Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2016, 8(8):675-680

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Anastomosis between median and ulnar nerve in forearm and hand

Johnn Taylor Casadiego Duran* and Humberto Ferreira Arquez

University of Pamplona, Norte de Santander, Colombia, South America

ABSTRACT

In the upper limb the communications between the median and the ulnar nerves are relatively common and have been described in different point throughout it, in or below the elbow. The purpose of this study is to determine the incidence, type, topography of the anastomoses between median and ulnar nerves in forearm and hand. A total of 14 cadavers were used for the study in the laboratory of Morphology of the University of Pamplona. Communication between the median and ulnar nerves was observed in 1 of 28 upper limbs. The communicating branch was originates from the branch of the median nerve to the flexor digitorum superficialis muscle. Other anastomoses were not found in the upper limb. Knowledge of these anatomical variations allows a more appropriate diagnostic and procedures of disorders of the peripheral nerves in the upper limb.

Keywords: Median nerve, ulnar nerve, anatomical variation, Martin–Gruber anastomosis, Marinacci anastomosis, Riche-Cannieu anastomosis, Berretini anastomosis.

INTRODUCTION

Anastomosis between ulnar nerve and median nerve can occur in the forearm region. It is composed in crosses of axons from the median nerve to the ulnar nerve which may produce changes in the innervations of the upper limb muscles [1,2]. This anastomosis involves axons leaving either the main trunk of median nerve or the anterior interosseous nerve, crossing through the forearm to join the main trunk of the ulnar nerve and ultimately innervating the intrinsic hand muscles [3]. Reports in the literature describe the four communicating branches between median and ulnar nerve in the upper limb: Martin-Gruber Anastomosis, Marinacci anastomosis, Riche-Cannieu anastomosis, Berretini Anastomosis.

In the forearm, median and ulnar communication was first described by the Swedish anatomist Martin (in 1763) and later by Gruber (in 1870) and thus referred to as the Martin-Gruber Anastomosis (MGA). Various forms and connections were found in Martin's cadaver dissections [4,5]. The incidence of MGAs ranges from 5% to 40%, with an average of 17% [6,7]. Most of these connections cross from the median nerve to the ulnar nerve, and are bilateral in 10-40% of the cases. When present, unilateral MGAs occur more frequently in the right arm [8]. The crossing axons can innervate intrinsic muscles supplied by the ulnar nerve, the median nerve or both. The motor deficit of the muscles varies according to the level of nerve injury. In this context, an anatomical investigation of the topography of MGAs is very important for reinforcing clinical electrophysiological findings and in helping to understand motor, sensory and autonomic dysfunctions [9-10]. Another type of anastomosis can happen in the forearm. When the anastomotic branch originates proximally in ulnar nerve and unites distally to median nerve is simply called anastomosis of Median-Ulnar type, or Martin-Gruber reverse anastomosis or Marinacci anastomosis. Marinacci in 1964 made a case report of a patient who traumatized the medium nerve in forearm, but still had preservation of the median nerve innervations in the hand muscles, although had denervation of the flexor muscles in forearm. The Marinacci anastomosis is infrequently notified. In some studies this type of anastomosis had not been found, being considered for many authors as anatomical anomaly. The Riche-Cannieu anastomosis occurs in the palm between the recurrent branch of the median nerve and the deep branch of the ulnar nerve. And the communicating branch between common digital nerves that arise from the ulnar and median nerves in the palmar surface of hand is called 'Berretini Anastomosis, ramus communicans or superficial communicating branch. [5,11]. The purpose of this study is to determine the incidence, type, topography of these anastomoses.

