CASE REPORT

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Stud Guns Revisited: Report of a Suicide and Literature Review

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ABSTRACT: Stud guns (powder-actuated fastening tools) are a commonly used construction tool. Accidental injuries and fatalities are no longer frequent, presumably because of current safety features and practices. A case of an intentional fatal wound (suicide) is described. A literature review of stud gun injuries is also presented.

KEYWORDS: pathology and biology, suicide, stud guns, powder-actuated tools, Hilti gun, Ramset, power hand tools, unusual weapons, industrial accidents, occupational injuries, building construction hazard

Stud guns have become an indispensable tool in modern building construction and maintenance. They are used to attach materials to wood, steel, and concrete. They were first introduced in the early 1950s; now, perhaps as many as a hundred may be found at a single construction site. The device is known by many names, such as powder-actuated tool, explosive-actuated fastening tool, cartridge-operated fixing tool, nail gun, masonry gun, or such trade names as Ramset, Hilti Gun, or Spitmatic. Stud guns have largely replaced the manual star drill and the electric hand drill with a masonry bit, since they have improved quality and, more significantly, proved a tremendous labor saver. They have also been used illegally for cracking coin boxes [*1*]. Powder-actuated tools are but one type of power-operated hand tools, a category that also includes electric power-operated tools, pneumatic power tools, fuel-powered tools, and hydraulic power tools, according to the U.S. Occupational Safety and Health Administration (OSHA) construction standard 1926.302 (*Construction Standards and Interpretations*, Vol. 3, 1979).

The stud gun is a tool with a superficial resemblance to a handgun. The device is loaded with a .22 to .38 caliber powder cartridge or blank fired by a trigger mechanism. The load power is designated by a color code (Table 1). The tool is meant to be fired at tight contact with the target. Usually, a pressure of greater than 22 N above the weight of the tool must be exerted on the muzzle to allow firing, thereby preventing accidental discharge. A nail, stud, or steel pin is fired that ultimately binds the materials being fastened. The pins have a flat head and a

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washer, whereas studs may have a threaded head, a head that contains an eyelet, or other configurations.

Stud guns are of three basic types: high, medium, or low velocity. A tool that is capable of propelling a standard pin at velocities in excess of 150 m/s is designated a high-velocity tool in the American National Standards Institute Safety Requirements for Explosive-Actuated Fastening Tools (A 10.3-1977). These are simply constructed so that the explosive pressure of the discharging load is directly released through an open bore on the projectile. Present day equipment is generally of the medium- to low-velocity type, in which pressure is indirectly exerted by an intervening piston. The lowering of the velocity is due to the increase in mass (that is, projectile plus piston) with the same expenditure of energy. Some low-velocity tools use a hammer to operate the piston. The piston can be made sensitive to misalignment of the projectile.

The high velocity tools are primarily used on high-rise buildings to fasten wood to metal. These tools are capable of sustaining a significant free flight of the expressed projectile, and therefore have the potential to be used as weapons. This is particularly important since the studs, pins, and fasteners are made of steel, which, because of its rigidity, will achieve a greater penetration with a given charge than a comparable lead projectile [*1*]. The muzzle retraction safety, which generally prevents the use of the tool as a firearm, can be overcome by propping the muzzle against the side of a door frame or by firing into and through an easily penetrable material such as sheet rock.

Although there are several reports of stud gun injuries or fatalities [*1–20*], the last was published in 1976. It concerned a suicide involving injury to the chest [*20*]. Before that, we do not know of any reported intentional deaths caused by stud guns. To our knowledge, the following is the first report of a suicide resulting from lethal cranial injury by a stud gun. A literature review of stud gun injuries will also be presented.

