JOURNAL OF PLASTIC SURGERY AND HAND SURGERY
2023, VOL. 57, NOS. 1–6, 178–180
https://doi.org/10.1080/2000656X.2022.2032103

ARTICLE

Topography of the deep branch of the ulnar nerve between genders: a cadaveric study with potential clinical implications

Alfio Luca Costa[a,b], Konstantinos Natsis[c], Marco Romeo[d], Maria Piagkou[e], Franco Bassetto[b], Cesare Tiengo[b], Bruno Battiston[f], Paolo Titolo[f], Nikolaos Papadopulos[g] and Michele Rosario Colonna[a]

[a]Department of Human Pathology of the Adult, the Child and the Adolescent, University of Messina, Messina, Italy; [b]Clinic of Plastic Surgery, Padova University Hospital, Padova, Italy; [c]Department of Anatomy and Surgical Anatomy, School of Medicine, Faculty of Health Sciences, Aristotle University of Thessaloniki, Thessaloniki, Greece; [d]Section of Plastic and Reconstructive Surgery. Department of Surgical, Oncological and Oral Sciences, University of Palermo, Palermo, Italy; [e]Department of Anatomy, School of Medicine, National and Kapodistrian University of Athens, Athens, Greece; [f]Depatment of Traumatology, Azienda Ospedaliero-Universitaria Citta della Salute e della Scienza di Torino, Turin, Italy; [g]Dept. of Plastic Surgery and Hand Surgery, Munich Technical University (TUM), Munich, Germany

ABSTRACT

The lack of meticulous knowledge concerning the topographical anatomy of the deep branch of the ulnar nerve (DUN) may pose difficulties, leading to a delay or a misdiagnosis of a DUN injury. Identification of the DUN is quite difficult without precise anatomical landmarks as reference points. The current study investigates the topography of the DUN between genders, taking as a reference point a well-known landmark, the Kaplan line, used in hand surgery for carpal tunnel release. Twenty-two (15 males and 7 female) fresh frozen adult cadaveric hands were dissected by using magnifying loupes (3.5 and 5.0 x). We marked values proximal to the Kaplan line as positive (+), while we marked distal ones as negative (-). The mean distance DUN–Kaplan line was 1.69 ± 4.45 mm. In male hands, the mean distance was 4.17 ± 1.88 mm, distal to the Kaplan line, while in females, the mean distance was -4.92 ± 0.69 mm proximal to the Kaplan line. Gender dimorphism was detected, with higher statistically significant values in male hands ($p = 0.001$). Cadaveric studies of the DUN topography, course, and distribution pattern are uncommon. The current study provides an accurate description of the DUN topography, taking the Kaplan line as a reference point, emphasizing gender differences. The DUN is located distally in males and proximally in females. Knowledge of these predictable anatomical relations may help hand surgeons intraoperatively when dealing with a DUN lesion, because of hand trauma or during the decompression of the DUN.

ARTICLE HISTORY
Received 4 June 2021
Revised 1 December 2021
Accepted 16 January 2022

KEYWORDS
Ulnar nerve; microsurgery; hand surgery

Introduction

Several authors agree with the statement that the anatomy of the deep branch of the ulnar nerve (DUN) is complex and often little known; even hand surgeons often find it difficult to understand its three-dimensional arborization pattern [1,2]. This branch runs in a space between the flexor digitorum profundus (FDP) tendons and the interosseous muscles in the hand, an area that a microsurgeon rarely sees in clinical practice, except for hand trauma or rare elective pathologies [3–8]. Besides this, although the anatomy of this branch can also be found in the more common hand surgery atlas, its arborization patterns were unclear until a few years ago [1–2]. This poor anatomical knowledge in clinical practice can lead to a delay in diagnosis or misdiagnosis of the DUN lesion. Several noxae, such as cysts, penetrating trauma, displaced fractures, flexor injuries in zone III, can be associated with a DUN injury [3–8]. Surgeons often relate loss of fine hand movement and pinching and grasping force to the trauma itself, to a reduction in flexor tendon function, or poor rehabilitation of the patient following trauma rather than injury to the DUN or its terminal branches [9]. Atkins first and Gil later clarified the anatomy with radiographic landmarks [1,2]. However, no data exists concerning the nerve identification in relation to a precise anatomical landmarks, as well as possible gender variability in DUN position and course. Aim of this study is to define the position of the arc of the DUN relative to a clear and well-known reference point on the surface of the hand, the Kaplan line, a well-known landmark in hand surgery for carpal tunnel release [10].

