RESEARCH ARTICLE / *Araştırma Makalesi*

Splenule Frequency on Computed Tomography Scans in Children, Presenting to the Emergency Department

Acil Servise Başvuran ve Bilgisayarlı Tomografi Çekilen Çocuk ve Ergenlerde Splenül Sıklığı

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Abstract

Introduction	Accessory spleen, also known as "splenule", is the presence of splenic tissue in ectopic localisations. The presence of splenule is important, especially in patients scheduled for splenectomy, as it may cause refractory symptoms. The aim of the present study is to define the frequency of splenule(s) in children (0-17 years) who received non-contrast and contrast enhanced computed tomography (NECT and CECT) protocols in the emergency department.
Materials and Methods	748 children (aged 0 to 17 years) who were admitted to the emergency department between May 2015 – September 2022 and had NECT and CECT abdominal scans were included in the study. Patients whose CT protocols were incomplete and cases with traumatic splenic injury and / or cases with poor image quality and patients with a history of splenectomy or hematologic pathology were excluded from the study (n: 100). A total of 648 patients were included in the cohort. NECT and CECT scans of all patients were assessed; the localisation as well as the antero-posterior (AP), medio-lateral (ML) and cranio-caudal (CC) dimensions of each splenule were assessed.
Results	A total of 648 cases with 467 males (72.1%) and 181 females (27.9%) were included in the study. Splenules were observed in 131 (20.2%) cases. More than one splenule was were detected in 21 of these 131 cases. 159 splenules were observed in total, with a mean volume of 0,72 ±0,95 ml. The most common location was found to be the splenic hilus (n=55, 41.9%).
Conclusion	Our study has proved that splenules are common anatomical variants, seen at a rate of 20.2% in this age cohort. A cross-sectional imaging should be performed to determine the presence, location, and number of the splenules before a scheduled splenectomy.
Keywords	Abdomen, accessory spleen, contrast enhanced computed tomography, non-contrast enhanced computed tomography, pediatric, splenule

Öz

Amaç	*Dalak dokusunun ektopik lokalizasyonda bulunmasına aksesuar dalak veya splenül ismi verilmektedir. Cerrahi girişim planlanan hastalarda splenül varlığının tayini önem teşkil etmektedir. Çalışmamızın amacı acil servise başvuran ve kontrastlı ve kontrastsız bilgisayarlı tomografi (BT) çekimi yapılan çocuk hastalarda (0-17 yaş) splenül sıklığını belirlemektir.*
Yöntem ve Gereçler	*Mayıs 2015 ile Eylül 2022 arasında acil servise başvuran ve batın BT ile tetkik edilen 748 çocuk hasta içerisinden çekim protokolü eksikliği olanlar, travmatik dalak hasarı olanlar, geçirilmiş splenektomi öyküsü veya hematolojik hastalık öyküsü olan olgular çıkarılarak 648 hasta çalışmaya dahil edildi. Kontrastsız ve kontrastlı BT görüntüleri gerek splenül lokalizasyonu gerekse boyut ve hacimleri açısından incelendi.*
Bulgular	*Çalışmaya 467 erkek (%72.1) ve 181 kadın (%27.9) olgu içerisinden 131'inde (%20.2) splenül tespit edildi. 21 olguda birden fazla splenül tespit edildi. Toplamda 159 splenül izlenmiş olup tespit edilen splenüllerin ortalama hacmi 0.72 ±0.95 ml ve en sık yerleşim yeri dalak hilusu (n=55, %41.9) olarak gözlendi.*
Sonuç	*Çalışmamız sık bir anatomik varyant olan splenül'ün bu yaş grubunda %20.2 oranında görüldüğünü göstermiştir. Oldukça sık görülen bu anatomik varyantın tedavi amacıyla splenektomi planlanan çocuk hastalarin preoperatif değerlendirilmesinde splenül varlığının ve sayısının kesitsel görüntüleme yöntemleriyle belirlenmesi önerilir.*
Anahtar Kelimeler	*Abdomen, aksesuar dalak, bilgisayarlı tomografi, pediatri, splenül*

