Original Article

Microbiological Spectrum and Antibiotic Susceptibility in Septic Arthritis: Insights from a Tertiary Pediatric Centre in Karnataka

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Abstract

Background: Neonatal septic arthritis (SA) is an infection and inflammation of the synovial membrane with purulent effusion caused by bacterial or fungal pathogens. It is a serious deep-seated infection in neonates, with a global incidence of 0.3 per 1000 live births and 0.6 per 1000 live births in India. Early diagnosis is challenging due to subtle clinical signs. **Material and Methods:** This observational study was conducted at a tertiary pediatric referral centre in Karnataka. A total of 55 pus, synovial fluid, and tissue samples from neonates with suspected SA were collected between July 2023 and June 2024. Samples were Gram-stained and inoculated onto Blood Agar, MacConkey Agar, Sabouraud Dextrose Agar, and Thioglycolate broth, incubated aerobically at 37°C for 24–48 hours. Positive cultures were identified by colony characteristics, Gram staining, biochemical reactions, and Vitek2 confirmation. Fungal growth was also noted. All bacterial isolates underwent antimicrobial susceptibility testing as per CLSI guidelines. **Results:** Of 55 samples, 33 (60%) were culture positive. The most common isolate was Klebsiella pneumoniae, followed by Staphylococcus aureus. Klebsiella pneumoniae showed highest susceptibility to Meropenem and Imipenem (28.57%) and Cotrimoxazole (21.43%). Staphylococcus aureus was 100% susceptible to Linezolid, Cotrimoxazole, and Vancomycin. **Conclusion:** Klebsiella pneumoniae and Staphylococcus aureus are the predominant pathogens causing neonatal SA in this setting. Early identification and culture-directed antibiotic therapy are essential to prevent joint damage and improve outcomes.

Keywords: Septic arthritis, Neonatal SA, Microbiological profile, Antibiogram.

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Introduction

Septic arthritis (SA) is an acute infection of the joint space caused by bacterial or less often, fungal microorganisms which causes inflammation of the synovial membrane and purulent effusion in the joint capsule. It's a true orthopaedic emergency and delay in diagnosis and treatment is the most crucial determinant of prognosis,[1] especially in the neonatal population. Neonates have an immature immune system, and if not treated, an infection can quickly destroy the articular cartilage, damage the physeal surfaces and result in dislocation of the joints and permanent disability.[2]

Although significant progress has been made in the treatment of antimicrobial infections and neonatal intensive care, septic arthritis of the newborn remains a very difficult diagnosis and treatment. Clinical symptoms are usually not very specific, laboratory results can be misleading and early radiological changes are often not helpful because the joints in newborns are cartilaginous.[3,4] The disease is stereotypically associated with hip joint disease, as it is this joint, with its special anatomy and vascular supply, that is almost always involved and is commonly accompanied by disease of the joint itself (concomitant osteomyelitis).[5,6] Microbiological profile of neonatal septic arthritis varies from other children in later childhood and has changed over time, with shifts in predominant organisms, introduction of new fungal infections and changing antibiotic resistance patterns, with a notable change in the profile of hospital acquired infections.[3,7]

Neonatal septic arthritis is associated with a high risk of long-term sequelae, including destruction of joint, limb-length discrepancy, gait abnormalities, and growth disturbances, with reported rates ranging from 6% to 50%.[4,6,8] Early identification of causative organisms and understanding their antibiotic sensitivity patterns are crucial for timely and effective management. However, data from developing countries remain

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limited regarding the bacteriological profile, antimicrobial susceptibility, and predictors of poor outcome in neonatal septic arthritis. This study was therefore undertaken to isolate and identify the pathogens causing neonatal septic arthritis, assess their antibiotic susceptibility patterns and determine the most frequent causative organisms.

Materials and Methods

This observational study was conducted over a period of one year, from July 2023 to June 2024, in a tertiary care microbiology laboratory. The study included pus/exudate, blood, and tissue samples obtained from neonates who were clinically diagnosed with septic arthritis and referred for microbiological evaluation. This study was approved by the Institutional Ethics Committee of Indira Gandhi Institute of Child health [IGICH/ACA/EC/01/2023-24].

The sample size was calculated based on a previous study that reported a culture positivity rate of 68.1% in neonatal septic arthritis. Using a confidence level of 95% (Z = 1.96), a precision of 15%, and applying a design effect of 1.5, the final calculated sample size was 55 cases.

