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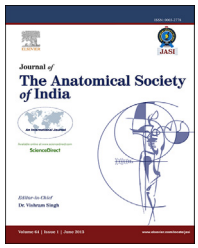

Original Article

Anatomy and variations of plantaris muscle in fetuses

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ARTICLE INFO

Article history:
Received 17 November 2014
Accepted 18 April 2015
Available online 12 May 2015

Keywords:
Fetal development
Morphometry
Plantaris muscle
Anatomy
Variations

ABSTRACT

Introduction: We have aimed at researching into the morphometric development and variations of the plantaris muscle and its tendon throughout the fetal period and comparing them with the results of the study performed on adults.
Method: A total of 102 fetal legs (51 human fetuses: 26 male, 25 female) whose ages varied between 15 and 40 gestational weeks without any external pathology or anomaly were incorporated in the study. The fetuses were divided into groups according to gestational weeks, trimesters and months. After the general external measurements of the fetuses had been made, the leg dissection was performed. Later on, the morphometric parameters of plantaris muscle were measured.
Results: The averages and standard deviations of the measured parameters were determined according to gestational weeks, trimesters and months. There was a significant correlation between the measured parameters and the gestational age ($p < 0.001$). There was no difference between genders in terms of parameters ($p > 0.005$). All the obtained results were discussed by making comparisons with the previous studies.
Discussion: We are of the opinion that the data obtained in our study will be of use to the involved clinicians in the evaluation of the development of plantaris muscle, and in the clinical studies and practices.

1. Introduction

Plantaris muscle is a small, fusiform and flexor muscle of the posterior compartment of the leg. Starting from linea supracondylaris lateralis and ligamentum popliteum, this muscle is found between gastrocnemius and soleus muscles. With 7–10 cm long belly part, the muscle runs downwards and inwards, and once it reaches the upper side of soleus muscle, it extends downwards in the form of a thin and long

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http://dx.doi.org/10.1016/j.jasi.2015.04.013

tendon, after which it ends up at calcaneus by running downwards along the medial side of calcaneal tendon.[1–5] It rarely ends up at retinaculum flexorum or on the superficial fascia of the leg.[1,2,4] Analogous to the lower extremity of palmaris longus muscle, plantaris muscle is rudimentary in humans, and its size varies. Plantaris muscle can be quite important clinically, and it may sometimes be dual or may not be found in 10% of the cases.[1,2,4,6,7] The tendon of plantaris muscle is also used as a perfect graft.[2,4,8] Separately, since the tendon of this muscle is long and flat, it may easily be mistaken for a nerve. For this reason, the tendon in question is also referred to as the "Freshman nerve".[2,5,9] It is quite necessary to have the knowledge of the anatomy of plantaris muscle in order to establish the clinical diagnosis of muscle ruptures and interpret the magnetic resonance images (MRI).[3,4] Additionally, it is important for the surgeons to have the knowledge of the initial position of plantaris muscle to evaluate the tendon transfer operations.[3] Plantaris muscle and tendon ruptures have always been a matter of discussion, because it is difficult to diagnose the plantaris muscle and tendon ruptures clinically due to the fact that it is located between gastrocnemius and soleus muscles.[5,10] Since the muscle and tendon ruptures are accompanied by the clinical findings, such as hemorrhage and haematoma or the muscle and tendon ruptures copy these findings, the diagnosis of plantaris muscle and tendon ruptures are clinically important.[4,11]

Apart from the study on the morphometry of plantaris muscle, performed by Yildiz et al,[2] we have never come across another study conducted during the fetal period. The conducted studies mainly comprised the anatomical, morphometric, ultrasonographic and variational studies performed on adult cadavers and adult humans.[3–6,8,10]

Yildiz et al,[2] in the study they conducted, aimed at researching into the plantaris muscle morphometry and variations on 24 fetuses and comparing the obtained results with those performed on adults. Rana et al[4] and Nayak et al,[3] in the study they conducted on adult cadavers, touch on the variations regarding plantaris muscle and their clinical importance.

Alagoz et al,[8] in the study they conducted on adult cadavers, aimed at comparing the tendon grafts in donors, measuring them and estimating the sizes of these tendons prior to the operation. Leekam et al,[10] in their study, aimed at finding out the diagnosis of plantaris muscle and tendon injuries through the ultrasonographic method. On the other hand, Spina et al,[5] in their studies, aimed at preparing a draft on the plantaris muscle anatomy, injury and treatment, and imaging them for diagnostic purposes.

