The Rap Sheet on Restraints

BY **GEOFFREY DESMOULIN**

Geoffrey T. Desmoulin, Ph.D., R.Kin., P.L.Eng., Principal of GTD Scientific Inc. in North Vancouver, holds two degrees in both Engineering Sciences and Kinesiology, allowing him to predict human injury in any environment. He was previously an Emergency Medical Technician, firefighter, and military reservist. Since 2009, GTD Scientific Inc. has garnered Federal and Supreme Court qualifications and an extensive international client list within the legal and law enforcement communities.

Lawsuits

While handcuffs provide the control necessary to ensure the overall safety of both the detainee and the arresting officer, they can also cause injuries. The injuries result from the interplay between police training, hand-cuff design and detainee behavior. Handcuffing that does result in injury, can lead to significant lawsuits. Consider the news article "Handcuff Suit [...] Man Says Arrest Damaged Hands" by Mr. Mike FOLKS printed on June 5, 1993. A jury awarded a significant settlement to a man who said sheriff's deputies caused nerve damage to his wrists by refusing to loosen handcuffs after an arrest in Boca Raton. The Palm Beach County Circuit Court jury deliberated for four hours before finding the Palm Beach County Sheriff's Office guilty of negligent handcuffing. Cases like these are becoming more prevalent. In Canada, this is relevant due to similarities to the United States in police equipment design, police training and detainee behaviour, but there is also a connection between Canadian defendants and American judgements that have been obtained.[1]

It is evident that research is needed to understand how handcuff neuropathy occurs and what can be done to prevent it. GTD Scientific, Inc. was engaged to conduct a study to compare the risk of handcuff neuropathy with various handcuff designs.

Handcuff Anatomy

Typically, handcuffs are made with two interlocking steel strands that are riveted together and have rachet teeth to tighten the strands around a subject's wrist. Once handcuffs are applied, they cannot be loosened unless a key is inserted. On the other hand, some handcuffs can tighten on their own after they are applied, unless a double locking mechanism is engaged. Thus, failure to engage the double lock effectively can result in inadvertent increased tightening, leading to nerve compression injuries known as handcuff neuropathy.

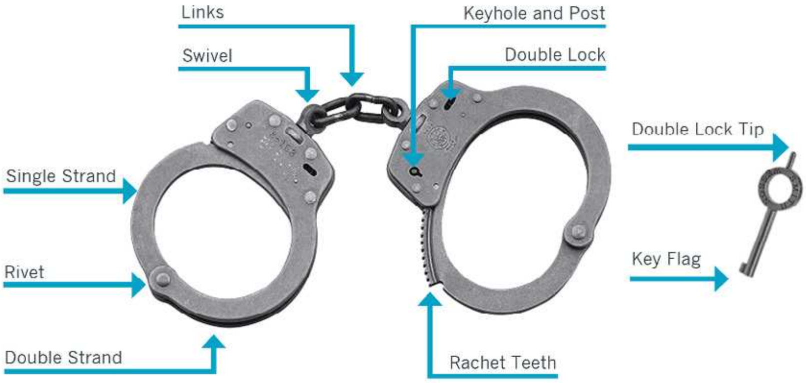

FIGURE 1: HANDCUFF DESIGN

Nerve Injury Background

Overly tight handcuffs or movements by the detainee can cause the strands to compress blood vessels and nerves. The superficial radial nerve is particularly susceptible to compression as it runs along the outside of the radius bone at the wrist.[2] Handcuff neuropathy due to prolonged compression results in numbness in the fingers, which can impair dexterity, and the ability to detect harmful situations like touching sharp objects or burning heat. Severity of nerve damage is related to handcuff tightness, length of time under compression, and the amount of force applied against the handcuffs by the detainee.[3] Studies demonstrated that constant compression of 60 mm Hg (approximately 1 PSI) pressure to a nerve can cause total functional loss after 150 minutes and that constant compression of even 30 mm Hg (approximately ½ PSI) reduces nerve function by 50% after 210 minutes.[4]

Injury Test Methods

Since an individual of any gender or build might be placed in handcuffs, the GTD study was designed to simulate the risk of handcuff neuropathy for a broad population: from a small female to a large male. Forearm models were constructed to simulate the two bones (radius and ulna) at the wrist for each category. A surrogate nerve was created from a thin silicone tube pressurized with fluid (mineral oil) and connected to a pressure sensor. Two different current handcuff designs were compared.

Risk of Injury Findings

The handcuff was placed around the forearm-nerve model and the ratchet mechanism was engaged to tighten the handcuff. The increase in nerve pressure was monitored as the ratchet was tightened. From a firm "fit" to exceeding nerve injury thresholds, in some cases, required only a single click, i.e. tightening by one ratchet tooth (Figure 2).

To simulate force applied against the handcuffs, weights were attached to the handcuffs to pull the strand against the forearm-nerve model. Handcuffs positions were varied to simulate both pulling apart and twisting of the handcuffs.

The pressure after over tightening by a single click of the ratchet was roughly 130 mm Hg (approximately 2.5 PSI) in the most severe case for the Handcuff A and 115 mm Hg (approximately 2.2 PSI) in the most severe case for the Handcuff B, presented in the upper panel of Figure 2. In three of the four tested configurations, the recorded pressures at maximum tightness were well above 60 mm Hg, shown to produce total loss of nerve function when applied for two and a half hours.[5] Even partial over tightening could exceed 30 mm Hg, shown to produce up to 80% loss of nerve function over four and a half hours.[6] Even over tightening the handcuff by a single ratchet click could increase the pressure from little risk to high risk of nerve injury since the pressure appears to increase exponentially with handcuff tightness as maximum tightness is approached.