Case Report

The victim, a 34-year-old white man, was found seated on a bedroom couch with a stud gun adjacent to his left side. The responding officer noted a puncture wound to the left side of

TABLE 1—*Power load identification.*[a]

	Color Identification		Nominal Velocity[b]	
Power Level	Case Color	Load Color	Meters per Second (+13.5)	Feet per Second (+45)
1	brass	gray	91	300
2	brass	brown	119	390
3	brass	green	146	480
4	brass	yellow	174	570
5	brass	red	201	660
6	brass	purple	229	750
7	nickel	gray	256	840
8	nickel	brown	283	930
9	nickel	green	311	1020
10	nickel	yellow	338	1110
11	nickel	red	366	1200
12	nickel	purple	393	1290

[a]This material is reproduced from American National Standard A 10.3, Safety Requirements for Powder-Actuated Fastening Systems, copyright 1977 by the American National Standards Institute. Copies of this standard may be purchased from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

[b]The nominal velocity applies to a 9.53-mm (3/8-in.) diameter, 22.7-g (350-grain) ballistic slug fired in a test device and has no reference to actual fastener velocity developed in any specific tool.

the head and summoned Fire Rescue for transport to a local hospital. A skull film (Fig. 1) revealed a nail within the cranial vault. The projectile was surgically extracted, despite supportive care, accompanied by respirator therapy, consciousness was never regained. Loss of blood pressure and heart rate eventually culminated in death approximately 30 h after the injury.

Police investigation revealed that the victim was recently depressed over financial affairs and that a few hours before the incident, he told his wife that she would not have to worry about waking him up for work any more. The decedent, a carpenter, was left-handed and familiar with the occupational use of the stud gun. The home environment was clean and orderly.

The stud gun used was a piston drive tool, Model Hilti-DX350. In this instance, the tool used a .22 caliber cartridge and 7.8-cm metal nail (Fig. 2). The force required for firing is exerted through the point of the nail partially protruding through the muzzle (Figs. 3 and 4).

Postmortem examination revealed surgical alteration at the nail entry site resulting from the craniotomy incision (Figs. 5 and 6). The oblong wound, consisting of perforated skin with a partial abrasion collar, was located along the left lateral parietal region above the top of the ear. The pathway continued into the cranial vault, perforated the left basal ganglia, and lodged within the basal ganglia on the right. Because of the craniectomy under the skin entry site, bone fragments were not readily available for study. The pathway was directly from left to right, and the perimeter of brain tissue about the pathway was pulpified with foci of blood extravasation. The edematous brain (1610 g) had subdural and subarachnoid blood extravasation about the entry site within the left cerebral hemisphere. Acute bronchopneumonia of the right lower lobe of the lung was the only other autopsy finding of significance. There was no evidence of other traumatic injuries present.

The investigative and autopsy findings are consistent with suicide as the manner of death.

