Histobiometrical Study of the Ocular Muscles of Japanese Fetuses.

V. Size of Muscle Fibres.

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With 10 Text-figures.

Contents.

I.	Introduction	259
II.	Material and Methods	259
III.	Observations	260
IV.	Summary	267
V.	Conclusions	283

I. Introduction.

The size of muscle fibres in the human ocular muscles has already been studied by several authors as J. Halban (1894), G. Schwalbe and R. Mayeda (1899), P. Schiefferdecker (1904, 1927), H. Voss (1935), Y. Kohashi (1937) and T. Kato (1938). But these authors studied only one or a few ocular muscles or ocular muscles of one or a few individuals and nobody has hitherto measured the size of the muscle fibres in seven ocular muscles of many individuals in a certain period of age. In the present investigation, I have traced in detail the size of muscle fibres in the ocular muscles on both sides of Japanese fetuses in the 7th-10th fetal month. The data obtained are presented here as the fifth report of the histobiometrical study of the ocular muscles.

II. Material and Methods.

In this study the material used was entirely the same as in the first report¹⁾, comprising of total 10—male and female—fetuses. The details are recorded

1) Histobiometrical Study of the Ocular Muscles of Japanese Fetuses. 1. Number of Muscle Fibres. Okajimas Fol. anat. jap. Bd. 20. 1941.

in Table 1. All the cadavers were injected over the whole body and preserved in 10% formol solution.

The methods were also the same as those in the first report. The total ocular muscles dissected out of fetuses, dehydrated and embedded in celloidin. The preparation of the transverse sections was made in the midst of the belly of the ocular muscles at 10–15 μ in thickness. The sections, in which the whole muscle fibres transversely appeared, were stained with hematoxylin and eosin.

The muscle fibres in such transverse sections were projected at an enlargement of 600 upon a piece of paper and the area of cross-sections of 100 muscle fibres was measured. The average value of the true size of the 100 fibres was calculated from the result of this measurement.

Table 1. Material.

Case	Embryo-number	Sex	Age	Stature	Body-weight
1	833	♂	7 m	38.0 cm	1000 gr
2	1044	♀	7	33.5	780
3	969	♂	8	42.0	1440
4	1109	♀	8	43.0	1665
5	749	♂	9	46.5	2130
6	552	♀	9	46.0	2120
7	1209	♂	10	—	3150
8	966	♂	10	53.0	3310
9	774	♀	10	51.0	2600
10	1193	♀	10	52.0	2755

III. Observations.

In the most ocular muscles, as described by Voss (1935) and Kato (1938), I could also divide the muscle fibres into two groups, i.e., axial thick and peripheral fine fibres. So I have carried out the measurement of the size of the fibres in the two—superficial and profound—parts. The data obtained is demonstrated in the following tables (Table 2–21).

Table 2. Size of the axial thick fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 1.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	142.1	200.1	171.1	41.53%	58.47%	16.94%
Rectus medialis	152.3	102.0	127.2	59.89	40.11	19.78
Rectus lateralis	184.8	110.9	147.9	62.50	37.50	25.00
Rectus inferior	152.0	108.2	130.1	58.42	41.58	16.84
Obliquus superior	135.2	181.3	158.3	42.72	57.28	14.56
Obliquus inferior	117.9	190.9	154.4	38.18	61.82	23.64
Levator palp. sup.	172.9	140.7	156.8	55.13	44.87	10.26
Average	151.0	147.7	149.4	51.20	48.80	12.15
Max.+Min.	1.57	1.96	1.35	—	—	—

In the Table 2-21

R=Size of fibres in the right muscles, L=Size of fibres in the left muscles.

Table 3. Size of the peripheral fine fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 1.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	71.5	66.6	69.1	51.77%	48.23%	3.54%
Rectus medialis	53.7	62.2	58.0	46.33	53.67	7.34
Rectus lateralis	47.1	34.7	40.9	57.58	42.42	15.16
Rectus inferior	40.0	51.2	45.6	43.86	56.14	12.28
Obliquus superior	42.8	73.6	58.2	36.77	63.23	26.46
Obliquus inferior	41.4	60.6	51.0	40.59	59.41	18.82
Levator palp. sup.	59.3	44.8	52.1	56.96	43.04	13.92
Average	50.8	56.2	53.6	47.69	52.31	13.93
Max.+Min.	1.79	2.12	1.42	—	—	—

Table 4. Size of the axial thick fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 2.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	205.9	167.1	186.5	55.20%	44.80%	10.40%
Rectus medialis	200.8	174.9	187.9	53.45	46.55	6.90
Rectus lateralis	222.2	141.9	182.1	61.03	38.97	22.06
Rectus inferior	300.1	125.0	212.6	70.60	29.40	41.20
Obliquus superior	122.5	226.6	174.6	35.09	64.91	29.82
Obliquus inferior	232.2	183.1	207.7	55.91	44.09	11.82
Levator palp. sup.	189.1	163.2	176.3	53.68	46.32	7.36
Average	210.4	168.8	189.7	54.99	45.01	18.51
Max.+Min.	2.45	1.81	1.22	—	—	—

Table 5. Size of the peripheral fine fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 2.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	83.4	110.9	97.2	42.92%	57.08%	14.16%
Rectus medialis	86.8	90.0	88.4	49.10	50.90	1.80
Rectus lateralis	100.6	92.7	96.7	52.04	47.96	4.08
Rectus inferior	87.4	100.0	93.7	46.64	53.36	6.72
Obliquus superior	90.4	106.7	98.6	45.87	54.13	8.26
Obliquus inferior	88.9	109.0	99.0	44.92	55.08	10.16
Levator palp. sup.	83.3	101.6	92.5	45.05	54.95	9.90
Average	88.7	101.6	95.2	46.65	53.35	7.87
Max.+Min.	1.21	1.23	1.12	—	—	—

Table 6. Size of the axial thick fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 3.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	190.4	218.5	204.5	46.56%	53.44%	-6.88%
Rectus medialis	195.3	217.8	206.6	47.28	52.72	5.44
Rectus lateralis	149.0	202.6	175.8	42.38	57.62	15.24
Rectus inferior	152.0	216.5	184.3	41.82	58.18	16.36
Obliquus superior	176.4	209.4	192.4	45.72	54.28	8.56
Obliquus inferior	307.4	215.6	261.5	58.78	41.22	17.56
Levator palp. sup.	163.2	214.9	189.1	43.16	56.84	13.68
Average	190.5	213.6	202.0	46.53	53.47	12.67
Max.+Min.	2.06	1.08	1.49	—	—	—

Table 7. Size of the peripheral fine fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 3.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	65.5	72.1	68.8	47.60%	52.40%	4.80%
Rectus medialis	59.4	62.1	60.8	48.89	51.11	2.22
Rectus lateralis	61.5	69.4	65.5	45.98	54.02	8.04
Rectus inferior	58.6	64.0	61.3	47.80	52.20	4.40
Obliquus superior	57.8	68.5	63.2	45.76	54.28	8.48
Obliquus inferior	65.8	69.1	67.5	48.78	51.22	2.48
Levator palp. sup.	64.3	72.1	68.2	47.14	52.86	5.72
Average	61.8	68.2	65.0	47.41	52.59	10.62
Max.+Min.	1.07	1.16	1.13	—	—	—

Table 8. Size of the axial thick fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 4.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	296.7	368.7	332.7	44.59%	55.41%	10.82%
Rectus medialis	225.8	272.4	249.1	45.32	54.68	9.36
Rectus lateralis	244.9	280.3	262.6	46.63	53.37	6.74
Rectus inferior	173.1	211.0	192.1	45.07	54.93	9.86
Obliquus superior	145.8	186.0	165.9	43.94	56.06	12.12
Obliquus inferior	184.3	199.0	187.7	49.11	50.89	1.78
Levator palp. sup.	183.4	216.5	199.8	45.91	54.09	8.18
Average	207.7	246.6	227.2	45.80	54.20	8.41
Max. + Min.	2.03	1.98	0.21	—	—	—