INTRODUCTION

Ectopic splenic tissue is a well-known entity, which can be found in different locations, apart from the main body of the spleen[1]. Theoretically they arise from the fusion failure in mesenchymal budding. The latter must be differentiated from the post-traumatic splenosis; which is an ectopic splenic tissue resulting from an abdominal trauma and splenic tissue spread[2]. The parenchymal morphology as well as the function are the same as the original spleen. Vascular supply in the majority of cases is from the splenic artery[3].

It is of an imaging importance for radiologists because of the differential diagnosis, which comprises lymphadenopathy, pancreas, suprarenal gland and / or tumor and even kidney tumors. Clinically less relevant but still they can complicate while presenting to the emergency department (ED) with torsion, spontaneous rupture or can lead to unsuccessful splenectomy once misinterpreted or unseen on preoperative scans. Therefore the knowledge of this tissue and awareness of possible locations could help to improve surgeons‘ success in the abdominal interventions[4]. Even if there's no proven gold standard imaging for the splenic tissue, Mortele et al. stated that splenules have a characteristic appearance on CT as well-marginated, round masses with a homogenous enhancement on CECT images[5]. Abdominal radiologists can assess splenic tissue whether original or ectopic by any means available such as CT, MRI or ultrasound (US), with US being the most accessible but the least sensitive modality in the investigation of accessory splenic tissue, or splenule. The wide-angled scanning possibility of the cross-sectional imaging tools such as CT and MRI make the search of a splenule more accurate and provide a higher overall sensitivity.

Therefore, we wanted to assess our pediatric abdominal imaging data for such a query. The aim is to find out whether in the pediatric patient group, the frequency of a splenule would differ from the adult group. The advantage of our cohort is that all patients received native and contrast enhanced CT scans for their differentials, while presenting to the ED.

As there is extensive literature on the occurrence/prevalence of splenules amongst adults, our study aims to fill a gap about the prevalence of splenules in young children and adolescents.

MATERIALS and METHODS

A total number of 748 children between May 2015 and September 2022 were scanned in our institution for diverse abdominal emergencies. 100 cases were excluded from the study cohort due to the absence of contrast enhanced CT protocol (CECT) on examination, history of traumatic splenic rupture, deficiencies with image quality, and cases with previous splenectomy and/or with known hematological disorders. All CT scans were obtained in a 160-slice computed tomography scanner with a 128-detector equipment (Aquilion Prime, Toshiba Medical Systems, Otawara, Japan). 3 dimensional (3D) reconstructions as well as the raw data pictures were then analyzed retrospectively by two blinded radiologists using the Picture Archiving and Communication System (PACS) (Sectra AB, Linköping. Sweden) of Adnan Menderes University Hospital. The board-certified radiologists were attending physicians with a subspeciality focus on abdominal imaging with 5 years or more of an experience. Non-ionic intravenous (IV) contrast medium (300mg/100ml, with 1.5 ml/kg doses) was administered for all the patients. CT confirmed splenules have been categorized upon their locations. Their densities were correlated with region of interest (ROI) and density measurements in Hounsfield Units (HU) and the volumes have been measured using three axes and the formula of: height x depth x length x 0,52 respectively[6].

The study was approved by the Aydin Adnan Menderes University ethics committee (Project number: E-53043469-050.04.04-337450) and was conducted in accordance with the principles of the declaration of Helsinki. MS-Excel and

SPSS (version 26.0, IBM Corp., Armonk, NY, USA) were used to stratify the obtained data. As per standard practice for our institution, parental consent was obtained for each CT examination before the examination was held.

