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Revisiting Pneumatic Nail Gun Trigger Recommendations

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Summary

Use of a pneumatic nail gun with a sequential actuation trigger (SAT) significantly diminishes the risk for acute traumatic injury compared to use of a contact actuation trigger (CAT) nail gun. A theoretically-based increased risk of work-related musculoskeletal disorders from use of a SAT nail gun, relative to CAT, appears unlikely and remains unproven. Based on current knowledge, the use of CAT nail guns cannot be justified as a safe alternative to SAT nail guns. This letter provides a perspective of ergonomists and occupational safety researchers recommending the use of the sequential actuation trigger for all nail gun tasks in the construction industry.

Background

Modern home-building involves the ubiquitous use of the pneumatic framing nail gun. These tools have dramatically increased framing productivity beyond what could be achieved with a hand hammer. However, the dramatic increase in productivity introduced a new injury potential that can be summarized as follows:

> *You're using a gun to do something faster, and fast isn't safe. …. It might be making it easier, but all around, it's shooting projectile at a high speed to go through hard materials. It's just dangerous to work with* (Union carpenter, St. Louis, MO).

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The findings and conclusions in this paper are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

Before pneumatic nail guns were available, nail puncture injuries on a construction site typically occurred when a carpenter or other tradesperson *stepped* on a nail protruding from a piece of lumber. Carpenters did not "accidentally" drive nails into their own body or a co-worker's body with repeated strikes from a hammer. These injuries, however, became common occurrences with the application of compressed air to power pneumatic nail guns to drive nails "at a high speed to go through hard materials."

Pneumatic nail guns have a safety device (workpiece contact, *nose, yoke, tip*) at the end of the gun muzzle that must be depressed before the fastener can be discharged. There are generally two types of trigger systems which then define how the nail gun fires in response to a trigger press.

- The *sequential actuation trigger (**SAT***) requires that each nail can only be discharged when the safety tip is first depressed and, while held depressed, the trigger is squeezed.
- The *contact actuation trigger (**CAT***) allows the operator to first squeeze the trigger and, while holding the trigger squeezed, repeatedly *bump* the safety tip on the work piece to shoot multiple nails.

Of these two trigger mechanisms the SAT provides a positive safety advantage (Stanley Works, 2002; European Committee for Standardization 2009) in that it prevents the unintended firing of a nail that can otherwise occur when the trigger is depressed and the workpiece contact is bumped. (See Figure 1.)

Traumatic injuries can occur when an operator *intentionally* discharges a nail using *both* types of actuation systems and the nail penetrates through the wood or misses it altogether. However, a nail gun equipped with a SAT system is much less likely to be discharged unintentionally, as the trigger must be activated while the safety tip is depressed against the body (NIOSH/OSHA 2011). Unintentional nail discharge using the CAT system typically takes place following nail gun recoil (resulting in a "double fire" - second unintended shot) or when the operator has their finger on the trigger and the nail gun nose inadvertently contacts an object (Lipscomb et al, 2003). Although operators are advised against holding the trigger in the depressed position when not intending to shoot a nail, nail gun physical characteristics, including weight (8–9 lbs.), balance, trigger location and hand-grip design, make it easier to hold the gun with a full power grip that includes the index finger. (See Figure 2.)

Nail gun injury studies

Portable pneumatic nail guns have been used to frame new wooden structures since the mid-60s and gradually replaced the framing hammer as the tool of choice. As pneumatic nail gun use increased throughout the in the 1980s and 1990s, so did the number of medical case reports of pneumatic nail gun fatalities and traumatic injuries to the head, eyes, chest, and the lower and upper extremities.

The first nail gun injury epidemiology report was published by the Washington State Department of Labor and Industries in 1999 and later appeared in Professional Safety

(Baggs et al 2001). The study reported the analysis of Washington State nail gun injury workers' compensation claims from 1990 to 1998. The injury incident rate for building construction workers (SIC 15 Building Construction) was 78 incidents/10,000 full-time equivalent (FTE) workers/year, while the incident rate for wood framing tasks was 206/10,000 FTE.