EXPERIMENTAL SECTION

A total of 14 cadavers of both sexes (13 men and 1 women) with different age group were used for the study. 14 cadavers were studied bilaterally, in total 28 sides of upper limb regions of the cadavers were carefully dissected as per the standard dissection procedure in the Morphology Laboratory at the University of Pamplona. An incision was carried out, covering the whole anterior surface of the forearm. The superficial fascia was opened and the flexor carpi ulnaris muscle and tendon mobilized to give full exposure of the ulnar artery and ulnar nerve. The branches of the ulnar nerve in the forearm were dissected and all possible anastomoses between median and ulnar nerves were documented. The level at which the connections joined the median and ulnar nerves was measured using the medial epicondyle of the humorous as reference. According to Kazakos and coworkers: the anastomoses were classified into three types depending on the level of origin of the anastomosis from the median nerve. Type I originates from the branch of the median nerve to the flexor digitorum superficialis muscle, Type II from the median nerve itself and Type III from the anterior interosseous nerve and the branch passed medially to join the ulnar nerve in either its upper or middle one-third.

RESULTS AND DISCUSSION

Communication between the median and ulnar nerves was observed in 1 of 28 upper limbs (3.6%). No ulnar to median connections were found. Among the median to ulnar connections, one were present on the right of a forearm male. The length of the anastomosis was 6.5 cm. Its origin was on 6.7 cm distal to the medial epicondyle, and its connection to the ulnar nerve was on 10.5 cm distal to the medial epicondyle. The anastomosis joined the ulnar nerve as a single branch. The branch had followed an oblique path since its origin, after the division of the brachial artery. The branch was located between the flexor digitorum profundus and the flexor digitorum superficialis and was located antero-medial to the ulnar artery. The communicating branch was originates from the branch of the median nerve to the flexor digitorum superficialis muscle. Other anastomosis were not found in the upper limb.

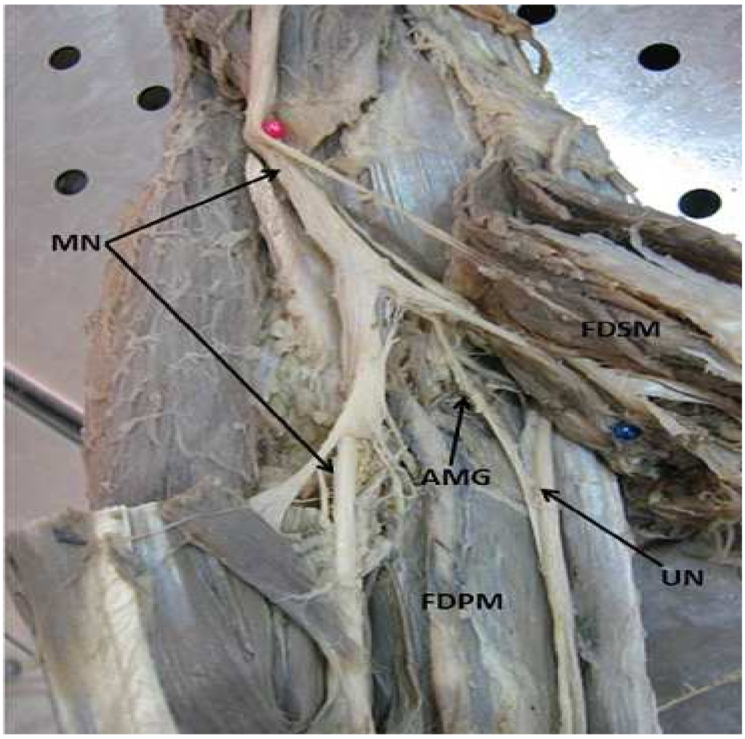

Figure 1. MN. Median nerve; UN: ulnar nerve; FDPM: flexor digitorum profundus muscle; FDSM: flexor digitorum superficialis muscle; AMG: anastomosis of Martin -Gruber

