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Karnataka Paediatric Journal

Editorial

Ending preventable newborn and child deaths

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India has made considerable progress in reducing newborn mortality, thereby reducing its share of the global newborn mortality burden from one-third of newborn deaths in 1990 to below one-fifth of total newborn deaths today. Nearly 46 per cent of all maternal deaths and 40% of neonatal deaths happen during labour or the first 24 h after birth. Some of the major causes of newborn deaths among babies <29 days old are–prematurity and low birth weight (48%), birth asphyxia and birth trauma (13%), neonatal pneumonia (12%) and non-communicable diseases (7%). Nearly 3.5 million babies in India are born too early, and 1 million newborns are discharged each year from Special Newborn Care Units (SNCUs). These newborns remain at high risk of death, stunting and developmental delay.

Many such deaths are largely preventable through access to skilled birth attendants and emergency health services during and after delivery. Enabling access to emergency services and obstetric care can go a long way in preventing the death of a newborn and its mother. In 2020, there were nearly 1 million fewer newborn deaths and 8520 fewer maternal deaths each month in India, as compared to 2016. This progress results from dedicated efforts to encourage institutional delivery, which enables access to obstetric care and emergency services. More women are delivering in health facilities today than they did earlier.

Just over a decade ago, six out of ten women delivered at home without the support of a skilled birth attendant, putting both their and their newborn's life at risk. Today, this number has reduced three-fold, with nine out of ten women delivering in a health facility. The quality-of-service delivery, though, needs to catch up with the increase in coverage. Early initiation of breastfeeding – an essential to ensure the health of the child – has been recorded in just 41% of cases, high rates of stillbirths (4/1000 births) and many deaths due to asphyxia in SNCUs are consequences of low quality of healthcare services delivery across the country.

The increase in coverage has also been inequitable among the majority of women who are tribal and from the poorest households. Often living in hard-to-reach areas, most women still deliver in their homes. So even though India has shown significant progress in the reduction of child mortality, the focus now needs to be on reaching the most marginalised, with particular attention on the girl child. The rapid scale-up of SNCUs in the country has accelerated the reduction of neonatal mortality. However, it has also brought to light socio-cultural barriers, societal biases and gender disparity. Although evidence reveals newborn girls as biologically more potent, they remain socially vulnerable due to widespread male child preference, reflected in the higher infant and under-five mortality of girl children. In India, more girl babies die than boy babies (U5MR) and the gender differential in under-five mortality rate is by 2 points. To ensure an enabling environment for the proper growth and

development of every child, we should mobilise communities with social and behavioural change initiatives to:

i. Generate demand for and uptake of quality Maternal and Newborn Health services, especially in hard-to-reach areas in aspirational districts
ii. Address gender biases and harmful socio-cultural norms in newborn care-seeking.

The day of birth is the riskiest for both mother and newborn, with nearly half of all maternal deaths and 40% of newborn deaths and stillbirths happening on the day a child is born. Therefore, government should prioritise the day of birth with convergent interventions from health, nutrition and WASH programmes that lead to a triple return on investments in terms of reducing maternal, stillbirth and neonatal deaths. Indian Academy of Paediatrics and its every member should support India's efforts to eliminate preventable neonatal deaths by 2030, with a particular focus on the girl child.

Dr. Bhaskar Shenoy,
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Karnataka Paediatric Journal

Review Article

The entirety of paediatric osteoarticular infections

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ABSTRACT

Bone and joint infections are the important cause of morbidity and mortality in children which results in deformities and affects motor development of the child. In paediatric practice, early diagnosis and treatment of osteoarticular infections is very important to prevent morbidity and mortality. The main objective of this article is to understand the clinical, diagnostic and therapeutic profile of paediatric osteoarticular infections, which will help in having a basic framework and algorithm for early diagnosis and appropriate management which decreases the morbidity and mortality associated with osteoarticular infections.

Keywords: Osteoarticular infections, Septic arthritis, Osteomyelitis, Paediatric, Arthroscopy

INTRODUCTION

Paediatric osteoarticular infections include osteomyelitis, septic arthritis and a combination of both. The incidence of osteomyelitis varies between 1 and 13/1 lakh children/year[1] in developed countries to 200/1 lakh children/year in low- and middle-income countries and incidence rates of septic arthritis are reported as 4–37/1 lakh population.[2] 1% of paediatric hospital admissions are due to bone and joint infections.[1] Early diagnosis and treatment play a key role in achieving better outcomes and preventing sequelae leading to disabilities. It is important to understand the clinical and diagnostic profile of paediatric osteoarticular infections to know changing trends in every aspect of management as well as to know the significance of laboratory and radiological investigations which will act as a catalyst for early diagnosis and treatment.

CLASSIFICATION

Paediatric osteoarticular infections are classified into:[3]

1. Osteomyelitis
2. Septic arthritis
3. Combination of both.

PREDISPOSING/RISK FACTORS

The following are the probable associations described in osteoarticular infections:

1. Upper respiratory tract infection – *Kingella kingae*
2. Trauma, blunt injury and varicella infections – group A streptococcus
3. Sickle cell anaemia – Salmonella species
4. 4, Immunodeficiency – Serratia, Aspergillus
5. Penetrating wounds – Pseudomonas and anaerobes
6. Animal handling and laboratory work – *Brucella*, *Coxiella*

7. Contact with pulmonary tuberculosis – *Mycobacterium tuberculosis*
8. Prematurity, central venous lines and bacteraemia.

AETIOLOGY

The most common etiological agents of bone and joint infections are tabulated below in Table 1.[3]

Pathophysiology

Osteomyelitis affects bone and its medullary cavity. Bone is resistant to infection unless it is subjected to trauma, disruption of blood flow that deprives the bone of normal host immunity, a large inoculum of blood-borne or external microorganisms or a foreign body.[4] Haematogenous inoculation usually starts in the metaphysis, wherein the blood flow is slow in the sinusoidal blood vessels. Inflammatory cells migrate to the area, leading to oedema, vascular congestion and small vessel thrombosis, leading to an increase in intraosseous pressure resulting in impaired blood supply to the medullary canal and periosteum leading to the formation of sequestrum (necrotic bone). Bony tissue attempts to compensate for the tensile stresses caused by infection by creating new bone around the areas of necrosis. This new bone deposition is called an involucrum. Anatomic distribution of osteoarticular infections is shown in Figure 1.[5]

Septic arthritis is usually a consequence of haematogenous spread or direct inoculation into the joint. The lack of a basement membrane makes the highly vascular synovium vulnerable to bacterial seeding. From synovium, infection reaches articular cartilage, leading to increased production of synovial fluid, causing joint effusion leading to ischaemic damage of the cartilage.[2]

Clinical features of bone and joint infection in children

The clinical features of bone and joint infections[3] are tabulated in Table 2. The management of bone and joint infections[3] is tabulated in Table 3. The choice of empirical IV antibiotics[3] is tabulated in Table 4.

Table 1: Etiological agents in bone and joint infections.

Age	Aetiological agent
<3 months	*Staphylococcus aureus* *Escherichia coli* and gram-negative bacteria Group B streptococcus *Candida albicans* *Neisseria gonorrhoea* (neonate)
3 months–5 years	*Staphylococcus aureus* *Kingella kingae* Group A streptococcus *Hemophilus influenza* b *Streptococcus pneumoniae*
Older child >5-year old	*Neisseria gonorrhoea* *Staphylococcus aureus* *Streptococcus pneumoniae*

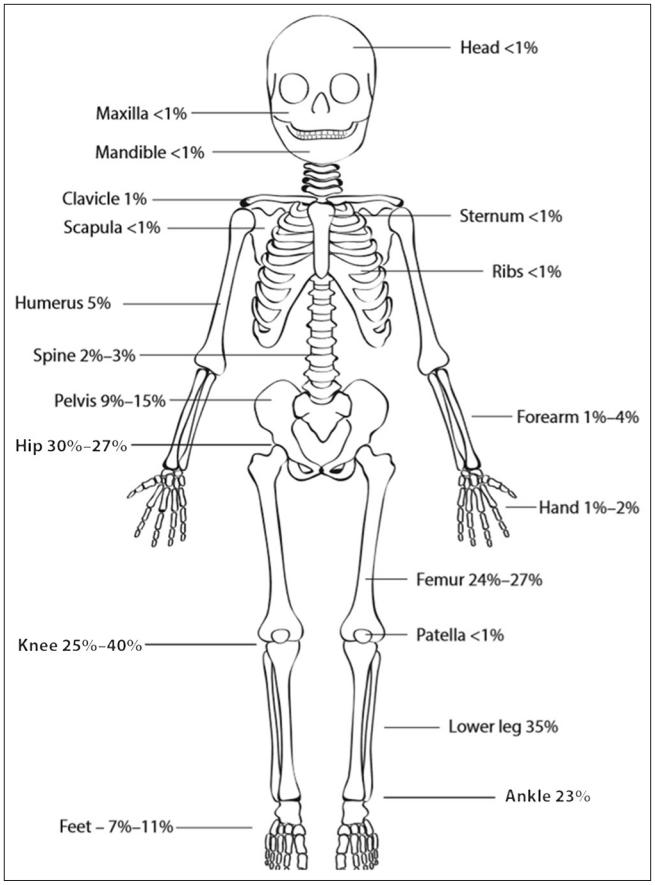

Figure 1: Anatomic distribution of osteoarticular infections.

Surgical interventions

Include: Arthrotomy, arthroscopy, arthrocentesis and lavage – chosen based on institutional expertise and clinical condition.[3]

Complications/sequelae

1. Limping, deformity, pyomyositis, chronic pain, rigidity and chronic
2. Recommended follow-up intervals with paediatrician and orthopaedic surgeons post-discharge are as follows: 2 weeks, 6 weeks, 3 months, and 12 months after discharge
3. Pain-free normal activity is the end point to end follow-up.

Physical therapy

1. Support and protection devices such as removable cast and boot case depend on the site and severity of bone and joint infections. Instructions are given to avoid weight-bearing and encourage passive movements to prevent rigidity.

Table 2: Clinical features of osteoarticular infections in children

	Age	Symptoms	Local symptoms
OM	<30 days	Fever Irritability/ excessive cry Poor feeding Nonspecific symptoms	Limb pain Local inflammation Pseudoparalysis If flat bones are involved, no localising signs are found
OM	1 month to 2 years	Vomiting, poor feeding, irritability Fever Severe systemic symptoms due to bacteraemia	Refusal to bear weight Limping Local inflammation
	2 year–18 years		Limp Pain Swelling Erythema Older children tend to localise
SA	0–18 years		Hot, swollen, immobile peripheral joint Pain on passive joint movement

OM: Osteomyelitis, SA: Septic arthritis

Table 3: Management of osteoarticular infections

	Uncomplicated OM/SA	Complicated OM/SA
1. Hospitalisation	Yes	Yes
2. Blood tests	CRP, ESR, CBC	ESR, CRP, CBC
3. Bacteriology	Blood Culture: 4 mL in children and 2 mL in neonates: Blood, synovial fluid or bone/tissue sample Consider PCR	Blood Culture: 4 mL in children and 2 mL in neonates: Blood, synovial fluid or bone/tissue sample Consider PCR
4. Imaging	Osteomyelitis - X-ray, MRI Septic arthritis - USG, MRI (to document any evidence of osteomyelitis)	Osteomyelitis - X-ray, MRI Septic arthritis - USG, MRI; (to document any evidence of osteomyelitis). Bone scan if MRI is not available
5. Surgery	Indications: Effusion, pus, bone destruction and lack of clinical response	Indications: Effusion, pus, bone destruction and lack of clinical response
6. Antibiotic treatment	Discussed separately	
7. Monitoring	When pathogen is not known	Consider 2nd line or additional antibiotics if gram negative and MRSA are not ruled out.
8. IV to oral switch	Clinical improvement in pain mobility and swelling Afebrile for 24–48 h Decreased CRP (30–50% of highest value)	Minimum of 1 week of IV therapy and same factors to be considered for switch
Up to 3 months of age	Switch after 14–21 days Duration of treatment - 4–6 weeks (for both OM and SA)	Switch after 21 days Duration of treatment - 4–6 weeks (for both OM and SA)
3 months of age – time to switch and duration	Switch after 24–48 h of clinical improvement Total duration: OM: 3–4 weeks (MRSA –6 weeks) SA: 2–3 weeks	2 weeks of IV antibiotics and then switch to oral to cover the total duration of treatment of 4–6 weeks (for both OM and SA)
9. Follow-up	CRP Longer follow-up is required in infants and complicated infections. Follow-up imaging (USG/MRI) may be required.	End point of therapy is difficult to determine in complicated infections which can be based on normal CRP and improvement in symptoms Follow-up with the orthopaedic surgeon to address on-going sequelae.

CRP: C-reactive protein, CBC: Complete blood count, ESR: Erythrocyte sedimentation rate, USG: Ultrasound, MRI: Magnetic resonance imaging, PCR: Polymerase chain reaction, OM: Osteomyelitis, SA: Septic arthritis, MRSA: Methicillin resistant staphylococcus aureus

Table 4: Choice of empirical IV antibiotics

Age	Empirical IV antibiotic treatment
<3 months	Cefazolin and gentamicin (alternative – ASP + cefotaxime)
3 months–5 years	Cefuroxime/cefazolin, in non Kingella regions – add clindamycin; Alternatives: Ceftriaxone or ASP or amoxicillin-clavulanate or ampicillin-sulbactam
>5 years	Cefazolin or ASP or clindamycin (high MRSA prevalence)

MRSA: Methicillin resistant staphylococcus aureus, ASP: Antistaphylococcal penicillin.

2. Management of bone and joint infections is by a multidisciplinary approach which includes a team of paediatrician, paediatric orthopaedic surgeons, paediatric infectious disease specialists and rehabilitation.

CONCLUSION

Paediatric osteoarticular infections always pose diagnostic challenges due to their non-specific clinical presentation. Due to the non-availability of 'gold standard' diagnostic tests, many diagnostic algorithms were proposed which were never a substitute for clinical decision-making. Recommendations in the literature are based on expert opinions, case series and descriptive studies. There is a need for large multicentric randomised controlled trials and prospective studies for better understanding of paediatric osteoarticular infections to decrease morbidity and mortality.

Ethical approval

Institutional Review Board approval is not required.

Declaration of patient consent

Patient's consent was not required as there are no patients in this study.

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Nil.

Conflicts of interest

Dr. Bhaskar Shenoy is on the editorial board of the Journal.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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Karnataka Paediatric Journal

Original Article

Admission trends, associated factors and the outcomes for children hospitalised to paediatric intensive care unit for asthma – A population based longitudinal study

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ABSTRACT

Objectives: This study aims to quantify the burden of pediatric intensive care unit (PICU) admissions from acute severe asthma and to describe the associated factors and outcome in these admissions.

Material and Methods: This was a prospective longitudinal population based study from 2015 through 2019. Included all children (< 16 years) with acute severe asthma who needed hospitalization. Ethical approval for the data collection was obtained. Real time hospital admission date was collected by one of the authors. The medical records of the patients were examined as per the objectives of the study.

Results: From among the 13407 Emergency Room visits from acute asthma during study period, there were 1748 (13.0%) required hospital admissions and 101 (0.8%) including 66 (65.3%) males and 35 (34.7%) females were admitted to the PICU. Of the PICU admissions, 76 (75.2%) and 47 (46.5%) had previous hospitalization and PICU admissions respectively. Among those admitted to PICU 29 (28.7%), 61 (60.4%) and 11 (10.9%) were on daily inhaled corticosteroids (ISC), were non-compliant with their inhaled corticosteroids (ICS) and were not on any ICS. There was no mortality from asthma during the study period.

Conclusions: The majority of the PICU admissions for acute asthma was among children with previous asthma hospitalization and those who did not use ICS or did not comply with ICS.

Keywords: Asthma, Paediatrics, Intensive care unit

INTRODUCTION

Asthma is one of the most prevalent non-communicable diseases in paediatric age group globally.[1] It carries a significant risk of morbidity and mortality, especially among children and adolescents.[2-4] Severe acute asthma is defined as an asthma exacerbation refractory to the usual therapy and accounts for up to 20% of all admissions to the paediatric intensive care unit (PICU) worldwide.[5,6] Over the past years, the frequency of PICU admissions for acute severe asthma has shown a significant rise in many countries.[5,6] Hospitalisation due to asthma is one of the most common ambulatory care-sensitive preventable admissions in children.[7-9] This may reflect the failure of appropriate, timely treatment, which is a predictor of the general management of asthma in the community.

Barbados, one of the countries in the Caribbean region of the Americas, has a population of 301,865 (2021 est.), with 17.5% of the inhabitants below 15 years of age (2021 est.). The infant

mortality rate is 10.23/1,000 live births; life expectancy at birth, at 78.3 years, is amongst the highest of the Caribbean islands.[10] The literacy rate in this country is nearly 100%.[10] The health care indicators of Barbados are at par with the developed world. The country provides free health care for all residents.[11-13]

Barbados has one of the highest prevalences of asthma in the world, with a mean of 10,348 cases seen at the emergency clinic per year, as reported by Depradine and Lovell in 2015, and a 31.1% prevalence of recurrent wheezing amongst toddlers, as reported by Kumar *et al*. in 2021 for an estimated population of 284,000, including 53,000 children under the age of 16 years.[14-16] Asthma carries significant morbidity and risk of hospitalisation in this country.[14-19] Despite the substantial disease burden, there is no published data regarding sick asthmatic children requiring intensive care admissions from the region. A better understanding of the epidemiology and healthcare utilisation by sick asthmatic children may be useful in devising strategies to help reduce the frequency, severity, and mortality from acute severe asthma. The aim of the present study was to examine the trends in PICU admissions from acute severe asthma in Barbados and to describe the associated factors and outcome of PICU admissions from acute severe asthma.