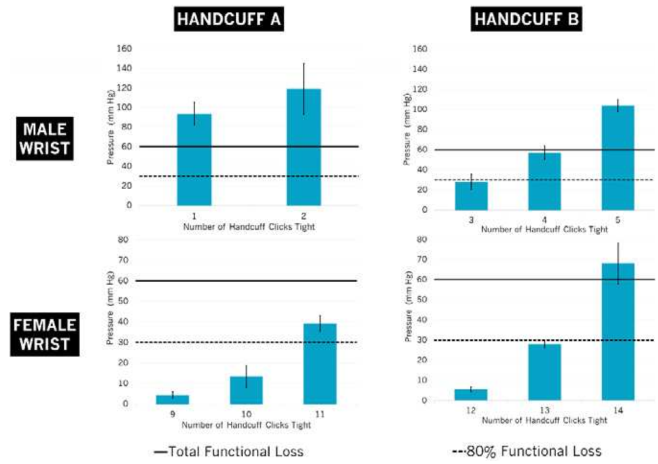

FIGURE 2: NERVE PRESSURE IN RELATION TO HANDCUFF TIGHTNESS (FIRM "FIT" TO FUNCTIONAL LOSS)

The relation between pressure and force applied to the handcuff was not statistically different between the two handcuff designs (Figure 3). In other words, the force applied to the handcuff determines the pressure on the nerve independent of current variations in handcuff design.

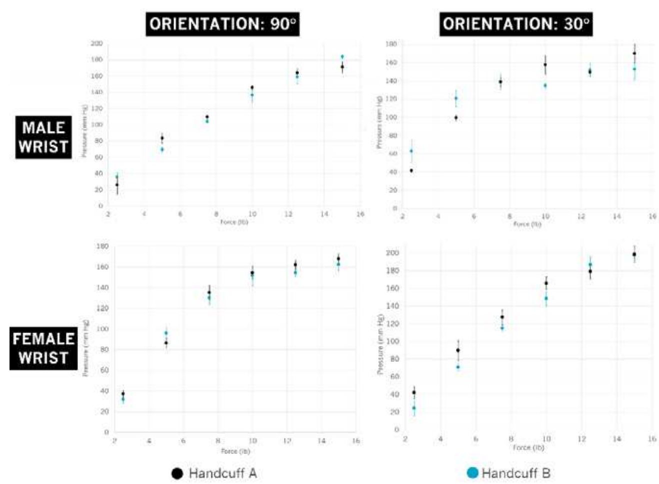

FIGURE 3: NERVE PRESSURE IN RELATION TO APPLIED FORCE

Figure 4 represents a substantial increase in pressure simply due to changing the orientation of the handcuff without changing the load, similar to what might occur when twisting the wrists in the handcuffs. Given that the baseline pressure of the test load created approximately 80 mm Hg, twisting in the handcuffs could increase the pressure to levels as large as those recorded for maximum tightness.

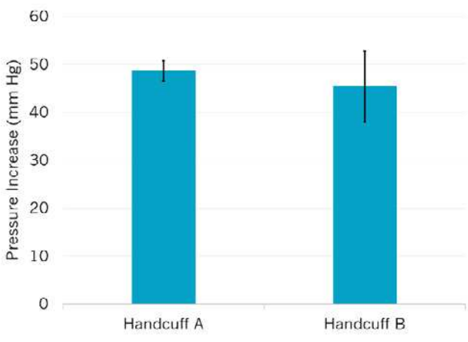

FIGURE 4: INCREASE IN NERVE PRESSURE INDUCED BY A TEST TO MIMIC HAND TWISTING IN HANDCUFF

Avoiding Injuries

GTD's findings reinforce the necessity of adequate training in applying handcuffs to minimize the risk of nerve injury. Officers should always engage the double locking mechanism to prevent inadvertent further tightening of handcuffs, and ensure that handcuffs are not overly tight. It is also incumbent on officers to inform detainees that they could sustain nerve injury by twisting their wrists in attempting to free themselves from handcuffs. In addition to increasing pressure on the nerve, struggling may induce swelling at the wrist, elevating any risk of nerve injury. Further, improving on current handcuff designs may reduce the chance of injury. However, based on GTD's findings, ensuring that handcuffs are not overly tight, that they are double locked and warning detainees about the risk of nerve injury is the best way for police departments to be proactive in avoiding handcuff neuropathy injuries and potential litigation. V

HANDCUFF INJURY MECHANISMS

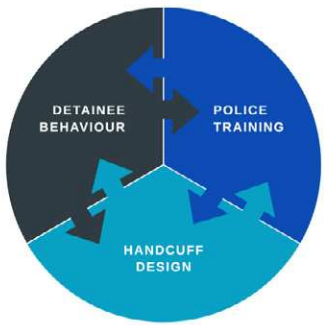

FIGURE 5: HANDCUFF INJURY MECHANISMS

1 https://www.wagnersidlofsky.com/enforcing-american-judgment/ by Mr. Charles Wagner accessed 11 JUL 2022
2 Richmond and Fligelstone, 1988; Scott et al., 1989
3 JJ Payne-James, "Restraint Techniques, Injuries, and Death: Handcuffs," Encyclopedia of Forensic and Legal Medicine, pp. 127–129, 2016.
4 R. M. Szabo and N. A. Sharkey, "Response of peripheral nerve to cyclic compression in a laboratory rat model," Journal of Orthopaedic Research, vol. 11, no. 6, pp. 828–833, 1993.
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