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Effectiveness of Differential Diagnosis of Primary Neck Masses in Children

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ABSTRACT

Aim. To assess the diagnostic features and accuracy of differential diagnosis of primary neck masses in pediatric patients, emphasizing the role of a reference center.

Materials and methods. A retrospective analysis was conducted in patients (aged 1 month to 17 years) who underwent surgical treatment at the Dmitry Rogachev National Research Center (Moscow, Russia) between 2012 and 2022. Inclusion criteria were as follows: age under 18 years, presence of a primary non-visceral neck mass, and confirmed histopathological diagnosis.

Results. This study was performed using data collected from 153 patients. The study cohort included malignant neoplasms in 34.6% (53/153), benign neoplasms in 29.4% (45/153), and lymphatic malformations in 36.0% (55/153) of cases. The median age at disease onset was 1.40 years (0.01; 5.12), and at hospital admission – 2.58 years (1.02; 7.86). Lymphatic malformations were most commonly diagnosed in the prenatal and neonatal periods (52.7%, 29/55), malignant neoplasms typically presented before the age of 3 years (56.6%, 30/53), while benign neoplasms were more common in children older than 3 years (80.0%, 36/45). In 55.5% of cases, the initial outpatient diagnosis was revised upon hospitalization. Diagnostic biopsy performed outside of reference centers proved insufficiently informative: an accurate initial diagnosis was made in 23.5% (36/153) of patients in non-specialized facilities. Initial histopathological examination was carried out at the Dmitry Rogachev National Research Center in 54.9% (84/153) of cases and remained unchanged in 98.7% (151/153) of cases following an internal review.

Conclusion. Non-visceral neck masses in children are frequently misdiagnosed at the outpatient stage. This study highlights the importance of a multidisciplinary approach – including imaging, biopsy, and slide review in reference centers – to improve diagnostic accuracy and guide an optimal treatment strategy.

Keywords: children, neck, neck masses, diagnosis, histopathology, pediatric

Conflict of interest. The authors declare no obvious or potential conflicts of interest related to the publication of this article.

Conformity with the principles of ethics. The study protocol was approved by the independent Ethics Committee at Dmitry Rogachev National Research Center (Minutes No. 5/2023 dated June 20, 2023).

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Эффективность дифференциальной диагностики новообразований внеорганный шейной локализации у детей

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РЕЗЮМЕ

Цель. Оценить особенности и эффективность дифференциальной диагностики первичных образований внеорганный шейной локализации у детей с участием референс-центра.

Материалы и методы. Проведено ретроспективное исследование пациентов (1 мес – 17 лет), перенесших хирургическое лечение в ФГБУ «НМИЦ ДГОИ им. Д. Рогачева» МЗ РФ в 2012–2022 гг. Критериями включения служили: возраст пациента до 18 лет, первичное внеорганный образование шеи и наличие патоморфологической верификации диагноза.

Результаты. Исследование выполнено на основе данных 153 пациентов. Выборочную совокупность составили: злокачественные новообразования (ЗНО) – 34,6% (53/153); доброкачественные новообразования (ДНО) – 29,4% (45/153); лимфатические мальформации – 36,0% (55/153). Медиана возраста при дебюте заболевания составила 1,40 (0,01; 5,12) года, при госпитализации – 2,58 (1,02; 7,86) года. Лимфатические мальформации диагностированы преимущественно на пре- и неонатальных периодах (52,7%; 29/55), при ЗНО – до 3 лет (56,6%; 30/53), при ДНО – старше 3 лет (80,0%; 36/45). У 55,5% пациентов первичный диагноз, установленный на амбулаторном этапе, был изменен в стационаре. Диагностическая биопсия вне референс-центров была недостаточно информативна: в условиях неспециализированного стационара инициально корректный диагноз был выставлен в 23,5% (36/153) случаев. Инициально патоморфологическое исследование биоптата или операционного материала проводилось преимущественно в НМИЦ ДГОИ – в 54,9% (84/153) случаев и не подвергалось изменению в дальнейшем в 98,7% (151/153) (пересмотр проходил внутри центра).

Заключение. Внеорганный новообразования и мальформации шеи у детей часто диагностируются с ошибками на амбулаторном этапе. Исследование подчеркивает важность мультидисциплинарного подхода, включающего визуализацию, биопсию и пересмотр материала в референс-центрах для повышения точности диагностики и выбора оптимальной тактики лечения.