Materials and methods

22 (15 males and 7 female) fresh frozen adult cadaveric hands were dissected. Investigators used the following procedure to expose the DUN: removal of the skin and palmar fascia to expose the underlying plane of the flexor tendons; the opening of the carpal canal and careful reflection of the median nerve and superficial and deep flexor tendons; detection of ulnar nerve branches and opening of Guyon's canal; dissection of the DUN through its muscular canal in the hypothenar eminence; gentle dissection, with 3x and 5x magnification, of the DUN in the deep interosseous plane (Figure 1).

Photographic documentation was captured through a digital camera (Nikon D90, 12,3 Megapixel). Subsequently, the measurements were made after a perspective correction and a calibration

CONTACT Alfio Luca Costa alfiocosta@hotmail.it Via Toscanini n° 7, Bagheria, CAP 90011, Italy
This article has been republished with minor changes. These changes do not impact the academic content of the article.

on one frame. For this, the authors used a feature from Adobe Photoshop CC 2019.

The program allows correcting the perspective deformation of the image to get the corresponding ideal rectangular shape. Subsequently, the images were scaled to get a 1 to 1 scale image in which it is possible to make measurements directly on the image. Next, the Kaplan line was added with Adobe Photoshop and the distance between it and the DUN was measured. Measurements were got by taking the distance from the top of the convexity of the DUN to the Kaplan line. We took as a reference point of the apex of the convexity the point where the arc of the DUN crosses the axis that goes from the midpoint of the interstyloid line to the apex of the third finger. In cases of an arch created proximal to the Kaplan line, negative values (-) were calculated, while in cases of an arch distal to the Kaplan line positive values (+) were considered (Figure 2).

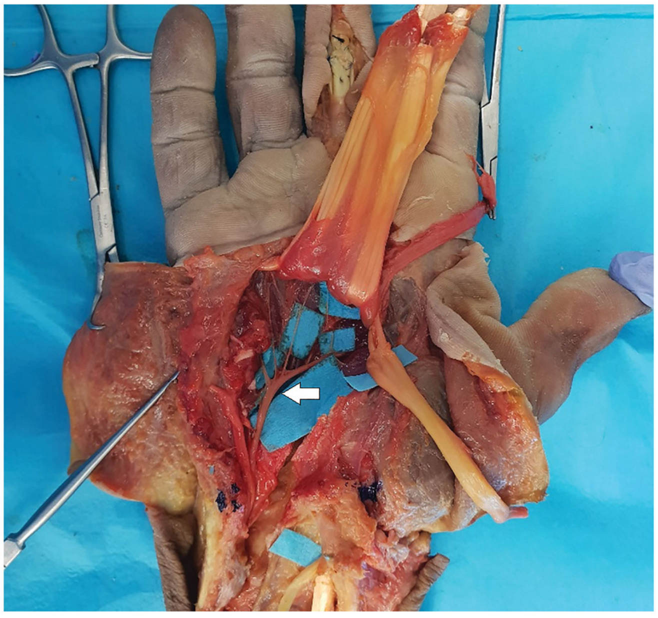

Figure 1. Distribution pattern of the deep branch of ulnar nerve in the fibrous tunnel formed between the hook of the hamate and the pisiform (Guyon's canal), in a right-sided male cadaveric hand.

Statistical analysis

We performed the statistical evaluation using the SPSS Statistics version 21 (*IBM; Armonk, New York*). All descriptive variables were expressed as mean ± SD. Fisher's exact test was performed in cases of categorical variables with less than 5 observations. Distributions' normality was checked using Shapiro-Wilk test (sample $\leq$ 50) and p-value was calculated. In cases of no normal distributions, instead of mean values, percentiles were used (*taking into consideration the 95% confidence interval for mean with the upper and lower bound*). To examine gender impact, i.e. the association of the DUN location to the Kaplan line (-proximal/+distal) for the gender, the distributions of male and female cadaveric hands were checked for normality, and in cases of normal distribution parametric tests were used (*Independent Samples T test*). Otherwise, gender impact was detected *via* non-parametric tests (*Mann-Whitney U test*).