MATERIAL AND METHODS

Case definition

Paediatric asthma is characterised by persistent or recurrent respiratory symptoms such as wheezing, coughing, shortness of breath, and chest tightness. Severe acute asthma is an acute onset of severe and potentially life-threatening asthma symptoms that does not respond to usual treatment with bronchodilators and systemic corticosteroids.

Study design and period

The retrospective study was conducted on the data available from the PICU admission database from a single centre for the period from January 2015 to December 2019.

Study population and inclusion criterion

The PICU at the Queen Elizabeth Hospital (QEH) is the only such facility in Barbados that caters to the entire paediatric population of this country. Asthmatic children from 3 to 16 years of age who were admitted into the PICU at the QEH with any one of the following criteria was included in the study: persistent hypoxia (SPO_2 <90% in room air and PaO_2 <60 mmHg) or hypercarbia (Pa CO_2 >50 mmHg), need for very frequent (<2 h) or continuous nebulisation therapy, signs of exhaustion with shallow respiration, altered mental state, air leak syndrome, or respiratory failure. Those children with acute severe asthma who died on arrival or died within 2 h of admission were not included in this study.

Study outcome

Independent variables such as age, gender, final diagnosis at discharge, comorbidities, history of past admissions to hospital and PICU for acute asthma, management details, length of intensive care unit stay, and the admission outcome were recorded.

Operational definition

Admission outcome indicates either the patient discharged or died at the time of discharge.

Length of PICU stay was defined as a period in days from admission time to discharge time.

PICU management included medications used for the control and reversal of the acute severe asthma, type and need for respiratory support needed if any and any complications.

PICU Mortality was calculated as the number of deaths from acute severe asthma divided by the total number of patients admitted with acute severe asthma.

Data collection protocols and procedures

The ethics approval was obtained before starting data collection from the Institutional Review Board at the Queen Elizabeth Hospital on 17 January 2015 (Ref: board201501). Patients were identified from the PICU admission registry. Data was extracted from the case records by investigators using a pre-designed data collection sheet. To ensure content validity, the questionnaire was adapted from previous related studies and suitably modified. The medical records of the patients were examined as per the objectives of the study.

Data collection and analysis

Data were collected manually, de-identified (anonymised), coded and entered into Epi info version 7 computer program. It was then exported to Statistical Package for the Social Sciences version 26.0 for analysis. Bivariable analysis was carried out to examine the effect of explanatory variables over the outcome variable. A $P < 0.05$ on bivariable analysis was considered significant. Strength of association was measured by an adjusted odds ratio with a 95% confidence interval (CI). Frequency, percentage, tables and figures were used to present the data.

RESULTS

There were a total of 12708 children who presented to the emergency room (ER) at the QEH during the 5 years study period. Of those presenting to the ER, 1748 children (13.8%; 95% CI = 13.2%, 14.4%) were admitted to the paediatric wards and 101 (0.7%; 95% CI = 0.6%, 0.9%) required PICU admission

due to acute asthma. During the same period there were a total of 539 admissions to the PICU. The PICU admissions for acute severe asthma accounted for 18.7% (95% CI = 15.6%, 22.3%) of the total PICU admissions. Of those requiring PICU admissions, 24 (23.8%; 95% CI = 16.1%, 33.5%) were admitted directly from the ER while the remaining 77 (76.2%; 95% CI = 66.5%, 83.9%) were transferred from the ward after worsening of their clinical condition.

Trends in the proportion of children visiting the ER for acute asthma who required PICU admission are shown in Figure 1. Analysis of the trends in the PICU admissions rate (children with acute severe asthma requiring admission to PICU/total number of children with acute asthma presenting to the emergency care service) over the 5 year study period by Chi-square test returned a value of 0.1353 (non-direction) which was not significant. Trends in the proportion of the total PICU admissions that were from acute severe asthma (PICU admissions from acute severe asthma/ total number of PICU admissions) as shown in Figure 2 were also not significant ($P = 0.9513$).

The demographic characteristics of the study population are shown in Figure 3. Of the 101 children admitted to the PICU for acute severe asthma, 49 (48.5%; 95% CI = 38.5%, 58.6%) were children younger than 5 years and 66 (65.3%; 95% CI = 55.2%, 74.4%) were males. Amongst the 49 under-5 children admitted to the PICU for acute severe asthma, 26 (53.1%; 95% CI = 38.4%, 67.2%) children had an additional diagnosis of pneumonia. Whereas of the 24 children in the age group 10 to <15 years who were admitted to the PICU with acute severe asthma, 6 (25%; 95% CI = 10.6%, 47.1%) had an additional diagnosis of pneumonia.

Past asthma history of children admitted to the PICU for acute severe asthma is shown in Table 1. Overall 22 (21.8%; 95% CI = 14.4%, 31.3%) children were previously not known to have asthma but were prescribed bronchodilator medication in the past, and 18 (17.8%; 95% CI = 11.2%, 27.0%) were previously not known to have asthma and never prescribed bronchodilator medication in the past. Past treatment characterisation of 101 children admitted to the PICU for acute severe asthma is shown in Table 2. Overall 51 (50.5%; 95% CI = 40.4%, 60.5%) were non-compliant with their inhaled corticosteroid medication, and 21 (20.8%; 95% CI = 13.6%, 30.2%) were not prescribed any inhaled corticosteroids medication.

Over all eight patients required intubation and ventilator support and there was one death in a 4-year-old child with asthma and bilateral bronchopneumonia and sepsis. Remaining 100 children admitted to the PICU for acute severe asthma during the study period were discharged from the PICU.

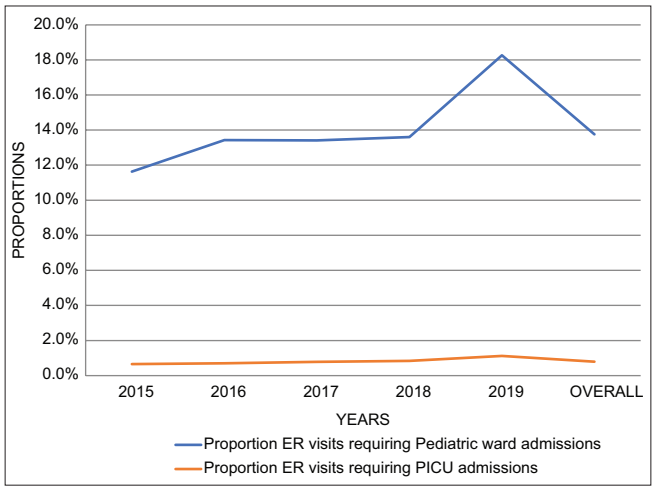

Figure 1: Trends in the proportion of childhood asthma emergency room (ER) visits admitted to the paediatric general ward and the paediatric intensive care unit during 2015 through 2019 in Barbados. PICU: Paediatric intensive care unit.

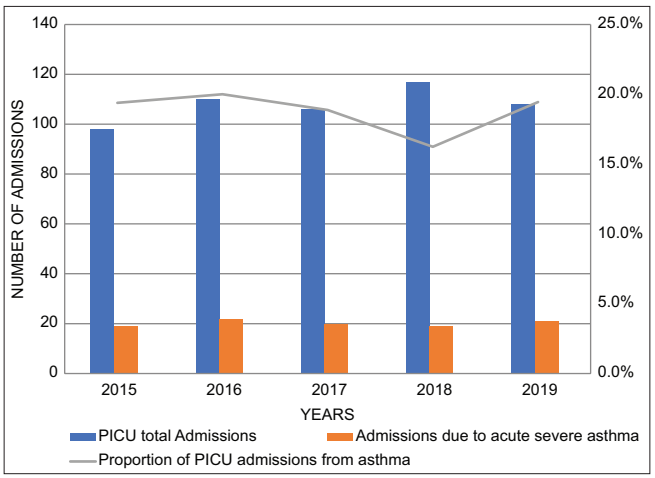

Figure 2: Trends in the proportion of paediatric intensive care unit admissions from acute severe asthma during 2015–2029 in Barbados. PICU: Paediatric intensive care unit.

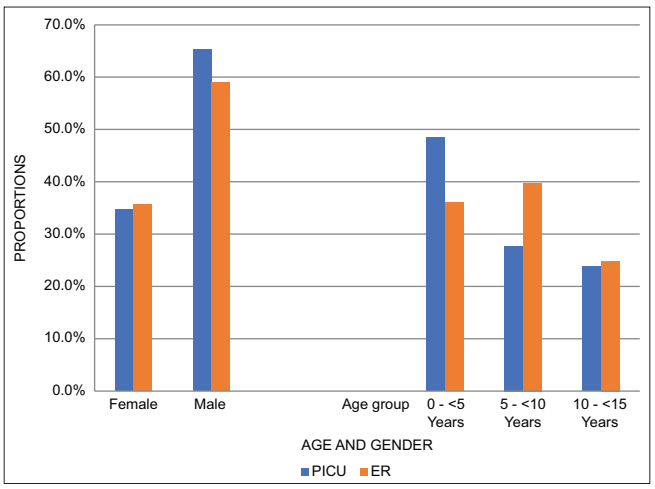

Figure 3: Demography of children admitted to the paediatric intensive care unit and those presenting to the emergency room (ER) in Barbados. PICU: Paediatric intensive care unit.

Table 1: Past asthma history of children admitted to the PICU for acute severe asthma in Barbados.

Past asthma history	*n*=101	% (95% confidence interval)
Previously known to have Asthma	61	60.4 (50.1, 69.8)
Previously not known to have Asthma but was prescribed bronchodilator and corticosteroid medication in the past	22	21.8 (14.4, 31.3)
Previously not known to have Asthma and never prescribed bronchodilator medication in the past	18	17.8 (11.2, 27.0)

PICU: Paediatric intensive care unit

Table 2: Past treatment characterisation of 101 children admitted to the PICU for acute severe asthma in Barbados.

Previous asthma admission to general paediatric ward	76	75.24 (65.5, 83.1)
Previous PICU admissions	47	46.5 (36.6, 56.7)
On daily inhaled steroid and compliant	29	28.7 (20.7, 38.7)
Non-compliance with inhaled steroid	51	50.5 (40.4, 60.5)
Not on inhaled steroid	21	20.8 (13.6, 30.2)

PICU: Paediatric intensive care unit

DISCUSSION

In this population-based study, we found that <1% of all children presenting to the ER for acute asthma required PICU admissions and a little over 5% of all hospital admissions for acute severe asthma were to the PICU. The reported proportion of the children admitted to the hospital for severe acute asthma that required PICU admission ranged from 5% to 25%.[5,6,20] However, a more recent 2023 study from the USA reported that 1.6% of children presenting with acute asthma required PICU admission and 5.6% of all asthma admissions in children were to the PICU.[21] These figures are similar to those of our findings in this study. Asthma being a common condition in this population, its management in the health care setting of this country is standardised and the standard of care is rigorously adhered to. Adequate standard care of children in our settings may be the reason for a lower rate of PICU admissions of children with severe acute asthma (SAA). We did not notice any trend in the PICU admissions for SAA in children in this study over the 5-year period. Increasing trends of PICU admissions for asthma as reported in some studies.[6,20,22]

The majority of the children who required PICU admissions for the SAA were in the age group 0–<5 years and nearly two-thirds were males. Similar observations have been made in other studies.[6,21,22] Of note nearly two third of these children had an additional diagnosis of bronchopneumonia. The role of viral respiratory infections in the exacerbation and severity of acute asthma has been well documented.[23,24] Lung infection in children could be a trigger for acute attack of asthma and may also exaggerate the impact of the acute asthma by further compromising oxygenation and overall well-being of these children. Furthermore, infectious conditions are more common in male children compared to females.

Another notable finding from this study was that over a fifth of the children admitted to the PICU for SAA were not known to be asthmatic to their parents, although they have had medications typically used to treat asthma. Diagnosis of asthma in young children is problematic and there are distinctly different asthma phenotypes in children. Due to the complexities surrounding asthma diagnosis in young children, physicians often do not provide asthma diagnosis to younger children. However, this may have compromised the adequacy of asthma management in these children and predisposed them for SAA. This may have reflected in the finding of over half of all the children admitted to the PICU for SAA in this study were non-compliant with their inhaled corticosteroids (ICS) inhalers and history of previous hospitalisation for SAA in the past in nearly half the cases. Similar findings have been reported in other studies.[6,25] However, recent studies have failed to support the lack of inhaled corticosteroids in the treatment or non-adherence to ICS as a risk factor for PICU admissions for SAA in children.[25,26]

CONCLUSION

A very small proportion of children with acute asthma who present to the emergency care facility are found to have severe acute exacerbation and require paediatric intensive care support. The majority of these children are under-5 males, have had inadequate asthma treatment in the past and have been hospitalised for asthma previously. The salient findings from this seminal study of PICU admission for SAA in children make a strong case for more comprehensive study of the risk factors for the SAA in children that necessitate PICU admission and how this could be prevented.

Ethical approval

The ethics approval was obtained from the Institutional Review Board at the Queen Elizabeth Hospital (Ref: board201501), on 17th January 2015.

Declaration of patient consent

Patient consent was not required as it is a retrospective clinical audit of PICU patients by the PICU consultant who provided the care.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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Original Article

Clinico-etiological profile of haematuria in children: A retrospective analysis

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ABSTRACT

Objectives: The objectives of this study were to study demographic, etiological and clinical profiles of children presenting with haematuria.

Material and Methods: This was a retrospective hospital-based study conducted by referring medical records of patients (aged 1 month–16 years) admitted to Yenepoya Medical College, Mangalore, who were treated for haematuria between January 2018 and December 2022.

Results: Of the 84 children (40 males, mean age 7.3 ± 4.94 years) who presented with haematuria, 48 were microscopic, 36 were with gross haematuria, and 56 were with non-glomerular, 28 were with glomerular haematuria. Common causes included urinary tract infections (47%), post-infectious glomerulonephritis (22.6%), renal calculi and hydronephrosis. Deranged renal function (17.6%) and dyselectrolytemia (53.5%) were frequent complications. Anaemia (61.9%) was the most prevalent associated comorbidity. Acute renal failure occurred in 7.14% and mortality in 2.4%. Glomerular haematuria was associated with hypertension, oliguria and oedema.

Conclusion: This study highlights the diverse aetiologies of haematuria in children, emphasising the need for a comprehensive evaluation and prompt management to prevent long-term renal damage. The findings inform clinical practice and guide further research into paediatric haematuria. The distinction between glomerular and non-glomerular aetiology will help in the proper investigation of the child and further aid in effective management.

Keywords: Haematuria, Glomerulonephritis, Urinary tract infection, Glomerular

INTRODUCTION

Haematuria is described as the continuous presence of more than five red blood cells (RBCs)/ high-power field (HPF) in urine that have not been centrifuged.[1] Although underlying disease may be indicated by 10–50 RBCs/μL, severe haematuria is typically defined as >50 RBCs/HPF.[1] Persistent microscopic haematuria occurs in <1% of children. Gross haematuria (visible discoloration noted in urine due to RBCs) occurs much less often (incidence <0.1%).[2]

According to whether the haematuria is glomerular or non-glomerular in origin, the causes of gross haematuria are divided into different categories.[3] RBCs that are dysmorphic or eumorphic in glomerular and non-glomerular haematuria, respectively, can be identified by microscopic analysis of the urine.[4]

Gross haematuria is more frequently seen as a presenting symptom of acute post-streptococcal glomerulonephritis, immunoglobulin A (IgA) nephropathy, and Alport syndrome, even though

glomerular disorders are almost invariably linked to some degree of haematuria.[5]

Idiopathic hypercalciuria, bacterial or viral urinary tract infections (UTIs), urolithiasis, urinary tract structural abnormalities and sickle cell trait are the most common causes of non-glomerular haematuria.[6]

When evaluating a child with haematuria, it is important to rule out any major underlying renal illness that may have a dire prognosis.[7]

Gross haematuria usually prompts emergency care, but little is known about the long-term effects, clinical features, aetiology and associated symptoms in children from this geographical area. This retrospective review was performed with the aim to study the demographic, etiological and clinical profile of children presenting with haematuria, with the following objectives: To elucidate the underlying aetiology of microscopic and macroscopic haematuria in children and to characterise clinical and laboratory profile of children presenting with macroscopic and microscopic haematuria and its outcome.

MATERIAL AND METHODS

This retrospective study was conducted in Yenepoya Medical College hospital by retrieving case records of patients (aged 1 month to 16 years) presented with haematuria (from 01 January 2018 to 31 December 2022). Ethical clearance was obtained from the Institutional Ethics Committee before the study.

