MINI REVIEW

A Review of the Anatomical Variations of the Hand and Forearm and the Clinical Implications of these

Oscar Guest*

Guest O. A Review of the Anatomical Variations of the Hand and Forearm and the Clinical Implications of these. Int J Anat Var. 2024;17(3): 524-525.

ABSTRACT

Our understanding of anatomy minutiae, and the variations that exist between different individuals, is of increasing significance in a world of highly precise surgical medicine. This review highlights the clinical significance of anatomical variations pertaining to palmaris longus, flexor digitorum superficialis, the median nerve and the superficial palmar arch.

Keywords: Anatomy; Forearm; Anatomical variation

INTRODUCTION

Our understanding of anatomy's minutiae, and the variations that exist between different individuals, is of increasing significance in a world of highly precise surgical medicine. As a surgeon, you need to be aware that the generalized anatomy studied at medical school is not applicable to all patients. This variation has the propensity to affect methods used in surgery and the post-operative recovery for patients. My essay aims to explore the literature concerning just some of the clinically significant anatomical variations of the hand and forearm.

THE ANATOMICAL VARIATIONS OF PALMARIS LONGUS (PL)

PL lies superficially in the anterior compartment of the forearm, originating from the medial epicondyle and inserting distally onto the palmar aponeurosis. Morphological variability of PL is well documented owing to its routine harvesting in tendon reconstruction surgery. There is significant morphological variation at a population level, with 16% exhibiting unilateral and 9% showing bilateral absence of PL [1] in the UK.

A 2017 study [2] was able to categorise PL into one of three different types based on two main factors; the 'variations in its insertion [2] and the 'tendon-to-muscle length ratio [2]. This study noted that there were three variants in the insertions of the PL; Type 1 being normal i.e. from the medial epicondyle to the palmar aponeurosis. However, deviations from Type 1 are when the PL bifurcates distally so that the medial division inserts into the flexor retinaculum and the lateral division continues to insert onto the palmar aponeurosis; this was Type 2. Any other rare anomalies that couldn't be classified as either Type 1 or 2 fell into the Type 3 category. The subtypes of PL are either A, B or C; where subtype A has a tendon to muscle ration of less than 1. Subtype B is when this ratio is 1-1.5 and subtype C is when the ratio is greater than 1.5. The Type 1 classification was predominant across all participants, with a 78.8% occurrence [2]. This most common variant of PL has been shown in other studies as well, with Mathew et al [3] finding 81.25% of cadavers having a Type 1 variation.

Owing to their obscurity, I find some of the Type 3 PL variations extremely fascinating. Reverse PL, characterized by the long tendinous portion inserting onto the medial epicondyle of the humerus and the muscular belly onto the pisiform bone, was noted by Mathew et al. [3] Additionally, one specimen had a congenitally acquired additional accessory PL unilaterally. Bernardes et al [4] noted several case studies of Type 3 PL, the most notable of which was where, in one case, the distal tendon of PL passed beneath the flexor retinaculum to replace the flexor digitorum superficialis of the fourth phalanx. There was no functional deficit noted in this fourth phalanx by the patient before their death. Interestingly, there appears to be a geographical link to complete absence of PL, with particularly high absence rates in Turkish (63.9%) and Egyptian (50.8%) populations [5]. Low absence rates were reported by Gangata [6] in Ghanaian and Zimbabwean populations, with PL absence rates of just 3.1% and 1.5%6 respectively. The fact these nations, with completely opposing PL absence rates, are geographically close, would lead me to believe that there is no evolutionary basis influencing these results, as selection pressures in both nations would be very similar.

Primarily used in tendon grafts, the absence of PL was shown by Cetin et al [7] to not affect any of the movements associated with the hand; such movements included pinch and grip strength. PL is most frequently used to graft finger flexors, and the classification system proposed by Olewink et al2 can now be used to assess the risk of such repairs. With the necessary length and diameter, and ability to be removed without causing a pathology, PL satisfies all of the criteria to make it perfect for tendon harvesting. If a person presents with the bifurcating Type 2 PL, more tension will be placed on the tendon where it overlies the median nerve. This ultimately increases the risk of both median nerve injury and tendon splitting in these patients. Surgery to retrieve the PL tendon is now conducted such that ablation begins proximally in the wrist with incisions being made every 5cm to ensure the distal tendon is located such that it won't cause nerve damage when finally removed through the proximal incision [8]. It is thus aberrantly clear that a detailed knowledge of the PL tendon-median nerve intersection is critically important when conducting a tendon harvesting operation.

