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Normal filum terminale thickness in newborns: sonographic screening

Yenidoğanda normal filum terminale kalınlığı; sonografik tarama

Mehmet Ozturk

Department of Pediatric Radiology, Diyarbakır Children's Hospital, Diyarbakır, Turkey

Abstract

Aim: The filum terminale is a fibrovascular structure formed of long bundles of 5-20 micron thickness bound to each other with collagen bands. The filum terminale ends between L5 and S3. Our aim in this study, the aim is to sonographically identify normal filum terminale thickness in newborns.

Materials and Methods: This prospective study included a total of 500 healthy mature newborn cases, comprising 250 males and 250 females. Sonographic Investigations were completed in the decubitus position, with all vertebrae and spinal cord from the cervical region to the sacral region screened in transverse and sagittal planes with cord pulsation and conus medullaris level assessed. The filum terminale thickness was measured a mean of 1.5 cm from the conus medullaris in the sagittal plane using ultrasound, with the mean calculated from three different measurements. Mean values were calculated for all of the cases and separately according to sex. Comparison between the groups was completed with the Independent Samples T test Bootstrap results.

Results: The maximum- minimum values for age were 30- 3 days for males, 30- 1 day for females and 30- 1 day for all newborns The filum terminale thickness was 1.04± 0.24 mm in males, 1.06± 0.17 mm in males and 1.05± 0.21 mm for all newborns. There was no statistically significant difference between the groups according to sex.

Conclusion: In conclusion, the mean filum terminale thickness in newborns was measured as 1.05 mm. This value is important as a threshold value for the diagnosis of pathologies causing thickening of the filum terminale.

Keywords: Newborn; Ultrasound; Filum Terminale.

Öz

Amaç: Filum terminale, 5-20 mikron kalınlığında uzunlamasına demetlerden oluşan ve kollajen bantlarla birbirlerine bağlanmış fibrovasküler bir yapıdır. Filum terminale L5 ile S3 arasında bir seviyede sonlanmaktadır. Bu çalışmada amacımız yenidoğanda sonografik olarak normal filum terminale kalınlığını saptamak.

Gereç ve Yöntem: Bu prospektif çalışmaya 250'si erkek ve 250'si kız olmak üzere toplam 500 sağlıklı matur yenidoğan olgu dahil edildi. Sonografik İncelemede; dekübit pozisyonda, servikal bölgeden itibaren sakral bölgeye kadar tüm vertebra ve spinal kord transvers ve sagittal planlarda tarandı, kord pulsasyonu ve konu medüllaris seviyesi değerlendirildi. Filum terminale kalınlığı ultrason ile konus medüllaristen ortalama 1.5 cm uzaklıkta, sagittal planda ölçülmüş olup, üç farklı ölçümün ortalaması alındı Olguların tamamında ve cinsiyetlere göre ayrı ayrı ortalama değerler hesaplandı. Grupların karşılaştırılmasında Independent-Samples T testi Bootstrap sonuçlarıyla birlikte kullanıldı.

Bulgular: Yaşın maksimum- minimum değerleri erkeklerde 30- 3 gün, kızlarda 30- 1 gün ve tüm yenidoğanlarda ise 30- 1 gün bulundu. Cinsiyet grubları arasında yaşa göre istatiksel anlamlı farklılık saptanmadı Filum terminale kalınlığı erkeklerde 1,04± 0,24 mm, kızlarda 1,06± 0,17 mm ve tüm yenidoğanlarda ise 1,05± 0,21 mm bulundu. Cinsiyete göre grublarası istatiksel anlamlı farklılık saptanmadı.

Sonuç: Sonuç olarak yenidoğanda filum terminale kalınlığı ortalama 1,05 mm ölçülmüştür. Bu değer filum terminalede kalınlaşmaya yol açan patolojilerin tanısında, eşik değer olması açısından önemlidir.

Anahtar Kelimeler: Yenidoğan; Ultrason; Filum Terminale.

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Correspondence/İletişim
Mehmet Ozturk
Department of Pediatric Radiology,
Diyarbakır Children's Hospital,
Diyarbakır, Turkey
E-mail: drmehmet2121@gmail.com

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INTRODUCTION

The filum terminale is a fibrovascular structure continuing from the conus medullaris and extending to the level of the second sacral vertebra. The development of the conus medullaris and filum terminale is the secondary neurolation process. Problems occurring during this developmental process may cause thickening of the filum terminale and tethering of the conus medullaris leading to a range of neurological problems, primarily incontinence (1).