Ключевые слова: дети, шея, внеорганный новообразование, диагностика, патоморфологическое исследование

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

Источник финансирования. Авторы заявляют об отсутствии финансирования при проведении исследования.

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INTRODUCTION

The differential diagnosis of pediatric neck masses is broad, encompassing a wide range of congenital, inflammatory, and neoplastic lesions. Notably, up to 80–90% of head and neck masses in children are

benign [1–5]. In most cases, these patients present with lymphadenopathy that either regresses spontaneously or resolves with antibiotic therapy within 2 to 6 weeks. Persistence beyond this period may require biopsy [6–9].

The age at onset, duration, and nature of symptoms, as well as the anatomical location and size of the

lesion, are key factors in identifying the most likely malignant neoplasms to include in the differential diagnosis. However, these clinical parameters alone are often insufficient to distinguish between benign and malignant processes. In such cases, the diagnosis should be based on imaging studies and, when indicated, histopathological examination, including immunohistochemical and molecular genetic analyses. Current literature does not provide evidence regarding the role or degree of involvement of reference centers within multimodal diagnostic approaches for neoplastic conditions.

The aim of the study was to evaluate the diagnostic features and the effectiveness of differential diagnosis for primary neck masses in pediatric patients, specifically in cases involving a reference center.

MATERIALS AND METHODS

The article presents the results of a retrospective quantitative study involving non-random sampling of patients. The study was approved by the independent Ethics Committee of Dmitry Rogachev National Medical Research Center of Pediatric Hematology, Oncology and Immunology (Minutes No. 5/2023 dated June 20, 2023). The approval was granted taking into consideration the Declaration of Helsinki.

The study included patients who underwent surgical treatment at Dmitry Rogachev National Medical Research Center of Pediatric Hematology, Oncology and Immunology (Moscow, Russia) between January 2012 and December 2022 (a 10-year period). Inclusion criteria were as follows: 1) age under 18 years at the time of hospitalization to Dmitry Rogachev Center; 2) presence of a primary non-visceral cervical mass; 3) histopathologically confirmed diagnosis of a lymphatic malformation, benign tumor, or malignant neoplasm of the neck. Lymphatic malformation was selected as the representative entity among congenital developmental anomalies, based on its high prevalence in the study cohort and to reduce the risk of potential systematic bias associated with the inclusion of other malformations.

All statistical analyses were preceded by verification of the assumptions required for the application of each test. A conventional significance threshold of 0.05 was used for comparisons between two groups. For pairwise comparisons among three groups, the significance level was adjusted to 0.017 using the Bonferroni correction. The Kruskal–Wallis test was used to compare three independent groups. The Mann–Whitney U test adjusted for multiple

comparisons was applied for comparisons between two independent groups and for post hoc pairwise analyses.

To assess differences in categorical variables across three clinical subgroups, the Pearson χ^2 test was used when expected frequencies were evenly distributed and no cells had expected counts of less than 5. In all other cases, the likelihood ratio χ^2 test (G^2), which accounts for the logarithmic relationship between observed and expected frequencies, was employed. The coefficient of variation of expected frequencies was used as a numerical indicator of distribution uniformity. The use of the G^2 test was based on current methodological research demonstrating its superior accuracy and statistical power in contingency table analysis involving small sample sizes and uneven distributions [10]. In addition, the G^2 test demonstrated greater sensitivity to deviations from independence in contingency tables larger than 2×2 , making it a statistically preferable method for analyzing frequency data in pediatric studies with limited sample sizes. All statistical analyses were performed using IBM SPSS Statistics version 26. The data are presented as absolute and relative values n (%), the median, the interquartile range, and maximum and minimum values Me ($Q1$; $Q3$; min–max).

RESULTS

From January 2012 to December 2022, surgical treatment for non-visceral cervical lesions was performed in 370 patients. During the selection process, 277 patients were excluded: 217 due to lymphadenopathy of various etiologies (predominantly secondary metastatic involvement) and 60 due to the absence of histopathological confirmation of lymphatic malformation, as these patients were treated exclusively with sclerotherapy.

As a result, data from 153 patients (78 girls and 75 boys) with tumors and lymphatic malformations were included in the analysis. The sample consisted of malignant neoplasms in 34.6% of cases (53/153), benign neoplasms in 29.4% (45/153), and lymphatic malformations in 36.0% (55/153) of cases. Detailed information is presented in Fig. 1.

