Injection Palsy of Peripheral Nerves

Raghav Singla[1] Shashi Kala Tiwary[2] Het Shah[1] Rajeev Sharma[1]

[1] Department of Neurosurgery, All India Institute of Medical Sciences, New Delhi, India
[2] Department of Community Medicine, Armed Forces Medical College, Pune, Maharashtra, India

Address for correspondence Rajeev Sharma, MCh, Department of Neurosurgery, All India Institute of Medical Sciences, New Delhi 110029, India (e-mail: rajufbd79@rediffmail.com).

J Peripher Nerve Surg 2024;8:16–19.

Abstract

Accidental injection of a drug either into the nerve tissue or around the nerve during an intramuscular injection can lead to peripheral nerve dysfunction. Recommended treatment ranges from conservative management to immediate operative exposure and irrigation, early or delayed neurolysis, and resection followed by cable grafting after 8 weeks. Intramuscular injection should be strongly discouraged when a drug can be given by other routes. Only well-qualified, competent, and certified staff or paramedical workers should be allowed to administer intramuscular injections.

Keywords
- injection palsy
- peripheral nerves
- intramuscular injection
- neuroma
- neurolysis

Introduction

Direct injury to the peripheral nerve trunks by accidentally injecting a drug either into the nerve tissue or around the nerve while giving deep intramuscular (IM) injection of drugs (prophylactic or therapeutic) leading to nerve dysfunction is called injection palsy of the peripheral nerves.[1,2] After the first report of sciatic injection palsy by Turner in 1920 following an IM quinine injection in the buttock, many clinical series of injection palsies have been published in the literature.[3] In a surveillance of acute flaccid paralysis (AFP) in children, injection nerve palsy comprised 12 to 20% cases of AFP.

Etiology

IM injection is an abused mode of drug delivery especially in the developing countries. A significant number of patients who receive IM injections by poorly trained nursing assistants especially in the unregistered small health care facilities (like private clinics or nursing homes) or at home in rural/peripheral areas are at a relatively higher risk of developing injection palsy.[4] Poorly educated and low social class people who do not have access to quality health care workers and are afraid of trained modern doctors due to their expensive prescriptions rely on these relatively friendly poorly skilled health care workers for minor ailments like fever, cough, diarrhea, etc., and demand IM injections for quick relief. IM injections are often used for the administration of certain drugs in children (especially noncooperative ones) due to difficulty in achieving intravenous access. Ample thickness of subcutaneous tissue and musculature can be protective. Malnourished or thin-built children and chronically debilitated elderly are at a higher risk of developing injection nerve palsy following IM injection due to less muscle mass.[2,5]

Nerves Affected and the Injury Mechanisms

The sciatic and radial nerves are the most commonly affected following buttock and arm IM injections, respectively.[6,7] The other nerves reported getting injured following an IM

DOI https://doi.org/10.1055/s-0044-1788662.
ISSN XXXX-XXXX.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

injection are median nerve, peroneal nerve, and posterior femoral cutaneous nerve.[6]

The most common involvement of the sciatic nerve at the buttock level in most of the injection palsy series may be due to its large size, making it more vulnerable to injury. As compared with its tibial division, the peroneal division of the sciatic nerve has a greater propensity to injury (due to lateral and superficial location of the common peroneal division within the sciatic nerve) and also has less likelihood of regenerating to a level of useful function.[2,8] Sciatic deficits can be partial or complete in one (tibial or peroneal) or both (tibial and peroneal) sciatic divisions. A complete or severe deficit in one or both divisions that fail to recover spontaneously over a period of few months and severe pain not responding to pharmacological treatment with complete or partial loss of function are the usual indications for surgery. Partial deficits usually improve with time and may not require surgery.[8]

