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*Fascicular structure of terminal divisions  
of the brachial plexus posterior cord in man*

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Budowa pęczkowa końcowych części pęczka tylnego splotu ramiennego u człowieka

The division of the posterior cord into two terminal parts, medial and lateral, leads to mixed nerves formation – radial and axillary. They differ greatly in the area of innervation. Therefore, the comparison of some features of their internal structure is worthwhile. In the present work the thickness of nerves, the size of cross-section area of their fascicles, the number of fascicles and index of fascicle's area were described.

The studies were carried out bilaterally on the bodies of 47 males (♂) and 47 females (♀) who died between 1st day and 87th year of age. The cadavers were divided into six age groups. Group I included 8 ♂ and 8 ♀ up to 1 year of age, group II – 9 ♂ and 9 ♀ between 1st and 14th year, group III – 6 ♂ and 5 ♀ between 15th and 22nd year, group IV – 10 ♂ and 7 ♀ between 23rd and 40th year, group V – 7 ♂ and 10 ♀ between 41st and 60th year and group VI – 7 ♂ and 8 ♀ above 60th year of life. The methods of excising the segments and their fixing, staining of the slides, the methods of determining the nerves and their fascicle's thickness as well as the number of fascicles and the index of fascicle's area were described in the previous papers (10, 11).

RESULTS

The posterior cord gives off several short motor nerves and then splits into two terminal parts, lateral and medial. The lateral part (lp) makes the axillary nerve, the medial part (mp) makes the radial nerve which is the continuation of the posterior cord.

## THICKNESS OF LATERAL AND MEDIAL PARTS OF THE POSTERIOR CORD

The value of the cross-section area of the axillary nerve (ax) ranged between 0.208 and 4.437 sq mm, and of the radial nerve (rd) between 1.543 and 18.904 sq mm. It was similar on both sides of the single body in 9.6% in lp and in 18.1% in mp. The discussed value was greater on the right side in 51.1% and 41.5%, and it was greater on the left side in 39.3 and 40.4% of the cases, respectively. The thickness of rd was greater from ax in all the cases.

The average thickness of ax was (in sq mm) 1.785 – on the right side (r) 1.790, on the left side (l) 1.779, in males (♂) 1.727, in females (♀) 1.842, and of rd 8.428 (r – 8.404, l – 8.452, ♂ – 8.631, ♀ – 8.225). The discussed values came out to be: 0.687 and 3.256 in group I, 1.316 and 5.652 in group II, 2.134 and 10.064 in group III, 2.234 and 10.885 in group IV, 2.340 and 10.892 in group V, and 2.123 and 10.501 in group VI, respectively.

## NUMBER OF FASCICLES

The number of fascicles ranged from 1 to 9 in lp, and from 2 to 32 in mp. There were 1 to 5 fascicles in 87.2% in lp and in 2.5% in mp, 6–10 fascicles were found in 12.8 and 14.4%, respectively, and more fascicles already only in mp – from 11 to 15 fascicles – in 30.3%, 16–20 fascicles in 30.9%, 21–25 fascicles – in 15.4%, and more than 25 fascicles – in 6.3% of the cases. The same number of fascicles in both sides of one body was found in 35.1% in lp and in 7.4% in mp. The number of fascicles was greater on the right side of the body in 36.2 and 50.0%, respectively, and it was greater on the left side in 28.7 and 42.6% of the cases. The number of fascicles was similar in both parts on the same side of the body in 0.5%. It had the highest values in mp in 99.0%, and in lp in 0.5% of the cases.

The mean number of fascicles in ax equalled 2.7 (r – 2.8, l – 2.6, ♂ – 2.4, ♀ – 3.1), and in rd – 16.1 (r – 16.1, l – 16.2, ♂ – 15.4, ♀ – 16.9). In the age groups it was: in group I – 3.0 and 15.5, in group II – 2.7 and 16.2, in group III – 3.3 and 16.0, in group IV – 2.0 and 14.9, in group V – 3.2 and 17.3, in group VI – 2.3 and 15.9, respectively.

## SIZE OF THE CROSS-SECTION AREA OF FASCICLES

The thickness of the individual fascicle showed the following range of values: 0.004–3.318 sq mm in ax and 0.001–6.944 sq mm in rd. On the basis of size of fascicle's cross-section area very thin fascicles (up to 0.1 sq mm), thin fascicles (0.101–0.3 sq mm), medium-thick fascicles (0.301–0.5 sq mm), thick fascicles (0.501–1.0 sq mm) and very thick fascicles (over 1 sq mm) were differentiated. Very thin fascicles (vtn) formed 22.9% of the ax and 30.4% of the rd. Thin fascicles, (tn) formed 32.3%, and 35.8%, medium-thick fascicles (mtk) – 14.1 and 18.0%, thick fascicles (tk) – 14.3 and 12.8%, and very thick fascicles (vtk) – 16.4 and 3.1%, respectively.