In our study, different from the others, we aimed at researching into the morphometry and variations of plantaris muscle and its tendon throughout the fetal period by using the anatomical dissection method on a large scale and comparing them with the results of the study performed on adults.

2. Material and method

The study comprised of 102 fetuses leg (51 fetuses: 26 males, 25 females) at a gestational age of 15–40 weeks; the fetuses were obtained from the prenatal period or after abortion. All were spontaneous abortions or stillbirths and neonatal deaths (died owing to premature or prenatal asphyxia) obtained from Isparta Maternity and Paediatric Hospital during 1996–2013. In order to use the fetuses as experimental materials, the signed consents were obtained from the families and the experimental procedures were ethically approved by the official laws and regulations of Turkish Ministry of Health. The fetuses with external pathology or anomalies and those cases with anomalies (omphalocel, gastroschisis, diaphragm hernia, Meckel diverticulum, colon malposition, renal agenesis, ectopic kidneys, agenesis of external genitalia, etc.) after dissection were also not studied.

Gestational ages of the fetuses were determined using crown-rump length (CRL), bi-parietal diameter (BPD), head circumference (HC), femur length (FL) and foot length.[12] Fetuses were assigned to one of three groups according to their gestational ages: Group I (2nd trimester, 15–25 weeks), Group 2 (3rd trimester, 26–37 weeks) and Group 3 (4th trimester, 38–40 weeks). Fetuses were also divided into 7 groups according to their gestational age in months; fetuses aged 13–16, 17–20, 21–24, 25–28, 29–32, 33–36, and 37–40 weeks were assigned to 4, 5, 6, 7, 8, 9, and 10-months groups, respectively.

First of all, a leg dissection was performed through the anatomical dissection method in all the fetal materials. By removing the skin and the subcutaneous layer of fat on the posterior part of the leg, the sural nerve, gastrocnemius muscle caput mediale and caput laterale, soleus muscle and calcaneal tendon were made visible. Afterwards, the plantaris muscle was made visible by lifting up gastrocnemius muscle. In the study, the priority was given to the initial location of plantaris muscle, its variational characteristics, whether the plantaris muscle tendon joined tendo calcaneus or not and the ultimate location of the tendon, after which the morphometric parameters of plantaris muscle were measured. The measurements of the macroscopic parameters used in the study were taken with the help of a digital compass. **The Morphometric Parameters Taken in the Study:**

Length of the leg: The vertical distance between the midpoint of the knee joint and the midpoint of the malleolus medialis.
The muscular belly length of plantaris muscle: The vertical distance between the transverse axis passing by the initial and ultimate points of plantaris muscle.
The muscular belly width of plantaris muscle: The widest transverse distance between the vertical axis passing by the internal and external sides of plantaris muscle.
The muscular belly thickness of plantaris muscle: The largest sagittal distance between the transverse planes passing by the frontal and posterior parts of plantaris muscle.
The tendon length of plantaris muscle: The vertical distance between the transverse axis passing by the initial and ultimate points of the tendon.

By utilizing the SPSS statistical program, the averages and standard deviations of the parameters according to genders, gestational age and groups were ascertained. The significance level in the statistical analysis was taken as $p < 0.05$. The

Table 1 – Frequency of absence of plantaris muscle with respect to sides and genders n (%).

Groups	N	Bilateral agenesis	Unilateral agenesis		
Male	26	9 (34.61)	4 (15.38)	Right	3 (75)
				Left	1 (25)
Female	25	7 (28)	2 (8)	Right	–
				Left	2 (100)
Total	51	16 (31.37)	6 (11.7)	Right	3 (50)
				Left	3 (50)

$p > 0.05$: no differences between sides. $p < 0.05$: differences between genders. Bilateral absence was more common than unilateral absence in all case ($p < 0.001$).

parametric values given in accordance with the groups were shown with the average + standard deviation. In the comparison of the groups, non-parametric tests were used due to the scarcity of the number of cases in some groups. Firstly, the Kruskal–Wallis variance analysis was performed. As the result of this analysis, the groups regarded as significant were compared in groups of twos by means of Mann–Whitney U test. The levels of significance were assessed through the Bonferroni Correction. The relationships between the parameters taken and the gestational age (week) were determined through the use of Pearson correlation test. In the inter-gender and inter-side comparison of the parametric data, the Student-T test (in total for all the cases) and Mann–Whitney U test (within each group while comparing separately) were utilized. The values, p obtained were given in the findings section and under the tables involved.