Results

The mean distance 'DUN–Kaplan line' was 1.69 ± 4.45 mm (*min −5.70, max 6.90, range 12.60*). The distribution did not follow the normality, thus instead of mean value, the 25–75 percentiles were used (*−4.10–4.72 mm*). In male hands, the mean distance was 4.17 ± 1.88 mm distal to the Kaplan line (*min 2.10, max 6.90, range 9.00*) and in female ones, the mean distance was −4.92 ± 0.69 mm proximal to the Kaplan line (*min −5.70, max −4.10, range 1.60*). The distributions were normal for the female hands ($p = 0.258$) and not normal for male hands ($p = 0.04$). We found gender dimorphism, with higher statistically significant values in males ($p = 0.001$).

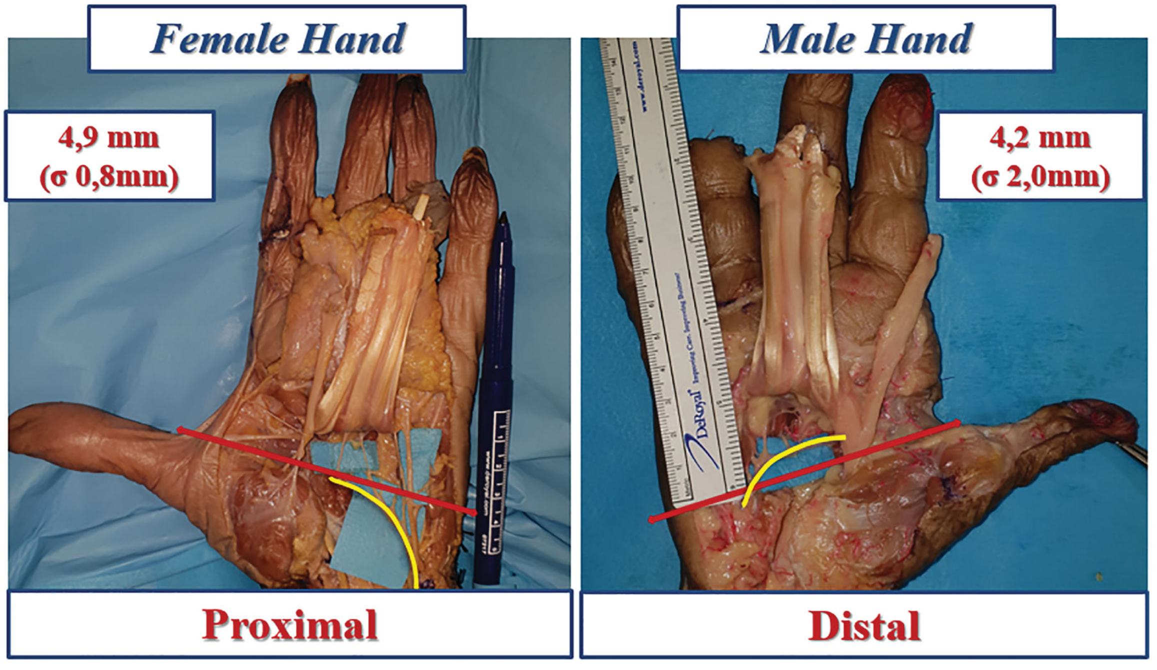

Figure 2. The reference point for the distance calculation in between ulnar nerve deep branch (DUN) and Kaplan line (red horizontal line) in female and male cadaveric hands. In females, the arc (in yellow) is located proximal (− values), while in males is located distal (+ values).

Discussion

The deep branch of the ulnar nerve usually innervates the interosseous muscles, the 3rd and 4th lumbrical muscles, the hypotenar muscles and the adductor of the thumb; as a result, it contributes to grip, grip strength, and fine hand movements.

While a plethora of articles refer to the study of the anatomy of the Median Nerve and its variants, little data exists regarding the anatomy of the DUN and its course and variants [11].

The space in which the deep branch of the ulnar nerve runs between the deep flexors of the fingers and the interosseous muscles has often been neglected. This space, however, can be prone to several types of noxae, such as bone trauma and flexor tendon injuries, which can lead to a DUN injury. Such injuries, especially in complex hand trauma, may be undiagnosed and attributed to other traumatic factors [3–8].

With the advancement of imaging and the rapid changes in hand technology (including magnification), the knowledge of the deep neural branching pattern of the hand increased, as well as treatment modalities and hand surgeons' expectations. However, cadaveric studies, such as the current one, focusing on the ulnar nerve branching pattern in the hand, remain the gold standard in educational anatomy.

