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SM Journal of Clinical Anatomy

Research Article

Cannieu-Riché Anastomosis: New Classification

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Article Information

Received date: Jun 14, 2017
Accepted date: Jul 07, 2017
Published date: Jul 12, 2017

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Keywords Median nerve; Ulnar nerve; Cannieu-Riché anastomosis

Abstract

Objective: The aim of this paper is to report the incidences and provide a new classification of the various types of Cannieu-Riché Anastomosis (CRA).

Materials and methods: The anatomical dissections of 80 limbs from 40 fresh adult cadavers were performed in the Department of Anatomy of the Medical School of the Catholic University of São Paulo. Sixty hands were dissected from 1979 to 1983, and 20 hands were dissected from 2011 to 2015. In all subjects, both hands were studied. Careful dissections were performed under high magnification (with a surgical microscope) with special reference to the incidence of CRA.

Results: CRA was found in all of the dissected hands (100%). We propose a new classification of CRA: Type I until Type XI, describing the communication between the recurrent branch of the median nerve and the deep branch of the ulnar nerve to the deep head of flexor pollicis brevis, which is the most common type of anastomosis and our others observations.

Conclusion: According to our study, CRA should be viewed as a normal anatomical neural connection and not as an anatomical variation. The knowledge of this anastomosis is essential because the presence of such neural communication can cause confusing clinical, surgical and electromyographical findings in cases of complete or incomplete median or ulnar nerve lesions or entrapment neuropathies.

Introduction

Cannieu-Riché anastomosis (CRA) is a neural connection between the deep branch of the ulnar nerve and branches of the median nerve at the thenar eminence. CRA has been considered to carry motor branches between the median and ulnar nerves. Axons derived from these two nerves cross to deliver motor innervation to the intrinsic muscles of the hand. The presence of this anastomosis can cause a risk of iatrogenic injury during surgical procedures and difficulties in the interpretation of electrophysiological studies for diagnoses of neuropathies [1]. These anatomical variations should be differentiated from incomplete nerve lesions [2]. In particular, carpal tunnel syndrome has been associated with exacerbated or diminished symptoms in the presence of these anastomoses [3,4]. There are three other anomalous types of neural connections between the median and ulnar nerves in the upper limb: Martin-Gruber anastomosis (communication between in which the branch rises from the median nerve to join to ulnar nerve), Marinacci anastomosis (so-called reverse Martin-Gruber anastomosis), and Berrettini anastomosis (communication between common digital nerves that join the ulnar and median nerves in the palmar surface of the hand). The multiple aberrant connections between the nerve components of the median and ulnar nerves occur in many different combinations [5].

CRA was first described by Riché [6] and Cannieu [7] as the palmar anastomosis between the recurrent branch of the median nerve and the deep branch of the ulnar nerve. Although this condition is generally believed to be present in a high proportion of the population, the defined parameters of the anastomoses are difficult to classify and are thus not very well described [8].

The cause, nature, incidence and direction of these fibers of CRA are relatively unknown. Although unknown, the cause of CRA is generally believed to be aberrant development in early embryogenesis Boland et al [9]. Similar to Martin-Gruber anastomosis, a genetic basis for the development of CRA has been proposed by Boland et al. [9] who inferred a familial tendency with autosomal dominant inheritance based on a 21-year-old man whose father and brother also had the anastomoses.

The authors have reviewed the anatomic and clinical literature. There are wide discrepancies regarding the prevalences of CRA based on different methods of investigation that have produced increased results, such electromyography studies, anatomical studies, and nerve block and clinical examinations were employed. According to our findings, we report the incidence CRA anastomosis and provide a new classification of the various types of this neural connection.

OPEN ACCESS
ISSN: 2578-6954

How to cite this article Caetano EB, Vieira LA, Nakmichi YC, Sawada MM, de Andrade RA and Nakasone MT. Cannieu-Riché Anastomosis: New Classification. SM J Clin Anat. 2017; 1(1): 1001.

