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Original Research Article

Diagnostic Accuracy of Fine Needle Aspiration Cytology in Pediatric Peripheral Lymphadenopathy: A Cross-Sectional Study with Histopathological Correlation in a Tertiary Care Center

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Abstract

Background: Peripheral lymphadenopathy is a common clinical presentation in children and is predominantly associated with benign and inflammatory conditions. Fine needle aspiration cytology (FNAC) serves as a minimally invasive, rapid, and cost-effective diagnostic modality for evaluation of pediatric lymphadenopathy. Our study aimed to evaluate the diagnostic accuracy of FNAC in pediatric peripheral lymphadenopathy with histopathological correlation and Sydney system categorization.

Methods: Our study was a cross-sectional observational study conducted in the Department of Pathology at a tertiary care center. Seventy-seven pediatric patients with clinically palpable peripheral lymphadenopathy underwent FNAC. Cytological diagnoses were categorized according to the Sydney system. Histopathological correlation was performed wherever available. Sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy were calculated.

Results: The mean age was 8.95 ± 4.83 years with male predominance (58.4%). Cervical lymph nodes were most commonly involved (28.6%). Reactive lymphadenitis was the most frequent diagnosis (22.1%), followed by granulomatous lymphadenitis, suppurative lymphadenitis, and lymphoma (20.8% each). Most cases belonged to the L2 benign category (64.9%) under the Sydney system. Histopathology revealed 80.5% benign and 19.5% malignant lesions. FNAC showed sensitivity of 90.9%, specificity of 95.4%, positive predictive value of 93.8%, negative predictive value of 93.3%, and overall diagnostic accuracy of 93.5%.

Conclusion: FNAC is a safe, minimally invasive, and reliable first-line diagnostic tool for pediatric peripheral lymphadenopathy. The Sydney system provides effective structured reporting and risk stratification. FNAC significantly reduces unnecessary surgical biopsies while maintaining high diagnostic accuracy.

Keywords: Fine-Needle Aspiration, Lymphadenopathy, Cytodiagnosis, Histopathology, Sydney System, Diagnostic Accuracy, Risk Assessment.

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Introduction

Peripheral lymphadenopathy is a common clinical presentation in children and often necessitates diagnostic assessment in outpatient and tertiary care populations [1,2]. In contrast to adults where malignant etiologies predominate, lymphadenopathy in the pediatric population is primarily related to benign and reactive issues due to changes of an developing immune system [1,2]. Childhood adenopathy is commonly due to hyperplastic lymphoid activity in response to infections, parasitic infestations or granulomatous disease, such as tuberculosis [3,4]. The most affected area is the cervical region, as it drains lymph from upper aerodigestive tract [5]. Nevertheless, clinical assessment dependent on the attributes of nodal characteristics is frequently insufficient for characterising a benign versus malignant cause with reliability [6]. The majority of there are no neoplastic, but malignancy (lymphoma or leukemia or metastatic disease) needs to be considered [7]. The latter is particularly important in the case of persistent

lymphadenopathy, supraclavicular involvement or systemic symptoms as early differentiation may avoid a bad outcome [7]. At the same time, unnecessary invasive procedures may increase childhood morbidity [7]. FNAC has been an effective diagnostic tool in clinical practice as a minimally invasive method, low cost and rapid results [8]. It allows cytomorphological categorization as reactive, infective, granulomatous and neoplastic lesions so that clinical treatment could be guided [8]. Studies on lymphadenopathy have demonstrated a sensitivity and specificity of more than 90% for FNAC [9]. The Sydney System of lymph node cytopathology is a principles-based classification with objective criteria that was developed to facilitate standardized reporting and improve clinical communication [10,11]. It provides a five-level risk of malignancy classification with management recommendations [10,11]. This system has allowed for better diagnoses and risk stratification [10,11]. However, FNAC is still limited by high sampling errors and cytological overlap between reactive conditions and low-grade lymphomas [12], causing diagnostic ambiguity. Therefore, histopathological evaluation is the gold standard in some instances [12].

