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Literature review

Agensis, functional deficiency and the common type of the flexor digitorum superficialis of the little finger: A meta-analysis

Agénésie, déficit fonctionnel, et variations anatomiques les plus courantes du flexor digitorum superficialis de l'auriculaire : une méta-analyse

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ABSTRACT

Agensis, functional deficiency and the common type of the flexor digitorum superficialis of the little finger are reported in the literature to be highly variable with significant discrepancy between clinical and cadaveric frequencies. The aim of this systematic review was to generate overall clinical and cadaveric weighted frequencies, along with ancestry-based, side-based, sex-based and laterality-based frequencies. A systematic literature search identified 34 studies including 12,213 forearms/hands that met the inclusion criteria. Functional deficit of the FDS tendon of the little finger was significantly more prevalent among Iranian and Caucasian populations as compared to Indian, East African and Chinese populations. The weighted "clinical" frequency of functional absence of the FDS tendon of the little finger was 7.45%, while prevalence of the common type was 37.5%. The weighted "cadaveric" prevalence of muscle absence of the FDS-5 in the forearm was 2.5% while tendon absence in the hands was nil. An expanded examination technique proved to be the most accurate test for FDS function. In case of injury, inadequate knowledge of different connections or substitutions of the FDS-5 could lead to a total loss of flexion of the little finger. These findings support the hypothesis of a dual origin of the FDS-5 where the muscle portion originates in the forearm, while the tendon portion originates in the hand.

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R É S U M É

L'agénésie, le déficit fonctionnel et les variations anatomiques les plus courantes du flexor digitorum superficialis de l'auriculaire (FDS-5) sont rapportés dans la littérature avec une grande variabilité et une divergence significative entre les fréquences cliniques et cadavériques. Le but de cette revue systématique était de générer des valeurs pondérées de fréquence clinique et cadavérique avec celles basées sur l'ethnicité, le côté, le sexe et la latéralité. Une recherche systématique dans la littérature a identifié 34 études, comprenant 12.213 avant-bras et mains, et remplissant les critères d'inclusion. Le déficit fonctionnel du tendon du FDS-5 était significativement plus fréquent parmi les populations iraniennes et caucasiennes que parmi les populations indiennes, chinoise et de l'Afrique de l'Est. La fréquence clinique pondérée de l'absence fonctionnelle du tendon du FDS-5 était de 7,45 % tandis que celle du type commun était calculée à 37,5 %. La prévalence cadavérique pondérée de l'absence du muscle FDS-5 à l'avant-bras était de 2,5 % et celle de son tendon à la main était de 0 %. La technique de

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l'examen clinique étendu constitue le test le plus précis pour évaluer la fonction du FDS. Dans le cas d'une lésion, une connaissance incomplète des différentes connexions ou substitutions du FDS-5 pourrait aboutir à une perte totale de la flexion du 5^e doigt. Ces résultats supportent l'hypothèse d'une double origine du FDS-5 où la partie musculaire proviendrait de l'avant-bras tandis que la partie tendineuse naîtrait de la main.

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1. Introduction

1.1. Anatomy and anatomical variations

The flexor digitorum superficialis (FDS) is an extrinsic muscle that arises by two heads – humeroulnar and radial [1,2]. The muscle usually divides into two layers towards fingers 2 to 5. The superficial layer divides distally into two tendons for the middle and ring finger, while the deep layer gives tendons for the index and little finger [2,3]. Thus, the tendons are arranged in two pairs within the carpal tunnel – the superficial pair consists of the middle and ring finger tendons, while the deep pair consists of the index and little finger tendons [4]. In each finger, the FDS tendon enters the digital flexor sheath (A1 pulley) and splits into two equal bundles that rotate, pass around and then behind the flexor digitorum profundus (FDP). The two slips reunite deep to the FDP at Camper's chiasm, and insert as two separate slips on the anterior surface of the middle phalanx [5]. The FDS is a flexor of all the joints over which it passes: proximal interphalangeal joint (PIPJ), metacarpophalangeal joint (MCPJ) joint and wrist [2].