Among malignant neoplasms, the most frequently identified entities were poorly differentiated neuroblastoma (34.0%, 18/53), extrarenal extracranial rhabdoid tumor (13.2%, 7/53), and alveolar rhabdomyosarcoma (13.2%, 7/53).

Among benign neoplasms, the most common were schwannoma (15.2%, 7/46), paraganglioma (8.7%,

4/46), and lipoma (8.7%, 4/46). Additional benign lesions included venous malformation (8.7%, 4/46), congenital non-involuting hemangioma (NICH) (4.3%, 2/46), and small vessel-rich arteriovenous malformation (2.2%, 1/46).

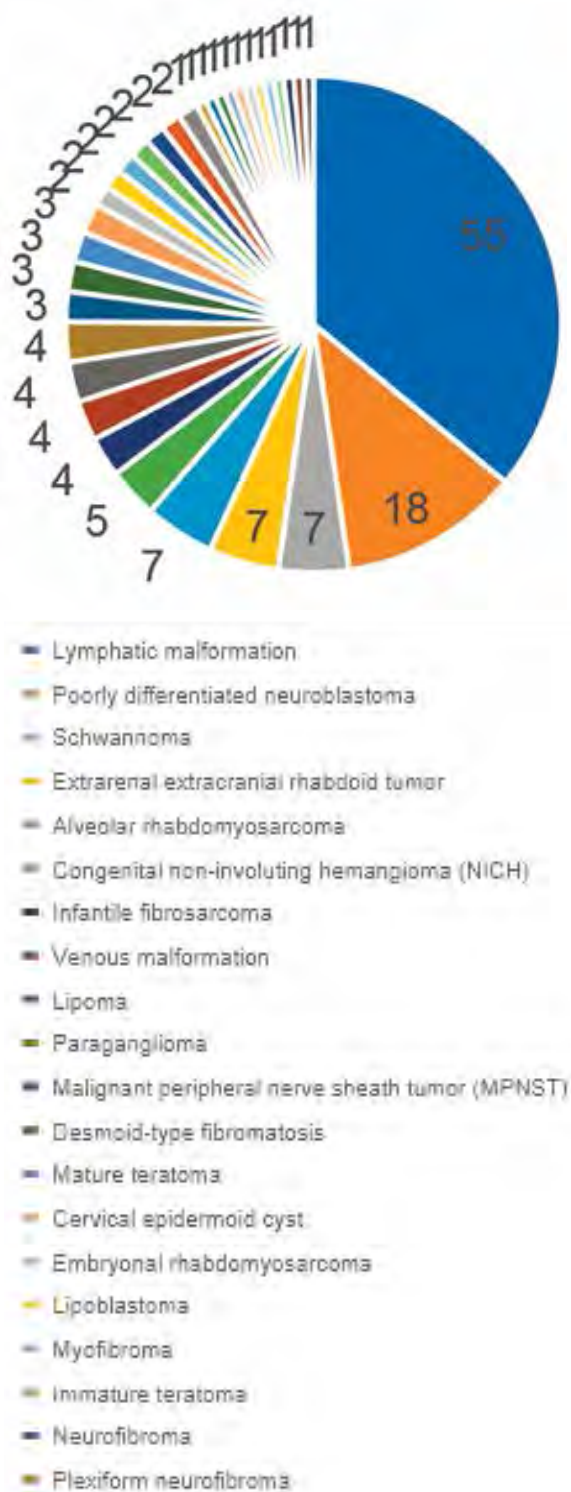


Fig. 1. Distribution of neoplastic and malformative lesions of non-visceral cervical localization

The median age at initial clinical presentation was 1.40 years (0.01; 5.12), and the median age at admission to Dmitry Rogachev National Medical Research Center was 2.58 years (1.02; 7.86). Prenatal diagnosis was reported in 9.2% of cases (14/153). Detailed data are presented in Table 1.

As shown in Table 1, lymphatic malformations were most commonly diagnosed during the prenatal and neonatal periods, accounting for 52.7% (29/55) of cases. Malignant neoplasms typically manifested before the age of 3 years (56.6%; 30/53), whereas benign neoplasms were significantly more likely to present after 3 years of age (80.0%; 36/45), with a statistically significant difference observed ($\chi^2(2) = 13.292; p = 0.001$). This distribution was also reflected in the median age at symptom onset, diagnostic verification, and first admission to the reference center: 1) patients with lymphatic malformations were diagnosed significantly earlier; 2) the greatest diagnostic delay was observed in patients with benign neoplasms, with a median time to diagnosis of 7.43 months (*Me* 3.33–18.98). However, despite a later onset, patients with malignant neoplasms were more frequently hospitalized and diagnosed at an earlier stage at the reference center.

