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Review

The dorsum of the hand: Focus on topographic anatomy

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Abstract. *Introduction:* The anatomy of the hand has traditionally been described primarily from a functional standpoint. However, aesthetic and anti-ageing interventions for hand rejuvenation require a precise and comprehensive understanding of anatomy. Recent investigations into hand anatomy have been conducted with greater methodological refinement than earlier studies, as classical cadaveric dissections are now complemented by high-resolution ultrasonography and other advanced imaging modalities. These approaches have led to the identification of previously unrecognised anatomical features. *Objectives:* The purpose of the present study is to provide a detailed description of the topographic anatomy of the dorsal aspect of the hand, with a particular focus on its clinical relevance for physicians performing aesthetic and age-related procedures. The analysis was deliberately restricted to the dorsum of the hand, which represents the most common site of minimally invasive rejuvenation techniques. *Methods:* In addition to standard anatomical reference texts, we conducted a systematic search of PubMed-indexed literature using the terms 'hand dorsum' combined with 'topographic anatomy', 'hand ageing', and 'aesthetic medicine.' Thirty relevant publications, published between 1933 and 2023, were identified. *Results:* The topographic anatomy of the dorsum of the hand can be conceptualised as a multilayered arrangement of overlapping structures. These layers are separated by vertical fibrous septa that delineate compartments containing critical anatomical elements such as tendons, vascular branches, and neural structures. *Conclusions:* A detailed description of this layered configuration is provided in the following sections.

Key words: Hand dorsum, topographic anatomy, hand ageing, aesthetic medicine

Introduction

Ageing hands reveal the passage of time even more than the face and the body.

Over the last 20 years, an increasing number of procedures have been proposed to correct age-related changes in the hand.

The anatomy of the hand has traditionally been regarded from a purely functional perspective.

This approach supports the invasive procedures used to restore hand function, which trauma, neoplasms, degenerative conditions, and congenital malformations have compromised.

Aesthetic and anti-ageing medical procedures for hand rejuvenation require a distinct and detailed understanding of anatomy.

Recent anatomical investigations of the hand have achieved a higher level of sophistication compared with earlier studies[1,2], as classical cadaveric dissections and histological analyses can now be complemented by modern diagnostic modalities, including high-resolution ultrasonography[3,4], fluoroscopy, and computed tomography (CT) imaging techniques[5,6]. These advances have enabled the identification of anatomical structures that had previously remained unrecognised.

This study aims to give a detailed account of the topographic anatomy of the dorsum of the hand, considering not only the basic anatomy but also the most common anatomical variations.

This will be beneficial for physicians conducting aesthetic anti-ageing medical procedures, particularly invasive ones like injections.

Materials and Methods

The anatomical focus of this study was deliberately limited to the dorsum of the hand, the most commonly targeted area in anti-ageing procedures. We adhered to the standard boundaries of the dorsum of the hand: distally at the level of the metacarpal-phalangeal joints; proximally at the level of the carpo-metacarpal joint; on each side at the radial margin of the second metacarpal bone; and at the ulnar margin of the fifth metacarpal.

In addition to consulting classical human anatomy textbooks, we searched for PubMed-indexed articles using the keyword 'hand dorsum' in combination with 'topographic anatomy', 'hand ageing', and 'aesthetic medicine' in various combinations.

Results

Our search, based on the aims of this review, retrieved a total of 30 selected publications, with dates ranging from 1933 to 2023.

The topographic anatomy of the dorsum of the hand can be effectively depicted as a complex structure of overlapping layers (Figure 1). These layers, in turn, are divided by a system of vertical septa, which compartmentalise and house noble anatomical structures.

Skin

The skin on the dorsal portion of the hand varies by gender, age, and ethnic origin.[8,9] Skin histo-metrics are detailed in Table 1.

