Physiological Benefits of the *Quadra Clicks RBT Mouse* in Preventing Carpal Tunnel Syndrome

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When I was first asked to evaluate Quadra Click RBT mouse, I recoiled as if a rattlesnake showed up in the room. That's because for decades now, manufacturers of this or that "cure for carpal tunnel syndrome" have darkened my door looking for endorsements. Some of them waving a fat check in my face. Unfortunately, my medical specialty is fraught with frauds and cheats. I have never, and will never, lower my scientific standards.

But my nurse, Rose Matters urged me to take a look. She'd been in conversation with the inventor and felt like he was the real deal. What I discovered, to my great pleasure and some amazement, is that the Quadra Clicks RBT Mouse **will help prevent carpal tunnel syndrome**. I'm gratified to finally be able to recommend a product that will help anyone at risk of developing carpal tunnel syndrome.

How the Quadra Clicks RBT mouse is different

It's different because it's the first mouse that solves the pathology initiated by the repetitive stress of clicking. There's a symphony of biomechanical activity going on inside your hand to enable the clicking action on a traditional mouse. The Quadra Clicks mouse bypasses this activity by calling on an alternative set of biomechanical processes.

All other computer mice laying claim to carpal tunnel benefits are based on ergonomics. Ergonomic design eases the pressure on tissues vulnerable to carpal tunnel. Easing pressure helps, but over time the benefits give way to the constant barrage of clicking, and clicking, and clicking. That's why the gaming community and computer professionals are so vulnerable to the disease.

The Quadra Clicks mouse is built on solid biomechanical principles. In so doing, its design eliminates the source of the problem. This mouse entirely reinvents HOW people click so that vulnerable tissues are no longer exposed to overuse trauma.

I've simplified the physiology and biomechanics explaining why Quadra Clicks is different and how it works with an overview of the following topics:

- What is carpal tunnel syndrome
- Its symptoms
- Who gets it
- A gamer's risk of developing it
- How symptoms happen
- Kinds of repetitive stress
- Biomechanics of tendon stress
- How the Quadra Clicks RBT mouse overcomes stress

What is carpal tunnel syndrome?

Carpal tunnel syndrome gets its name from the *location* of the pathology. It occurs deep inside the wrist joint, in a confined anatomical space called the "carpal tunnel." This area is no larger in diameter than a thimble. But through this narrow opening pass several important structures. All of them crowd together as they squeeze through the carpal tunnel space. The most prominent structures are:

- 9 flexor tendons which control finger flexion (1 flexor pollicis longus, 4 flexor digitorum superficialis, 4 flexor digitorum profundus tendons)
- The median nerve which controls sensation in the fingers and palm
- Blood vessels transporting nutrients and waste products between the hand and heart
- Lymphatic vessels which drain fluid from the hand and wrist areas

That's a lot of important structures trying to squeeze through such a small diameter hole! And therein is the problem underlying carpal tunnel syndrome: *crowding inside the carpal tunnel space.*

Symptoms of carpal tunnel syndrome

Carpal tunnel syndrome feels differently from one person to the next. But certain symptoms are characteristic of the disorder. These are:

- Hand or finger pain, numbness, tingling, burning, pins-and-needles or itching
- Shooting electric shock-like feelings from the fingers to the hand or wrist
- Symptoms are most pronounced in the thumb, pointer and middle fingers
- Either pain or numbness may wake you up from a dead sleep
- Hand weakness or clumsiness causes you to drop things
- Difficulty pinching small objects, like coins, a shirt button or shoelaces

Who gets carpal tunnel syndrome?

First and foremost, carpal tunnel syndrome is a disorder of the hand that begins inside the wrist joint. It results from a median nerve that's crushed by inflamed and swollen tendons.

Nobody is certain why some people acquire carpal tunnel syndrome while others don't. But we're sure certain factors put you at risk for seeing symptoms. These risk factors are:

- Anyone with a family history of the disorder
- Being female
- "Small-boned" individuals
- Pregnant women (mostly in the third trimester)
- Workers who use vibrating hand tools
- People who repetitively stress their hand or fingers on the job
- People with rheumatoid arthritis, fibromyalgia or diabetes
- Anyone who sprained or broke a wrist

Risk of carpal tunnel syndrome in gamers

With some half million new cases each year, carpal tunnel syndrome has become the most prevalent musculoskeletal disorder in the USA. And it accounts for the second most number of operative procedures performed.