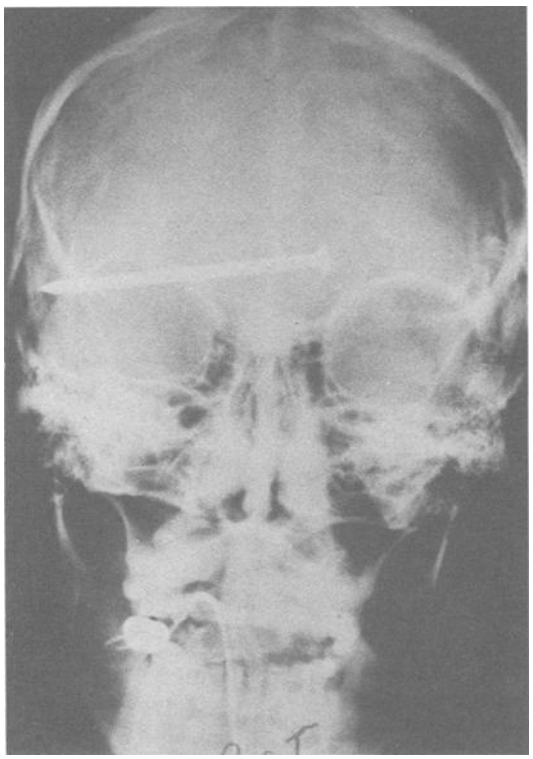

FIG. 1—*Stud gun nail lodged within skull (clinical X-ray).*

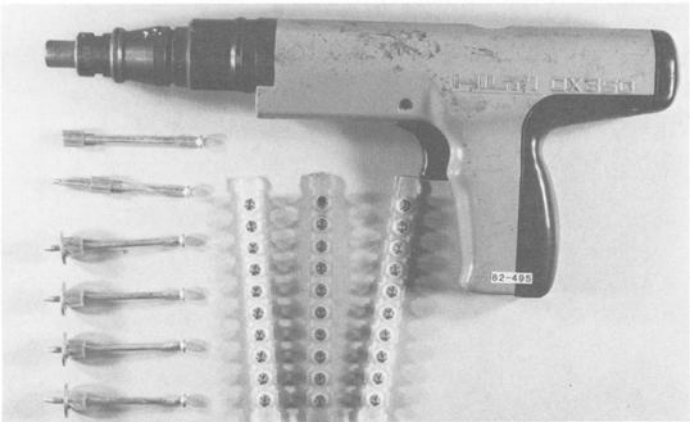

FIG. 2—*Hilti-DX350 stud gun with .22 caliber cartridges and nails.*

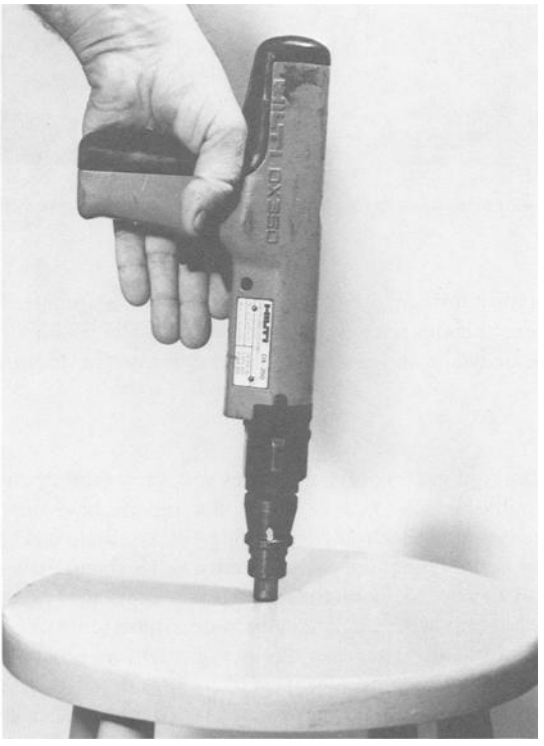

FIG. 3—*Stud gun before discharge.*

Depression resulting from financial affairs, as well as a probable suicide threat, provide data regarding motivation as well as possible intent. Intent is even better documented in terms of the degree of force required to discharge the stud gun. In fact, using the stud gun must have been very painful, since the pressure required for firing is exerted at the sharp nail tip. It is hard to believe that a victim would cooperate with a murderer by holding his head still. Cer-

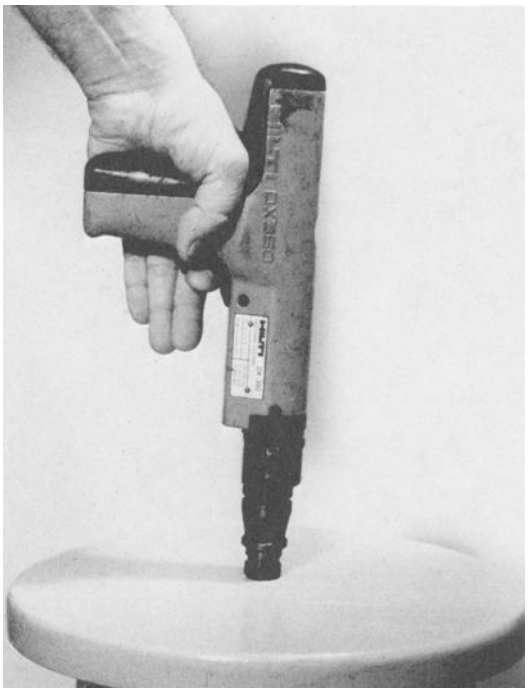

FIG. 4—*Stud gun ready for discharge (note retraction of muzzle into barrel).*

tainly, other traumatic injuries may be expected if there was a struggle. The degree of force required for discharge mitigates strongly against accident. The position of the stud gun at the scene as well as the body and the absence of disarray is also consistent with suicide.