THE ANATOMICAL VARIATIONS OF FLEXOR DIGITORUM SUPERFICIALIS (FDS)

With the presence of accessory tendons, muscle belly variations and atypical tendon connections, anatomical variations of FDS are frequently reported. The clinical significance of such variations depends on the nature of the abnormality. However, hand surgeon's knowledge of these anatomical discrepancies is of particular importance in determining the course of action for patients who have suffered tendon injuries or are showing the characteristic sign of nerve entrapment. Larger than all other forearm muscles, the FDS marks the boundary between the superficial and deep layers of the forearm muscles.

Categorising the anatomical variations of the FDS into five types, Elliot et al [9] described the evolutionary significance of FDS. The superficial flexor tendons in amphibians originate in the palm of their hand, along the course of our evolution this insertion point has migrated into the forearm. Elliot et al's Type IV variation describes projection of the FDS muscle belly into the hand. This variation may thus be an evolutionary remnant from our amphibious ancestors. Other notable variations are Type II, when connections are present that link the tendons of FDS to the flexor retinaculum, and Type V. The Type V refers to any anatomical variation that is present in the compartment of the forearm.

The clinical relevance of the Type IV extension of the FDS's muscle belly into the hand relates to carpal tunnel syndrome surgery. This unexpected muscle belly may present as a soft tissue tumour or cause median nerve compression. Consequently, extension and flexion of the digits in patients with a type IV variation may result in intermittent symptoms of carpal tunnel syndrome,

Department of Human Anatomy Demonstrator, University of Bristol, School of Anatomy, Bristol, UK

Correspondence: Oscar Guest, Department of Human Anatomy Demonstrator, University of Bristol, School of Anatomy, Bristol, UK; E-mail: oscar.guest@hotmail.co.uk

Received: 01-Mar-2024, Manuscript No: ijav-24-6952; Editor assigned: 04-Mar-2024, PreQC No. ijav-24-6952 (PQ); Reviewed: 20-Mar-2024, Qc No: ijav-24-6952; Revised: 26-Mar-2024 (R), Manuscript No. ijav-24-6952; Published: 29-Mar-2024, DOI:10.37532/1308-4038.17(3).370

especially during flexion of the interphalangeal joint. I have found numerous reports of the Type V variation, most of which have been discovered during either surgery or cadaveric dissection. Elliot et al [9] noted that FDS had an accompanying muscle that arched over the median nerve anteriorly resulting in median nerve compression. Mainland [10] was the first to document such variation of FDS in 1927, noting that the fourth and fifth phalanx's tendons attached to three separate muscles, two of which had their bellies in the forearm. Interestingly, this cadaver also had PL absent. I couldn't find any literature concerning a possible correlation between anatomical variation of PL and FDS, however this would be an interesting area of research.

THE ANATOMICAL VARIATIONS OF THE MEDIAN NERVE

I have already alluded to the numerous anatomical variations associated with the median nerve in terms of its relation to muscles in the forearm. However, this section of my essay will explore the possible variations in the path of the median nerve through the carpal tunnel. Lanz [11] suggested that the median nerve's tract falls into one of four classes. 'Group I-variations of the course of the thenar branch; Group II-accessory branches at the distal carpal tunnel; Group III-high division of the median nerve; Group IV-accessory branches proximal to the carpal tunnel. [11] It is to be noted that these variations are all deviant from normal; a diagram of which is depicted below [Figure 1].

The relevance of these early findings in a clinical setting is that they compounded the significance of conducting carpal tunnel surgery of the median nerve from the ulnar side. This is due to the possibility of accessory branches of the median nerve emanating proximal to the flexor retinaculum; a possibility in the Group IV variation. The primary aim of approaching such surgery from the ulnar side is thus to reduce the risk of lacerating the variant branches of the ulnar nerve. Beris et al [12] conducted a review into the successfulness of releasing the transverse carpal ligament in the treatment of a compressed median nerve. This procedure is widely performed and normally conducted without any complication. However, Beris et al noted that a major source of iatrogenic injury was caused by 'an aberrant sensory branch arising from the ulnar side of the median nerve and piercing the ulnar margin of the transverse carpal ligament' [12]. 3 out of 110 patients in this investigation expressed this abnormality. This study further confirms the importance of surgeon's ability to recognise anomalous branches of the median nerve, and decompress them if necessary.

ANATOMICAL VARIATION OF THE SUPERFICIAL PALMAR ARCH (SPA)

The anatomy of the SPA has been extensively reviewed; the vast array of imaging techniques available to observe blood vessels make doing so relatively simple. Other than dissection techniques, angiography, Doppler studies and ultrasonography have all been used to advance our appreciation of the SPA's normal and variant anatomies. Conventionally, the SPA is fed primarily by the ulnar artery, with contributory branches from the superficial palmar branches of the ulnar and radial arteries as well as arteria radialis indica. The first classification system for the SPA was put forth in 1897 [13], discrepancies between cadaveric specimens depended upon the presence or absence of communication between the vessels contributing to the SPA and its distal branches. This method of classification is still in use today; a 1928 study [14] reported seven variations in the branching of SPA. 77.3% of specimens had four common digital arteries, the first of which supplying the ulnar portion of the thumb and the radial portion of the index finger. The remaining three branches supplied the spaces between the remaining medial fingers. A further classification of the SPA is in terms of whether or not it is 'complete'; this is based on the presence or absence of anastomosis between constituting vessels. An incomplete SPA would exhibit no anastomosis between the superficial palmar branches of the radial and ulnar arches.