In 2009, Atkins et al. clarified the three-dimensional anatomy of the motor branch of the ulnar nerve and its branches [1]. This study illustrated the different branching patterns and the relationships of these with the deep muscles and skeletal structures. Gil et al., in 2016, emphasized the position of the DUN inside the hand, taking the piso-scaphoid line, located very proximal to the DUN, as the bone reference point [2]. In the study, the authors found a variability in the location of the deep motor branch of the ulnar nerve, however recognizing a BIAS in having chosen a proximal reference point and therefore having obtained measurements that are influenced by the size of the hand [2]. However, it is appropriate to point out that there are no standards in the literature for measuring the size of a hand, and consequently is not possible to make an adequate proportion. To clarify better the position of the deep branch of the ulnar nerve at the palm level, it appeared appropriate for the authors to identify a more distal landmark in the palm. The Kaplan line was therefore chosen, a well-known clinical landmark widely used in the hand and relatively close to the DUN [10]. The Kaplan's line was suitable for our study, because we also needed to establish a landmark that covers the entire palm to locate the deep branch of the ulnar nerve along its path.

Interestingly, significant gender differences occurred. The average distance was 1.69 ± 4.45 mm e, associated with great variability. In male hands, however, the DUN was always localized distal to the Kaplan line with a mean value of 4.17 ± 1.88 mm mm and relatively low variability, while in female hands the DUN was always localized proximal to the Kaplan line with a mean value -4.92 ± 0.69 mm and still a low variability.

Conclusions

Anatomical studies of the course and muscular branching of the DUN are uncommon. This study provides a detailed description of the location of the DUN reference Kaplan's line. Knowledge of these predictable anatomical relations can aid hand surgeons in the intraoperative exploration for a lesion of the DUN that can occur consequently of a hand trauma. Furthermore, this study has shown that the DUN, in relation to the Kaplan Line, is located distally in men and proximally in women. These gender differences are statistically significant and should be taken into consideration in the operating theater. Further studies, if possible of three-dimensional anatomy, may be necessary to better clarify the knowledge on the anatomy of the deep branch of the ulnar nerve.

Ethical approval

The Scientific Committee of the Italian Society for Hand Surgery and the Ethical Committee of the Aristotle University of Thessaloniki approved the study.

Statement of human and animal rights

All procedures followed were under the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Statement of informed consent

All individual participants included in the study gave informed consent pre-mortem.

Disclosure statement

The authors report no conflicts of interest to disclose.

References

[1] Atkins S, Logan B, McGrouther D. The deep (motor) branch of the ulnar nerve: a detailed examination of its course and the clinical significance of its damage. J Hand Surg Eur Vol. 2009;34(1):47–57.

[2] Gil Y, Shin K, Lee S, et al. Anatomy of the deep branch of the ulnar nerve. J Hand Surg Eur Vol. 2016;41(8):843–847.

[3] Almeida V, de Carvalho M. Lesion of the deep palmar branch of the ulnar nerve: Causes and clinical outcome. Neurophysiol Clin. 2010;40(3):159–164.

[4] Jennings J, Jennings J. Isolated compression of the ulnar nerve motor Branch: A Case Series With 3 Unique Etiologies. Ann Plast Surg. 2018;80(5):529–532.

[5] Dahlin L, Palffy L, Widerberg A. Injury to the deep branch of the ulnar nerve in association with dislocated fractures of metacarpals II-IV. Scand J Plast Reconstr Surg Hand Surg. 2004;38(4):250–252.

[6] Terrono A, Belsky M, Feldon P, et al. Injury to the deep motor branch of the ulnar nerve during carpal tunnel release. J Hand Surg [Am]. 1993;18(6):1038–1040.

[7] Leslie I. Compression of the deep branch of the ulnar nerve due to oedema of the hand. Hand. 1980;12(3):271–272.

[8] Capitani D, Beer S. Handlebar palsy-a compression syndrome of the deep terminal (motor) branch of the ulnar nerve in biking. J Neurol. 2002;249(10):1441–1445.

[9] Barberie JE, Connell DG, Munk PL, et al. Ulnar nerve injuries of the hand producing intrinsic muscle denervation on magnetic resonance imaging. Australas Radiol. 1999;43(3):355–357.

[10] Vella J, Hartigan B, Stern P. Kaplan's cardinal line. J Hand Surg Am. 2006;31(6):912–918.

[11] Blair WF, Percival KJ, Morecraft R. Distribution pattern of the deep branch of the ulnar nerve in the hypothenar eminence. Clin Orthop Relat Res. 1988;229:294–301.