Case files were obtained from the medical records department, using the international classification of diseases (ICD) codes of 'haematuria' and all probable causes of haematuria, which includes post-infectious glomerulonephritis, IgA nephropathy (Berger disease), thin glomerular basement membrane disease, membranoproliferative glomerulonephritis, membranous nephropathy, Alport syndrome, focal segmental glomerulosclerosis, antiglomerular basement membrane disease, Henoch-Schönlein purpura nephritis, systemic lupus erythematosus (SLE) nephritis, haemolytic uremic syndrome, Wegener granulomatosis, polyarteritis nodosa., Goodpasture syndrome, sickle cell glomerulopathy, pyelonephritis, interstitial nephritis, acute tubular necrosis, hydronephrosis, papillary necrosis, nephrocalcinosis, polycystic kidney disease, tumours (Wilms, angiomyolipoma and rhabdomyosarcoma), urolithiasis/hypercalciuria and coagulopathy using respective ICD 10 codes.

Demographic details, clinical presentation and relevant laboratory/radiological investigation, which contribute to making a diagnosis, were noted down.

The outcome of the patient, including mortality and morbidity associated with disease (such as persistent hypertension/deranged renal function and persistent urinary abnormalities) at the time of discharge, was noted down.

Reports of renal biopsy or any other invasive procedures were also noted.

Glomerular haematuria was defined as microscopic urine examination with >5 RBC/HPF and >20% dysmorphic RBC, combined with moderate proteinuria (dipstick 2+) with or without casts.[8] Based on information from the history, clinical examination and urinalysis, the condition was finally classified as either glomerular or non-glomerular haematuria.[8]

Statistical analyses were conducted using the Statistical Package for the Social Sciences 27.0 program. The Fisher exact/Mann–Whitney U-test was used to compare continuous variables, while the Chi-square test was used to analyse categorical variables. $P < 0.05$ was regarded as significant.

RESULTS

Total of 84 children, consisting of 40 boys, with average age of 7.3 ± 4.94 years, (ranging from 3 months to 16 years) were assessed for microscopic and macroscopic haematuria.

The most common presenting complaints were fever, which occurred in 60.7% (n = 51) of patients, dysuria, affected 33.3% (n = 28) of patients, oedema, present in 34.5% (n = 29) of patients, lower abdominal pain, experienced by 27.4% (n = 23) of patients, reduced urine output, reported by 21.4% (n = 18) of patients, excessive cry/irritability, observed in 11.9% (n = 10) of patients and hypertension, affecting 28.5% (n = 24) of patients.

The symptoms appeared 1 day–2 years before the cause of haematuria was determined. Fourteen cases presented with haematuria were known cases of renal illnesses such as nephrotic/nephritic syndrome, end-stage renal disease, chronic kidney disease, mesangioproliferative glomerulonephritis and focal segmental glomerulosclerosis. There were five known cases of SLE and one case of Wiskott–Aldrich syndrome; gross haematuria was observed in 42.4% (n = 36) of patients, whereas microscopic haematuria was seen in 57.6% (n = 49). Glomerular haematuria accounted for 32.9% (n = 28) of cases, while non-glomerular haematuria was seen in 67.1% (n = 57) of cases.

In children with non-glomerular haematuria, UTI (40, 47%), hydronephrosis (5, 5.9%) and renal calculi (4; 4.7%) constituted the most common causes, whereas post-infectious glomerulonephritis (19, 22.6%), lupus nephritis and membranoproliferative glomerulonephritis constituted most common causes among glomerular haematuria [Tables 1 and 2].

UTI nephrotic syndrome constituted the most common cause among microscopic haematuria, whereas post-infectious glomerulonephritis, hydronephrosis and UTI constituted the most common causes among macroscopic haematuria [Tables 3 and 4]. A few cases of acute glomerulonephritis also presented with microscopic haematuria.

Anaemia was present in 61.9% (n = 52) of patients. Severe anaemia necessitating a packed-cell transfusion was observed in 10.6% (n = 9) of patients. Moderate anaemia was reported in 28.2% (n = 24) of patients, while mild anaemia was seen in 22.4% (n = 19) of patients – predominantly due to nutritional causes.

Deranged renal function tests were observed in 17.6% (n = 15) of patients; five of them had chronic kidney disease (three children were on maintenance haemodialysis), rest with acute kidney injury. Six children, representing 7.14% of the study population, developed acute renal failure requiring dialysis. Rapidly progressive glomerulonephritis was observed in two children who had glomerular haematuria.

Dyselectrolytemia was noted in 53.5% (n = 45) of patients. Thirty patients (35.7%) had hyponatremia (Na <134), and one patient with hypernatremia (Na-152). Hypokalaemia (K <3.4) was observed in 4 children (4.8%) and 2 children (2.4%) had hyperkalaemia (K >5.5). Hypercalcemia (Ca >10.5) and hypocalcemia (Ca <8.5) were observed in 15 children (17.8%) and 2 children (2.4%), respectively. Similarly, 4 children (4.8%) had hypophosphatemia (P < 3.5) and 8 children (9.5%) had hyperphosphatemia (P > 6).

Fourteen children (16.6%) had raised antistreptolysin O (ASO) antibody titres, antinuclear antibody (ANA) immunofluorescence (IF) was positive for eight children (9.5%) and 21 children (25%) had low C3 levels. Mean (SD) C3 levels noted in glomerular haematuria were 40.5 (37.3) mg/dL.

Renal biopsy was performed in three children, revealing membranoproliferative glomerulonephritis, renal cortical necrosis and tubulointerstitial nephritis.

Mortality was observed in 2 (2.4%) cases, died due to SLE lupus nephritis with multi-organ dysfunction and haemolytic uremic syndrome with uremic encephalopathy.

Thirty-four cases (40.4%) had persistent abnormal urine analysis at the time of discharge, two cases were discharged with persisting hypertension and 12 cases (14.3%) with deranged renal function tests.

Table 1: Diagnosis in children with haematuria (glomerular vs. non-glomerular).

Glomerular origin	
Diagnosis	**No (%)**
Post-infectious glomerulonephritis	12 (14.2)
Acute glomerulonephritis	7 (8.3)
Nephrotic syndrome	5 (5.9)
Membranoproliferative glomerulonephritis	3 (3.5)
Henoch-Schonlein purpura	1 (1.2)
Lupus nephritis	5 (5.9)
IgA nephropathy	1 (1.2)
Haemolytic uremic syndrome	3 (3.5)

IgA: Immunoglobulin A

Table 2: Diagnosis in children with haematuria (glomerular vs. non-glomerular).

Non-glomerular origin	
Diagnosis	**No (%)**
Urinary tract infection	40 (47)
Renal calculi	4 (4.7)
Hydronephrosis	5 (5.9)
Benign haematuria	1 (1.2)
Haemolytic anaemia	3 (3.5)
PUJ obstruction	1 (1.2)

PUJ: Pelvi-ureteric junction

Table 3: Diagnosis in children with haematuria (microscopic vs. macroscopic).

Microscopic haematuria	
Diagnosis	**No (%)**
Urinary tract infection	33 (39.2)
Post-infectious glomerulonephritis	5 (5.9)
Hydronephrosis	1 (1.2)
Haemolytic anaemia	2 (2.4)
Nephrotic syndrome	4 (4.7)
Renal calculi	1 (1.2)
Henoch-Schonlein purpura	1 (1.2)
Lupus nephritis	3 (3.5)
IgA nephropathy	1 (1.2)
PUJ obstruction	1 (1.2)

IgA: Immunoglobulin A, PUJ: Pelvi-ureteric junction

Table 4: Diagnosis in children with haematuria (microscopic vs. macroscopic).

Macroscopic haematuria	
Diagnosis	**No (%)**
Urinary tract infection	7 (8.3)
Post-infectious glomerulonephritis	14 (16.6)
Haemolytic uremic syndrome	3 (3.5)
Renal calculi	3 (3.5)
Hydronephrosis	4 (4.7)
Benign haematuria	1 (1.2)
Haemolytic anaemia	1 (1.2)
Nephrotic syndrome	1 (1.2)
Membranoproliferative glomerulonephritis	3 (3.5)
Lupus nephritis	2 (2.4)

On analysis between parameters [Tables 5.1 - 5.3 and 6.1 - 6.3], it is noted that hypertension, oliguria and oedema were significantly more in glomerular haematuria. Urine-specific gravity was significantly lower in microscopic and non-glomerular haematuria. Renal functions showed elevated serum creatinine levels in macroscopic (P = 0.046) and glomerular haematuria (0.076). Hypoalbuminemia, hypertriglyceridemia and low complement levels were also noted significantly in glomerular haematuria.

Significant associations were also noted between glomerular haematuria with macroscopic haematuria, and non-glomerular haematuria with microscopic haematuria.

Patients with macroscopic/glomerular haematuria had more associated complications (acute kidney injury, dyselectrolytemia, sepsis, multiple organ dysfunction syndrome [MODS], hypertension, renal failure, posterior reversible encephalopathy syndrome, uremic encephalopathy and pulmonary oedema) and morbidity at the time of discharge and had more hospital stay.

Table 5.1: Analysis between glomerular and non-glomerular haematuria (clinical features).

Clinical features	Non-glomerular	Glomerular	*P*-value
Microscopic haematuria	42	7	<0.001
Macroscopic haematuria	15	21	
Fever			
Present	38	13	0.096
Absent	18	15	
Oedema			
Present	10	19	<0.001
Absent	47	9	
Blood pressure			
Normal	46	14	0.006
Hypotension	0	1	
Hypertension	11	13	
Urine output*			
Normal	41	7	<0.001
Increased	1	0	
Decreased	8	10	
Per abdomen examination			
Normal	39	13	0.036
Hepatomegaly	4	1	
Splenomegaly	3	0	
Fluid thrill	0	2	
Shifting dullness	4	5	
Renal angle tenderness	0	1	
Known case of systemic illness/renal disease**			
No	49	16	0.006
Yes	8	12	

*Documented cases only considered. **Systemic illness includes - Wiskott Aldrich syndrome, chronic kidney disease, end stage renal disease, nephrotic syndrome, mesangioproliferative glomerulonephritis, hemolytic anemia, systemic lupus erythematosus, focal segmental glomerulosclerosis

Comparison of parameters showed age, gender, birth history, vital signs (temperature, pulse rate and respiration rate), urine analysis (pH, colour, pus cells and epithelial cells), urine culture between glomerular and non-glomerular groups, microscopic haematuria and macroscopic haematuria group did not render significant association.

Similarly, a comparison of haemoglobin, total leucocyte counts, platelet counts, C-reactive protein levels, blood urea, serum electrolytes (Sodium, potassium, calcium and phosphorus), liver function test (serum glutamic-oxaloacetic transaminase [SGOT], serum glutamic pyruvic transaminase [SGPT], alkaline phosphatase [ALP] and bilirubin), blood culture, ASO, ANA-IF, chest X-ray and ultrasound abdomen also did not render any significant associations.

Table 5.2: Analysis between glomerular and non-glomerular haematuria (urine analysis).

Urine analysis	Non-glomerular	Glomerular	*P*-value
Urine appearance			
Clear	13	0	0.001
Slight turbid	44	26	
Turbid	0	2	
Urine specific gravity			
1.005	7	1	0.005
1.010	15	8	
1.015	24	5	
1.020	5	12	
1.025	5	2	
1.030	1	0	
Urine RBC			
1–2	15	1	<0.001
2–4	17	3	
4–6	10	3	
6–10	6	4	
10–15	2	2	
15–20	3	2	
Numerous	4	13	
Urine protein			
Negative	30	0	<0.001
Trace	4	0	
1+	23	3	
2+	0	14	
3+	0	6	
4+	0	5	
Urine casts/crystals			
Nil	53	14	<0.001
Granular casts	2	14	
Calcium oxalate crystals	1	0	
Uric acid crystals	1	0	
Urine culture			
Positive	19	8	0.806
Negative	38	19	

RBC: Red blood cell

Table 5.3: Analysis between glomerular and non-glomerular haematuria (blood investigations/complications).

Blood investigations/ complications	Non Glomerular	Glomerular	*P*-value
Renal function tests			
Normal	50	20	0.076
Elevated creatinine	7	8	
S. albumin			
<2	0	3	0.033
2–2.4	1	4	
2.5–2.9	3	8	
3–3.4	10	3	
3.5–3.9	14	4	
>4	25	4	
Lipid profile*			
Normal	3	3	0.012
Hypertriglyceridemia	2	6	
Venous blood gas*			
Normal	4	9	0.002
Metabolic acidosis	6	3	
Metabolic alkalosis	1	0	
Respiratory acidosis	0	2	
Complement levels*			
Normal	4	3	<0.001
Low C3	3	18	
Low C3, Low C4	0	1	
Complications#			
No	46	12	0.001
Yes	11	16	
Duration of hospital stay			
<7 days	35	8	0.006
8–14 days	16	11	
>15 days	5	9	
Morbidity at discharge			
Abnormal urine analysis	12	22	<0.001
Hypertension	1	1	
Deranged RFT	6	6	
Renal scarring	1	0	
MODS	1	0	

*Documented cases only considered. #Complications include - acute kidney injury, dyselectrolytemia, sepsis, mods, hypertension, renal failure, posterior reversible encephalopathy syndrome, uremic encephalopathy, pulmonary oedema. RFT: Renal function test; MODS: Multiple organ dysfunction syndrome

Table 6.1: Comparison between microscopic and macroscopic haematuria (clinical features).

Clinical features	Microscopic	Macroscopic	*P*-value
Non-glomerular haematuria	42	15	<0.001
Glomerular haematuria	7	21	
Fever			
Present	34	17	0.042
Absent	14	19	
Oedema			
Present	9	20	<0.001
Absent	40	16	
Blood pressure			
Normal	39	21	0.028
Hypotension	1	0	
Hypertension	9	15	
Urine output*			
Normal	32	16	0.109
Increased	1	0	
Decreased	8	10	
Per abdomen examination			
Normal	33	19	0.028
Hepatomegaly	3	2	
Splenomegaly	2	1	
Fluid thrill	2	0	
Shifting dullness	1	8	
Renal angle tenderness	0	1	
Known case of systemic illness/renal disease**			
Yes	10	10	0.450
No	39	26	

*Documented cases only considered. **Systemic illness includes - Wiskott Aldrich syndrome, chronic kidney disease, end stage renal disease, nephrotic syndrome, mesangioproliferative glomerulonephritis, hemolytic anemia, systemic lupus erythematosus, focal segmental glomerulosclerosis

DISCUSSION

In our retrospective study of 84 children presented with microscopic/macroscopic haematuria, we found that non-glomerular causes were more common. However, glomerular causes were predominant in patients presented with macroscopic haematuria. These results were consistent with previous findings noted by Mishra *et al.*[7] Our study showed that UTI was the most common cause of microscopic/non-glomerular haematuria, and infection-related glomerulonephritis was the most common cause of glomerular/macroscopic haematuria. These findings were in agreement with studies by Mishra *et al.*[7] but were contradicting in comparison to some of the existing studies, where IgA nephropathy was the most common cause for macroscopic haematuria.[3,9-11]

Our results show that children with glomerular haematuria were more likely to present with high blood pressure, oedema and oliguria compared to those with non-glomerular haematuria. This is in agreement with the previous studies.[12] According to research by Ashraf *et al.* (2013), children having glomerular diseases often present with significant proteinuria and dyslipidaemia[12], which was in agreement with our findings.

The high incidence of anaemia (61.9%) and dyselectrolytemia (53.5%) underscores the importance of thorough laboratory evaluation, including complete blood counts, electrolyte panels and renal function tests. Anaemia was the most commonly

Table 6.2: Comparison between microscopic and macroscopic haematuria (urine analysis).

Urine analysis	Microscopic	Macroscopic	*P*-value
Urine appearance			
Clear	12	1	0.003
Slight turbid	37	33	
Turbid	0	2	
Urine specific gravity			
1.005	5	3	0.946
1.010	12	11	
1.015	17	12	
1.020	9	8	
1.025	5	2	
1.030	1	0	
Urine RBC			
1–2	16	0	<0.001
2–4	20	0	
4–6	13	0	
6–10	0	10	
10–15	0	4	
15–20	0	5	
Numerous	0	17	
Urine protein			
Negative	22	8	0.001
Trace	4	0	
1+	17	9	
2+	3	11	
3+	1	5	
4+	2	3	
Urine casts/crystals			
Nil	43	24	0.019
Granular casts	5	11	
Calcium oxalate crystals	0	1	
Uric acid crystals	1	0	
Urine culture			
Positive	20	7	0.059
Negative	29	28	

RBC: Red blood cell

Table 6.3: Comparison between microscopic and macroscopic haematuria (blood investigations/complications).

