JK SCIENCE pISSN: 0972-1177

ORIGINAL ARTICLE

Activity of Anti-MRSA Quinolone, Levonadifloxacin Against Gram Positive Cocci Obtained from Clinical Samples in a Tertiary Care Center in Western India

Aishwarya Babu, Meera Modak, Mahadevan Kumar, Sonali Gajare

Abstract

Background: Gram-positive cocci, including *Staphylococcus aureus*, *Enterococcus* species, and coagulase-negative *Staphylococcus* species (CONS), are major causes of nosocomial infections. The increasing prevalence of drug-resistant strains such as methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant *Enterococcus* (VRE) has made treatment increasingly difficult. Levonadifloxacin, a novel indigenous antibiotic, has shown promising activity against MRSA and other multidrug-resistant Gram-positive pathogens. This study evaluated the efficacy of levonadifloxacin against Gram-positive cocci isolated from clinical samples in a tertiary care hospital. **Methodology:** A cross-sectional observational study was conducted over one year at a tertiary care centre in Western India. Gram-positive cocci isolated from clinical samples were identified, and their susceptibility to levonadifloxacin was determined. **Results:** Out of 500 Gram-positive cocci isolates, *Staphylococcus aureus* was the most common, followed by CONS. Levonadifloxacin showed an overall susceptibility rate of 84%. Resistance was highest among blood isolates, whereas pus isolates showed the lowest resistance. **Conclusion:** Levonadifloxacin demonstrated high efficacy against MRSA and other Gram-positive cocci, particularly in skin and soft tissue infections. However, a slightly declining trend in susceptibility compared to previous studies was observed. Although levonadifloxacin remains a promising alternative for the treatment of multidrug-resistant Gram-positive infections, routine susceptibility testing is recommended before its use.

Key Words

Antibiotic Susceptibility, Levonadifloxacin, MRSA

Introduction

Gram-positive cocci constitute a major cause of nosocomial infections and include *Staphylococcus aureus*, *Enterococcus* species, and coagulase-negative staphylococci (CONS)[1,2]. These organisms are responsible for a wide variety of infections, including skin and soft tissue infections, pneumonia, urinary tract infections, and bloodstream infections[3]. The rising prevalence of drug-resistant strains such as MRSA, quinolone-resistant *Staphylococcus aureus* (QRSA), and VRE has significantly complicated treatment options[3].

In India, the prevalence of MRSA has increased steadily, reaching 37% between 2015 and 2020[4]. An ICMR survey in 2021 reported MRSA prevalence as high as 48% in certain regions[5]. The common

Department of Microbiology, Bharati Vidyapeeth (DU) Medical College, Pune, Maharashtra, India.

Correspondence to: Dr Aishwarya Babu, Department of Microbiology, Bharati Vidyapeeth (DU) Medical College, Dhankawadi, Pune, Maharashtra, India.

Manuscript Received: 17.10.2025; **Revision Accepted**: 21.12.2025
Published Online First: 10th April, 2026
Open Access at: https://journal.jkscience.org

Cite this article as: Babu A, Modak M, Kumar M, Gajare S. Activity of Anti-Mrsa Quinolone, Levonadifloxacin Against Gram Positive Cocci Obtained from Clinical Samples in a Tertiary Care Center in Western India. JK Science 2026; 28(2):83-6.

therapeutic options for MRSA include vancomycin, linezolid, and daptomycin. However, vancomycin has been associated with treatment failures due to emerging resistance and carries a risk of nephrotoxicity at higher serum concentrations[2,3]. Prolonged use of linezolid may result in adverse effects such as peripheral neuropathy, lactic acidosis, optic neuropathy, and thrombocytopenia[6]. Daptomycin is ineffective in pneumonia because it is inactivated by pulmonary surfactant[2].

Levonadifloxacin (intravenous) and its oral prodrug alalevonadifloxacin belong to the benzoquinolizine class of antibiotics and exhibit broad-spectrum activity. These agents are highly effective against MRSA, QRSA, linezolid-resistant staphylococci, CONS, vancomycin-resistant *Staphylococcus aureus* (VRSA), quinolone-susceptible streptococci, Gram-negative bacteria, and anaerobes. They have been approved in India for the treatment of acute bacterial skin and skin structure infections (ABSSSI), including wound infections, cellulitis, erysipelas, and large skin abscesses (>75 cm^2)[7,8].

Levonadifloxacin selectively inhibits DNA gyrase in *Staphylococcus aureus*. It has demonstrated superior efficacy in eradicating biofilm-associated MRSA and QRSA and intracellular MRSA compared with vancomycin and linezolid. A major advantage is that dose adjustment is not required in renal or hepatic impairment[7,8]. In addition, levonadifloxacin achieves higher pulmonary penetration than other fluoroquinolones[8].

