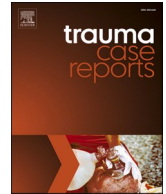




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Case Report

Nail gun injury to the median nerve: A barbed issue

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ABSTRACT

Nail gun injuries to the hand are an increasingly common encounter amongst those in the construction industry and a frequent presentation to the emergency department. Despite their frequency, nail gun injuries rarely involve significant structural injury.

We present a rare case of severe injury by a barbed nail to the median nerve requiring surgical exploration.

At our latest follow up 14 months post-operatively, the patient had ongoing sensory and motor deficits, cold intolerance and reduced proprioception and range of motion at the index finger. Continued hand therapy resulted in improved range of motion and desensitization. A systematic literature search has revealed no other reported cases of median nerve injury by nail gun.

Introduction

Nail gun injuries are common, with American figures showing over 37,000 cases annually [1]. First introduced in 1959, nail guns are an increasingly common tool used in the construction industry and by the general public. They may be powered by electricity, compressed air, such as in pneumatic nail guns, or by a localized explosion in powder actuated guns. Velocities up to 426 m per second can be produced by these tools, and serious injury can result from velocities as low as 59 m per second. Fired nails are frequently equipped with copper wire barbs or resin which may lodge in soft tissues and structures.

Most nail gun injuries involve soft tissue only and can be managed non-operatively with simple nail extraction and washout. However, structural injury of nerves, vessels, tendons, joints or bone occurs in a quarter of nail gun injuries [2], and can result in significant loss of time from work [3]. Structural injury by nail gun frequently necessitates operative management, however a thorough pre-operative assessment is crucial to appropriate care. On assessment, the presence of metal barbs on the nail is a key complicating factor which must not be missed, as these structures may trap vital soft tissues which may be unnecessarily injured during nail removal if not dissected appropriately.

We present a rare case of nail gun injury to the median nerve requiring special attention to the present barbs. This report is aimed at increasing awareness barbed nail gun injuries, to ensure appropriate surgical management and avoidance of iatrogenic injury in such cases.

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Case presentation

A healthy 25-year-old right-hand dominant male was brought to our emergency department 6 h after inadvertently firing a pneumatic nail gun into the volar aspect of his left wrist while at work. This nail passed directly through his glove, retaining the fabric in the wound (Fig. 1). History taking revealed no medical comorbidities, no smoking history and that he worked in carpentry. The accident had occurred due to misfire while checking the nail gun's function after recent repair.

On arrival he complained of paraesthesia along the distribution of the median nerve.

Physical examination revealed reduced two-point discrimination along the radial 3 1/2 fingers and weakness of the flexor digitorum superficialis to the index finger. There were no other motor deficits noted and the finger was vascularly intact.

In the emergency department the patient received analgesia post examination, anti-tetanus, and IV broad spectrum antibiotics (cefuroxime). No attempt was made to remove the nail at this point due to likely nerve injury. Wrist and hand X-rays were performed to assess the nail's position further.

Plain films (Fig. 2) showed no evidence of associated fracture but did reveal the complicating presence of two barbs within the injury site. The young male was promptly brought to the operating room.

Under general anaesthesia, the patient was placed in supine position with an arm tourniquet. An extended carpal tunnel approach was chosen to expose the median nerve. This revealed the median nerve trapped by the nail, with fascicles on either side. Under the microscope, interfascicular dissection technique was used to separate the nail from the nerve. Unfortunately, a copper nail barb was wrapped around the sensory fascicle to the ring finger, requiring further extensive dissection for full release from soft tissue (Fig. 3). Next copious irrigation, and a full carpal tunnel release were performed. As the nail remained lodged in bone, a ring finger flexor digitorum superficialis (FDS) split was performed to gain access to the carpus and manipulated out in a retrograde fashion using bony nibblers. No remaining metalwork, resin or other debris was visible and nerve sheath repair was not required. Washout was completed with betadine and saline prior to closure. Plain marcaine 0.25 % was injected to achieve wrist block for pain relief, and post-operatively, Vitamin C and Amitriptyline prescribed to prevent the development of chronic pain syndrome. Inpatient stay totalled four days.

Postoperatively the patient received regular hand therapy and clinic review. Several deficits remained from his injury, as follows.

Sensation was reduced in the index, middle and the radial aspect of the ring finger (scoring eight, six and two in the Ten Test, respectively). Proprioception was impaired, and the patient could not discern differences between shapes with his eyes closed. These sensory deficits significantly affected the patient's dexterity at work, ultimately forcing a reluctant career change. Cold intolerance in the affected hand was also reported.



Fig. 1. Pre-operative clinical photograph demonstrating the nail and portion of glove remaining at the volar wrist.



Fig. 2. Preoperative anteroposterior (left) and lateral X-rays (right) demonstrating no bony injury. Radio-opaque barbs from the nail are visible within the soft tissue of the wrist.