Blood investigations/ complications	Microscopic	Macroscopic	*P*-value
Renal function tests			
Normal	44	26	0.046
Elevated creatinine	5	10	
S. albumin			
<2	1	2	0.652
2–2.4	3	2	
2.5–2.9	4	7	
3–3.4	5	9	
3.5–3.9	11	8	
>4	23	6	
Lipid profile*			
Normal	2	4	0.214
Hypertriglyceridemia	4	4	
Venous blood gas*			
Normal	5	8	0.233
Metabolic acidosis	3	6	
Metabolic alkalosis	1	0	
Respiratory acidosis	1	1	
Complement levels*			
Normal	4	3	<0.001
Low C3	3	18	
Low C3, Low C4	0	1	
Complications#			
No	41	17	<0.001
Yes	8	19	
Duration of hospital stay			
<7days	30	14	0.077
8–14 days	11	16	
>15days	8	6	
Morbidity at discharge			
Abnormal urine analysis	7	27	<0.001
Hypertension	1	1	
Deranged RFT	4	8	
Renal scarring	1	0	
MODS	1	0	

*Documented cases only considered. #complications include – acute kidney injury, dyselectrolytemia, sepsis, multiple organ dysfunction syndrome (MODS), hypertension, renal failure, posterior reversible encephalopathy syndrome, uremic encephalopathy and pulmonary oedema. RFT: Renal function test

associated comorbidity, predominantly due to nutritional causes. The significant correlation between glomerular haematuria and hypoalbuminemia highlights the need for close observation of kidney function and consideration of renal biopsy.

Our study demonstrated that children with glomerular haematuria had a longer hospital stay and higher morbidity at discharge compared to those with non-glomerular haematuria. This emphasises the value of early detection and management of glomerular diseases to prevent long-term complications. A study by Youn *et al*. reported similar findings, highlighting the need for prompt intervention in children with glomerular haematuria.[3]

Our findings are consistent with the previous studies[8] that reported similar aetiologies and clinical profiles of haematuria in children. However, our study highlights the need for increased awareness of UTI as a common cause of haematuria in children.

Our research highlights the significance of promptly evaluating children who have haematuria for identifying underlying aetiologies, consideration of UTI as a potential cause of haematuria and aggressive management of glomerular diseases to prevent long-term complications.

Our study was limited by its single-centre design and rather a small sample size, which may limit generalizability.

CONCLUSION

There are various causes for haematuria in children, both glomerular and non-glomerular. The clinical presentation and laboratory findings can differ based on the underlying reason. The findings highlight the importance of the early recognition and management of glomerular diseases and UTIs as a common cause of haematuria. The distinction between glomerular and non-glomerular aetiology will help in the proper investigation of the child and further aid in effective management. More research is required to comprehend the pathophysiology and management of haematuria better.

Ethical approval

The research/study approved by the Institutional Review Board at Yenepoya Deemed to be university, number YEC-1/2023/286, dated 7th October 2023.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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Original Article

The role of lung ultrasound in the diagnosis of respiratory distress syndrome in preterm neonates

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ABSTRACT

Objectives: Respiratory distress syndrome (RDS) poses a significant challenge in neonatal care. This study evaluates the efficacy of lung ultrasound (LUS) in diagnosing RDS in preterm neonates at a tertiary care teaching hospital neonatal intensive care unit.

Material and Methods: An 18-month observational study enrolled 200 preterm neonates with respiratory distress. LUS was performed bedside by a single expert. Data included demographic details, maternal history, clinical parameters and outcomes.

Results: LUS showed high sensitivity and specificity for diagnosing RDS, surpassing chest X-rays. Specific features such as bilateral white lung and B-lines correlated with RDS severity. LUS emerges as a non-invasive, cost-effective and radiation-free tool for RDS diagnosis. It outperforms traditional imaging modalities in detecting RDS-related complications.

Conclusion: LUS is a valuable adjunct in diagnosing and monitoring RDS in preterm neonates, offering real-time assessment and guiding interventions.

Keywords: Respiratory distress syndrome (RDS), Lung ultrasound (LUS), Discharge against medical advice (DAMA)

INTRODUCTION

Respiratory distress syndrome (RDS) is a leading cause of respiratory failure and neonatal mortality in newborns. The advent of lung ultrasound (LUS) has revolutionised the diagnosis of respiratory conditions, particularly RDS, due to its high sensitivity and specificity.[1,2]

Advantages of LUS

High sensitivity and specificity

LUS has been demonstrated to be extremely sensitive and specific in diagnosing various respiratory conditions, including RDS.

Comprehensive diagnosis

Many lung conditions previously identified by chest X-ray (CXR) or computed tomography (CT) scan, such as RDS, transient tachypnoea in neonates, pneumonia, atelectasis and pneumothorax, can now be easily recognised by LUS.

Benefits of X-rays and CT scans

Compared to traditional imaging modalities such as X-rays and CT scans, LUS offers several benefits, including simplicity, accuracy, dependability, affordability and lack of radiation danger.[3,4]

Reduced radiation exposure

Infants are particularly vulnerable to the harmful effects of ionising radiation from X-rays. The use of LUS eliminates the risk of radiation exposure, thus minimising potential side effects.

Interobserver concordance

Conducting and interpreting LUS can be done rapidly and with excellent interobserver concordance, unlike cardiac scans, which require substantial training.[5,6]

Risk of ionising radiation in children

Children are more susceptible to the harmful effects of ionising radiation compared to adults. Their developing organs and tissues are more sensitive to radiation-induced damage. The risk of developing cancer from the same amount of ionising radiation exposure is 10–15 times higher in children aged one compared to adults.[7] LUS is a simple, accurate and bedside procedure with no radiation risk compared to CXR.

Aims and objectives

The aims of this study were as follows:
- To study the features of RDS on LUS
- To use LUS in the diagnosis and prognosis of RDS
- To study the stages and severity of RDS.

MATERIAL AND METHODS

- Study design – Observational study
- Location of study – Tertiary Care Hospital Neonatal Intensive Care Unit (NICU)
- Duration of study – 24 months
- Sampling method – Consecutive samples
- Sample size – 200

Inclusion criteria

All preterm newborns of both sexes and all stages with respiratory distress admitted to NICU from January 2022 to December 2023 were included in the study. Neonates with clinical and radiographic signs of neonatal respiratory distress within the first 24 hours of life were included in this study.

Exclusion criteria

Full-term neonates and preterm neonates with meconium aspiration syndrome and birth asphyxia were excluded from the study.

Data collection

Prospective

This was observational study.

Study duration

Data collection occurred from January 2022 to December 2023 in a prospective observational study focusing on the utility of bedside LUS in neonatal RDS.

Study design

The study employed a prospective observational design, with a single expert conducting bedside LUS using a constant ultrasound machine throughout the study period.

Ultrasound indices

Various ultrasound indices were observed during the study, including the pleural line, A-line, B-line, lung consolidation, air bronchograms, bilateral white lung, interstitial lung syndrome, lung sliding, lung pulse and pleural effusion.

Ultrasound index description

Each ultrasound index was defined and described to ensure consistency in interpretation. For instance, the pleural line was described as a regular echogenic line under the superficial layers of the thorax, with abnormal pleural lines referring to disappearance or distinct thickness exceeding 0.5 cm. Similarly, the A-line, B-line, lung consolidation and other indices were clearly defined to facilitate accurate assessment.

Procedure of study conduct

The study followed a detailed procedure for conducting lung ultrasonography in neonates with RDS. Patient preparation did not require specific measures such as sedation or dietary restrictions. Neonatal risk factors were assessed based on maternal antenatal records, and comprehensive clinical examinations were conducted within 24–48 hours of admission.

Ultrasound equipment

High-resolution line probes operating at frequencies exceeding 7.5 MHz, such as the GE Voluson or E6 from the USA, were used for bedside lung ultrasonography. The transthoracic approach involved a longitudinal scan of both anterior and posterior chest walls, with a maximum ultrasound execution time of 5 min.

Post-ultrasound evaluation

Following LUS, conventional anteroposterior CXRs were promptly performed bedside on RDS patients. Interpretation

of CXRs were conducted by a radiologist unaware of ultrasound findings to ensure double-blinded analysis.

Patient monitoring and statistical analysis

Neonates were closely monitored until recovery and discharge from the NICU. Statistical analyses, including correlation assessments and calculation of *P*-values, were carried out using the Chi-square test in the Statistical Package for the Social Sciences software version 29.

Review of literature

RDS is a significant cause of neonatal morbidity and mortality, especially among preterm neonates. A number of studies [Table 1] have explored the prevalence, risk factors and outcomes of RDS across various populations, offering insights into demographic patterns and the potential of early diagnostic interventions. This review summarises findings from several studies examining the incidence of RDS, male predominance and mortality rates among neonates in tertiary care settings.

RESULTS

The distribution of gender [Table 2] among the patient cohort showed that 69.5% were male and 30.5% were female. Among male patients, 117 were discharged after recovery, 7 discharged against medical advice (DAMA) and 15 experienced mortalities. For female patients, 52 were discharged after recovery, four left against medical advice and five succumbed to their conditions.

Statistical analysis revealed that there was no significant difference in outcomes between male and female patients (P=0.79), indicating that gender did not appear to influence the likelihood of discharge, DAMA or mortality in this patient population.

The weight of patients at the time of admission [Table 3] was analysed to understand its correlation with outcomes. Patients weighing between 1 kg and 1.5 kg constituted the majority, accounting for 56.5% of the cases. Among these patients, 93 were discharged after recovery, five DAMA and 15 experienced mortalities.

For those weighing 1.5–2.5 kg, making up 37% of the cases, 68 patients were discharged after recovery, five left against medical advice and one succumbed to their conditions. Patients weighing <1 kg represented 6.5% of the cases, with eight discharged after recovery, one leaving against medical advice and four experiencing mortalities.

The differences in outcomes based on the weight of the patients were statistically significant (P=0.006), indicating that lower birth weights were associated with higher mortality rates.

The gestational age of the patients at the time of delivery [Table 4] was analysed to determine its impact on outcomes. The majority of deliveries occurred between 34 and 36 weeks, accounting for 52.5% of the cases. Among these, 99 patients were discharged after recovery, six DAMA and none experienced mortality.

Deliveries between 36 and 37 weeks constituted 22% of the cases, with 39 patients discharged after recovery, five leaving against medical advice and no mortalities. For gestational ages of 32–34 weeks (8%), 68 patients were discharged after recovery, and four succumbed to their conditions, with no DAMA cases.

In the 30–32 weeks range (7%), 19 patients were discharged after recovery, and five experienced mortality. For the 28–30 weeks group (10.5%), ten patients were discharged after recovery, and 11 succumbed to their conditions, with no DAMA cases.

The differences in outcomes across the gestational age groups were statistically significant ($P < 0.0001$), indicating that earlier gestational ages were associated with higher mortality.

The maternal history [Table 5] of the 200 patients revealed various underlying conditions. Diabetes was present in 70 patients, accounting for 35% of the cases. Pregnancy-induced hypertension was reported in 15 patients (7.5%). The majority of patients, 115 (57.5%), had other conditions, including hypothyroidism, human immunodeficiency virus, oligohydramnios, per vaginal (PV) leak and PV bleed. This data highlights the diverse range of maternal health issues in the patient population.

The mode of delivery [Table 6] for the patient cohort showed significant associations with their outcomes. Lower-segment

Table 1: Review of literature.

Study details	Haque *et al.*[8]	Abdelrahman *et al.*[9]	Wadi and Kareem[10]	Santosh *et al.*[11]	Swarnkar and Swarnkar[12]	Dutta and Sinhamahapatra[13]
Total admitted cases	562	177	167	553	855	152
Male predominance (%)	64	54	61	-	75	53.9
Respiratory distress syndrome (%)	30.2	4.83	1.2	31.5	17.2	7.9
Mortality rate (%)	16.7	8	9	7.8	22.86	-

Table 2: Gender-wise distribution of patients.

Gender	Percentage	Outcome		
		DAMA	Discharged after recovery	Mortality
Male	69.5	7	117	15
Female	30.5	4	52	5

P=0.79, DAMA: Discharge against medical advice

Table 3: Distribution of patients as per weight at birth.

Weight of patient (kgs)	Percentage	Outcome		
		DAMA	Discharged after recovery	Mortality
<1	6.5	1	8	4
1–1.5	56.5	5	93	15
1.5–2.5	37	5	68	1

P=0.006, DAMA: Discharge against medical advice

Table 4: Distribution of patients as per gestational age.

Gestational age in weeks	Percentage	Outcome		
		DAMA	Discharged after recovery	Mortality
28–30	10.5	0	10	11
30–32	7	0	19	5
32–34	8	0	68	4
34–36	52.5	6	99	0
36–37	22	5	39	0

P<0.0001, DAMA: Discharge against medical advice

caesarean section (LSCS) was the mode of delivery for 64.5% of the patients. Among these, 112 were discharged after recovery, nine DAMA and eight experienced mortalities.

For those who had a normal vaginal delivery, which accounted for 35.5% of the cases, 57 patients were discharged after recovery, two left against medical advice and 12 succumbed to their conditions. The difference in outcomes between LSCS and normal vaginal delivery was statistically significant (P = 0.03), indicating varying recovery and mortality rates associated with each mode of delivery.

The Silverman–Anderson score [Table 7] was assessed for a group of patients, revealing a range of respiratory distress levels. A score of 4 was the most common, observed in 109 patients (54.5%). Scores of 6 and 5 were noted in 34 patients (17%) and 33 patients (16.5%), respectively. Less frequently, 11 patients (5.5%) had a score of 7, while 7 patients (3.5%) had a score of 8 and 6 patients (3%) had a score of 9. These findings indicate that the majority of patients had moderate respiratory distress, with a score of 4 being predominant.

Table 5: Distribution of patients as per maternal history.

Maternal history	Number of patients	Percentage
Diabetes	70	35
Pregnancy-induced hypertension	15	7.5
Others (hypothyroidism, HIV, oligohydramnios, PV leak and PV bleed)	115	57.5
Total	200	100

HIV: Human immunodeficiency virus, PV: Per vaginal

Table 6: Distribution of patients as per mode of delivery.

Mode of delivery	Percentage	Outcome		
		DAMA	Discharged after recovery	Mortality
LSCS	64.5	9	112	8
Normal vaginal	35.5	2	57	12

P=0.03, DAMA: Discharge against medical advice, LSCS: Lower-segment caesarean section

Table 7: Distribution of patients as per Silverman–Anderson score.

Silvermann Anderson score	Number of patients	Percentage
4	109	54.5
5	33	16.5
6	34	17
7	11	5.5
8	7	3.5
9	6	3

The analysis of the mode of oxygen delivery [Table 8] among the patients revealed significant differences in outcomes. Continuous positive airway pressure (CPAP) was the predominant method used in 88% of the cases. Among these patients, 165 were discharged after recovery, 11 DAMA and none experienced mortality.

In contrast, 12% of the patients required an invasive mechanical ventilator. Among these patients, four were discharged after recovery, while 20 succumbed to their conditions. The difference in outcomes between the two modes of oxygen delivery was statistically significant (P < 0.001), highlighting the higher mortality rate associated with invasive mechanical ventilation.

A review of chest X-ray findings on admission [Table 9] for 200 patients revealed the distribution across different stages. The majority of patients, 115 (57.5%), were classified as Stage 2. Stage 1 accounted for 61 patients (30.5%), while Stage 4

Table 8: Distribution of patients as per mode of oxygen delivery.

Mode of O_2 delivery	Percentage	Outcome		
		DAMA	Discharged after recovery	Mortality
CPAP	88	11	165	0
Invasive mechanical Ventilator	12	0	4	20

P<0.001. DAMA: Discharge against medical advice, CPAP: Continuous positive airway pressure

Table 9: Distribution of patients as per chest X-ray on admission.

Chest X-ray on admission	Number of patients	Percentage
Stage 1	61	30.5
Stage 2	115	57.5
Stage 3	4	2
Stage 4	20	10
Total	200	100

was identified in 20 patients (10%). Stage 3 was the least common, with only 4 patients (2%) in this category. This distribution highlights that more than half of the patients were at Stage 2 on admission.

In the analysis of ultrasonography (USG) lung findings [Table 10] among the patients, several key abnormalities were identified. All patients (100%) exhibited absent A-lines and consolidations. Pleural-line abnormalities were present in 95% of the cases, while 80% showed B-lines. Bilateral white lung was observed in 75% of the patients. Pleural effusion was the least common finding, occurring in 10% of the cases. These findings indicate a high prevalence of significant lung abnormalities in the patient population.

The clinical outcomes for a cohort of 200 patients were analysed. The majority of patients, 169 in total (84.5%), were discharged after full recovery. A smaller group, comprising 20 patients (10%), unfortunately, succumbed to their conditions, resulting in mortality. In addition, 11 patients (5.5%) chose to leave the hospital against medical advice. Overall, the data highlight a high recovery rate among the patients, with discharge after recovery being the predominant outcome [Table 11].

DISCUSSION

The four-stage RDS severity scale, based on X-ray findings, is considered the gold standard for radiological diagnosis of RDS, closely reflecting the true severity of the condition. The objective of the current investigation was to explore the potential of LUS in diagnosing RDS in preterm newborns.

Table 10: Distribution of patients as per USG lung findings.

USG lung findings	% of total cases
Pleural effusion	10
Pleural-line abnormalities	95
Absent A-lines	100
Bilateral white lung	75
B-lines	80
Consolidations	100

USG: Ultrasonography

Table 11: Distribution of patients as per outcome.

Outcome	Number of patients	Percentage
DAMA	11	5.5
Discharge after recovery	169	84.5
Mortality	20	10
Total	200	100

DAMA: Discharge against medical advice

With significant clinical implications, a newborn LUS serves as a valuable non-invasive indicator of both lung injury and oxygenation status.[14]

Gender distribution

In the assessment of gender distribution among neonates diagnosed with RDS, three studies have been compared: Raimondi *et al.,*[15], Chen *et al.,*[16] and the present study.