The primary objective of this study was to evaluate the in-vitro susceptibility of levonadifloxacin against Gram-positive cocci isolated from clinical samples. The secondary objective was to analyze the susceptibility pattern of these isolates to routinely used antibiotics for Gram-positive infections.

Material and Methods

This cross-sectional observational study was conducted over one year (January 2023 to December 2023) in the Department of Microbiology after obtaining approval from the Institutional Ethics Committee (BVDUMC/IEC/263 dated 14.02.2023).

Inclusion criteria

Clinical samples such as blood, pus, urine, cerebrospinal fluid (CSF), sterile body fluids, and tissue that yielded Gram-positive cocci on culture and were identified as *Staphylococcus* species, *Streptococcus* species, and *Enterococcus* species using the Vitek-2 system (bioMérieux, Marcy-l'Étoile, France) were included.

Exclusion criteria

Samples yielding other Gram-positive cocci such as *Kocuria* species were excluded.

Sample size and sampling technique

All samples satisfying the inclusion criteria during the one-year study period were included. A convenient sampling method was used.

All samples received in the microbiology laboratory were processed according to standard microbiological procedures. They were inoculated on blood agar and MacConkey agar. Isolates showing Gram-positive cocci were further identified by the Vitek-2 system (bioMérieux, Marcy-l'Étoile, France) and routine biochemical tests such as catalase, coagulase, and bile esculin tests.

Antibiotic susceptibility testing for penicillin/oxacillin, ciprofloxacin, levofloxacin, and vancomycin was obtained from Vitek-2 results, and the minimum inhibitory concentration (MIC) values were interpreted according to CLSI guidelines. Susceptibility to levonadifloxacin was determined using the Kirby–Bauer disk diffusion method on Mueller–Hinton agar (HiMedia Laboratories Pvt. Ltd., India) and interpreted as per CLSI guidelines[9]. Since interpretive breakpoints for CONS are not defined, *Staphylococcus aureus* breakpoints were applied. Data were entered and analyzed using Microsoft Excel.

Results

A total of 500 Gram-positive cocci isolates were included. Of these, 61% (303/500) were from male patients. Forty-five percent (224/500) were from surgical wards, 31% (156/500) from medical wards, and 24% (120/500) from critical care units. Most isolates were obtained from pus/tissue samples (47.4%, 237/500) followed by blood (36.4%, 182/500) (Figure I).

Staphylococcus aureus was the most frequently isolated organism (45%, 224/500), followed by CONS (32%), *Enterococcus* species (15%), and *Streptococcus* species (8%). Overall, 84% (418/500) of isolates were susceptible to levonadifloxacin. Susceptibility rates were 93% for MRSA, 94% for methicillin-sensitive *Staphylococcus aureus* (MSSA), 91% for CONS, 71% for *Streptococcus* species, 45% for *Enterococcus* species, and 28% for VRE.

Sample-wise resistance to levonadifloxacin was observed in 3.8% of pus isolates, 6.8% of blood isolates, 0.6% of sterile body fluid isolates, 0.6% of respiratory isolates, and 4.4% of urine isolates. Among all Gram-positive cocci, 17% were susceptible to ciprofloxacin, 17% to levofloxacin, and 99% to vancomycin (Figures II