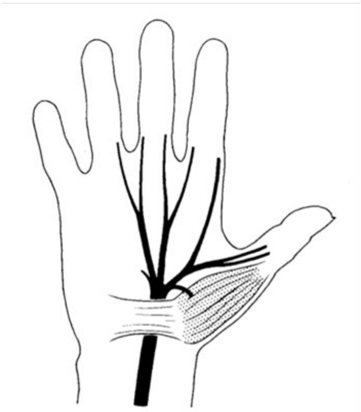

Figure 1) *Regular branching of the median nerve [11].*

Such mechanisms of classification hold immense importance in improving the success of microvasculature procedures for reconstructive hand surgery. A 1993 investigation [15] revealed an occurrence of 'incomplete' SPA in 4.2% of patients. The incomplete SPA results in an increased risk of ischaemia in the distal hand post trauma, thus advanced examination of the patient's hand vascular is of great clinical use in preparation for reconstructive surgery. Furthermore, cannulation procedures, including transradial angiography, increase the risk of ischaemic damage when the SPA is incomplete.

CONCLUSION AND REFLECTION

This review has explored four aspects of anatomical variation relating to the medial aspect of the forearm and hand. Whist many variations are rare; as a clinician it is of critical importance to have awareness that not all patients are anatomical clones. As such, especially in the case of surgery, appreciating that there may be abnormal anatomy can help to improve the outcome for patients and reduce the risk of iatrogenic complications.

REFERENCES

1. Thompson N, Mockford B, Cran G. Absence of the palmaris longus muscle: a population study. Ulster Med J 2001; 70(1):22-24.
2. Olewnik L, Wysiadecki G, Polguj M, Podgórski M, Jezierski H et al. Anatomical variations of the palmaris longus muscle including its relation to the median nerve a proposal for a new classification. BMC Musculoskeletal Disorders 2017;18(1) 539.
3. Mathew A. Versatile but Temperamental A Morphological Study of Palmaris Longus in the Cadaver. Journal of clinical and diagnostic research 2015; 9(2).
4. Bernardes A, Melo C, Pinheiro S. A combined variation of Palmaris longus and Flexor digitorum superficialis Case report and review of literature. Morphologie 2016;100(331):245-249.
5. Raouf H, Kader G, Jaradat A, Dharap A, Fadel R et al. Frequency of palmaris longus absence and its association with other anatomical variations in the egyptian population. Clinical Anatomy 2013;26(5):572-577.
6. Osonuga A, Mahama H, Brown A, Osonuga O, Serbeh G, Harding A et al. The Prevalence of Palmaris longus agenesis among the Ghanaian population. Asian Pacific Journal of Tropical Disease 2012;2:S887-S889.
7. Cetin A, Genc M, Sevil S, Coban Y. Prevalence of the Palmaris Longus Muscle and its Relationship with Grip and Pinch Strength: A Study in a Turkish Pediatric Population. HAND 2013;8(2):215-220.
8. Lawler E, Adams B. Reconstruction for DRUJ Instability. HAND 2007;2(3):123-126.
9. Elliot D, khandwala A, Kulkarni M. Anomalies of the Flexor Digitorum Superficialis Muscle. Journal of Hand Surgery 1999;24(5):570-574.
10. Mainland D. An uncommon abnormality of the flexor digitorum sublimis muscle 1927; 86-89.
11. Lanz U. Anatomical variations of the median nerve in the carpal tunnel. The Journal of Hand Surgery 1977;2(1):44-53.
12. Beris A, Lykissas M, Kontogeorgakos V, Vekris M, Korompilias A. Anatomic variations of the median nerve in carpal tunnel release. Clinical Anatomy 2008;21(6):514-518.
13. Jaschtschinski S. Morphologie und Topographie des arcus volaris sublimis uno profundus des Menschen. Referate und Beitr age zur Anatomie und Entwickelungsgeschichte 1896;7(2):161-188.
14. Shimada K. Beitraumlge zur Anatomie des Zentralnervensystems der Japaner. V Corpus striatum. Folia Anatomica Japonica 1928;6(5):425-455.
15. Gajisin S, Zbrodowski A. Local Vascular Contribution of the Superficial Palmar Arch. Cells Tissues Organs 1993;147(4):248-251.