Materials and Methods

Sixty hands of 30 fresh adult cadavers where dissected from 1979 to 1983, and 20 adults hands were dissected from 2011 to 2015. One of the limitations of our work was to compose a significant number of anatomical pieces over the years, due the changes in Brazilian legislation regarding the donation of fresh cadavers for study. In all subjects, both hands were studied. Careful dissections were performed under high magnification (with a surgical microscope) to permit fine dissections with a special reference to the incidence of CRA. The ages ranged from 17 to 68 years, and the sex distribution was 36 males and 4 females that were available in the Department of Anatomy of the Medical School of the Catholic University of São Paulo. Exclusion criteria were fresh cadavers with traumatic lesions or surgical scars on the hands. An initial pilot study consisting of the dissection of 4 hands from 2 fresh cadavers was performed to familiarize us with the regional anatomy of the palmar surface of the hand and is not included in this paper. The results were recorded by photography and drawings. These dissections were performed through a palmar carpal tunnel-type incision that extended distally along the palmar surface of the hand. The palmar skin, subcutaneous tissue and palmar fascia were removed. The median nerve was identified at the proximal edge of the transverse carpal ligament, the ligament was divided, and the recurrent branch was distally dissected. The ulnar nerve was also identified in the wrist proximal to the Guyon canal, and its deep motor branch was followed distally until its communication with the branches of the median nerve with the help of 2.5X magnifying glass. The dissection was then inspected under a microscope using 10- to 16-fold magnification mainly to identify the intramuscular communication. Schematic drawings of the pieces were created and systematically photographed. This study was approved by the Ethics Committee of Faculdade de Ciências Médicas e da Saúde, Pontíficia Universidade Católica de São Paulo (CAAE n° 43267715.2.0000.5373).

Results

The Cannieu-Riché anastomosis was found in all 80 of dissected hands (100%). In all hands, we found that the anastomotic branch of the ulnar nerve always originated from the deep branch. The branches of the median nerve originated from the recurrent motor branch in 35 hands. In 24 limbs, the anastomotic fascicles originated from the separated of the median nerve at the level of its division at the distal edge of the transverse carpal ligament. In 17 limbs, the anastomotic branch originated from the radial collateral nerve of the thumb. In 4 observations, we identified the anastomotic branch as originating from the common digital nerve, which branched into the ulnar collateral nerve of the thumb and the radial collateral of the index). In 3 cases, we found that the fascicles that originated from the median nerve originated in two different places. We did not identify the branch of the anastomosis coming from the digital collateral branches of the index finger in our dissections. We propose the following classification of the various types of Cannieu-Riché anastomosis (Figure 1):

Type I: Communication between the Recurrent Branch of the Median Nerve (RBMN) and the Deep Branch of the Ulnar Nerve (DBUN) to the deep head of Flexor Pollicis Brevis (FPB). This was the most common type of anastomosis (Figure 2). We identified this type in 15 hands. In these cases, the deep head of the FPB received double innervation.

Type II: Communication between and the RBMN and the DBUN to the superficial and to the deep heads of the FPB limbs (Figure 3).

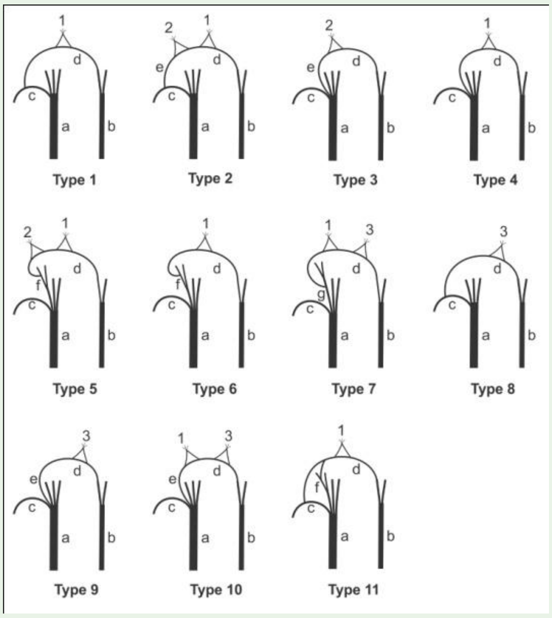

Figure 1: Schematic drawing of the classification of the various types of RCA. (a): median nerve, (b): ulnar nerve, (c): recurrent branch of median nerve, (d): deep branch of ulnar nerve, (e): separate branch of median nerve, (f): collateral radial branch to the thumb, (g) first common digital nerve, (1) branches to deep head of flexor pollicis brevis, (2) branches to the superficial head of flexor pollicis brevis, (3) branches to adductor pollicis.