Video gamers make up about 10% of the patients I speak with every single day. I know their pains and their challenges. And they're not alone. Gamers, graphic artists, musicians, hairdressers, dental hygienists, cashiers, stenographers, and assembly line workers are in the top 5% of those at risk for developing carpal tunnel syndrome.

Why? They all perform very similar repetitive hand and finger activities.

Interestingly, despite numerous research studies, there is insufficient epidemiological evidence that computer keyboard and mouse use actually "causes" carpal tunnel syndrome. But the association is too complex to simply view this as a cause-and-effect problem.

To illustrate this relationship, we can say repetitive stress is *associated* with carpal tunnel syndrome in much the same way obesity is *associated* with diabetes. Obesity doesn't actually "cause" diabetes, but there's a very strong *association* between the two. And if the obese person loses weight, the probability of developing diabetes decreases. Likewise, we know that if patients reduce their repetitive stress activity, the probability of developing carpal tunnel syndrome also decreases.

It's therefore logical to assume we can *prevent* carpal tunnel syndrome from ever happening by either:

1. Eliminating the repetitive stress activity
2. Modifying the activity so it doesn't stress the flexor tendons

Many people use a computer mouse as an integral part of their lives. So *eliminating* computer mouse use is very challenging, if not impossible. But *modifying* how a mouse is used is much easier. *And* m*odifying mouse activity is what makes the Quadra Clicks RBT mouse* so successful.

Because Quadra Clicks changes the WAY a person clicks, there's a very short learning curve involved. You'll get used to it quickly.

Symptoms occur due to a crushed median nerve

Fundamentally, carpal tunnel syndrome is a *neuropathy* of the median nerve. That means the nerve does not function properly. And median nerve dysfunction can be devastating because it's one of the primary nerves of the hand.

The median nerve passes through the jam-packed carpal tunnel passageway along with the other structures. And key to understanding carpal tunnel syndrome is that this nerve squeezes through the congested carpal tunnel passageway immediately *adjacent* to the flexor tendons.

When tendons become irritated, they begin to swell and expand with fluid. Anywhere else in the body this isn't such a big issue because there's usually plenty of room for the swelling. But tendons expanding inside the crowded carpal tunnel space is another matter altogether. *There's no room to swell!* So as tendons swell and expand, they crush the adjacent, innocent bystander: the median nerve.

Crushing any nerve causes it to react badly. This is why crushing the median nerve inside the carpal tunnel gives you all of the symptoms of carpal tunnel syndrome. Hand and finger pain, numbness, tingling, soreness, and weakness are all a result of the median nerve being crushed by swollen tendons inside the carpal tunnel space.

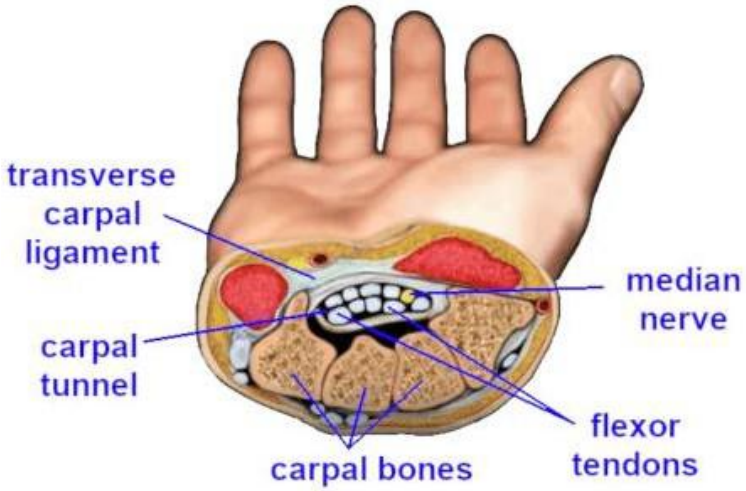

Figure 1: The underlying problem in carpal tunnel syndrome is that the flexor tendons, running next to the median nerve, become irritated, swell, and crush the adjacent median nerve.