RESULTS

After the exclusion of the non-suitable cases, the remaining 648 patients (181 females; 27.9% and 467 males; 72.1%) were then analysed. In 131 (20.2%) cases we observed splenules in various sizes and locations. The mean patient age was 9.9 ±4.9 years, with 98 (74.8%) males and 33 (25.2%) females with splenules. The mean splenule volume was measured 0.72 ±0.95 ml. Patient demographics are shown in Table 1.

Table 1: Baseline characteristics of the patient cohort

Baseline Characteristics	# (or %)
Total cases	748
Excluded cases	100
Gender: F / M	181 / 467
Mean Age	9.9 ±4.9 years
Total cases with splenules	131
Total number of splenules	159
Splenule gender distribution: F / M	33 (25%) / 98 (75%)
Mean splenule volume	0.72 ±0.95 ml
Cases with n > one splenule	21
Patients with two splenules	16
Patients with three splenules	4
Patients with four splenules	1

There were 21 cases (16%) with CT-proven polysplenia; this being the presence of more than two ectopic splenic tissue. 16 of these cases had two, 4 cases had three and in one case we found four splenules; resulting in a total number of 159 splenules in the analysed cohort.

The most common location of splenules in our study was the splenic hilum (SH) with 54 splenules (33.9%), followed by 46 (28.9%) in the gastrosplenic ligament (GSL) (see Fig. 1), 34 (21.3%) in the splenocolic ligament (SCL) (see Fig. 2) , 16 (10%) in the splenorenal ligament (SRL), seven (0.4%) into the pancreatic tail (PT) (see Fig. 3) , two (1.2%) in the greater omentum (GO) (see Fig. 4). Examples of splenules' localisations can be seen in Figures 1 to 4. No splenules were found in the pelvis (Table 2).

Table 2: Localisations of the splenules

Localisations	# of cases
Pancreas tail (PT)	7
Splenic hilum (SH)	54
Gastrosplenic ligament (GSL)	46
Splenorenal ligament (SRL)	16
Splenocolic ligament (SCL)	34
Greater omentum (GO)	2
Pelvis	0

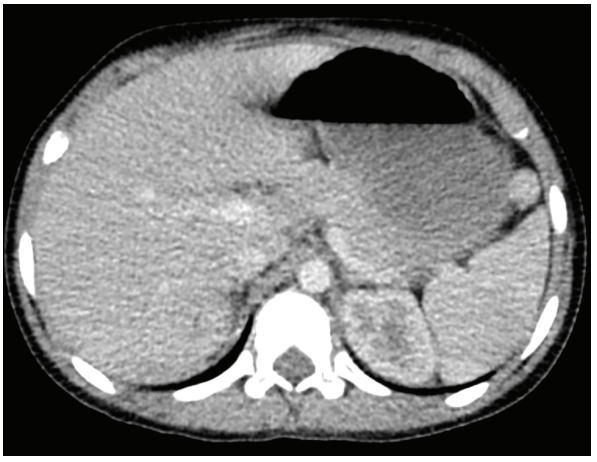
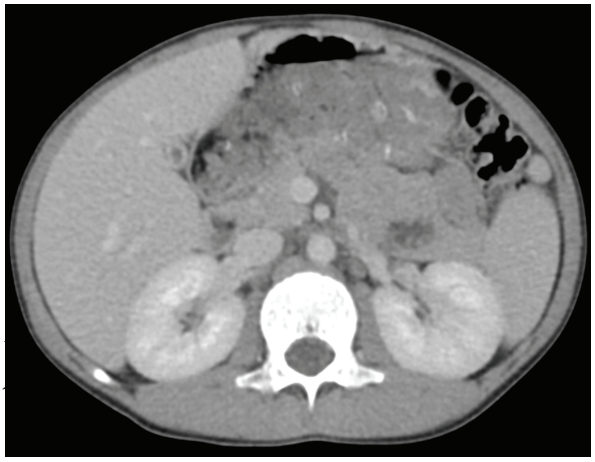


Figure 1: Splenule at the gastrosplenic ligament (GSL) of a 10 years old boy.