Dement et al [2003] analyzed Ohio Bureau of Workers' Compensation claims (1994–1997) for all Ohio carpenters and residential construction workers employed (1996–1999) by North Carolina Home Builders Association members. Nail gun injury rates for the North Carolina and Ohio cohorts were, respectively, 91 cases/10,000 FTE and 132/10,000 FTE. A subset of claims was analyzed (n = 185) that included written narrative descriptions of the injury incident and the authors concluded at least 69% of the incidents may have been the result of an unintentional nail gun discharge or misfire.

Lipscomb et al [2003] investigated all acute work-related injuries (n=783) among a St. Louis, MO carpenters' union apprentice cohort working in the residential building industry (1999–2001). Nearly 14% (80) of the injuries involved nail gun use. The rate for apprentice carpenters was higher (3.7/100 FTEs) than the journey-status carpenters' rate (1.2/100 FTEs). A majority of injuries occurred when the CAT mechanism was used and the authors concluded that 65% of the injuries could have been prevented if the nail guns had been equipped with the SAT mechanism.

Lipscomb and Jackson (2007) analyzed reports of nail gun injuries treated in U.S. hospital emergency departments from 2001 to 2005. The range in annual occupationally-related injuries was 19,300 to 28,600, with an annual average of 22,200. Most injuries were to the upper extremities (66%) and lower extremities (24%); bone fractures were involved in 4% of the injuries. The data did not include information describing nail gun actuation systems utilized when the traumatic injuries occurred.

There is no question about the potential for serious injury or death using pneumatic nail guns. An unpublished review of nine nail gun-related fatality investigations in the OSHA Integrated Management Information System (IMIS) revealed three of nine fatality cases that were clearly attributable to the CAT trigger (that is, preventable with SAT) and five of nine fatality cases that lacked adequate information to clearly determine the role of trigger type in causation. Only one of the nine fatality cases was deemed to have been clearly unpreventable with SAT. We also know that the SAT system provides a positive safety advantage over the CAT system. Despite this recognized advantage, the CAT system is more likely to be used than the SAT system.

One argument that has been anecdotally provided against using the SAT system is the potential for developing "trigger finger" (stenosing tenosynovitis) as a result of the need to squeeze the trigger for each nail discharged. In the 2001 article published in *Professional Safety* Washington State Department of Labor and Industries, Safety and Health Assessment and Research for Prevention (SHARP) researchers (Baggs et al, 2001; p. 37) provided an opinion that nail gun users use the SAT system. SHARP researchers however added the following:

> As employees gain experience with the tool, the “bump” (CAT) trigger system can be implemented to reduce the potential risk of musculoskeletal disorders (e.g., trigger finger). Manufacturers should work with users and safety professionals to better balance speed and productivity of using the “bump” mode with accuracy and potential for fewer acute trauma injuries using the sequential mode. In all cases the possibility of trigger finger must be considered.

The *Professional Safety* article and a preceding SHARP technical report (Baggs et al., 1999) provided an opinion that the SAT should be used, postulating that the SAT nail gun likely posed less traumatic injury risk to the user. As such, less experienced nail gun users were encouraged to use the SAT to reduce the likelihood of injury. Transition to a CAT nail gun, was opined to provide ‘speed and productivity’ advantages over the SAT and diminish risk for musculoskeletal disorders – implying the possible differential risk for work-related musculoskeletal disorders between SAT and CAT nail guns. These opinions were not necessarily intended as policy guidelines. In the 13 years since the 2001 article in *Professional Safety* no evidence has emerged in the medical case report, ergonomic or the injury epidemiology literature indicating use of the safer *single shot* SAT trigger mechanism differentially increases a worker’s risk of developing a work-related musculoskeletal disorder.

