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Original article

An anatomical approach to hand rejuvenation: The AB (Anatomically Based) techniques for aesthetic injections in the hand

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Abstract. *Background:* the focus of non-surgical rejuvenation has historically been predominantly on facial treatments, with facial anatomy being a regular training topic in aesthetic injection and aesthetic medicine courses and training programmes. Although the importance of addressing hand rejuvenation concerns has become increasingly acknowledged, the literature on this topic remains limited only to some aspects. *Aim:* this study aims to address the gaps in the current literature on detailed techniques for hand rejuvenation injections, describing an anatomically based approach to dermal filler and skin booster injections and addressing the specific hand changes caused by muscular wasting. *Methods:* the techniques described in this study are based on consolidated knowledge and widely known anatomical concepts, further confirmed by the author's own experience as a hand and wrist surgeon and aesthetic doctor and on cadaveric hand dissections. *Results:* injection sites and approaches have been developed based on the anatomical features of the hand, in areas where the risk of damaging vessels, nerves, tendons, ligaments, muscles and other structures can be reduced. *Conclusions:* sound anatomical knowledge with an awareness of the risks and potential complications allows for an appropriate and safer planning and performance of aesthetic hand injections. An anatomical study based on twenty-six cadaveric hand dissections, with proposed clinical applications for hand rejuvenation is presented.

Key words: hand anatomy, aesthetic injection, injection technique, rejuvenation, dermal filler, skin booster

Introduction

Dermal filler and skin booster injections are well established non-surgical aesthetic procedures. Over the past years, there has been a focus on injectable products that do not cause any permanent effects. However, the focus of non-surgical rejuvenation has historically been predominantly on facial treatments, and facial anatomy has been a regular training topic in aesthetic injection and aesthetic medicine courses and training programmes. Although the importance of addressing hand rejuvenation concerns has become increasingly acknowledged, the literature on this topic remains limited only to some aspects[1]. Furthermore, hand rejuvenation has traditionally been considered largely a topic relating to the cutaneous and subcutaneous layers only, as the existing literature has mostly focused on the changes caused by the skin and subcutaneous tissue ageing process[2-6]. Fat grafting and calcium hydroxylapatite (CaHA) fillers have traditionally been considered as viable choices to address the subcutaneous atrophy[2,5-15]. Hyaluronic Acid (HA) fillers are commonly utilised for dorsal hand rejuvenation, and injections of polylactic acid (PLA) have also been described[16-19]. HA or HA + CaHA based skin boosters have also been developed and are a popular aesthetic treatment. However, the ageing process of the hand is a far more complex and a multifactorial phenomenon

than just a cutaneous and subcutaneous one hence the relevant muscular changes, as well as the bony and articular ones should be taken into account when assessing a patient and making a hand rejuvenation treatment plan[20].

Over time, not only health professionals with sound anatomical training and experience but also other aesthetic practitioners from varied backgrounds have started to inject in the hands. However, this has been largely done in the absence of formal hand anatomy training and of detailed and specific anatomically based guidance on hand injection techniques. This represents a matter of concern as a lack of an anatomically based approach, guidance and training for aesthetic hand injections may lead to poor outcomes and patient safety issues with an increased rate of complications. Complications of hand rejuvenation procedures have been reported in the literature[21].

The author, a senior hand surgeon expert in hand anatomy, aesthetic doctor and hand anatomy trainer, has developed anatomically based (AB) techniques for dermal filler and skin booster injections in the hand that are described in this study, with proposed clinical applications.

