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The Roots and the Trunk of the Median Nerve in Man

Kotzenie i pień nerwu pośrodkowego u człowieka

Despite many works concerning the median nerve morphology there is lack of those that discuss the internal structure of trunk and its roots in the same material. The aim of this study was to examine the origin of the median nerve with some features of its internal structure considered.

MATERIAL AND METHODS

The study was carried out on material obtained bilaterally from the cadavers of 53 males and 52 females who died between 1 day and 87 years of age. It was divided into 6 age groups as described in the previous paper (15). Group I included 8 males and 8 females, group II — 12 males and 9 females, group III — 7 males and 6 females, group IV — 11 males and 9 females, group V — 9 males and 12 females, group VI — 6 males and 8 females. The dissection method visualized the brachial plexus fascicles and their terminal branches, the roots and trunk of median nerve. Its segments were excised, fastened to a glass frame and fixed in formalin. Further preparation of the excisions, staining of slides, the methods of determining the nerves' roots and trunk thickness, their fascicles' thickness as well as the number of fascicles and the index of fascicles' area was described in the previous paper (15). The results of investigation on some features of the internal structure of the beginning of median nerve concerned 50 males and 50 females in whom on both sides of the single body the musculocutaneous nerve arose from the lateral fascicle.

RESULTS

The median nerve arose from lateral and medial fascicles of the brachial plexus. The nerve's roots derived from the fasciculi, they surrounded the axillary artery and merged to form a loop situated mostly in axilla, occasionally in the arm. Sometimes the roots formed a double loop. Five types of the beginning of median nerve were distinguished according to the origin and the number of roots and the site of their connection.

In type I the nerve was formed by the junction of two roots, the lateral and medial, derived from the lateral and medial fascicles. The roots formed a loop in axilla. This type was observed in 158 cases (75.2%): 84 males (79.2%) and 74 females (71.2%).

Type II, present in 5 cases (2.4%): 3 males (2.8%) and 2 females (1.9%), was composed of the interior root and the lateral fascicle junction. In this cases musculocutaneous nerve was absent. Branches to anterior group of arm muscles and the lateral antebrachial cutaneous nerve derived from the median nerve.

Type III included 10 cases (4.8%): 2 males (1.9%) and 8 females (7.7%). It was characterized by low roots union, which took place in the arm: in 4 cases (1.9%) in the upper, in 3 cases (1.43%) in the middle and in 3 cases in the lower part.

In type IV double loop occurred. It was observed in 9 cases (4.3%): 6 males (5.7%) and 3 females (2.9%) in which the lateral root divided into two branches, the upper and the lower one. The upper one reached the medial root to form a loop in the axilla. The lower one joined the trunk resulting from their junction to form another loop located in the arm: in 7 cases (3.3%) in its upper, in 1 case (0.5%) in the middle and in 1 case in the lower part.

Type V, observed in 28 cases (13.3%): 11 males (10.4%) and 17 females (16.3%), was characterized by a double loop resulting from two lateral roots presence. The upper lateral root left the lateral fascicle before its division and joined the medial root in the axilla. The lower lateral root formed the terminal medial branch of the lateral fascicle. It closed the inferior loop in 21 cases (10%) in the upper, in 4 cases (1.9%) in the middle and in 3 cases (1.4%) in the lower part of the arm.

Thickness of roots and trunk of the median nerve

The values of the cross-section area of median nerve roots in males are presented in Figure 1, and in females in Figure 2. The age of subject is marked on the abscissa axis and the age groups are separated by vertical lines. On the ordinate axis the values of the lateral and medial root cross section areas are presented. The cases where two lateral roots occurred are presented as sums of their cross-section area.

The discussed value was similar on both sides of the single body in the lateral root in 10%, in the medial root in 7% and in the trunk of the median nerve in 4% and it was greater on the right side in 51%, 44% and 50% and greater on the left side in 39%, 49% and 46% of cases respectively.

