Repetitive stress injuries which occur in the laboratory are most often caused by incorrect hand tool use and incorrect body position in operation of instrumentation. These Cumulative-trauma disorders are known by a number of different names such as carpal tunnel syndrome, tendonitis of the hands or elbow, “trigger finger”, tenosynovitis, ischemia of the tissues, vibration-induced white finger and others (Sanders, 1993).

Human joints are an intricate system of muscles, tendons and ligaments which are able to carry, flex and move in a wide range of motion. It is when the limitations of this system are exceeded that injury, pain and trauma can occur. Gripping and fine motor movement depend on muscle contraction of the forearms, which transfer the force to the finger bones along tendons. If the wrist and arm are in the correct position to each other, the force is delivered successfully. If the wrist exceeds 30 degrees from the arm position, there is added stress, fatigue and weakness to the tissues, resulting in the onset of a repetitive injury (Robinson, 1994). All of the above conditions are caused by repetitive and fixed-position tool use which restricts blood flow, muscle movement and puts pressure on nerves and tendons. Working in awkward positions (against anthropometric limits) for extended periods of time leads to these injuries. The cost to the company for not preventing injuries is decreased productivity, lost workdays and increased medical and worker’s compensation claims (Carson, 1993). Please see Appendix II for an explanation of tissue injuries and possible causes of them.

In the laboratory, there are many situations where the tool used and the manner in which it is used can cause repetitive injury. Hand pipettors are the primary source of tendonitis of the hand and thumb, as well as carpal tunnel syndrome. Incorrect position and poor posture while performing microscopy and tissue culture can cause shoulder, arm and neck injuries. The constant use of forceps and tweezers without a spring-loaded mechanism can cause tendonitis of the thumb. Using specialized tools designed for right-handed people with the left hand is sure to cause discomfort, if not injury.

Repetitive stress injuries occur in the laboratory setting because there is not a great deal of thought put into the design of those hand tools used. Anthropometric measurements have not been considered to design tools for the routine work we do; new tools and equipment are usually designed for specific projects. The problem of injuries in this type of workplace is that until recently, many people were not aware of the origin of their injuries. With the advent of more and more automatic procedures (cell counters, bioassays, ELISA, PCR), which consist of repeated movements such as pipetting of small amounts of fluids into wells or tubes that are then placed into a machine, repetition for long durations is required. In addition, almost everyone in the lab uses keyboards to operate instrumentation or to process or record data and generate reports. Keyboard use can also cause these injuries if the technician is not trained and given safety equipment. As in so many other industries, people in science-oriented labs have not focused on prevention of repetitive stress injuries until recently, when medical claims increased dramatically.

I am going to discuss my specific injury from repetitive motions in the lab, since tendonitis and tenosynovitis are fairly common injuries. De Quervain’s tenosynovitis is caused by the inflammation of two specific tendons on the radial (thumb) side of the wrist, as they pass through a tunnel in the end of the radius bone. They are the abductor pollicis longus (the AP tendon) and the Extensor pollicis brevis (EP tendon). The mechanism of injury, in repetitive use cases, is repetitive ulnar deviation (flexion of the hand outward towards the baby finger) during thumb-grasp tasks, such as using forceps, tweezers, scalpels, pipettes and scissors. Weakness, swelling and tenderness occur on the wrist directly below the thumb joint (Morgan, 1997). There are many therapies to allow relief from tendonitis, but the only way not to continue to aggravate the site is to stop the repetitive motion causing the problem or have surgery to open the space in which the tendons become restricted. I had tried hand braces very soon after I first experienced the tendonitis, but they proved to be more of a problem than a help. My work involved immersing my hands and equipment in water, which could destroy my braces and splints; I couldn't fit the gloves on top of the splint without tears occurring. The biggest problem in wearing a splint while doing tissue culture was that I worked in a sterile environment and the splint was not clean.

The area needing improvement in tissue culture is tool design. The Internet is filled with sites for specific tools in dentistry and surgery, especially tools which would necessitate being held stationary for a long period of time and with a certain amount of force exerted (a retractor, for instance). I was not able to find tools specifically designed to replace the non-ergonomic, damaging design of tweezers, forceps and scalpels. Some of the information on tool design that I came across is somewhat applicable to lab work and is a general guideline in purchasing tools:

- Tools should not require the pinch grip (what injured me). When maintaining the pinch grip while using small instruments, such as tweezers, the hand works four to five times harder than with the use of the whole hand;
- Tools should be ambidextrous, whenever possible, so that there is no need to consider handedness when picking up the tool;
- Find tools that will not cause any deviation of the wrist and will allow it to be aligned with the arm in a straight position; and
- Use tools that will allow the arms to remain close to the body, so that there is no energy lost and there is less fatigue in the arms.

(Carson, 1993)

Another area that could be improved is the nature of tissue culture itself. This type of work is usually done experiment by experiment, which cause the technician to stay at the bench for 3 to 4 hours of continuous fine tool use, not allowing for enough muscle recovery time. Some things that can be done in this type of work include:

- Broadening the number of tasks that each person in the lab can perform;
- Rotation of all members of the group from task to task;
- Requiring break time and stretching of the affected areas to increase circulation and relieve tension;
- The limit of time spent at the task per day; and

- Increasing the number of technicians working on the task (less items to do per person).