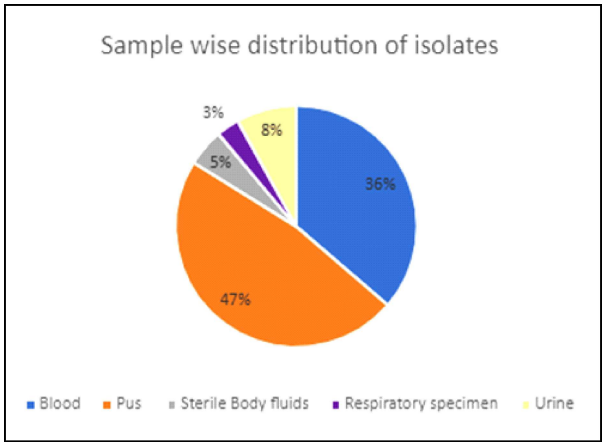

Figure I : Sample wise Distribution of the Isolates

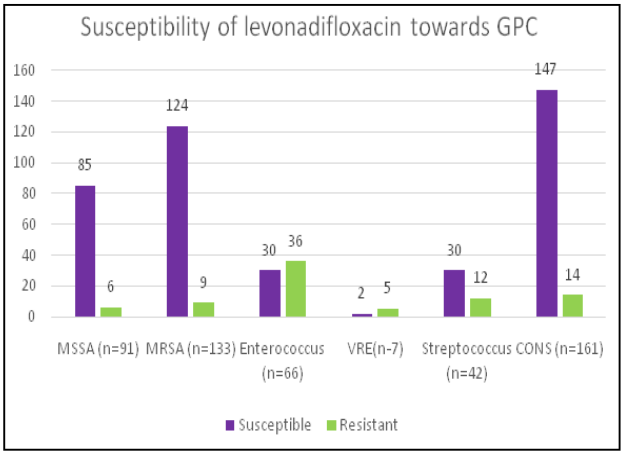

Figure II : Susceptibility Pattern of Levonadifloxacin towards Gram Positive Cocci

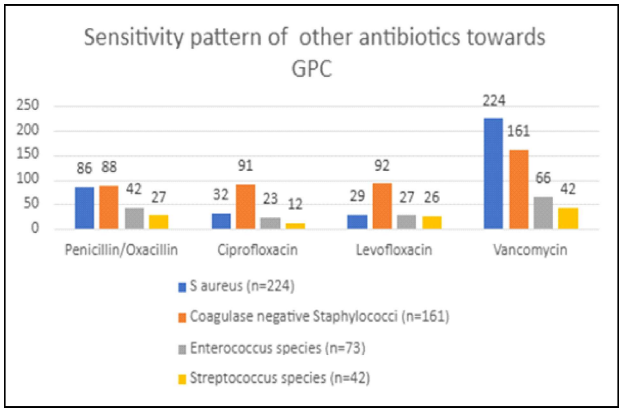

Figure III : Sensitivity Pattern of other Antibiotics towards Gram Positive Cocci

and III).

Abbreviations used: GPC- Gram Positive Cocci, MSSA- *Methicillin Sensitive Staphylococcus aureus*, VRE- Vancomycin Resistant Enterococcus, CONS- Coagulase Negative Staphylococcus.

Abbreviations used: GPC- Gram Positive Cocci

Discussion

The global burden of infections caused by multidrug-resistant Gram-positive organisms continues to rise and represents a major threat, particularly for critically ill and immunocompromised patients[8]. Currently available anti-MRSA agents such as vancomycin, teicoplanin, daptomycin, linezolid, quinupristin-dalfopristin, and tigecycline are associated with several limitations and safety concerns in high-risk patients[10]. Multiple studies have demonstrated the superior in-vitro activity of levonadifloxacin against multidrug-resistant Gram-positive cocci[11,12].

In our study, most isolates were recovered from pus and tissue specimens of patients with surgical site infections, diabetic foot ulcers, abscesses, cellulitis, and pustular lesions. *Staphylococcus aureus* and *Streptococcus pyogenes* are well-established causative agents of skin and soft tissue infections (SSTIs)[13,14].

Overall susceptibility to levonadifloxacin in our study was 84%, with a higher susceptibility of 93% among MRSA isolates. Previous Indian studies have reported even higher susceptibility rates. Qureshi et al. (2021) and Vinayan et al. (2022) reported 100% susceptibility of MRSA isolates, while Siddiqui et al. (2020) reported 100% susceptibility among all Gram-positive cocci[10,15,16]. Bakthavatchalam et al. (2020), in a multicentric study involving 15 hospitals across India, reported a susceptibility rate of 98.7%[17].

The comparatively lower susceptibility observed in our study may be attributed to the larger and more diverse sample size, which included multiple species such as *Staphylococcus*, *Streptococcus*, and *Enterococcus*. Many earlier studies focused primarily on MRSA alone. Nevertheless, 96% of pus isolates in our study were susceptible to levonadifloxacin, supporting its utility in ABSSSI.

A real-world study by Mehta et al. demonstrated clinical improvement in 82% of ABSSSI patients within 72–96 hours of levonadifloxacin therapy[8].

Conclusion

Our study demonstrates a slight decline in levonadifloxacin susceptibility among Gram-positive cocci compared with previously published data. Although

levonadifloxacin is a relatively new antimicrobial agent and is not yet widely used, the early emergence of resistance is a matter of concern. Therefore, antimicrobial susceptibility testing should be performed prior to prescribing levonadifloxacin to ensure optimal therapeutic efficacy.