The median nerve has two roots from the lateral (C5, 6, 7) and medial cords (C8, T1), which embrace the third part of the axillary artery, and unite anterior or lateral to axillary artery. It runs distally in the arm on the lateral side of the brachial artery until it reaches the middle of the arm, where it crosses to the median side and contacts the brachialis. The median nerve has no branches in the axilla or the arm, but it does supply articular branches to the elbow joint. Enters cubital fossa medial to brachial artery; exits by passing between heads of pronator teres; descends in fascial plane between flexors digitorum superficialis and profundus; runs deep to palmaris longus tendon as it approaches flexor retinaculum to reverse carpal tunnel. The ulnar nerve arises from the medial cord (C8, T1) but often receives fibres from the ventral ramus of C7. It runs distally through the axilla medial to the axillary artery, between it and the vein. Continuing distally medial to the brachial artery as far as the midarm. Here it pierces the medial intermuscular septum. Like the median nerve, the ulnar nerve has no branches in the arm, but it also supplies articular branches to the elbow joint. It enters the forearm between two heads of flexor carpi ulnaris superficial to the posterior and oblique parts of the ulnar collateral ligament. The ulnar nerve leaves the forearm by emerging from deep to the tendon of the flexor carpi ulnaris. It continues distally to the wrist via the ulnar canal. [5, 12,13]. Anastomoses between median and ulnar nerves in the forearm are of phylogenetic significance. In many mammals and frequently in primates there are similar connections between the median and ulnar nerve at or below the elbow. Anastomoses could be remnants of the common ventral nerve trunk innervating flexor muscles in the upper extremity, which is noted in the early stages of evolution. Anastomoses occur frequently in humans and are therefore considered a variation rather than an anomaly [14]. In the literature, there are several studies on Martin Gruber Anastomosis (MGA) classification; by different techniques anatomical [7,8,16], histological [17] and electrophysiological [15,18,19]. In these studies, 4-6 subtypes of MGA reported regarding the origin and connection of communication the nerves. Figure 2. But, Lee et al. [18] reported that three morphologic features of MGA that could not be detected by an electrodiagnostic method: Firstly; a branch innervating the flexor digitorum profundus and not crossing over to the ulnar nerve, secondly; a very thin anastomotic branch between the median and ulnar nerves, thirdly; a branch arising proximally to the elbow joint.