DISCUSSION

Splenules are often incidental findings on different imaging examinations generally without significant clinical relevance[7]. On the other hand, they are radiologically on the differential diagnosis list amongst tumors or metastatic lymph nodes. Since splenectomy is a curative treatment in diseases such as hereditary spherocytosis and chronic immune thrombocytopenic purpura, the occurrence of a potential splenule in these patients becomes clinically relevant. Hence, underdiagnosis can lead to recurrence of the disease[8]. There are also rare complications of a splenule itself, such as torsion, hemorrhage, rupture, and bowel obstruction[7,9,10]. According to one of the main textbook of the anatomy (Gray's Anatomy) the prevalence of splenule is as low as 10% in the human population[11]. Mortele et al. have found in their retrospective analysis the prevalence to be as high as 15.6%[5], whereas Romer et al. have found it to be 11% in their patient cohort of 1735 CT scans[12]. A similar investigation amongst the Turkish population showed its presence to vary between 10 to 30% in the report of Yildiz et al.[13]. A well detailed meta-analysis by Vikse et al. in 2017 found this prevalence to be as high as 14.5% but claimed that it could vary amongst different countries and populations[14]. In the same study it was pointed out that 53 out of 81 studies were surgically lead cohorts whereas only 22% of studies in the meta-analysis were imaging studies. Their incidence rates ranged between 95 % (cadaveric studies) and 16% (imaging studies); this demonstrates the

wide-angle approach when it is about the imaging of the human body. Vikse et al. stated that studies with a smaller sample size found a higher prevalence of splenules. An additional finding was that patients with known Immune Thrombocytopenic Purpura (ITP) or with previous splenectomy tended to have a higher prevalence for splenules. Last comparable remark with their meta-analysis is that 19% of patients have more than one splenule, which correlates with our findings, being 16%. The aforementioned findings raised our awareness towards the lack throughout the literature about the radiologic identification of splenules in the pediatric age group of patients.

Hence, the youngest case of splenule ever reported is a 17 years old patient[15], there is no clear answer to the question about the incidence in children. Even if our statistical findings were parallel to the co-existing literature, the fact that our youngest case with splenule was a 14-month-old baby, proves that our investigation is unique in the field because of the focused age group of our cohort. As defined in the study of Vikse et al; a splenule can be found as high as in 15% of people and with a quarter of these patients having more than one splenule[14]. These findings are well correlated with our age-specific patients' group.

The spleen acts as a hematopoietic center, maintaining its properties throughout the later stages of life[16]. Splenules have demonstrated to have various volumes in the literature ranging from 0.5 to 3.5 ml[17]. The volumetric measurements mentioned in the literature correlate well with our values obtained; mean volume being measured of 0.72 ±0.95 ml. The commonest location of splenules being at the hilum itself, they can be found in any part of the abdomen[18], thus may lead to various surgical and medical misdiagnoses and pathological consequences.

Its retrospective design, lack of inter-observer conformity, not having a representative cohort for the prevalence of the splenule in this age group, not having homogenous gender and age distribution throughout the patients and lastly lack of surgical or pathological diagnosis of our cases, were the limitations of the study. Being adequately representative for the regional population because of the high number of scans evaluated, including NECT and CECT protocols has led to an increased diagnostic accuracy validated by two different blinded radiologists which were the study strengths.

CONCLUSION

Splenules are well-shaped round masses mostly less than 2 cm in diameter and are commonly seen structures (20.2% in our cohort) during abdominal imaging examinations. They can be found in various locations; with the splenic hilum being the most frequent site (34%). The presence of splenules has a clinical significance in the preoperative assessment of children and adolescents with abdominal emergencies. Our study findings offer a guide into the identification of splenules in children aged 0-17 years presenting with abdominal emergencies and/or with various splenic disorders.

Kaynaklar

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