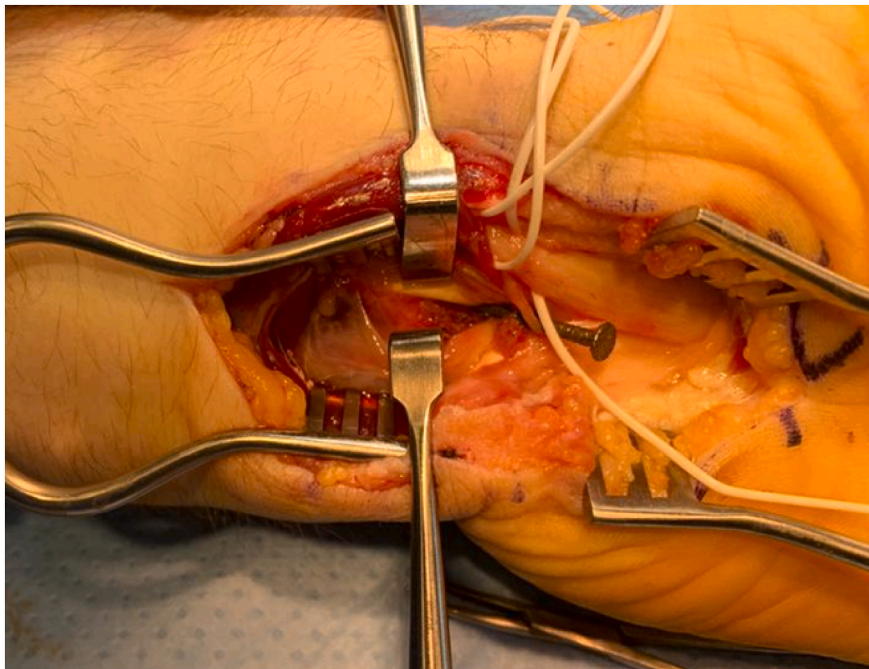


Fig. 3. Intra-operative visualisation of the nail near FCR and median nerve.

There was loss of five degrees of extension at the wrist, and the FDS to the ring remained weak (MRC 2 on exam). Tinel's sign was strongly positive at the wrist and mid palm.

The psychological impact of the injury resulted in symptoms of post-traumatic stress, with the patient reporting flash backs and anxiety around machinery. Psychology input was sought, and the patient attended several counselling sessions. At 14 month follow up, the above described sensory, motor and range of movement deficits persisted but good progress was made in symptom alleviation with

hand therapy input.

Discussion

As seen in our case, nail gun injuries to the hand are a potentially life changing injury and pose considerable therapeutic challenges. Over 65 % of nail gun trauma results in hand injury, through the volar aspect in 80 % of cases. The non-dominant hand is most frequently affected, at 91 %, as it is used to position objects for nailing. Using the Verdan classification, zone II and III injuries appear to be most frequent at 29 %, followed by zone II injuries at 13 % and zone V at 5% [2].

Mechanisms of injury by nail gun primarily involve direct penetration, but shrapnel wounds from exploding cartridges and high-pressure injection injuries by compressed air have been documented. Accidental discharge and over penetration of the nailed surface are the most frequent circumstances of injury [4]. The high kinetic energy of fired nails can result in energy transference to soft tissues via shock waves, forming localized cavitations. This phenomenon can injure tissues that are not directly penetrated [5].

Presentation is variable. Patients with isolated soft tissue injury may simply present with pain and swelling at the injured site, whereas cases with involvement of structures such as nerves, tendons, vessels or bone may cause sensorimotor deficits and limitation in range of motion [6].

Detailed physical examination is key to appropriate management and must be performed systematically. Barbs present at the nail's surface are important to note, and strongly suggest the presence of barbs deeper in the injured tissue.

Plain film X-ray is crucial to identify such barbs, and can show bony penetration and nail angulation, all important factors in planning surgical approach. However, it must be noted not all barbs are visible on X-ray, again highlighting the importance of meticulous physical examination.

Several case reports [7–9] document safer approaches to extricating barbed nails, such as anterograde removal, cutting the nail's head first, and extensive dissection. In all these, the key lies in first recognising the presence of barbs.

In any case, standard management protocols include anti-tetanus toxoid, intravenous antibiotics and local decontamination. Surgical exploration is recommended when structural injury is suspected, and under the Plastics team in nerve injury [2,10]. Non-surgical management with simple nail extraction and local irrigation appears adequate in isolated soft tissue injury [11]. We suggest that all cases of tendon or bony injury requiring hand splinting should be followed up with hand therapy input.

Complications, including long term deficits are not uncommon in nail gun injuries. While outcomes are poorly reported in the literature, a systematic review conducted by the authors of available case series [2,11,12] showed persistent sensory issues in 8 % of cases, limited range of movement in 4.5 %, and motor deficits were rare at 0.6 %. Infection is thankfully a rare complication, with available case series [2,11,12] showing rates near zero.

As seen in our case, nail gun injuries to the hand can have devastating long term effects. Significant iatrogenic injury was avoided through identification of multiple barbs in the embedded nail, and we the authors hope this important complicating factor is considered in the review of these common injuries.

Conclusion

Nail gun injuries to the hand are frequent and increasing in incidence. While nerve injury is relatively rare in these cases, it may have devastating consequences. The authors present to the best of our knowledge the first case of a barbed nail gun injury involving the median nerve.

The presence of barbs is a complicating factor which may lead to inadvertent iatrogenic injury and must be carefully considered when planning surgical approach. Follow up with hand therapy input is crucial in cases with residual functional deficits.

We hope that through reporting our experience, this case will raise the awareness of barbed nail gun injuries and the necessary steps in assessment and management.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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