The SHARP report was not the only guidance at that time to suggest that risk factors for cumulative trauma disorders/repetitive strain injury be considered in the adoption of SAT systems. In 2001 the New Zealand Department of Labor published “Guidelines for the safe use of portable mechanically powered nailers and staplers”. The New Zealand department of Labour also acknowledged risk of overuse syndrome with SAT, but only in high volume production when “thousands of trigger pulls everyday” are required. The New Zealand guideline only allows for CAT use under safely-managed high-volume pallet and wood crate assembly operations (not construction work) when a number of nail gun management, operator training, and work station design requirements are met.

We suggest that theoretical concerns about repetitive trigger actuation manifesting as symptoms of specific stenosing tenosynovitis have not been confirmed by either surveillance or biomechanical evidence. A recent NIOSH study conducted to assess finger displacement and predicted finger tendon travel did not result in cumulative tendon travel at the levels previously associated with hand/wrist MSDs (Lowe et al., 2013). A second NIOSH study (Albers et al 2013) queried residential building framing subcontractors and carpenter-framers working in 9 focus groups conducted in 5 states. Some focus group participants described having developed or knowing someone who developed carpal tunnel syndrome related to nail gun use, irrespective of the trigger mechanism they used. No participant, however, described the same for “trigger finger” with either trigger system.

None of these observations specifically *refutes* a potential association between SAT use and finger tendon cumulative trauma, but, collectively, they cast serious doubt on the existence of a problem – for which no documentation exists - attributable to a specific trigger system. When contrasted with the overwhelming evidence in support of traumatic injury risk

reduction with the sequential trigger (SAT) it seems imprudent to justify any recommendation other than the use of SAT in the context of construction safety and health.

Unfortunately, the awareness of overuse syndrome potential can be easily cited out of context - creating the impression that overuse syndrome is differentially associated with SAT use in construction work with nail guns. Misappropriated emphasis on the theoretically-based causation of repetitive motion injury (e.g. “trigger finger”) may create a distraction from the evidence-based acute traumatic injury risk. This can be seen clearly in nail gun injury litigation defense and in recommendations from occupational safety and health agencies. For example, in *Martin Oliver v. Hitachi Koki USA, Ltd.* (2012) the defense drew specific attention to the SHARP (Baggs et al., 2001) and New Zealand (2001) documents described above in justifying use of CAT based on a theoretical reduction in repetitive motion injury risk. Oregon OSHA issued a 2009 *Hazard Alert* circular on nail guns which clearly described nail gun safety hazards. However, a recommendation in this circular stated: “Use the bump action trigger for… rapid nailing on flat, stationary surfaces such as decking, sheathing, and siding. This mode is very fast and can reduce the risk of musculoskeletal disorders such as trigger finger” (Oregon OSHA, 2009). It is our view that an unintended consequence of the 2001 recommendations appearing in *Professional Safety* has been to create the appearance of competing risks with nail gun trigger systems. This may undermine policy efforts to reduce the high prevalence of traumatic injury attributable to the CAT.

Summary Recommendation

Work-related musculoskeletal disorders among carpenters and other construction workers are of real concern. We recognize that further studies are needed on risk factors such as forceful exertions, repetitive movements and awkward postures associated with construction tasks and nail gun use irrespective of the nail gun triggering mechanisms. However, at present, there is no evidence showing the SAT differentially increases risk of developing trigger finger or any other work-related musculoskeletal disorder. In contrast, there is overwhelming epidemiologic evidence that the CAT trigger mechanism increases the risk of unintentional nail discharge and associated injuries and that the SAT trigger mechanism provides a positive safety advantage. Given the current state of evidence regarding traumatic and cumulative trauma injury risks in construction, “the full sequential trigger is always the safest trigger mechanism for the job” (NIOSH/OSHA, 2011; p. 6).