Materials and methods

Anatomical considerations

The dorsum of the hand is covered by thin, pliable skin that can glide and be stretched in a proximal to distal direction during fingers flexion and in the opposite direction during fingers extension. The dorsal skin of the hand exhibits longitudinal extensibility, enabling it to adapt to the positions of the hand and wrist in all planes[22]. The dorsal subcutaneous tissue layer of the hand is typically thin and undergoes a reduction in thickness with age. However, three fatty layers called dorsal superficial, intermediate, and deep lamina respectively have been identified[23]. Blood vessels and sensory cutaneous nerves are in the subcutaneous tissue, with the veins and nerves located in its intermediate lamina. The dorsal branch of the ulnar nerve (DBUN), the superficial branch of the radial nerve (SBRN) and in some patients also terminal branches of the lateral antebrachial cutaneous nerve (LABCN) supply the dorsum of the hand[24,25]. The contribution of the median nerve to the dorsal sensory innervation is solely limited to the nail bed region of the thumb, index finger, middle finger and radial half of the ring finger.

The dorsal hand veins are the largest vessels on the dorsum of the hand, and their anatomical distribution is highly variable. Their pattern variations have even been considered in forensics for human identification[26,27]. The dorsal veins of the hand are connected to the basilic vein on the ulnar aspect and to the cephalic vein on the radial aspect. The dorsal arteries size is variable, and small perforator arteries are also present[28].

More deeply, the extensor tendons and the extensor hood, i.e. the tendinous-aponeurotic complex located over each metacarpophalangeal joint, (MCPJ) can be found[29]. The dorsal fascia of the dorsal interossei muscles covering the underlying interossei muscles constitutes the following layer. This fascia attaches onto the periosteum of the metacarpals[30]. The interossei muscles are located between the neighbouring metacarpals, with the dorsal interossei located more dorsally and the palmar interossei located underneath them[31]. There are 4 dorsal interossei muscles and only 3 palmar interossei muscles, as in the first intermetacarpal space the palmar interosseous action is performed by the adductor pollicis muscle[32]. The interossei muscles and the adductor pollicis muscle are part of the intrinsic musculature of the hand. Intrinsic hand muscles wasting caused by either neuropathic/neuromuscular disorders or ageing alters the appearance of the hand, leading to an increased visualisation of the hand skeleton.

This study is based on established anatomical concepts, further confirmed by the author's own experience with twenty-six cadaveric hand dissections and fifteen years of specialist hand and wrist surgery practice.

Results

The assessment of the cadaveric specimens allowed to confirm the anatomical basis for the proposed injection techniques. The techniques described here

are based on the author's preliminary clinical experience subsequent to the anatomical study.

Key considerations, pearls and pitfalls:

- Most of the previously described injection techniques in the hand focus on the depth of injection based on the subcutaneous layers (fatty laminae) features, without providing a more comprehensive anatomically based approach.
- The diameter of the dorsal hand veins is on average 0.9 mm whereas the diameter of a 21 Gauge cannula is 0.8 mm[33]. The diameter of a 25 Gauge cannula is 0.5 mm. The risk of entering a dorsal vein and performing an accidental intra-venous injection has to be considered when performing a treatment, therefore the correct cannula positioning should always be checked throughout the procedure.
- The metacarpal bones have a dorsal convex shape. Therefore, using a fanning injection technique with a cannula access through a single-entry point on the dorsum of the hand may lead to an inadequate distribution of the injectable product as the cannula is deviated and lifted due to the dorsal shape of the bones. Furthermore, redirecting a cannula laterally multiple times with a fanning injection technique can increase the risk of injury on extensor tendons, nerves and vessels, as the cannula repeatedly intersects these structures.
- When the fingers MCPJs are flexed, the dorsal skin is stretched, and the dorsal nerves and veins and the extensor tendons are also stretched and pulled distally, becoming more difficult to identify and less free to glide away from a cannula or needle tip. Furthermore, the dorsal skin tightness increases and the dorsal subcutaneous space reduces (Figure 1). This makes injections more difficult to perform and increases the risks of damage to all anatomical structures.
- If the fingers MCPJs are flexed during a procedure that requires an entry point located in-between the metacarpal heads, there is also an increased risk of accidental penetration of the tip of the cannula or of the needle inside or underneath the extensor hood, into a neighbouring MCPJ, or inside or in-between the dorsal and palmar interossei muscles (Figure 1).
- The cannula and/or the needle tip must be identifiable (either visible or palpable) underneath the skin at all times throughout the procedure as it should always remain dorsal to the extensor hoods, extensor tendons and dorsal interossei muscle fascia. An accidental injection of the product underneath the muscle fascia, intramuscularly or in-between the dorsal and palmar intrinsic musculature would lead to an ineffective procedure with no aesthetic benefit for the patient and may also cause muscular and/or neurovascular damage, compartment syndrome and other serious complications (Figure 1).