All samples received were analysed microbiologically as is standard practice. Samples collected, stored and transported incorrectly were not included in the study. Samples with growth of skin flora were also excluded as were samples taken from neonates that had been treated with antibiotics. All samples were made into direct smears and Gram stained to get a preliminary identification. The samples were then subcultured onto Blood agar, Macconkey agar, Chocolate agar, Sabouraud dextrose agar and Thioglycolate broth. These samples were then subcultured in Blood agar, Macconkey agar, Chocolate agar, Sabouraud dextrose agar and Thioglycolate broth. Bacterial cultures were grown aerobically at 37°C for 24–48 hours and fungal cultures were grown according to standard lab techniques.

Bacterial isolates were identified by colony morphology, Gram staining and using standard biochemical tests. If necessary, an automated identification system was used to identify and confirm species-level. Colony morphology on Sabouraud dextrose agar, micro morphology and appropriate biochemical reactions were used to identify the fungal isolates as yeasts and molds. [Figure 1]

The antimicrobial susceptibility testing (AST) of bacterial isolates was carried out by the Kirby–Bauer disc diffusion method on Mueller–Hinton agar. The inoculum was prepared in the following way: 4-5 isolated colonies were suspended in the peptone water to get a standardized inoculum corresponding to 0.5 mc Farland turbidity. Then, the lawn culture was done in Mueller–Hinton agar plates with the appropriate antibiotic discs placed on the surface of the agar. The plates were cultured at 37°C for 18-24 hrs. The zone of inhibition around each antibiotic disc was measured after incubation using ruler and interpretation was done according to Clinical and Laboratory Standards Institute (CLSI) in terms of sensitive, intermediate and resistant. Quality control strains were used to ensure the accuracy and reliability of culture and antimicrobial susceptibility testing procedures.

All data collected were entered into a structured proforma and analyzed using descriptive statistical methods. Demographic variables, clinical characteristics, culture results, and antimicrobial susceptibility patterns were summarized using frequencies and percentages. Age, sex distribution, gestational age, joint involvement, culture positivity, microbial isolates, and antibiotic susceptibility profiles were analyzed descriptively and presented in the form of tables and graphs. No inferential statistical tests were applied, as the primary objective of the study was to describe the microbiological profile and antibiotic susceptibility pattern of neonatal septic arthritis.

Results

A total of 55 pus/exudate and tissue samples were collected from neonates clinically diagnosed with septic arthritis during the study period. Of these, 29 neonates (52.7%) were aged less than 30 days. The remaining cases were distributed across older neonatal age groups. There was no significant gender predominance, with 27 males (49.1%) and 28 females (50.9%). With respect to gestational age, 41 neonates were full term and 14 were preterm.

Regarding joint involvement, single joint involvement was observed in 36 cases (65.4%), while multiple joint involvement was noted in 19 cases (34.6%), including cases with bilateral joint involvement. The hip joint was the most commonly affected joint, involved in 36 cases (65.4%), followed by the knee joint in 14 cases (25.5%). Bilateral involvement was observed in a small proportion of cases, with bilateral hip involvement in 3 cases (5.4%) and bilateral knee involvement in 2 cases (3.6%), all of which were included under multiple joint involvement.

Microbiological culture yielded growth in 33 cases (60%), while 22 cases (40%) showed no growth. Among the 33 culture-positive cases, true pathogenic organisms were isolated in 27 cases (49.1%), while 6 cases (10.9%) were identified as contaminants and excluded from pathogen analysis. Among pathogenic isolates, bacterial organisms accounted for 26 cases (47.3%), while one case (1.8%) showed a mixed infection with Staphylococcus aureus and Candida tropicalis.

