How Your Hands Don't Work

Dan Formosa, Ph.D.

My friend GG – that's how he signs his name – bought a new guitar. Playing it is causing some unexpected finger pain. The new guitar is not very different from his other one. He's blaming the guitar's neck shape and how his hand fits around it. But that difference is subtle at best. Maybe string gauge and scale length of the neck – both affect how tightly the strings need to be tightened to be in tune. But again, I don't think so – differences may be noticeable but not that significant.

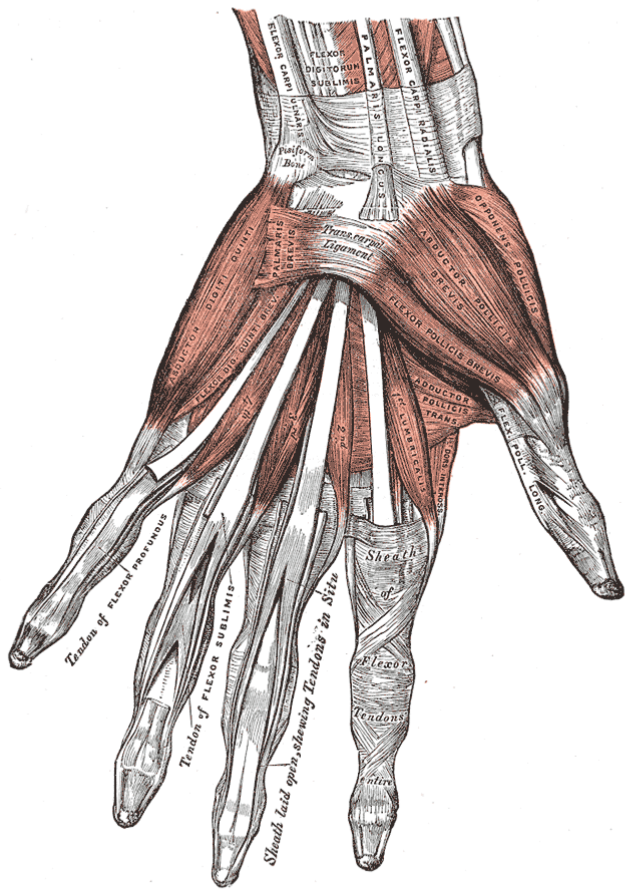
My advice was that he should not just look at his fingers, but also at his entire body posture – the affect of the new guitar's larger size, its balance and angle that it's being held, and possible effects on his shoulder, elbow and wrist angles – the entire arm. In understanding the hand you need to understand what's happening at least up to the shoulder.

Hand problems, including Tendonitis and Carpal Tunnel Syndrome, are popular among musicians. They can devastatingly impair their ability to perform. A combination of rapid finger movements, excessive hours of practice, and sometimes-awkward hand positions can cause mechanical havoc. Musicians aren't alone. People in the meat-packing industry, construction workers, hair stylists, people who type a lot and sewing machine operators can have similar problems. Women are more at risk than men. Obesity contributes as a factor. Cold weather doesn't help.

A hand's mechanical issues can be many. Each one contains 27 bones, 123 ligaments and 30 arteries. Movements are controlled by 17 small muscles within the hand itself, and 18 in the forearm. As a mechanism, it's versatile. We use our hands to sense things – fingertips are sensitive to touch, able to distinguish minute qualities of an object, detecting subtle differences in shape and texture. Hands can sense cold and heat, airflow, dryness and moisture. Hands can accomplish tasks that require brute force, and others that require speed and precision. They can capably wield a heavy hand tool or help push a broken-down vehicle to the side of the road – but they can also thread a needle or play a violin. The hand is a stunning example of mechanical engineering. Kind of.

It's also complex. And like any complex mechanism, it's easily susceptible to damage. With 27 bones each hand has 27 major joints – actually more when you count every intersection of the wrist bones. Among its 27 bones are some of the smallest in the body. You've got smaller bones in the ear, but those are protected by your head. Your little toe is tiny and at risk of being stubbed, but shoes prevent that from occurring too often. Hands are generally exposed, often overworked, and frequently at risk of some type of accident or mechanical failure.

The muscles that enable your fingers to do most of the work – grabbing, pinching or squeezing – are not in your hand. Fingers are controlled by large muscles located in your forearm, one body part away. A well-orchestrated array of muscles, tendons and ligaments allow that to happen. Tendons are the string-like tissue that connects muscle to bone. Ligaments are similar in composition, but they connect one bone to another. Both are made of collagen and are surprisingly strong, lots of tensile strength. If you've ever had a strain or sprain somewhere on your body, you are probably well aware of their function and their limitations.



Cuts, scrapes and burns can put your hand out of commission. An accident, some sort of physical trauma, can do damage also. The causes of those problems are obvious. Let's focus on the more hidden risks, problems caused by tasks a person is deliberately preforming – and in cases where a man-made object may play a role, can be prevented by design. This understanding can also improve performance, because the same principles that reduce risk will optimize the ability of the hand to accomplish quick or complex tasks, or tasks requiring strength and endurance.

All that lifting, pushing, pulling, pressing, pinching, hanging, turning, luggage carrying, writing, typing, track-balling, texting, scissoring, hammering, piano playing, rock climbing, fall-preventing, among other activities, can take a toll. Improper wrist angles can exacerbate those detrimental effects. So can factors like weather, or vibrations, or rapid repetitions of movement. The hand works like any other mechanical object, subject to the same laws of physics. When designing, it helps to consider the hand as a mechanism too. Here's a quick overview of how your hand works, and how it doesn't.

