Case report: Neurological deficit associated with intraneural needle placement without injection

Présentation de cas: Déficit neurologique associé au placement intraneural d'une aiguille sans injection

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Received: 20 July 2009 / Accepted: 14 September 2009 / Published online: 25 September 2009
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Abstract

Purpose Recent reports of painless intraneural injection of low volumes of local anesthetic without subsequent neurological deficit have led to the suggestion that deliberate subepineural injection may be a safe and therefore acceptable practice.

Clinical features This report describes a case where a venous cannulation needle inadvertently penetrated a patient's median nerve. Sudden onset severe lancinating pain occurred in the median nerve sensory distribution. A subsequent thorough ultrasound examination showed the median nerve to be located immediately posterior to the targeted median cubital vein. New onset sensory symptoms (numbness, tingling, pain, and altered sensation to touch) in the distribution of the penetrated median nerve persisted for >6 weeks.

Conclusion This report highlights the hazards of intraneural needle placement irrespective of an associated injection.

Résumé

Objectif Des comptes-rendus récents rapportant une injection intraneurale indolore de faibles volumes d'anesthésique local sans déficit neurologique subséquent nous ont mené à l'hypothèse qu'une injection sous l'épinièvre pourrait constituer une pratique sécuritaire, donc acceptable.

Éléments cliniques Ce compte-rendu décrit la situation suivante : une aiguille de canulation veineuse a pénétré par inadvertance le nerf médian d'un patient. Une douleur

lancinante sévère et soudaine est apparue dans la distribution sensorielle du nerf médian. Par la suite, nous avons réalisé un examen approfondi par ultrason qui a révélé que le nerf médian se situait immédiatement derrière la veine cubitale médiane visée. De nouveaux symptômes sensoriels (engourdissement, picotement, douleur, et sensation altérée au toucher) ont persisté dans la distribution du nerf médian pénétré durant > 6 semaines.

Conclusion Ce compte-rendu démontre les risques d'un placement intraneural d'aiguille indépendamment d'une injection associée.

Recent reports have suggested that intraneural needle placement and subsequent intraneural injection of local anesthetic may be more common than previously thought and not associated with prolonged neurological deficit or procedural pain.^{1–6} This report concerns a case where a venous cannulation needle was placed into a patient's peripheral nerve. The event was associated with severe lancinating pain and subsequent neurological deficit. Written consent was obtained from the patient for publication of this report.

Case report

A 50-yr-old male who was a previous recreational intravenous opioid user presented to the operating room for open reduction and internal fixation of a malunited fractured left clavicle. Regular medication included daily methadone 140 mg. He had previously received successful interferon therapy for hepatitis C infection, but there was otherwise no significant medical history.

Attempted peripheral venous cannulation proved to be challenging as a result of his previous intravenous drug use,

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and this necessitated several attempts in both arms. Subsequent ultrasound scanning (SonoSite MicroMaxx, Bothell, WA, USA) of the non-operative right antecubital fossa revealed the brachial artery and medially the median cubital vein. Both were confirmed with Color Flow Doppler. As this was a vascular access procedure, a detailed and thorough attempt at visualizing the median nerve was not conducted; however, specific nerves were not immediately obvious during this procedure. An 18G peripheral venous cannula (Venflon, BD, Oxford, UK) was advanced towards the vein under real-time ultrasound guidance using the “walk down” technique,⁷ and at the moment of venous puncture (with needle placed approximately 45° to the skin), the patient reported mild discomfort only. The needle was then advanced purposefully into the vein so as to reduce the likelihood of the vein rolling away from the needle, and at that point the patient protested loudly. The needle was immediately withdrawn and the pain subsided. When questioned, the patient described the pain as, “the most severe pain that I have ever experienced” and “like a hot metal rod being advanced down the middle of my forearm”. The pain was well localized to the cutaneous innervation of the median nerve with involvement of the 2nd, 3rd, and 4th digits.

A right internal jugular central venous line was subsequently placed with a single needle pass under ultrasound guidance, and the procedure proceeded uneventfully in the sitting position with the non-operative arm resting on an armrest, the shoulder slightly abducted, and the elbow maintained at approximately 90°.

The next day, the patient gave written informed consent for combined ultrasonography/needle electrical stimulation of the median nerve to confirm its precise anatomical location. With a detailed sonographic scan, the median nerve was located immediately posterior to the median cubital vein and electrical needle stimulation under real-time in-plane ultrasound guidance elicited finger flexion typical of median nerve stimulation. During this procedure, the patient reported slight discomfort at the site of needle entry. When the needle tip came into very close proximity to the nerve, the patient reported a “prickly” sensation (typical of conventional paresthesia) in the forearm and in the 2nd through 4th digits. On postoperative day two, the patient noticed numbness, tingling, mild pain, and altered sensation to touch in the same distribution, but with no associated weakness. These symptoms progressively improved; however, intermittent shooting pain in the same distribution occurred over the next two weeks. After 4 weeks, residual symptoms included numbness of the ring finger distal to the distal interphalangeal joint. At this time, electrophysiological examination of the right median nerve revealed digital sensory amplitude from the ring finger which was less than 30% of that from the same finger of the

opposite arm. There was no slowing of median nerve conduction across the wrist. Needle examination showed fibrillations in the right flexor pollicis longus. These results were consistent with a partial or fascicular injury proximal to the mid-forearm. Over the next two weeks, the patient noticed a slow but progressive improvement in symptoms. He was thus discharged from formal follow up.

