Needle-free anesthesia: a promising technique for the treatment of palmoplantar hyperhidrosis with botulinum toxin A

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Botulinum toxin type A (BTX-A) has recently emerged as an effective therapeutic option to control palmar hyperhidrosis. The main problem with this treatment is the intense pain felt by the patient during the penetration of the needle to inject BTX-A into the densely innervated skin of the palm. Injection of needle-free lidocaine, delivered through a needle-free device, the MED-JET® MBX by Medical International Technologies Inc. Canada, renders the BTX-A injections almost painless. The mixture of lidocaine and BTX-A does not jeopardize toxin potency. Needle-free anesthesia prior to BTX-A injection with a needle is an emerging technique that may encourage more clinicians to treat palmoplantar hyperhidrosis.

Hyperhidrosis (HH) is a socially embarrassing disease that may affect work productivity, self-confidence and personal relationships, resulting in a poor quality of life [1]. Most patients benefit from a trial of topical $AlCl_3$ hexahydrate in absolute alcohol or in a salicylic acid gel [2]. If there is no response, iontophoresis with or without glycopyrrolate could be used either alone or in combination with the topical preparations [3]. If that step still fails to control HH, botulinum toxin type A (BTX-A) is indicated before resorting to surgical options [4].

BTX-A injections have proven efficacious in the treatment of HH. However, when it comes to palmar HH, intense pain associated with the injection into the densely innervated skin of the palms at the injection site limits this therapy [2]. External topical anesthetics do not reduce injection pain [5], neither does the application of ice immediately before injection. Therefore, adequate local anesthesia is essential for patient acceptance of this treatment. Kavanagh and colleagues reported the treatment of palmar HH with BTX-A delivered through an iontophoresis device [6]. The effect lasted only 3 months compared with the injected BTX-A, which lasted 6 months.

The most common methods of analgesia include nerve block, intravenous regional anesthesia (Bier's block), cryoanalgesia and recently, needle-free anesthesia [7].

Nerve block technique involves injection of 1–2% lidocaine without epinephrine on the wrist. 3 ml is injected just lateral to the *palmaris longus*, where lies the median nerve, 2 ml is injected underneath the tendon of *flexor carpi ulnaris*, where lies the radial nerve and 1 ml is injected at the *thenar eminence*, where lies a superficial branch of the radial nerve. The nerve block can increase the risk of neural and vascular injury caused by mechanical or chemical damage. Apart from causing impaired hand dexterity, it also induces reactive hyperemia, which increases the tendency to bleed from the injection sites. If a nerve were to be repeatedly injured with the needle, it would cause scarring [8,9].

Bier's block consists of inserting a venous catheter in a distal vein on the back of the hand and installing a proximal tourniquet on the forearm. Prilocaine 0.5% is injected through the distal catheter. This technique provides excellent analgesia but can induce toxic reactions by the passage of the anesthetic into systemic circulation and pain related to the needle prick [10].

Cryoanalgesia may cause a mild tingling sensation lasting for a few minutes after the session and the occasional difficulty in injecting the diluted BTX-A in frozen tissues [11]. For these reasons, many clinicians who contentedly treat axillary HH, are uncomfortable in treating palmar and plantar HH.

Analgesia could also be obtained by the vibration technique [12], local anesthetic administered through an iontophoresis device and many other modalities [13].

Description of the needle-free anesthesia technique

This technique involves the use of tiny amounts of 2% lidocaine without epinephrine that is injected by a needle-free device at the sites where BTX-A is to be injected with a needle. It

Keywords: botulinum toxin type A, needle-free anesthesia, palmar hyperhidrosis, peripheral nerve blockade