At the time of initial clinical presentation, the most common primary complaint was the presence of a palpable neck mass. This symptom was reported in 92.7% (51/55) of patients with lymphatic malformations and in 100.0% (45/45) of those with benign neoplasms. In contrast, it was less frequently observed in patients with malignant neoplasms – 64.2% (34/53) – a statistically and clinically significant difference ($\chi^2(2) = 31.682; p < 0.001$). Symptoms of respiratory distress were reported predominantly in the malignant neoplasm group (6/53; 11.3%). Other presenting complaints included swelling of the neck, face, supraclavicular area, or upper limb (6/153; 3.9%), neurologic symptoms (5/153; 3.3%), and nonspecific signs such as low-grade fever, lethargy, and reduced appetite (2/153; 1.3%).

At the time of initial admission to Dmitry Rogachev National Medical Research Center, an exacerbation of clinical symptoms was observed in association with rapid tumor growth. Neurological deficits were documented in 20.3% of patients (31/153), respiratory insufficiency of varying severity – in 14.4% (22/153), and dysphagia – in 10.5% (16/153). Respiratory insufficiency was more frequently observed in patients with malignant neoplasms: 24.5% (13/53) compared to 14.5% (8/55) in patients with lymphatic

malformations and 2.2% (1/45) in those with benign neoplasms, a statistically significant difference ($\chi^2_{(2)} = 11.742$; $p = 0.003$).

Among 22 patients with respiratory insufficiency: 50.0% (11/22) were tracheostomy-dependent at the time of admission; 13.6% (3/22) required mechanical ventilation, with tracheostomy performed at the Center; in 4.5% (1/22), tracheostomy was not feasible due to extensive tumor infiltration; 9.1% (2/22) received supplemental oxygen therapy; and 22.3% (5/22) did not require any respiratory support. Neurological symptoms were also more commonly associated with malignant neoplasms, occurring in 37.7% (20/53) of cases compared to 10.9% (6/55) in patients with lymphatic malformations and 11.1% (5/45) with benign neoplasms ($\chi^2_{(2)} = 14.671$; $p = 0.001$).

Dysphagia was more frequently observed in the lymphatic malformation group and was absent in patients with benign neoplasms. This symptom was documented in 21.8% (12/55) of patients with lymphatic malformations compared to 7.5% (4/53) in the malignant neoplasm group and 0% in the benign neoplasm group.

Further details regarding the diagnostic verification ("roadmap") of neoplastic lesions are presented in Table 2. For the purpose of comparative analysis, patients were divided into three clinical groups: group A – lymphatic malformations ($n = 55$); group B – benign neoplasms ($n = 45$); group C – malignant neoplasms ($n = 53$). A change in the initial diagnosis established at the outpatient stage was documented in 55.5% (75/135) of cases.

Diagnostic fine-needle aspiration biopsy (FNAB) performed at the local clinic was recorded in 10.9% (6/55) of cases in group A, 2.2% (1/45) in group B, and 17.0% (9/53) in group C ($\chi^2_{(2)} = 6.726$; $p = 0.035$). In all such cases, the biopsy results were either non-informative or contained diagnostic inaccuracies. Notably, none of these procedures were performed at reference centers, including Dmitry Rogachev National Medical Research Center.

Pre-hospital surgical attempts to remove the lesion prior to admission to Dmitry Rogachev National Research Center were recorded in 25.5% (14/55), 35.6% (16/45), and 20.8% (11/53) of patients in groups A, B, and C, respectively ($\chi^2_{(2)} = 2.751$; $p = 0.253$).

Initial histopathological examination of biopsy or surgical specimens was performed at Dmitry Rogachev National Research Center in 54.9% of cases (84/153). The group-wise distribution was as follows:

67.3% (37/55) in group A, 53.3% (24/45) in group B, and 30.2% (16/53) in group C ($\chi^2_{(2)} = 11.570$; $p = 0.003$). These differences are likely attributable to the inclusion criterion requiring histological confirmation for lymphatic malformations, as well as the lack of indication for biopsy in cases with characteristic imaging findings during the preoperative workup.

