Pediatric Radiology (2024) 54:2006–2014
https://doi.org/10.1007/s00247-024-06069-2

ORIGINAL ARTICLE

Normal size of retropharyngeal lymph nodes in children on three dimensional magnetic resonance imaging

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Received: 19 April 2024 / Revised: 26 September 2024 / Accepted: 26 September 2024 / Published online: 22 October 2024

Abstract

Background Age–specific normal measurements or specific size criteria for retropharyngeal lymph nodes in children have not been defined.

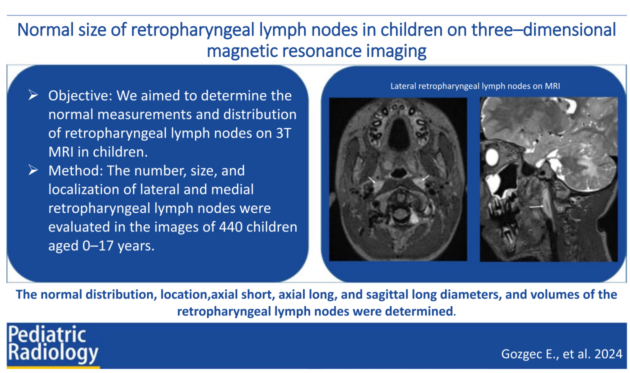
Objective We aimed to determine the normal measurements and distribution of retropharyngeal lymph nodes on three–dimensional magnetic resonance imaging (3–D MRI) in children.

Materials and methods In this retrospective study, we included 440 patients (213 girls) aged 0–17 years who were admitted to our center with seizures and headaches and underwent brain and neck MRI with T2–sampling perfection with application–optimized contrasts using different flip angle evolution sequences. We evaluated the number, laterality, and level distribution of lateral and medial group lymph nodes according to the skull base–cervical vertebrae. For both groups, we measured the short and long diameters of the largest lymph node in the axial plane and the craniocaudal diameter in the sagittal plane. The short/long diameter ratios and volumes were determined.

Results In 433 cases (98%), 1,554 lateral group lymph nodes were detected. Medial group lymph nodes were less common (7%). The lateral group was mostly bilateral, while the medial group was unilateral. Lateral group lymph nodes extended from the skull base–first cervical (C1) vertebral level to the C4, while the medial group extended from the C2 vertebral level to the C4. The mean axial short axis, axial long axis, and sagittal long axis diameters were 5.8 mm, 10.1 mm, and 15.5 mm for the lateral group and 3.8 mm, 7.6 mm, and 10.8 mm for the medial group, respectively.

Conclusion The findings of the study show that normally retropharyngeal lymph nodes are frequently seen in children and provide valuable information for lateral and medial lymph nodes depending on age.

Graphical Abstract



Keywords Children · Lymph nodes · Magnetic resonance imaging · Retropharyngeal

Extended author information available on the last page of the article

Introduction

Lymphadenopathy is an important marker of malignancy and infection in children. Knowledge of the normal size is very important to identify an abnormally enlarged lymph node. Furthermore, the ratio of the short diameter to the long diameter of the lymph node may also be indicative of the potential for malignancy. In the pediatric population, this ratio exceeding 0.5 is regarded as anomalous and cause for concern. There are two longitudinal chains of lymph nodes in the retropharyngeal space, the medial and the lateral. These lymph nodes, which are integral components of Waldeyer's ring, receive lymphatic drainage from various anatomical structures including the nasopharynx, oropharynx, nasal cavity, paranasal sinus, eustachian tube, and hypopharynx. Due to their non–palpable nature during physical examination, radiologic imaging serves as the primary modality for evaluation. Ultrasound, commonly utilized for the assessment of cervical lymph nodes, lacks the capability to visualize this anatomical region. Therefore, computed tomography (CT) and magnetic resonance imaging (MRI) are indispensable modalities for evaluating retropharyngeal lymph nodes. An understanding of the distribution of lymph nodes may assist in differentiating between various types of mass lesions observed on imaging. It is important to be acquainted with the typical short and long diameters of lymph nodes on cross–sectional imaging to determine whether they are pathological [1–4]. Mancuso et al. showed that the largest diameter of the lateral retropharyngeal lymph nodes on CT of adult patients was between 3–7 mm [5]. However, to the best of our knowledge, there is no comprehensive information in the literature on the normal size and distribution of retropharyngeal lymph nodes in children according to age groups.

On MRI, lymph nodes are best visualized on fluid–sensitive sequences such as T2–weighted and short tau inversion recovery (STIR) sequences. This is because they exhibit iso–intensity with muscle on T1–weighted sequences [6]. T2–SPACE (sampling perfection with application–optimized contrasts using different flip angle evolution– Siemens, Germany) is a three–dimensional (3–D) turbo spin echo (TSE) sequence and is used in routine imaging in many centers. Its advantages over conventional sequences include its speed and thin–section capability. This multiplanar imaging capability helps reduce the partial volume effect. As a result, high spatial resolution images provide detailed anatomical information [7–9].

The aim of this study was to determine the normal size, short–to–long axis ratios, anatomical levels, volumes, and number of medial and lateral chain retropharyngeal lymph nodes in relation to age in the pediatric population.