The frequency of occurrence of different size fascicles in terminal parts of the posterior cord was unequal in the age groups. In group I vtn reached 52.1% in ax and 60.0% in rd, tn 27.1 and 33.9%, mtk – 11.5 and 3.2%, tk – 9.4 and 2.8%, and vtk 0 and 0%, respectively. In group II vtn made 28.5 and 29.9%, tn – 33.7 and 47.3%, mtk – 9.2 and 14.8%, tk – 19.4 and 7.7%, and vtk – 9.2 and 0.3%, respectively. In group III ax involved 16.7% and 19.4% vtn, 34.7 and 34.8% tn, 20.8 and 24.5% mtk, 9.7 and 17.7 tk, and 18.1 and 3.7% vtk, respectively. In group IV ax was in 8.8% and rd in 20.3%

composed of vtn, in 20.6 and 30.8% of tn, in 16.2% and 22.5% of mtk, in 14.7 and 17.9% of tk, and in 39.7 and 8.5% of vtk, respectively. In group V vtn constituted 13.0% of ax and 21.7% of rd, tn – 40.7 and 33.7%, mtk – 14.8 and 23.0%, tk – 14.8 and 18.9%, and vtk – 16.7 and 2.7%, respectively. In group VI vtn made 10.2% of ax and 27.4% of rd, tn – 33.3 and 32.4%, mtk – 14.5 and 22.4%, tk – 17.4 and 13.6%, and vtk – 24.6 and 4.2%, respectively.

The cross-section area of all the fascicles forming the ax ranged between 0.147 and 3.704 sq mm, and in the rd ranged between 0.899 and 7.846 sq mm. It showed similar values on both sides of one body in 14.9% in ax, and in 16.0% in rd, greater on the right side in 41.5 and 37.2%, greater on the left side in 43.6 and 46.8% of the cases, respectively. The sum of the thicknesses of fascicles of rd compared with the respective sum of ax was greater in all the cases.

The average value of cross-section area of fascicles of ax equalled (in sq mm) 1.333 ( $r = 1.334$ ,  $l = 1.331$ ,  $\delta = 1.325$ ,  $\eta = 1.340$ ), and of rd – 4.516 ( $r = 4.510$ ,  $l = 4.521$ ,  $\delta = 4.580$ ,  $\eta = 4.472$ ). It was different in the age groups: in group I – 0.514 and 1.881, in group II – 1.017 and 3.395, in group III – 1.661 and 5.588, in group IV – 1.759 and 5.949, in group V – 1.687 and 5.602, in group VI – 1.459 and 5.030, respectively.

#### INDEX OF THE CROSS-SECTION AREA OF FASCICLES (IAF)

The size of the index of the fascicle's area of lp ranged between 49.5 and 90.0, and of mp ranged between 36.4 and 77.7. It was similar on both sides of the single body in 23.4% in ax, and in 7.4% in rd, greater on the right side in 36.2 and 43.6%, greater on the left side in 40.4 and 49.0% of the cases, respectively. IAF showed similar values in both terminal parts in 1.1%, greater in lp in 94.7%, greater in mp in 4.2% of the cases.

The average value of the index equalled 74.7 in ax ( $r = 74.5$ ,  $l = 74.8$ ,  $\delta = 76.7$ ,  $\eta = 72.7$ ), and 53.6 in rd ( $r = 53.7$ ,  $l = 53.5$ ,  $\delta = 52.8$ ,  $\eta = 54.4$ ). The IAF value ranged in the age groups as follows: in group I 74.8 in ax and 57.8 in rd, in group II, respectively – 77.3 and 60.1, in group III – 77.8 and 55.5, in group IV – 78.7 and 54.6, in group V – 72.1 and 51.4, in group VI – 68.7 and 47.9.

#### DISCUSSION

The posterior cord usually splits into two terminal parts. The thicker part passes down in its continuation and becomes the radial nerve, and the thin part, passes laterally and becomes the axillary nerve (3, 4, 12). The same division of the posterior cord was observed in all the cases in the present work.

The current investigations of some features of the internal structure of both terminal parts of the posterior cord have shown a great individual variability and asymmetry, similarly to other spinal and cranial nerves (1, 2, 5–11). The same or similar values on both sides of one body of 4 features were not found in rd, and only in 2.1% in ax, for 3 features – 1.1% of each nerve, for 2 features – in 8.5% in rd and in 20.2% in ax. Similar values of single feature were found also rarely on both sides of one body: radial nerve thickness in 10.6%, and axillary nerve – in 5.3%, cross-

–section area of fascicles in 9.6 and 8.5%, fascicle number in 4.3 and 12.8%, index of the fascicle's area in 4.3 and 4.3% of the cases respectively.

The terminal parts or the posterior cord differed between each other in thickness, number of fascicles, their size as well as index of their cross-section area.