The literature has consistently shown a predominance of benign lesions in lymphadenopathy in children [13]. However, diversity in the spectrum of disease and efficacy with FNAC among regions have been observed particularly suited to their endemicity for tuberculosis [3,9]. However, data on regionwise from eastern India are scanty and studies evaluating the Sydney system in children have not been conducted [3,9]. Hence, our study was undertaken to assess the accuracy of FNAC in the diagnosis of peripheral lymphadenopathy in children with histopathological correlation. It will further evaluate cytological outputs, via the Sydney reporting system to aid in improving diagnostic stratification and clinical intervention.

Methodology

Our study was a cross-sectional observational study, carried out in the Department of Pathology of a Rajendra Institute of Medicall Sciences, Ranchi. Consecutive sampling method was used and the study included pediatric patients with an age less than 18 years with clinically palpable peripheral lymphadenopathy, who were referred for fine needle aspiration cytology (FNAC) during our study period, as our study population. There were 77 cases that met the inclusion criteria and were enrolled. Our study excluded patients with incomplete clinical data or those who could not undergo FNAC. As this was a hospital based observational study all the cases presented to the department has been included into the study consecutively. A structured proforma was used to record detailed clinical information such as age, sex, duration of lymphadenopathy, lymph node size, location of involvement, and related symptoms such as fever, weight loss, and history of tuberculosis. Clinical examination was used to select peripheral lymph nodes of accessible sites for aspiration.

FNAC was done under aseptic precautions using the standard method with a disposable needle and syringe. When needed, several passes were made to obtain sufficient material. The material was aspirated onto glass slides, air-dried, and fixed with alcohol as necessary. Routine cytological stains, such as Leishman-Giemsa stain, were used to stain smears. Acid-fast bacilli (AFB) Ziehl–Neelsen (ZN) staining was done in those cases that had clinical or cytological suspicion of granulomatous lymphadenitis.

Cytomorphological analysis was done by senior pathologists, and the cases were classified into diagnostic categories like reactive lymphadenitis, granulomatous lymphadenitis, suppurative lymphadenitis, lymphoma, and metastatic malignancy as per the laid-down cytological criteria. Moreover, all the cases were categorized under the Sydney System of reporting lymph node cytopathology into five categories: L1 (inadequate), L2 (benign), L3 (atypical), L4 (suspicious of malignancy), and L5 (malignant).

In situations where lymph node biopsy or excision specimens were available, histopathological examination was done. These results were taken as the reference standard for final diagnosis, and cytological results were compared with histopathology wherever available.

Test statistics were conducted to assess the diagnostic capabilities of FNAC. Based on the results of true positive, true negative, false positive, and false negative, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy were calculated using standard formulas. Demographic and clinical variables were summarized using descriptive statistics.

The relationship between FNAC categories and final histopathological diagnosis was tested using the chi-square test, and a p-value of less than 0.05 was considered significant. Our study was ethically approved by the Institutional Ethics Committee (letter no. 86 dated 01.02.2025), and informed consent was obtained from parents/guardians and assent from the patient (if >7 years of age) before the procedure.

Results

They were 77 pediatric patients with peripheral lymphadenopathy. The mean age was 8.95 ± 4.83

years, with the majority of cases in the 11–15-year age group, 26 (33.8%). There was a slight male predominance, 45 (58.4%) (Table 1).

Table 1: Demographic Characteristics of Study Population (n = 77)

Variable	Category	Number (n)	Percentage (%)
Age	≤5 years	22	28.6
	6–10 years	23	29.9
	11–15 years	26	33.8
	>15 years	6	7.8
Sex	Male	45	58.4
	Female	32	41.6

The cervical lymph nodes were the most commonly involved site (28.6%), followed by supraclavicular (26.0%) and inguinal (23.4%) lymph nodes (Table 2).

Table 2: Clinical Profile and Lymph Node Characteristics

Variable	Category	Number (n)	Percentage (%)
Lymph Node Site	Cervical	22	28.6%
	Supraclavicular	20	26.0%
	Inguinal	18	23.4%
	Axillary	10	13.0%
	Submandibular	7	9.1%
Clinical Features	Fever (Present)	38	49.4%
	Fever (Absent)	39	50.6%
	Weight Loss (Present)	8	10.4%
	Weight Loss (Absent)	69	89.6%
	History of TB (Present)	22	28.6%
	History of TB (Absent)	55	71.4%

Ziehl–Neelsen staining demonstrated acid-fast bacilli positivity in 9 (11.7%) cases, while 46 (59.7%) were negative (Table 3).