Materials and methods

Study population

In this retrospective study, we included patients aged 0–17 years who underwent brain and neck MRI including T2–SPACE sequence for headache and epilepsy at our center between January 2020 and November 2023. Ethics committee approval was granted by our institution. Since it was a retrospective study, the informed consent form was waived. The study included only the first acquisition of patients with recurrent MR images at different ages. The study population comprised patients with no discernible pathology on MRI and a normal MRI brain scan. Exclusion criteria were known disease causing lymphadenopathy (such as malignancy, leukemia, lymphoma, fever, and vasculitis), history of surgery, and inability to be evaluated due to motion artifact.

Magnetic resonance imaging technique and image interpretation

All patients' cranial MR images were acquired from 3–T MRI (Magnetom Skyra; Siemens Healthcare, Erlangen, Germany) using a standard head coil. General anesthesia was administered by an anesthetist to all children who could not remain still during imaging. T2–SPACE sequence parameters in the sagittal plane were as follows: TR, 3,200 ms; TE, 400 ms; FOV, 256/182 mm; slice thickness, 1 mm; flip angle, variable.

All MR images were analyzed on high–resolution monitors and communication system (Syngo Via console, software v. 2.0; Siemens Medical Solutions, Erlangen, Germany). A radiologist (E.G.) with 8 years of experience performed the analysis. The ages of the patients were divided into 18 groups ranging from 0 years to 17 years. To determine interobserver agreement, 51 randomly selected cases from each age group were examined by a radiologist (H.O.) with 16 years of experience. After the age of the patient was determined, oval structures with high signal intensity in the retropharyngeal area were defined as retropharyngeal lymph nodes. Those in the midline in the anterior part of the spine were considered as the medial group. Those located medial to the carotid sheath and lateral to the longus colli and capitis muscles were considered as the lateral group. In each patient, the number and laterality (unilateral or bilateral) of lymph nodes in the lateral and medial groups were first noted. Then, the level of distribution of the lymph nodes from superior to inferior was determined according to the level of the cervical vertebrae. Axial short and long and sagittal long diameters of the largest of the lateral and medial lymph nodes were measured in millimeters. Axial short/axial long diameter (S/L) ratio and axial short/sagittal long diameter (S/L*) ratio were calculated. The volume measurement method employed for the lymph nodes was based on the volume measurement of the ellipsoid structure. Automatic measurements were made using three diameters obtained.

Statistical analysis

Statistical evaluations were performed in a computer environment using SPSS version 25.0 program (IBM SPSS Statistics for Windows, Armonk, NY). The Kolmogorov–Smirnov test was used to test the conformity of the measured values with the normal distribution, and it was found that the distribution was not normal, and $P<0.05$ was accepted as the significance level. The interclass correlation confidence (ICC) test was used for interobserver agreement. The relationship between age and lymph node size was evaluated by the linear regression test. The Mann–Whitney *U* test was used to evaluate sex and lymph node size. The size of lymph nodes according to the level of lymph node location was evaluated by the Kruskal–Wallis test and presented by box plots. Due to the non–normal distribution of the data, we calculated the association between sex and lymph node size using bootstrapping and confidence estimates (including *P*-values and 95% confidence intervals) with 5,000 bootstrap resamples.

Results

A total of 449 patients were initially evaluated. However, four patients were excluded due to a diagnosis of lymphoma, and an additional five patients were excluded due to suspected lymphoma or malignancy. As a result, 440 patients were included in the study, of which 213 were girls. Lateral or medial lymph node was not seen in seven cases and all of them were in the age group of 0 years (3 girls).

The measurements obtained by observer 1 were as follows: axial short diameter, 5.9±1.6 mm; axial long diameter, 10.4±2.5 mm; sagittal diameter, 15.9±4.5 mm. Observer 2's measurements were as follows: axial short diameter, 6.3±1.6 mm; axial long diameter, 10.8±2.4 mm; sagittal diameter, 16.2±4.4 mm. The ICC test revealed excellent agreement between observer 1 and observer 2 for all three measurements of lymph node measurements ($P<0.001$), indicating a high level of reliability in the data.

A total of 1,554 lymph nodes were observed in the lateral group. Of the 433 cases, 210 were girls. The mean number of lateral group lymph nodes per case was 3.5. Among the lymph nodes, 15% (224/1,554) were unilateral, while the remaining was bilateral. The mean axial short diameter was 5.8 mm (min 2.3 mm, max 11.7 mm), the mean axial long diameter was 10.1 mm (min 4.3 mm, max 18.1 mm), and the mean sagittal long diameter was 15.5 mm (min 4.7 mm, max 31.1 mm). The mean S/L ratio was 0.58 (min 0.31, max 0.89) and the S/L* ratio was 0.40 (min 0.15, max 0.83). The mean volume of the lymph nodes was 547.9 mm^3, with a range of 28.2–2,885.8 mm^3. Examples of lateral retropharyngeal lymph nodes are presented in Fig. 1. Axial short and long diameters and sagittal long diameters, S/L and S/L* ratios, and volumes of lateral group lymph nodes according to age groups are summarized in Table 1.