2.1. *Findings*

First of all, the general external measurements of the fetuses were made, after which the dissection of the posterior leg was performed. By removing the skin and the subcutaneous layer of fat on the posterior part of the leg, the sural nerve, gastrocnemius muscle caput mediale and caput laterale, soleus muscle and calcaneal tendon were made visible. Afterwards, the plantaris muscle was made visible by lifting up gastrocnemius muscle. At the end of the examination, it was determined that plantaris muscle was not bilateral in 16 out of 102 cases (15, 6%) and not unilateral in 6 of them (6, 9%). It was observed that 9 (56, 25%) of those with bilateral agenesis were

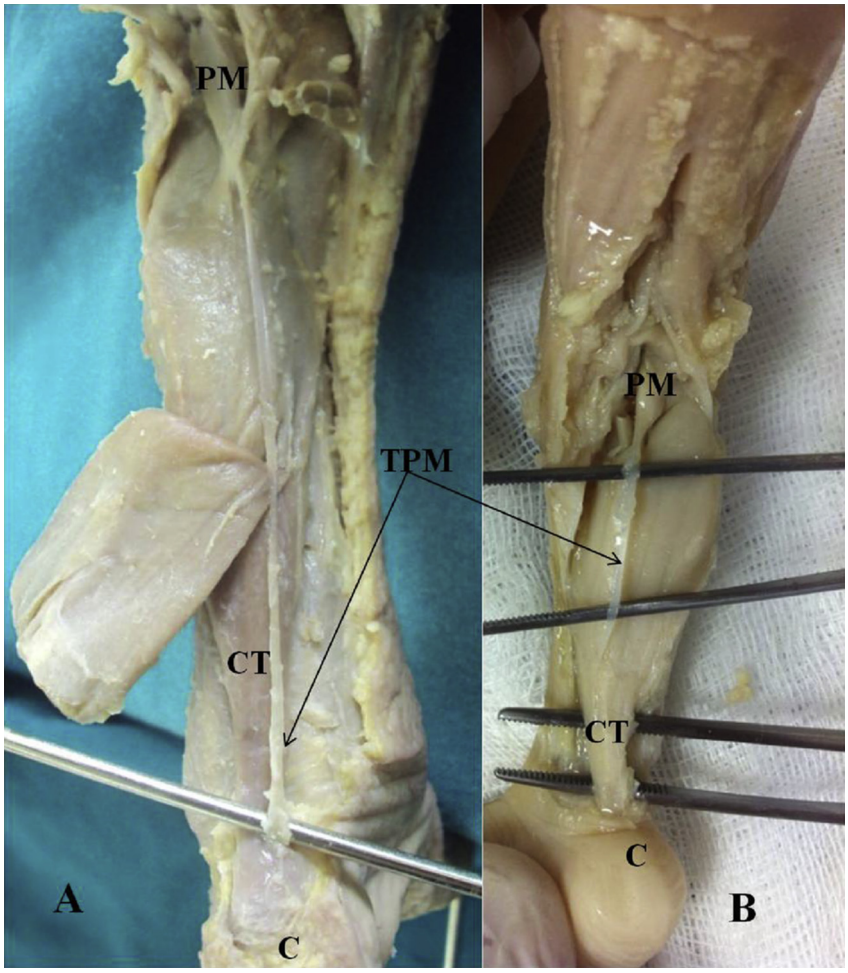


Fig. 1 – The picture illustrates the relationship between tendon of plantaris muscle (TPM) and calcaneal tendon (CT). A: From the posterior aspect of the left leg. Tendon of plantaris muscle has not integrated into calcaneal tendon, B: From the posterior aspect of the right leg. Tendon of plantaris muscle has integrated into calcaneal tendon. C: calcaneus, PM: plantaris muscle.

Table 2 – The averages of the parameters of plantaris muscle according to age (weeks) (mm).