The thickness of both roots showed similar values in 10%. Medial root was greater in 35.5% and lateral root was greater in 54.5% of cases. In all cases the thickness of the median nerve trunk was greater both from the lateral and from the medial root. Comparison of the cross-section area of the trunk of median nerve with the sum of the cross-section area of two roots showed similar value in 9.5%, was greater in 21.5% and smaller in 69% of cases.

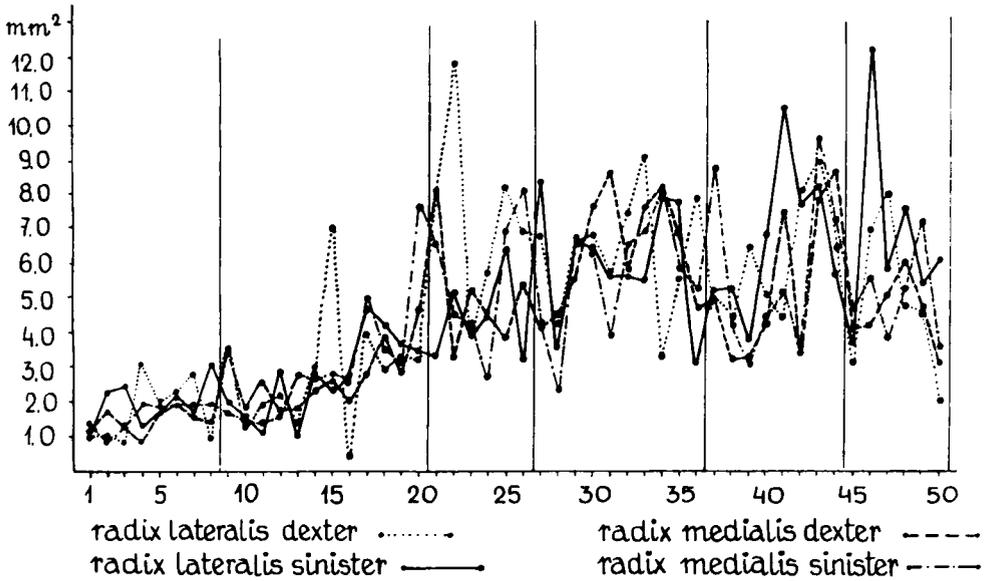


Fig. 1. Thickness of roots of the median nerve in males

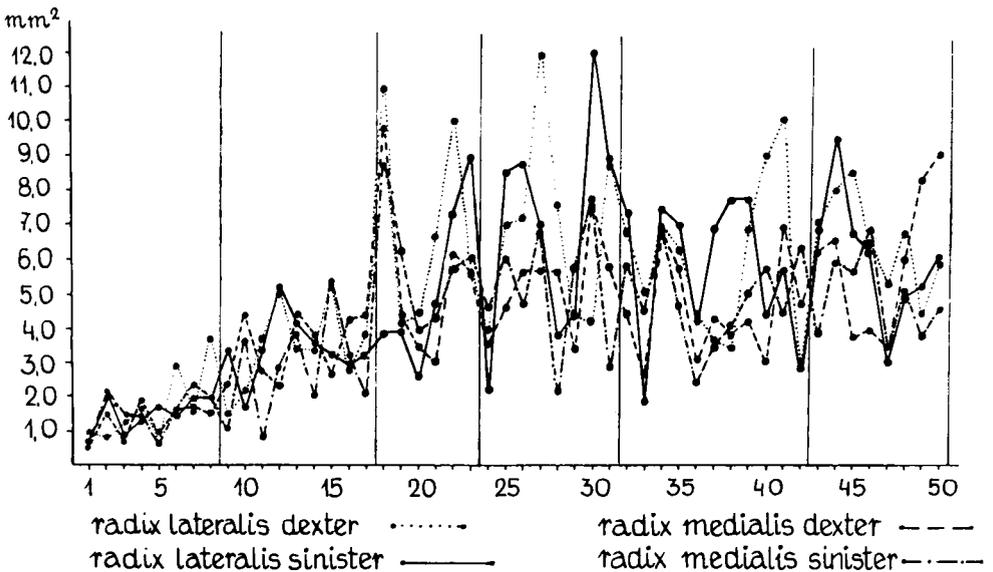


Fig. 2. Thickness of roots of the median nerve in females

When double lateral root was observed the upper root was thicker in 6.5% and the lower one in 12% of cases.