Table 9. Size of the peripheral fine fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 4.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	61.4	67.8	64.6	47.52%	52.48%	4.96%
Rectus medialis	69.9	72.4	71.2	49.12	50.88	1.76
Rectus lateralis	59.3	65.9	62.6	47.36	52.64	5.28
Rectus inferior	64.3	67.7	66.0	48.71	51.29	2.58
Obliquus superior	80.8	67.2	74.0	54.59	45.41	9.18
Obliquus inferior	80.8	65.6	73.2	55.19	44.81	10.38
Levator palp. sup.	75.4	66.4	70.9	53.17	46.83	6.34
Average	58.7	67.6	68.9	50.81	49.19	5.78
Max. + Min.	1.36	1.10	1.18	—	—	—

Table 10. Size of the axial thick fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 5.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	320.8	244.8	282.8	56.72%	43.28%	13.44%
Rectus medialis	302.1	309.6	305.9	49.39	50.61	1.22
Rectus lateralis	335.5	303.8	319.7	52.48	47.52	4.96
Rectus inferior	366.0	297.5	316.8	55.16	44.84	10.32
Obliquus superior	363.8	287.1	325.5	55.89	44.11	11.78
Obliquus inferior	401.6	289.6	345.6	58.10	41.90	16.20
Levator palp. sup.	403.1	173.3	288.2	69.93	30.07	39.86
Average	356.1	272.2	312.1	56.81	43.19	13.97
Max. + Min.	1.33	1.79	1.22	—	—	—

Table 11. Size of the peripheral fine fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 5.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	103.4	99.1	101.3	51.06%	48.94%	2.12%
Rectus medialis	90.0	100.1	95.1	47.34	52.66	5.32
Rectus lateralis	96.4	106.8	101.6	47.44	52.56	5.12
Rectus inferior	95.9	107.5	101.7	47.15	52.85	5.70
Obliquus superior	101.7	103.4	102.6	49.59	50.41	0.82
Obliquus inferior	94.4	95.7	95.1	49.66	50.34	0.68
Levator palp. sup.	99.0	99.2	99.1	49.95	50.05	0.10
Average	97.3	111.8	99.5	48.88	51.12	2.84
Max. + Min.	1.15	1.12	1.08	1.08	—	—

Table 12. Size of the axial thick fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 6.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	141.1	113.1	127.1	55.51%	44.49%	11.02%
Rectus medialis	111.1	150.3	130.7	42.50	57.50	15.00
Rectus lateralis	142.6	187.5	165.1	43.20	56.80	13.60
Rectus inferior	104.9	188.1	146.5	35.80	64.20	28.40
Obliquus superior	122.7	196.2	159.5	38.48	61.52	23.04
Obliquus inferior	106.3	202.6	154.5	34.41	65.59	31.18
Levator palp. sup.	109.4	167.2	178.3	30.68	69.32	38.64
Average	119.7	172.1	151.7	40.08	59.92	22.98
Max. + Min.	1.36	1.79	1.36	—	—	—

Table 13. Size of the peripheral fine fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 6.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	73.6	81.8	77.7	47.36%	52.64%	5.28%
Rectus medialis	71.3	78.2	74.8	47.69	52.31	4.62
Rectus lateralis	79.1	118.9	99.0	39.95	60.05	20.10
Rectus inferior	77.4	95.7	86.9	44.56	55.44	10.88
Obliquus superior	73.6	95.0	84.3	43.65	56.35	12.70
Obliquus inferior	73.3	94.0	83.7	43.81	56.19	12.38
Levator palp. sup.	76.4	104.4	90.4	42.26	57.74	15.48
Average	75.0	95.4	85.3	44.18	55.82	11.63
Max. + Min.	1.11	1.52	1.32	—	—	—

Table 14. Size of the axial thick fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 7.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	121.3	117.5	119.4	50.80%	49.20%	1.60%
Rectus medialis	116.9	97.8	107.4	54.45	45.55	8.90
Rectus lateralis	141.7	100.8	121.3	58.43	41.57	16.86
Rectus inferior	110.5	98.3	104.4	52.92	47.08	5.84
Obliquus superior	126.4	100.6	113.5	55.68	44.32	11.36
Obliquus inferior	108.5	99.5	104.0	52.16	47.84	4.32
Levator palp. sup.	128.6	102.7	115.7	55.60	44.40	11.20
Average	122.0	102.5	121.0	54.29	45.71	8.58
Max. + Min.	1.31	1.20	1.17	—	—	—

Table 15. Size of the peripheral fine fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 7.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	107.5	53.0	80.3	66.98%	33.02%	33.96%
Rectus medialis	59.2	47.3	53.3	55.59	44.41	11.18
Rectus lateralis	83.4	58.6	71.0	58.73	41.27	17.46
Rectus inferior	75.4	49.7	62.6	60.27	39.73	20.54
Obliquus superior	79.5	48.9	64.2	61.92	38.08	23.84
Obliquus inferior	62.3	58.0	60.2	57.79	42.21	15.58
Levator palp. sup.	77.9	56.0	67.0	58.18	41.82	16.36
Average	77.9	53.1	65.5	59.92	40.08	19.85
Max. + Min.	1.82	1.24	1.51	—	—	—

Table 16. Size of the axial thick fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 8.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	272.0	216.5	244.3	55.68%	44.32%	11.36%
Rectus medialis	314.1	285.0	299.7	52.41	47.59	4.82
Rectus lateralis	414.0	429.1	421.6	49.10	50.90	1.80
Rectus inferior	391.3	223.2	307.3	63.68	36.32	27.36
Obliquus superior	375.1	282.1	328.6	57.08	42.92	14.16
Obliquus inferior	382.7	275.7	263.4	58.13	41.87	16.26
Levator palp. sup.	374.4	256.3	315.4	59.36	40.64	18.72
Average	359.5	281.1	311.5	56.49	43.51	13.50
Max. + Min.	1.52	1.98	1.73	—	—	—

Table 17. Size of the peripheral fine fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 8.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	84.5	104.4	94.5	44.73%	55.27%	10.54%
Rectus medialis	75.7	99.6	87.7	43.18	56.82	13.64
Rectus lateralis	70.8	116.0	93.4	37.90	62.10	24.20
Rectus inferior	77.6	104.6	90.9	42.71	57.29	14.58
Obliquus superior	75.0	96.0	85.5	43.86	56.14	12.28
Obliquus inferior	75.0	101.2	88.1	42.57	57.43	14.91
Levator palp. sup.	74.1	90.2	82.2	45.10	54.90	9.80
Average	76.1	101.6	88.9	42.86	57.14	14.28
Max. + Min.	1.19	1.29	1.15	—	—	—

Table 18. Size of the axial thick fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 9.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	492.8	357.6	425.2	57.95%	42.05%	15.90%
Rectus medialis	507.2	438.6	472.9	53.63	46.37	7.26
Rectus lateralis	490.0	411.8	450.9	54.34	45.66	8.68
Rectus inferior	419.5	401.6	410.6	51.09	48.91	2.18
Obliquus superior	449.6	384.7	417.2	53.89	46.11	7.78
Obliquus inferior	228.9	385.9	307.4	37.23	62.77	25.54
Levator palp. sup.	470.7	397.3	434.0	54.23	45.77	8.46
Average	437.1	397.8	417.9	51.77	48.23	10.83
Max. + Min.	2.22	1.23	1.54	—	—	—

Table 19. Size of the peripheral fine fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 9.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	97.3	199.2	148.3	32.82%	67.18%	34.36%
Rectus medialis	80.2	122.8	101.5	39.51	60.49	20.98
Rectus lateralis	97.7	118.6	108.2	45.17	54.83	9.66
Rectus inferior	109.2	108.1	108.7	50.25	49.75	0.50
Obliquus superior	107.6	107.5	107.6	50.02	49.98	0.04
Obliquus inferior	95.0	109.8	102.4	46.39	53.61	7.22
Levator palp. sup.	110.5	105.3	107.9	51.20	48.80	2.40
Average	99.6	124.5	112.1	45.05	54.95	10.74
Max. + Min.	1.38	1.89	1.46	—	—	—

Table 20. Size of the axial thick fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 10.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	365.3	308.1	336.7	54.25%	45.75%	8.50%
Rectus medialis	328.0	286.6	307.3	53.37	46.63	6.74
Rectus lateralis	332.3	365.4	348.9	47.63	52.37	4.74
Rectus inferior	357.9	325.5	341.7	52.37	47.63	4.74
Obliquus superior	340.2	227.3	283.8	59.95	40.05	19.90
Obliquus inferior	358.0	269.3	313.7	57.07	42.93	14.14
Levator palp. sup.	333.0	216.3	274.7	60.62	39.38	21.24
Average	345.1	285.5	315.3	55.04	44.96	11.43
Max. + Min.	1.11	1.69	1.27	—	—	—

Table 21. Size of the peripheral fine fibres in the ocular muscles and comparison between the corresponding muscles on both sides in case 10.