Figure 1. (Donor 139/22) Incorrect fingers positioning in flexion, leading to incorrect subfascial cannula placement between the dorsal and palmar interossei muscles.

The dermal Filler Anatomically Based injection technique ('FAB technique')

Treatment site skin cleansing and preparation with an antiseptic solution must always be performed, and sterile gloves should be used to minimise the risk of infection. A topical anaesthetic cream can be applied if the patient presents no allergies to local anaesthetic, otherwise other analgesia methods need to

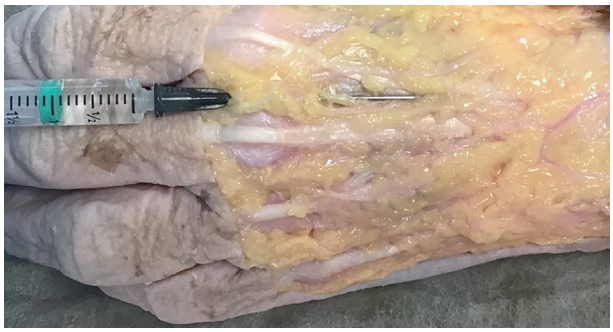

Figure 2. (Donor 140/22) Correct subcutaneous cannula insertion in the intermetacarpal space with a distal to proximal direction. In the second, third and fourth intermetacarpal spaces the entry point is located between the neighbouring metacarpal heads. A retrograde longitudinal thread injection technique is used.

Figure 3. (Donor 139/22) Cannula placement in the first intermetacarpal space. The cannula is inserted subcutaneously with a distal to proximal direction via an entry point located radial to the second metacarpal head. A fanning injection technique is used.

be considered. Cannulas between 21 Gauge and 25 Gauge can be used, selecting the most appropriate cannula diameter and length based both on hand size and the specific characteristics of the dermal filler being injected. The fingers are extended at all joints and the hands are positioned flat on a steady surface. The hands are held below the heart level to increase the blood flow and the visibility of the dorsal veins[34]. Finger extension relaxes vessels, tendons and nerves and creates sufficient dorsal skin laxity and subcutaneous space so that the cannula can be inserted in the correct layer (Figure 2). The four entry points for cannula insertion are identified and marked. They are located in-between the metacarpal heads of each finger for the second, third and fourth intermetacarpal space respectively (Figure 2), and on the radial aspect of the metacarpal head of the index finger for the first intermetacarpal space (Figure 3). Repeated cleansing of the skin with an antiseptic solution is recommended throughout the procedure[34]. The cannula can either be inserted in the superficial fatty lamina or in the deep fatty lamina, above (i.e. dorsal to) the muscular fascia of the interossei. The former option is preferred when subcutaneous tissue loss is present and prominent dorsal veins need to be masked, whereas the latter is preferred when a more severe intermetacarpal hollow caused by muscular wasting is present. Due to the fact that filler injection in the deep fatty lamina alone may lead to an increased visualisation of the overlying veins as they are lifted up, a two-layer technique ('2-layer FAB technique') can also be performed, injecting a filler with a higher G prime more deeply, and one with a lower G prime more superficially. However, the optimal filler injection depth also varies based on the specific composition and characteristics of the filler used. Furthermore, when performing a two-layer technique, great attention and care should be taken to avoid overfilling the hand as the spaces are small and the neurovascular structures may end up being compressed between the two layers of filler. This could cause vascular, nerve or skin complications. The author advocates to monitor the blood perfusion of the skin and any potential onset of pain during the procedure. Filler threads are injected in a retrograde manner whilst withdrawing the cannula in a proximal-distal direction along the interosseous space. The injected filler can then be evenly distributed across the interosseous space by applying pressure gently onto the overlying skin, and the patient is asked to make a fist after the injection as this motion also allows to evenly distribute the injected filler[34]. Care must be taken to ensure that the cannula remains placed in the correct plane throughout the procedure. The superficial injection plane should remain located in the superficial lamina layer, whereas the deep injection plane should remain in the deep lamina, above the dorsal interossei muscle fascia, underneath the subcutaneous veins and nerves.