Table 3: Ziehl–Neelsen (ZN) Stain for Acid-Fast Bacilli

ZN Stain Result	Number (n)	Percentage (%)
Positive	9	11.7
Negative	46	59.7
Not Done	22	28.6

The mean lymph node size was 2.48 ± 0.97 cm, and the mean duration of lymphadenopathy was 12.77 ± 6.92 weeks (Table 4).

Table 4: Descriptive Statistics of Lymph Node Size and Duration

Variable	Mean	Standard Deviation (SD)
Node Size (cm)	2.48	0.97
Duration (weeks)	12.77	6.92

Cytomorphological evaluation revealed reactive lymphadenitis as the most common finding (17, 22.1%), followed by granulomatous lymphadenitis, suppurative lymphadenitis, and cytomorphological features suggestive of lymphoma (16 cases each, 20.8%). Cytomorphological features suggestive of metastatic malignancy were observed in 12 (15.6%) cases. (Figure 1).

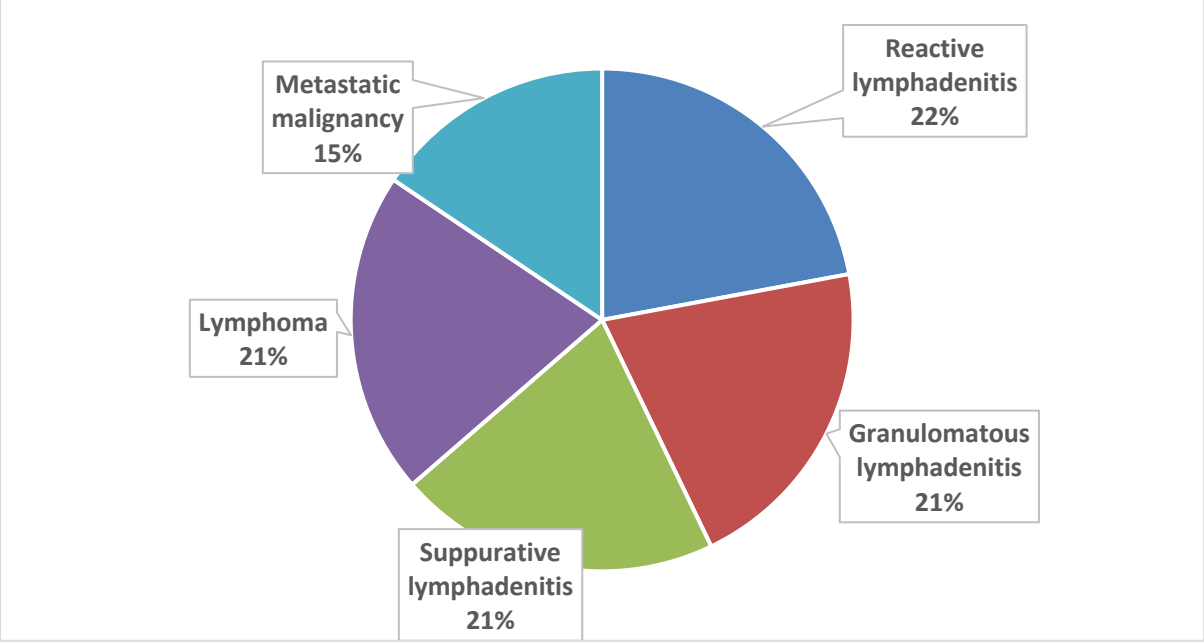

Figure 1: Distribution of cytomorphological diagnoses on FNAC (n = 77)

According to the Sydney system, the majority of cases were categorized as benign (L2), 50 (64.9%), followed by suspicious (L4), 10 (13.0%), and malignant (L5), 8 (10.4%) categories (Figure 2).