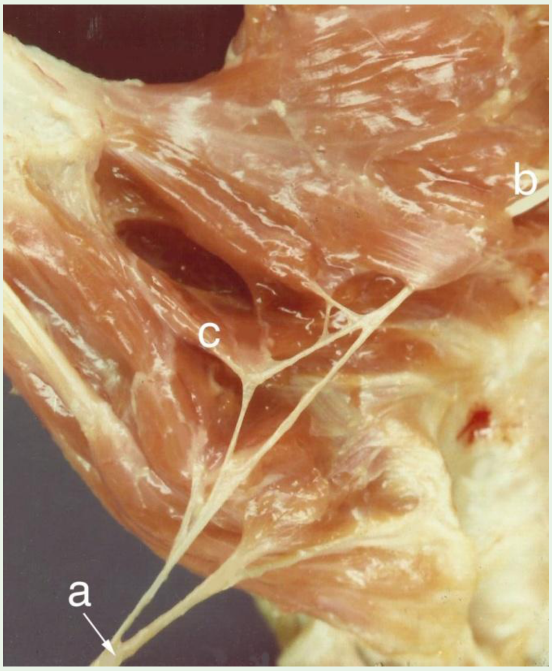

Figure 2: Type I: Communication between the recurrent branch of the median nerve (a) and the deep branch of the ulnar nerve (b) to the deep head of flexor pollicis brevis (c). The most common type of anastomosis. We identified this type in 15 hands.

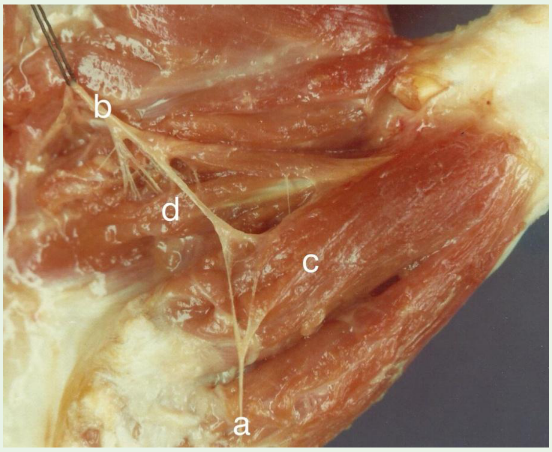

Figure 3: Type II: Communication between and the between the recurrent branch of the median nerve (a) and the deep branch of the ulnar nerve (b) to the superficial (c) and to deep head of flexor pollicis brevis (d). We identified this type in 8 hands.

We identified this type in 8 hands. The superficial and the deep head of the FPB exhibited double innervation.

Type III: Anastomosis between a Separate Branch of the Median Nerve (SBMN) and the DBUN to the superficial head of the FPB (Figure 4). We identified this type of anastomosis in 9 hands. The superficial head of the FPB exhibited double innervation.

Type IV: Anastomosis between the SBMN and the DBUN to the deep head of the FPB (Figure 5). The deep head of the FPB exhibited double innervation. We identified this type of anastomosis in 7 hands.

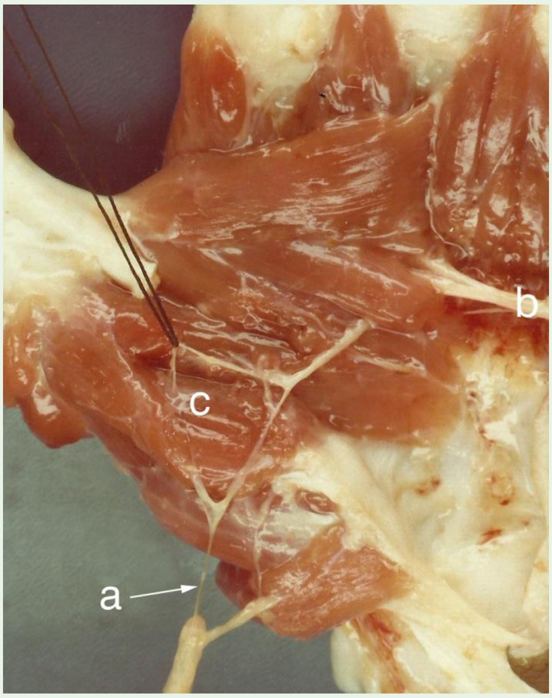

Figure 4: Type III: The anastomosis between a separate branch of the median nerve (a) and the deep branch of ulnar nerve (b) to the superficial head of flexor pollicis brevis (c). We identified this type in 9 hands.