Discussion

In the 1960s, a flurry of case reports of injuries and a few fatalities from the United States and abroad were published [*2–18,21–23*]. Very few reports have appeared since that time [*19,20*]. In fact, the National Electronic Injury Surveillance System (U.S. Consumer Product Safety Commission) found only three cases of injury and estimated 196 incidents throughout the nation for 1981. In accordance with the experience of the Dade County Medical Examiner's Department, few cases of powder-actuated gun injuries have recently come to the attention of the local OSHA Department.[3] The small number of recent reports suggests a decline in stud gun injuries and deaths. This seems to be most likely a result of the adoption of safety regulations and the increased use of low-velocity tools. The early literature called for statutory regulation of what was considered an occupational hazard. By 1962, eight states and the District of Columbia had passed laws directly or indirectly concerning the use of powder-actuated tools [*4*]. The British standards were promulgated as specifications for cartridge-operated fixing tools in 1966 [*3*]. Interestingly enough, the U.S. Treasury Department determined that the devices are not firearms and thus limited their regulations [*1*]. In addition, the Powder-Actuated Tool Manufacturers Institute (New Haven, CT) prepared a uniform code relating to these tools emphasizing safety in design, training, and written certification of operators [*18*]. In 1966, the

[3]Silverberg, OSHA, personal communication, 28 March 1983.

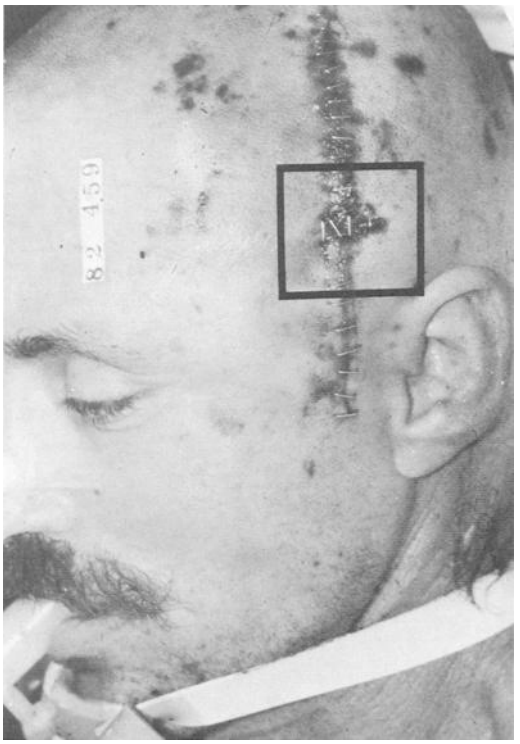

FIG. 5—*Entry site for stud gun nail with superimposed craniotomy incision (see boxed-in area).*

American National Standards Institute produced a standard based on these recommendations, A 10.3. In 1971, the Occupational Safety and Health Standards Act promulgated mandatory regulations concerning the use of these tools. This act, in fact, incorporates the American National Standards recommendation [*19*; see also Occupational Safety and Health Standards Act (29 *CFR* 1910, 243, 1971) and OSHA standard 1926.302].

The present OSHA regulations regarding tool specifications call for:

(1) a protective shield,
(2) inability to fire during loading or if dropped,
(3) dependence on at least two actions of the operator for firing,
(4) inability to fire unless the muzzle is pressed against the work surface with a force at least 22 N greater than the tool weight,
(5) inability to fire if any bearing surface of the guard is tilted by more than 8° from the plane of the work surface, and
(6) possibility to vary power level.

They also require operator training or certification. However, an operator card per se is not required.

Possibly the most significant contribution to safety relates to the switch from high velocity to lower velocity tools by the preponderance of the industry. The literature is mute with regard to what specific types of stud gun resulted in the early accidental injuries and fatalities, but it would appear that they were of the high velocity type, which are no longer in common usage. Another contributing factor in the decline in stud gun injuries may be greater experience and