Financial Support and Sponsorship : Nil
Conflict of Interest: Nil

References

1. Patel FM, Vegad MM. Prevalence of nosocomial infections by multidrug resistant organisms inpatients admitted to the critical care area of the Regional Cancer Center,Gujarat, India..SLJID. 2019; 9(2):129–40.
2. Vazquez-Guillamet C, Kollef MH. Treatment of Gram-positive infections in critically ill patients. BMC Infect Dis. 2014;14:92.
3. Mamtora D, Saseedharan S, Rampal R, Joshi P, Bhalekar P, Ahdal J et al. In Vitro activity of a Novel Benzoquinolizine Antibiotic, Levonadifloxacin (WCK 771) against Blood Stream Gram-Positive Isolates from a Tertiary Care Hospital. J Lab Physicians. 2020;12(3):230-2.
4. Patil SS, Suresh KP, Shinduja R, Amachawadi RG, Chandrashekar S, Pradeep S, et al. Prevalence of Methicillin-resistant *Staphylococcus aureus* in India: A Systematic Review and Meta-analysis. Oman Med J. 2022;37(4):440.
5. Kaur J, Singh H, Sethi T. Emerging trends in antimicrobial resistance in bloodstream infections: multicentric longitudinal study in India (2017–2022). The Lancet Regional Health-Southeast Asia. 2024;26.
6. Zou F, Cui Z, Lou S, Ou Y, Zhu C, Shu C, et al. Adverse drug events associated with linezolid administration: a real-world pharmacovigilance study from 2004 to 2023 using the FAERS database. Front Pharmacol. 2024;15:1338902.
7. Bakthavatchalam YD, Rao SV, Isaac B, Manesh A, Nambi S, Swaminathan S, et al. A comparative assessment of clinical, pharmacological, and antimicrobial profile of novel anti-methicillin-resistant *Staphylococcus aureus* agent levonadifloxacin: Therapeutic role in nosocomial and community infections. Indian J Med Microbiol. 2019;37:478-87
8. Mehta KD, Sharma JB, Anand A, Reddy N PK, Kadam P, Debnath K et al. Real-World Evidence of Efficacy and Safety of Levonadifloxacin (Oral and IV) in the Management of Acute Bacterial Skin and Skin Structure Infections (ABSSSI): Findings of a Retrospective, Multi-Center Study. Cureus. 2022;14(4):24299.
9. Performance standards for antimicrobial susceptibility testing. 34th Edition. Clinical and Laboratory; 2024.
10. Vinayan S, Sistla S, Manoharan M, Walia K, Sugumar M. In vitro efficacy of levonadifloxacin against methicillin-resistant *Staphylococcus aureus* (MRSA) including hVISA isolates collected across India. Indian J Med Microbiol. 2025;53:100788.
11. Veeraraghavan B, Bakthavatchalam YD, Manesh A, Lal B, Swaminathan S, Ansari A et al. India-discovered levonadifloxacin & alalevonadifloxacin: A review on susceptibility testing methods, CLSI quality control and breakpoints along with a brief account of their emerging therapeutic profile as a novel standard-of-care. Indian J Med Microbiol. 2023;41:71-80.
12. Saseedharan S, Dubey D, Singh RK, Zirpe K, Choudhuri AH, Mukherjee DN et al. Treatment challenges in the management of difficult-to-treat gram-positive infections: A consensus view apropos therapeutic role of novel anti-MRSA antibiotics, levonadifloxacin (IV) and alalevonadifloxacin (oral). Indian J Med Microbiol. 2024;47:100528.
13. Woodford N, Livermore DM. Infections caused by Gram-positive bacteria: a review of the global challenge. Journal of Infection.2009;59:S4–S16.
14. Del Giudice P. Skin Infections Caused by *Staphylococcus aureus*. ActaDermVenereol. 2020;100(9):adv00110.
15. Qureshi D, Gandham NR, Das NK, Vyawahare CR, Bhaumik S, Kannuri S, *et al.* Susceptibility of Contemporary *Staphylococcus aureus* Isolates to a Novel Antibiotic Levonadifloxacin: A Report from a Tertiary Care Center. Med J DY Patil Vidyapeeth.2023; 16(6): 941-3.
16. Siddiqui T, Shamim R, Patel SS,Sahu C. Levonadifloxacin: A Novel Approved Drug Exhibiting Potent In vitro Activity against Gram Positive Bacterial Isolates from Patients Admitted in Intensive Care Units. Journal of Clinical and Diagnostic Research. 2021;15(7):26-9.
17. Bakthavatchalam YD, Shankar A, Muniyasamy R, Peter JV, Marcus Z, Triplicane Dwarakanathan H, et al. Levonadifloxacin, a recently approved benzoquinolizine fluoroquinolone, exhibits potent *in vitro* activity against contemporary *Staphylococcus aureus* isolates and Bengal Bay clone isolates collected from a large Indian tertiary care hospital. J Antimicrob Chemother. 2020;75(8):2156-9.