What causes tendon swelling?

If tendons swell and crush the median nerve, then what causes tendons to swell in the first place? The simple answer is “mechanical stress”.

Tendons are normally well lubricated and glide smoothly, back and forth, inside a “tendon sheath”. Think of it like a pencil gliding inside a drinking straw.

But when some tendons experience a certain form of stress, that smooth gliding becomes obstructed. The stress most commonly associated with causing tendon disorders is known as “repetitive stress.”

Repetitive stress

Repetitive stress is also called “repetitive strain.” It can result in Repetitive Strain Injury, or RSI. An RSI can happen in a number of ways:

Rapid movement

Rapid movement is when the fingers, hand or wrist engage in fast muscle movements. It’s most observable when the fingertips move rapidly by flexing and extending. These activities are common when clicking a mouse, using a keyboard, playing a musical instrument, and knitting.

Slower, repetitive movement

You don't have to move your fingers fast to develop a repetitive strain injury. Slower repetitive activities using more gripping force are just as harmful. Such activities include picking up and scanning grocery items, using a styling scissors, and using dental hygiene tools.

Slower, forceful motions

You can even slow down the movement of your fingers, hand or wrist and still produce repetitive strain injury. This occurs when the fingers, hand or wrist undergo high stresses at slow speed. Common examples are golfing, bricklaying, weightlifting, pushups, wrench torqueing, and bowling.

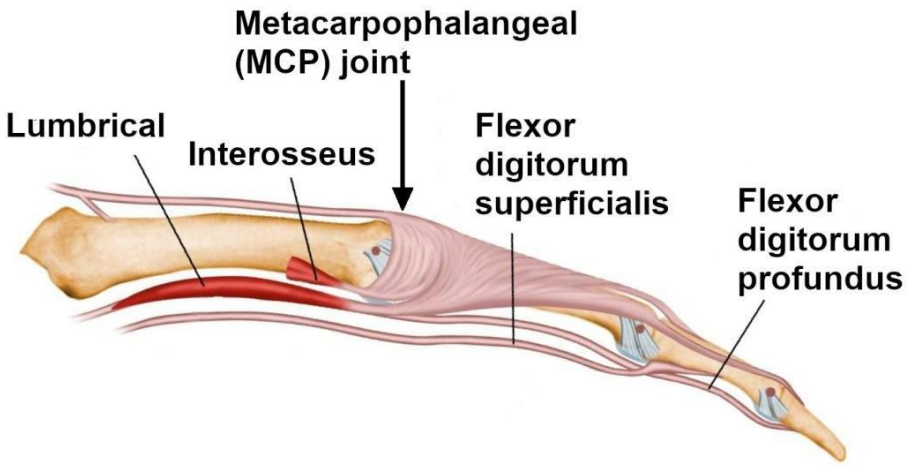

Figure 2: Contraction of the 2 tendons running below the finger will curl the finger starting at the MCP (knuckle) joint.

The biomechanics of tendon stress

Carpal tunnel syndrome occurs when flexor tendons become stressed. The most common type of stress is repetitive stress. As we've seen, stress can be in the form of fast, rapid movements of the fingers. Or it can occur with slower, more forceful finger movements. If we analyze the physical demands of using a conventional computer mouse, the repetitive stress forces on the finger become clearer.

Curling the fingertip area of the forefinger requires the flexor tendons to produce tremendous mechanical forces.

The 2 flexor tendons (flexor digitorum profundus and flexor digitorum superficialis) together produce 2 key motions in the process of actuating the mouse button. These are *inward* and *downward* motions. Their movement produces the following actions:

1. The tendons force the fingertip to pull inward, onto the mouse button. Doing so increases the distance of travel for both (digitorum profundus and flexor digitorum superficialis) tendons.
2. Both tendons force the 3 phalanges (finger bones) downward, onto the mouse button.

The resultant motion is **fingertip curling**, which actuates a conventional mouse button. But in fact, this seemingly tiny motion requires surprisingly great mechanical forces.