Age (weeks)	N	Length of the leg	The muscular belly length of plantaris muscle	The muscular belly width of plantaris muscle	The muscular belly thickness of plantaris muscle	The tendon length of plantaris muscle
15. weeks	2	28.01	5.36	1.38	0.39	24.34
16. weeks	2	30.31	5.96	1.43	0.40	25.31
17. weeks	4	33.61	6.37	1.77	0.46	26.05
18. weeks	4	35.97	6.72	1.88	0.50	27.01
19. weeks	4	38.98	7.47	1.97	0.61	28.55
20. weeks	4	40.71	8.53	2.29	0.69	29.64
21. weeks	4	43.80	9.24	2.78	0.77	31.30
22. weeks	4	46.53	9.78	2.85	0.85	33.51
23. weeks	4	48.41	10.45	3.29	0.92	35.68
24. weeks	4	50.93	10.97	3.33	1.08	38.45
25. weeks	4	52.09	11.77	3.69	1.18	40.91
26. weeks	4	54.23	12.28	4.01	1.26	43.51
27. weeks	2	56.78	13.08	4.28	1.37	45.45
28. weeks	6	58.54	14.55	4.36	1.51	48.21
29. weeks	2	60.69	15.52	4.67	1.74	50.76
30. weeks	4	63.67	16.51	4.91	1.91	53.29
31. weeks	4	65.99	17.72	5.21	2.14	56.52
32. weeks	2	67.93	18.88	5.65	2.27	59.56
33. weeks	2	69.06	19.91	5.88	2.41	61.52
34. weeks	4	71.89	20.76	6.15	2.59	63.60
35. weeks	4	72.30	21.65	6.32	2.75	66.29
36. weeks	2	74.61	22.49	6.87	2.90	69.16
37. weeks	2	76.82	23.14	7.52	3.03	71.68
38. weeks	4	78.28	24.42	7.89	3.12	73.59
39. weeks	2	79.40	25.13	8.13	3.24	75.73
40. weeks	2	80.89	26.10	8.42	3.33	77.02

$p > 0.05$: no differences between genders.

male, whereas 7 of them (43, 75%) were female fetuses. On the other hand, 4 (66, 6%) of those with unilateral agenesis were determined to be male, while 2 of them (33, 4%) were female. 3 of the unilateral ageneses in male fetuses were observed in the right leg and 1 in the left leg (Table 1). Both of the unilateral ageneses in female fetuses were observed in the left leg. It was ascertained in our study that there were more bilateral agenesis compared to unilateral ones, which were also statistically significant ($p < 0.001$, Table 1).

Separately, it was monitored that 11(55%) plantaris muscle tendons in the right leg joined the structure of calcaneal tendon, while 9 (23, 2%) of them in the left leg joined it. It was determined that 7 (63, 6%) of the tendons in the right leg belonged to the female fetuses, whereas 4 (36, 4%) of them belonged to the male ones, and that 5 (55, 5%) of the tendons in the left leg belonged to the female fetuses, while 4 (44, 5%) of them belonged to the male ones (Fig. 1A, B).

Later on, the leg lengths of the fetuses and the morphometric measurements of plantaris muscle and its tendon were taken. The averages and standard deviations of these measurements taken were determined according to weeks, trimesters and months (Tables 2–4). There was a significant correlation between the measured parameters and the gestational age ($p < 0.001$). There was no difference in terms of

Table 3 – The averages and standard deviations of plantaris muscle parameters according to the trimesters (groups) (mm).

Groups (trimesters)	N	Length of the leg	The muscular belly length of plantaris muscle	The muscular belly width of plantaris muscle	The muscular belly thickness of plantaris muscle	The tendon length of plantaris muscle
Group 1 (15–25 weeks)	40	40.24 ± 9.22	8.00 ± 2.38	2.44 ± 0.83	0.56 ± 0.14	34.02 ± 9.18
Group 2 (26–37 weeks)	38	61.86 ± 10.83	12.67 ± 2.57	4.68 ± 1.07	0.99 ± 0.36	46.60 ± 1.49
Group 3 (38–40 weeks)	8	75.36 ± 23.90	15.97 ± 1.95	6.03 ± 1.04	1.21 ± 0.24	49.92 ± 15.65
Total (15–40 weeks)	86	53.86 ± 17.28	10.62 ± 3.62	3.68 ± 1.58	0.79 ± 0.36	41.50 ± 13.19

$p < 0.05$: Difference between trimesters (in the parameter of muscular belly thickness of plantaris muscle and in the length parameter of plantaris muscle tendon, apart from the 3rd–4th trimesters).