A histopathological review was not performed in 24.8% of patients (38/153). When a pathology report from a local facility was available, the original slides were forwarded to Dmitry Rogachev National Research Center in 11.1% (5/45) of group B cases and in 34.0% (18/53) of group C cases ($\chi^2_{(2)} = 28.103$; $p < 0.001$). In the absence of a prior pathology report, histological specimens were referred to the reference center in 18.9% (10/53) of patients in Group C. Direct re-examination of histological material upon admission to Dmitry Rogachev National Research Center was performed in 2.2% (1/45) of patients in group B and in 7.5% (4/53) in group C. Thus, in most cases, histopathological evaluation was initially performed at Dmitry Rogachev National Medical Research Center.

The highest rate of diagnostic errors prior to admission to Dmitry Rogachev Center was observed in group A (60.0%), compared to 8.9% and 24.5% in groups B and C, respectively ($\chi^2_{(2)} = 33.278$; $p < 0.001$). A correct diagnosis established at the local level was documented in 23.5% of patients (36/153), primarily among those with lymphatic malformations, which may reflect a tendency toward overdiagnosis of this condition at the outpatient stage. The greatest diagnostic challenges outside of reference centers were associated with the verification of malignant tumors. At Dmitry Rogachev National Research Center, the correct initial diagnosis was established in 75.8% of cases (116/153). In other reference centers, a correct diagnosis was reported only in group B (2.2%). Taken together, these findings underscore the critical role of reference centers in establishing accurate histopathological diagnoses of neck masses.

At Dmitry Rogachev National Research Center, the initial diagnosis was accurate in 75.8% of cases (116/153). A primary diagnosis consistent with the final histopathological verification and issued by other reference centers was documented exclusively in group B (2.2%; 1/45).

Correction of the initial diagnosis following the review of histological materials obtained at local facilities was required in 1.8% (1/55) of cases in group A, 8.9% (4/45) in group B, and 18.9% (10/53) in group

Table 1

Primary Clinical and Diagnostic Characteristics of the Study Cohort				Statistical analysis results
Clinical and Diagnostic Parameters		Group A: lymphatic malformations, <i>n</i> = 55	Group B: benign neoplasms, <i>n</i> = 45	Group C: malignant neoplasms, <i>n</i> = 53
Sex ratio, <i>n</i> (%)	Female	24 (43.6)	25 (55.6)	29 (54.7)
	Male	31 (56.4)	20 (44.4)	24 (45.3)
Timing of initial presentation, <i>n</i> (%)	Prenatal	11 (20.0)	1 (2.2)	2 (3.8)
	Neonatal	18 (32.7)	8 (17.8)	5 (9.4)
	1 month to 3 years	15 (27.3)	12 (26.7)	23 (43.4)
	Older than 3 years	11 (20.0)	24 (53.3)	23 (43.4)
Age at onset of clinical presentation, years ¹ <i>Me</i> (<i>Q</i> ₁ ; <i>Q</i> ₃ ; min-max)		0.03 (0.00; 2.38; -0.39; 10.87)	3.54 (0.36; 11.27; -0.56; 17.06)	$\chi^2_{(2)} = 11.969; p = 0.003$ $\chi^2_{(2)} = 9.438; p = 0.009$ $\chi^2_{(2)} = 4.164; p = 0.125$ $\chi^2_{(2)} = 12.721; p = 0.002$ H = 22.528; <i>p</i> < 0.001 U_{(A-B)} = 645.000; <i>p</i> < 0.001} U_{(A-C)} = 813.500; <i>p</i> < 0.001} U_{(B-C)} = 1086.500; <i>p</i> = 0.450}
Age at initial admission to the reference center, years <i>Me</i> (<i>Q</i> ₁ ; <i>Q</i> ₃ ; min-max)		2.10 (0.54; 5.83; 0.09; 17.72)	6.96 (1.89; 13.68; 0.12; 17.90)	1.86 (0.85; 5.49; 0.13; 17.94)
Age at diagnosis confirmation, years <i>Me</i> (<i>Q</i> ₁ ; <i>Q</i> ₃ ; min-max)		3.12 (1.03; 6.77; 0.00; 17.21)	7.15 (2.07; 13.52; 0.13; 18.01)	1.86 (0.54; 4.56; 0.07; 17.96)
Time from symptom onset to diagnosis confirmation, months <i>Me</i> (<i>Q</i> ₁ ; <i>Q</i> ₃ ; min-max)		1.23 (0.13; 16.40; 0.03; 147.63)	7.43 (3.33; 18.98; 0.10; 211.07)	2.50 (0.92; 6.27; 0.07; 62.07)
Presenting complaints at onset, <i>n</i> (%)	Palpable neck mass	51 (92.7)	45 (100.0)	34 (64.2)
	Lymph node enlargement and/or tenderness	3 (5.5)	4 (8.9)	5 (9.4)
	Signs of respiratory distress	1 (1.8)	none	6 (11.3)
	Neurological symptoms	none	1 (2.2)	4 (7.5)
	Dysphagia	none	none	1 (1.9)
Presenting complaints at admission, <i>n</i> (%)	Palpable neck mass	53 (96.4)	45 (100.0)	39 (73.6)
	Lymph node enlargement and/or tenderness	2 (3.6)	1 (2.2)	7 (13.2)
	Signs of respiratory distress	8 (14.5)	1 (2.2)	13 (24.5)
	Neurological symptoms	6 (10.9)	5 (11.1)	20 (37.7)
	Dysphagia	12 (21.8)	none	4 (7.5)
Maximum Lesion Size, mm <i>Me</i> (<i>Q</i> ₁ ; <i>Q</i> ₃ ; min-max)		69.50 (58.3; 93.0; 20.0; 173.0)	42.50 (35.25; 59.25; 14.0; 194.0)	43.50 (33.75; 57.25; 20.0; 90.30)
¹ Prenatal diagnosis was established in 9.2% of cases (14/153); in group A – 20.0% (11/55); in group B – 2.2% (1/45), and in group C – 3.8% (2/53).				