Extent of nerve damage following nerve injection depends on the characteristics of the nerve fibers within the fascicles of the nerve, location/site of drug delivery in relation to the fascicles (intra- or extrafascicular; ►**Fig. 1**), the chemical properties of the drug (like pH), and quantity of the drug injected into or around the nerve. Large heavily myelinated nerve fibers are more vulnerable to drug injection–related injury than smaller, thinly myelinated nerve fibers. After injection injuries, conduction in motor fibers is affected earlier and more severely than in sensory fibers. Intrafascicular (through the perineurium into the nerve fascicle) injection is associated with severe nerve injury, whereas extrafascicular (through the epineurium into the epineural tissue surrounding the fascicles) injection causes minimal nerve damage. However, extrafascicular injections can also produce intrafascicular lesions. Injectable drugs are usually a mixture of pharmaceutically active compounds, solvents, and buffering agents, and all of them contribute individually to the extent of nerve injury. Depending on the chemical properties of their constituents, certain drugs are much more damaging than others when injected into a peripheral nerve. The most toxic agents in most common intramuscularly delivered drugs (antibiotics, analgesics, antiemetics, local anesthetics, vaccines, vitamins, steroids, etc.) are penicillin, diazepam, chlorpromazine, meperidine, dimenhydrinate, tetanus toxoid, procaine, hydrocortisone, and drug mixtures.[2] The effect is produced by the injury of the nerve fiber unit: both the axon and the schwann cell with its myelin sheath.[3] A summary of factors that increase the likelihood of injection nerve palsy is given in ►**Table 1**.

Postulated mechanisms of nerve damage following injection injury include physical damage by needle and injection pressure, chemical damage, ischemia due to changes in intraneural microcirculation and blood nerve barrier, allergic neuritis, and circumferential constriction by scar and interfascicular scarring, leading to conduction and/or mechanical blockage.[3,5] Axonal (Wallerian) and myelin degeneration occurs after the injury, and is followed by regeneration with time. Extent of recovery depends on the subsequent regeneration followed by myelination of the axons. Rate of regeneration depends upon the inherent toxicity of the drug injected and its dose, diameter of the regenerating axons, and proximity of the site of injection to neuromuscular junction.[3] Regeneration in damaged nerves is a constant finding; even the most severely injured nerves, with total axonal degeneration, undergo subsequent regeneration.[3]

Clinical Presentation

In the study by Kline et al,[8] the most common scenario for sciatic nerve injection injury was encountered when the site of needle insertion was located more medial and/or inferior than the recommended site on the upper, outer quadrant of the buttock in an individual of normal habitus. The most frequent presentations include radicular pain and paresthesias, along with an almost immediate onset of variable motor and sensory deficit.

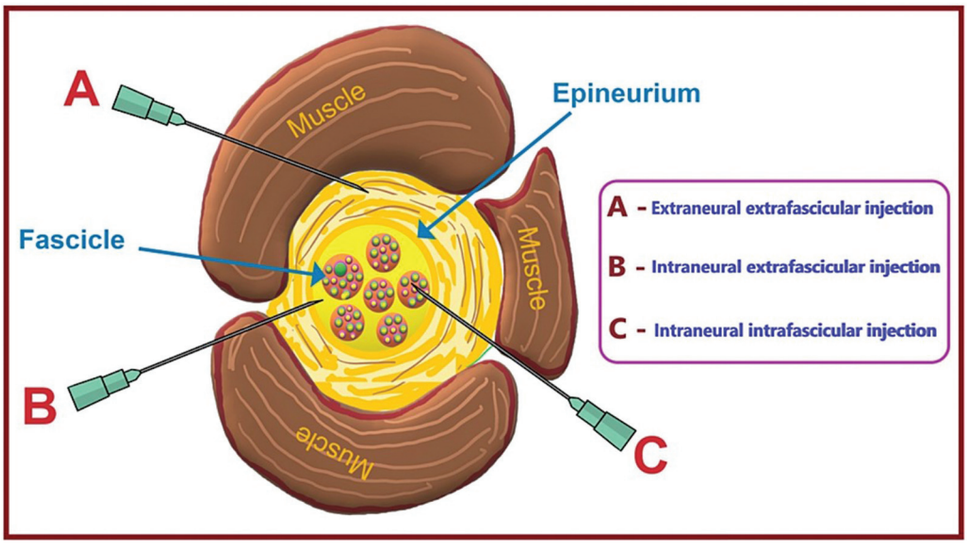

Fig. 1 Schematic diagram showing the sites of neural injection.[9]

Table 1 Factors increasing the likelihood of Injection nerve palsy on intramuscular injections[10]

1. Location of the nerve (e.g., peroneal branch of the sciatic nerve is at a higher risk due to its superficial location and relative tethering of the nerve)
2. Anatomical variations (e.g., absent piriformis muscle or passing of the peroneal nerve through the piriformis)
3. Malnourishment or thinly build physique with less subcutaneous fat
4. Inappropriate injection techniques (e.g., not inserting the face of the bevel parallel to the nerve fibers; forcibly restraining an agitated child while injecting, etc.)
5. Inappropriate instruments (e.g., a tapered needle resulted in minimal perineurial injury as compared with straight needles)
6. Inappropriate medications (e.g., neurotoxic agents like local anesthetics [ropivacaine, lidocaine], analgesics, and antibiotics cause more damage on intraneural injection)