In the statistical evaluation, it was determined that the size of the lateral group lymph nodes was lower in girls than in boys. Looking at the relationship between age and the measurements of the lateral retropharyngeal lymph nodes, it can be seen that all three measurements change with age. The axial short diameter is found to decrease with age, the axial long diameter is unchanged, and the sagittal long diameter is increasing (Fig. 2). Figure 3 presents the curve that

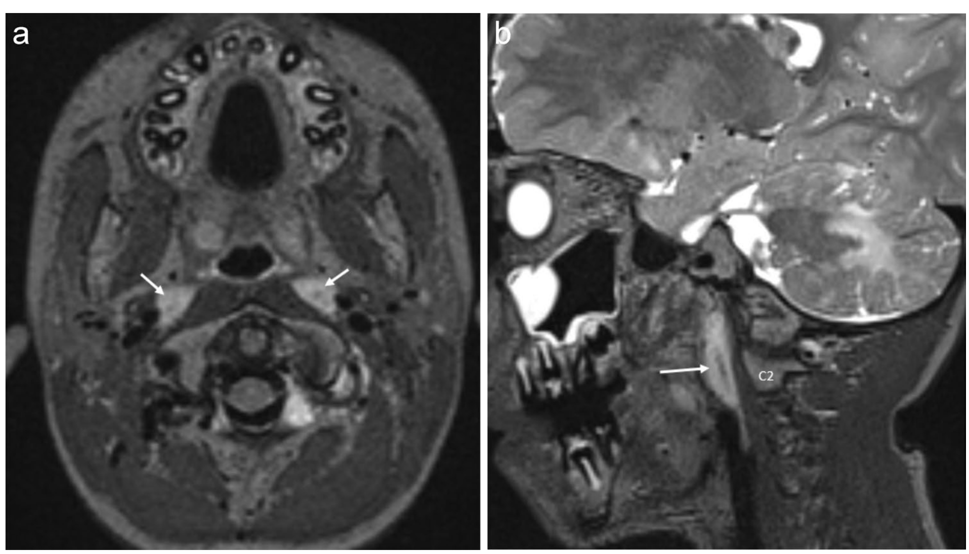


Fig. 1 A 9–year–old boy with normal bilateral lateral group retropharyngeal lymph nodes. **a** Axial non–contrast T2-weighted sampling perfection with application–optimized contrasts using different flip angle evolution (SPACE) sequence magnetic resonance image shows bilateral hyperintense lateral retropharyngeal lymph nodes (*arrows*). **b** Sagittal non–contrast T2-weighted SPACE sequence magnetic resonance image shows hyperintense lateral retropharyngeal lymph node (*arrow*) at the base of the skull at the 2nd cervical vertebra (*C2*) level

Table 1 The measurements of the lateral group lymph nodes and their distribution according to age

n=433 Age (years)	Axial short diameter (mm) median (25th–75th)	Axial long diameter (mm) median (25th–75th)	Sagittal long diameter (mm) median (25th–75th)	S/L median (25th–75th)	S/L[a] median (25th–75th)	Volume (mm^3) median (25th–75th)
0 (n=21)	4.3 (3.1–5.7)	8.0 (4.8–9.9)	99.0 (6.8–11.0)	0.59 (0.52–0.67)	0.48 (0.38–0.58)	177.4 (42.9–340.9)
1 (n=28)	5.1 (4.2–6.1)	8.1 (7.1–9.6)	10.5 (8.6–12.0)	0.61 (0.52–0.66)	0.47 (0.39–0.60)	189.7 (120.2–322.6)
2 (n=23)	5.4 (4.8–6.5)	10.6 (8.7–11.9)	13.2 (11.5–14.9)	0.56 (0.50–0.61)	0.43 (0.35–0.50)	388.7 (249.4–563.6)
3 (n=22)	6.6 (5.7–7.7)	10.6 (9.5–11.9)	15.4 (12.9–17.1)	0.63 (0.54–0.69)	0.45 (0.39–0.51)	515.9 (414.2–767.8)
4 (n=25)	6.3 (5.4–7.3)	11.5 (10.0–13.0)	16.7 (13.9–18.3)	0.61 (0.51–0.64)	0.39 (0.34–0.46)	631.2 (451.6–910.0)
5 (n=31)	6.8 (5.4–8.4)	10.7 (8.7–12.7)	15.5 (12.5–18.2)	0.64 (0.59–0.71)	0.46 (0.38–0.51)	599.1 (305.1–1,086.4)
6 (n=30)	6.3 (5.3–8.2)	10.6 (8.6–11.9)	16.0 (14.6–19.0)	0.64 (0.57–0.73)	0.41 (0.32–0.48)	538.2 (359.7–880.8)
7 (n=18)	6.9 (5.5–7.4)	11.1 (10.0–12.1)	18.1 (15.5–20.2)	0.61 (0.52–0.69)	0.38 (0.31–0.44)	658.4 (429.2–807.0)
8 (n=18)	6.8 (5.4–8.2)	11.3 (9.9–13.1)	17.7 (13.9–21.4)	0.60 (0.53–0.67)	0.38 (0.35–0.47)	675.7 (410.2–1,227.0)
9 (n=29)	6.4 (5.1–8.0)	11.3 (9.2–12.6)	16.9 (13.6–21.7)	0.62 (0.53–0.72)	0.39 (0.31–0.43)	637.3 (384.8–984.5)
10 (n=23)	5.6 (4.6–7.0)	9.9 (8.2–11.3)	14.5 (9.8–18.5)	0.58 (0.50–0.67)	0.44 (0.33–0.53)	463.0 (180.9–715.7)
11 (n=26)	5.7 (4.4–6.7)	10.3 (8.7–12.0)	77.2 (11.4–20.2)	0.55 (0.49–0.59)	0.34 (0.30–0.43)	516.9 (308.6–751.1)
12 (n=20)	5.6 (4.5–6.4)	11.0 (8.6–12.2)	17.0 (14.9–20.9)	0.53 (0.48–0.58)	0.34 (0.26–0.37)	493.4 (338.4–855.4)
13 (n=23)	5.2 (4.2–6.5)	9.6 (8.6–12.1)	16.0 (11.6–20.3)	0.51 (0.45–0.58)	0.37 (0.32–0.39)	491.0 (228.7–714.9)
14 (n=20)	4.7 (4.1–5.6)	9.0 (8.3–10.0)	13.4 (12.0–20.2)	0.53 (0.46–0.59)	0.38 (0.26–0.41)	283.9 (245.8–501.2)
15 (n=22)	4.8 (4.2–6.9)	10.5 (8.1–12.3)	18.7 (16.5–21.6)	0.52 (0.44–0.56)	0.28 (0.25–0.34)	517.1 (285.1–998.2)
16 (n=25)	4.7 (3.8–5.9)	9.2 (7.6–10.8)	16.9 (12.9–20.2)	0.54 (0.49–0.59)	0.31 (0.26–0.38)	379.2 (213.4–634.4)
17 (n=29)	4.5 (3.6–5.3)	8.6 (7.7–9.5)	14.8 (11.1–17.5)	0.52 (0.47–0.57)	0.32 (0.26–0.38)	272.6 (173.9–446.3)