	Size of the muscle fibres			Percentage		
	R	L	$\frac{R+L}{2}$	$\frac{R}{R+L} \times 100$	$\frac{L}{R+L} \times 100$	$\frac{R-L}{R+L} \times 100$
	sq. μ	sq. μ	sq. μ			
Rectus superior	61.1	87.2	74.2	41.20%	58.80%	17.60%
Rectus medialis	69.2	87.8	78.5	44.08	55.92	11.84
Rectus lateralis	81.9	139.8	110.9	36.94	63.06	26.12
Rectus inferior	87.5	100.9	94.2	46.44	53.56	7.12
Obliquus superior	92.3	73.5	82.9	55.67	44.33	11.34
Obliquus inferior	94.4	70.3	82.4	57.32	42.68	14.64
Levator palp. sup.	88.5	77.3	82.9	53.38	46.62	6.76
Average	82.1	91.0	86.6	47.86	52.14	13.63
Max. + Min.	1.55	1.99	1.49	—	—	—

IV. Summary.

To sum up the findings of the above measurement, the following interesting results are obtained. As already described, the most ocular muscles consist of two kinds of muscle fibres, namely the axial thick and the peripheral fine fibres. In the following the findings regarding the two kinds of muscle fibres are explained separately.

1. Axial thick fibres.

The area of the transverse section of the axial thick fibres, i.e., the size of the axial thick fibres in the ocular muscles varies, as represented in Table 22, not only according to muscles, but also with individuals and the body-sides to which the muscles belong. It is in the right Rectus medialis of case 9 (507.2 sq. μ) the greatest and in the left Rectus medialis of case 7 (97.8 sq. μ) the smallest. The ratio of the greatest to the smallest value is 5.2 : 1.

Table 22. Size of axial thick fibres in each case.

Case and body-side		Rs	Rm	RI	Ri	Os	Oi	Lps	Average	Max. Min.
		sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	
1	r	142.1	152.3	184.8	152.0	135.0	117.9	172.9	151.0	1.57
	l	200.1	102.0	110.9	108.2	181.3	190.9	140.7	147.7	1.96
2	r	205.9	200.8	222.2	300.1	122.5	232.2	189.1	210.4	2.45
	l	167.1	174.9	141.9	125.0	226.6	183.1	163.2	168.8	1.81
3	r	190.4	195.3	149.0	152.0	176.4	307.4	163.2	190.5	2.06
	l	218.5	217.8	202.6	216.5	209.4	215.6	214.9	213.6	1.08
4	r	296.7	225.8	244.9	173.1	145.8	184.3	183.4	207.7	2.03
	l	368.7	272.4	280.3	211.0	186.0	191.0	216.5	246.6	1.98
5	r	320.8	302.1	335.5	366.0	363.8	401.6	403.1	356.1	1.33
	l	244.8	309.6	303.8	297.5	287.1	289.6	173.3	272.2	1.79
6	r	141.1	111.1	142.6	104.9	122.7	106.3	109.4	119.7	1.36
	l	113.1	150.3	187.5	188.1	196.2	202.6	167.2	172.1	1.79
7	r	121.3	116.9	141.7	110.5	126.4	108.5	128.6	122.0	1.31
	l	117.5	97.8	100.8	98.3	100.6	99.5	102.7	102.5	1.20
8	r	272.0	314.1	414.0	391.3	375.1	382.7	374.4	359.5	1.52
	l	216.5	285.0	429.1	223.2	282.1	275.7	256.3	281.1	1.98
9	r	492.8	507.2	490.0	419.5	449.6	228.9	470.7	437.1	2.22
	l	357.6	438.6	411.8	401.6	384.7	385.9	397.3	397.8	1.23
10	r	365.3	328.0	332.3	357.9	340.2	358.0	333.0	345.1	1.11
	l	308.1	286.6	365.4	325.5	227.3	269.3	216.3	285.5	1.69
Average		243.0	239.4	259.6	236.1	232.0	236.6	228.8	239.4	1.67

In this and the following tables -

Rs—Rectus superior, Rm—Rectus medialis, RI—Rectus lateralis, Ri—Rectus inferior, Os—Obliquus superior, Oi—Obliquus inferior and Lps—Levator palpebrae superioris.

The proportion of the highest and lowest value of the size (max./min.) on one body-side lies between 1.08 (left side of case 3) and 2.45 (right side of case 2), corresponding to the average value of 1.67. These figures indicate that among the ocular muscles on one body-side the variation of the size of axial thick fibres is of low degree. The proportion is on only 4 out of 20 sides of the body greater than 2.00 and on all body-sides it is smaller than 2.50.

As seen on Table 22, the average size of axial thick fibres in the same named muscles on 20 sides of the 10 fetuses is the greatest in Rectus lateralis, then come Rectus superior, Rectus medialis, Obliquus inferior etc., being the least in Levator palpebrae superioris.

I calculated on the basis of Table 22 the correlation coefficient between the size of axial thick fibres in the left and right same named muscles and obtained $r \pm m_r = 0.79 \pm 0.045$. From this it may be concluded that the right and left same named muscles show regarding the size of their axial thick fibres a high correlation between them.

As demonstrated in Table 23, the order of the size of axial thick fibres in the seven ocular muscles on one side of the body differs according to each side of the body and each individual. It is also found that all 20 body-sides differ respectively more or less in order and that no individual shows

the same order on both sides. The correlation coefficient between the order number of the same named muscles on both sides is extremely small and comes up to only 0.03 ± 0.119 .

Table 23. Order of the size of axial thick fibres in each case (body-side).

Case and body-side		Rs	Rm	Rl	Ri	Os	Oi	Lps
1	r	5	3	1	4	6	7	2
	l	1	7	5	6	3	2	4
2	r	4	5	3	1	7	2	6
	l	4	3	6	7	1	2	5
3	r	3	2	7	6	4	1	5
	l	1	2	7	3	6	4	5
4	r	1	3	2	6	7	4	5
	l	1	3	2	5	7	6	4
5	r	6	7	5	3	4	2	1
	l	6	1	2	3	5	4	7
6	r	2	4	1	7	3	6	5
	l	7	6	4	3	2	1	5
7	r	4	5	1	6	3	7	2
	l	1	7	3	6	4	5	2
8	r	7	6	1	2	4	3	5
	l	7	2	1	6	3	4	5
9	r	2	1	3	6	5	7	4
	l	7	1	2	3	6	5	4
10	r	1	7	6	3	4	2	5
	l	3	4	1	2	6	5	7
Average of the order number		3.7	4.0	3.1	4.4	4.5	4.0	4.4

When the order number of the same named muscles on 20 body-sides is balanced, it is found that the number is in Rectus lateralis 3.1, in Rectus superior 3.7, in Rectus medialis and Obliquus inferior 4.0, in Rectus inferior and Levator palpebrae superioris 4.4 and in Obliquus superior 4.5 (Table 23). This order is almost in accordance with the order regarding the average value of the size itself, which leads to conclusion that the size of thick fibres is in general in Rectus group greater than in Obliquus group and Levator palpebrae superioris, although the difference between them is very small.