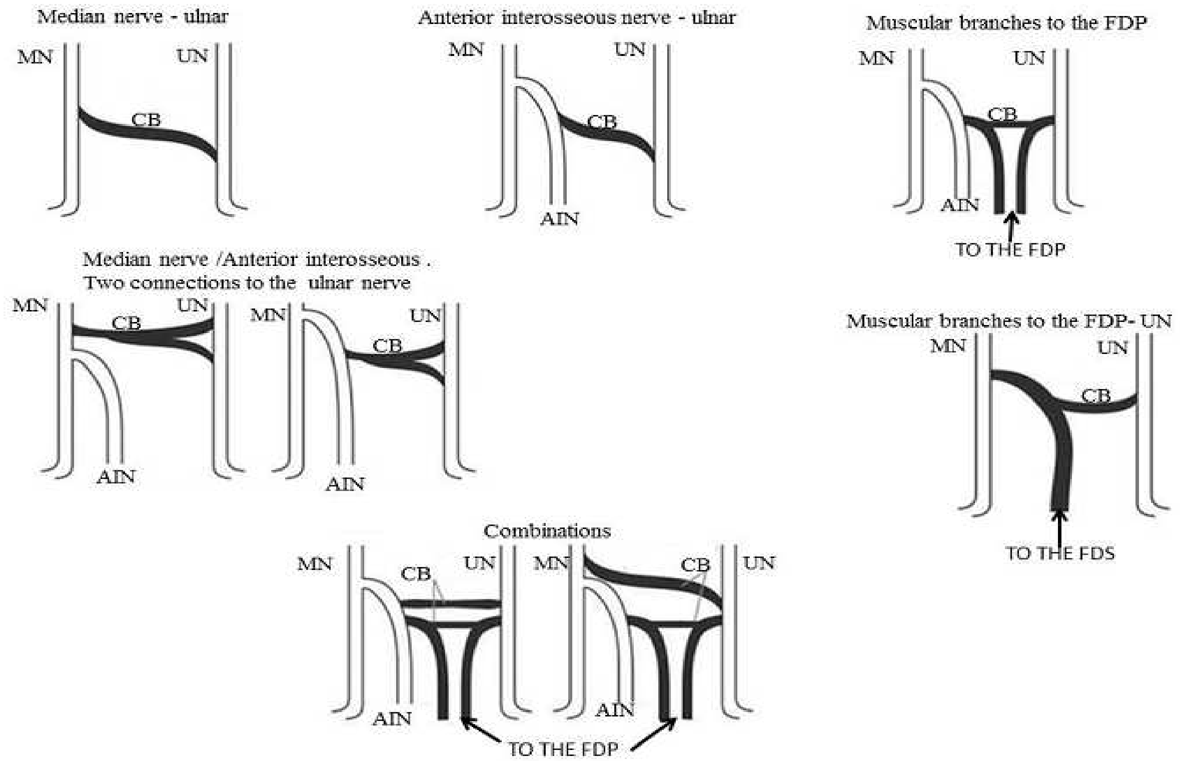

Figure 2. Schematic drawings of the types of anastomosis of Martin-Gruber. MN: median nerve, UN: ulnar NERVE, FDP: Flexor digitorum profundus, FDS: Flexor digitorum superficialis, AIN: anterior interosseous nerve, CB: communicating branch. (from reference 15)

There is no consensus in the literature about the classification of anastomosis between the two nerves. Numerous classifications have been proposed by Nakashima [22], Hirasawa [20], Thomson [21], Shu et al [23], Srinivasan and Rhodes [16] and Rodriguez-Niedenfuhr et al [7]; their classifications were based on anatomical dissections. Uchida and Sugioka [19], Oh et al [24] and Kimura et al [2] proposed classifications based on electrophysiological examinations and Shu [23] proposed another classification based on histological examinations. A summary of these classification schemes is shown in table I.

Table 1. Classifications of anastomosis between the median and ulnar nerves. MN : median nerve, UN : ulnar nerve, AIN : anterior interosseous nerve, TM : thenar muscles, HM : hypothenar muscles, FDP : flexor digitorum profundus muscle, FDI : first dorsal interosseous. (from reference 14)

Anastomosis Between	Hirasawa (20)	Thomson (21)	Srinivasan (16)	Nakashima (22)	Rodriguez (7)	Shu (23)	Uchida (19) Oh (24) Kimura (2)	Ferreira A. H. Present study
AIN and UN	Oblique Anastomosis	Class I	Type I,II,VI	Type Ia	Pattern I (Type Ic) Pattern II	Type I		
MN and UN	Oblique Anastomosis	Class II	Type III	Type Ib	Pattern I (Type Ia, Ib)	Type II		
MN and UN innervating HM.							Type I	
MN and UN Innervating the FDI muscle							Type II	
MN and UN Innervating TM muscles							Type III	
Muscular branch to FDP muscle	Looped Anastomosis	Class III		Type II		Type III		
AIN and UN, muscular branches FDP muscle originated from the connection						Type IV		
Combination or other	Combined Anastomosis		Type IV, V	Type III (combination of Type Ia, Ib, and II)		Type V (two anastomotic branch)		Type Ia

The present study used the classification of patterns and types [7] to compare the results to those of previous reports. Pattern I comprises cases with one anastomotic branch, and Pattern II those with two anastomotic branches. Types a, b, and c are subdivisions depending on the level of origin of the anastomosis from the median nerve. Type a, originates from the branch of the median nerve to the superficial forearm flexor muscles. Type b originates from the median nerve itself and Type c from the anterior interosseous nerve. Our results confirm that the anastomosis appears as one branch with various origins from the median nerve or its branches, as already described by Thomson [21], Srinivasan and Rhodes [16] and Taams [8]. Table III. Intramuscular anastomosis has also been described [7, 22], but such anastomosis was not found during dissection in the present study.