n number of patients with lateral group lymph nodes, *S/L* axial short diameter/axial long diameter, *S/L*[a] axial short diameter/sagittal long diameter

shows the 25th, 50th, and 75th percentiles of axial short diameter and sagittal long diameter by sex.

Regarding the distribution of lateral lymph nodes according to the level, the upper limit of visualization of the lateral group lymph nodes was the first cervical (C1) vertebra. Most of the cases were between the skull base–C2 vertebra (43%, 184/433) and at the level of the skull base–C1 vertebra (35%, 152/433). In the other cases, the distribution was as follows: skull base in 55, C1 vertebra in three, skull base–C3 vertebra in 37, and skull base–C4 vertebra in two. When lymph node sizes were analyzed according to location, the difference was found to be statistically significant (P<0.001 for all three measurements, Fig. 4).

Medial group lymph nodes were most commonly seen in the 1–6 age groups and were present in 31 cases (7%). Medial lymph nodes were twice as common in boys than in girls (21/10). A total of 38 lymph nodes were laterality; 68% of the medial lymph nodes were unilateral. The medial lymph nodes had a mean short diameter of 3.8 mm (min 2 mm, max 7.1 mm), a mean long diameter of 7.6 mm (min 3.6 mm, max 13.2 mm) in the axial section, and a mean long diameter of 10.8 mm (min 5.8 mm, max 17.3 mm) in the sagittal section. Figure 5 presents examples of medial retropharyngeal lymph nodes. The prevalence of medial lymph nodes according to age and diameter measurement is summarized in Table 2. The S/L ratio varied between 0.15 and 0.76 with a mean of 0.35. The S/L* ratio exhibits a range of values between 0.18 and 0.61, with an average of 0.37. The mean volume of the medial lymph nodes was 170.58 mm^3, with a range of 24.2–731.6 mm^3.

Regarding the distribution of medial lymph nodes, no medial lymph node was observed above the level of the C2 vertebra. It was most commonly observed at the C2–C3 vertebral level (18/31). Of the others, seven were at the C2 vertebral level, two at the C3 vertebral level, and four at the C3–C4 vertebral level. No retropharyngeal lymph node was observed below the level of the C4 vertebra.

Discussion

The retropharyngeal space is a potential space bounded anteriorly by the buccopharyngeal fascia and posteriorly by the alar fascia. It contains lymph nodes, adipose tissue, and vascular structures. The lymph nodes are categorized into two groups: the lateral and medial chain. The lateral group is located lateral to the retropharyngeal adipose tissue and medial to the carotid sheath. The lymph nodes in this group are located on the anterior–lateral aspect of the longus colli and longus capitis muscles. The medial group is defined