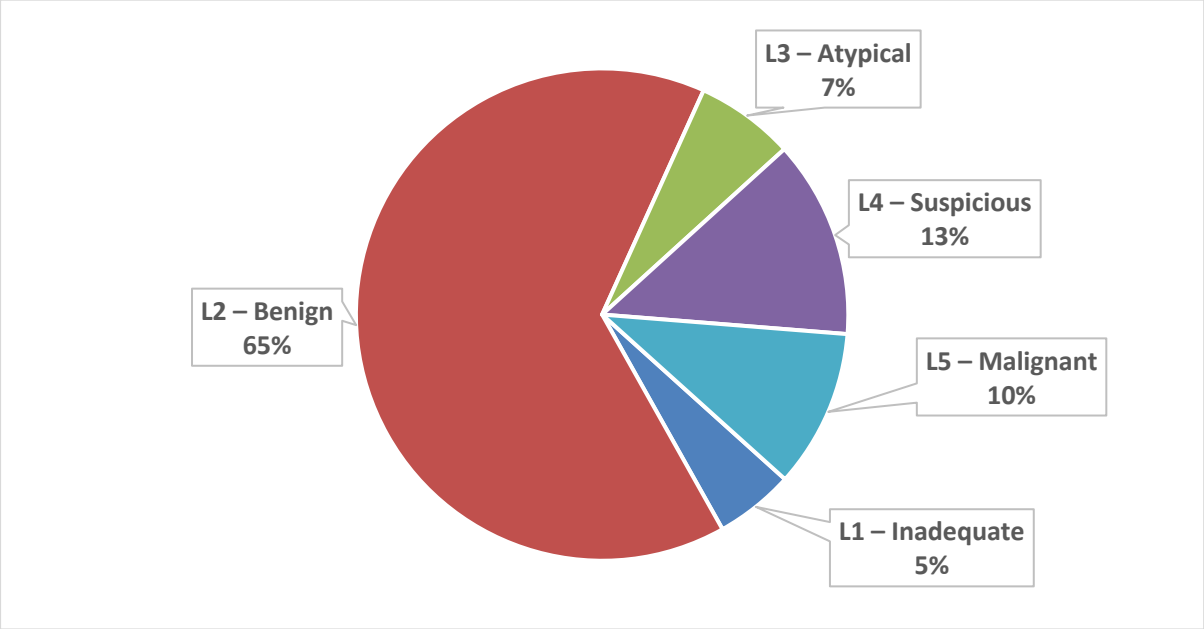

Figure 2: Distribution of cases according to the Sydney System (n = 77).

Histopathological examination was available in 40 (51.9%) of the 77 patients. Among these cases, 33 (82.5%) were diagnosed as malignant and 7 (17.5%) as benign on histopathological examination. (Table 5).

Table 5: Histopathological Diagnosis (n=40)

Histopathological diagnosis	n	%
Benign	7	17.5
Malignant	33	82.5
Total	40	100.0

Among the 40 histopathologically correlated cases, FNAC correctly identified 30 true-positive and 5 true-negative cases. There were 2 false-positive and 3 false-negative cases (Table 6).

Table 6: Histopathological Correlation and Diagnostic Performance of FNAC

FNAC interpretation	Histopathology Malignant	Histopathology Benign	Total
Positive (L3–L5)	30	2	32
Negative (L1–L2)	3	5	8
Total	33	7	40

***Fisher's exact test, p = 0.0015**

FNAC demonstrated a sensitivity of 90.9%, specificity of 71.4%, positive predictive value of 93.8%, negative predictive value of 62.5%, and an overall diagnostic accuracy of 87.5% when compared with histopathological diagnosis.