Chen *et al.*[16] reported that among neonates with RDS, 55.5% were male and 44.5% were female. Conversely, Raimondi *et al.*[15] found a slightly higher proportion of female neonates with RDS, with 46.8% male and 53.2% female.

In the present study, a different gender distribution was observed, with 69.5% of male neonates and 30.5% of female neonates diagnosed with RDS.

These findings suggest some variation in the gender distribution among neonates diagnosed with RDS across different studies. Further research may be warranted to explore the factors contributing to these variations and their implications for clinical management and outcomes.

Gender-wise outcome

A comparison of outcomes between male and female neonates reveals notable differences in various categories.

- Discharged against medical advice: Among male neonates, seven were discharged against medical advice, while among female neonates, this number was 4.
- Discharged after recovery: The majority of both male and female neonates were discharged after recovery, with 117 male neonates and 52 female neonates falling into this category.

- Mortality: Unfortunately, mortality rates were observed in both genders, with 15 male neonates and five female neonates experiencing mortality.

These findings suggest potential differences in outcomes between male and female neonates, particularly in the discharge status and mortality rates. Further investigation may be warranted to understand the underlying factors contributing to these differences and to optimise clinical management strategies accordingly.

Birth weight

In the comparison of birth weight distribution and mortality cases among neonates, Raimondi *et al.*[15] and the present study are examined.

In their study, Raimondi *et al.*[15] found that among neonates with RDS, 22% had a birth weight <1 kg, while 78% had a birth weight between 1 and 1.5 kg.

Present study: In contrast, the present study observed a different distribution of birth weights among neonates with RDS. Specifically, 6.5% had a birth weight <1 kg, 56.5% had a birth weight between 1 and 1.5 kg and 37% had a birth weight between 1.5 and 2.5 kg. Birth weight data for neonates with birth weight >2.5 kg is not available.

Mortality cases: Among the 20 mortality cases recorded, 19 had a birth weight of <1.5 kg. Out of the remaining 180 cases, 11 were discharged against medical advice, while 169 were discharged after complete recovery.

These findings underscore the significant impact of low birth weight on mortality risk among neonates with RDS. Further research may be necessary to explore strategies for improving outcomes, particularly among neonates with extremely low birth weights.

Out of 20 mortality cases, 19 cases had a birth weight <1.5 kg.

Out of the remaining 180 cases, 11 cases were discharged against medical advice, and 169 cases were discharged after complete recovery.

Gestational age

A comparison of gestational age distribution and mortality cases among neonates with RDS is conducted between Raimondi *et al.*[15] and the present study.

- In the study by Raimondi *et al.*,[15] specific data for gestational ages 28–30 weeks and 30–32 weeks are not provided. However, among neonates with RDS, 27.2% had a gestational age of 34–36 weeks, and 72.8% had a gestational age of 36–37 weeks.
- Present Study: In contrast, the present study reveals a different distribution of gestational ages among neonates with RDS. Gestational ages 28–30 weeks, 30–32 weeks and 32–34 weeks accounted for 10.5%, 7% and 8% of cases, respectively. A majority of cases (52.5%) had a gestational age of 34–36 weeks, while 22% had a gestational age of 36–37 weeks.
- Mortality Cases: Notably, all 20 mortality cases recorded in the present study had a gestational age of <34 weeks. This highlights the increased vulnerability of preterm neonates to mortality associated with RDS.

These findings emphasise the critical importance of gestational age in assessing the risk and prognosis of RDS in neonates. Effective management strategies tailored to the specific needs of preterm neonates may help improve outcomes and reduce mortality rates.

All 20 mortality cases had a gestational age of <34 weeks.

Mode of delivery

A comparison of delivery method distribution between Raimondi *et al.*[15] and the present study is presented below:

- Raimondi *et al.*:[15] In their study, Raimondi *et al.* reported that 31.1% of neonates with RDS were delivered vaginally, while the majority, accounting for 68.8%, were delivered through caesarean section.[15]
- Present study: Conversely, the present study observed a slightly higher percentage of neonates with RDS delivered vaginally, at 35.5%, with 64.5% delivered through caesarean section.

These findings suggest some variability in the choice of delivery method for neonates with RDS across different studies. Further investigation into the factors influencing this variability may be warranted to optimise delivery practices and improve neonatal outcomes.

Mode of oxygen delivery

In the analysis of the association between mode of oxygen delivery and mortality among neonates with RDS, the following observations were made:

- Mode of oxygen delivery: The majority of cases, accounting for 88%, received oxygen therapy through CPAP, while 12% required invasive mechanical ventilation.
- Association with mortality: An association was observed between the mode of oxygen delivery and mortality. Specifically, all mortality cases were associated with the use of invasive mechanical ventilation as the mode of oxygen delivery.

These findings underscore the potential impact of the mode of oxygen delivery on neonatal outcomes, particularly mortality risk. Further research may be warranted to explore strategies for optimising oxygen therapy management in neonates with RDS to reduce mortality rates and improve overall outcomes.

An association was observed between the mode of oxygen delivery and mortality, as all mortality cases were seen with invasive mechanical ventilator mode of oxygen delivery.

Chest X-ray stage

A comparison of disease severity staging among different studies is presented below:

- El-Malah *et al.*:[17] In their study, El-Malah *et al.* reported cases across stages 1, 2 and 3, with 32 cases in stage 1, 44 cases in stage 2 and 22 cases in stage 3. Data for stage 4 is not provided.
- Liu *et al.*:[18] Liu *et al.* observed cases in stages 2, 3 and 4, with 10 cases in stage 2, 20 cases in stage 3 and 20 cases in stage 4. Data for stage 1 are not provided.
- Present study: The present study indicates the distribution of cases across stages 1, 2, 3 and 4, with 30.5% in stage 1, 57.5% in stage 2, 2% in stage 3 and 10% in stage 4.

These findings suggest variability in the distribution of disease severity staging among neonates with RDS across different studies. Further research may be needed to explore factors influencing disease severity and its implications for clinical management and outcomes.

USG lung findings

A comparison of ultrasonic indicators of RDS among different studies is presented below:

- Abnormal pleural line: Chen *et al.*[16] reported abnormal pleural lines in 100% of cases, while Liu *et al.*[18] and the present study also observed this ultrasonic indicator in all cases.
- Absence of A-lines: All studies, including Chen *et al.*,[16] Liu *et al.*[18] as well as the present study, reported the absence of A-lines in 100% of cases.
- Presence of B-lines: While not observed in Chen *et al.*'s[16] study, Liu *et al.*[18] and Oktem *et al.*[19] reported the presence of B-lines in 100% of cases. In the present study, B-lines were present in 80% of cases.
- Lung consolidation: This ultrasonic indicator was observed in 100% of cases in all studies that reported it, including Chen *et al.*,[16] Liu *et al.*[18] and the present study.
- Interstitial syndrome: Chen *et al.*[16] reported interstitial syndrome in 14.8% of cases, while Oktem *et al.*[19] did not provide specific data on this indicator. The present study did not observe interstitial syndrome.
- Bilateral white lung: Chen *et al.*[16] reported bilateral white lung in 88% of cases, while Liu *et al.*[18] observed it in 10% of cases. The present study reported this indicator in 75% of cases.
- Pleural effusion: Chen *et al.*[16] observed pleural effusion in 31.7% of cases, while Liu *et al.*[18] did not provide specific data on this indicator. In the present study, pleural effusion was present in 5% of cases.
- In addition, it is noted that thicker pleural lines, bilateral coalescent B-lines and white lungs without sparing zones are identified as the most prevalent ultrasonic indicators of non-reversible dysplasia.

Overall, LUS is recognised as a valuable tool for early diagnosis and accurate intervention in neonates with RDS.

The thicker pleural line, bilateral coalescent B-lines and white lung without sparing zones are the most prevalent ultrasonic indicators of non-reversible dysplasia.

LUS helps in early diagnosis and accurate intervention.

CONCLUSION

LUS in neonatal care:

1. Early diagnosis and intervention: LUS plays a crucial role in the early diagnosis of respiratory conditions in neonates, allowing for prompt intervention and management. This is especially important in the NICU where timely treatment can significantly impact outcomes.
2. Cost-effectiveness and bedside accessibility: LUS is a cost-effective imaging modality that provides accurate and reliable results. Its bedside accessibility makes it convenient for use in the NICU setting, eliminating the need for transport to radiology departments and reducing delays in diagnosis and treatment.
3. Safety and repetition: Unlike other imaging modalities such as X-rays, LUS does not expose the neonate or healthcare provider to radiation hazards. In addition, LUS can be repeated several times a day, allowing for real-time monitoring of respiratory status and response to treatment without concerns about radiation exposure.
4. Predictive value in preterm neonates: LUS follows a reproducible pattern that correlates with the respiratory status of preterm neonates. This makes it a valuable tool for predicting the need for respiratory support and guiding clinical decision-making regarding the initiation or adjustment of interventions.
5. High sensitivity and specificity: LUS has demonstrated high sensitivity and specificity for many respiratory conditions when compared to CXRs. Its ability to accurately detect lung pathologies makes it a reliable diagnostic tool in the NICU.
6. Real-time examination: LUS allows for real-time examination of the lungs, providing immediate feedback to healthcare providers. This enables timely adjustments to treatment plans and interventions based on the observed findings.
7. Detection of RDS: Studies have shown that LUS is highly sensitive for the detection of neonatal RDS. While it may potentially miss comorbid air-leak syndromes, further research is needed to evaluate its diagnostic accuracy

and economic feasibility compared to chest radiography.
8. Superiority to CXR: LUS has been found to be superior to CXR in detecting complications of RDS, such as consolidation, atelectasis and microabscesses. This not only improves diagnostic accuracy but also reduces unnecessary radiation exposure for neonates.

In summary, lung ultrasonography offers numerous advantages in the early diagnosis, monitoring and management of respiratory conditions in neonates. Its safety, accessibility and effectiveness make it a valuable tool in the NICU, with the potential to improve outcomes and reduce radiation exposure for vulnerable patients.

Ethical approval

Institutional Review Board approval is not required as it is an observational study during which the treatment protocol was not altered.

Declaration of patient consent

Patient consent is not required as the patient's identity is not disclosed or compromised.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript, and no images were manipulated using AI.

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Karnataka Paediatric Journal

Original Article

Diagnostic value of flexible fibre optic bronchoscopy in the evaluation of children with suspected airway foreign body: A retrospective study

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ABSTRACT

Objectives: To evaluate the role of flexible fibre optic bronchoscopy in the diagnosis of suspected airway foreign bodies in children.

Material and Methods: A retrospective study of suspected airway foreign bodies in 124 cases in children was done.

Results: Results were obtained in terms of percentage of cases in which foreign body was seen, age incidence, sex difference, type of foreign body, history, bronchoscopy findings and findings of other relevant radiological investigations and data compiled and compared with some other retrospective studies

Conclusion: The negative predictive value of a diagnostic bronchoscopy in viewing a foreign body is high and can also guide in finding other causes for the obstruction. It also provides an opportunity for other procedures, such as tracheo-bronchial lavage and suctioning of secretions, in addition to removal of foreign bodies in some.

Keywords: Bronchoscopy, Fibre optic, Children, Aspiration

INTRODUCTION

Paediatric foreign body (FB) aspiration is one of the potentially serious and common household problems of significance presenting to the emergency room. Children of a younger age are vulnerable to foreign body aspiration.

This is attributed to children's curiosity and tendency to explore the environment in this particular age group. Furthermore, children with developmental and psychological disorders are more prone to have foreign body aspirations. A higher incidence is seen in children with congenital malformations, as mentioned in some previous studies [Pie chart 1].[1]

The incidence of FB aspiration is higher in boys than girls and this sex predilection may be related to different physical and psychomotor development seen in both sexes and also to the methods of parenting and sex ratio of the population.[2]

With a confirmed history of choking followed by repeated coughing episodes, the possibility of a foreign-body aspiration should be sought.

The various settings related to a foreign body aspiration in a child need to be considered:

As compared to children of other ages, children <1 year old are immediately attended to in case of emergency as they are less developed verbally. Children more than 6 years of age can clearly express concern and show discomfort in aspirated foreign bodies.

The location of an FB, when it is trapped beyond the trachea, is seen mainly in the right bronchus owing to a larger angle between the right main bronchus and the airway.

The FB type, whether organic or non-organic, depends many times on the dietary habits of the region involved.

Airway FB is often missed clinically or radiologically initially but comes with complications that arise due to an old retained FB. They may cause complications such as obstructive emphysema, atelectasis, and co-morbid long-term pulmonary infection or sometimes even bronchopneumonia. Other lesser-known complications are pulmonary bulla, pleural effusion and pneumothorax with mediastinal emphysema.[3]

The delay in the diagnosis of airway FB in children has many reasons.

As per the literature, only 16–40% of cases show a classic triad of sudden-onset choking, coughing and wheezing or unilaterally decreased air entry.[4]

Various paediatric common illnesses such as bronchiolitis, pneumonia or asthma can be confused with a similar presentation.

Lower airway foreign bodies can present with subtle or non-specific symptoms of lower respiratory tract involvement. Complications arising from non-indicated treatment such as steroids, antibiotics and bronchodilators further add to the confusion. The differentiation from many chronic childhood illnesses such as pulmonary infections, bronchiectasis, asthma and lung collapse or lung abscess can become difficult.

The chest X-ray has a poor diagnostic yield in the diagnosis of airway FB. It can detect only 16% of radio-opaque foreign bodies. A negative X-ray alone however does not exclude a foreign body diagnosis.[1] It is even difficult to pick up complications arising from a retained FB like emphysema or atelectasis. As a comparison, chest computed tomography (CT) has a high sensitivity (99%) and specificity (92%) for the detection of airway FB, but a negative CT scan, at the same time, does not necessarily rule out an FB.[5]

With a high clinical suspicion, irrespective of whether the history is suggestive of FB ingestion or not, both rigid and flexible bronchoscopy is implicated in FB removal in children. The role of rigid bronchoscopy remains unequivocal in diagnosing and removing only established airway FB confirmed either on history or by clinical examination or radiologically. In cases with high clinical suspicion or a history indicative of aspiration, in radio-lucent objects, the role of flexible bronchoscopy is noteworthy. It can also be considered in the removal of certain paediatric cases in expert hands.

MATERIAL AND METHODS

The record of patients who had undergone flexible fibre optic bronchoscopy for foreign body evaluation in Varad Children's Hospital, Aurangabad, India, from 2017 to 2022 was retrospectively evaluated.

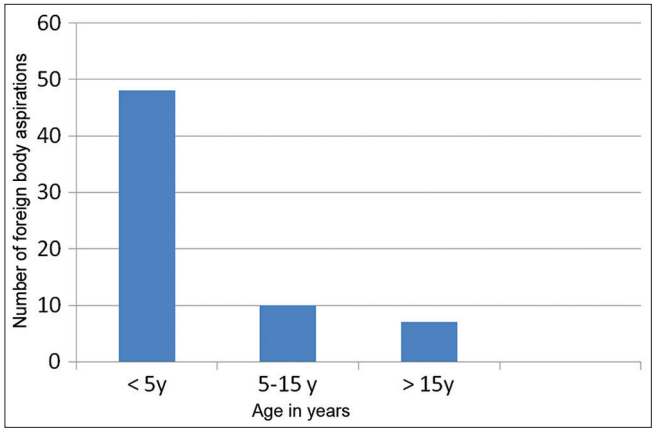
A retrospective study of 124 cases was conducted in which a paediatric airway foreign body was suspected and flexible fibre optic bronchoscopy was done. The parameters considered were the age group, sex of the child, clinical presentation, other supportive radiological investigations, and their results, outcome of fibre optic bronchoscopy, types of FB visualized, and complications.

The points under consideration were:

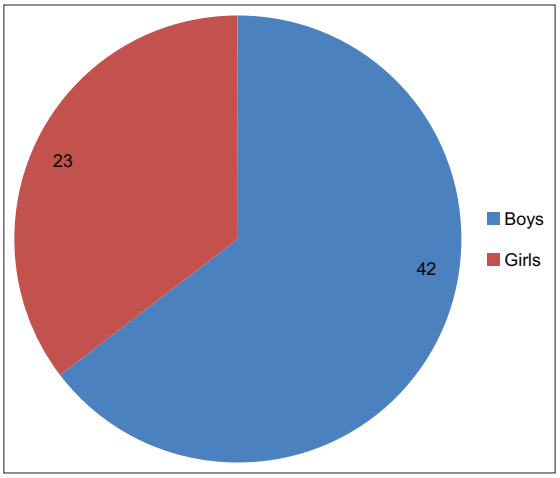
1. Initial clinical presentation:
   The cases were grouped taking into view the clinical presentation; some presented with a history of choking and some with a strong clinical suspicion on the part of the referring physician. In some cases, a non-resolving pneumonia was present or recurrent respiratory involvement was seen at a particular location. In some, either a chest X-ray or a CT scan guided this.
2. Investigations done before the fibre optic bronchoscopy:
   An X-ray chest was ordered in all cases in which FB was suspected. The various findings detected on an X-ray consisted of lung hyperinflation, either unilateral or bilateral, collapse of a part or a lobe , and pneumothorax. They are depicted in Graph 1.
3. Procedure:
   The diagnostic bronchoscopy was done with a 3.5 mm fibre optic Pentax flexible bronchoscope with a working channel of 1.2 mm. The bronchoscope is supported with a side port which can be utilized either for flushing the lumen during bronchoscopy as well as for instillation of a local anesthetic. The exact duration of time required from start to the end was also noted. A mild sedation was achieved with a short-acting benzodiazepine like midazolam, and a 2% xylocaine solution was instilled at the level of vocal cords or trachea after the bronchoscope was introduced. Complications, if any, were noted.