Currently radiography, computed tomography (CT), ultrasound (US) and magnetic resonance imaging (MRI) are used to image the spinal cord and vertebrae in the newborn period. Radiography and CT involve ionizing radiation. MRI is accepted as the gold standard radiological method for evaluation of the spinal cord due to high resolution of soft tissues. In recent times, different studies have been published on the use of US for diagnosis of filum terminale pathologies (2, 3). Classic knowledge assesses filum terminale thickness above 2 mm as being pathologic (4). However, there is no specific threshold value measured with US during newborn period.

The aim of this study is to identify the normal filum terminale thickness sonographically in newborns and assess variation according to sex.

MATERIALS and METHODS

Cases

This prospective study was completed after receiving permission from the local clinical research ethics committee. The study included a total of 504 normal mature newborns, 252 male and 252 female, born between 38- 42 weeks, ages ranging from 1- 30 days, with no abnormal physical examination findings. The patients were evaluated with spinal US from October 2015 to April 2016. Prior to evaluation, "informed consent" was obtained from the parents of all cases that were included in the study. During investigations, 2 cases with high conus medullaris and 2 cases with no spinal cord pulsation were excluded from the study. Cases with history of prematurity and abnormal physical examination (like sacral dimple) were also excluded from the study.

Ultrasound Investigation

All cases were examined with a 4.8-11.0 mHz linear transducer Aplio™ 500 (Toshiba Medical Systems Co. Ltd, Otawara, Japan) ultrasound device operated by a pediatric radiology expert (5 years experience of pediatric radiology). Investigations were completed in the decubitus position, with all vertebrae and spinal cord from the cervical region to the sacral region screened in transverse and sagittal planes with cord pulsation and conus medullaris level assessed. The filum terminale thickness was measured a mean of 1.5 cm from the conus medullaris in the sagittal plane, with the mean calculated from three different measurements (Figure 1).

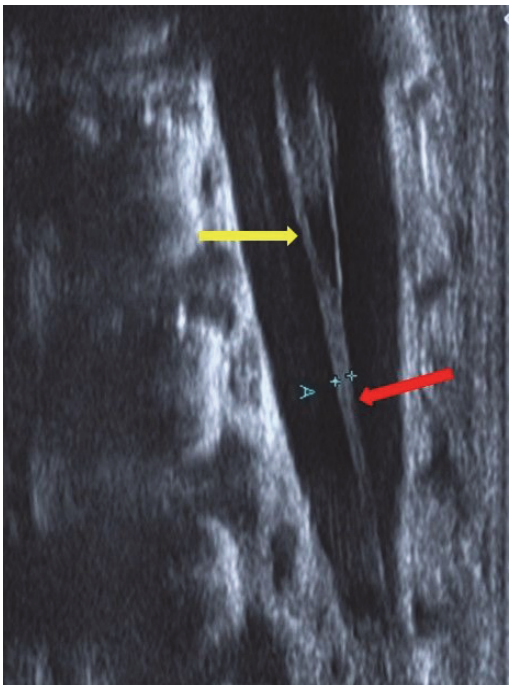

Figure 1. The filum terminale thickness was measured a mean of 1.5 cm from the conus medullaris in the sagittal plane (between +'s), filum terminale (red arrow) and conus medullaris (yellow arrow).

Statistical Analysis

For data analysis the SPSS 22.0 (IBM Corporation, Armonk, New York, United States) program was used. Data were tested for normal distribution with the Shapiro-Wilk test and variance coefficients and variance homogeneity was assessed with the Levene test. Comparison of two independent groups was conducted with the Independent samples T test Bootstrap results. Quantitative data are given in the table as mean ± std (standard deviation) and range (maximum-minimum), while categorical data are given as n (number) and percentage (%). Data were investigated at the 95% confidence interval and p value less than 0.05 was accepted as significant.

RESULTS

The mean values of filum terminale thickness and ages of all cases are summarized in Table 1.

The maximum-minimum values for filum terminale thickness values were 1.6-0.5 mm in males, 1.3-0.7 mm in females and 1.6-0.5 mm in all newborns. There was no statistically significant difference in filum terminale thickness between the sex groups.

The maximum-minimum values for age were 30-3 days for males, 30-1 day for females and 30-1 day for all newborns. There was no statistically significant difference in filum terminale thickness between the sex groups according to age.

2016;23(3):281-4
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Tablo 1. Mean age and filum terminale thickness according to sex

	Boys (n=250) mean±std	Girls (n=250) mean±std	Total (n=500) mean±std	p value
Age (day)	21,73±6,82	22,25±6,80	21,97±6,79	0,646
Filum terminale thickness (mm)	1,04±0,24	1,06±0,17	1,05±0,21	0,626

DISCUSSION

This study performed US measurements in the sagittal plane to identify normal thickness of the filum terminale in the newborn age group and determined important results. The first is that the mean filum terminale thickness in newborns was measured as 1.05 mm. The second is that there was no difference in filum terminale thickness according to sex. The third is that this value may be important as a threshold value in the newborn age group for the diagnosis of pathologies causing thickening of the filum terminale.