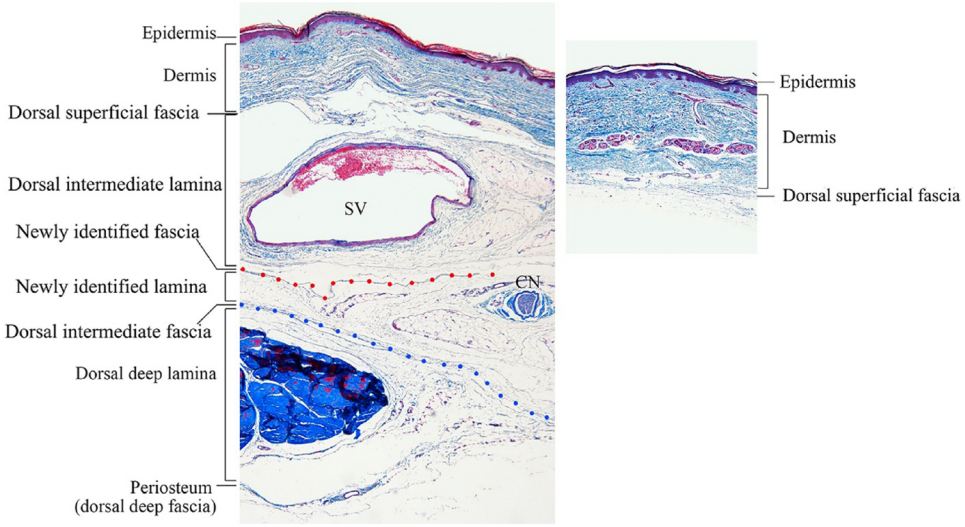

Figure 1. Overlapping anatomical layers in a histological sagittal section of the hand. The superficial fascia is not consistently identified. The dorsal intermediate fascia (blue dots) separates the intermediate lamina from a newly identified lamina. The dorsal veins lie within the dorsal intermediate lamina, and cutaneous nerves run in the separated layer (red dots) beneath the dorsal intermediate lamina. The extensor tendons are located in the dorsal deep lamina (left). Histological findings of the skin (right). Reprinted from Kim JS, Lee W, Oh W, Park JA, Yang EJ. Identification of a suitable layer for injecting calcium hydroxylapatite fillers in the hands. *J Plast Reconstr Aesthet Surg. 2021* Apr;74(4):866-873. doi: 10.1016/j.bjps.2020.10.027. Epub 2020 Nov 1. Copyright (2021), with permission from Elsevier.

Table 1. Skin thickness according to gender[8]

Anatomical structure	Female		Male	
	Mean	Median	Mean	Median
Epidermis	195,3 µm	181 µm	244,8 µm	232,5 µm
Dermis	2115 µm	1864 µm	2538,5 µm	2263 µm
Full-thickness skin	2310,2 µm	2170 µm	2284 µm	2529 µm