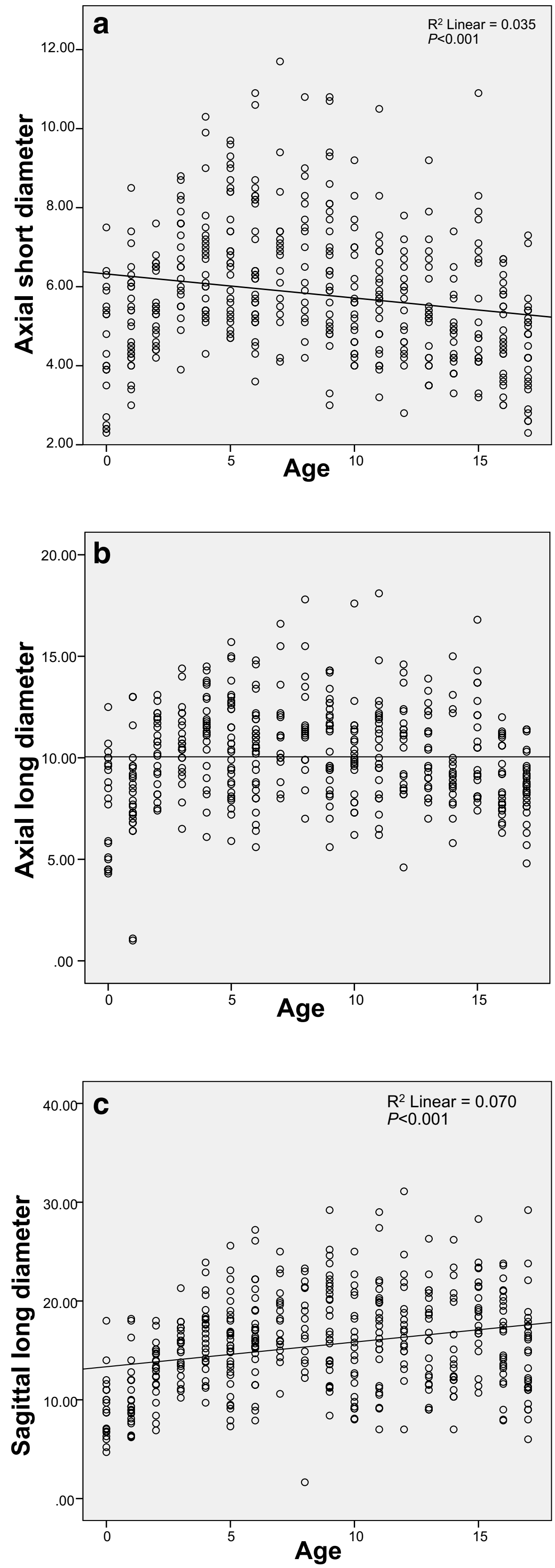


Fig. 2 The graphs show the distribution of diameter measurements of retropharyngeal lymph nodes according to age. **a** Axial short diameter measurement and age distribution. **b** Axial long diameter measurement and age distribution. **c** Sagittal long diameter measurement and age distribution

as being anterior to the midsagittal line and anterior to the spine [2, 10–12]. To our knowledge, this study represents the first and most comprehensive investigation in the literature of the normal size of retropharyngeal lymph nodes in children categorized according to age groups.

Understanding the typical dimensions of retropharyngeal lymph nodes in children holds significance for diagnosing infectious and malignant conditions. Kawasaki disease is a vasculitis that affects infants and young children and can lead to sudden death and major complications. Some patients may initially present with symptoms such as fever and lymphadenopathy [13–15]. One study evaluated Waldeyer's ring with multimodality imaging in 14 lymphoma patients. It showed that four patients had retropharyngeal lymph node involvement without Waldeyer's ring involvement. After chemotherapy, these lymph nodes showed a lymphoma–like response [16]. While nasopharyngeal carcinoma is rare in children, it constitutes one–third of nasopharyngeal neoplasms [17, 18]. In a study involving 10 children with nasopharyngeal cancer, cervical lymphadenopathy was present in all patients, and retropharyngeal lymphadenopathy was observed in four patients [19]. These studies show that the retropharyngeal lymph nodes in children may be involved in vasculitis and malignancy in addition to infectious diseases. Therefore, it is important to know the normal distribution and dimensions of retropharyngeal lymph nodes on radiological evaluation according to age groups in the diagnosis and follow–up of patients.

The development of the lymphatic system in children increases rapidly in early childhood, similar to other systems. Lymph nodes, which are thought to reach adult size by the age of 6, undergo involution during puberty [6]. In our study, the mean axial short diameter of the lateral group lymph nodes increased until 6–9 years of age and decreased at later ages. Mean long axial diameter peaked at the age of 4 years and mean sagittal diameter peaked at the age of 7 years. Medial group lymph nodes were numerically more common in the first 6 years. Lymph nodes in the lateral group were observed in all age groups. Lymph nodes in the medial group were not present in all age groups and were less numerous. The values of the lateral group lymph nodes were higher in all three diameter measurements.

The occurrence of lateral retropharyngeal lymph nodes was found to be 66% in a study by Mancusso et al. [5] and 50% in another cadaveric study [11]. In a study of 150 children with obstructive sleep apnea (OSA) and 150 children without OSA, lateral group lymph nodes were more common