Table 7: Diagnostic performance of FNAC using histopathology as the reference standard (n = 40)

Measure	Value (%)	95% CI
Sensitivity	90.9	75.7–98.1
Specificity	71.4	29.0–96.3
Positive Predictive Value (PPV)	93.8	79.2–99.2
Negative Predictive Value (NPV)	62.5	24.5–91.5
Diagnostic Accuracy	87.5	73.2–95.8

Discussion

Our study revealed that the largest proportion of pediatric peripheral lymphadenopathy is comprised of benign and inflammatory lesions, with reactive lymphadenitis (22.1%) and granulomatous lymphadenitis (20.8%) being the most frequent cytological diagnoses. This observation is consistent with those reported by Silas et al. [13], who revealed inflammatory lesions in almost 88 percent of pediatric cases, and Rijhsinghani et al. [14], who found benign etiologies in more than 60 percent of patients. Our mean age of 8.95 years, with highest incidence in the 11–15-year age range, is also in line with the literature, including that of Rijhsinghani et al. [14], which indicates greater lymphoid reactivity in school-aged children. Granulomatous lymphadenitis was observed in 20.8% of cases, which means that tuberculosis has a considerable burden in the region. Nonetheless, the AFB positivity (11.7%) was significantly lower in comparison to that reported in other studies by Viswanathan and Shroff [16] and Vimal et al. [17] (58.1% and 68.5%, respectively). This difference is probably due to variations in study design, where other studies were based on confirmed tuberculous lymphadenitis, whereas our study involved all etiologies, as well as the known limitations of smear-based detection in paucibacillary conditions. The most common diagnosis in our cohort was reactive lymphadenitis, as also reported by Robert and Saldanha [18], with a higher rate of malignant lesions (36.4%), whereas in Silas et al. [13] (11.5%) and Rijhsinghani et al. [14] (5.46%), malignant cases were lower and less frequent.

The use of the Sydney System showed that most cases fell under the L2 (benign) category (64.9%), which is in line with the results of Das et al. [19] (60%). Progressive increases in malignancy across higher Sydney categories were revealed by our study, with the highest levels being found in higher categories; however this did not reach statistical significance (p = 0.11). This resembles trends found by Gupta et al. [20], Juanita et al. [21], and Sable et al. [22].

FNAC–histopathology discordance was seen in 48.1% of cases, the majority of which were atypical (L3) and suspicious (L4). Reactive or granulomatous lesions that simulated malignancy were the primary causes of false-positive cases, while sampling errors and subtle cytological patterns were the main causes of false-negative cases. These findings are consistent with the results of Gupta and Dey [12], who also noted the risk of diagnostic confusion between reactive lymphadenitis and low-grade lymphoma. Das et al. [19] have also reported similar problems in indeterminate categories, emphasizing that such cases must be confirmed by histopathology.

On the whole, our study findings are mostly in line with the existing literature, showing that benign lesions are predominant, FNAC risk stratification is highly accurate, and the Sydney system is useful in risk stratification, although there are limitations in equivocal diagnostic categories. The strengths of our study are that it exclusively focused on the pediatric population, thus offering age-specific information about peripheral lymphadenopathy. Fine needle aspiration cytology is a minimally invasive diagnostic modality with a high diagnostic rate and is cost-effective, increasing its applicability, especially in resource-constrained environments [8,9]. The standardisation of reporting and risk stratification using the Sydney system, coupled with its association between histopathology [8] profile (Table 1) and additional clinical parameters [9], supports diagnostic validity. Nonetheless, there are some shortcomings. The limitations include single-center nature of study, hence the generalizability may be restricted. Histopathological diagnosis was not universally

achievable and immunocytochemistry/molecular diagnostics were rarely used, which could potentially reduce accuracy in any equivocal Page 12 of 16 - AI Writing Submission ID trn:oid:::1:3578837865 cases. This is a limitation as follow-up was not possible due to the cross-sectional study design, and inherent limitations of FNAC such as sampling error or interobserver variability could not be avoided.

Conclusion

Fine needle aspiration cytology is a safe, less invasive and cost-effective diagnostic method of choice for peripheral lymphadenopathy in paediatric age group. Most were non-neoplastic/ inflammatory, largely reactive/nonspecific (dominant), and granulomatous lymphadenitis. FNAC sensitivity and specificity, as well as overall diagnostic accuracy closely matched histopathology providing support for the use of FNAC as a first-line investigation. The introduction of the Sydney system allowed for organised reporting and risk stratification, aiding clinical decision-making—particularly in those cases that are atypical/suspicious. Although some cytological constraints still require histopathological confirmation, FNAC plays a critical role in conjunction with appropriate clinical correlation to reduce unnecessary surgical biopsies.

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