The average thickness of the lateral root was (in square millimeters) 4.802; on the right side (r) — 4.927, on the left side (l) — 4.677, in males (m) — 4.633, in

females (f) — 4.971, of the medial root 4.161 (r — 4.176, l — 4.146, m — 4.223, f — 4.099) and of the trunk of median nerve 8.046 (r — 8.206, l — 7.887, m — 8.049, f — 8.044). The discussed value came out to be: 1.696, 1.428 and 2.583 in age group I, 3.066, 2.910 and 5.723 in group II, 5.975, 5.331 and 10.194 in group III, 6.478, 5.586 and 10.392 in group IV, 6.051, 5.041 and 10.140 in group V and 6.099, 5.132 and 10.077 in age group VI.

Number of fascicles

In the material studied there were observed one to five fascicles in the lateral root in 21.5%, in the medial root in 32.5% and in the trunk of median nerve in 17.5%, from six to ten fascicles in 49.0, 46.0 and 40.5% respectively, from eleven to fifteen fascicles in 20.0, 19.0 and 25.0% and more than fifteen fascicles in 9.5, 2.5, and 17.0% of cases. The same number of fascicles on both sides of one body was found in 11% of cases in the lateral root, in 12% in the medial root and in 9% in the trunk of the median nerve. The number of fascicles was greater on the right side of the body in 46, 45, and 54% respectively and it was greater on the left side in 43, 43 and 37% of cases.

The number of fascicles was the same in both roots in 9%, it was greater in the lateral root in 53% and in the medial root in 38% of cases. The sum of fascicles number in both roots compared with the number of fascicles in the trunk of median nerve was equal in 10%, greater in 67% and smaller in 23% of cases.

The mean number of fascicles in the lateral root was 8.8 (r — 8.9, l — 8.8, m — 8.1, f — 9.6), in the medial root 7.7 (r — 7.9, l — 7.6, m — 7.5, f — 7.9) and in the median nerve 10.4 (r — 10.4, l — 10.4, m — 9.4, f — 11.4). In the age groups it was as follows: in group I — 6.4, 5.1, and 7.3, in group II — 6.8, 6.5, and 7.6, in group III — 8.9, 8.4, and 11.0, in group IV — 10.7, 8.4, and 12.1, in group V — 9.5, 9.1, and 12.5, in group VI — 11.2, 9.5, and 12.7.

Value of the cross-section area of fascicles

Five groups of the fascicles were distinguished according to their cross-section area as described in a previous publication (16). Very thin fascicles formed 20.8% of the lateral roots, 22.6% of the medial roots and 15.4% of the trunks of the median nerve. Thin fascicles formed 42.6, 43.2 and 36.1%, medium thick fascicles — 22.2, 18.6 and 22.6%, thick fascicles — 12.1, 13.1 and 18.7%, very thick fascicles — 2.3, 2.5 and 7.2% respectively.

The value of cross-section area of all the fascicles was similar on both sides of single body in 5% in the lateral root, in 11% in the medial root and in 8% in the trunk of median nerve. It was greater on the right side in 5, 47 and 46% respectively, greater on the left side in 44, 42 and 46% of cases. The sum of thickness of fascicles in the lateral root compared with the respective sum in the

medial root was similar in 9.5%. It was greater in 52.0% but it was smaller in 38.5% of cases. The sum of the cross section area of fascicles in lateral and medial root in relation to the cross section area of fascicles in median nerve was greater in 58.5%, smaller in 23.5% and similar in 18.0% of cases.