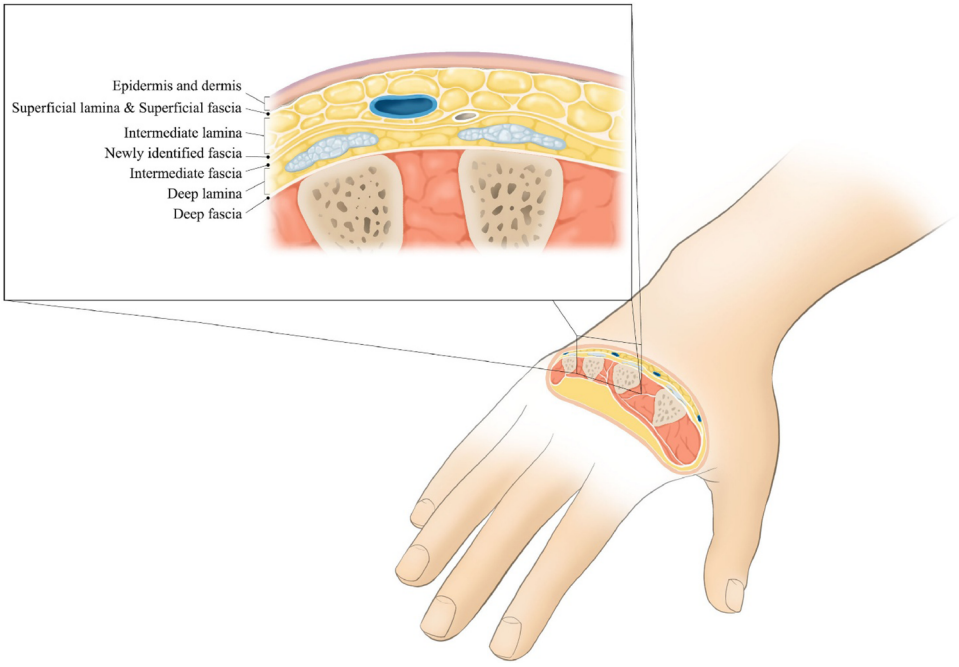

Figure 2. Illustration showing the different fascial layers and fatty lamina of the dorsum of the hand. The dorsal deep fascia is the deep muscular fascia continuous with the periosteum over the dorsal aspect of the metacarpals. The dorsal veins are located in the dorsal intermediate lamina, cutaneous nerves are in the separate lamina below the dorsal intermediate lamina, and the extensor tendons are in the dorsal deep lamina. Reprinted from Kim JS, Lee W, Oh W, Park JA, Yang EJ. Identification of a suitable layer for injecting calcium hydroxylapatite fillers in the hands. J Plast Reconstr Aesthet Surg. 2021 Apr;74(4):866-873. doi: 10.1016/j.bjps.2020.10.027. Epub 2020 Nov 1. Copyright (2021), with permission from Elsevier.

The papillary dermis is made of loose areolar connective tissue that interacts with the epidermis, enhancing nutrient exchange and providing mechanical stability. The reticular dermis consists of dense, irregular connective tissue characterised by lower elasticity compared to other body areas. It contains skin appendages such as hair follicles, sebaceous glands, and sweat glands, along with small terminal blood vessels, capillary networks, and sensory receptors[10]. Usually, skin appendages are limited, although they are more abundant in male skin.

The dermis provides the skin with tensile strength and elasticity, supporting the mechanical demands placed on the hand.

Subcutaneous tissue

Subcutaneous tissue is organised into areolar adipose tissue laminae, separated by a system of spongiform fascial layers (Figure 2). Its thickness ranges from 0.3 to 2 mm[11].

Moving down from the surface of the skin into the tissue are the following layers[12]:

- The dorsal superficial lamina (DSL) is located just beneath the dermis and lacks neurovascular structures. This lamina is divided by vertical connective septa into volume compartments that vary in distribution from proximal to distal.[5] In the proximal two-thirds of the dorsum of the hand, three compartments (radial, median, and ulnar) can be identified[13], while in the distal third, a total of four compartments gradually emerge among the metacarpal-phalangeal joints[10].
- Just beneath the DSL, and closely adherent to it, runs the dorsal superficial fascia (DSF).
- Immediately below the DSF, we encounter the dorsal intermediate lamina (DIL). This layer, in turn, is divided by the subvenous fascia[9] into a superficial plane - housing the dorsal superficial subcutaneous veins - and a deep one, where the terminal nerve branches run in.
- Beneath the DIL, there is the deep intermediate fascia (DIF).
- Continuing downwards from the DIF, we encounter the dorsal deep lamina (DDL). This is not a layer of fatty tissue, but rather a fascia surrounding the tendons, corresponding to the plane of the more proximal extensor retinaculum.
- Below the DDL, the dorsal deep fascia (DDF) can be identified. This layer represents the distal extension of the deep antebrachial fascia. This fascia is closely connected with the periosteum of the metacarpal bones and the perimysium of the interosseous muscles.

Within all of these loosely connected planes, there may be potential spaces for inflammatory and/or blood collections.