(Carson, 1993)

Again, the biotechnical laboratory industry has been slow in the prevention of repetitive stress injuries and is starting to see the value in prevention versus treatment and disability of workers, like me. One of the problems with the industry is that there are new procedures and instrumentation introduced frequently and most companies do not devote enough time focusing on the ergonomics of workstations when using these new instruments. Much of the work, by nature, is repetitive and routine. These types of tasks – pipetting, dispensing, microscopy, transferring, and others – are always going to be part of lab work, regardless of the instrumentation involved. There is also so much more computer time involved in running the instruments, which is another area of work to involve in the prevention of injuries. Workstations should be adjustable and training should be given to instruct employees on their use (Roberg, 1999).

In Sanders and McCormick, there are a number of hand tool device design principles worth discussing. The one design principle which could potentially prevent injuries to the hands and wrists is the practice of maintaining a straight wrist position so that all nerves, tendons and vessels are not pinched by palmar flexion or ulnar deviation. The design change would be to make hand tools which allow for a more anatomically correct positioning of the hand. This desired position requires a bend of roughly 20º ± 5º in the handle of tools, so that the wrist is held as straight as possible, decreasing fatigue and pressure. Handles of tools should be made larger so that the force exerted to use them would be distributed across a larger surface of the hand, which reduces pressure on the palm. Tools should be free of finder grooves because due to the anthropometric variety of hand sizes, not everyone's fingers fit along the grooves. Fingers could be squeezed together or be irritated by pressure of the edge of a groove in which they do not fit (Sanders, 1993).

To avoid trigger finger, a type of tenosynovitis, operation of the tool with flexion of the index finger should be replaced with thumb controls or finger-strip control. Both methods allow the wrist to remain straight and the pressure exerted to be distributed across four fingers or a thumb, rather than one finger. There should be accommodations made for the left-handed and women, who quite often have smaller hands than for which the tool has been designed. Being left-handed, I have always had a hard time with pruning knives, pruning sheers, loppers and scissors in nursery work because right-handed forms have always been provided. The cutting blades are designed for the force of the cut to come from the right side, and the cut turns into a tear or rip of plant tissue instead of a clean cut (Sanders, 1993).

Along with tissue culture of plants, I was responsible for maintaining my stock plants and the trees from which I obtained my samples. I came across a site that was related to the ergonomics of nursery work. http://ag-ergo.ucdavis.edu/papers/impact.htm is a paper presented to the 1997 meeting of the National Institute for Farm Safety, Inc. It discusses a number of modifications which can be made in nursery work to reduce the incidence of stress injuries. Repetitive gripping of the edge of three to 4 1-gallon nursery cans at a time to move them to another location can cause stress on the thumbs and fingers from gripping. This job is repeated 13 to 20 times a minute. Twisting and flexing of the trunk is part of nursery work and can strain the lower back easily. There is repeated lifting, moving and carrying of containers which are heavy with soil and plants, and usually wet, which adds to the weight and stress.

Among the interventions are the use of tools which eliminate the handling of multiple containers, such as loading them on push carts, using “Mules” (gas- or electrically powered carts) to drive containers from one location to another; limit the amount of twisting is necessary in planting and handling stock; improvement on posture of the back and more efficient use of the arms and legs in lifting; limiting the amount of weight that is lifted at one time; and avoidance of pinching of container edges to carry them.

The best strategy in guarding against workplace injuries such as tendonitis, carpal tunnel syndrome, tenosynovitis and other repetitive stress injuries, is the prevention of them. Vigilant evaluation of the workplace is necessary to insure that the equipment and instrumentation used is not contributing to injuries. I have included (as Appendix I) a chart that can be used at the workplace to evaluate tools and be used as a checklist for design features that are ergonomically correct. Taking a short inventory of available equipment and evaluating its safety is such a small thing to do to avoid down time, injury and the cost associated with it.

Appendix I

HAND-HELD TOOL ANALYSIS

DESIGN FEATURE	OPTIMUM	ACTUAL
Handle shape	Natural wrist/arm posture	
Pistol	70 to 80 degree angle	
Inline	Cylindrical	
Other	Two-hand, T-wrench, ball	
Grip	Allows optimum performance	
Power	1.25-1.75 inches (30mm-45mm)	
Precision	0.2-0.5 inch (5mm-12mm) Dia.	
Surface	Nonslip, nonconductive	
Length	4.5-5.0 inches (115mm-125mm)	
Left/Right Hand	Dominant hand, interchangeable	
Scissors/Pliers	Natural wrist/arm posture	
Handle Span	2.5-3.5 inches (65mm-90mm)	
Spring opening	Spring loaded action	
Tool weight	Moderate static muscle loading	
Power	>5lbs. (2.3 kg.) counterbalanced	
Precision	>1lb. (0.4kg.) counterbalanced	
Power Tool	Air, electric, hydraulic	
Trigger	Finger, thumb, strip, push, lever	
Vibration	Frequency, dampening material	
Torque	Air shut-off, impulse, clutch	
Noise	Noise > 85 dBA0	
Air Exhaust	Adjustable diverter	
Other		

From: Robinson, Fred, Jr. and Bruce K. Lyon. (1994, August). Ergonomic Guidelines for Hand-Held Tools. Professional Safety, 39, 16-21.

Appendix II

OVERUSE INJURIES AT WORK

TISSUE	PATHOLOGY SITE AND PROBABLE CAUSE
Muscles	Tears of muscle-tendon junction due to high load Fatigue; disruption of muscle substance due to static contraction
Tendons	Micro tears (tendonitis) due to friction Synovial thickening (tenosynovitis) due to friction
Nerves	Hypoxia due to compression of blood supply by muscles/tendons

From: Ranney, Don. (1993). Work-related injuries of the forearm and hand: their specific diagnosis and management. Ergonomics, 36 (8), 88-92.

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