The average value of the cross-section area of fascicles in the lateral root was (in square millimeters) 2.497 ($r = 2.582$, $l = 2.412$, $m = 2.436$, $f = 2.457$), in the medial root 2.219 ($r = 2.267$, $l = 2.170$, $m = 2.278$, $f = 2.159$) and in the median nerve 4.513 ($r = 4.595$, $l = 4.431$, $m = 4.487$, $f = 4.539$). It was different in the age groups: in group I in lateral root 1.040, in the medial root 0.889 and in the median nerve 1.686, in group II — 1.865, 1.780 and 3.561, in group III — 3.080, 2.991 and 5.844, in group IV — 3.143, 2.798 and 5.698, in group V — 3.058, 2.719 and 5.568, in group VI — 3.019, 2.310 and 5.075 respectively.

Index of the cross-section area of fascicles (IAF)

The value of the cross-section area of fascicles index was similar on both sides of one body in 7% in the lateral root, in 3% in the medial root and in 8% in the median nerve. It was greater on the right side in 47, 54 and 46% respectively and it was greater on the left side in 46, 43 and 46% of cases. It was similar in both roots in 3.5%, greater in the lateral root in 41.0% and greater in the medial root in 55.5% of cases.

The average value of index was: in the lateral root 52.0 ($r = 52.4$, $l = 51.6$, $m = 52.6$, $f = 51.5$), in the medial root 53.3 ($r = 54.3$, $l = 52.3$, $m = 53.9$, $f = 52.7$), in the median nerve 56.1 ($r = 56.0$, $l = 56.2$, $m = 55.7$, $f = 56.4$). The value mentioned above ranged in age groups as follows: in group I in the lateral root 61.3, in the medial root 62.3 and in the median nerve 65.3, in group II — 60.8, 61.2, 62.2, in group III — 51.5, 56.1, 57.3, in group IV — 48.5, 50.1, 54.8, in group V — 50.5, 53.9, 54.9 and in group VI — 49.5, 45.0 and 50.4 respectively.

DISCUSSION

The median nerve appears constantly in man, but the manner of its formation shows numerous variations. Most often it arises from two roots, one from the lateral and one from the medial fascicle. Sometimes the number of roots increases, rarely decreases. In one of its variations the median nerve derives from the common trunk of three or two long nerves. Such primitive relations are observed constantly in some mammals, seldom in higher primates. Close relations between the median, musculocutaneous and ulnar nerves, described in anthropogenetical row, are expressed in man by their frequent mutual completion and quite often by presence of joining branches between them (1—3, 5, 14). Musculocutaneous nerve becomes independent later than ulnar nerve and this is why even in man sometimes it separates from the trunk of median nerve. In material presented here such variation was observed in 2.4% of cases.

Thickness of both roots which usually form the median nerve is not equally estimated by different authors. Some of them say that medial root is thicker in most of the cases while the others believe that the lateral root is thicker. In the study presented here lateral root was thicker in 54.5% of cases, medial root in 35.5% of cases and in 10% their thickness was the same.

In this study some features of the median nerve trunk and roots internal structure were explored. They are important both from theoretical and practical points of view (8). They are quite variable in different cases and on both sides of the body, like in other nerves (4, 6, 9—13, 15, 16). The median nerve trunk and roots differ in persons in the same age group and of the same height and similar weight. Even in one body the same or similar values of the four features considered were observed only in 1% in the lateral root, three of them in 1% in the median nerve trunk and two of them in 4% in the lateral root, in 2% in the medial root and in 1% in the median nerve trunk. The same or similar values of single features were also rare on both sides of the body: lateral root thickness in 7%, medial root in 6% and median nerve in 3%, cross-section area of fascicles in 2, 10 and 8% respectively, fascicle number in 8, 10 and 8%, index of cross-section area of fascicles in 4, 3 and 7% of cases.

From the features studied the values which were bigger on the right than on the left side of the body were the following: lateral root thickness in 51%, medial root in 44% and median nerve in 50%, cross-section area in 51, 47 and 46% respectively, number of fascicles in 46, 45 and 54%, index of cross-section area of fascicles in 47, 54 and 46% of cases. The following features had bigger values on the left side: lateral root thickness in 39%, medial root in 49% and median nerve in 46%, fascicles cross-section area in 44, 42 and 46%, fascicles number in 43, 43 and 37%, index of cross-section area of fascicles in 46, 43 and 46% of cases respectively.