Vascularisation of the dorsum of the hand

Arteries

The vascular supply of the hand and forearm is a complex network of vessels derived from the radial and ulnar arteries[14,15]. The blood supply to the dorsum of the hand results from the merging of the dorsal carpal branch of the radial artery, the dorsal carpal branch of the ulnar artery, and the anterior and posterior interosseous arteries from the ulnar artery into the dorsal carpal arch. The dorsal carpal arch lies beneath the extensor tendons, at the level of the radiocarpal joint. Most dorsal metacarpal arteries branch from the dorsal carpal arch, running distally along the second, third, and fourth dorsal interosseous muscles, and bifurcate into six dorsal digital arteries at the level of the distal metacarpal heads. These include the dorsal ulnar branch to the index finger, dorsal branches to the middle and ring fingers, and the radial dorsal branch to the little finger. Near their origin, the dorsal metacarpal arteries anastomose with the deep palmar arch via perforating arteries. Similarly, near their distal bifurcation, they connect with the digital branches of the superficial palmar arch through perforating arteries. The radial artery branches off the first dorsal metacarpal artery and then runs deep between the two heads of the first interosseous muscle towards the palm. An unusual superficial branch, given off before entering the palm, may be at risk for iatrogenic injury during surgical approaches in that region[16].

Near its point of origin, the radial artery splits into the dorsal artery of the thumb and the radial dorsal branch to the index finger.

On the ulnar side of the wrist, the ulnar dorsal carpal branch diverges from the ulnar artery.

The ulnar dorsal carpal branch divides into two separate arteries. The first is the ulnar digital dorsal branch to the little finger, while the second joins the dorsal carpal arch. The branch to the little finger runs along the ulnar side of the fifth metacarpal bone and continues in the same direction into the little finger.

All the dorsal metacarpal arteries lie within a delicate layer of deep fascia.

A superficial vascular arch in the proximal third of the metacarpals of the long fingers has been described as the only source of vascularisation of the proximal third of the third space, with a dominant ulnar side in the majority of cases, although numerous anatomical variations exist[17].

The dorsal skin of the hand receives most of its blood supply from the distal perforators located at

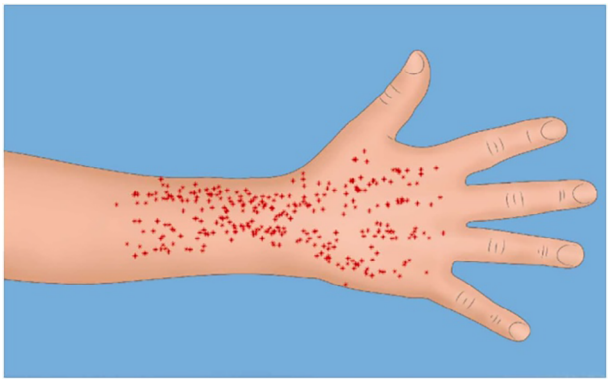

Figure 3. Positions of all arterial skin perforators in a standard lower forearm and hand. Reprinted from Wagner T, Hummelink S, Mathot F, Ulrich D. The anatomical relationship of dorsal arterial perforators of the distal forearm, wrist, and dorsum of the hand with conclusions for the clinic. *J Plast Reconstr Aesthet Surg*. 2023 Aug;83:141-147. doi: 10.1016/j.bjps.2023.04.040. Epub 2023 Apr 25, under the terms of the Creative Commons CC-BY license[18].

the level of the metacarpophalangeal (MCP) joints. These perforators originate from the dorsal metacarpal arteries (DMCA) at the first to fourth web spaces (Figure 3). They connect just proximal to the knuckle joints through small, thin arcading vessels. The very centre of the dorsal skin has almost no underlying feeding perforator and is mainly nourished by the intra- and subcutaneous small arteries[18].

Capillaries

Capillaries form an extensive thin-walled mesh of vessels within the dermal and subdermal tissues.

Measurement of the microcirculation on the dorsum of the hand using combined laser-Doppler and spectrometry techniques showed that, with age, cutaneous oxygen saturation decreases while blood flow velocity significantly increases[19].

Veins

The venous system of the hand is arranged in two groups, radial and ulnar, above the transverse midline of the dorsum. The area between these two groups, corresponding to the proximal halves of the second metacarpal bone, the second intermetacarpal space, and the third metacarpal bone, might be called 'vein-lacking area'[20].

This system comprises both superficial and deep components. The deep venous system consists of paired veins that run alongside the arteries, known as *venae comitantes*.