The thickness of rd was greater from the thickness of ax in all the cases. It was greater up to 3 times in 6.9%, 3.1–4 times in 29.8%, 4.1–5 times in 25.5%, 5.1–6 times in 14.9%, 6.1–8 times in 16.0%, and over 8 times in 6.9% of the cases. In the whole material the average thickness of rd was greater 4.7 times than the average thickness of ax ( $r = 4.7$ ,  $l = 4.8$ ,  $\delta = 5.0$ ,  $\eta = 4.5$ ), but in group I – 4.7 times, in group II – 4.3 times, in group III – 4.7 times, in group IV – 4.9 times, in group V – 4.7 times, and in group VI – 4.9 times. In the postnatal life the thickness of rd increased 3.3 times, and of ax – 3.4 times.

The number of fascicles in both nerves was the same in 0.5%. It was 1.5 times greater in ax than in rd in 0.5% of the cases. The number of fascicles was greater in rd than in ax in 99.0%: up to 3 times greater in 12.2%, 3.1–6 times in 27.7%, 6.1–9 times in 18.1%, 9.1–12 times in 15.4%, and over 12 times greater in 25.5% of the cases. In the whole material the average number of fascicles of rd was greater 6 times than the average number of fascicles of ax ( $r = 5.7$ ,  $l = 6.2$ ,  $\delta = 6.4$ ,  $\eta = 5.5$ ), but in the age group I – 5.5 times, in group II – 6 times, in group III – 4.8 times, in group IV – 7.4 times, in group V – 5.4 times, and in group VI – 6.9 times. The average number of fascicles was the highest in group V in rd and in group III in ax, but the smallest average number of fascicles – in group IV in both nerves.

The value of the cross-section area of fascicles of rd was greater from the corresponding value of ax in all the cases. It was greater up to 3 times in 31.4%, 3.1–4 times in 42.0%, 4.1–5 times in 17.6%, 5.1–6 times in 4.3 times, and over than 6 times in 4.8% of the cases. In the whole material the average value of the cross-section area of fascicles of rd was greater 3.4 times than the corresponding value of ax ( $r = 3.4$ ,  $l = 3.4$ ,  $\delta = 3.5$ ,  $\eta = 3.3$ ), but in the group I – 3.7 times, in group II – 3.3 times, in group III – 3.4 times, in group IV – 3.4 times, in group V – 3.3 times, and in group VI – 3.4 times. In the postnatal life the value of the cross-section area of rd increased 3.2 times, and of ax increased 3.4 times.

Different thickness fascicles participation in terminal parts of the posterior cord was unequal. Vtn, tn and mtk were observed more often in rd than in ax. Tk and vtk occurred more often in ax than in rd. Mtk and tk were observed more often on the right side in rd and on the left side in ax, but tn – more often on the left side in rd and on the right side in ax. There were certain differences in the fascicular structure in relation to the sex: vtn occurred more often in females in ax and were present equally in the persons of both sexes in rd, whereas mtk and tk were found more often in males in rd and in females in ax. The participation of fascicles of different

thickness in both nerves structure changed greatly in postnatal life. The very thin fascicles, made more than half of all in both nerves in children up to 1 year of age, in adults collected about 1/4 of fascicles of rd and 1-of ax. The percentage of tn changed least, especially in rd, but of mtk increased considerably in rd and not much in ax. The participation of tk and vtk in rd and ax structure increased most in postnatal life.

The size of the index of the fascicle's area was similar in both examined parts in 1.1% and greater in rd than in ax from 2 to 15% in 4.2% of the cases. In ax there were observed greater values of IAF than in rd in 94.7%: it was greater up to 20% in 24.5%, 20.1–40% in 29.3%, 40.1–60% in 17.6%, 60.1–80% in 16.5%, and over 80% in 6.9% of the cases. In the whole material the average value of IAF of ax was greater than the corresponding value of rd by 39.4%, but in age group I – by 29.4%, in group II – by 28.6%, in group III – by 40.2%, in group IV – by 44.1%, in group V – by 40.3%, and in group VI – by 43.4%. The average value of IAF was the greatest in group II in rd and in group IV in ax, but it was the smallest in group VI in both nerves.

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## STRESZCZENIE

W końcowych częściach pęczka tylnego – n. promieniowym i n. pachowym – pobranych obustronnie ze zwłok 94 osób obojga płci, badano grubość, liczbę pęczków i wielkość powierzchni ich poprzecznego przekroju oraz wskaźnik powierzchni pęczków. N. promieniowy w porównaniu z n. pachowym jest grubszy 4,7 razy, ma powierzchnię poprzecznego przekroju pęczków 3,4 razy większą, 6 razy większą liczbę pęczków. Wskaźnik powierzchni pęczków n. pachowego jest większy o 39,4% od wskaźnika n. promieniowego. W n. promieniowym obserwuje się częściej niż w n. pachowym pęczki bardzo cienkie, cienkie i średniej grubości, a rzadziej pęczki grube i bardzo grube.