Discussion

This case report highlights the risks associated with intra-neural needle placement and the important but poorly described clinical sign of nerve impalement, i.e., severe (lancinating) procedure-related pain. It also highlights the value of performing a detailed thorough scan when performing intravenous cannulation under ultrasound guidance in order to identify critical structures or anatomical anomalies.

Recently, multiple reports have described clear intra-neural injections of local anesthetic (as evidenced by ultrasound) in association with both low^{1–3} and high^{5,6,8} local anesthetic volume without subsequent prolonged clinical neurological deficit.^{1–6} Consequently, this has led to the suggestion that injecting small volumes of local anesthetic beneath the epineurium but outside the perineurium is an acceptably safe practice.⁹ The report described here was associated with placement of a needle within a peripheral nerve and was associated with new neurological deficit despite the absence of an intraneural injection. The deficit could not be explained by any other associated pathological mechanism.

Limited data exist regarding the consequences of intraneurally placed needles without an associated injection. It has been shown that the intentional intraneural placement of very fine (28–32G) electroneurography needles are associated with subsequent electrophysiological conduction disturbances,¹⁰ but symptoms are reported in only about 10% of patients.¹¹ These symptoms typically persist for 3–7 days but very occasionally can persist for several weeks.¹¹ Reported data regarding the effects of intraneurally placed (larger caliber) nerve block needles without an associated injection are even more limited. It has been shown in animals that needles used for regional anesthesia produce a proportionately greater degree of axonal injury than microneurography needles when fascicles are accidentally impaled.^{12,13} Long bevelled needles inserted with the bevel transverse to the long axis of the nerve fibers also cause more fascicular damage than those inserted longitudinally to the fibers.¹⁴ These observations all point to a possibly greater disruption of nerve integrity with intraneurally placed larger caliber needles than with intraneurally placed electroneurography needles. As was observed in this report, more frequent and more severe symptoms might therefore be expected.

Fig. 1 Configuration of typical needle bevels used for venous cannulation vs. nerve blocks. **a** Regular/long bevel (e.g., used for venous cannulation). **b** Short bevel (e.g., used for nerve blocks). Images are courtesy of Dr. Xavier Sala-Blanch

Long bevelled needles, as used in this report (Fig. 1a, b), are not commonly used for peripheral nerve blocks—a practice often based on animal studies that have shown that short bevelled needles are less likely to penetrate both the epineurium (intraneural) and perineurium (intrafascicular).^{14,15} However, if a short bevelled needle penetrates a fasciculus, it has been shown to result in more axonal damage than a long bevel.¹³ Regardless of bevel type, when nerve impalement occurs, all needle types have been associated with axonotmesis and interruption of the myelin sheath.¹⁶

The focus of the traditional ideology featured prominently throughout educational material has been on severe procedure-related pain associated with intraneural injection rather than with nerve impalement. Central to this teaching has been the recommendation that patients remain conscious during a nerve block procedure so that the injection can cease immediately when the patient reports severe pain. Only a limited number of case reports support this

teaching, albeit partly due to the medico-legal implications of reporting such cases.¹⁷ In a review of severe chronic pain syndromes following presumed intraneural injections, all eight patients retrospectively reported severe procedure-related pain.¹⁸ However, due to the retrospective nature of that review, the exact timing of the pain in each case in relation to needle placement or injection could not be reliably determined. In two large prospective series of seven patients who developed nerve-related symptoms after block resolution, five had pain associated with the procedure.^{19,20} Two of these patients were unconscious²⁰; one had pain on injection,²⁰ and it was not entirely clear at what stage the pain appeared in the remaining four patients.¹⁹ Finally, in two other case reports of severe block-related neuropathies, severe pain was said to have been present during the injection phase of the block procedure, but again, the presence of pain on needle placement was not specifically mentioned.^{21,22} Therefore, in all of the aforementioned cases, pain occurred either during injection or it was unclear when it occurred. Other prolonged neuropathies have occurred without any significant procedure-related pain.^{23,24} These observations have in part been responsible for a reappraisal of the routine requirement for patient consciousness during these procedures, as it has been argued that intraneural injection-related nerve injury would have occurred by the time the patient reported pain. In the current report, severe pain was unequivocally associated with intraneural needle placement without an associated injection. This pain was not replicated when a needle was subsequently placed into very close proximity (as possible with the imaging capabilities of our system) with the same nerve under ultrasound guidance.

A detailed and thorough ultrasound scan was not performed at the time of the attempted cannulation. If this had occurred, it is probable that the location of the median nerve immediately posterior to the median cubital vein would have been appreciated. This could have prompted an alternative cannulation technique, such as long axis imaging of the median cubital vein with real-time in-plane imaging of the needle. Accurate visualization of the needle tip may have prevented the needle from piercing the nerve and averted the resulting neurological deficit.

A limitation of this report was the patient's chronic methadone treatment and therefore probable opioid-induced hyperalgesia. This condition may have manifested as an exaggerated response to neural originating pain. Nevertheless, the patient described the pain as the worst he had ever experienced.

In summary, this report describes a case where a patient developed clear neurological deficit directly as a result of intraneural needle placement (without injection) during attempted intravenous cannulation in the antecubital fossa. This incident was associated with sudden onset severe

procedure-related pain. The report serves as a reminder of the risks associated with the deliberate placement of needles into peripheral nerves and for the performance of nerve blocks in unconscious patients.

Conflicts of interest None declared.

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