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Original Article

Anatomy and variations of plantaris muscle in fetuses

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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.

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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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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 al⁴ 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 (omphalocele, 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

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