Table 2. Patterns and types of anastomosis shown by different authors. (from reference 14)

	Pattern I	Type Ia	Type Ib	Type Ic	Pattern II
Gruber	95%	13%	8%	74%	5%
Thomson	100%	3%	19%	78%	–
Hirasawa	50%	15.4%	–	34.6%	50%
Srinivasan and Rhodes	100%	6%	3%	91%	–
Nakashima	95.6%	–	4.35%	91,3%	4.35%
Taams	100%	7%	–	93%	–
Shu	64,7%	–	17.6%	47.1%	35.3%
Rodriguez-Niedenfuhr	89,5%	47.3%	10.6%	31.6%	10.5%
Kazakos et al.	100%	7%	7%	87%	–
Ferreira A. H. Present study	100%	3,6	-	-	-

Prevalence of MGA, an anomalous median-to-ulnar forearm communication, is well reported in literature while Marinacci communication (figure 3), the reverse of Martin-Gruber with forearm ulnar-to-median communication is underrecognized [26]. Marinacci (in 1964) first reported patient who, following trauma to the median nerve at the forearm, had preservation of median nerve innervated hand muscles despite denervation of forearm flexors [27]. Marinacci communication involving only sensory nerve fibers rise from the median nerve distally to ulnar nerve proximally has been reported [28]. In the patient, reported by Hopf [28], that the nerve action potentials evoked by stimulation of the middle finger (ulnar side) and the ring finger (radial side) digital nerves were propagated with the median nerve at the wrist and the ulnar nerve at the elbow. Occurrence frequency for Marinacci communication was reported as 1.3% by Kimura et al. [2], 4% by Sundaram et al. [26], 16.7% by Golovchinsky [29]. But in many studies, they did not find any ulnar-to-median communication [30,31]. Golovchinsky [29] suggested that, when an ulnar to median anastomosis is suspected, special care should be exerted in evaluation of motor distal latency of the median nerve with a gradual and slow increase of the stimulus voltage [5].

In the hand (figure 3). Riche (1897) and Cannieu (1897) described a neural connection between the deep branch of the ulnar nerve and the recurrent branch of the median nerve at the thenar eminence [2]. Ulnar to median nerve anastomosis, in the forearm, is generally known as a rare condition although its frequency for Riche-Cannieu anastomosis (RCA) was reported as 83.3%, 77% [2, 29]. According to Boland et al. [32] these findings infer an hereditary basis for RCA, consistent with an autosomal dominant pattern of inheritance. In the American black population, this neural communication was detected statistically less frequently when compared with the other populations ($p<0.05$). There was no significant difference in this percentage between the Caucasian and Hispanic populations [2]. Clinical presentations of RCA may vary, resulting in a hand that: 1) is completely supplied by the ulnar nerve [33]; 2) has motor innervation solely supplied by the ulnar nerve [34], as reported in a patient with a sensory presentation of cubital tunnel syndrome, but with weakness of abductor pollicis brevis; or 3) has ulnar innervation for a proportion of typically median innervated muscles [5].

Berretini anastomosis is the communications between common digital nerves that arise from the ulnar and median nerves in the palmar surface of hand is called 'ramus communicans cum nervi ulnari' in anatomical terminology. Overlap and variations of this division exist and communicating branch between the ulnar fourth common digital nerve and the median third common digital nerve can explain further variations in digital sensory patterns. Berretini's anatomic drawings from 1741 are the earliest illustrations of communicating branch [35]. The incidence of Berretini anastomosis reported in these studies (5, 35) varied significantly (4-94%). Because, many investigators [5, 36] found its incidence to be over 80%, the Berretini anastomosis should be considered a normal structure rather than an anatomic variation (figure 3).