The findings of the procedure were noted and are presented in the results section.

The findings are presented in a tabular form and analysed [Table 1].



Graph 1: Age-specific foreign body (FB) aspiration incidence in 65 cases.



Pie chart 1: Sex difference in foreign body (FB) aspiration in total 65 cases.

Table 1: Findings detected in our study of 124 cases.

FB detected	65 (124)
History	
History of choking	27 (21)
History of cough	45 (37)
Wheezing	18 (15)
X-ray findings	
Normal	31 (47)
Hyperinflation	21 (32)
Right side	10
Bilateral	4
Left	6
Lung collapse	10 (15)
Right side	6
Left side	4
Pneumothorax	3
Type of FB	
Organic	52 (80.25)
Inorganic	13 (19)

FB: Foreign body.

RESULTS

A foreign body could be visualized in 65 of the total 124 cases. The remaining cases were grouped as:

- 42 cases consisted of a normal tracheo-bronchial tree.
- 12 cases were seen to have copious secretions and mucus plugs, which were suctioned but no FB was found.
- 5 cases were suspected to have an extrinsic compression visualized from inside the lumen and were referred back to the treating physicians to get further relevant investigations done but the track of the records was not kept for this study.

The fibre optic bronchoscopy was found very useful in detecting the site, location and type of FB. It helped to check for partial or complete airway obstruction. A search was also made to look for any granulation tissue surrounding it or take out the secretions during the procedure.

The FBs were again divided into organic and non-organic. The organic FB mostly comprised of peanuts, cashew nut pieces, almond pieces, coconut fragments, turmeric and chikoo seeds and small food particles in some. The non-organic FBs were mostly small plastic beads and pebbles. The findings are also presented in a tabular form [Table 1].

In our study of 124 cases in which fibre optic bronchoscopy was performed, no complications were observed.

DISCUSSION

In our experience, the information gained from fibre optic bronchoscopy could be utilized for rigid bronchoscopy in FB removal with safety according to the site, type, nature of the FB and its associated complications detected on fibre optic bronchoscopy.

The location of the aspirated FB depends upon the age of the child and the position/posture at the time of aspiration. In the majority of cases in our study, the FB was removed from the right main bronchus as compared to the left, which explains the wider and steeper anatomy of the right main bronchus; but in infants and smaller children, due to the predominance of left main bronchus, the aspiration was also seen on the left in younger age group.

Complications like obstructive emphysema, atelectasis, or co-morbid associated complications like bronchopneumonia were seen rarely in our study. This shows the relatively lesser incidence of a retained FB in our study, in which more inflammation and infection are expected.

The aspiration of organic versus non-organic FB was studied only to show a relatively higher incidence of organic FB in our

study. Peanut piece was a common object obtained reflecting society and family's social, cultural and dietary habits.[6]

This probably is attributed to the low cost and availability of peanuts in our region.

Choking and coughing, which are the likely events to be associated with FB aspiration, had an account only in a small percentage of children. This could be due to a lower age at presentation, having lesser verbal cues from the patients in the event of aspiration and the failure of the parents to recognize the symptoms early. Other cases with a high incidence were referrals from physicians in the setting of persistent respiratory symptoms.

The children were subjected to chest radiography in all cases. Among many normal X-ray findings when FB was recovered later, the most noticeable radiological findings were obstructive emphysema, localized or generalized, atelectasis or a partial lobe collapse. Longer retention time of FB, particularly an organic type, can give rise to complications of pneumonia and collapse consolidation.[7]

The diagnostic fibre optic bronchoscopy lasted for an average duration of 2–3 min and was relatively a shorter time compared to some other studies. The longer time required in other case studies might be attributed to the FB removal in the same setting which was possible due to the availability of expertise[7] and a rigid bronchoscope apparatus. In our study, only a diagnostic study was conducted, taking less time. The advantage of this study lies in the very short exposure to mild sedation and local anaesthesia which subjected the children to very low risk.

The only limitations of this study are seen as follows: This was an experience from a single centre and cannot be uniformly applied to all. CT scan of the chest which has a comparable sensitivity and specificity was not available for many of the children in our study.

No other diagnostic modality could give the information we achieved with a diagnostic fibre optic bronchoscopy and was superior to a more invasive rigid bronchoscopy,[8] the advantages also being a wide margin of safety and doing so with relative ease.

CONCLUSION

The yield of a clinical examination in the confirmation of a suspected airway foreign body is low. This is attributed to the low sensitivity and specificity of a good clinical examination in the identification of a penetration syndrome merely on the auscultatory findings.

A good radiological examination in the form of an X-ray may also have a poor interpretation and is based on variables like inspiratory or expiratory films and their reporting.

Doing a CT chest might add to the information gained from history clinical examination and equivocal X-ray interpretation, but it is sometimes not available or not feasible in some situations.

Fibre optic bronchoscopy can be implicated in the confirmation of airway FB and to gain information about the location, the nature, the type of obstruction, impacted or partially impacted and its mobility, the amount of granulation tissue present and other inflammatory signs seen and can be done safely in expert hands with a minimum of anaesthesia required. It helps in the proper visualization of the airway with its smooth passage to visualize the distal airways with precision. It helps in suctioning the secretions which can be analysed for cytology and bacteriological studies. As mentioned in the literature, this can even be the method of removal of some of the foreign bodies in expert hands.

Various disadvantages of a rigid bronchoscope to consider are as follows:

- Bronchi, upper or subsegmental, are not readily visible with a rigid one
- There are limitations to using a rigid bronchoscope for patients with cervical spine, mandible or head abnormalities
- Not suitable for FB in peripheral airways, especially those in the upper lungs
- Highly operator-based and qualified personnel are limited
- Complications associated with rigid bronchoscopy are hypoxemia, tracheal bronchial lacerations or bleeding, laryngeal oedema, broncho-laryngospasm, pneumothorax, pneumomediastinum, re-intubation, mechanical ventilation, cardiac arrest, anoxic brain injury, etc.

More invasive and risky procedures of rigid bronchoscopy can be spared only for a confirmed FB and after getting its relevant details from a diagnostic modality like fibre optic bronchoscopy.

Ethical approval

Institutional review board approval is not required as this is a retrospective study in children for diagnostic purposes only.

Declaration of patient consent

Informed consent was taken before bronchoscopy was done in all cases. Declaration of patient consent for this study was not required as patients' identity was not disclosed or compromised.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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Karnataka Paediatric Journal

Original Article

Occurrence of diabetic retinopathy in children with type 1 diabetes mellitus

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ABSTRACT

Objectives: Type 1 diabetes mellitus (T1DM) represents approximately 5–10% of all diabetes cases. Over time, nearly all individuals with T1DM are likely to experience diabetic retinopathy (DR). Within this group, the incidence of retinopathy is around 25% after 5 years of diagnosis, increasing to 60% after 10 years and reaching approximately 80% after 15 years. (1) To study the occurrence of DR in T1DM affected children and adolescents. (2) To study the relation of occurrence of DR with glycaemic control. (3) To study the relation between the duration of Type-1 diabetes and the occurrence of DR.

Material and Methods: Following approval from the institutional ethics committee and informed consent from the parents of participating subjects, a prospective observational study was conducted involving 54 paediatric patients with T1DM from the outpatient and inpatient departments. A comprehensive history was documented for each participant, and screening for DR was performed using direct ophthalmoscopy. Glycaemic control was assessed by measuring glycated haemoglobin (HbA1c) levels, with findings recorded in a structured pro forma. Data were entered into Microsoft Excel and were analysed using IBM Statistical Package for the Social Sciences Version 25.0, with both qualitative and quantitative analyses conducted. A $P < 0.05$ was considered statistically significant.

Results: The study analysed 54 children with type 1 diabetes, equally divided by gender, with a mean age of 12.72 years. The onset age was most common between 6–10 and 11–15 years, averaging 8.87 years. Most children (79.6%) had diabetes for 1–5 years, with a mean duration of 3.85 years. HbA1c levels were ≥8.5% in 83.3% of the children, averaging 10.6%. No children exhibited symptoms of DR, though 3.7% had DR. Significant associations were found between higher HbA1c levels, longer diabetes duration and the presence of DR ($P < 0.05$).

Conclusion: The present study demonstrates a relatively low incidence of DR among children with diabetes. It underscores the significance of diabetes duration and HbA1c levels as contributing factors in Indian paediatric patients. Optimal glycaemic control is highlighted as crucial in mitigating the onset and progression of DR in young diabetics.

Keywords: Diabetic retinopathy, Glycated haemoglobin (HbA1C), Diabetes mellitus, Type 1, Ophthalmoscopy, Paediatric patients

INTRODUCTION

Diabetes is a chronic, complex condition necessitating regular medical management with multifaceted strategies for risk reduction beyond glycaemic control. According to the World Health Organization, global diabetes prevalence has escalated from 108 million to 422 million in 1980–2014.[1]

Type 1 diabetes mellitus (T1DM) accounts for approximately 5–10% of all diabetes cases, resulting from the autoimmune destruction of pancreatic beta cells, with around three-quarters of diagnoses occurring in individuals under the age of 18.[2]

It is estimated that nearly 5 lakh children under 15 years old worldwide have type 1 diabetes, with significant regional variations in incidence.[3]

Diabetic retinopathy (DR), a microvascular complication associated with diabetes mellitus (DM), results from damage to the retinal capillaries and venules, making it the most prevalent microvascular condition amongst children with type 1 diabetes.[4]

Nearly all individuals with type 1 diabetes will eventually develop DR, with approximately 25% affected within 5 years of diagnosis, 60% within 10 years, and 80% within 15 years. After 15 years, around 18% of patients may progress to proliferative DR.[5]

The global incidence of diabetes has steadily risen over recent decades across all age groups, including youth, and this trend is projected to continue.[6]

This study aims to highlight the significance of DR occurrence in individuals with T1DM, which will, in turn, support the development of effective screening and management strategies for these conditions.

MATERIAL AND METHODS

Source of data

Data were gathered from confirmed cases of T1DM in patients under 18 years of age who attended the Outpatient Departments (OPDs)/Inpatient Departments of Basaveshwar Hospital and Sangameshwar Hospital, both affiliated with M.R Medical College in Kalaburagi, Karnataka.

Methods of data collection

Study design

Cross-sectional study.

Study setting

Department of Pediatrics - Basaveshwar Hospital and Sangameshwar Hospital, both affiliated with M. R Medical College in Kalaburagi, Karnataka.

Study cases

50 cases.

Sampling method

Simple random sampling.

Study duration

August 01st, 2022 –January 31st, 2024 (18 months).

Eligibility criteria

1. Patients under 18 years of age with confirmed T1DM, diagnosed according to the American Diabetes Association guidelines.[1]

Exclusion criteria

1. Other ophthalmological conditions such as hypertensive retinopathy and retinopathy of prematurity.

Methodology

- Upon receiving clearance from the Institutional Ethics Committee and informed consent from patients, parents, or guardians, 54 subjects diagnosed with T1DM were enrolled in the study according to specified inclusion criteria.
- A comprehensive history was obtained from each participant, covering details such as age at enrollment, age at initial Type 1 diabetes diagnosis, gender, duration since diagnosis, type of insulin used, and signs and symptoms of DR.
- All patients are screened for DR by direct ophthalmoscopy in ophthalmology OPD.
- Glycated haemoglobin (HbA1c) levels were measured from venous samples using high-performance liquid chromatography.

Data analysis

Statistical analysis was performed using IBM Statistical Package for the Social Sciences software version 25.0. Data collected were organised in an Excel spreadsheet to create a master chart, from which tables and graphs were generated. For quantitative data, mean and standard deviations were calculated, with the *t*-test applied to determine statistical significance. For qualitative data, the Chi-square test and Fisher's exact test were used to assess significance. A $P < 0.05$ was taken as statistically significant.

RESULTS

The study investigated 54 children with T1DM to evaluate several aspects, including age, gender, duration of diabetes, glycaemic control and the prevalence of DR [Table 1].

A majority of the participants (51.9%) were within the 11–15-year age range, while 25.9% were aged 16–18 years. The average age of the sample was 12.72 years, with no statistically significant difference observed between females and males ($P = 0.532$). The cohort comprised an equal

Table 1: Demographic and clinical characteristics of type 1 diabetic children.

Variable	Category	Number of children	Percentage	Mean±SD	*P*-value and significance
Age distribution	1–5 years	4	7.4		
	6–10 years	8	14.8		
	11–15 years	28	51.9	12.72±4.04	*P*=0.532, NS
	16–18 years	14	25.9		
Gender distribution	Male	27	50.0		
	Female	27	50.0		
Age of onset of diabetes	1–5 years	11	20.4	8.87±3.82	
	6–10 years	21	38.9		
	11–15 years	21	38.9		
	16–18 years	1	1.8		
Duration of diabetes	1–5 years	43	79.6	3.85±2.49	
	6–10 years	10	18.6		
	11–15 years	1	1.8		
HbA1c levels	<8.5%	9	16.7	10.6%±2.37	
	≥8.5%	45	83.3		

SD: Standard deviation, HbA1c: Glycated haemoglobin, NS: Non-significant

Table 2: Retinopathy and fundoscopy findings.

Variable	Status	Number of children	Percentage
Signs and symptoms of retinopathy	Absent	54	100.0
	Present	0	0.0
Diabetic retinopathy	Absent	52	96.3
	Present	2	3.7
Fundoscopy findings	Normal	52	96.3
	Abnormal	2	3.7

distribution of females and males, each representing 50.0% of the total sample.

The most common age of onset for diabetes was between 6–10 years and 11–15 years, with each age group representing 38.9% of the cases. The mean age of diagnosis of T1DM was 8.87 years. A significant percentage of the children (79.6%) had been living with diabetes for 1–5 years, with an average duration of 3.85 years [Chart 1].

A significant majority (83.3%) of the children exhibited HbA1c levels ≥8.5%, reflecting inadequate glycaemic control. The mean HbA1c level across the group was 10.6% [Chart 2].

No signs or symptoms of retinopathy were reported amongst the entire cohort. However, 3.7% of the participants were diagnosed with DR. The majority (96.3%) displayed normal findings upon fundoscopy [Table 2].

A statistically significant relationship was identified between elevated HbA1c levels and the presence of DR (P = 0.011), with children exhibiting retinopathy showing a notably higher mean HbA1c of 13.60%. Furthermore, a significant correlation was established between the duration

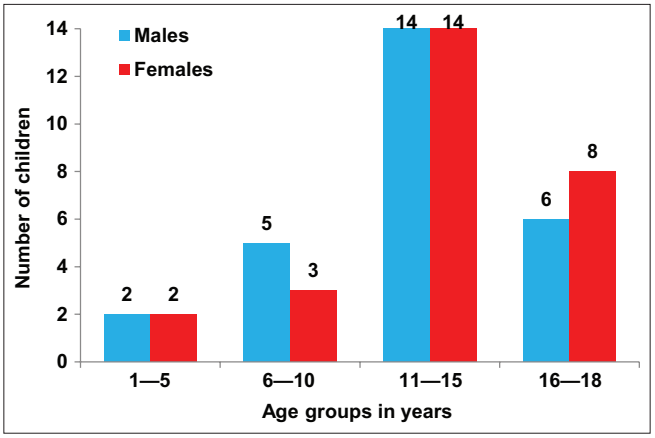

Chart 1: Multiple bar diagram represents age and sex-wise distribution of children.

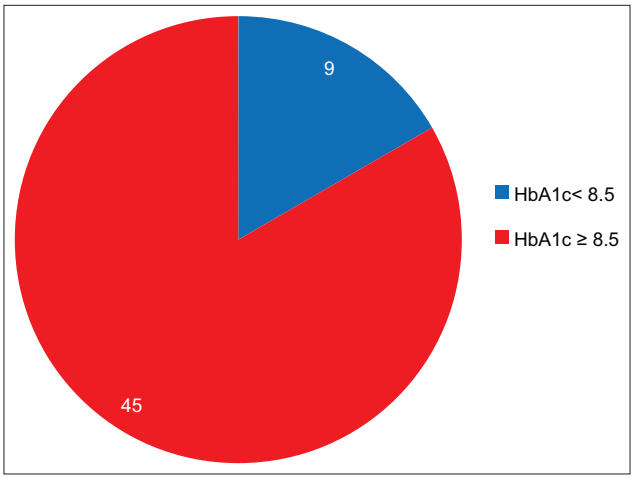

Chart 2: Pie diagram represents level of glycated haemoglobin (HbA1c)-wise distribution.

of diabetes and the occurrence of retinopathy (P = 0.023). Children with retinopathy had a longer average duration of diabetes (7.33 years) compared to those without retinopathy [Table 3].

In conclusion, the study indicates that while the prevalence of DR in children with T1DM is relatively low, poor glycaemic control and longer diabetes duration are significantly associated with the development of DR.