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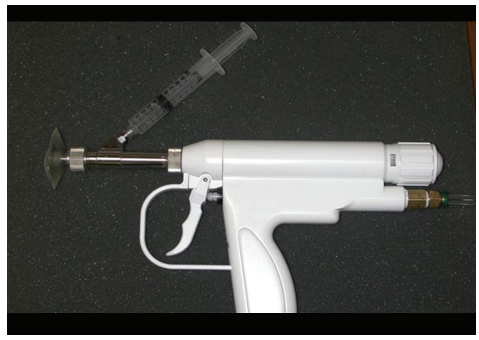
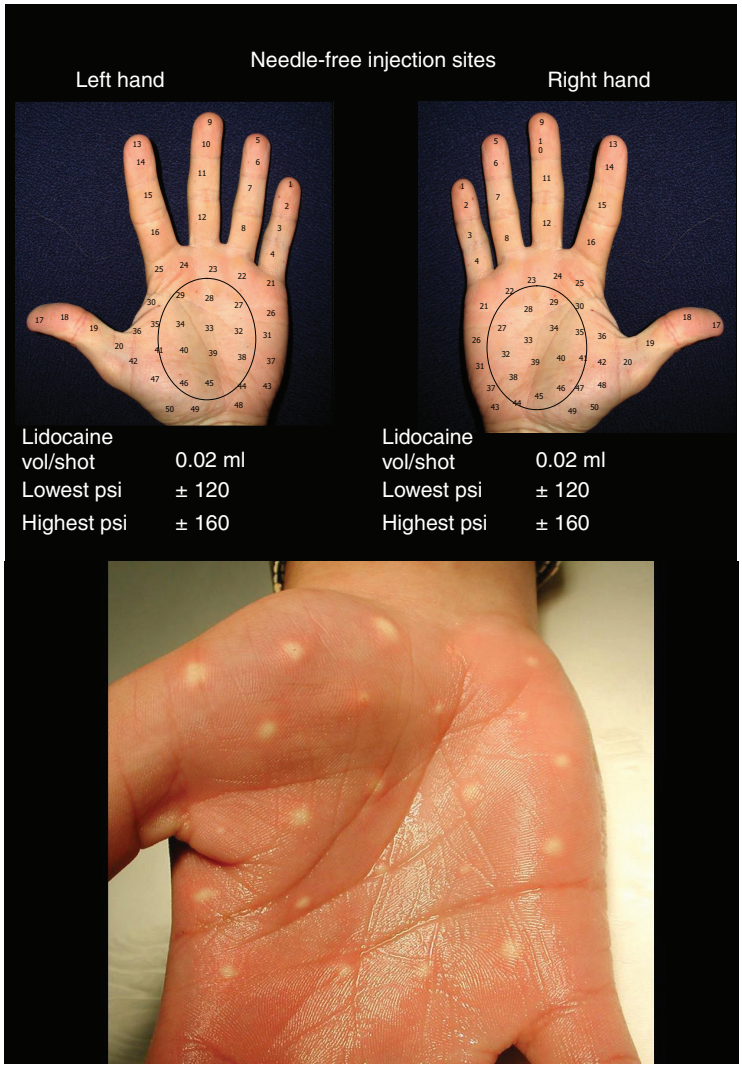
Figure 1. The MED-JET® MBX.



avoids the use of nerve block or other forms of anesthesia. The mixture of lidocaine and BTX-A does not jeopardize toxin potency since reconstitution of BTX-A with lidocaine has already been reported [14].

The needle-free device used is the MED-JET® MBX (Medical International Technologies Inc., QC Canada) (**Figure 1**). It has recently been approved by Health Canada, and US FDA approval is pending. The MED-JET is powered by CO_2 and has an adjustable pressure system that allows the injected material to reach the targeted depth in the skin, even in anatomical areas where the epidermis is much thicker, such as the palms and soles. The device also has an adjustable volume control ranging from 0.02 to 0.3 ml/spurt. Sterilization of the device is achieved by autoclaving the metal component of the device at 134°C for 30 min and cold sterilization of the plastic component. Universal precautions are taken as usual to avoid contamination caused by potential blood splatter. In addition, a disposable, transparent, plastic, cup-shaped adaptor limits the splash-back during the needle-free injections.

Figure 2. Sites of superficial skin wheals to be produced by needle-free lidocaine on both hands.



psi: Pounds per square inch.