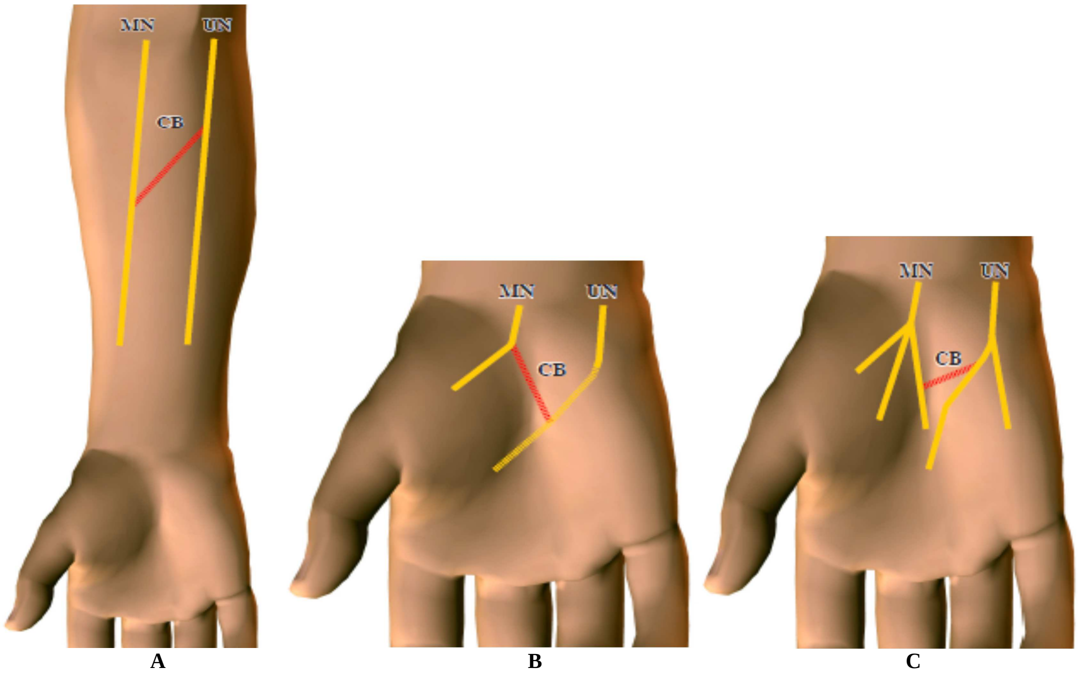

Figure 3. MN: median nerve; UN: Ulnar nerve; CB: communicating branch; A: Schematic illustration of Marinacci communication; B: Schematic illustration of Cannieu Riche communication; C: Schematic illustration of Berretini communication. (from reference 5)

CONCLUSION

The knowledge of this anastomosis and anatomical study of muscles supplied by the ulnar and median nerves is clinically important for understanding the mechanism of lesions and the correct diagnosis of peripheral neuropathies in the differentiation of partial traumatic injuries and total. MGAs have resulted in misdiagnosis during the assessment of nerve injuries, carpal tunnel syndrome, cubital tunnel syndrome, surgical procedures for the transposition of medial epicondyle of humerus and leprosy neuropathy. Adequate investigation of these connections needs to be underscored. Surgical, therapeutic and diagnostically invasive procedures require extreme caution to prevent lesions of the anastomotic branches. Understanding the existence of this variation, its location and its possible presentation is important for correct patient assistance.

Acknowledgements
The author thanked to the University of Pamplona for research support and/or financial support and Erasmo Meoz University Hospital for the donation of cadavers identified, unclaimed by any family, or persons responsible for their care, process subject to compliance with the legal regulations in force in the Republic of Colombia.

