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Review Article

A comprehensive review of ciprofloxacin: Clinical pharmacology

Vijay Gaikwad[1]*

[1]Dept. of Pharmacy, CAYMET's Siddhant College of Pharmacy, Pune, Maharashtra, India.

Abstract

Ciprofloxacin, a fluoroquinolone antibiotic, has been a cornerstone in the treatment of various bacterial infections for decades. This review provides a comprehensive analysis of the pharmacology, clinical uses, efficacy, safety profile, and considerations associated with ciprofloxacin tablets. The pharmacological properties of ciprofloxacin, including its mechanism of action, spectrum of activity, and pharmacokinetics, are discussed. Clinical indications for ciprofloxacin use, ranging from respiratory and urinary tract infections to skin and soft tissue infections, are delineated, with emphasis on its efficacy compared to alternative antibiotics. Additionally, safety considerations, including common and serious adverse effects, contraindications, and drug interactions, are outlined. Special populations such as pediatric, geriatric, pregnant, and breastfeeding patients are addressed, along with dosing considerations and formulations available. By synthesizing evidence from clinical trials, post-marketing surveillance, and pharmacovigilance data, this review aims to provide clinicians and researchers with a comprehensive understanding of the role of ciprofloxacin tablets in contemporary medical practice, along with insights into optimizing its use while mitigating associated risks.

Keywords: Ciprofloxacin, Tablets, Clinical pharmacology, Safety, Efficacy, Uses

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1. Introduction

Ciprofloxacin, a potent fluoroquinolone antibiotic, has been widely used for decades in the treatment of various bacterial infections. Its broad spectrum of activity and oral bioavailability make it a popular choice among healthcare professionals (Mandell et al., 2020). Ciprofloxacin works by inhibiting DNA gyrase and topoisomerase IV, two essential enzymes for bacterial DNA replication and transcription, leading to bacterial cell death.[1] The drug has a broad spectrum of activity, covering both Gram-positive and Gram-negative bacteria, including common pathogens such as Escherichia coli, Klebsiella pneumoniae, Staphylococcus aureus, and Streptococcus pneumoniae.

However, concerns have emerged regarding its safety profile and the development of antimicrobial resistance. Adverse effects associated with ciprofloxacin include gastrointestinal symptoms, tendon rupture, peripheral neuropathy, central nervous system effects, QT prolongation, and photosensitivity. Additionally, the use of ciprofloxacin in certain populations, such as pediatric, geriatric, pregnant, and breastfeeding patients, requires careful consideration due to potential risks.

This review aims to provide a concise overview of ciprofloxacin tablets, including their pharmacology, clinical uses, efficacy, and safety considerations. By synthesizing evidence from clinical trials and post-marketing surveillance, we aim to offer insights into optimizing the use of ciprofloxacin tablets in clinical practice while minimizing associated risks.

2. Pharmacology

Ciprofloxacin's mechanism of action involves inhibiting two essential bacterial enzymes, DNA gyrase and topoisomerase IV, which are responsible for DNA replication and transcription. Inhibition of these enzymes leads to bacterial cell death (Mandell et al., 2020). The drug has a broad spectrum of activity, covering both Gram-positive and Gram-negative bacteria, including common pathogens such as

*Corresponding author: Vijay Gaikwad
Email: vijaysg2002@gmail.com

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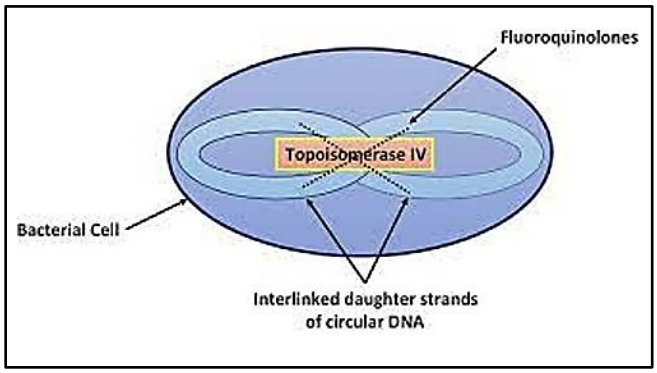
Escherichia coli, Klebsiella pneumoniae, Staphylococcus aureus, and Streptococcus pneumoniae (Mandell et al., 2020). Ciprofloxacin is well absorbed orally, with peak plasma concentrations achieved within 1-2 hours after administration. It has a volume of distribution of approximately 2-3 L/kg, indicating good tissue distribution (Mandell et al., 2020). The drug is primarily excreted unchanged in the urine, with a terminal elimination half-life of approximately 4-7 hours (Mandell et al., 2020).



3. Clinical Applications

Ciprofloxacin is indicated for the treatment of various bacterial infections, including urinary tract infections (UTIs), respiratory tract infections, skin and soft tissue infections, and gastrointestinal infections (Mandell et al., 2020).

Urinary Tract Infections (UTIs): Ciprofloxacin is commonly used to treat uncomplicated and complicated UTIs caused by susceptible bacteria, including Escherichia coli, Klebsiella pneumoniae, Proteus mirabilis, and Enterococcus species (Mandell et al., 2020). A meta-analysis by Wang et al. (2018)[7] found that ciprofloxacin was as effective as trimethoprim-sulfamethoxazole in treating uncomplicated UTIs, with comparable cure rates and adverse effect profiles.