One additional site located over the radial-palmar aspect of the hand can also be injected for aesthetic purposes. This site corresponds to the radial aspect of the thenar region, where no major vascular or nerve structures are located and unsightly muscle wasting

may be present. This region can be injected using a cannula introduced into the subcutaneous tissue layer via an entry point located on the radial aspect of the thumb metacarpal head (Figure 4), performing filler injections with a fanning technique (Figure 5).

The skin Booster Anatomically Based injection technique ('BAB technique')

Treatment site skin cleansing and preparation with antiseptic solution must always be carried out, and sterile gloves must be used to minimise the risk of infection. A topical anaesthetic cream can be applied if the patient presents no allergies to local anaesthetic, otherwise other analgesia methods need to be considered. A 30 Gauge, 4 mm long needle for subcutaneous injections is used. The subcutaneous tissue thickness in the hand is minimal even in young and healthy individuals. Furthermore, skin and subcutaneous thinning have been identified in association with ageing and diabetes, hence a 4 mm long needle suits all cases[35]. The fingers are extended at all joints and the hands are positioned flat on a steady surface. The hands are held below the heart level to increase the blood flow and visibility of the dorsal veins[34]. Finger extension relaxes vessels, tendons and nerves and creates sufficient dorsal skin laxity and subcutaneous space for the injections. Dorsal veins and tendons can often be visualised through the skin; therefore it is paramount to perform the procedure under a light source and to palpate gently the dorsum of the patient's hand to identify the aforementioned structures so that they can be avoided when the needle is inserted. The bony landmarks should also be visually appreciated and palpated when planning the injection sites. Nine injection sites per hand are identified and marked. One injection site is located over the dorsum of the wrist in the hollow between the third and fourth extensor tendons compartments that can be identified on palpation. Two injection sites are located in the distal portion of the first dorsal intermetacarpal

Figure 4. (Donor 139/22) Dermal filler injection technique for the thenar region. The cannula is inserted subcutaneously with a distal to proximal direction via an entry point located radial to the first metacarpal head.

Figure 5. (Donor 139/22) Dermal filler fanning injection technique with a cannula in the thenar region, allowing for distribution of the filler throughout the defect.

Figure 6. Skin booster injection sites.

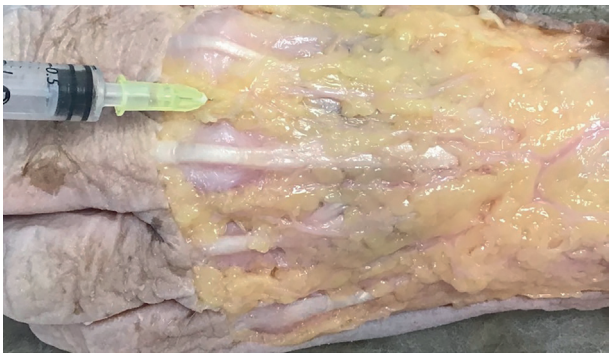

Figure 7. (Donor 140/22) Skin booster injection technique. A 30 Gauge, 4 mm long needle is used.

space (one radial to the neck of the second metacarpal and the other ulnar to the neck of the first metacarpal). Two injection sites are planned in each second, third and fourth dorsal intermetacarpal spaces. One injection site is located more proximally between the metacarpal shafts, and the other more distally, between the neighbouring metacarpal heads (Figure 6). No injection should be performed in the proximal portion of the first intermetacarpal space due to the risks of accidental radial artery damage and intravascular injection. Repeated cleansing of the skin with antiseptic solution is recommended throughout the procedure[34]. The 4 mm long needle is inserted at a 45-degree angle, however the needle inclination can be modified depending on individual variations in skin and subcutaneous tissue thickness, based on a thorough assessment of the patient (Figure 7). Aspiration prior to each injection is also recommended, to ensure that the needle has not entered a blood vessel.