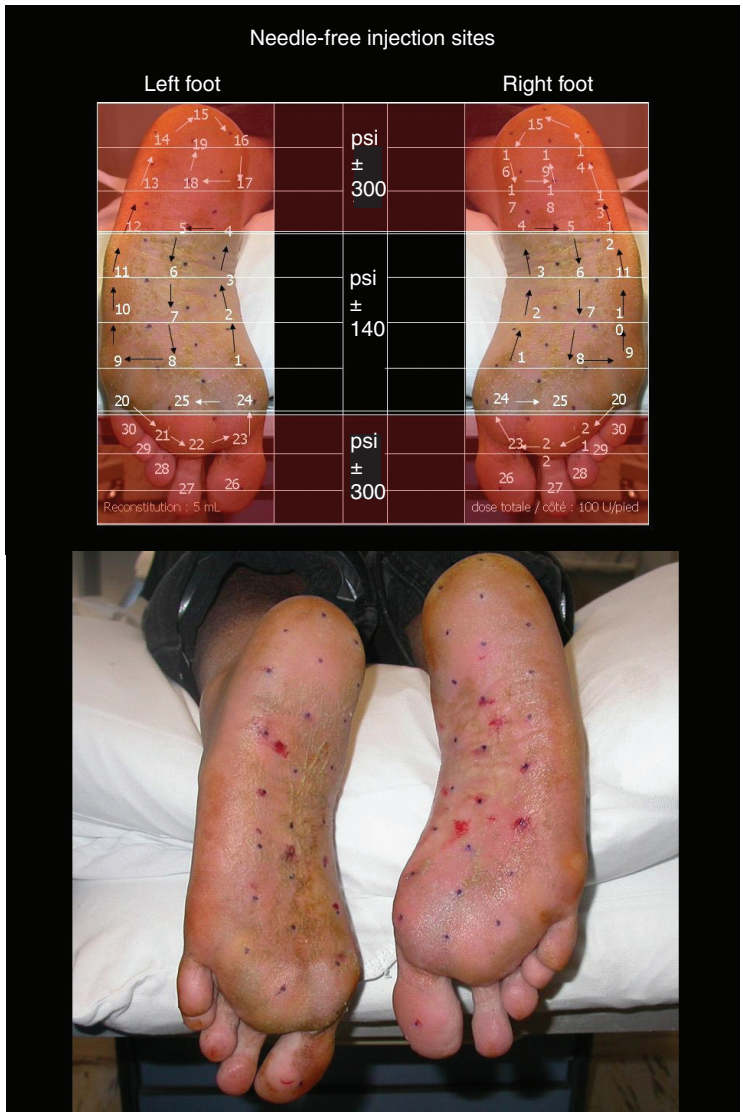
Treatment of palmar HH

The patient is installed in the supine position. The device is prepared by adjusting the volume per spurt to 0.02–0.03 ml. The pressure system is set to 140 psi and a first injection is launched at the center of the palm. Usually an anesthetic wheal is formed instantly. If the wheal fails to appear, pressure is raised by increments of 10 psi until a lidocaine wheal is formed. Once the wheal is formed, injections are continued evenly at 1.5–2-cm intervals over the whole palmar surface, including the fingers (**Figure 2**).

Treatment of plantar HH

Treating the plantar surface is somewhat more complex since the thickness of the epidermis is less homogeneous than that of the palm. The patient is installed in the prone position. The device is prepared by adjusting the volume per spurt to 0.02–0.04 ml, then the pressure system is set to 140 psi and a first injection is launched at the center of the sole. As with palmar HH, if a superficial wheal fails to develop, the pressure is gradually increased by increments of 10 psi, until a wheal is obtained. Once the wheal is formed, injection of the entire middle part of the foot is continued with the same pressure setting evenly at 2-cm intervals (**Figure 3**) from the ball of the foot (distally) to the heel of the foot (proximally), where the

Figure 3. Sites of superficial skin wheals to be produced by needle-free lidocaine on both feet.



psi: Pounds per square inch.

lidocaine wheals cease to appear owing to the thicker epidermis. The pressure setting is then raised to higher levels, up to 300 psi or more if necessary, in order to obtain a lidocaine wheal. The heel and the ball of the foot, as well as the toes, are similarly injected.

Botulinum toxin injection

BTX-A is injected through a 33-gauge needle (**Figure 4**). The rationale is to produce a smaller track in the skin than 30-gauge needles, thus obtaining less backflow of BTX-A onto the skin after each injection. BTX-A is reconstituted in 5 ml preserved saline, since injection of BTX-A in low concentration and higher volume results in greater diffusion and a larger affected area [15].

