Visualize one of these scenarios, or something like them. We have all been there, done that. It is very late. You are frantically typing a term paper the night before it’s due. Perhaps you are rushing to get a major grant proposal completed and in on deadline. Or maybe you are simply finishing up the annual Christmas letter to the relatives back home. The computer hums as your fingers fly over the keyboard. That is when it hits you. Your hand begins to tingle. Then it begins to hurt. It hurts a lot. Your fingers start to get numb. Finally, you stop to rest. The deadline slides past.
while you sit nursing your wrist. You are the newest victim of carpal tunnel syndrome (CTS). About 2 million Americans suffer from CTS, a disorder characterized by wrist pain, tingling, numbness, and loss of grip strength. CTS is a repetitive strain injury. It is caused by repeated hand motions such as typing, use of vibrating tools, cutting, small parts assembly, and sewing.
Richard Hinrichs started his personal education about repetitive strain injuries almost 10 years ago when he began experiencing pain while typing. He did more than just read about the problem, however. He decided to try to help solve it.

Hinrichs is an associate professor of exercise science at Arizona State University. He has teamed with Benjamin Sucher, D.O., an osteopathic physician in Paradise Valley, Ariz. Together, they are working to develop an effective non-surgical treatment for CTS. Every year, between 200,000 and 400,000 Americans undergo surgery to relieve carpal tunnel syndrome. But, Hinrichs says that surgery is not always effective.

"About one-third of all the people who have the surgery report results of fair to poor. That means surgery didn’t solve the problem at all. And more than half report some return of symptoms," he says. "One of the scary things is that a small percentage of people actually lose the ability to grip, or they lose some grip strength. If you can’t grab things and carry them around, that’s a major problem."

Hinrichs and Sucher are trying to develop a treatment that would produce the same results as a successful surgery—without the risks. Like surgery, their treatment would involve widening the carpal tunnel inside the wrist. However, they would use a non-invasive method for doing so. As its name implies, the carpal tunnel is a tunnel-like structure in the wrist. It is created by the eight carpal bones on one side and the transverse carpal ligament (TCL) on the other. Flexor tendons inside the tunnel are responsible for finger movement. The tunnel also contains the median nerve which connects to the hand’s many sensory cells.

Repetitive motions such as typing cause the tendons to become irritated and inflamed. With no room to expand inside the narrow tunnel, the tendons put pressure on the median nerve. This pressure causes the pain and numbness of CTS.

In carpal tunnel release surgery, the TCL is cut to widen the carpal tunnel. As a result, the inflamed tendons no longer put pressure on the median nerve. Hinrichs and Sucher want to widen the carpal tunnel without cutting the ligament. Instead, they plan to stretch it by using a special wrist brace that could be worn at night while patients sleep.

Hinrichs has demonstrated the effectiveness of stretching the transverse carpal ligament with a technique he uses on his patients. The two-part technique involves manual manipulation of the wrist, performed at Sucher’s office, and stretching exercises that the patient performs at home.

"It’s a very effective technique," Sucher says. "But patients have to be taught precise techniques in order to do the stretching. There’s a bit of a learning curve and a compliance issue."

Sucher says that he has no way to ensure that patients are doing the exercises properly or regularly. In addition, they have to show up for frequent office visits. The technique is hard on Sucher, too. "It requires a lot of physical work to do the manipulations. It’s a bit challenging," he says.

Preventing the pain
The best treatment for carpal tunnel syndrome is prevention. Richard Hinrichs gives these guidelines as a means to avoid repetitive strain injuries while typing or working on a computer keyboard.

Use tools and workstations designed to reduce repetitive strain injuries. Such tools include split keyboards, wrist cushions, adjustable keyboard trays, and chairs with proper support and adjustable positions.

Use proper posture at all times.

Avoid awkward wrist positions. When typing, your hand and wrist should form a straight line, without bending at the wrist.

Take a short break at least once an hour.

The American Academy of Orthopaedic Surgeons recommends the following exercises. Perform this exercise 10 times before you start working:

1. Extend and stretch both wrists and fingers acutely as if they are in a hand-stand position. Hold for a count of 5.

2. Straighten both wrists and relax fingers. Hold for a count of 5.

3. Make a tight fist with both hands and bend both wrists down. Hold for a count of 5.

4. Straighten both wrists and relax fingers. Hold for a count of 5.

5. Hang arms loosely at side and shake them for a couple of seconds... — Diane Boudreau

Richard Hinrichs
and Benjamin Sucher

John C. Phillips Photo
The wrist brace would be much easier for everyone to use. "A patient wouldn't have to go into the doctor's office to get a ligament stretched," explains Hinrichs. "The patient could stretch the ligament on his or her own while sleeping."

To develop the brace, Hinrichs and Sucher conduct experiments to determine the optimum amount of force to apply to the wrist. Their test subjects spend up to 12 hours with weights draped into their wrist bones. But they never complain. That's because the researchers are experimenting on cadaver limbs obtained from the University of Arizona Medical School.

"This work is probably too risky to try on a living subject because the bones are too small," Hinrichs says. "You can fracture a bone easily while drilling into a wrist."

During the experiments, the cadaver hands are turned palms-up. Pins are inserted into the scaphoid and trapezium bones on the thumb side of the wrist, and into the pisiform and hamate bones on the opposite side. The researchers then attach a wire to each pin. Using pulleys, they hang a weight from each wire. The downward force of the weights pulls the wrist bones apart. Because the transverse carpal ligament is attached to these bones, it stretches when the bones move.

Next comes the difficult part. How do the researchers determine the distance that the TCL has stretched? Because they can't actually see the ligament, Hinrichs and Sucher videotape their experiments. They then use a special computer program to determine the exact change in ligament length.

The program is based on principles of three-dimensional stereo-photogrammetry. It works by mathematically combining two videos taken from different angles. This allows the computer to determine 3D coordinates for objects on-screen. Unfortunately, the researchers want to know the coordinates of points that cannot be seen—the points at which the pins enter the ligament.

To solve this problem, Hinrichs and Sucher place two tiny balls on each pin—one at the top of the pin and one at skin level. By determining the 3D coordinates of these balls, the researchers can draw an imaginary line that extends into the ligament. Once they know the distance from the skin to the ligament (measured later through dissection), they can calculate the precise location at which the pin enters the ligament.

"The ligament stretches most rapidly in the first few minutes, then begins to level off. After several hours, we cannot detect any additional movement of the pins," he says. "The ligament shortens again when we remove the weights. But not all the way to its original length, at least not right away."

Step one is to figure out the best weight needed to achieve a reasonable ligament stretch. Step two will be to test a special brace that was designed and patented by Sucher. The brace pulls apart the wrist bones by pushing up on the top of the wrist and pulling apart the lower sides.

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"We're going to test the brace on the cadaver hands and make more measurements," Hinrichs says.

Sucher says that the brace could replace his current manipulation technique. "A low load over a long time may be able to achieve the same effects with a lot less work on everybody's part," he explains. The brace also might work as a supplement to his therapy by making the ligament more receptive to manipulation.

The wrist brace is a promising option for frustrated patients because it actually widens the carpal tunnel. While other non-surgical treatments exist, they typically involve reducing inflammation through medication and/or wrist braces.

"These other non-surgical treatments are not doing anything to actively open up the carpal tunnel," Sucher says. While such treatments can be effective, the motions that initially caused problems could aggravate the wrist again.