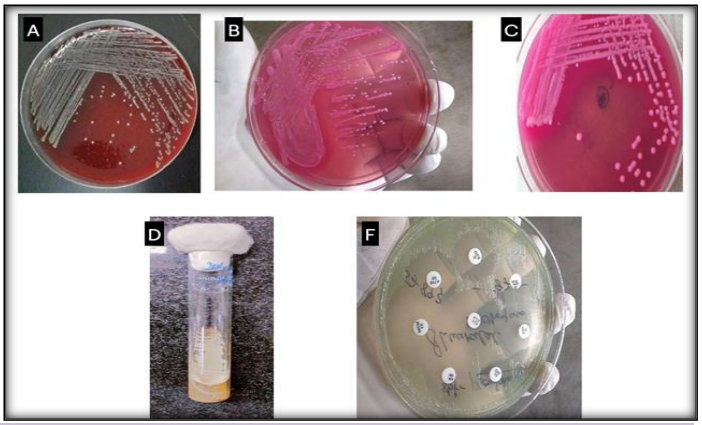

Figure 1: Microscopic and culture characteristics of common neonatal septic arthritis isolates - a. Staphylococcus aureus colonies on Blood Agar, b. Escherichia coli colonies on MacConkey Agar, c. Klebsiella pneumoniae colonies on MacConkey Agar, d. Yeast-like fungal growth on Sabouraud Dextrose Agar (SDA), e. Antimicrobial susceptibility testing performed on Mueller Hinton Agar by Kirby-Bauer disc diffusion method (CLSI guidelines)

Klebsiella pneumoniae was the most common bacterial isolate, identified in 14 cases (25.5%), followed by Staphylococcus aureus in 11 cases (20%). Coagulase-negative Staphylococcus species were isolated in 6 cases (10.9%). Acinetobacter species and Escherichia coli were isolated in one case each (1.8%).

Among the 11 Staphylococcus aureus isolates, 8 (73%) were methicillin-resistant Staphylococcus aureus (MRSA) and 3 (27%) were methicillin-sensitive Staphylococcus aureus (MSSA) [Figure 2]. Antimicrobial susceptibility testing of Klebsiella pneumoniae isolates demonstrated the highest sensitivity to carbapenems, with 4 isolates (28.6%) sensitive to both meropenem and imipenem. Cotrimoxazole sensitivity was observed in 3 isolates (21.4%), while ceftazidime and ciprofloxacin sensitivity was seen in 2 isolates each (14.3%). Lower sensitivity rates were noted for gentamicin, cefuroxime, ceftriaxone, and cefixime (7.1%), with least sensitivity observed to amoxicillin–clavulanic acid [Figure 3].

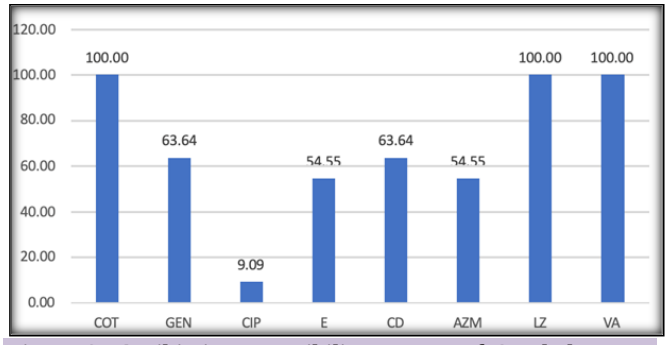

Figure 2: Antibiotic susceptibility pattern of Staphylococcus aureus isolates.

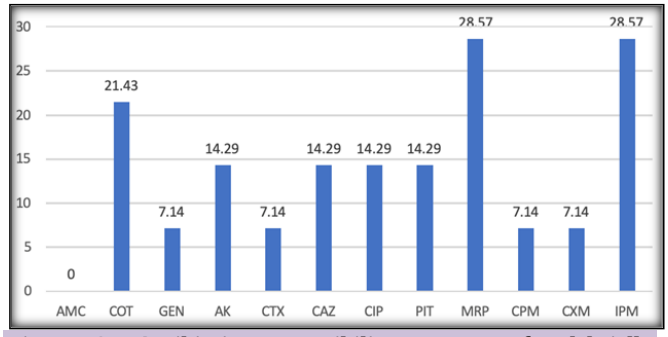

Figure 3: Antibiotic susceptibility pattern of Klebsiella pneumoniae isolates.

All Staphylococcus aureus isolates showed 100% susceptibility to vancomycin (tested by MIC), linezolid, and cotrimoxazole. Susceptibility to gentamicin and clindamycin was observed in 7 isolates (63.6%), while erythromycin and azithromycin showed sensitivity in 6 isolates (54.5%). The least susceptibility was observed with ciprofloxacin, seen in only one isolate (9.1%).