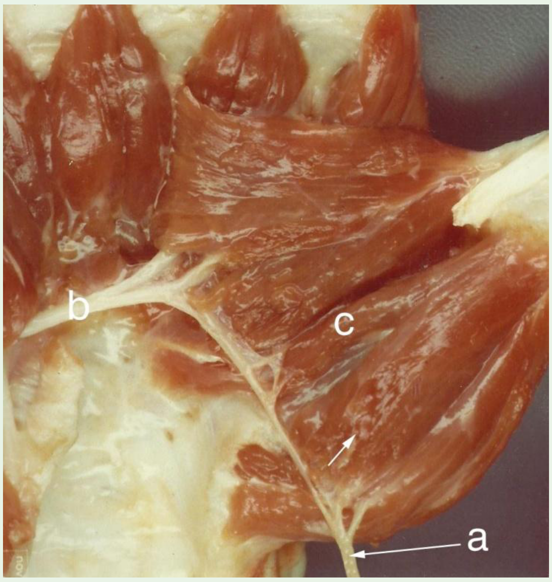

Figure 5: Type IV: The anastomosis between a separate branch of the median nerve (a) and the deep branch of ulnar nerve (b) to the deepl head of flexor pollicis brevis (c). We identified this type in 7 hands.

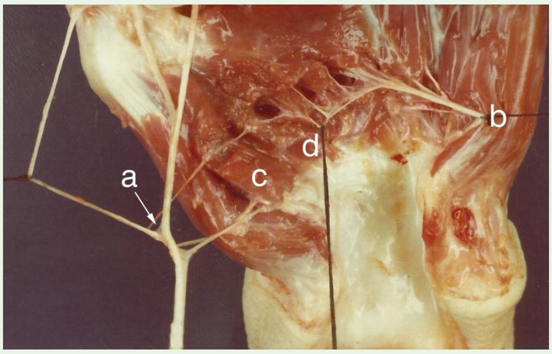

Figure 6: Type V: Communication between and the collateral radial branch to the thumb of the median nerve (a) and the deep branch of ulnar nerve (b) to the superficial (c) and deep head (d) of flexor pollicis brevis. We identified this type in 7 hands.

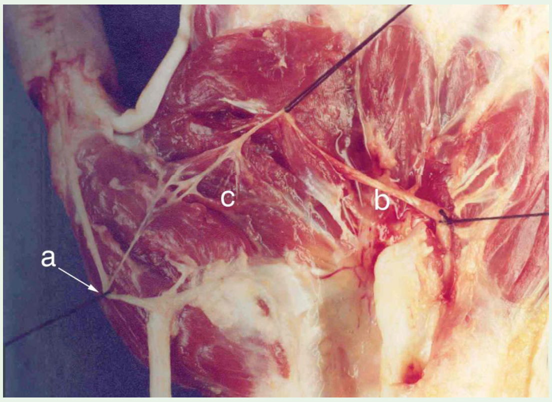

Figure 7: Type VI: Communication between the collateral radial branch to the thumb of the median nerve (a) and the deep branch of ulnar nerve (b) to the deep head of flexor pollicis brevis (c). We identified this type in 10 hands.

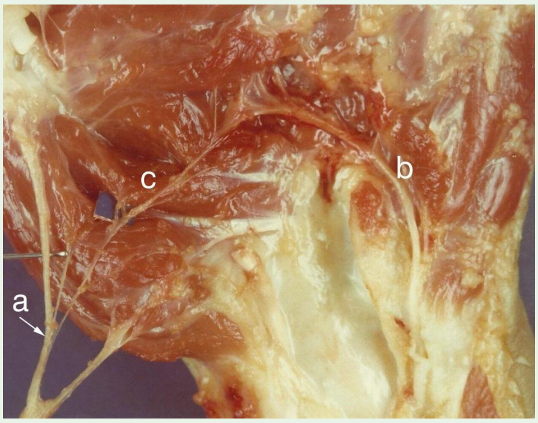

Figure 8: Type VII: Communication between and the first common digital branch of the median nerve (a) and the deep branch of ulnar nerve (b) to the deep head of flexor pollicis brevis (c) and adductor pollicis (d). We identified this type in 4 hands.