The right percentage, i.e., the percentage of the size of axial thick fibres in one right muscle to the sum of the size in the corresponding muscles on both sides ($\frac{R}{R+L} \times 100$) is the greatest in the Rectus inferior of case 2 (70.60%) and the smallest in the Levator palpebrae superioris of case 6 (30.68%), showing an average value of $51.30 \pm 0.96\%$. The right percentage greater than 50.00% is found in 7 muscle pairs of case 7, in 6 pairs of case 2, 5, 9 and 10, in 5 pairs of case 8, in 4 pairs of case 1 and in 1 pair of case 3 and 6. From this observation it is clear that in 42 out of 70 muscle pairs the right percentage is higher than 50.00% and in 7 out of 10 cases it is in the majority of the 7 muscle pairs greater than 50.00%. These facts indicate that those

muscle pairs, of which the axial thick fibres in the right muscle have a greater size than that in the left muscle, are greater in number than those muscle pairs, of which the axial thick fibres in the left muscle show a greater size than that in the right muscle (Table 24).

Table 24. Right percentage in each case (axial thick fibres).

Case	Rs	Rm	Rl	Ri	Os	Oi	Lps	Average
1	41.53%	59.89%	62.50%	58.42%	42.72%	38.18%	55.13%	51.20%
2	55.20	53.45	61.03	70.60	35.09	55.91	53.68	54.99
3	46.56	47.28	42.38	41.82	45.72	58.78	43.16	46.53
4	44.59	45.32	46.63	45.07	43.94	49.11	45.91	45.80
5	56.72	49.39	52.48	55.16	55.89	58.10	69.93	56.81
6	55.51	42.50	43.20	35.80	38.48	34.41	30.68	40.08
7	50.80	54.45	58.43	52.92	55.68	52.16	55.60	54.29
8	55.68	52.41	49.10	63.68	57.08	38.13	59.36	56.49
9	57.95	53.63	54.34	51.09	53.89	37.23	54.23	51.77
10	54.25	53.37	47.63	52.37	59.95	57.07	60.62	55.04
Average	51.88	51.17	51.77	52.69	48.84	47.91	52.83	*51.30

* $M \pm m$ is in the right percentage $51.30 \pm 0.96\%$ and in the left $48.70 \pm 0.96\%$.

The average value of the right percentage in each case is in case 5 (56.81%) the highest, then come case 8, 10, 2, 7, 9, 1, 3 and 4, being the lowest in case 6 (40.08%). In the latter 3 cases it is lower than 50.00%.

Rectus superior, Rectus inferior and Levator palpebrae superioris show the right percentage over 50.00% in 7 out of 10 cases, Rectus medialis in 6 cases and Rectus lateralis, Obliquus superior and Obliquus inferior in 5 cases. From this we see that in 4 out of 7 kinds of ocular muscles the right percentage is in the majority of 10 cases greater than 50.00%. The average value of the right percentage in each kind of muscles is the highest in Levator palpebrae superioris (52.83%), followed in order by Rectus inferior, Rectus superior, Rectus lateralis etc., Obliquus inferior represents the lowest (47.91%) and in two kinds of muscle the average value is lower than 50.00%, as indicated in Table 24.

The average value of the right and left percentage in all examined muscle pairs is $51.30 \pm 0.96\%$ and $48.70 \pm 0.96\%$. There is no significant difference between the right and left averaged percentage, so that it may be said that between the right and left muscles no significant difference regarding the size of axial thick fibres is found.

The difference between the right and left percentage $\left(\frac{R-L}{R+L} \times 100\right)$ shows the extent of the difference in size of axial thick fibres between the right

and left same named muscles compared with the sum of the size of axial thick fibres in the two muscles. The smaller this difference is, the higher is the similarity in the size of axial thick fibres in the same named muscles on both sides. Among the total 70 muscle pairs the difference varies from 1.22% (Rectus medialis of case 5) to 41.20% (Rectus inferior of case 2). The difference lower than 10.00% show five pairs in case 4 and 9, four pairs in case 7 and 10, three pairs in case 3, two pairs in case 2, 5 and 8, and no pair in case 1 and 6. Accordingly, in 27 out of 70 muscle pairs this difference is smaller than 10.00%. Presuming that in the muscle pairs with a difference lower than 10.00% the size of axial thick fibres in the right and left same named muscles are closely related each other, it might be said that in 27 out of 70 pairs the size of axial thick fibres in the right and left muscles resemble each other and that in the majority of the seven muscle pairs, the size of thick fibres in the same named muscles on both sides is in 4 out of 10 cases similar (Table 25).

The average value of the difference between the right and left percentage in each case is the greatest in case 6 (22.98%) and the smallest in case 4 (8.41%). It is smaller than 10.00% in case 4 and 7.

In 7 kinds of ocular muscles the average difference is the smallest in Rectus medialis (8.54%), then come Rectus superior, Rectus lateralis etc., and the greatest in Levator palpebrae superioris (17.75%). From this it becomes clear that the size of axial thick fibres in the left and right same named muscles is in Rectus group generally more similar than in Obliquus group and Levator palpebrae superioris (Table 25).

Table 25. Difference between the right and left percentage in each case (axial thick fibres).

Case	Rs	Rm	Rl	Ri	Os	Oi	Lps	Average
1	16.94%	19.78%	25.00%	16.84%	14.56%	23.64%	10.26%	18.15%
2	10.40	6.90	22.06	41.20	29.82	11.82	7.36	18.51
3	6.88	5.44	15.24	16.36	8.56	17.56	13.60	11.95
4	10.82	9.36	6.74	9.86	12.12	1.78	8.18	8.41
5	13.44	1.22	4.96	10.32	11.78	16.20	39.86	13.97
6	11.02	15.00	13.60	28.40	23.04	31.18	38.64	22.98
7	1.60	8.90	16.86	5.84	11.36	4.32	11.20	8.58
8	11.36	4.82	1.80	27.36	14.16	16.26	18.72	13.50
9	15.90	7.26	8.68	2.18	7.78	25.54	8.46	10.83
10	8.50	6.74	4.74	4.74	19.90	14.14	21.24	11.43
Average	10.69	8.54	11.97	16.31	15.31	16.24	17.75	*13.83

* $M \pm m = 13.83 \pm 1.07\%$.

The average value of this difference obtained in 70 examined muscle pairs is $13.83 \pm 1.07\%$. From this it may be concluded that the extent of the difference of the size of axial thick fibres between the same named muscles on both sides corresponds in average to $13.83 \pm 1.07\%$ of the sum of the size of axial thick fibres in the two muscles. But this figure expresses only the average value of the extent of the difference in size of axial thick fibres between the same named muscles on both sides, without any consideration in which of the left and right muscles the size of axial thick fibres is greater than the other. That there is a significant difference in the size of axial thick fibres between the corresponding muscles on both sides is not compatible with the above mentioned fact that there is no significant difference in size of axial thick fibres between the left and right same named muscles.

Presuming that the average value of the size of axial thick fibres in the right and left same named muscles in one individual ($\frac{R+L}{2}$) represents the size of axial thick fibres in the corresponding muscles of the corresponding individual and presuming that the average value of the size of axial thick fibres in the same named muscles in individuals of the same sex and age presents the size in the corresponding muscles in the corresponding sex and age, the Table 26 was obtained.

Table 26. Size of axial thick fibres in each fetal month and sex.