the parameters between the genders ($p > 0.005$). In the comparison between these parameters taken and the trimester groups, there was some difference in the thickness parameter of the plantaris muscle and the length parameter of the plantaris muscle tendon, except for the 3rd–4th trimesters ($p < 0.05$, Table 3). On the other hand, in the monthly comparison of the measured parameters, there was some difference in the leg length parameter, except for the months between 4.–5., 4.–6., 5.–6., 6.–7., 7.–8., 8.–9., 9.–10; and in the length parameter of plantaris muscle, except for the months between 4.–5., 4.–6., 6.–7., 8.–9; and in the width parameter of plantaris muscle, except for the months between 4.–5., 4.–6., 5.–6., 7.–8., 8.–9., 9.–10; and in the thickness parameter of plantaris muscle, except for the months between 4.–5., 4.–6., 4.–7., 6.–7., 8.–9., 9.–10; and in the length parameter of plantaris muscle tendon, except for the months between 4.–5., 4.–6., 4.–9., 5.–6., 5.–9., 6.–7., 6.–9., 6.–10., 7.–8., 7.–9., 7.–10., 8.–10., 9.–10 ($p < 0.05$, Table 4).

3. Discussion

It is important that the structure of plantaris muscle be known during the fetal period, since it can be stated that the pathologies seen in adults with respect to plantaris muscle may be related with the fetal development and that some pathologies, in fact, begin to occur during the fetal period. Separately, the diagnosis of plantaris muscle and tendon ruptures is both difficult to establish and clinically important due to the fact that the muscle and tendon ruptures are accompanied by the clinical findings, such as hemorrhage and haematoma, or that the muscle and tendon ruptures copy these findings.[4,n:11] Therefore, it is important that the anatomy of plantaris muscle be known right from the start of the fetal period. Considering the previous studies conducted on plantaris muscle, no detailed datum as to the fetal development of plantaris muscle and its tendon has been found apart from the study conducted on 24 fetuses by Yildiz et al.[2]

In our study, different from the previous ones, it was aimed that more detailed morphometric data regarding the fetal plantaris muscle and its tendon be obtained by using the anatomical dissection method. With the anatomical dissection performed, the localization of plantaris muscle was examined. As the result of the examination, it was determined that plantaris muscle was not bilateral in 16 out of 102 cases (15, 6%) and not unilateral in 6 of them (6, 9%) (Table 1). Yildiz et al,[2] in the study they conducted on 24 fetuses, state that there is no presence of plantaris muscle at a rate of 6.25%. On the other hand, in the studies conducted on adults, the absence of plantaris muscle was reported to be 5.8%,[8] 6.67%,[13] 7–20%,[14] 31%[15] and 5%.[16] The previous study results and the one obtained in our study were compared in Table 5. As the result of the comparison, our study result, while our study result was in concordance with the one conducted on adults by Simpson et al,[14] it does not accord with the other study results obtained from adults. We considered that this outcome was associated with endemically and ethnically different developmental process of plantaris muscle. Our study result does not accord with the one acquired from the fetuses used by Yildiz et al,[2] either, which, we thought, was associated with the fewer number of cases in the study conducted by Yildiz et al.[2] Furthermore, it was determined in our study that plantaris muscle was not seen to be unilateral by 11.7%. 50% of these cases were monitored in the right leg, whereas 50% of them were observed in the left leg (Table 1). Yildiz et al,[2] in the study they conducted on 24 fetuses, express that plantaris muscle is not present in the right leg by 8.3% and in the left leg by

Table 5 – Prevalence of the absence of plantaris muscle in different studies.

Study	Bilateral agenesis (%)
Our study	15.6
Yıldız et al.[2]	6.25
Alagoz et al.[8]	5.80
Daseler et al.[13]	6.67
Simpson et al.[14]	7–20
Harvey et al.[15]	31
Wehbe et al.[16]	5

Table 4 – The averages and standard deviations of plantaris muscle parameters according to months (mm).