Respiratory Tract Infections: Ciprofloxacin is effective in treating respiratory tract infections such as acute exacerbations of chronic bronchitis, community-acquired pneumonia, and acute bacterial sinusitis caused by susceptible pathogens including Haemophilus influenzae, Moraxella catarrhalis, Streptococcus pneumoniae, and atypical pathogens like Mycoplasma pneumoniae and Legionella pneumophila (Mandell et al., 2020). A randomized controlled trial by File et al. (1997)[2] found that ciprofloxacin was non-inferior to amoxicillin-clavulanate in the treatment of acute exacerbations of chronic bronchitis.

Skin and Soft Tissue Infections: Ciprofloxacin is indicated for the treatment of skin and soft tissue infections caused by susceptible bacteria, including Staphylococcus aureus, Streptococcus pyogenes, and Enterobacter species (Mandell et al., 2020). A randomized controlled trial by Stein et al. (1999)[6] found that ciprofloxacin was as effective as ceftriaxone in the treatment of complicated skin and soft tissue infections.

Gastrointestinal Infections: Ciprofloxacin can be used to treat gastrointestinal infections such as infectious diarrhea and bacterial gastroenteritis caused by pathogens such as Salmonella, Shigella, Campylobacter, and enterotoxigenic Escherichia coli (ETEC) (Mandell et al., 2020). A randomized controlled trial by Guerrant et al. (2001)[3] found that ciprofloxacin was more effective than placebo in resolving diarrhea caused by ETEC.

4. Safety

Ciprofloxacin is generally well-tolerated, but like all medications, it carries a risk of adverse effects.

Common Adverse Effects: The most commonly reported adverse effects of ciprofloxacin include gastrointestinal symptoms such as nausea, diarrhea, and abdominal pain (Mandell et al., 2020). Other common side effects may include headache, dizziness, insomnia, and rash (Mandell et al., 2020).

Tendon Rupture and Tendinopathy: Ciprofloxacin has been associated with an increased risk of tendon rupture, particularly in the Achilles tendon (Mandell et al., 2020). Tendonitis and tendon rupture can occur within hours to weeks after starting treatment and may be more common in older adults, patients receiving corticosteroids, and those with a history of tendon disorders (Mandell et al., 2020).

Peripheral Neuropathy: Rare cases of peripheral neuropathy, including sensory or sensorimotor axonal polyneuropathy, have been reported with the use of fluoroquinolone antibiotics, including ciprofloxacin (Mandell et al., 2020). Symptoms may include pain, burning, tingling, numbness, and weakness, which can be irreversible in some cases (Mandell et al., 2020).

Central Nervous System Effects: Ciprofloxacin may rarely cause central nervous system adverse effects such as seizures, hallucinations, confusion, and tremors (Mandell et al., 2020). These effects are more common in elderly patients and those with a history of CNS disorders (Mandell et al., 2020).

QT Prolongation and Cardiac Arrhythmias: Ciprofloxacin has the potential to prolong the QT interval, which may lead to cardiac arrhythmias such as torsades de pointes (Mandell et al., 2020). This risk is higher in patients with preexisting QT prolongation, electrolyte imbalances, or those taking other medications that prolong the QT interval (Mandell et al., 2020).

Photosensitivity: Ciprofloxacin can increase sensitivity to sunlight (photosensitivity), leading to sunburn reactions or skin rash (Mandell et al., 2020). Patients should be advised to

avoid excessive sunlight exposure and use sunscreen while taking ciprofloxacin.

5. Special Populations

Pediatric Patients: Ciprofloxacin is not recommended as a first-line antibiotic in pediatric patients due to the risk of joint damage (Mandell et al., 2020). However, it may be used in certain circumstances, such as the treatment of complicated UTIs or infections caused by multidrug-resistant bacteria (Mandell et al., 2020).

Geriatric Patients: Ciprofloxacin should be used with caution in geriatric patients due to the increased risk of adverse effects, including tendon rupture and peripheral neuropathy (Mandell et al., 2020).[5]

Pregnant and Breastfeeding Patients: Ciprofloxacin is classified as a category C drug during pregnancy, meaning that it should be used during pregnancy only if the potential benefit justifies the potential risk to the fetus (Mandell et al., 2020). Ciprofloxacin is excreted in breast milk and should be used with caution in breastfeeding mothers (Mandell et al., 2020).

6. Dosing Considerations

Ciprofloxacin is available in various formulations, including tablets, oral suspension, and intravenous solution (Mandell et al., 2020). The recommended dosage varies depending on the indication and the patient's renal function (Mandell et al., 2020). Dosage adjustments may be necessary in patients with impaired renal function (Mandell et al., 2020).

7. Marketed Preparations

Ciprofloxacin is available under various brand names, including Cipracin, Cipstar, and Ciprogen (Lexi-Comp, 2022).[4]

8. Conclusion

Ciprofloxacin stands as a cornerstone antibiotic for treating diverse bacterial infections due to its broad spectrum of activity and convenient formulations. However, its usage demands cautious consideration of potential adverse effects like tendon rupture and antibiotic resistance. It's crucial for healthcare providers to balance efficacy with safety, emphasizing patient education and antimicrobial stewardship. With ongoing surveillance and research, optimizing ciprofloxacin use ensures effective treatment while safeguarding against emerging challenges in bacterial resistance.

9. Source of Funding

None.

10. Conflict of Interest

None.

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