The FDS is one of the most variable muscles in the human body. Its variations can be attributed to variations of the FDS muscle, FDS tendons or intertendinous connections (Fig. 1). Variations of the FDS muscle include accessory, absent or anomalous muscle bellies [6–8]. The FDS may have a thin, doubled, absent tendon or have a tendon slip arising from the FDP [9–13]. Intertendinous connections between the FDS and FDP are frequent, particularly between the FDS of adjacent fingers [9,13]. However, the FDS of the little finger (FDS-5) is known to have the greatest variability compared to those of the 2nd, 3rd and 4th fingers. The FDS-5 is usually thinner (hypoplastic), functionally inferior to the FDS tendons of the other fingers, and sometimes connected to the FDS tendon of adjacent fingers, particularly the ring finger (FDS-4) [10,11,14,15]. Variations of the FDS-5 can complicate its assessment in healthy individuals and in patients presenting with tendon injuries. An injury to the ring or little finger can cause a malfunction of either one when there are intertendinous connections between these two fingers [5,16].

1.2. Clinical tests used to detect FDS-5 function

The following clinical tests described in the literature can be used to assess the ability of the FDS tendon to flex the PIPJ of the little finger and to classify its function:

- standard test: the subject is asked to flex the little finger while the three other fingers are held out in full extension; the wrist is kept in full supination and neutral extension (Fig. 2A, B). The result is considered positive when the subject can perform full flexion of the PIPJ of the little finger with extended distal interphalangeal joint (DIPJ) and the other three fingers. Inability to flex the PIPJ of the little finger is considered negative result [7];
- modified test: in the case of a negative or partial result following the standard test, the subject is asked to flex the PIPJ of the ring finger (Fig. 2C). The result is considered positive when the

flexion of the PIPJ of the little finger is improved along with that of the ring finger. Inability to improve the PIPJ flexion of the little finger along with that of the ring finger is considered a negative result [10];

- Mishra's test: the subject is asked to press the fingertip pulp of all fingers together against the proximal part of the palm. The test is positive when the PIPJ and MCPJ of the little finger are fully flexed, while DIPJ remains in extension. If all three joints of the little finger are flexed, result of this test is negative [17];
- Tan's test (expanded examination method): the subject is asked to flex the finger of interest while the other three fingers are held out in full extension at the MCPJ and DIPJ. In the case of a negative or partial response, the subject is asked to free the adjacent fingers sequentially and re-test. The result is positive when the subject can flex the PIPJ of the little finger with extended DIPJ and the other three fingers. Inability to flex the PIPJ of the little finger independently of the DIPJ flexion is considered FDP substitution. If the PIPJ flexion of the released adjacent finger (or fingers) improves flexion of the PIPJ of the little finger, this is suggestive of a connection between the FDS-5 and the adjacent FDS-4 or FDS-3 [14].

If the tendon of the FDS-5 passes freely from the muscle belly through the fibro-osseous carpal tunnel with no attachment to the tendons of the adjacent fingers or structures, independent flexion of the PIPJ of the little finger is possible and the standard test will be positive (Fig. 1A, 1C, 1D, 1E, 1F). If the FDS-5 tendon is connected to the FDS-4 tendon, the standard test will be negative, but the modified test will be positive (Fig. 1I, J). A positive Mishra's test suggests independence of the FDS-5 tendon or presence of intertendinous connection between the FDS-5 and FDS of adjacent fingers. Tan's test is positive when the FDS-5 tendon is independent; this test may be useful for identifying intertendinous connections between the FDS-5 and FDS of adjacent fingers. Inability to flex the PIPJ of the little finger independently of the DIPJ flexion during Mishra's and Tan's test is considered as FDP substitution (Fig. 1B, G, H, K).

1.3. Agenesis and functional deficit of FDS-5

When reviewing the literature, a surprising discrepancy is noted between the very low frequency of FDS-5 agenesis reported in cadaver studies [6,7,9,11,18–21] and the variable frequency of FDS-5 functional absence in clinical articles. The latter ranges from 0% in an Indian population to 30.77% in a British population [22,23]. Clinical assessment of the FDS-5 tendon (functional ability of the FDS to flex the PIPJ) results in one of the following three outcomes: independent function (ability to flex the PIPJ of the fifth finger while the other fingers are extended), common function (ability to flex the PIPJ of the fifth finger only when the ring finger PIPJ is flexed simultaneously) and absent function (inability to flex the PIPJ even when flexion of the ring finger PIPJ is allowed) [9,22,24–26].

The aim of this systematic review was to generate weighted frequencies and compare the prevalence of cadaveric FDS-5 agenesis to those of clinical FDS-5 function (absence and common),

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