First, a sequence of four to eight lidocaine wheals are produced with the MED-JET. The idea is to allow 1–2 sec for each wheal to become fully anesthetized. Then, the syringe containing the BTX-A is injected, through a 33-gauge needle into the first of the four to eight wheals obliquely in the epidermis in order to avoid any amount of backflow that may leak out of the injection tract. The backflow may significantly impact the effectiveness of the injections [16]. Heckmann and colleagues have suggested that intradermal rather than subcutaneous injections of BTX may reduce the incidence of significant muscular weakness [17], and Pearson and Cliff found that pain was significantly greater with intradermal than with subcutaneous injections [18]. The anesthetic wheal satisfies both of these requirements: being subepidermal, it allows painless intradermal injection of BTX-A with a needle and, by staying away from the subcutaneous tissues, it may avoid muscle weakness.

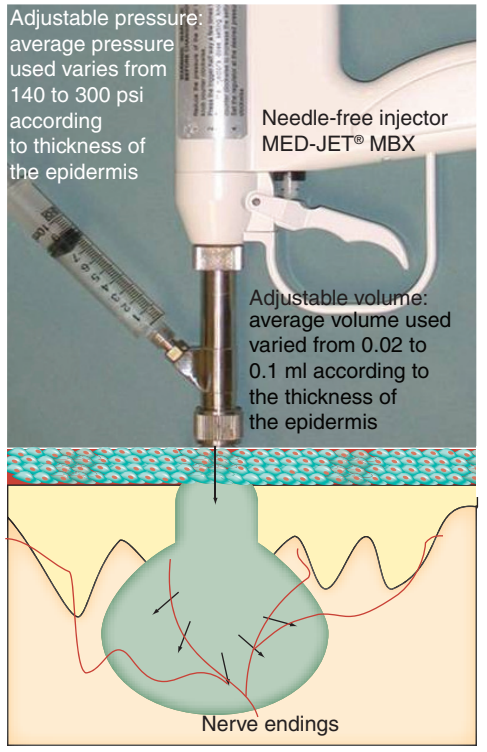
An average of 50 sites/hand or 30 sites/foot are injected in this manner. Although some minor pain may be perceived during the needle-free lidocaine injection, the BTX-A injection that follows through a needle into each lidocaine wheal is painless.

Discussion

The majority of recent research has demonstrated less painful injections with needle-free jet devices compared with traditional needle delivery [19]. Needle-free devices are used to inject all types of liquid (anesthetics and corticosteroids) by painless intradermic projection without the use of a needle or contact with the

Figure 4. 33-gauge needles for botulinum toxin type A injection.

Figure 5. Diagrammatic representation of the injectate: bulb-shaped distribution with the broad side facing the muscle fascia.



patient's skin. They penetrate skin with high-pressure fluid. They have potential advantages over needles and syringes in mass immunization programs, but concerns over their capacity to transfer blood-borne viruses have been a barrier to acceptance [20]. Contrary to mass immunization programs, the needle-free technique prior to BTX-A injection aims to treat one patient at a time with a fully sterile device.

Lidocaine injected with the MED-JET is directed through a small orifice, four times smaller than a 30-gauge needle. This extremely small stream of liquid under pressure will pierce the skin at a high speed and the remainder of the dose will be dispersed into the dermis where the free nerve endings, responsible for pain, are usually located. It is assumed that the spatial 3D reconstruction of the injected liquid has a bulb-shaped distribution with the broad side facing the muscle fascia and the narrow side underneath the epidermis (**Figure 5**) [21].

Needle-free lidocaine injection with the MED-JET provides immediate anesthesia in addition to mapping out the BTX-A injection sites. The average dose of 2% lidocaine without epinephrine used for one hand is 1 ml (50 sites × 0.02 ml) and for one foot is 1.2 ml (30 sites × 0.04 ml), much less than the 6–10 ml needed with the conventional wrist or ankle nerve-block methods. The technique basically circumvents the use of a nerve block, which has many potential drawbacks as aforementioned. Studies involving plantar HH are rare. This condition is particularly distressing as it may be accompanied by a host of other disorders [22], among them, plantar bromhidrosis (commonly called smelly feet), which may be very embarrassing for the affected person and their surroundings.