Table 3: Relationships between HbA1c, duration of diabetes and diabetic retinopathy.

Comparison	Diabetic retinopathy	Mean±SD	95% CI	*P*-value and significance
HbA1c Levels	Present	13.60±3.48	1.34–6.44	*P*=0.011, S
	Absent	10.38±2.25		
Duration of diabetes	Present	7.33±3.21	0.46–5.96	*P*=0.023, S
	Absent	3.58±2.21		

SD: Standard deviation, CI: Confidence interval, HbA1c: Glycated haemoglobin, S: Significant

Table 4: Gender distribution and ratio in T1DM studies.

Study	Male (%)	Female (%)	Male-to-female ratio (M)
Ferm *et al.*, 2018[4]	47.1	52.9	1:1.12
Shibeshi *et al.*, 2015[2]	45.3	54.7	1:1.20
Porter *et al.*, 2018[6]	44.3	55.7	1:1.25
Rajguru *et al.*, 2021[7]	56	44	1:0.96
Present study	50	50	1:1

TIDM: Type 1 diabetes mellitus, HbA1c: Glycated haemoglobin

Table 5: Mean age at diagnosis and duration of diabetes in T1DM studies.

Study	Mean age at diagnosis (Years)	Mean duration of diabetes (Years)
Ferm *et al.*, 2018[4]	9.1	6.7
Shibeshi *et al.*, 2015[2]	14.2	8
Porter *et al.*, 2018[6]	11.5	4.1
Zabeen *et al.*, 2017[8]	12.0	–
Rajguru *et al.*, 2021[7]	–	4.65
Present Study	8.87	3.85

T1DM: Type 1 diabetes mellitus

DISCUSSION

In this cross-sectional study of 54 patients with T1DM, we examined the impact of glycaemic control and diabetes duration on the prevalence of DR over 18 months. The study found a 3.7% prevalence of DR, with significant associations between higher HbA1c levels and longer diabetes duration. Our cohort was evenly split by gender, with 27 males and 27 females, contrasting with other studies such as those by Ferm *et al.*,[4] Shibeshi *et al.*[2] and Porter *et al.*,[6], where as Rajguru *et al.*[7] had male prevalence, which reported a higher female prevalence [Table 4].

The mean age diagnosis of diabetes in our study was 8.87 years, aligning closely with Ferm *et al.*[4] findings but lower than the mean ages reported by Zabeen *et al.*[8] and Shibeshi *et al.*[2] The mean duration of diabetes was 3.85 years, which is shorter compared to Ferm *et al.*[4] and Shibeshi *et al.*[2] findings [Table 5].

This study observed a mean HbA1c of 10.6%, reflecting poorer glycaemic control relative to other studies like those by Ferm *et al.*,[4] Zabeen *et al.*,[8] Porter *et al.*[6] and Strul *et al.*[9] [Table 6].

In patients with DR, the mean HbA1c was significantly higher at 13.6%, a result consistent with Ferm *et al.*[4] and Porter *et al.*[6] studies. The mean duration of DM amongst these patients was 7.3 years, which aligns with Zabeen *et al.*[8] and indicates that both extended diabetes duration and elevated HbA1c levels are significant risk factors for DR. These findings emphasise the critical role of maintaining stringent glycaemic control to mitigate the risk of retinopathy in paediatric T1DM patients.

Limitation of the study

1. Single centre study and relatively small sample size.
2. The cases were not monitored over an extended period to evaluate the progression of DR.

Table 6: Glycaemic control and retinopathy in T1DM studies.

Study	Mean HbA1c (%)	Mean HbA1c in DR patients (%)	Mean duration of diabetes in DR patients (Years)	Percentage of DR	*P*-value (DR)
Ferm *et al.*, 2018[4]	9.75	10.3	9.4	3.5	<0.01
Zabeen *et al.*, 2017[8]	9.35	9.6	7.6	6.6	0.013
Porter *et al.*, 2018[6]	8.65	9.8	10.4	3.8	0.45
Strul *et al.*, 2019[9]	9.45	10.2	11	6.0	<0.001
Present Study	10.6	13.6	7.3	3.7	0.023

T1DM: Type 1 diabetes mellitus, DR: Diabetic retinopathy, HbA1c: Glycated haemoglobin

CONCLUSION

The current study demonstrates a relatively low incidence of DR amongst children with diabetes. It underscores the significance of diabetes duration and HbA1c levels as contributing factors in Indian paediatric patients. Optimal glycaemic control is highlighted as crucial in mitigating the onset and progression of DR in young diabetics. Given the chronic nature of diabetes and the heightened risk of DR with prolonged disease duration, ensuring stringent glycaemic control is imperative as the primary and most effective measure to prevent or delay retinal complications. In addition to counselling for improved diabetes management, both young patients and their caregivers should be educated about the risks associated with DR and its potential vision-threatening consequences. Healthcare institutions and governmental bodies are encouraged to initiate extensive educational campaigns and screening initiatives, particularly amongst minority groups and rural populations.

Ethical approval

The research/study was approved by the Institutional Review Board at Mahadevappa Rampure Medical College Kalaburagi, number 202207102, dated 27th July, 2022.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

Dr. Sharanagouda Patil is on the editorial board of the Journal.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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Karnataka Paediatric Journal

Case Report

Metachromatic leukodystrophy (MLD) presenting as initial cognitive regression and myoclonic epilepsy with normal magnetic resonance imaging (MRI) of the brain

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ABSTRACT

Metachromatic leukodystrophy (MLD) is a rare disorder due to mutations in the ARSA gene leading to arylsulfatase A deficiency. We present a case of late infantile onset MLD with a novel phenotype. A 5-year-old boy presented with myoclonic jerks and tonic seizures from two years of age followed by initial cognitive and later motor regression. On examination, horizontal nystagmus, spasticity with power >3/5 in all limbs, and sluggish deep tendon reflexes were noted. MRI brain done at 2, and 5 years were normal. Exome sequencing showed compound heterozygous variants in ARSA: NM_0010854 25.3: c.433C>T: p. Arg145Ter (exon 3) and c.902G>A: p. Arg301Gln (exon-5) classified as pathogenic and likely pathogenic as per ACMG classification respectively and segregated with the disease in the family. Arylsulfatase A was low: 0.25nmol/hr/mg protein (normal range 0.6-5.0). To conclude MLD can have normal neuroimaging even at 5 yr. with atypical initial cognitive regression.

Keywords: Metachromatic Leukodystrophy, Progressive myoclonic epilepsy, Cognitive regression

INTRODUCTION

Metachromatic leukodystrophy (MLD) is a rare disorder due to mutations in the arylsulfatase A (*ARSA*) gene leading to arylsulfatase A deficiency.[1] We present a case of late infantile onset MLD with a novel phenotype.

CASE REPORT

A 5-year-old boy presented with myoclonic jerks and tonic seizures from 2 years of age, followed by initial cognitive and later motor regression. Loss of meaningful language output, comprehension, and ability to drink and feed by himself after the onset of seizures. The child developed stereotypes in the past 6 months. On examination, horizontal nystagmus, spasticity with power >3/5 in all limbs, sluggish ankle jerk, and normal in the other deep tendon reflexes were noted. Magnetic resonance imaging (MRI) brain done at 2, and 5 years were normal [Figure 1]. Tandem mass spectroscopy and enzyme for neuronal ceroid lipofuscinosis (NCL) 1 and 2 were normal. Exome sequencing showed compound heterozygous variants in *ARSA*: NM_0010854 25.3: c. 433C>T: p. Arg145Ter (exon 3) and c.902G>A: p. Arg301Gln (exon-5) classified as pathogenic and likely pathogenic as per ACMG classification, respectively, and segregated with the disease in the family. Arylsulfatase A was low: 0.25 nmoL/h/mg protein (normal range 0.6–5.0).

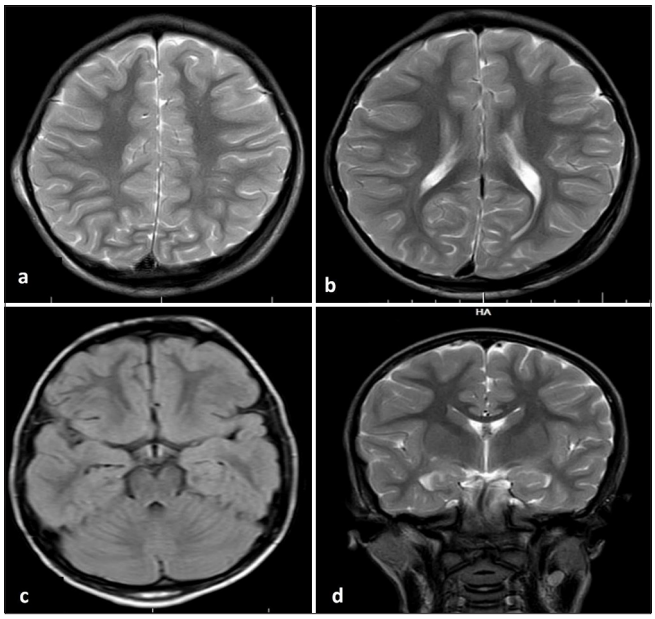

Figure 1: (a-d) Magnetic resonance imaging of the brain not showing any abnormalities.

DISCUSSION

Differentials considered were NCL and gangliosidosis. The neuroimaging in MLD is usually abnormal except for the late infantile form, where the initial scans may be normal or have minimal changes.[2,3] The neuroimaging anomalies in these cases were estimated to be seen at the breakpoint of 1.75 years.[2,4] However, repeat neuroimaging at 5 years was also normal in the current case. Normal MRI may mislead and delay the diagnosis of MLD and, in turn, the period for genetic counselling. The possible explanations for normal neuroimaging are the presence of immature myelin, signs of neuropathy leading to neurological symptoms, enzyme levels and genetic factors.[2]

CONCLUSION

MLD can have normal neuroimaging even at 5 years with atypical initial cognitive regression.

Ethical approval

Institutional Review Board has waived the ethical approval for this study

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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Karnataka Paediatric Journal

Case Report

Situs inversus totalis in a case of Joubert syndrome

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ABSTRACT

Joubert syndrome (JS) is an uncommon genetic condition distinguished by a unique midbrain-hindbrain abnormality known as the 'molar tooth sign (MTS)'. Classic JS is defined by three main findings: the MTS is a specific cerebellum and brain stem abnormality, hypotonia and developmental abnormalities. Over 40 causal genes have been found to date, accounting for up to 94% of cases. Individuals with JS who carry pathogenic mutations in TMEM67 are much more likely to develop liver fibrosis, whereas pathogenic variants in NPHP1, RPGRIP1L and TMEM237 are frequently associated with JS and renal involvement. Individuals with causative mutations in CEP290 or AHI1 require greater monitoring for retinal degeneration and, in the case of CEP290, chronic renal disease. These examples demonstrate how an accurate description of the range of clinical symptoms associated with abnormalities in each causal gene, particularly rare ones, would assist in improving prognosis and guide individualised care. We present a neonatal case of JS with situs inversus.

Keywords: Genetics, Joubert syndrome, Situs inversus totalis, Vermian hypoplasia

INTRODUCTION

Situs inversus (SI) represents the most extreme form, where all major organs are mirror-images from their typical positions, usually asymptomatic and most lead normal lives.[1,2] While generally well-tolerated, SI can sometimes co-occur with other developmental malformations. Vermiform hypoplasia refers to the underdevelopment of cerebellar vermis, a vital region. While the severity can vary, affected individuals may experience varying degrees of motor incoordination, gait abnormalities and speech difficulties.[3] The co-occurrence of cerebellar-vermis hypoplasia and SI in a neonate presents a unique clinical scenario.[4] A case of Joubert syndrome (JS) associated with SI in a newborn is reported [Figure 1], and the need to detect the syndrome in the neonatal period is emphasised.

CASE REPORT

This baby was a second born at term after an uneventful pregnancy, which was unnoticed till 5 months of pregnancy as the mother was under the pretext of lactational amenorrhoea and was not followed up, or antenatal follow-up was not done for the first and second trimester. The neonate was the product of a third-degree consanguineous marriage. The prenatal ultrasound identified hyperechogenic kidneys, and all other features were remarkable. The mother was not exposed to any radiation or harmful drugs during her pregnancy, with proper follow-up after the second trimester. The newborn was delivered vaginally and cried shortly after birth, with a normal Apgar at 1 and 5 min. The Apgar scores were 6 at 1 min and 8 at 5 min. Physical

examination revealed a weight of 3280 g (50th percentile), a height of 48 cm (25th percentile) and a head circumference of 34 cm. The baby had a large nose bridge, anteverted nostrils and a triangular-shaped open mouth.

Soon after birth, the baby started developing respiratory distress in the form of cyanosis and an irregular pattern of respiratory (waxing and waning pattern). The baby was admitted to this level III neonatal intensive care unit for post-natal care and was given continuous positive airway pressure (CPAP) support for the initial duration. Other physical examination findings noted shifted apical impulse to the right side of the chest and liver, palpable on the left hypochondrium [Figure 2].

The initial X-ray showed SI with major organ shifts, including liver and heart. The baby had persistent distress and had to mechanically ventilate for the initial few days. The baby was treated based on an initial diagnosis of respiratory distress syndrome and early-onset newborn sepsis. After weaning off the ventilator in the 2nd week of life, respiratory assistance was reduced to CPAP. The dramatic respiratory anomaly persisted since birth, even when on assistance. The newborn was discovered to have periods of panting with a respiratory rate of up to 100 breaths/min, alternating with apnoea lasting 15–20 s without cyanosis. The baby was weaned off respiratory support by the 3rd week of life and was discharged on room air. The genetic sequencing confirmed the diagnosis of JS.

Laboratory investigations, including haemoglobin level, serum calcium level, haematocrit, phosphorus, blood urea nitrogen, creatinine, alkaline phosphatase, blood sugar, electrolytes, lactate, cerebrospinal fluid examination, acid-base values and blood and urine amino acids were normal.

X-ray and ultrasound examinations showed SI-shifted pericardium and liver. Ultrasound sonography abdomen showed increased echogenic focus in both kidneys. Further, investigations like contrast-enhanced abdominal computed tomography scans could be considered to precisely map the location of all major organs and identify any potential.

Normal cardiac anatomy and function: A 2D echocardiogram confirmed normal heart structure and function. This is reassuring, as cardiac malformations are sometimes associated with SI.

Transcranial ultrasound: Confirmed the prenatal diagnosis of vermian hypoplasia with no other associated vascular malformations [Figure 3].

DISCUSSION

JS is a rare congenital neurodevelopmental primary ciliopathy with a population-based frequency of 1.7/100,000 people aged 0–19 years.[5] The clinical picture is clear from neonatal age with hypotonia, aberrant eye movements (primarily ocular motor apraxia), developmental delay and, in a subset of individuals, episodic respiratory dysregulation;

Gene&Transcript	Variant	Location	Zygosity	In silico Parameters**	Disorder(OMIM)	Inheritance	Variant Classifcation
CEP290 NM_025114.4	c.5056G>T p.Glu1686*	Exon 38	Heterozygous	CADD: 37	JOUBERT SYNDROME 5; JBTS5:610188	Autosomal Recessive	Likely Pathogenic
CEP290 NM_025114.4	c.5445_5448delAACT p.Thr1816fs*3	Exon 40	Heterozygous	NA	JOUBERT SYNDROME 5; JBTS5:610188	Autosomal Recessive	Pathogenic

* Genomic Position based on Assembly GRCh37, **Number of applied in silico programs predicting the effect of the variant on the protein outcome (CADD: Combined Annotation Dependent Depletion (v1.6), SIFT,

Figure 1: (a) Whole exome sequencing report-suggestive of Joubert syndrome. The genetic report indicating pathogenic gene involvement and (b) chromosomal microarray. Chromosomal involvement is indicated in blue colour. NA: Not applicable, OMIM- Online mendelian inheritance in man.
Note: The red highlight indicates the genes mentioned are likely pathogenic and pathogenic variants.

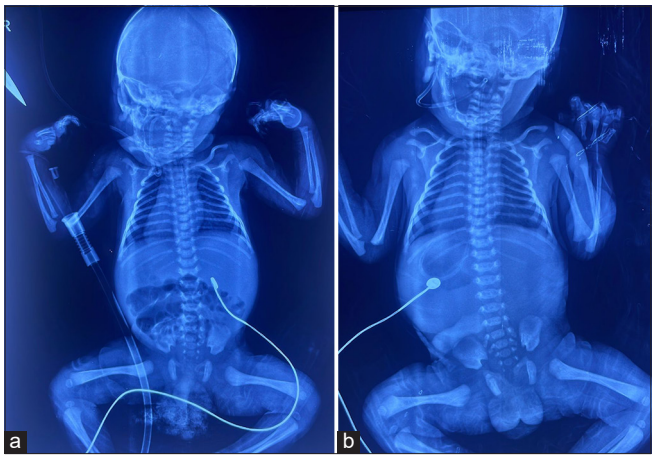

Figure 2: (a) Situs inversus totalis and (b) situs inversus totalis-shift of cardiac and liver.