The superficial venous system is located in the upper layer of the DIL. The superficial veins form a loosely woven network where two or three vessels run from distal to proximal along the interosseous spaces. The merging of the dorsal digital venous network forms these veins. It is not unusual to encounter a transverse, proximally concave venous arch in this area. The dorsal superficial hand vein pattern of each individual serves as a reference for biometric authentication.[21] This superficial venous system is supplied with numerous vascular anastomoses, exhibiting a wide range of anatomical patterns, including inosculation, merging, transverse, longitudinal, and perpendicular perforating connections. Many arteriolar-to-venular anastomoses have also been identified. In such cases, veins originate from these peculiar anastomoses, bypassing the capillary network. Both deep and superficial veins have paired, swallow's nest-shaped valves, with the downstream side being concave[22].

Lymphatic vessels

The lymphatic vessels on the dorsum of the hand initially develop from lymphatic capillary plexuses, which start in the extracellular spaces. There are about 15 to 18 in the dorsum of the hand: more in the metacarpal region, and fewer in the carpal area. The diameter of these vessels ranges from 0.2 mm to 0.6 mm. The lymphatic vessels of the fingers join at the base of the fingers and continue their course, meandering through the subcutaneous tissue and forming anastomoses with each other as they pass, over or under the veins they encounter[23].

Dorsal nerves

Although the innervation to the dorsal hand varies, specific patterns exist.

The dorsum of the hand is divided into two sensory areas: one supplied by the dorsal branch of the

ulnar nerve, the other by the superficial branch of the radial nerve. The nerve branches are located within the deep layer of the DIL.

The dorsal branch of the ulnar nerve divides into three terminal branches: one runs along the ulnar border of the dorsum of the hand, the middle branch travels along the fourth interosseous space, and the radial-most branch follows the third interosseous space.

Additionally, three terminal branches emerge from the superficial branch of the radial nerve. The first branch follows the radial border of the dorsum of the hand. The middle branch runs along the first interosseous space, and the third branch turns ulnarly to run along the second interosseous space.

Dual innervation, caused by communicating branches between the radial and ulnar nerves or overlapping nerves, has been documented. An entirely radial supply to the dorsum of the hand is possible, although this scenario is uncommon[24]. Variations in the superficial branch of the radial nerve among different races should also be taken into account[25]. Additionally, notable differences in the sensory distribution between the right and left hands within the same individual are observed.[26] The innervation pattern between the superficial branch of the radial nerve and the dorsal branch of the ulnar nerve is evenly distributed. Dual innervation is common between these two nerves, with the lateral antebrachial cutaneous nerve frequently contributing to thumb innervation[27].

Typically, a transverse anastomosis links the terminal branches of the ulnar and radial nerves, forming a proximally concave arch at the level of the carpometacarpal region[28]. Autonomic nerve fibres are supplied by the three primary nerves of the hand. The ulnar nerve supplies all of its cutaneous sensory territory; the median nerve usually provides vasomotor innervation to the skin on the radial side of the dorsum; the radial nerve supplies sudomotor innervation for the radial aspect of the dorsum of the hand but does not usually contribute vasomotor fibres to this area[29].

Discussion

The complex and unusual anatomical structure of the back of the human hand requires a comprehensive understanding by aesthetic physicians. It will be crucial in determining how and with what techniques they approach reversing the ageing process.

The softness and delicacy of the skin, along with the relative lack of skin adnexa, generally advocate a cautious approach to ablative techniques. As the soft tissue envelope of the dorsum of the hand is thinner in women and further thins with age[6,8], this approach must be even more cautious in older women.

The anatomy of the soft, layered tissues at the back of the hand influences the approach and methods used for injections to fill or biostimulate the skin. For safety reasons, the most widely supported opinions recommend ultrasound-assisted injection procedures in this area[30]. In fact, although the suggested anatomical layer for safe injections is the DSL, this manoeuvre is almost impossible to perform in clinical practice. In reality, most injections are carried out in the DIL at the level of the superficial dorsal veins[7].

To prevent compressing or damaging the function of arterial and venous vessels, as well as lymphatic and nervous structures, the number of injected volumes for both fillers and adipose tissue grafts must be carefully planned[3,11].

Last but not least, in the case of sclerotherapy, special attention must be paid to the anastomoses between the superficial and deep vascular systems.

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Conflict of Interest Disclosure: The authors declare that they have no conflict of interest.

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