REFERENCES

[1] L Mannerfelt. *Acta Orthopaedica Scandinavica*., **1966**, vol. 87, n. 2, 19-29.
[2] J Kimura; MJ Murphy; DJ Varda. *Archives of Neurology*., **1976**, vol. 33, 842-844.
[3] HR Erdem; S Ergun; C Erturk; S Ozel. Yonsei *Med. J*., **2002**, 43, 291–295.
[4] L Sarikcioglu; BM Demirel. *J. Hist. Neurosci*., **2006**, 15, 99–101.
[5] Unver Dogan et al. *Neuroanatomy*., **2009**, 8, 15–19
[6] SJ Leibovic; H Hastings. *J. Hand Surg*.,**1992**, 17, 47-53.
[7] M Rodriguez-Niedenführ; T Vazquez; I Parkin; B Logan, JR Sañudo. *Clin. Anat*.,**2002**, 15, 129-134.
[8] KO Taams. J. Hand Surg.,**1997**, 22B, 328–330.
[9] AD Oliveira; AA Barreira; W Marques Jr. *Clin. Neurophysiol*.,**2000**, 111, 1208-1210.
[10] Prates et al. *Brz.J.morphol.Sci*.,**2003**, 20(3),177-180.
[11] MM Felippe et al. *J. Morphol. Sci*., **2012**, vol. 29, no. 1, 23-26.
[12] Ferreira A. H. *IJGMP*., **2014**, Vol. 3, Issue 2, Mar, 71-78
[13] Ferreira A. H. *Int J Pharm Bio Sci*., **2015**, April, 6(2), (B) 951 –957
[14] KJ Kazakos; A Smyrnis; KC Xarchas; A Dimitrakopoulou, DA Verettas . *Acta Orthop Belg*., **2005**, Feb, 71(1), 29-35.
[15] E Herrera et al. *Salud UIS*.,**2009**, 41, 157-168
[16] R Srinivasan; J Rhodes. *Arch. Neurol*., **1981**, 38, 418–419.
[17] HS Shu; C Chantelot; C Oberlin; JY Alnot; H Shao. *Surg. Radiol. Anat*., **1999**, 21, 115–118.
[18] KS Lee; CS Oh; IH Chung; IN Sunwoo. *Muscle Nerve*., **2005**, 31, 95–97.
[19] Y Uchida; Y Sugioka. *J Hand Surg*., **1992**, 17-A, 54-59.
[20] K Hirasawa. Arb Anat Inst Kaiserlichen *Univ Kyoto*., **1931**, A2 , 135-136.
[21] A Thomson. *J Anat*., **1893**, 27, 183-194.
[22] T Nakashima. *Surg Radiol Anat*., **1993,** 15, 193-195.
[23] H Shu; C Chantelot; C Oberlin; JY Alnot; H Shao. *Morphologie*., **1999**, 83, 71-74.
[24] SJ Oh; GC Claussen; BK Ahmad. *Muscle Nerve*., **1995**, 18, 1332-1334.
[25] W Gruber. *Arch Anat Physiol Wissen Med*., **1870**, 37, 501-522.
[26] SM Sundaram; B Sundar; MJ Arunkumar. *Neurophysiology*., **2003**, 114, 2334–2337.
[27] L Sarikcioglu; BM Demirel. *J. Hist. Neurosci*., **2006**, 15, 99–101.
[28] HC Hopf. *Muscle Nerve*., **1990**, 13,654–656.
[29] V Golovchinsky. Electromyogr. *Clin. Neurophysiol*., **1990,** 30, 31–34.
[30] L Sarikcioglu; M Sindel; S Ozkaynak; H Aydin. *Med. Sci. Monit*., **2003**, 9, 351–356.
[31] G Amoiridis; IG Vlachonikolis. *Clin. Neurophysiol*., **2003**, 114, 94–98.
[32] RA Boland; AV Krishnan; MC Kiernan. *Clin. Neurophysiol*., **2007**, 118, 770–775.
[33] BJ Kim; ES Date; SH Lee, EW Lau, MK Park. *Am. J. Phys. Med. Rehabil*., **2004**, 83, 569–573.
[34] T Ganes. Electromyogr. *Clin. Neurophysiol*., **1992**, 32, 559–563.
[35] JPWD Don Griot; JM Zuidam; EOV Kooten, LP Prose, JJ Hage. *J. Hand Surg*., **2000**, 25A, 948–954.
[36] M Loukas; ZR Louis Jr; L Stewart; B Hallner; T Deluca; W Morgan. *J. Neurosurg*., **2007**, 106: 887–893.