Sex	Age	Case	Rs	Rm	RI	Ri	Os	Qi	Lps	Average
			sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ
♂	7 m	1	171.1	127.2	147.9	130.1	158.3	154.4	156.8	149.4
	8 "	3	204.5	206.6	175.8	184.3	192.4	261.5	189.1	202.0
	9 "	5	282.8	305.9	319.7	316.8	325.5	345.6	288.2	312.1
	10 "	7, 8	181.9	386.3	436.3	359.0	372.9	285.4	374.7	364.7
♀	7 m	2	186.5	187.9	182.1	212.6	174.6	207.7	176.3	189.7
	8 "	4	332.7	249.1	262.6	192.6	165.9	187.7	199.8	227.2
	9 "	6	127.1	130.7	165.6	146.5	159.5	154.5	178.3	151.7
	10 "	9, 10	381.0	390.1	399.9	376.2	350.5	310.6	354.4	366.6

In order to compare the size of axial thick fibres between the male and female fetuses at the same age, I calculated in each kind of muscle the proportion of the size between the male and female fetuses of the same age (male/female). These findings are represented in Table 27. In the 9th month this proportion is in all kinds of ocular muscles higher than 1.00, whereas in the 7th and 10th month all kinds of muscles and in the 8th month 5 out of 7 kinds of muscles show a difference lower than 1.00. The average value of this difference in each fetal month is only in the 9th month greater than 1.00

and that in all kinds of ocular muscles it is greater than 1.00. From these findings it is apparent that the size of axial thick fibres is in the majority of cases in the ocular muscles of the female fetuses greater than in that of the male fetuses of the same age, though the male fetuses were in general better nourished and developed than the female fetuses of the same age, as shown in Table 1.

Table 27. Proportion of the size of axial thick fibres between the male and female fetuses of the same age (δ/φ).

Age	Rs	Rm	Rl	Ri	Os	Oi	Lps	Average
7 m	0.92	0.68	0.81	0.61	0.91	0.74	0.89	0.79
8 "	0.61	0.83	0.67	0.96	1.16	1.39	0.95	0.94
9 "	2.22	2.34	1.94	2.26	2.04	2.24	1.62	2.09
10 "	0.47	0.52	0.68	0.55	0.63	0.70	0.61	0.59
Average	1.06	1.09	1.03	1.10	1.19	1.27	1.02	1.10

Supposing that the average value of the size of axial thick fibres in all the same named muscles in fetuses of the same age represents the size of the fibres in the corresponding muscles of the corresponding age, the Table 28 was obtained. This Table shows that the size of axial thick fibres in Rectus superior is in the 9th month the greatest and that in the other 6 kinds of muscles is in the 10th month the highest, while that in all kind of muscles is in the 7th month the smallest. The average value of the size in each month is the lowest in the 7th month, then come the 8th and 9th month and the highest in the 10th month.

Table 28. Size of axial thick fibres in each fetal month.

Age	Case	Rs	Rm	Rl	Ri	Os	Oi	Lps	Average
		sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ
7 m	1, 2	178.8	157.5	165.0	171.4	166.4	181.1	166.5	169.5
8 "	3, 4	268.6	227.9	219.2	188.2	179.4	224.6	194.6	214.6
9 "	5, 6	283.2	218.3	242.4	239.2	242.5	250.1	233.3	244.1
10 "	7, 8, 9, 10	281.4	296.8	335.7	291.0	285.8	263.6	284.9	291.3

According to Kato (1938), the size of axial thick fibres in the ocular muscles of a newborn baby is smaller than that of my 10 months fetuses (4 cases, 8 body-sides), as shown in Table 29. It is probably that this is caused by the individual fluctuation. Among my 10 months fetuses, there is a case

(case 7) which possesses nearly the same size as the newborn baby of Kato, whereas the other 3 cases have all thicker muscle fibres than the newborn baby.

Table 29. Size of axial thick fibres.

Muscles	Authors and materials	Kato (Newborn baby)	Hayashi (10 months fetuses)
Rectus superior		152 sq. μ	281.4 sq. μ
Rectus medialis		219	296.8
Rectus lateralis		115	335.7
Rectus inferior		136	291.0
Obliquus superior		98	285.8
Obliquus inferior		174	263.6

If the size of thick fibres in each ocular muscle in the 8th-10th month is represented with the percentage against the size in the corresponding muscles in the 7th month, the findings as in Table 30 are obtained. This Table indicates that the size of axial thick fibres has a tendency to increase with the age. In the 10th month the increase of the size reaches about 145-200% of the size in the 7th month.

Table 30. Proportion of the size of axial thick fibres in each fetal month.

Age	Rs	Rm	Rl	Ri	Os	Oi	Lps
7 m	100	100	100	100	100	100	100
8 "	150	145	133	110	108	124	127
9 "	158	139	147	140	146	138	144
10 "	157	188	203	170	172	146	172

2. Peripheral fine fibres.

The size of peripheral fine muscle fibres is in the left Rectus superior of case 9 (199.2 sq. μ) the greatest and in the left Rectus lateralis of case 1 (34.7 sq. μ) the smallest. The ratio of the former to the latter is 5.7:1. The proportion between the highest and lowest value on one body-side varies from 1.07 (right side of case 3) to 2.12 (left side of case 1); its average value comes up to 1.41, which is somewhat smaller than that in axial thick fibres. The proportion is on all sides of the body smaller than 2.15 and on only 1 out of 20 sides greater than 2.00 (Table 31). These facts indicate that the variation of the size of peripheral fine fibres among 7 ocular muscles on one body-side is very small and smaller than that of the axial thick fibres.

Table 31. Size of peripheral fine fibres in each case.

Case and body-side		Rs	Rm	Rl	Ri	Os	Oi	Lps	Average	Max. Min.
1	r	sq. μ 71.5	sq. μ 53.7	sq. μ 47.1	sq. μ 40.0	sq. μ 42.8	sq. μ 41.4	sq. μ 59.3	sq. μ 50.8	1.79
	l	66.6	62.2	34.7	51.2	73.6	60.6	44.8	56.2	2.12
2	r	83.4	86.8	100.6	87.4	90.4	88.9	83.3	88.7	1.21
	l	110.9	90.0	92.7	100.0	106.7	109.0	101.6	101.6	1.23
3	r	65.5	59.4	61.5	58.6	57.8	65.8	64.3	61.8	1.07
	l	72.1	62.1	69.4	64.0	68.5	69.1	72.1	68.2	1.16
4	r	61.4	69.9	59.3	64.3	80.8	80.8	75.4	70.3	1.36
	l	67.8	72.4	65.9	67.7	67.2	65.6	66.4	66.1	1.10
5	r	103.4	90.0	96.4	95.9	101.7	94.4	99.0	97.3	1.15
	l	99.1	100.1	106.8	107.5	103.4	95.7	99.2	101.7	1.12
6	r	73.6	71.3	79.1	77.4	73.6	73.3	76.4	75.0	1.11
	l	81.8	78.2	118.9	95.7	95.0	94.0	104.4	95.4	1.52
7	r	107.5	59.2	83.4	75.4	79.5	62.3	77.9	77.9	1.82
	l	53.0	47.3	58.6	49.7	48.9	58.0	56.0	53.1	1.24
8	r	84.5	75.7	70.8	77.6	75.0	75.0	74.1	76.1	1.19
	l	104.4	99.6	116.0	104.1	96.0	101.2	90.2	101.6	1.29
9	r	97.3	80.2	97.7	109.2	107.6	95.0	110.5	99.6	1.38
	l	199.2	122.8	118.6	108.1	107.5	109.8	105.3	124.5	1.89
10	r	61.1	69.2	81.9	87.5	92.3	94.4	88.5	82.1	1.55
	l	87.2	87.8	139.8	100.9	73.5	70.3	77.3	91.0	1.99
Average		87.6	76.9	85.0	81.1	82.1	80.2	81.3	82.0	1.41

The average size of peripheral fine fibres in the same named muscles on 20 sides of the 10 fetuses is the greatest in Rectus superior, followed in order by Rectus lateralis, Obliquus superior, Levator palpebrae superioris etc., being the least in Rectus medialis (Table 31). This order differs more or less from that of the axial thick fibres.

The correlation coefficient between the size of peripheral fine fibres in the left and right same named muscles is 0.58 ± 0.079 , which indicates that the left and right same named muscles show regarding the size of their peripheral fine fibres a little high correlation between them.

As described in Table 32, the order of the size of peripheral fine fibres in the 7 ocular muscles on one side of the body differs according to each body-side and each individual and there is no individual which shows the same order on both sides. The coefficient between the order number of the same named muscles on both sides is remarkably small and is 0.01 ± 0.119 .