The filum terminale is a fibrovascular structure formed of long bundles of 5-20 micron thickness bound to each other with collagen bands. The filum terminale ends between L5 and S3. However, the generally accepted view is that the filum terminale begins at the tip of the conus medullaris and ends at the second sacral vertebral level by adhesion to the vertebra corpus (5).

Tethered cord syndrome occurs due to thickening of the filum terminale and tethering of the spinal cord and conus medullaris. Tethered cord syndrome produces symptoms of greater pain with increasing age and incontinence. In the childhood period, physical examination findings are noted more than neurological findings. The appearance of findings such as hypertrichosis, hemangioma and sacral dimples in the lumbosacral region are significant. Another important marker later is progressive scoliosis (6). Although the filum terminale may have normal appearance and thickness, there are studies reporting the occurrence of tethered cord syndrome (7).

In cases with thick filum terminale without accompanying spinal dysraphism, the result of tethering may cause relative ischemia symptoms. This research reported variations in blood flow, and reduction/oxidation rates of cytochrome oxidase with tethering. Changing this ratio was assessed as a problem with oxidative metabolism. At the mitochondrial level, this problem is accumulative and accumulation above a certain level is stated to cause intracellular structural damage. The duration of this accumulation affects the occurrence of symptoms. Depending on how rapidly accumulation occurs and the severity of tethering, the occurrence of symptoms will occur at earlier ages (8). These results show how important it is to diagnose thick filum terminale and tethered cord in the early period. Doppler flow studies have reported that regional blood perfusion increases by three times after removal of tethering. Another study on guinea pigs stated that hypoxanthine and lipid peroxidation levels were clearly high in animals with induced tethered filum terminale. High levels of these materials show ischemic injury. Additionally the measured motor evoked potential and somatosensorial evoked potential waves were observed to display a clear delay in these animals (9).

In cases with symptoms and thickened filum terminale diagnosed with imaging methods, the treatment is surgery. The aim of surgery is to cut the thick filum terminale distally preserving functional nerve tissue as far as possible with the aid of nerve stimulation to remove the tension. Although duration of surgical intervention is controversial, research has reported that if left untreated tethered cord cases will definitely encounter neurological problems in the future. As a result, even if there are no symptoms, thick filum terminale including those identified only due to skin findings, require preventive treatment (10).

In the newborn period, imaging methods have an important place for early diagnosis of thick and oily filum terminale with hidden spinal dysraphism before the appearance of mass or characteristic symptoms and before formation of neurological injury (11). As a result even if children are asymptomatic screening methods are very important to identify thick filum terminale cases in the early period. Currently the most ideal radiological imaging method for this screening is US. However, there is no clear knowledge on threshold filum terminale thickness measured with US especially in the earliest stage of life, the newborn period. Though MRI is the gold standard imaging method for spinal cord and vertebral assessment in children, technical developments in the recent period allow US to provide similar information to MRI in the early period of life. Especially in the newborn period, US may clearly visualize the spinal cord, integrity of the bone vertebral structure and surrounding soft tissue. Additionally, different to MRI, it can evaluate real-time cord pulsation (12). The lack of anesthesia requirements and the short and repeatable test duration are the most important advantages of US. That it is user dependent, requires experience and has lower tissue resolution compared to MRI are its disadvantages.

Normal filum terminale on US has a thin echogenous structure distinguished from cauda equina fibers extending from the posterior of the coccygeal segments of the sacrum. Real-time sonographic investigation shows pulsation with the spinal cord (13). Classic information in the literature from US studies reported that the normal filum terminale thickness varies from 0.5-2 mm, with those more than 2 mm thick accepted as pathologic (14,15). Shin et al. in a study of infants aged from 12 to 180 days with a total of 111 cases correlated with MRI found 49 normal and 62 cases of filum terminale thickening and lipoma and reported a threshold value of 1.1 mm (16). In our study all of the cases were newborns with mean filum terminale thickness of 1.05 mm. However, in our study, we did not

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include the patient group with pathologically thick filum terminale or perform MRI correlation.

There are some limitations to our study. The first is the relatively low number of cases. The second is that there was no MRI correlation. The third is that no premature cases were included. Finally, US investigation was performed by a single user.

In conclusion, our study found the mean value for normal filum terminale thickness was 1.05 mm measured with US in newborns. This value is very important for early diagnosis of pathologies causing filum terminale thickening.

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