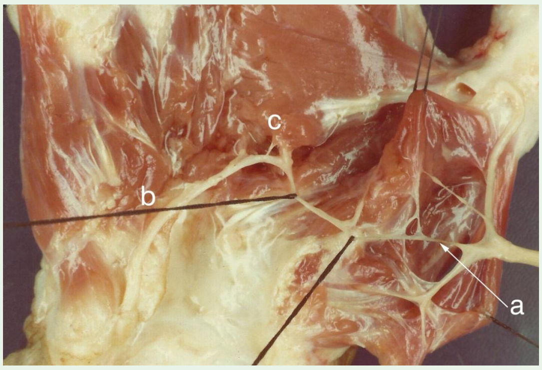

Figure 9: Type VIII: Communication between and the recurrent branch of median nerve (a) and the deep branch of ulnar nerve (b), to the adductor pollicis (c). We identified this type in 9 hands.

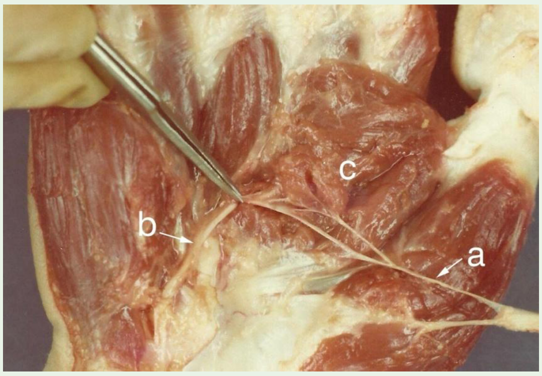

Figure 10: Type IX: Communication between and the separated branch of the median nerve (a) and the deep branch of the ulnar nerve (b), to the adductor pollicis (c). We identified this type in 4 hands.

Type V: Communication between the Collateral Radial Branch to the Thumb of the Median Nerve (CRBMN) and the DBUN to the superficial and deep heads of the FPB (Figure 6). We identified this of anastomosis in 7 hands. Both heads of the FPB exhibited double innervation.

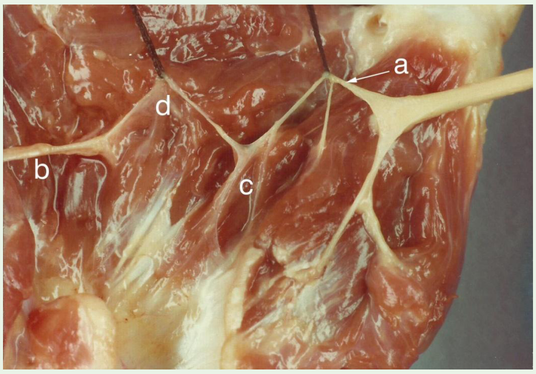

Figure 11: Type X: Communication between and the separate branch of median nerve (a) and the deep branch of ulnar nerve (b) to the deep head of flexor pollicis brevis (c) and adductor pollicis (d). We identified this type in 4 hands.

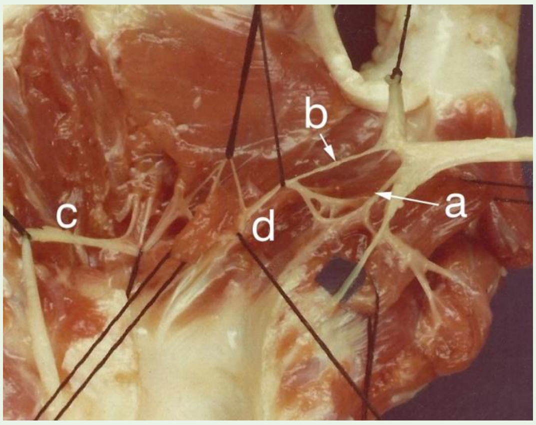

Figure 12: Type XI: Communication between two branches of the median nerve (recurrent branch of median nerve (a) and collateral radial branch of median nerve (b) and the deep branch of nerve ulnar (c), to the deep head of flexor pollicis brevis (d). We identified this type in 3 hands.

