods. There are beginning methods that tell students to use a pencil to line up the tips of the fingers into a straight line – a recipe for producing co-contraction. If the student plays that way and practices diligently, no one should be surprised if injury is the result. (Let me point out again that although "curled" fingers are dangerous, the "natural curve" is correct; the "natural curve" is not what I am arguing against. Also, I am well aware that not everyone who plays with curled fingers winds up injured. Some people are lucky, their bodies are more resistant, or whatever. But that does not alter the facts presented here; after all, some people smoke for sixty years without developing lung cancer, but smoking is still the cause of lung cancer.)

The movements that can cause injury do not necessarily feel bad or painful. Indeed, they are not dangerous in non-repetitive tasks. They are dangerous for pianists because piano playing is extremely repetitive. One handbook on stress injury considers "highly repetitive" any tasks requiring 1500 or so repetitions per hour. That may sound like a lot of repetition but it is nothing compared to piano playing. The hourly rate of repetition for sixteenth notes at a metronome setting of 120 is 28,800, a number that might give a health inspector apoplexy. In fact we *can* play sixteenth notes at 120, but we can't use just any motions to do it; some motions safely permit that level of repetition, and others do not.

Learning a less stressful way to move at the piano means abandoning old physical habits and replacing them with new ones. This is possible to do, though it takes time and application. But there is a deeper problem as well: the old ways may be embedded not just in our bodies but in our minds. Suppose I have been injured by my way of playing octaves. But suppose further that I was taught to play octaves by a teacher whom I deeply admire. Learning a new way to play octaves may cause me to modify my opinion of my former teacher. It may force me to re-think many aspects of my own teaching and playing, and I may be obliged to conclude that things I formerly believed sincerely were not actually the best. **In short, movement retraining forces me to examine myself and my relationship with the piano, and I must be prepared to question and change my attitudes and beliefs.** Even if the results make the effort worthwhile, the process is not easy.

6 Two Obstacles to Understanding

The sports analogy

In our sports-oriented society, comparisons with sports are everywhere and they can be very harmful. Playing the piano is not actually very much like an endurance sport, and building a technique is not a matter of building muscles. The amount of physical strength required to play the piano is very little, and endurance is not an issue if one is moving efficiently. The weight of the forearm alone is ample to push down the keys. Making this weight available as needed is a complex skill; we need to move rapidly and efficiently. But it is not a matter of strength.

The sports analogy infects our ways of dealing with injury; we may say "no pain, no gain" when our arms are sore, and continue practicing in the same way. If our hands feel weak – a frequent symptom of injury – we think the answer is to do strengthening exercises. In fact this may only make the problem worse. If a structure is injured, working it harder will not promote healing. Some (very few) comparisons of piano playing with sports may be useful, but for the most part the sports analogy is misleading and harmful.

Arguments from authority

I have in mind the invoking of a famous pianist or teacher as a justification for some element of piano playing. "Horowitz did it this way" or "Vengerova taught such and such." One reason to be suspicious is that we often have no way of knowing whether the claims are true – especially with historical figures. More important, though, is that the authority of a famous pianist or teacher does not make a movement efficient. What makes it efficient or inefficient are facts of anatomy. Some famous pianists have moved very efficiently, others have had techniques that included inefficient ways of moving (as is shown by the famous pianists with injuries). **We need to have the knowledge to recognize stressful movement, and if someone tries to justify a stressful movement by saying "so and so did it that way," we need to reply that if so and so really moved that way they were risking injury, and if they taught that way of moving they were putting their students at risk of injury.**

7 Conclusion

Movement retraining is an exacting process. It requires consistent, careful attention as the injured pianist develops awareness of the coordinate use of the entire body to play every note. Describing this in detail requires a book (such as my book "What Every Pianist Needs to Know about the Body," GIA Publications). Individual instruction from an appropriate teacher is immensely helpful, especially in the beginning stages. The time required for recovery varies a lot, but some injured pianists who were unable to play at all have progressed in six months to full, unrestricted playing with no pain. Others may take a longer or shorter time. Much depends on the length and severity of the injury and the dedication of the pianist.

I shall not describe movement retraining in further detail here, but conclude with three practical suggestions. The three principles I shall offer are aimed more at prevention than cure, but if teachers inculcated these habits in their students, we would see fewer injuries.

The first principle is to **sit at the correct height** and insist to students (or their parents) that the bench at home be at the correct height. Some piano methods do say things like "the forearm should be level when the student sits erect without hunching the shoulders," which is correct; much the same advice is found in any ergonomics text. If a person is not at the correct height, the body is likely to compensate somewhere. A person sitting too low may hunch the shoulders or lift the elbows, a person sitting too high may drop the wrist or pull the shoulders down. All of these compensations involve static muscular activity that limits freedom and can in time lead to injury.

Since the correct bench height is the one that puts the forearm level, it is not the same for everyone, and it may not be the same even for people of the same stature. The correct bench height is determined by the relation between the length of the upper arm and the length of the torso, and this proportion varies from one person to another. A handy way to find the correct height is to sit upright with the arms hanging freely and the fingertips resting on the keys. Then adjust the height of the bench so as to place the tip of the elbow even with the top of the white keys. To many pianists, the correct height will feel high at first, since most benches are too low for most people. Even adjustable benches do not go high enough for many people.

The second principle is to **avoid dropping the wrist**. The wrist should be roughly straight with the forearm, neither arching way up nor falling appreciably below the level of the main knuckles. The reason is that any other position puts stress on the tendons as they pass through the carpal tunnel. Forcefully flexing the wrist (as in "wrist octaves") is an important cause of carpal tunnel syndrome. The mid-range position of the wrist is the one in which the fingers move most easily and have the greatest strength, with least stress on the tendons.

The third principle is to **avoid ulnar and radial deviation** (which many pianists call "twisting"). That is, the hand should not be turned to either side, but should be straight with the forearm sideways as well as up and down. Again, the reason is anatomical: sideways bending of the wrist inhibits free motions of the fingers and puts extra stress on the tendons that pass from the arm to the hand. Common situations in which people twist are in bringing the thumb to the keyboard, or in playing black keys with the thumb. Twisting is one of the most common causes of injuries in pianists. (In terms of the four causes of injury given earlier, dropping the wrist and twisting both count as awkward positions.)

The three principles are not equally easily adopted. The first, correcting the bench height, is easy. A person soon gets used to the new height, and most people find that their playing improves immediately when the bench height is corrected. The other two principles are harder to assimilate, since they may involve changing long-established habits. If I habitually drop my wrist in playing chords, or twist when passing the thumb in a scale, I will need to learn a new way to accomplish those tasks.

Throughout this paper I have advocated movement retraining as the way to avoid or cure injury. But there is another point that is equally compelling: **we play better if we move efficiently**. Many pianists have retrained after

injury because it was the only way they could play at all, and then discovered that they could play better than before. Others have retrained without being injured and discovered the same thing: they could play better, with greater ease, play more difficult pieces, and overcome problems that formerly seemed hopeless. These facts are profoundly important, and every pianist or teacher should reflect on them. What they imply, I believe, is that all of us, students, pianists and especially teachers, should make the effort to learn the principles of efficient movement at the piano and apply those principles first in our own playing (since we can't teach what we can't do) and then in our teaching. An efficient technique is not only the way to cure or avoid injury, it is the best way to further our artistic goals.