Months	N	Length of the leg	The muscular belly length of plantaris muscle	The muscular belly width of plantaris muscle	The muscular belly thickness of plantaris muscle	The tendon length of plantaris muscle
4. month	4	29.46 ± 0.84	5.66 ± 0.73	1.57 ± 0.22	0.48 ± 0.07	26.18 ± 1.22
5. month	16	33.43 ± 5.89	6.49 ± 1.58	2.05 ± 0.67	0.51 ± 0.15	29.67 ± 4.36
6. month	16	43.83 ± 7.14	8.97 ± 2.18	2.72 ± 0.74	0.58 ± 0.14	37.59 ± 9.89
7. month	16	53.65 ± 3.82	10.67 ± 1.65	3.77 ± 0.82	0.70 ± 0.21	45.91 ± 8.90
8. month	12	59.94 ± 14.66	13.16 ± 2.44	4.47 ± 0.59	1.06 ± 0.39	52.38 ± 8.68
9. month	12	67.65 ± 4.64	13.79 ± 2.53	5.21 ± 1.15	1.15 ± 0.41	55.99 ± 8.68
10. month	10	74.21 ± 18.73	16.35 ± 1.41	6.12 ± 0.92	1.23 ± 0.22	58.33 ± 16.09

$p < 0.05$: Difference between months (in the leg length parameter, apart from the months between 4.–5., 4.–6., 5.–6., 6.–7., 7.–8., 8.–9., 9.–10.; in the parameter of muscular belly length of plantaris muscle, apart from the months between 4.–5., 4.–6., 6.–7., 7.–8., 8.–9.; in the parameter of the muscular belly width of plantaris muscle, apart from the months between 4.–5., 4.–6., 5.–6., 7.–8., 8.–9., 9.–10.; in the parameter of the muscular belly thickness of plantaris muscle, apart from the months between 4.–5., 4.–6., 4.–7., 5.–6., 5.–7., 6.–7., 7.–8., 8.–9., 8.–10., 9.–10.; and in the parameter of the tendon length of plantaris muscle, apart from the months between 4.–5., 4.–6., 5.–6., 6.–7., 7.–8., 7.–9., 7.–10., 8.–10., 9.–10.).

4.1%. The result we obtained in our study and that of Yildiz et al.[2] are not in accordance with each other, which was thought to be associated with the developmental process of plantaris muscle and the fewer number of cases in Yildiz et al[2] 's study. We have never come across any study as to whether or not the plantaris muscle tendon joined the formation of calcaneal tendon during the fetal period. There is information in reference books and in the studies conducted on adults that the tendon of plantaris muscle joins the formation of calcaneal tendon.[1,17–20] In our study, different from the others, we researched into whether or not the tendon of plantaris muscle joined the formation of calcaneal tendon throughout the fetal period in human fetuses. It was observed in consequence of the study that 11 plantaris muscle tendons (55%) in the right leg joined the calcaneal tendon structure, whereas 9 of them in the left leg (23, 2%) joined this formation. It was determined that 7 of those tendons in the right leg (63, 6%) belonged to female fetuses, while 4 of them (36, 4%) belonged to male ones; that, on the other hand, 5 of those tendons (55, 5%) in the left leg belonged to female fetuses, whereas 4 of them (44, 5%) belonged to male ones (Fig. 1A, B). We assumed that the reason for the difference between right-left legs and genders was associated with the developmental process of the plantaris muscle tendon and calcaneal tendon during the embryonal period. Moreover, we are of the opinion that the data obtained from our study will be of great use to the surgeons involved in this area and the clinicians involved.

The fetal period which starts from the 9th gestational week and lasts until delivery is the cycle in which the body grows up rapidly and the organs mature.[12] Like the other fetal formations, the dimensions of plantaris muscle also increase. In our study, parametric measurements were taken from human fetuses during the fetal period with respect to the morphometric development of plantaris muscle and its tendon (Tables 1–3). Considering the previous studies, we have only come across a morphometric study relative to plantaris muscle and its tendon, which was conducted on 24 human fetuses by Yildiz et al.[2] The other studies mainly comprised those conducted on adults.[9,21,22] The difference of our study from that of Yildiz et al is that it is more of a widely ranged anatomical study involving the morphometric development of plantaris muscle and its tendon between 15 and 40 weeks during the fetal period. Aragao et al,[21] in their study conducted on adults, note that the length of plantaris muscle is 11.38 cm, whereas the length of the tendon of plantaris muscle is 33.26 cm. Again, in another study on adults, it is reported that the length of the muscle is 9.5 cm, while the length of the tendon is 20 cm.[22] In reference books, on the other hand, the length of plantaris muscle is stated to vary between 7 and 13 cm.[1,9] In Table 6, we compared the results of the study by Yildiz et al[2] and those obtained from our study. As the result of the comparison, we determined that only apart from the result of the width parameter of plantaris muscle, the other study results showed difference, which, we thought, was associated with the developmental process of plantaris muscle and its tendon during the fetal period and the fewer number of fetuses used in the study.