Discussion

Neonatal septic arthritis remains a serious orthopaedic emergency because of its potential for rapid joint destruction and long-term disability if diagnosis or treatment is delayed. In the present study, most cases occurred within the first month of life, which is consistent with previous reports that highlight neonatal immune immaturity and hematogenous spread as major contributors to infection.[1,2] Multiple neonatal series from the world showed a similar prevalence of monoarticular involvement; the hip joint was most commonly involved,[3–5] which was also seen in this study. Deshpande et al. and Uthraraj et al. reported similar distributions, with hip involvement involving 60-80%, further highlighting the vulnerability of the neonatal hip caused by its vascular anatomy and intracapsular metaphysis.[6,7]

In our study, 60% of culture positivity was observed which is similar to Deshpande et al,[6] (60%) but lower than Berberian et al. (upto 82%).[8] This reduced production could be explained by having been administered an antibiotic, the sampling delay, or because small volumes of aspirates are seen in neonates. The predominant bacteria were gram negative (25.4% Klebsiella pneumoniae, 20% Staphylococcus aureus, 10.9% CONS, 1.8% Escherichia coli and 1.8% Acinetobacter) followed by the gram positive organisms. The trend of predominance of gram-negative bacteria is now reflected in the increasing epidemiological findings of predominance of gram-negative bacteria in neonatal septic arthritis, especially those related to hospital and NICU settings.[9–11] These findings are in agreement with the study conducted by Usha D et al., and Sankaran et al. in which Klebsiella was found as the most predominant pathogen.[7,12]

Gram-negative organisms were predominant, however, Staphylococcus aureus was found to be an important pathogen in our study, where 73% of isolates were found to be MRSA, which is similar to the pattern observed in recent studies conducted in India and Asia.[10,13] This is due to the rise of resistance of organisms to antimicrobial agents and hospital flora. Interestingly, a case of a joint mixed growth of Staphylococcus aureus and Candida tropicalis was shown. Though it is rare, fungal septic arthritis is more commonly seen in neonates who stay in the NICU for a longer time, have been on a broad-spectrum antibiotic, and also have indwelling catheters.[14,15] Rudraprasad et al. discussed Candida as one of the important causes of neonatal joint infections suggesting that if the organism is not found in culture or there is no response that fungal etiology should be also considered.

Antimicrobial susceptibility testing revealed limited sensitivity of Klebsiella pneumoniae to commonly used antibiotics, with the highest susceptibility observed to carbapenems (Meropenem and Imipenem, 28.57%), followed by Cotrimoxazole (21.43%). Resistance to Amoxicillin-clavulanic acid was high, consistent with ESBL-producing strains reported in neonatal units.[11,16] All Staphylococcus aureus isolates were 100% susceptible to Vancomycin, Linezolid, and Cotrimoxazole, while resistance was most notable to Ciprofloxacin. Similar resistance trends have been documented in recent pediatric septic arthritis literature, underscoring the importance of institution-specific antibiograms for guiding empirical therapy.[13,17]

Based on the microbiological profile observed, we recommend that empirical antibiotic therapy for suspected neonatal septic arthritis in our setting should provide robust Gram-negative coverage, particularly against Klebsiella pneumoniae, along with coverage for MRSA. A combination of a carbapenem

(Meropenem/Imipenem) with Vancomycin is appropriate for critically ill neonates until culture results are available. Cotrimoxazole may be considered as a step-down option based on sensitivity. Given the occasional isolation of fungal organisms, early consideration of fungal cultures and antifungal therapy is advised in high-risk neonates or in cases not responding to antibacterial treatment. Prompt joint aspiration, early microbiological diagnosis, and antibiotic de-escalation based on culture and sensitivity remain essential to optimize outcomes and prevent long-term sequelae.

Conclusion

This study highlights a high prevalence of Klebsiella pneumoniae among Gram-negative and Staphylococcus aureus among Gram-positive isolates in neonatal septic arthritis. Early evaluation of the microbiological pattern and routine antimicrobial susceptibility testing are essential to guide effective antibiotic therapy. Given the evolving resistance patterns and changing pathogen profile, periodic monitoring of local microbial trends is necessary to reduce the risk of complications. Neonatal septic arthritis, though rare, remains a potentially devastating condition that requires prompt recognition, aggressive antibiotic therapy, and, when needed, surgical intervention, along with careful long-term follow-up to prevent joint sequelae and optimize outcomes.

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Conflicts of interest

There are no conflicts of interest.

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