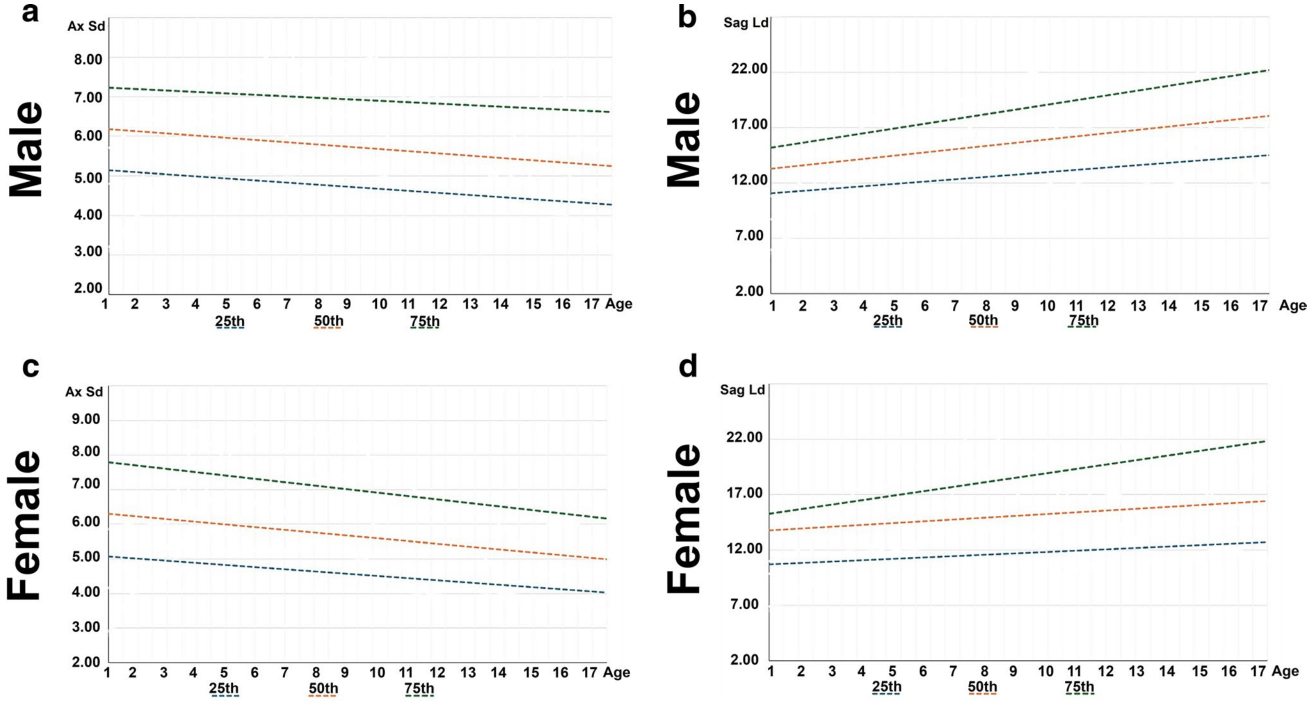


Fig. 3 The graphs illustrate the percentile values for the axial short diameter (**a**) and sagittal long diameter (**b**) for males and the axial short diameter (**c**) and sagittal long diameter (**d**) for females. *Ax Sd*, axial short diameter; *Sag Ld*, sagittal long diameter

than in previous studies with rates of 97% and 91%, respectively. When laterality was analyzed, it was shown to be bilateral with a rate of 88% and 97%, respectively [10]. In parallel with this, our study found that lateral group lymph nodes were very common in children with a rate of 98% and 85% of them were bilateral.

In the study by Mancuso et al., the maximum axial diameter of lateral retropharyngeal lymph nodes was found to vary between 3–7 mm [5]. An MRI study was conducted on 120 healthy patients to investigate lateral retropharyngeal lymph nodes, out of which 40 cases were between the ages of 6–19 years. In this young group, the mean axial maximal diameter was 9 mm (ranging from 6–12 mm) and the mean minimal diameter was 6.2 mm (ranging from 4–10 mm) [2]. In a different MR study, the axial anterior–posterior diameter was measured in children with and without OSA between the ages of 5 years and 14.3 years. The mean values were reported as 5.5 mm (4.3–6.9 mm) in children with OSA and 6.2 mm (4.9–7.7 mm) in children without OSA [5]. The axial short and long diameter values obtained in our study are consistent with recent research findings (mean axial short axis, 5.8 mm; axial long axis, 10.1 mm). Additionally, this study analyzed the sagittal long diameter and found that it exhibited higher values than other measurements, with a mean of 15.5 mm. The observation that axial short diameter decreases with age, while axial long diameter remains constant, suggests that the lymph nodes become more oval in shape with increasing age. The ratios of S/L and S/L* values reached their highest values of 0.64 and 0.46, respectively, at approximately 5 years to 6 years of age, and then exhibited a gradual decline.

Studies by Mancuso et al. and Ozlugedik et al. reported that medial group lymph nodes were not seen [5, 11]. In our study, the number of medial group lymph nodes decreased significantly after the age of 6 years and was not detected at some ages. This may be due to atrophy of the medial group lymph nodes with age. The small size and adult age of the included patient group may be the reason why medial group lymph nodes were not detected in previous studies. A study using MRI in children found that the incidence rate of the medial group was 19%, although less common than the lateral group. The axial anterior–posterior diameter of the medial group was between 2.7–6.1 mm and it was mostly unilateral [5]. In our study, the incidence rate was lower at 7% and similarly, it was more often unilateral than the lateral group. In the evaluation of neck masses in children, especially in early childhood when the retropharyngeal lymph nodes are larger, caution should be exercised in the presence of a lesion protruding into the air column. Knowing that medial retropharyngeal lymph nodes are usually unilateral and lateral nodes bilateral on inspection and radiological imaging may facilitate the differential diagnosis. The axial anterior–posterior diameter measurements were also similar, ranging from 2–7.1 mm.