Although almost immediate onset of radicular pain and paresthesias, with variable motor (even AFP of limb) and sensory deficit, is the most common presentation, a delayed onset of pain and paresthesias and/or progressive loss of motor function over minutes to hours after the injection may be seen in approximately 10% of cases. The latter is usually related to placement of the injection either adjacent to the nerve or into the epineurium.[8,11]

The technique of administering IM injections involves attention to the appropriate site of needle insertion, angle/direction of needle insertion, and needle length.

The immediate development of symptoms (severe radicular pain and paresthesias along the distribution of nerve, with immediate onset of variable motor and sensory deficit) suggests that the drug was injected directly into the nerve tissue. Delayed onset of symptoms suggests drug injection either in the epineurium or adjacent to the nerve in a tissue plane from where the drug can seep into the nerve, leading to delayed neurotoxicity. Perineural fibrosis leading to ischemia to the nerve is another cause of delayed worsening.[1,2]

Even if skin piercing point of needle is correct, misdirection of the course of the needle after piercing the skin at the right place or delayed drug displacement toward the nerve can be the other causes.[1] The isolated nature of the paralysis and its development within a brief interval after injection indicate a direct causal relationship.[1] The drug should be injected at a safe distance from important nerve trunks, and not more than 5 mL should be given in one injection.[1] A major limiting factor in its successful treatment is delayed referral for evaluation. Mechanisms to reduce the chances of nerve injury are mentioned in ►**Table 2**.

Site of IM injection marks the approximate site of nerve injection palsy. Surgical principle is to expose the nerve circumferentially by working alternatively from above and below the likely level of injury, dissecting the lesion site (site of injection palsy) at the last. Then, external and internal (making longitudinal incisions) neurolysis is done at the lesion site till healthy fascicles are seen both above and below the site of injection palsy. Intraoperative nerve action potential (NAP) monitoring should be used. Resection of the lesion and nerve grafting should be considered if there is dense scar or large neuroma formation.

In the study Kakati et al[2] involving 92 patients with injection nerve palsy, sciatic nerve (at buttock level) was involved in 80 patients, radial nerve in 8 patients, and other peripheral nerves in 4 patients. Seventy-one (77.2%) patients were younger than 16 years. Most (70%) of them received IM injections by uncertified medical personnel (other than doctors and nurses) for management of febrile illness. Most of them developed severe pain along the distribution of nerve with neurological deficits immediately after receiving an injection. Most of them were referred late after injury. Out of these 92 patients, 9 patients (9.8%) made some spontaneous recovery and were unwilling to undergo surgery. Five (5.4%) patients who presented late (>1 year after injury) had developed contractures and were not offered surgery. Only 39 (42.3%) patients underwent nerve exploration and neurolysis (external and internal). All 39 of them were found to have a lesion in continuity; 30 (10.3%) had scar, 4 (10.3%) had neuroma, and 5 (12.8%) had thinned-out nerves.

Table 2 Proposed mechanisms to decrease the risk of injection nerve palsies[10]

1. Total avoidance of intramuscular route if alternative routes of drug administration are available
2. If unavoidable, injecting the upper outer quadrant of the gluteal region to be used
3. Injection of the needle should be 90 degrees to the skin surface
4. Avoid injection of more than 5 mL volume at a time
5. Use tapering needles for injection with the face of the bevel parallel to the expected direction of nerve fibers
6. Medicolegal changes to ensure only trained health care professionals administer injections

Management and Outcome

Recommended treatment ranges from conservative management to immediate operative exposure and irrigation, early or delayed neurolysis, and resection followed by cable grafting after 8 weeks.[3]

A complete or severe deficit that fails to recover spontaneously over a few (4–5) months and severe pain not responding to pharmacological treatment with complete or partial loss of function are the usual indications for surgical exploration. Partial deficits usually improve with time and may not require surgery.[8]