Another needle-free device, the Dermojet® (Robbins Instruments, Inc.), has been used successfully to treat plantar HH. The Dermojet is a spring-loaded device that has a fixed pressure that cannot be changed to reach different penetration depths in the skin. The volume used by the Dermojet is fixed to 0.1 ml/spurt, another disadvantage that does not allow us to use smaller volumes to treat the hands. A single injection of local anesthetic instantly raises a well-defined wheal with minimum trauma, without contact with the injection site. An area of 1.5 cm diameter of subepidermal anesthesia is produced by a 0.1-ml injection. The depth of penetration varies as a function of the injection site, the distance and the angle with respect to skin surface. As a general rule, it varies from 4 to 6 mm; immediate visual inspection is possible through the papule, on top of which a small channel appears. The Dermojet has been used successfully for the treatment of palmar HH, but the risk of injury to nerves and vessels is high due to the superficial localization of these structures in the palms, particularly in the digits, where the Dermojet can deposit the toxin deeply. Such deeper injections may also cause weakness of the small muscles of the hand and weakening of the grip [23]. Compared with the

Figure 6. The Dermojet®.

Table 1. Suggested parameters to deliver 100 units of botulinum toxin type A per hand.

Dilution (cc)*	Volume/spurt	MU/spurt	Number of spurts
5 (more pain)	0.1	2 (less waste)	50
2.5	0.05	2	50
2.5	0.04	2	50
1.5	0.03	2	50
1 (less pain)	0.02	2 (more waste)	50

**A reconstitution in 2.5 ml appears to be the optimal dilution.*
MU: Mouse units.

Dermojet, the MED-JET is a low-pressure device that has an adjustable range of volumes (0.02–0.3 ml), while the Dermojet has a fixed volume of 0.1 ml/spurt. Since an increase in penetration depth correlates with increasing injection volumes [21], it is understandable why the Dermojet was deterred from treating palmar HH. Skin thickness in humans varies between body regions, races and gender. The Dermojet, with a fixed-pressure setting, does not have the versatility to reach different penetration levels, especially needed for the epidermis of the palms and soles where the thickness of the skin may vary considerably from one site to another.

Needle-free injection of BTX-A directly into the skin cannot be recommended for the time being since (according to the manufacturer Allergan) bubbling or violent agitation may cause denaturation of BTX-A. Further studies are warranted to corroborate or contradict this standpoint. Another problem with the needle-free direct injection of BTX-A is the waste of toxin due to splash-back. Nevertheless, it is worthwhile attempting the needle-free injection of BTX-A directly into the skin for the needle phobic. **Table 1** displays the parameters that could be used for 100 BTX-A units/hand.

Highlights

- Botulinum toxin A (BTX-A) is reconstituted in 5 ml preserved saline.
- The patient is installed in the supine position. The volume of the sterile MED-JET® MBX is adjusted to 0.02–0.03 ml/spurt.
- The pressure system is set to 140 psi.
- A first needle-free injection with lidocaine is launched at the center of the palm.
- If a wheal fails to form, the pressure setting is increased by increments of 10 psi until a wheal is visible.
- Once the wheal is formed, injections are continued evenly at 1.5–2-cm intervals over the whole palmar surface, including the fingers.
- After each sequence of four to eight lidocaine wheals, BTX-A is injected through a 33-gauge needle.
- An average of 50 sites/hand or 30 sites/foot are injected in this manner.
- Sterilization of the device is achieved by autoclaving the metal component of the device at 134°C for 30 min and cold sterilization of the plastic component.
- Universal precautions are taken as usual to avoid contamination caused by potential blood splatter.

Comments

To date, some 80 patients have been treated with this technique for palmar and/or plantar HH in the last 2 years. The success rate is approximately 70%, with an average dose of 100 units of BTX-A/hand or foot. Muscle weakness occurred among 20% of the patients and lasted for an average of 2 weeks. Two of the treated patients had a remission that exceeded 18 months. Two other patients affected with axillary as well as palmoplantar HH had a remission of all sites after the treatment of their palmar HH only. The treatment of palmoplantar HH remains a therapeutic challenge. The purpose of this article is to offer an easy and rapid technique to all clinicians who, so far, have been hesitant to treat this condition.

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