C ($\chi^2_{(2)} = 9.822; p = 0.007$). Re-evaluation of a diagnosis previously established at another reference center led to diagnostic revision after admission to Dmitry Rogachev National Research Center in 1.8% (1/55), 2.2% (1/45), and 5.7% (3/53) of cases in the respective groups.

These cumulative findings emphasize the critical role of reference centers in ensuring accurate histopathological verification of non-visceral neck masses. The diagnostic algorithm for non-visceral cervical masses is presented in Figure 2.

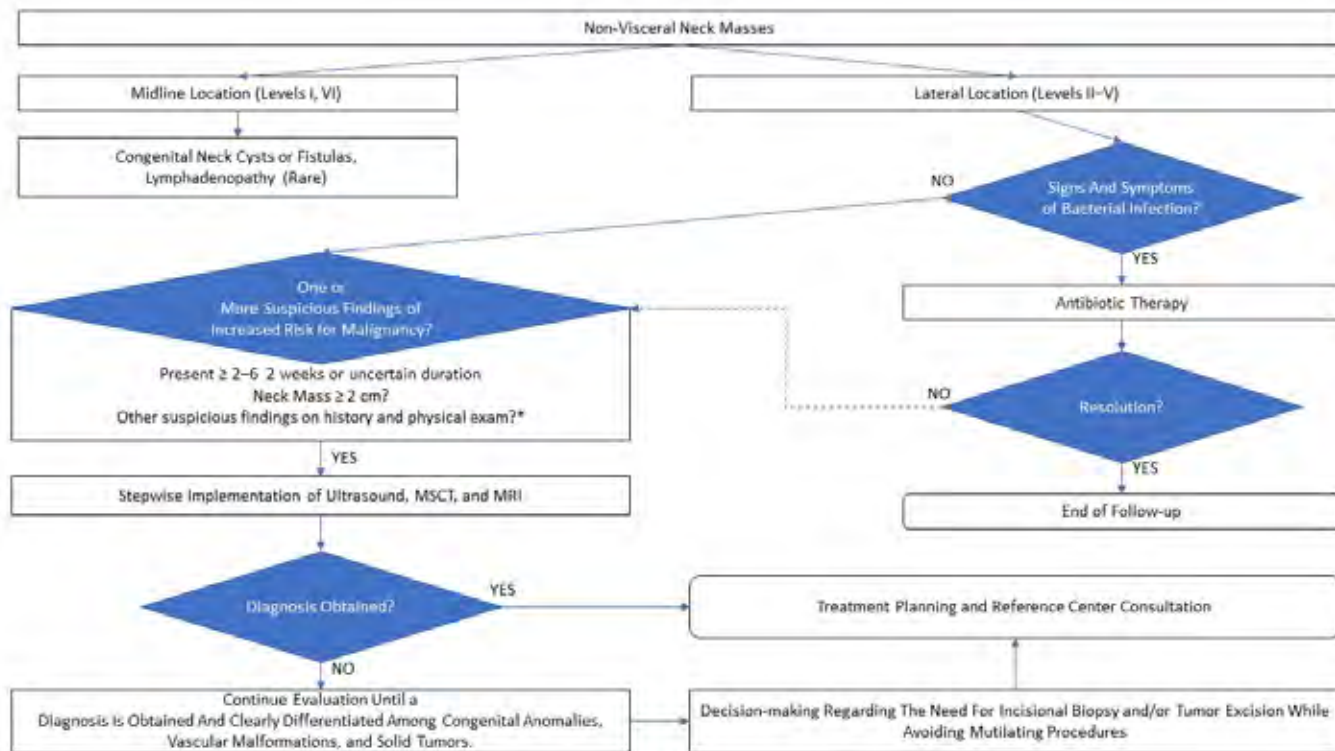


Fig. 2. Diagnostic Algorithm for Non-Visceral Neck Masses in Children.: * Other features suggestive of malignancy include the presence of a firm, painless mass, respiratory distress, and neurological symptoms

DISCUSSION

Non-visceral neck masses in children are commonly encountered in pediatric clinical practice and often pose a diagnostic challenge for clinicians. Several classification approaches have been proposed for pediatric neck masses, including age at presentation, anatomical location (taking into account fascial spaces and cervical compartments), imaging characteristics, and underlying etiology. Non-visceral neck tumors account for only a small proportion of all head and neck neoplasms [1]. This study evaluated the characteristics of initial diagnostic workup, referral pathways, and the effectiveness of histopathological examination in the verification of non-visceral cervical neoplasms and lymphatic malformations in children.

The results of the present study indicate that clinical history and physical examination alone are insufficient for accurate diagnostic verification. Notably, the initial diagnosis established in outpatient settings was

revised in 55.5% of cases (75/135). These findings are consistent with previously published literature [4].

When imaging non-visceral neck masses in children, the potential risk of radiation exposure must be considered. Therefore, ultrasound (US) is typically used as the first-line diagnostic modality. US demonstrates a sensitivity of 79–95% and a specificity of 83–84% in differentiating neoplastic from reactive lymph nodes [11, 12]. In addition, elastography may improve diagnostic accuracy, achieving a sensitivity of 85.9% and a specificity of 100% in differentiating malignant lymphadenopathy from benign one [13, 14]. We previously published a study on the imaging characteristics of secondary cervical lymph node involvement in children, presenting prognostic models for predicting the likelihood of malignant lymphadenopathy [15].

When necessary, additional imaging modalities, such as magnetic resonance imaging (MRI) and multidetector computed tomography (MDCT)