When the order number of the same named muscles on 20 body-sides is averaged, it is found that the averaged order number is in Rectus superior 3.2, in Rectus lateralis 3.5, in Obliquus superior 3.9, in Levator palpebrae superioris 4.0, in Rectus inferior 4.1, in Obliquus inferior 4.3 and in Rectus medialis 5.0 (Table 32). This order is quite equal to that of the average value of the size itself. Although the size of axial thick fibres is in general

Table 32. Order of the size of peripheral fine fibres in each case (body-side).

Case and body-side		Rs	Rm	Rl	Ri	Os	Oi	Lps
1	r	1	3	4	7	5	6	2
	l	2	3	7	5	1	4	6
2	r	6	5	1	4	2	3	7
	l	1	7	6	5	3	2	4
3	r	2	5	4	6	7	1	3
	l	1	7	3	6	5	4	1
4	r	6	4	7	5	1	1	3
	l	2	1	6	3	4	7	5
5	r	1	7	4	5	2	6	3
	l	6	4	2	1	3	7	5
6	r	4	7	1	2	5	6	3
	l	6	7	1	3	4	5	2
7	r	1	6	2	7	3	5	4
	l	4	7	1	5	6	2	3
8	r	1	3	7	2	4	4	6
	l	2	5	1	3	6	4	7
9	r	5	7	4	2	3	6	1
	l	1	2	3	5	6	4	7
10	r	7	6	5	4	2	1	3
	l	4	3	1	2	6	7	5
Average of the order number		3.2	5.0	3.5	4.1	3.9	4.3	4.0

in Rectus group greater than in the other muscles, the size of peripheral fine fibres does not show such a relation.

The proportion of size between the peripheral fine and axial thick fibres in an ocular muscle varies, as indicated in Table 33, from 1.1 (right Rectus superior of case 8) to 6.3 (right Rectus medialis of case 9), corresponding the average value of 3.0. It is in 6 out of 140 muscles lower than 1.5 and in 22 muscles over 4.0. The average value of this proportion on one body-side lies between 1.6 (left side of case 2 and right side of case 6 and 8) and 4.8 (right side of case 7); it varies with cases, but on both sides of one and the same fetus it is in almost all fetuses almost similar. The average proportion in the same named muscles on 20 body-sides is in Rectus medialis and Rectus lateralis 3.1, in Rectus superior and Obliquus inferior 3.0, in Rectus inferior 2.9 and in Obliquus superior and Levator palpebrae superioris 2.8. From this it becomes clear that the proportion is in average in all kinds of ocular muscles almost the same and that the axial thick fibres are, in general, in all kinds of muscles about 3 times thicker than the peripheral fine fibres.

The right percentage is the greatest in the Rectus superior of case 7 (66.98%) and the smallest in the Rectus superior of case 9 (32.82%), showing an average value of $48.15 \pm 0.75\%$. The right percentage greater than 50.00% is found in seven muscle pairs of case 7, in three pairs of case 1, 4, 9 and 10,

Table 33. Proportion of size between the axial thick and peripheral fine fibres.

Case and side of the body		Rs	Rm	RI	Ri	Os	Oi	Lps	Average	Max. Min.
1	r	2.0	2.8	3.9	3.8	3.2	2.8	2.9	3.1	1.95
	l	3.0	1.6	3.2	2.1	2.5	3.2	3.1	2.7	2.00
2	r	2.5	2.3	2.2	3.4	1.4	2.6	2.3	2.4	2.43
	l	1.5	1.9	1.5	1.2	2.1	1.7	1.6	1.6	1.75
3	r	2.9	3.3	2.4	2.6	3.1	4.7	2.5	3.1	1.96
	l	3.0	3.5	2.9	3.4	3.1	3.1	3.0	3.1	1.21
4	r	4.8	3.2	4.1	2.7	1.8	2.3	2.4	3.0	2.67
	l	5.4	3.8	4.3	3.1	2.8	2.9	3.3	3.7	1.93
5	r	3.1	3.4	3.5	3.8	3.6	4.3	4.1	3.7	1.39
	l	2.5	3.1	2.8	2.8	2.8	3.0	1.7	2.7	1.82
6	r	1.9	1.6	1.8	1.4	1.7	1.5	1.4	1.6	1.36
	l	1.4	1.9	1.6	2.0	2.1	2.2	1.6	1.8	1.57
7	r	3.2	4.1	5.8	5.0	5.0	5.1	5.1	4.8	1.81
	l	2.1	2.9	3.7	2.1	2.9	2.7	2.8	2.7	1.76
8	r	1.1	2.0	1.7	1.5	1.6	1.7	1.7	1.6	1.82
	l	2.2	2.1	1.7	2.0	2.1	1.7	1.8	1.9	1.29
9	r	5.1	6.3	5.0	3.8	4.2	2.4	4.3	4.4	2.63
	l	1.8	3.6	3.5	3.7	3.6	3.5	3.8	3.4	2.11
10	r	6.0	4.7	4.1	4.1	3.7	3.8	3.8	4.3	1.62
	l	3.5	3.3	2.6	3.2	3.1	3.8	2.8	3.2	1.46
Average		3.0	3.1	3.1	2.9	2.8	3.0	2.8	3.0	1.83

one pair of case 2 and 5. From this it is clear that in 21 out of 70 muscle pairs the right percentage is greater than 50.00% and in only 1 out of 10 cases it is in the majority of 7 muscle pairs higher than 50.00% (Table 34).

Table 34. Right percentage in each case (peripheral fine fibres).

Case	Rs	Rm	RI	Ri	Os	Oi	Lps	Average
1	51.77%	46.33%	57.58%	43.86%	36.77%	40.59%	56.96%	47.69%
2	42.92	49.10	52.04	46.64	45.87	44.92	45.05	46.65
3	47.60	48.89	46.98	47.80	45.76	48.78	47.14	47.41
4	47.52	49.12	47.36	48.71	54.59	55.19	53.17	50.81
5	51.06	47.34	47.44	47.15	49.59	49.66	49.95	48.88
6	47.36	47.69	39.95	44.56	43.65	43.81	42.26	44.18
7	66.98	55.59	58.73	60.27	61.92	57.79	58.18	59.92
8	44.73	43.18	37.90	42.71	43.86	42.57	45.10	42.86
9	32.82	39.51	45.17	50.25	50.02	46.39	51.20	45.05
10	41.20	44.08	36.94	46.44	55.67	57.32	53.38	47.86
Average	47.40	47.08	47.01	47.84	48.77	48.70	50.24	*48.15

* $M \pm m$ is in the right percentage $48.15 \pm 0.75\%$ and in the left percentage $51.85 \pm 0.75\%$.

The average value of the right percentage in each case is in case 7 (59.92%) the highest, then come case 4, 5, 10, 1, 3, 2, 9 and 6, being the lowest (42.86%) in case 8. In the former 2 cases it is higher than 50.00%.

Levator palpebrae superioris shows the right percentage over 50.00% in 5 out of 10 cases, Obliquus superior in 4 cases, Rectus superior, Rectus lateralis and Obliquus inferior in 3 cases, Rectus inferior in 2 cases and Rectus medialis in 1 case. The average value of the right percentage in each kind of muscles is the greatest in Levator palpebrae superioris (50.24%), followed in order by Obliquus superior, Obliquus inferior, Rectus inferior etc., Rectus lateralis represents the lowest (47.01%) and in 6 kinds of muscles the average value is lower than 50.00%, as indicated in Table 34.

The average value of the right and left percentage in all examined muscle pairs is $48.15 \pm 0.75\%$ and $51.85 \pm 0.75\%$. There is a significant difference between the right and left averaged percentage, so that it may be said that between the right and left muscles a significant difference regarding the size of peripheral fine fibres is found.