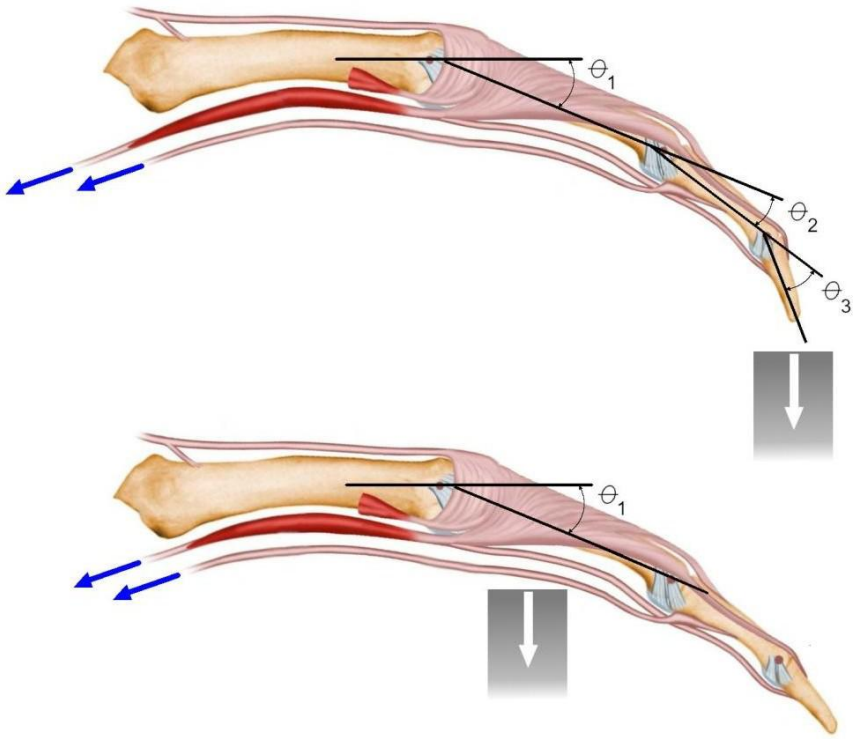

Figure 3: Clicking a conventional mouse (top) requires movement of all 3 finger bones. This results in more tendon force and longer tendon excursion into the carpal tunnel. Clicking the RBT mouse (bottom) requires fewer bone movments and shorter tendon excursion.

Neutral position and joint theta angles

When the hand and fingers are relaxed, they're said to be in the neutral position. Anyone can see this position by simply relaxing their hand on a table, sideways, with the thumb facing upward. The neutral position is a slight flexion of the wrist with fingers slightly curled.

Finger flexion – as when actuating a computer mouse button - requires deviation from the neutral position. Essentially, it requires the entire forefinger to curl. This creates a change in the angles of each bone's long axis relative to the long axis of the bone of their proximal (closer to the hand) neighbor. This is called the theta angle (Θ angle) of the joint. The greater the Θ angle of a joint, the greater the relative angular displacement of the bones.

In the finger, there are potentially three Θ angles (one for each phalanges bone) required to create a finger curl. This means to depress a conventional mouse button, the finger must produce a Θ_1 as well as Θ_2 and Θ_3 joint angle.

Obviously, creating fewer Θ angles (fewer bones) or lower Θ angles (less deviation) requires less tendon force and less tendon excursion (travel).

Physiological benefits of the *Quadra Clicks RBT mouse*

The actuating button ("clicking button") of the Quadra Clicks RBT mouse is uniquely positioned. It's located more proximally than a conventional mouse. This small positional shift radically changes the

biomechanics of mouse clicking. It effectively requires less flexor tendon stress, no matter how fast or how often you click the actuating button.

The reason why a more proximal positioning of the click button produces less tendon stress (compared to a conventional mouse button) is because the Quadra Clicks RBT mouse DOES NOT require:

- Extensive tendon excursion
- Forceful tendon flexion
- Maintaining static finger elevation
- Extreme lumbrical (intrinsic finger muscles) contractions

These points are expanded upon below. Essentially, the Quadra Clicks RBT mouse maintains the hand and fingers in the neutral position for longer periods of time. That means reduced forces and less finger movement to achieve mouse button activation.

Maintaining the hand and fingers in the neutral position longer reduces potential tendon irritation. Therefore, it reduces the probability of pathology, like carpal tunnel syndrome.