Table 2

Comparative Analysis of Histopathological Verification in Non-Visceral Neck Masses by Nosological Group					
Clinical and diagnostic parameters		Group A: lymphatic malformations, <i>n</i> = 55	Group B: benign neoplasms, <i>n</i> = 45	Group C: malignant neoplasms, <i>n</i> = 53	Statistical analysis results
Change of initial diagnosis made at a local outpatient facility, <i>n</i> (%) ¹	Local facility	8 (14.5)	28 (87.5)	39 (81.3)	$\chi^2_{(2)} = 69.417; p < 0.001$
	Other reference center ²	6 (10.9)	1 (2.2)	9 (17.0)	$\chi^2_{(2)} = 6.726; p = 0.035$
Diagnostic aspiration performed, <i>n</i> (%)	Dmitry Rogachev National Research Center	none	none	none	Not applicable
	Local facility	4 (7.3)	9 (20.0)	30 (56.6)	$\chi^2_{(2)} = 35.492; p < 0.001$
	Another reference center ²	none	none	5 (9.4)	Not applicable
Diagnostic biopsy performed, <i>n</i> (%)	Dmitry Rogachev National Research Center	none	2	2	Not applicable
	Total	4 (7.3)	11 (24.4)	37 (69.8)	$\chi^2_{(2)} = 52.487; p < 0.001$
Attempt to remove the malformation prior to hospitalization to Dmitry Rogachev Center, <i>n</i> (%)					
Biopsy/surgical specimen sent to a reference center					
No review performed at Dmitry Rogachev National Research Center		18 (32.7)	15 (33.3)	5 (9.4)	$\chi^2_{(2)} = 11.570; p = 0.003$
	Referred to Dmitry Rogachev National Research Center (with a prior histopathology report available)	none	5 (11.1)	18 (34.0)	$\chi^2_{(2)} = 30.204; p < 0.001$
	Referred to Dmitry Rogachev National Research Center (without a prior histopathological diagnosis)	none	none	10 (18.9)	Not applicable
Review of a specimen from local facility at Dmitry Rogachev Center (on admission)		none	1 (2.2)	4 (7.5)	Not applicable
	Initial histopathological examination performed at a reference center ¹	37 (67.3)	24 (53.3)	16 (30.2)	$\chi^2_{(2)} = 15.448; p < 0.001$
<i>Diagnostic accuracy of histopathological evaluation</i>					
No change in diagnosis	No diagnosis established at a local facility or another reference center, <i>n</i> (%)	33 (60.0)	4 (8.9)	13 (24.5)	$\chi^2_{(2)} = 33.278; p < 0.001$
	Accurate initial diagnosis established at a local facility	17 (30.9)	5 (11.1)	14 (26.4)	$\chi^2_{(2)} = 6.337; p = 0.042$
	Accurate initial diagnosis established at Dmitry Rogachev National Research Center	38 (69.1)	39 (86.7)	39 (73.6)	$\chi^2_{(2)} = 4.390; p = 0.111$
Change in diagnosis	Accurate initial diagnosis established at another reference center ¹	none	1 (2.2)	none	Not applicable
	Revision of diagnosis initially made at local facility following histopathological review at a reference center ¹	1 (1.8)	4 (8.9)	10 (18.9)	$\chi^2_{(2)} = 9.822; p = 0.007$
	Diagnosis revised after review at Dmitry Rogachev National Research Center (originally made at another reference center)	1 (1.8)	1 (2.2)	3 (5.7)	Not applicable

1. In the analysis of diagnosis changes between outpatient and inpatient stages, data on the initial (outpatient) diagnosis were unavailable for 11.8% of patients (18/153). 2. Throughout this study, the term «reference center» refers to specialized institutions in the Russian Federation officially designated as reference centers in accordance with Order No. 1372 of the Ministry of Health of the Russian Federation dated December 25, 2020.