Among the total 70 muscle pairs the difference between the right and left percentage varies from 0.04% (Obliquus superior of case 9) to 34.36% (Rectus superior of case 9). The difference lower than 10.00% show seven pairs in case 3 and 5, six pairs in case 4, five pairs in case 2 and 9, two pairs in case 1, 6 and 10, one pair in case 8 and no pair in case 7. Accordingly, in 37 out of 70 muscle pairs this difference is smaller than 10.00%. Presuming that in the muscle pairs with a difference lower than 10.00% the size of peri-

Table 35. Difference between the right and left percentage in each case (peripheral fine fibres).

Case	Rs	Rm	Rl	Ri	Os	Oi	Lps	Average
1	3.54%	7.34%	15.16%	12.28%	26.46%	18.82%	13.92%	13.93%
2	14.16	1.80	4.08	6.72	8.26	10.16	9.90	7.87
3	4.80	2.22	8.04	4.40	8.48	2.48	5.72	5.16
4	4.96	1.76	5.28	2.58	9.18	10.38	6.34	5.78
5	2.12	5.32	5.12	5.70	0.82	0.68	0.10	2.84
6	5.28	4.62	20.10	10.88	12.70	12.38	15.48	11.63
7	33.96	11.18	17.46	20.54	23.84	15.58	16.36	19.85
8	10.54	13.64	24.20	14.58	12.28	14.91	9.80	14.28
9	34.36	20.98	9.66	1.50	0.04	7.22	2.40	10.88
10	17.60	11.84	26.12	7.12	11.34	14.64	6.76	13.63
Average	13.13	8.07	13.52	8.63	11.34	10.73	8.68	*10.59

* $M \pm m = 10.59 \pm 0.92\%$.

peripheral fine fibres in the right and left same named muscles are closely related each other, it might be said that in 37 out of 70 pairs the size of the peripheral fine fibres in the right and left muscles resemble each other and that in five cases the right and left muscles show in the majority of seven muscle pairs similar size of fine fibres (Table 35).

The average value of the difference between the right and left percentage in each case is the largest in case 7 (19.85%) and the smallest in case 5 (2.84%). It is smaller than 10.00% in case 2, 3, 4 and 5.

In seven kinds of ocular muscles the average difference is the largest in Rectus lateralis (13.52%), then come Rectus superior, Obliquus superior etc., and the smallest in Rectus medialis (8.07%).

The average value of this difference obtained in 70 examined muscle pairs is $10.59 \pm 0.92\%$. From this it may be concluded that the extent of the difference of the size of peripheral fine fibres between the same named muscles on both sides corresponds in average to $10.59 \pm 0.92\%$ of the sum of the size of peripheral fine fibres in the two muscles and that the difference seems here to be smaller than that of the axial thick fibres.

Presuming that the average value of the size of peripheral fine fibres in the right and left same named muscles in one individual ($\frac{R+L}{2}$) represents the size of peripheral fine fibres in the corresponding muscles of the corresponding individual and presuming that the average value of the size of peripheral fine fibres in the same named muscles in individuals of the same sex and age presents the size in the corresponding muscles in the corresponding sex and age, the Table 36 was obtained.

Table 36. Size of peripheral fine fibres in each fetal month and sex.

Sex	Age	Case	Rs	Rm	Rl	Ri	Os	Oi	Lps	Average
			sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ
♂	7 m	1	69.1	58.0	40.9	45.0	58.2	51.0	52.1	53.6
	8 "	3	68.8	60.8	65.5	61.3	63.2	67.5	68.2	65.0
	9 "	5	101.3	95.1	101.6	101.7	102.6	95.1	99.1	99.5
	10 "	7, 8	87.4	70.5	82.2	76.7	74.9	74.2	74.6	77.2
♀	7 m	2	97.2	88.4	96.7	93.7	98.6	99.0	92.5	95.2
	8 "	4	64.6	71.2	62.6	66.0	74.0	73.2	70.9	68.9
	9 "	6	77.7	74.8	99.0	86.9	84.3	83.7	90.4	85.3
	10 "	9, 10	111.3	90.0	109.6	101.5	95.3	92.4	95.4	99.4

In order to compare the size of peripheral fine fibres between the male and female fetuses at the same age, I calculated in each kind of muscle the proportion of the size between the male and female fetuses of the same age

(male/female). These findings are represented in Table 37. In the 9th month this proportion is in all kinds of ocular muscles higher than 1.00, while in the 7th and 10th month all kinds of muscles and in the 8th month 5 out of 7 kinds of muscles show the difference lower than 1.00. The average value of this proportion in each fetal month is only in the 9th month greater than 1.00 and in each kind of ocular muscle it is all lower than 1.00. From these findings it is apparent that the size of peripheral fine fibres is in the majority of cases in the ocular muscles of the female fetuses greater than in that of the male fetuses of the same age, though the male fetuses were in general better nourished and developed than the female fetuses of the same age, as shown in Table 1.

Table 37. Proportion of the size of peripheral fine fibres between the male and female fetuses of the same age (♂/♀).

Age	Rs	Rm	Rl	Ri	Os	Oi	Lps	Average
7 m	0.71	0.66	0.42	0.49	0.59	0.52	0.56	0.56
8 "	1.07	0.85	1.05	0.93	0.85	0.92	0.96	0.95
9 "	1.30	1.27	1.17	1.22	1.22	1.14	1.10	1.20
10 "	0.79	0.78	0.75	0.76	0.79	0.80	0.78	0.77
Average	0.97	0.89	0.85	0.85	0.87	0.85	0.85	0.87

Supposing that the average value of the size of peripheral fine fibres in all the same named muscles in fetuses of the same age represents the size of the fine fibres in the corresponding muscles of the corresponding age, the Table 38 was obtained. This table shows that the size of peripheral fine fibres in Rectus superior is in the 8th month the smallest and in the 10th month the greatest, whereas in the other 6 kinds of muscles in the 8th month the lowest and in the 9th month the highest. The average value of the size in each month is the least in the 8th month, then come the 7th and 10th month and the greatest in the 9th month.

Table 38. Size of peripheral fine fibres in each fetal month.

Age	Case	Rs	Rm	Rl	Ri	Os	Oi	Lps	Average
		sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ
7 m	1, 2	83.1	73.1	68.8	69.7	78.4	75.0	72.3	74.3
8 "	3, 4	66.7	66.0	64.1	63.7	68.6	70.4	69.6	67.0
9 "	5, 6	89.5	84.9	100.3	94.2	93.5	89.4	94.8	92.4
10 "	7, 8, 9, 10	99.3	80.3	95.9	89.1	85.1	83.3	85.0	88.3

According to Kato (1938), the peripheral fine fibres in the ocular muscles of a newborn baby possess in general a similar size with those of my 10 months fetuses (4 cases, 8 body-sides), as demonstrated in Table 39.

Table 39. Size of peripheral fine fibres.

Muscles	Authors and materials	Kato (Newborn baby)	Hayashi (10 months fetuses)
Rectus superior		87 sq. μ	99.3 sq. μ
Rectus medialis		141	80.3
Rectus lateralis		60	95.9
Rectus inferior		90	89.1
Obliquus superior		47	85.1
Obliquus inferior		81	83.3

If the size of peripheral fine fibres in each ocular muscle in the 8th-9th month is represented with the percentage against the size in the corresponding muscles in the 7th month, the findings as in Table 40 are obtained. This table indicates that the size of peripheral fine fibres has a tendency to increase with the age. In the 10th month the increase of the size reaches about 110-140% of the size in the 7th month. From this findings it may be concluded that the axial thick fibres in the ocular muscles increase in size more markedly with the age than the peripheral fine fibres.

Table 40. Proportion of the size of peripheral fine fibres in each fetal month.

Age	Rs	Rm	Rl	Ri	Os	Oi	Lps
7 m	100	100	100	100	100	100	100
8 "	80	90	93	91	88	93	96
9 "	108	116	146	135	119	119	131
10 "	119	110	139	128	108	111	118

If the size of the ocular muscles are divided by the number of muscle fibres, of which the muscles consist, the quotient indicates the presumptive size of muscle fibres in the ocular muscles, under the presumption that in the ocular muscles there exists no connective tissue and every muscle fibres have the same size. The Table 41 shows the presumptive size of muscle fibres in 7 kinds of ocular muscles in each body-side and the Table 42 indicates that in each fetal month. If the presumptive size of muscle fibres in each ocular muscle in the 8th-10th month is represented with the percentage against the size in the 7th month, the findings as in Table 43 are obtained. From this table it is apparent that the presumptive size is in the 8th-10th month in the majority of cases slightly smaller than 100, which leads to the conclusion

that the extent of increase of the number of muscle fibres is a little greater than that of the size of ocular muscles.