Extensive tendon excursion

The result of producing three large Θ angles is a downward movement (curling) of the fingertip to actuate a conventional mouse button. This means longer excursion (travel) of the tendon from fingertip through the carpal tunnel space.

In contrast, the *Quadra Clicks RBT mouse* requires only the proximal phalanges to move. This means only one Θ angle (Θ_1) is required to actuate the RBT mouse button. Therefore, since only Θ_1 angle is required, the *excursion* of the flexor digitorum superficialis and flexor digitorum profundus tendons are greatly reduced compared to conventional mouse actuation.

Reduced tendon excursion can only result in reduced potential for stress and mechanical friction. This is how it can help prevent the likelihood of pathology, like carpal tunnel syndrome.

Forceful tendon flexion

Compared to a conventional mouse, the Quadra Clicks RBT mouse does not require forceful tendon flexion of the forefinger. That's because creating only the single Θ_1 angle means less force is required to actuate the mouse button. The result is minimal flexor tendon excursion (travel) required to actuate the button.

All this means less mechanical work to overcome friction along the tendon's length. And this, of course, means reduced flexor tendon stress. Lowering tendon stress will reduce the probability of pathology, like carpal tunnel syndrome.

And since there is less flexor muscle contraction required to actuate the mouse, it means the muscles don't work as hard. The outcome is that flexor muscles **don't fatigue as easily**. When finger fatigue is minimized, the fingers can be used more efficiently for longer periods of time. This is particularly crucial in video gaming.

Maintaining static finger elevation

Conventional mouse buttons require fingertip pressure to actuate the function. But when the button is not being depressed, the fingertip must remain in an elevated (non-pressure) position over the button. Such "hovering" involves the use of multiple muscle groups and tendons.

Studies show that maintaining this type of fingertip elevation increases the hydrostatic pressure inside the carpal tunnel **at least two-fold**. And fundamental to the pathophysiology of carpal tunnel syndrome is increased hydrostatic pressure inside the carpal tunnel.

The Quadra Clicks RBT mouse requires no such hovering stresses of the finger. Instead, the proximal phalanges (the bone nearest the knuckle) performs all of the movement. This saves the distal phalanges from hovering. As a result, it lessens pressure inside the carpal tunnel space. Less hydrostatic pressure means a lower probability of pathology, like carpal tunnel syndrome.

Extreme lumbrical contractions

To initiate finger flexion, the flexor tendons travel proximally (inward) and through the carpal tunnel space. Clicking a conventional mouse button requires powerful and sustained contraction of the flexor muscles as well as the fingers' intrinsic muscles, the lumbricals.

This contraction also causes the lumbrical muscles to also move inward. This is called increased lumbrical incursion into the distal carpal tunnel space. The lumbricals move inward because they're attached (at their distal point) to the flexor tendons.

Therefore, with more finger flexion, the more the lumbricals are pulled into the distal end of the carpal tunnel space. Studies show that this further increases hydrostatic pressure inside the carpal tunnel.

As we've seen, carpal tunnel syndrome is due to increased hydrostatic pressure around the median nerve. Therefore, increased pressure due to lumbrical incursion increases with greater finger movement. It's only logical that such pressure increases contribute to the probability of acquiring carpal tunnel syndrome.

Unlike conventional mouse devices, the Quadra Clicks RBT mouse results in less lumbrical incursion into the carpal tunnel. That's because only the Θ_1 angle is involved in actuating the Quadra Clicks RBT mouse button. With minimized lumbrical incursion, the probability of increased hydrostatic pressure inside the carpal tunnel is reduced. This therefore reduces the likelihood of developing carpal tunnel syndrome.

Summary

The ideal mouse will impose a lesser degree of musculoskeletal stress on the fingers and hand. Essentially, it will keep the hand and fingers in the neutral position for longer periods of time. This is one of the great benefits of the Quadra Clicks RBT mouse. It reduces tendon stress and simultaneously provides less muscle fatigue for increased accuracy and performance as compared to conventional computer mouse devices. Most importantly, it will greatly reduce the probability of acquiring a tendon pathology like carpal tunnel syndrome. By extension, therefore, we can classify the Quadra Clicks RBT mouse as a "preventative measure" against carpal tunnel syndrome.