Basics in physiology

Muscles contract. That's all they know how to do. Have your brain send your muscle a signal to fire and that muscle will get shorter. To expand a muscle you need to send a signal to an opposing muscle, stretching the first muscle back into place. That, or you need to rely on gravity or some other external force.

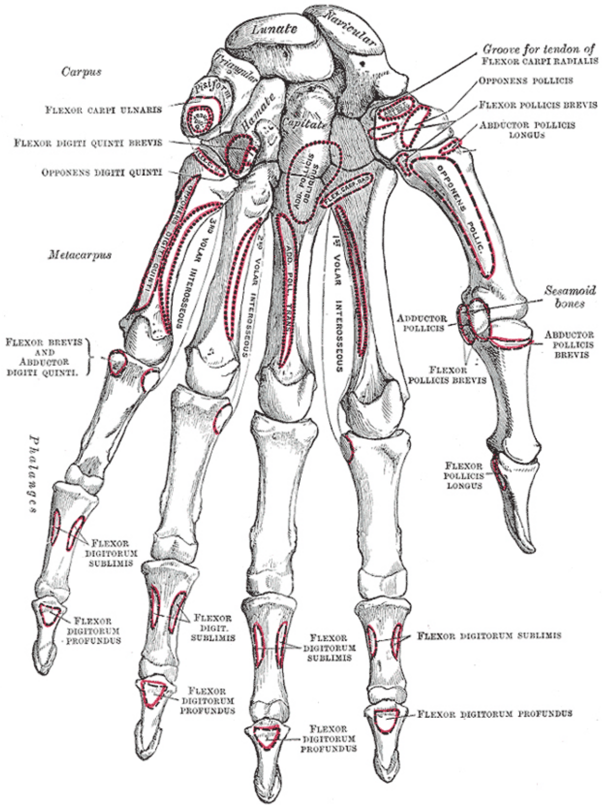
Your wrist

Grabbing something requires contraction of flexor muscles located in the underside of your forearm. Releasing your grip relies on the contraction of the extensor muscles located on the upper side of your forearm. Muscles are therefore either pulling from one side of the wrist or the other. The tendons that connect to those muscles run from the middle of your forearm to the very tips of your fingers. Finger movement is complicated by the fact that those tendons need to pass through your wrist – and your wrist can bend.

Your wrist contains a series of eight small, interlaced carpal bones. They allow your hand to rotate side to side – the movement we use here to wave down a New York City taxi. It can also flex forward and extend back, approximately 160° range of motion, although actual range will vary depending on the person. The carpal bones form a concave shape as you look at your wrist with you palm facing you. Stretching across the edges of the curve is the ribbon-like Transverse Carpal Ligament. That combination of bones and ligament form the Carpal Tunnel, through which the tendons must pass. Flexing a finger then extending it results in movement of its tendon through the tunnel.

With the wrist unbent the tendons can pass through the tunnel easily. When the wrist is bent, the tendons pull against the transverse ligament. Your grip will be much weaker.

Parts start to rub against each other. With rapid movement or excessive force that rubbing will cause tendons to become inflamed. The Median Nerve, sharing space within the Carpal Tunnel, can get squeezed, cutting off blood supply. Repeated movements just make things worse. Common terms for these problems include Repetitive Stress Injury and Cumulative Trauma Disorder. CTS stands for Carpal Tunnel Syndrome. These problems occur often.



Your fingers

Your index, middle, ring and little finger each have three bones: Distal (furthest from the wrist), Middle and Proximal. They therefore have three joints. The location of the furthest two joints can easily be seen by looking at the creases in the skin with your hand palm-side up. However, contrary to popular belief, the third joint is not located at the third crease in your finger – it's in the center of your palm.

Like the transverse ligament in the wrist, the fingers also have sheaths that keep the tendons in place. Three joints give each finger three places where things can go wrong. Repeated, rapid and excessive movements of the fingers, too often or under too much stress, will cause the tendons to inflame. A scroll wheel on a computer mouse, for example, can be one such cause. A small nodule can appear, making the tendon even less willing to pass through the sheath. A "snapping," referred to as Trigger Finger, will be felt. The remedy calls for not bending that finger for a few weeks – usually achieved by using a splint.

Your thumb has just two segments, Distal and Proximal. A few muscles in the palm at the base of the thumb help it to close, open and flex. Through overuse – like excessive gaming or texting – its parts are similarly susceptible to breakdown.

Smaller hands and the triple whammy

Your middle finger is strongest, your index finger and ring finger are next, just about equal. The little finger, a.k.a. the pinkie, has less strength. Don't write it off, however. For many tasks, such as squeezing a pair of pliers, the pinkie will also have the most leverage, since it's furthest from the hinge. It therefore contributes significantly. Females can be at more risk for hand problems due to three challenges they face using products that don't consider females' generally smaller hand sizes – a triple whammy:

1. smaller muscles and "mechanical components" within the hand and forearm,

2. smaller grip span may necessitate operation with fingertips, not the stronger middle segments of the fingers,

3. the pinkie may not be able to reach at all, therefore can't contribute.

Of course there's lots more information out there on this topic – consider this a primer.

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