Table 41. Presumptive size of muscle fibres.

Case and side of the body		Rs	Rm	RI	Ri	Os	Oi	Lps	Average	Max. Min.
		sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	
1	r	229.6	231.9	200.4	249.7	205.8	173.4	222.4	216.2	1.44
	l	238.4	182.1	165.3	219.4	298.0	217.2	177.9	214.0	1.80
2	r	214.1	204.8	241.8	199.0	233.9	320.4	240.6	236.4	1.61
	l	260.7	204.1	230.2	175.1	252.1	270.1	149.7	220.3	1.80
3	r	204.2	127.8	207.8	174.0	165.9	206.3	265.0	193.0	2.07
	l	203.3	170.8	174.9	138.4	184.4	140.7	172.1	169.2	1.47
4	r	209.8	168.7	231.3	185.0	155.0	247.9	231.4	204.2	1.60
	l	132.8	144.8	134.3	102.4	191.6	155.0	174.8	148.0	1.87
5	r	186.2	156.2	180.4	168.2	154.3	206.9	585.8	234.0	3.80
	l	160.1	196.0	201.2	175.0	141.5	217.8	226.7	188.3	1.60
6	r	226.7	196.9	176.8	129.4	161.1	279.1	229.1	199.9	2.16
	l	67.6	120.7	103.7	101.0	182.7	154.4	135.2	123.6	2.79
7	r	121.0	68.8	88.8	76.8	101.1	96.5	127.6	97.2	1.85
	l	160.8	88.4	143.6	141.1	213.8	239.3	145.3	161.8	2.71
8	r	154.4	167.4	209.7	137.3	209.6	315.7	258.1	207.5	2.30
	l	154.4	276.4	193.0	135.6	159.6	207.8	227.3	193.4	2.04
9	r	347.4	266.6	417.6	278.5	261.2	385.6	328.8	326.5	1.60
	l	294.3	258.6	496.4	286.2	210.8	223.8	398.8	309.8	2.35
10	r	208.0	183.6	266.0	200.2	208.0	239.3	146.0	207.3	1.82
	l	203.6	200.0	277.5	218.6	183.7	270.8	163.7	216.8	1.70
Average		198.9	180.7	217.0	174.5	193.7	228.4	230.3	203.4	2.01

Table 42. Presumptive size of muscle fibres in each fetal month.

Age	Case	Rs	Rm	RI	Ri	Os	Oi	Lps	Average
		sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ	sq. μ
7 m	1, 2	235.7	205.7	202.7	210.8	247.5	225.0	188.7	216.7
8 "	3, 4	187.5	153.0	187.1	155.0	174.2	187.5	210.8	179.3
9 "	5, 6	160.2	167.5	165.5	143.4	159.9	214.6	294.2	186.5
10 "	7, 8, 9, 10	205.5	188.7	261.6	184.3	193.5	247.4	224.5	215.1
Average		197.2	178.7	204.2	173.4	193.8	218.6	229.6	199.4

Table 43. Proportion of the presumptive size of muscle fibres in each fetal month.

Age	Rs	Rm	RI	Ri	Os	Oi	Lps
7 m	100	100	100	100	100	100	100
8 "	80	74	92	74	70	112	112
9 "	68	81	82	68	65	95	156
10 "	87	92	129	87	78	110	119

V. Conclusions.

Attempts have been already made to describe my observations and results. These findings will be summarized as follows :

1. The most ocular muscles consist of two kinds of muscle fibres, namely axial thick and peripheral fine fibres.

2. The size of muscle fibres in the ocular muscles is subject to fluctuation not only with different muscles, but also with different individuals and body-sides to which the muscles belong. The greatest size of muscle fibres is in axial part 507.2 sq. μ and in peripheral part 199.2 sq. μ , while the smallest is in the former 97.8 sq. μ and in the latter 34.7 sq. μ .

3. The proportion between the size of axial thick fibres and peripheral fine fibres in an ocular muscle is on the average in all kinds of ocular muscles almost the same and the axial fibres are in general in all kinds of muscles about 3 times thicker than the peripheral fibres.

4. There is seen a variation of the size of muscle fibres between the ocular muscles on one body-side. The proportion between the highest and the lowest size on one body-side varies in axial part from 1.08 to 2.45, corresponding to the average value of 1.67. It lies in peripheral part between 1.07 and 2.12, presenting the average value of 1.41. These facts indicate that the variation of the size of peripheral fine fibres among 7 ocular muscles on one body-side is very small and smaller than that of the size of axial thick fibres.

5. Between the same named muscles on both sides, there is a somewhat high correlation with regard to the size of muscle fibres. The correlation coefficient is in axial part 0.79 ± 0.045 and in peripheral part 0.58 ± 0.079 .

6. The order of the size of muscle fibres in axial as well as in peripheral part of the ocular muscles varies according to each body-side and each fetus. There is no fetus which shows the same order on both sides.

7. The size of axial thick fibres is in general the largest in Rectus lateralis, followed in order by Rectus superior, Rectus medialis, Obliquus inferior, Rectus inferior and Obliquus superior, being the smallest in Levator palpebrae superioris, although the order is not always the same on each body-side. The order of the size of peripheral fine fibres is not the same with that of axial thick fibres and ranges as follows : Rectus superior, Rectus lateralis, Obliquus superior, Levator palpebrae superioris, Rectus inferior, Obliquus inferior and Rectus medialis.

8. The right percentage, i.e., the percentage of the size of muscle fibres in a right muscle to the sum of the size of fibres in the two corresponding muscles on both sides, is in axial part in 42 and in peripheral part in 21 out

of 70 muscle pairs higher than 50.00%. The average value of the right and left percentage is in axial part $51.30 \pm 0.96\%$ and $48.70 \pm 0.96\%$, and in peripheral part $48.15 \pm 0.75\%$ and $51.85 \pm 0.75\%$. In the axial part, there is no significant difference between the right and left percentage, while in the peripheral part a significant difference is found. From this it may be said, that with regard to the size of axial thick fibres the right and left muscles show no significant difference between them, whereas the size of peripheral fine fibres is generally in the left muscles greater than in the right muscles.

9. The difference between the right and left percentage, i.e., the percentage of the difference of the size of muscle fibres between the right and left same named muscles against the sum of the size of fibres in the two muscles, varies in axial part from 1.22% to 41.20%, and lies in peripheral part between 0.04% and 34.36%. The difference is in axial part in 27 and in peripheral part in 37 out of 70 muscle pairs lower than 10.00%.

10. The average value of this difference in the 70 examined muscle pairs is in axial part $13.83 \pm 1.07\%$ and in peripheral part $10.59 \pm 0.92\%$. It is therefore right to declare that with regard to the size of muscle fibres the difference between the same named muscles on both sides comes in average to $13.83 \pm 1.07\%$ (axial thick fibres) and $10.59 \pm 0.92\%$ (peripheral fine fibres) for the sum of the size of muscle fibres in the two corresponding muscles. As these figures indicate, the size of peripheral fine fibres in the same named muscles on both sides is more closely related with each other than that of the axial thick fibres.

11. In the examined fetuses, the size of axial thick fibres as well as of peripheral fine fibres is in the majority of cases in the female fetuses larger than in the male fetuses of the same age.

12. The size of muscle fibres shows in the examined fetal stages a tendency to increase with increasing age and the increase is in axial thick fibres of higher degree than in peripheral fine fibres.

13. The extent of the increase of the size of ocular muscles is a little smaller than that of the number of muscle fibres in them.

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The literature cited therein will appear in the last report of this investigation.