References

Albers J, Hudock SD, Lowe BD. Residential building stakeholders’ attitudes and beliefs regarding nail-gun injury risks and prevention. New Solutions: A Journal of Environmental and Occupational Health Policy. 2013; 23(4):577–605.

Baggs, J.; Cohen, M.; Kalat, J.; Silverstein, B. SHARP Technical Report Number 59-1-1999. Olympia, WA: 1999. Pneumatic nailer (“Nail Gun”) injuries in Washington State, 1990–1998.

Baggs J, Cohen M, Kalat J, Silverstein B. Pneumatic nailer injuries: A report on Washington State 1990–1998. Professional Safety. 2001; 46(1):33–38.

Dement JM, Lipscomb H, Li L, Epling C, Desai T. Nail Gun Injuries Among Construction Workers. Applied Occupational and Environmental Hygiene. 2003; 18(5):374–383. [PubMed: 12746081]

European Committee for Standardization. Hand-held non-electric power tools – Safety requirements – Part 13: Fastener driving tools (EN 792-13:2000+A1:2008). Brussels, Belgium: Author; 2009. p. 37

Lipscomb HJ, Dement JM, Nolan J, Patterson D, Li L. Nail gun injuries in residential carpentry: lessons from active injury surveillance. Injury Prevention. 2003; 9(1):20–24. [PubMed: 12642553]

Lipscomb H, Jackson L. Nail-Gun Injuries Treated in Emergency Departments – United States, 2001–2005. Morbidity and Mortality Weekly Report. 2007; 56(14):329–332. [PubMed: 17431377]

Lipscomb HJ, Nolan J, Patterson D, Makrozahopoulos D, Kucera KL, Dement JM. How much time is safety worth? A comparison of trigger configurations on pneumatic nail guns in residential framing. Public Health Reports. 123(July–August):481–486. [PubMed: 18763410]

Lowe B, Albers J, Hudock S, Krieg E. Finger tendon travel associated with sequential trigger nail gun use. IIE Transactions on Occupational Ergonomics and Human Factors. 2013; 1:109–118.

Martin Oliver vs. Hitachi Koki, USA, Ltd. Superior Court of the State of California for the County of San Bernardino; Reporter's Transcript of Trial Proceeding; Wednesday, April 11th, 2012; 2012.

NIOSH/OSHA. Nail Gun Safety – A Guide for Construction Contractors (DHHS/NIOSH/2011 – 202). 2011. http://www.cdc.gov/niosh/docs/2011-202/

New Zealand Department of Labor. [accessed September 2013] Guidelines for the safe use of portable mechanically powered nailers and staplers. 2001. http://tinyurl.com/nmlbrrl

Oregon OSHA. [accessed April 2014] Hazard Alert: Pneumatic Nail and Staple Gun Safety. 2009. OR-OSHA 2993-21. http://www.cbs.state.or.us/osha/pdf/hazards/2993-21.pdf

Stanley Works. Industrial Tools and Fasteners (Catalog AD4020). Stanley Fastening Systems; L.P., East Greenwich, Rhode Island 02818: 2002.

Figure 1.

The full sequential actuation trigger (SAT) nail gun is safer because it requires that the two controls be actuated in a specific sequence. First the safety tip is pressed against the lumber (left panel), then the trigger is depressed to fire the nail (middle panel). When the nail gun fires, recoil of the tool away from the workpiece (right panel) can result in a second, unintended, contact of the safety tip. With the SAT a nail will NOT fire on the second contact of the safety tip because the trigger must first be released and then actuated after the safety tip. Conversely, a contact actuation trigger (CAT) fires with the controls actuated in either sequence and the trigger need not be released between successive nails fired. With a CAT nail gun unintended firing occurs when the tool is held or positioned with the trigger pressed and the tip inadvertently contacts the body or other object.

Figure 2.

It is natural and more efficient to grip a tool handle with a full power grip, which includes use of the index finger in the grip. With most nail guns the index finger must actuate the trigger to contribute to the grip of the tool, as shown above.