Alternatively, a cannula can be used, with the same technique that has been described in this study for superficial dermal filler injections. Only skin boosters containing non-cross linked Hyaluronic Acid are used. A combined, two-layer skin booster and dermal filler anatomically based technique ('B-FAB technique') can also be performed, using a 4 mm 30 Gauge needle for the booster and a cannula respectively, as per the techniques described above.

Potential risks and complications[21] of aesthetic hand injections:

1. Risks associated with incorrect technique (incorrect cannula or needle placement):
   - Tyndall effect (injections performed too superficially)
   - Vascular damage (haematoma, intravascular injection, vascular occlusion)
   - Nerve damage (sensory and/or motor nerves)
   - Tendon damage
   - Ligament damage
   - Joint damage (capsule and chondral articular surface)
   - Muscular damage
   - Compartment syndrome
2. Risks associated with the product injected:
   - Granuloma
   - Lumpiness
3. Other risks:
   - Infection
   - Necrosis of skin or other tissues
   - Pain, complex regional pain syndrome (CRPS)
   - Oedema
   - Swelling
   - Bruising
   - Stiffness

Discussion and conclusions

The techniques described in this study are based on the relevant aspects of hand anatomy aiming to enhance both the efficacy and the safety of aesthetic hand injection procedures. Needle techniques for intermetacarpal injection and superficial dermal filler injections are preferred by some authors[34,36]. Any anatomical consideration aims to reduce the risks of accidental intravascular injection, nerve, tendon or ligament damage and accidental injection into muscles or joints. This study introduces novel concepts as it addresses the effect of the intrinsic musculature wasting in terms of volume loss and contour modification of the hand, proposing a deep subcutaneous lamina filler injection technique and a two-layer injection technique on the dorsum of the hand. Muscle mass reduction is a well-known phenomenon that is not only associated with the ageing process, but also with nerve and neuromuscular disorders that may occur at any age, including the younger age group[37,38]. In particular, the wasting of interossei muscles and thenar muscles can be very obvious due to the exposed location of the affected areas, representing not only a functional issue but also an aesthetic concern for the affected individual.

The novel anatomically based techniques described in this study introduce, for the first time, the aesthetic treatment of an area of the hand that has previously been overlooked: the radial aspect of the thenar region in the palmar area. Longstanding muscular wasting that alters the shape and appearance of the hand may not improve despite a successful treatment of the primary aetiology, hence the reason for why an aesthetic improvement would be beneficial to the affected patient.

Although the largest dorsal veins can often be identified and avoided during aesthetic injections, the dorsal nerves and the smallest blood vessels cannot be visualised and are at risk of accidental injury. Due to this reason, the author advocates to keep the patient's fingers extended during any aesthetic injection procedure on the hand to create sufficient subcutaneous space and reduce the tension on the dorsal vascular, nervous, tendinous and capsuloligamentous structures. A tension-free subcutaneous space with increased relaxation and gliding of the aforementioned structures allows to reduce the risk of accidental damage. Cannulas should be inserted in the appropriate subcutaneous layer avoiding to intersect the dorsal vascular, nervous and tendinous structures. The use of a short needle (4mm long) is preferred for subcutaneous skin booster injections on the dorsum of the hand.

Sound anatomical knowledge with an awareness of the risks and potential complications allows for appropriate planning and performance of any invasive procedure. This also applies to aesthetic hand injection procedures, that have often been performed in the absence of specific, detailed techniques and guidelines. The injection techniques described in this study address the gaps in the existing literature on this subject. The author also advocates the establishment of appropriate, anatomically based aesthetic injections training courses for the aesthetic practitioners wishing to perform hand treatments, aiming to improve the safety and effectiveness of these procedures.

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