Type VI: Communication between the collateral radial branch to the thumb of the median nerve CRBMN and the DBUN to the deep head of the FPB (Figure 7). We identified this type in 10 hands. In these cases, the deep head of FPB receive double innervation.

Type VII: Communication between and the first Common Digital Branch of the Median Nerve (CBMN) and the DBUN to the deep heads of the FPB and AdP (Figure 8). We identified this type in 4 hands. The deep FPB and AdP exhibited double innervation.

Type VIII: Communication between RBMN and the DBUN with the AdP (Figure 9). We identified this type in 9 hands. The AdP muscle exhibited double innervation.

Type IX: Communication between and the separated branch of the median nerve and the deep branch of the ulnar nerve to the adductor pollicis (Figure 10). We identified this type in 4 hands. The AdP muscle exhibited double innervation.

Type X: Communication between the SBMN and the DBUN to the deep head of the FPB and the adductor pollicis (Figure 11). We identified this type in 4 hands. The deep heads of the FPB and AdP exhibited double innervation.

Type XI: Communication between two branches of the median nerve RBMN and CRBMN and the DBUN to the deep head of the FPB (Figure 12). We identified this type in 3 hands. The deep head the FPB exhibited double innervation.

The extramuscular CRA we found in 57 hands (Figure 3), intramuscular CRA in 19 hands (Figure 7). In four hands we found intra and extramuscular anastomosis (Figure 2).

Discussion

The incidence of Cannieu -Riché anastomosis is a controversial matter. There is a wide discrepancy in the literature regarding the prevalence rates of the CRA. Cannieu [7] dissected 23 hands and identified anastomosis in three (13%). In the same year, Riché [6] described three types of connections: Type I, between the deep branch of the ulnar nerve and the recurrent branch of the median nerve destined to both heads of the FPB; Type II, between the deep branch of the ulnar nerve and the median nerve within the belly of the transverse head of the adductor pollicis; Type III, between these two nerves within the belly of the lumbrical muscle. In a study combining EMG and percutaneous nerve stimulation, Forrest10 concluded that CRA should be much more common than we can imagine and also stressed the frequency of anomalous and double innervation of the thenar muscles. Harness and Sekeles [11] found CRA in 28 of 35 dissected hands (77%). Souza12 dissected 60 embalmed cadaver hands and found CRA in 30 hands (50%). In an EMG study, Kimura et al. [13] detected an incidence of 83.3% (125 of 150) in the hands of unselected living participants. Falcone and Spinner2 found this neural communication in three of 10 dissected hands (30%). Homma et al. [14] found RCAs in four of six dissected hands (66.6%), and Budak [15] found a CRA in 1 of 32 hands. Ajmani [16] dissected 68 hands from 34 cadavers, and 13 of the 68 hands exhibited anastomoses between the ulnar and median nerves. Bolukbasi [8] reported that no CRAs were been found in 108 electrophysiologically evaluated medical students (0 out of 216 hands). However, in a retrospective analysis of 870 patients who had been examined for upper extremity focal neuropathies via electroneuromyography, the prevalence of CRA was found to be 1.4%. In an extensive meta-analytic study of the anastomoses of the upper limbs, Roy et al. analyzed 501 cases from 6 studies and found a prevalence rate of CRA of 55.5%. These authors emphasized that the incidence of CRA could potentially be higher if finer dissection techniques and fresh cadavers were used to avoid missing the smaller anastomotic fibers. According to Yang et al., CRAs were observed in 45 of 90 cadaveric upper limbs (50%), were bilateral in 31% of the cadavers and unilateral in 38% and were observed significantly more frequently in the right hand (62%) than in the left hand (38%). The incidence was not affected by gender.

Harness and Sekeles [11] studied 19 prepared and 16 freshly dissected specimens and did not detect CRA anastomoses in eight of 35 hands. These authors explained that it was possible that the fibers originating from the ulnar nerve through this anastomosis were so small that the CRA could not be anatomically detected. They further suggested that CRAs would have been noted in all of the dissected hands if finer dissecting techniques and fresher fresh specimens had been used. In the 16 fresh specimens, they found anastomoses. Kimura et al. [13] detected this anastomosis in 83% of the hands of 150 unselected living participants, and their results led them to assume that perhaps the use of more sensitive electrophysiological techniques, such as recording with needle electrodes, a higher percentage of the detection of this anastomosis between the ulnar and median nerves in the hand would have been found. Our findings confirm the discussion from Harness and Sekeles [11] and Kimura et al [13]. We found this neural communication in all 80 of the dissected hands (100%). Careful dissections of fresh cadavers under high magnification (a surgical microscope at 10 to 16X) were performed to permit fine dissections. In some cases, the anastomotic branch was so small that magnification of 16X was necessary for visualization. We agree with these authors that the strong electrophysiological and anatomical evidence of a neural communication may imply that CRA should be perceived as a normal anatomical neural connection and not as an anatomical variation.