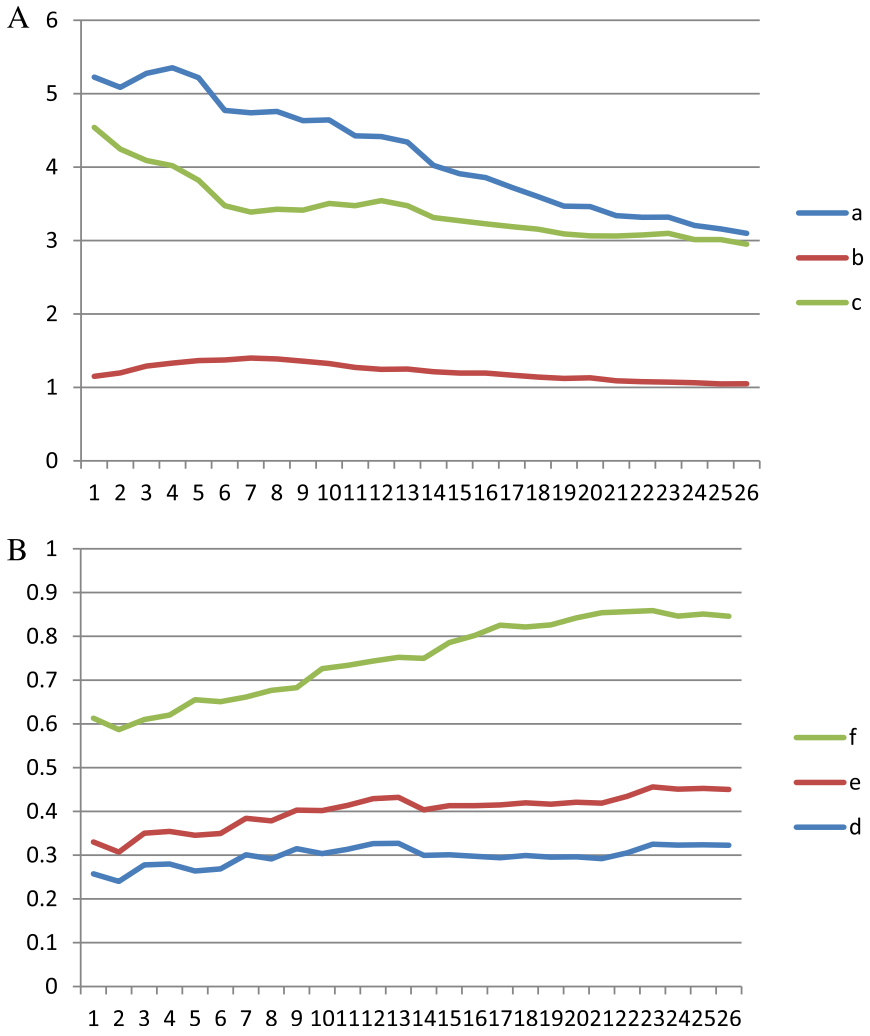
Separately, we assessed that the reason for the different outcomes in the studies on adults and in our study was that

Table 6 – The comparison of the morphometric study results by Yıldız et al[2] with the morphometric results obtained in our study for plantaris muscle and its tendon.

Trimesters	I. Trimester						II. Trimester						III. Trimester					
Parameters	The muscular belly length of plantaris muscle		The muscular belly width of plantaris muscle		The tendon length of plantaris muscle		The muscular belly length of plantaris muscle		The muscular belly width of plantaris muscle		The tendon length of plantaris muscle		The muscular belly length of plantaris muscle		The muscular belly width of plantaris muscle		The tendon length of plantaris muscle	
Sides	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
Yildiz et al.[2]	–	–	–	–	–	–	7.60	7.36	3.16	2.76	36.18	36.53	17.82	17.34	6.03	5.61	66.25	64.54
Our study	8.00		2.44		34.02		12.67		4.68		46.60		15.97		6.03		49.92	

the plantaris muscle and its tendon take their forms in an adult by proceeding their development after delivery.