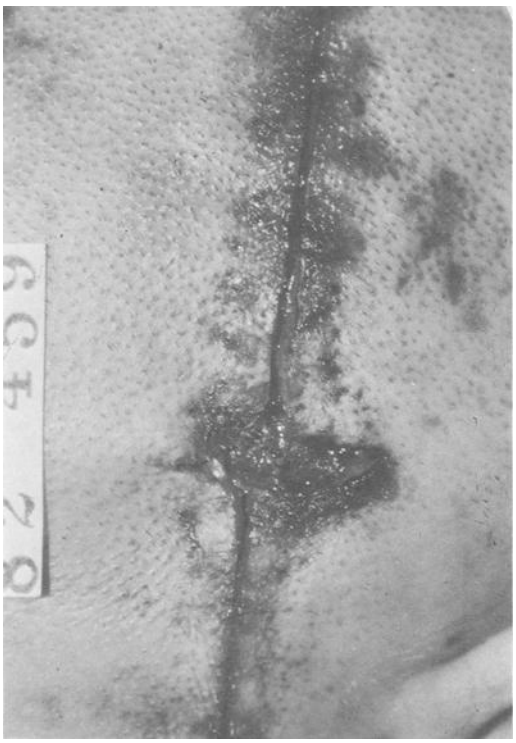

FIG. 6—*Closeup of stud gun nail entry site.*

training in the proper powder loads. Previously, the maximum charge was indiscrimately used for virtually all applications.[3]

Accidental injuries can occur in several ways [*20*]: "(1) accidental discharge of the stud, (2) careless operation of the gun, (3) complete penetration of the receiving structure, with injury by the exiting stud, (4) ricochet of the stud, and (5) shattering of the stud or receiving structure." A search of the literature, as well as a review of standard forensic pathology textbooks, revealed a total of 4 deaths and 46 injuries [2-19,21,22]. Six other fatalities and fifty-six additional injuries were only a briefly and nondescriptively alluded to in these articles [*4, 18*]. The nail guns discussed in the Soviet literature are homemade toys not related to the occupational tools described here [*23, 24*]. In 12 of 29 determinable cases in the English-language literature (41%), the machine operator was the injured party; in 17 (59%), a bystander was wounded. In the German literature, 12 of 13 determinable cases were machine operators injured by ricocheted nails [*21, 22*]. The injury involved a construction worker in 43 of 50 determinable cases (86%). The wounded party, if a bystander, was in a room other than that in which the gun was operated in 11 of 15 instances (73%) in which the location could be ascertained. The incident usually occurred as a result of the projectile perforating the wall on which the instrument was used. In the instances of operator injury, firing into metal with consequent fragmentation of the stud or the metal target material was not uncommon. An early report stressed the ease with which the nails may be shattered [*14*]. The sites of injury included the thorax or shoulder (15 cases), the abdomen (5 cases), the head (16 cases), the arms or legs (7 cases), and the hand (7 cases). The projectile perforated the injured party in one third of the cases (12 of 40 determinable cases), often in cases of hand injuries. In nine cases, the gun was unintentionally fired [*9, 18, 21, 22*], about half the time during loading.

The pathology of stud gun wounds of entry in the skin have been poorly described in the literature. One of the better descriptions was in a suicide reported by Goonetillecke [*20*]. In that instance, there was a circular punched-out hole 1.0 cm in diameter, surrounded by a 3.0-cm bruise and blood staining. The size and shape of the entrance wound correspond to the washer and nail head. There was minimal blackening of the clothing. Adherent disks of clothing were carried in with the washer. Spitz and Wilhelm produced a series of wounds experimentally [*1*]. They found that there was a tendency for internal tumbling and ricocheting of the projectile. The wounds were often larger than expected and had a ragged wound margin that was split radially. The skin was not abraded. There was only a small amount of soot and tattooing was not seen. It was speculated that the powder is more completely burned in this type of device. They illustrated two cases in which the projectile had a threaded head and hit the body sideways, producing a threaded pattern in the skin.

Before 1976, there were no cases of intentionally inflicted injury. The most recently reported death, as well as our case, involve successful suicides by victims for whom this tool was well-known in their occupations. Goonetillecke, in London, described the suicide [*20*] of a 37-year-old self-employed builder who discharged a 5.0-cm nail into his chest and through his heart. There is no doubt that the stud gun is capable of inflicting mortal injury when properly positioned. Use as a weapon for homicidal purposes is uncommon, most likely because either cooperation or stabilization of the victim would be needed to overcome muzzle discharge resistance. The incorporation of safety features have made accidental discharge unlikely; however, it seems that care must be taken to avoid discharge into materials that may permit perforation with subsequent injury to the innocent bystander. The use of the stud gun for suicidal purposes is a reflection of its availability to the user as well as good evidence supporting strong intent.

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