According to Chevrier [17], the median nerve fascicles from this anastomosis arise laterally to the flexor pollicis longus tendon when originating from the recurrent motor branch and medially when originating from the collateral digital nerve of the thumb. Souza found CRAs between the deep branch of the ulnar nerve and the recurrent branch of the ulnar nerve in 50% of cases and between the deep branch and ulnar nerve and a collateral digital nerve of the median nerve in 50% of cases that were always lateral to the flexor pollicis longus tendon. Falcone and Spinner found CRAs in three instances; two were lateral and dorsal to the flexor pollicis longus tendon, the third arose from a separate branch of the median nerve that ran dorsal and medial to the tendon of the flexor pollicis longus. In our findings, the branches originating from the median were always lateral and dorsal to the tendon of the flexor pollicis longus and passed between the tendon and the first metacarpal. Branches originating from the recurrent motor branch were observed in 35 hands, came from separated branches of the median nerve in 24 hands, came from the collateral radial nerve of the thumb in 17, and from the common collateral digital nerve in 7 hands. We did not find anastomotic branches originating from the digital palmar branch of the index finger in our dissections as described by Sarikcioglu et al. [18] and Paraskevas et al [19].

Paraskevas et al. [19] proposed the following 8 classifications of Cannieu-Riché anastomoses:

Type l: Anastomosis between the deep branch of the ulnar nerve of the deep head of the flexor pollicis brevis and the recurrent branch of the median nerve. We agree with these authors that this is the most common type of communication. We found this type of communication in 15 hands.

Type ll: Anastomosis between a separate branch of the median nerve to the superficial head and the ulnar branch to the deep head of the flexor pollicis brevis. This communication corresponds to the first type of Riché classification. In 13 hands, we observed communication of a separate branch of the median nerve and the deep branch of the ulnar nerve.

Type lll: Anastomosis between the digital branch to thumb and the ulnar branch to the deep head of the flexor pollicis brevis. We observed anastomosis of the deep head of the ulnar nerve with first common digital branch of the median nerve in 4 cases and collateral radial branches to the thumb in 17 cases. We did not observe communication of the collateral ulnar branch of the thumb in our dissections.

Type IV: Anastomosis between the branch of the digital nerve of the thumb and the ulnar branch to the adductor pollicis. This condition corresponds with the second type of Riché classification. We did not observe this type of communication; however, we found a similar type of communication between the recurrent branch of the median nerve and the deep ulnar branch with the adductor pollicis in 6 cases and between a separate branch of the median nerve and the deep ulnar branch with the adductor pollicis in 4 cases.

Type V: Anastomosis between the digital branch to the index finger and the ulnar branch to the deep head of flexor pollicis brevis.

Type VI: Anastomosis between the digital palmar branch to the index finger and the ulnar branch to the adductor pollicis.

Type VII: Anastomosis between the distal accessory thenar branch of the first common digital nerve and the deep branch of the ulnar nerve with the deep head of the flexor pollicis brevis. We did not find anastomotic branches originating from the digital palmar branch of the index finger and an accessory branch in our dissections. We found communications between two branches of the median nerve (recurrent and collateral radial branch) and the deep branch of the ulnar nerve with the deep head of the flexor pollicis brevis in 3 cases.

Type VIII: The authors describe the presence and the clinical relevance of a new type of very long CRA between the deep branch of the ulnar nerve for the adductor pollicis and the recurrent branch of the median nerve to the superficial head of the flexor pollicis brevis. We did not observe this rare type of communication in our study.

Conclusion

According with our study, CRAs should be perceived as normal anatomical neural connections and not as anatomical variations. The knowledge of these anastomoses is essential because the presence of such communications can cause confusing clinical, surgical and electromyographical findings in cases of median or ulnar damage or entrapment.

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