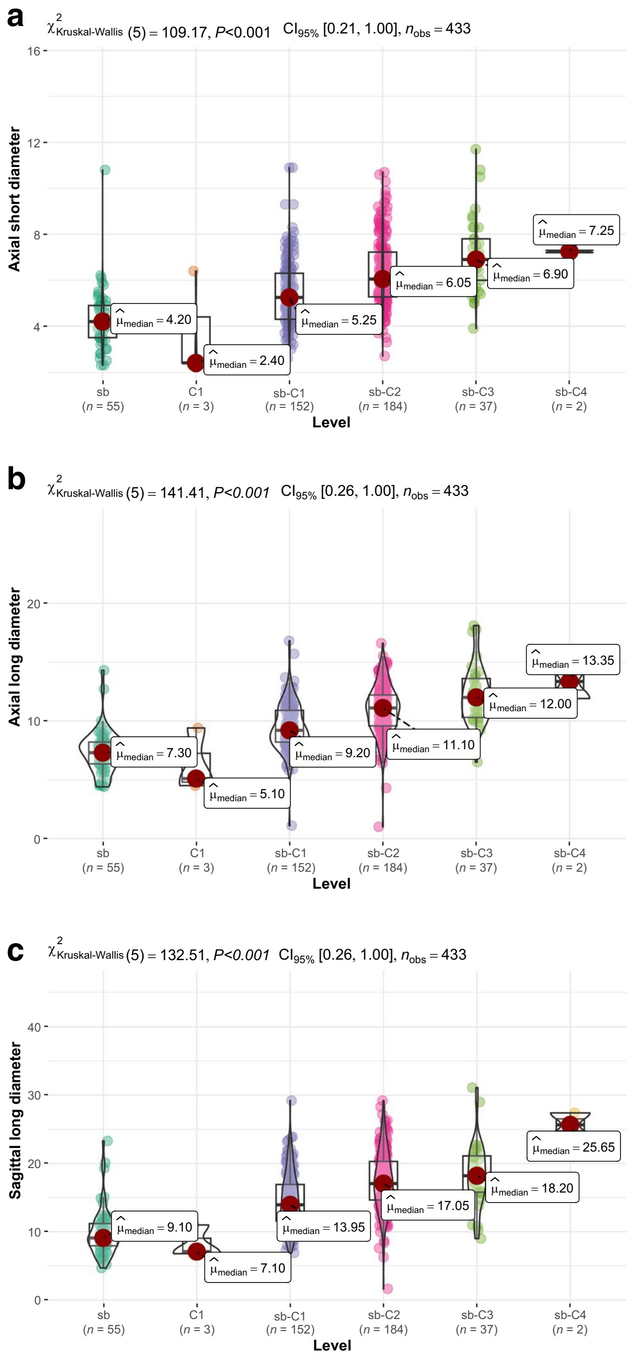


Fig. 4 Box plots show the relationship between retropharyngeal lymph node anatomical localization and their measurements in axial short diameter (**a**), axial long diameter (**b**), and sagittal long diameter (**c**). *C*, cervical vertebra; *sb*, skull base

The lateral retropharyngeal lymph nodes were initially described as having one to three nodes, usually extending to the level of C3 [20]. Later studies have shown that they are most commonly found at the level of C1–C2, and no lymph node has been observed caudal to the C3 vertebra [1, 5, 10, 11]. The study revealed that the frequency of lateral retropharyngeal lymph nodes was significantly higher, with an average of 3.5 per patient. Lymph nodes were observed most frequently at the skull base–C2 level, extending caudally as size increased. The above baseline level of the lateral lymph nodes was not below the C1 vertebra. In two patients, lymph nodes were observed at the C4 vertebra, and no lymph nodes were observed below this level. In contrast to the lateral group, the medial group was found to originate at the C2 level, consistent with previous studies [10, 20]. No medial group lymph node was observed above this level. However, in this study, in contrast to other studies, there was evidence of extension to the C4 level. The observation of lymph nodes at lower levels compared to previous studies may be attributed to the more comprehensive study and age distribution. Given these findings, any retropharyngeal lymph node below the level of C4 or any medial group lymph node above the level of C2 should be approached with suspicion for a possible abnormal lymph node.

In the context of cervical lymph nodes, it has been demonstrated that volume measurements offer greater prognostic value than maximum diameter alone. In general, the cut–off value of malignant lymph nodes in head and neck cancers varies between 6.86 cm^3 and 14 cm^3 [21–23]. In our study, volume measurements were found to be in accordance with these reports. Lateral group lymph nodes exhibited a maximum volume of 2.8 cm^3 (mean 0.5 cm^3), while medial group lymph nodes demonstrated a maximum volume of 0.7 cm^3 (mean 0.2 cm^3).

Our study had some limitations. The first one was the retrospective nature of the study and the fact that the data were accessed electronically. Since it was a retrospective study, the height and weight of the patients could not be determined and the effect of the differences on lymph node sizes could not be evaluated. Additionally, the study is limited in that no patient was histopathologically diagnosed. However, the cases we selected mostly presented with seizures, and there was no evidence of malignancy or any other disease that could cause lymphadenopathy on follow–up. Although our study was an anatomical study for the standardization of the size of retropharyngeal lymph nodes, our patients were not healthy volunteers. The fact that our patient group was a pediatric population would not have allowed this anyway. However, although none of these children had any pathological findings detected by MRI, all of the patients were brought to the hospital with any clinical symptoms and underwent cranial MRI. The possibility that any of these symptoms could cause an enlarged lymph node in the neck has the potential to adversely impact the results of the study.