The lateral root when compared to medial one was 15,4% thicker ($r = 18.0\%$, $l = 12.8\%$, $m = 9.7\%$, $f = 21.3\%$), its fascicles cross-section area was 12.5% bigger ($r = 13.9\%$, $l = 11.2\%$, $m = 6.9\%$, $f = 18.5\%$), its fascicles number was 14.4% bigger ($r = 12.8\%$, $l = 16.0\%$, $m = 8.1\%$, $f = 20.3\%$), but its IAF was 2.5% smaller ($r = 3.6\%$, $l = 1.4\%$, $m = 2.5\%$, $f = 2.3\%$). The sums of values of the studied roots features were bigger than the respective features of the median nerve: thickness by 11.4% ($r = 10.9\%$, $l = 11.9\%$, $m = 10.0\%$, $f = 12.8\%$), fascicles cross-section area by 4.5% ($r = 5.5\%$, $l = 3.4\%$, $m = 5.1\%$, $f = 3.9\%$) and fascicles number by 59.3% ($r = 61.4\%$, $l = 57.3\%$, $m = 66.8\%$, $f = 53.2\%$). IAF of median nerve was 7.9% bigger than IAF of lateral root ($r = 6.9\%$, $l = 8.9\%$, $m = 5.9\%$, $f = 9.5\%$) and 5.3% bigger than IAF of medial root ($r = 3.1\%$, $l = 7.5\%$, $m = 3.3\%$, $f = 7.0\%$).

Fascicles forming roots and trunk of the median nerve showed some differences in their thickness. Thin fascicles were smaller as regards the roots, bigger — the roots and median nerve. In the medial root very thin, and thick

fascicles were observed more often in the lateral root, while medium thick fascicles were less numerous. In median nerve thick and very thick fascicles appeared more often than in the roots, while very thin and thin fascicles more rarely. In postnatal life the studied features of median nerve roots and trunk undergo big changes, in particular until twenty years of age. The lateral root's thickness grew 3.8 times, medial root's 3.9 times, median nerve's 4.0 times, value of fascicles cross-section area 3.0, 3.4, and 3.8 times respectively, fascicles number 75.0, 86.3 and 74.0%. IAF was decreasing in lateral root 26.4%, in the medial root 38.4% and in the median nerve 29.6%. Different thickness fascicles share in forming the studied nerve's parts also varied. In children below one year of age fascicles of cross-section area less than 0.3 sq mm made more than 85% of all fascicles in both roots and 80% in the median nerve. Till twenty two years of age their share was diminishing: in roots to 52%, in median nerve to 40%. Fascicles of cross-section area more than 0.5 sq mm share was increasing and in roots it reached more than 20% and in the median nerve more than 36%.

Differences in roots and trunk of median nerve structure are mainly a result of uniting smaller fascicles to form bigger ones in the initial part of the median nerve and decreasing of the amount of the connective tissue forming it.

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STRESZCZENIE

Grubość korzeni i pnia nerwu pośrodkowego, wielkość powierzchni poprzecznego przekroju ich pęczków, liczbę pęczków i wielkość wskaźnika powierzchni pęczków badano obustronnie na zwłokach 100 osób. Nerw pośrodkowy był utworzony zazwyczaj przez połączenie dwu korzeni, bocznego i przyśrodkowego, odchodzących od jednoimiennych pęczków splotu ramiennego. Grubość obu korzeni była podobna w 10,0%, grubszy był korzeń boczny w 54,5%, a korzeń przyśrodkowy w 35,5% przypadków. Budowę wewnętrzną korzeni i pnia nerwu pośrodkowego charakteryzuje duża osobnicza zmienność i asymetria. W życiu pozapłodowym powiększały się znacznie grubość korzeni i pnia nerwu pośrodkowego oraz wielkość powierzchni poprzecznego przekroju ich pęczków. Liczba pęczków ulegała także zwiększeniu, natomiast wskaźnik powierzchni pęczków zmniejszał się. Zmiany te występowały głównie do 22 roku życia.