are employed. These methods enhance diagnostic confidence and provide important topographic and anatomical information, such as involvement of critical vascular structures and adjacent organs of the neck. This is particularly relevant given the limited penetration depth of ultrasound, which relies primarily on high-frequency probes for the assessment of superficial lesions [3].

A review of biopsy or surgical specimens obtained at local facilities was performed at a reference center in 75.2% of cases (115/153). An accurate histopathological diagnosis initially established outside a specialized institution was observed in only 23.5% of patients (36/153), the majority of which were cases of lymphatic malformation.

The greatest need for diagnostic re-evaluation was observed among patients with malignant tumors – 90.6% of cases (48/53), compared to 66.7% (30/45) among those with benign neoplasms. Revision of the initial diagnosis following the histopathological review was required in 24.5% of malignant cases (13/53) and in 11.1% of benign cases (5/45).

These findings underscore the critical role of reference centers in ensuring accurate histopathological verification of non-visceral cervical neoplasms in children.

Pediatric surgical oncologists play a critical role in the diagnosis, staging, and treatment of malignant solid tumors. Over time, many treatment protocols for solid tumors have increasingly advocated for an individualized surgical approach to both the primary tumor and metastatic lesions [1]. The decision to proceed with primary tumor resection at the diagnostic stage – or, conversely, to perform a biopsy followed by neoadjuvant therapy – is critically important and must be made by a multidisciplinary pediatric oncology team. This decision should be based on the clinical presentation, radiological findings, and results of histopathological evaluation. Inappropriate or untimely surgical intervention during the diagnostic stage of malignant neck tumors in children may result in both short- and long-term complications, incomplete tumor resection, and delays in the initiation of adjuvant therapy [16, 17]. This underscores the importance of timely and appropriate surgical intervention during the diagnostic phase to improve outcomes in children with malignant non-visceral cervical tumors.

CONCLUSION

Non-visceral neck masses in children present significant diagnostic variability and a high risk

of misdiagnosis at the outpatient stage: accurate verification outside reference centers was achieved in less than a quarter of cases. These findings underscore the need for a comprehensive multidisciplinary approach involving imaging, biopsy, and mandatory slide review in specialized centers. The implementation of standardized diagnostic algorithms may substantially improve diagnostic accuracy and patient management strategies.

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