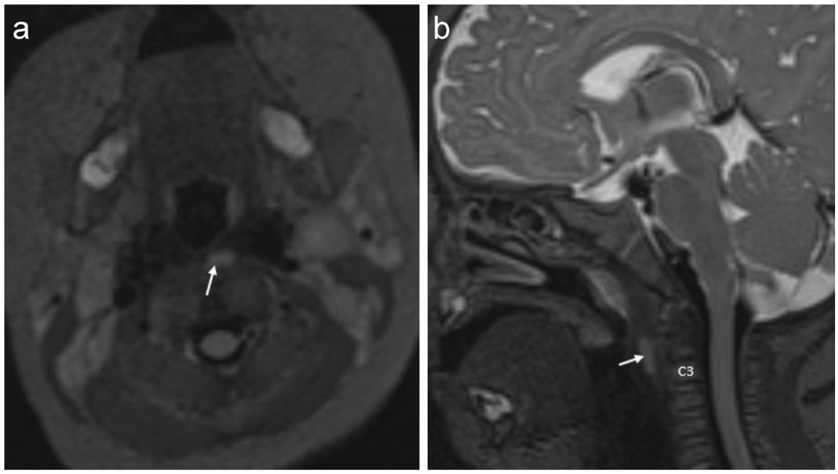


Fig. 5 A 2–year–old boy with normal medial group retropharyngeal lymph node. **a** Axial non–contrast T2-weighted sampling perfection with application–optimized contrasts using different flip angle evolution (SPACE) sequence magnetic resonance image shows hyperintense left medial retropharyngeal lymph node (*arrow*). **b** Sagittal non–contrast T2-weighted SPACE sequence magnetic resonance image shows hyperintense medial retropharyngeal lymph node (*arrow*) at cervical 2–3 vertebra level (*C3*)

Table 2 The measurements of the medial group lymph nodes and their distribution according to age

n=31 Age (years)	Axial short diameter (mm) median (25th–75th)	Axial Long diameter (mm) median (25th–75th)	Sagittal long diameter (mm) median (25th–75th)	S/L median (25th–75th)	S/L[a] median (25th–75th)	Volume (mm^3) median (25th–75th)
1 (n=3)	4.3 (4.1–4.8)	8.4 (8.3–9.0)	10.0 (5.7–10.0)	0.43 (0.38–0.48)	0.39 (0.36–0.46)	171.1 (97.9–218.9)
2 (n=5)	3.6 (2.9–3.8)	6.5 (5.5–8.8)	9.7 (6.1–10.6)	0.33 (0.22–0.38)	0.33 (0.31–0.39)	88.5 (72.3–185.3)
4 (n=4)	4.1 (3.5–5.3)	7.3 (5.4–9.0)	10.9 (9.6–12.5)	0.33 (0.27–0.41)	0.38 (0.30–0.49)	148.5 (125.1–220.7)
5 (n=6)	4.1 (3.5–4.4)	7.1 (6.3–9.4)	8.9 (8.1–15.6)	0.35 (0.29–0.41)	0.43 (0.41–0.48)	133,4 (93.5–337.8)
6 (n=5)	3.5 (3.2–4.0)	7.0 (6.9–7.8)	9.3 (8.6–11.6)	0.40 (0.31–0.49)	0.34 (0.33–0.39)	126.1 (121.5–192.7)
8 (n=1)	3.6	4.4	8.6	0.36	0.42	71.1
9 (n=2)	4.0 (3.0–5.0)	8.6 (6.7–10.5)	12.9 (8.8–17.1)	0.30 (0.21–0.39)	0.37 (0.18–0.57)	218.2 (154.4–282.0)
10 (n=2)	2.8 (2.5–3.1)	7.6 (6.3–8.8)	10.3 (9.5–11.0)	0.27 (0.22–0.33)	0.28 (0.23–0.32)	113.2 (90.7–135.7)
12 (n=1)	3.2	7.4	12.5	0.26	0.26	154.6
14 (n=1)	3.2	13.2	17.3	0.36	0.18	381.8
15 (n=1)	2.1	5.5	10.7	0.17	0.20	64.5

n number of patients with medial group lymph nodes, *S/L* axial short diameter/axial long diameter, *S/L*[a] axial short diameter/sagittal long diameter

Conclusion

Our study showed that lateral retropharyngeal lymph nodes are common in children with a prevalence of 98%. They begin at the level of the skull base–C1 vertebra and extend distally up to the level of C4. The medial group is less common, occurring in only 7% of cases, and may start at the C2 vertebral level and extend to the C4 vertebral level. The lateral group is generally bilateral, while the medial group is unilateral. As age increases, lateral group lymph nodes tend to become more oval in shape. Normative data on retropharyngeal lymph node distribution and size, as determined in different pediatric age groups, can be applied in daily clinical radiology evaluations.

Author contribution E.G., H.O., H.L.T.D.—conceptualization, data collection, writing initial draft. E.G., H.D., Z.O., H.L.T.D.—writing initial draft, editing, supervision. All authors read and approved the final manuscript.

Data availability All data collected were anonymized and stored in a password–protected Excel spreadsheet, in accordance with the principles of confidentiality and privacy. The datasets generated and/or analyzed during the current study are available upon reasonable request from the corresponding author.

Declarations

Conflicts of interest None

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