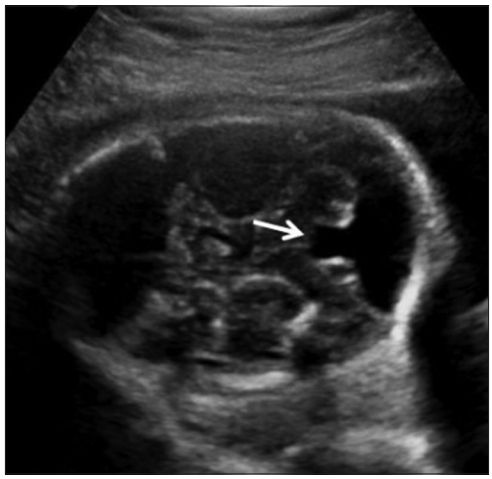

Figure 3: Vermian hypoplasia transcranial ultrasound. Vermian hypoplasia- indicated through an arrow.

subsequent clinical indicators include cerebellar ataxia and, usually, cognitive impairment.[6] Due to its complex presentation, JS is a multisystem disorder, and some clinical abnormalities may progress, complicating medical therapy.

JS can be divided into clinical categories according to related extra- central nervous system (CNS) characteristics:[6]

- Purely neurological JS - (Pure JS)
- JS with ocular involvement - (JS-O)
- JS with renal involvement - (JS-R)
- JS with oculorenal involvement - (JS-OR)
- JS with hepatic involvement - (JS-H, or COACH syndrome)
- JS with orofaciodigital involvement - (JS- orofaciodigital disease [OFD], or Oral-facial-digital type VI syndrome [OFDVI] syndrome)
- JS with acrocallosal features
- JS with Jeune asphyxiating thoracic dystrophy.

JS is typically associated with a spectrum of neurological and multi-systemic features. Here's a few points of discussion on JS -

1. Neurological features
    a. Molar tooth sign (MTS) – JS is distinguished by the appearance of the molar teeth sign on brain imaging, resulting from cerebellar vermis hypoplasia or aplasia, enlarged and elongated superior cerebellar peduncles and a deepened interpeduncular fossa
    b. Cognitive Impairment – Many individuals with JS exhibit intellectual disability, ranging from mild to severe developmental delay in motor skills, language and social interaction. Early signs include developmental milestone delays, ataxia (characterised by a broad-based, unstable stride and difficulty running or climbing stairs) and intellectual handicap.[7]
2. Ocular abnormalities
    a. Oculomotor apraxia and retinal dystrophy are noted in some individuals. This can result in impaired visual tracking and coordination.[8]
3. Renal involvement
    a. Nephronophthisis – Renal abnormalities, particularly nephronophthisis, are common in JS – chronic kidney ds characterised by fibrosis and atrophy of the renal tubules, leading to end-stage renal disease.
    b. Extrarenal manifestations – Additional cysts and horseshoe kidneys can be noted.[7]
4. Respiratory involvement
    Respiratory abnormalities, including episodes of abnormal breathing patterns such as hyperpnoea, apnoea and irregular breathing, are observed in a subset of individuals with JS. This can lead to respiratory distress and may require supportive interventions. As a 'classic hallmark' of the illness, respiratory abnormalities have been identified in all four of the siblings, which was reported first by Joubert *et al.*[9] It is not, however, a constant feature and reported 44% in a study by Kendall *et al.*,[10] 68% by Pellegrino *et al.*[11] and 71% by Maria *et al.*[12]
5. Five major genes (CPLANE1, CC2D2A, AHI1, CEP290 and TMEM67) accounted for approximately 6–9% of JS cases in the largest cohort yet reported; three additional genes (CSPP1, TMEM216 and INPP5E) accounted for approximately 3% of cases, and six additional genes accounted for approximately 1–2%; the remaining genes were mutated only in a minimal number of families.[3] Here, we try to emphasise that the presentation of JS with SI is not mentioned in any of the literatures, and this is one of the unique cases of JS-related disease with overlapping of SI. The gene related to this disease is CEP290 (NM_025114.4).

The association between SI totalis and vermian hypoplasia is relatively rare, and the underlying aetiology remains poorly understood. However, it is postulated that genetic factors may

play a significant role, as evidenced by the consanguineous marriage of the parents in this case. Genetic counselling and further genetic testing could provide valuable insights into the inheritance pattern and potential recurrence risks for future pregnancies.

CONCLUSION

JS is a well-known autosomal recessive disorder that is uncommon. A review of the literature suggests that the disorder's clinical symptoms do exist during the newborn period, but the right diagnosis is sometimes not obtained for several months or even years after birth. Since JS is a non-progressive illness with a wide range of presentations, the prompt diagnosis would improve the course of treatment and its final result. This study demonstrates that it is relatively possible to diagnose a new-born given the availability of genetic sequencing.

Ethical approval

Institutional Review Board approval is not required.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

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Karnataka Paediatric Journal

Case Report

Type 2 caudal regression syndrome

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ABSTRACT

Caudal regression syndrome (CRS), also known as caudal dysgenesis, consists of a constellation of caudal developmental anomalies along with soft-tissue anomalies. The severity of its spectrum ranges from lumbosacral agenesis to isolated absence of coccyx. The pathophysiology of the disease is not fully known due to its rarity. In this case report, we present a case study of CRS observed in a preadolescent school-aged male child. Our objective is to contribute to advancing the literature surrounding this exceedingly rare syndrome and contextualise our findings within the broader research landscape.

Keywords: Sacral agenesis, Agenesis, Anomaly, Children

INTRODUCTION

Caudal regression syndrome (CRS), also known as sacral agenesis/caudal dysplasia, is a very rare complex congenital abnormality that affects the lower segment of the spine. It includes structural as well as neurological abnormalities of the lower spine and systemic involvement. The incidence of CRS is 1–2 in 100,000 newborns, whereas it is 1 in 350 with a maternal history of diabetes mellitus.[1] The condition was first described by Saint-Hilaire and Hohl in 1852,[2] and 'The syndrome of caudal regression' was first coined by Duhamel.[3] Sacral agenesis may be associated with currarino triad and homebox gene abnormalities and with neurogenic bladder dysfunction (80%).[4]

CASE REPORT

A school-aged, preadolescent male child presented to the paediatric outpatient department with chief complaints of urinary incontinence, abnormal gait and localised swelling in the right index finger, which was initially noticed by parents at 1 year of age. The baby was born to non-consanguineous parents at term by caesarean section in view of polyhydramnios with no other maternal comorbidities. There was no history of maternal glycaemic abnormalities, exposure to teratogens or substance abuse during the antenatal period. The details of antenatal scans were unavailable. Antenatal and postnatal history was uneventful. Developmental milestones were appropriate for age. There was no family history of similar symptoms. On examination, the child had normal vitals and anthropometry appropriate for age. Musculoskeletal system examination revealed abnormal limping gait and right-sided flexion contracture of hips. The child also had a right-sided volar scaphotrapezial joint ganglion cyst. Other system examinations were unremarkable.

The anteroposterior view of the X-ray pelvis showed the absence of sacrum and coccyx with normal lumbar vertebrae and hip bones [Figure 1]. Magnetic resonance imaging (MRI) of the spine showed termination of the spinal cord at the L4 vertebral level, and the sacrum appeared to be hypoplastic with widely separated bilateral sacral ala. S2 S3 appeared small, whereas S4, S5 and coccyx were not visualised. Computed tomography (CT) pelvis with both hips was done, which showed features suggestive of partial agenesis of the sacrum (Hypoplasia of S2, S3), whereas S4, S5 and coccyx were absent. Reduced vertebral body height of the D5 vertebra (Butterfly vertebra) was noted. No evidence of meningocele was noted. Abdominal ultrasonography showed right-sided, mild hydronephrosis with bladder distension and diffuse urinary bladder wall thickening with trabeculations suggestive of chronic cystitis. The micturating cystourethrogram showed an enlarged bladder with normal urethral anatomy indicative of neurogenic bladder dysfunction [Figure 2].

Based on the clinical presentation and radio-imaging findings, the child was diagnosed with CRS type II (with neurogenic bladder). The primary differential diagnosis of CRS includes sirenomelia, characterised by fused legs that resemble a mermaid tail, and VACTERL syndrome, with which CRS has been associated. Another relevant consideration is Currarino syndrome, characterised by a presacral mass, sacral bone defect and anorectal malformation. All these differentials were ruled out in the index case.

CRS warrants a multidisciplinary approach involving paediatric surgery, orthopaedics, neurosurgery and urogenital specialties, with early motor rehabilitation and physiotherapy as the cornerstone of treatment. In this case, there was no systemic involvement except for the neurogenic bladder. Since there was no gross systemic involvement in the child, the prognosis was expected to be relatively better. The patient was referred for a paediatric surgery consultation for urodynamic studies. The child is currently being managed conservatively and is on regular follow-up.

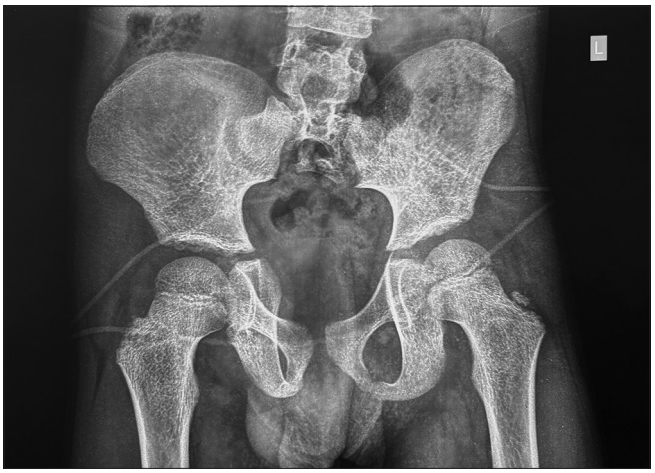

Figure 1: X-ray pelvis anterior-posterior view showing absent sacrum and coccyx.

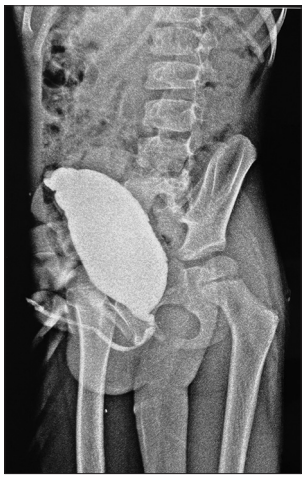

Figure 2: Micturating cystourethrogram shows an enlarged bladder depicting a neurogenic bladder.

DISCUSSION

CRS is a rare compound congenital disorder characterised by abnormalities in the vertebral column, spinal cord, lower limb abnormalities, systemic involvement such as genito-urinary abnormalities, cardiovascular and respiratory anomalies, foregut malformations, VACTERL anomalies and dysmorphic facial features.[2] Polyhydramnios is frequently associated with neural tube defects, whereas oligohydramnios is a very rare finding in CRS.[1]

The precise aetiology of this syndrome is unknown; however, factors such as maternal diabetes mellitus (insulin-dependent), vascular hypoperfusion and genetic influences are considered to be potential contributors.[5] The widely accepted theory of pathogenesis proposes that anomalies in the development of the embryonic caudal mesoderm, possibly resulting from defects in the formation of the mid-posterior axis of the mesoderm appear before the fourth week of embryogenesis, leading to skeletal malformations and organ dysplasia.[5,6] As in most reported cases, our case lacks a specific identifiable risk factor.

CRS classification, as proposed by Renshaw, delineates distinct types based on the extent and nature of anatomical involvement. This classification system provides a comprehensive framework for understanding the varied presentations of CRS. The existing literature substantiates the diagnosis of CRS prenatally by antenatal sonography scans[1] and postnatally confirmed by MRI scans.[4]

As per the published literature, common vertebral and central nervous system anomalies in CRS include hypoplastic vertebrae, vertebral fusion, hemivertebrae, butterfly vertebrae, tethered cord syndrome and spinal column malalignment (scoliosis and kyphosis) and spina bifida. In our case, the child had D5 butterfly vertebrae with reduced vertebral body height, sacrococcygeal hypoplasia with spinal cord ends at L4 vertebral level and scoliosis.

Prevalent lower limb anomalies described in the literature include talipes equinovarus, popliteal webbing, frog leg posture and short limb. Our child has an abnormal limping gait and flexion contracture of the hips. Genitourinary abnormalities described in CRS include neurogenic bladder (67% of patients of CRS),[7] vesicoureteric reflux, renal agenesis, absent bladder and transposition of external genitalia. The index case had a neurogenic bladder and bilateral hydronephrosis. An additional unique finding in our case is the presence of a right volar scaphotrapezial joint ganglion cyst, which was asymptomatic. Such association has previously been undocumented in the CRS literature. No other systemic abnormalities were found in our case.

CONCLUSION

CRS is a rare congenital condition with anomalies in the vertebral column, spinal cord, lower limbs and systemic involvement like genitourinary abnormalities. CRS can occur even in the absence of maternal gestational diabetes mellitus. Timely recognition of the condition with the delivery of informed genetic counselling is crucial for affected individuals. In all suspected cases of CRS, a complete workup of all associated systemic anomalies should be done. Further research is necessary to understand the pathophysiology of this condition.

Ethical approval

Institutional Review Board approval is not required.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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Karnataka Paediatric Journal

Letter to the Editor

Management of obstructive sleep apnoea in Apert syndrome with non-invasive ventilation

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Dear Editor,

Apert syndrome is an uncommon form of craniosynostosis marked by early fusion of the skull sutures. Patients with this condition can develop obstructive sleep apnoea syndrome (OSAS) due to their craniofacial anomalies. Here, we describe a case of Apert syndrome complicated by OSAS, which responded well to continuous positive airway pressure (CPAP) treatment.

A 7-year-old boy presented with characteristic features of Apert syndrome, including craniosynostosis, sclerodactyly, short stature, ridging along the cranial sutures, prominent bulging eyes, underdeveloped midface with maxillary hypoplasia, crowded teeth, and a high-arched palate.

The referral to the Paediatric Sleep Medicine clinic was prompted by reports from the boy's teacher indicating increased daytime sleepiness and instances of falling asleep during meals. This worsening in alertness was noted to be more severe than usual, with the child even falling asleep while standing. In addition, the mother reported that the boy slept excessively, averaging around 20 h/day, and had a history of snoring since birth, along with frequent awakenings at night and episodes of Apnoea. Child did not have choanal atresia. Drug-induced sleep endoscopy (DISE) ruled out any anatomical abnormalities. Computed tomography (CT) scan of head and neck was not performed.

A comprehensive diagnostic polysomnography (PSG) was conducted, providing valuable insights into the boy's sleep patterns and respiratory events during the night. The PSG revealed a total sleep time of 458.5 min, with a sleep efficiency of 81.9%. The distribution of sleep stages showed 21.2% in N1 sleep, 63% in N2 sleep, 5.9% in N3 sleep and 10% in rapid eye movement (REM) sleep.

Importantly, the PSG recorded 76 respiratory events, including 35 predominantly obstructive apnoeas. The apnoea and hypopnea index were calculated at 10.9 events/h, indicating significant respiratory disturbances during sleep, there were no central apnoeas. The central apnea-hypopnea index (AHI) was less than 0.1. In addition, there were 373 recorded snores, with a mean oxygen saturation (SaO_2) of 98% and a minimum SaO_2 of 72%, leading to a desaturation index of 10.8 events/h.

Based on these PSG findings and the clinical presentation, the decision was made to initiate CPAP therapy at 6 cm H_2O using an oronasal mask. Mask fitting and sensitisation were performed in the hospital for 48 hours. pressures were started at physiological pressures and gradually escalated. Oronasal mask was well tolerated. The boy responded well to CPAP treatment, demonstrating good adaptation and compliance. CPAP data extracted showed usage for more than 5 hours per night for more than 30 days, with minimal leak. Three months after starting CPAP therapy, the

boy showed remarkable improvement, with the resolution of daytime sleepiness, increased activity levels, improved ability to engage in conversations, and nearly normal school attendance, good school time behavior and better focus during tasks and activities.

Apert syndrome, the most severe form of syndromic craniosynostosis, is caused by mutations in the fibroblast growth factor receptor 2 (FGFR2) gene and inherited in an autosomal dominant manner. It is characterised by various craniofacial abnormalities such as symmetrical complex syndactyly of the hands and feet, bicoronal synostosis, exorbitism, hypertelorism and midface hypoplasia.[1] About 40% of Apert syndrome cases may develop OSAS, primarily due to midface hypoplasia. However, OSAS can also arise from changes in the changes in the tone of the pharynx, larynx and/or tracheal lumen.[2]

Untreated OSAS in Apert syndrome can lead to complications such as sleep disturbances, frequent infections, growth and developmental delays, cognitive impairment, cor pulmonale or even sudden death. Therefore, a PSG study is essential as it is the standard test for diagnosing OSA.

Studies indicate that CPAP therapy can be an effective treatment for severe OSAS in children with syndromic craniosynostosis.[3] However, recent experiments have shown that a significant number of children may still experience severe OSAS even after undergoing midfacial advancement surgery.[4] DISE ruled out the need for surgery as the collapse was mainly a pharyngeal collapse, and surgery would not be beneficial.

CPAP therapy significantly improved OSAS symptoms in Apert syndrome, emphasising its crucial role in comprehensive management.

Ethical approval

Institutional Review Board approval is not required.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

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Conflicts of interest

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