External neurolysis is performed from the areas of healthy tissue (proximally and distally) to the injured segment. Apparent areas of entrapment are released. The exact procedure to be performed is dictated by both the gross and electrophysiological surgical findings. The general surgical principle is to work alternately from above and below the presumed level of injury, gaining circumferential exposure. The last area to be dissected is the lesion site itself. Intraoperative electrophysiological assessment of the nerve segment presumed to have been injected using NAP recordings is very beneficial in final tailoring of the surgical repair. Absence of a transmitted NAP across the lesion several months postinjury indicates a predominant neurotmetic injury with minimal chance of recovery without resection of the neuroma-in-continuity and repair by means of end-to-end suture or grafts. Sural nerve grafts harvested from the opposite normal leg are interposed between the prepared proximal and distal stumps and sewn into place. A recordable NAP denotes either significant sparing of function or adequate regeneration through the lesion site, thus suggesting that external neurolysis alone is adequate. Occasionally, NAP may be transmitted across a lesion in continuity, but one part of the cross-section looks worse than the rest. This worse portion is dissected away by means of an internal neurolysis and assessed separately, and the nontransmitting portion is resected and repaired (split repair). Also, internal neurolysis (what about external) relieves severe neuritic pain due to significant interfascicular scarring.[8] During the period of watchful wait (conservative management) and after surgery, appropriate physical therapy and rehabilitation help in smooth recovery and prevent complications like deformity and disability.[5]

Prevention

Discouraging the indiscriminate use of IM injections in nonessential cases and proper IM injection site selection and technically appropriate administration at appropriate IM site only by trained personnel in essential cases should be stressed for prevention of these avoidable iatrogenic injection injuries. General public awareness about refusing IM injections in nonessential/trivial situations can also be helpful.[12]

The superolateral quadrant of the gluteal area between the iliac crest and the greater trochanter must be properly defined as the preferred site for IM injection in buttocks. Giving IM injections at sites other than the buttock may be advantageous in children particularly those aged $\leq$5 years. Alternatively, buttocks should preferably be avoided as an IM injection site in all children irrespective of age. It is suggested that this route (IM injection) be strongly discouraged when a drug can be given by any other route (like oral, sublingual, inhalational, transdermal patch, intravenous).[5] Also, there is a need to organize compulsory focused refresher courses for the health care personnel giving IM injections, thereby improving their understanding of the need and the proper technique of IM injections. Also, focused public awareness or educational programs can help in changing the mindset of people by reducing the willingness and demands for IM injections.[5]

Funding
None.

Conflict of Interest
None declared.

References

1 Woodson FG. Sciatic nerve injury due to the intramuscular injection of paraldehyde. JAMA 1943;121(17):1343–1344
2 Kakati A, Bhat D, Devi BI, Shukla D. Injection nerve palsy. J Neurosci Rural Pract 2013;4(01):13–18
3 Gentili F, Hudson A, Kline DG, Hunter D. Peripheral nerve injection injury: an experimental study. Neurosurgery 1979;4(03):244–253
4 Buhroo AMAM, Arshad S. Management of foot drop due to post injection sciatic nerve injury. IJPMR 2007;18(02):44–47
5 Al-Samman D, Nashwan A AA. Iatrogenic sciatic nerve injuries following gluteal intramuscular injection among children. Int Res J Pharm. 2014;5(04):267–270
6 Shukla DPBD, Devi BI, Moiyadi A. Injection injuries of peripheral nerves. IJNT 2004;1(02):21–23
7 Arwade DJ. A new approach for resistant post- injection radial nerve palsy. J Maharashtra Orthop Assoc. 2006;4:187–188
8 Kline DGKD, Kim D, Midha R, Harsh C, Tiel R. Management and results of sciatic nerve injuries: a 24-year experience. J Neurosurg 1998;89(01):13–23
9 Sonawane K, Dixit H, Thota N, Mistry T, Balavenkatasubramanian J. "Knowing it before blocking it," the ABCD of the peripheral nerves: part B (nerve injury types, mechanisms, and pathogenesis). Cureus 2023;15(08):e43143
10 Jung Kim H, Hyun Park S. Sciatic nerve injection injury. J Int Med Res 2014;42(04):887–897
11 Eker HECO, Cok OY, Aribogan A. A treatment option for post-injection sciatic neuropathy: transsacral block with methylprednisolone. Pain Physician 2010;13(05):451–456
12 Kumar A, Garozzo D, Shukla DP. Indiscriminate use of intramuscular injections: an unforeseen public health hazard. Neurol India 2019;67(1, Supplement):S92–S93