In our study, different from the other ones, we examined the thickness of plantaris muscle throughout the fetal period (Tables 2–4). As the result of the study, we came to the conclusion that the muscle thickness increased with the age throughout the fetal period ($p < 0.001$, Table 2), which, we thought, was an important acquisition in terms of the functioning of the muscle. Aragao et al,[21] in their study on adults, express that the proportion of the muscle length to the length of the tendon is 0.3. On the other hand, Yildiz et al,[2] in their studies on fetuses, report that the proportion of the muscle length to the length of the tendon is 0.20 in the IInd trimester, while it is 0.26 in the IIIrd trimester. In our study, however, this proportion was determined to be 0.23 in the IInd trimester, 0.27 in the IIIrd trimester and 0.31 in the IVth trimester (full term). The results in our study are in concordance with the other study results. In our study, we also took into consideration the proportions of the taken parameters with each other throughout the fetal period (Graphic 1A, B). When we examined, in our study, the proportion of the muscle length to the leg length, we noticed that this proportion was in favor of the muscle length (Graphic 1A), which we interpreted in the way that the muscle, during the fetal period, developed more rapidly than the leg, and which, we thought, was a significant gain in terms of the functioning of the muscle. Separately, we examined the proportion of the tendon length to the leg length and determined that at first, this proportion was in favor of the leg length and then in favor of the tendon length, which, we thought, was associated with the development of structures during the fetal period (Graphic 1A). In our study, we also examined the proportion of tendon length to the muscle length (Graphic 1A). Consequently, we observed that this proportion was in favor of the muscle



Graphic 1 – A: The proportions of the parameters to each other, which were taken in our study (a: length of the leg/the muscular belly length of plantaris muscle, b: length of the leg/the tendon length of plantaris muscle, c: the tendon length of plantaris muscle/the muscular belly length of plantaris muscle). B: The proportions of the parameters to each other, which were taken in our study (d: the muscular belly width of plantaris muscle/the muscular belly length of plantaris muscle, e: the muscular belly thickness of plantaris muscle/the muscular belly length of plantaris muscle, f: the muscular belly thickness of plantaris muscle/the muscular belly width of plantaris muscle).

length, which we interpreted in the way that the muscle during the fetal period developed more rapidly than the tendon and thought that this was an important gain in terms of the functioning of the muscle. Afterwards, in our study, we examined the proportions of muscle width and muscle thickness to muscle length (Graphic 1B). Eventually, we ascertained that these proportions were in favor of the muscle width and muscle thickness. We concluded that this outcome was the reason for the fact that the muscle width and thickness during the fetal period developed more rapidly than the muscle length, which, in our opinion, was an important gain in terms of the functioning of the muscle.

In our study, we also examined the proportion of muscle thickness to the muscle width and observed that this proportion was in favor of the muscle thickness (Graphic 1B). We interpreted this in the way that the muscle developed more rapidly than the muscle width during the fetal period and concluded that the muscle thickness in the functioning of the muscle was more important within the parameters regarding muscles.

It is required that the anatomy and development of plantaris muscle with a clinically important role be well-known, since there are also studies which indicate that changes take place in the morphology of plantaris muscle along with the age.[12] Separately, it is of great importance for the pathologies and anomalies regarding plantaris muscle to be known well during the fetal period for the diagnosis and treatment of pathologies relative to plantaris muscle, such as absence of muscles or double muscles. For this reason, we think that the anatomical dissection is the method which allows for achieving more accurate and reliable results when compared with radiological methods during the fetal period. Hence, in our study, different from the others, detailed morphometric data in relation to the fetal plantaris muscle on a larger scale were dealt with. The findings in our study should be evaluated as a precursor study in order to evaluate the plantaris muscle through the obstetrical ultrasonography during the intrauterine period. We are also of the opinion that the findings in our study will be of use in the evaluation of the pathologies and anomalies related to plantaris muscle in the fetal autopsy materials.

In conclusion, we consider that in determining the anomalies, pathologies and variations regarding the development of plantaris muscle during the fetal period, the data obtained in our study will contribute to the studies in the scientific fields, such as obstetrics, perinatology, radiology, forensic medicine, and phytopathology as well as the diagnoses and treatments to be performed in this field.

Conflicts of interest

All authors have none to declare.

The authors declare this study has received no financial support.

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