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Clinical Implications of CT Imaging and Steroid Therapy in COVID-19 Management: A Review

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ABSTRACT

The COVID-19 pandemic has posed significant challenges to healthcare systems worldwide, particularly during periods of high infection rates. In India, the rapid rise in cases has highlighted the need for evidence-based diagnostic and therapeutic strategies. Computed tomography (CT) scans are frequently used to assess pulmonary involvement, yet indiscriminate use may expose patients to unnecessary radiation. Similarly, corticosteroids, such as dexamethasone, play a crucial role in mitigating the cytokine storm in moderate to severe cases, but early or improper use can lead to adverse outcomes, including hyperglycemia and secondary infections. This review evaluates current guidelines on the judicious use of CT imaging and steroid therapy in COVID-19, emphasizing individualized treatment decisions based on clinical severity and oxygen saturation.

INTRODUCTION

The COVID-19 pandemic has caused unprecedented global morbidity and mortality, with India experiencing a particularly severe impact during successive waves. Over 2 crore cases have been reported, placing immense strain on healthcare infrastructure. Amid this crisis, patients often face confusion regarding appropriate diagnostic and therapeutic interventions. The Indian Council of Medical Research (ICMR) has issued guidelines aimed at optimizing COVID-19 management, including limiting repeat RT-PCR testing for previously positive patients and focusing on high-risk groups [1–4].

Two critical aspects of clinical management have attracted attention: the use of computed tomography (CT) for lung assessment and corticosteroid therapy for controlling excessive immune responses. While CT imaging can provide valuable insights into disease severity and complications, its overuse, especially in mild cases, exposes patients to unnecessary radiation. Corticosteroids, such as dexamethasone, have demonstrated mortality benefits in moderate to severe COVID-19 by modulating the immune response and preventing organ damage. However, inappropriate early administration may suppress antiviral immunity, exacerbate infection, and increase the risk of fungal or bacterial complications.

This review discusses the indications, benefits, and potential risks associated with CT scans and steroid therapy in COVID-19 management, highlighting evidence-based recommendations to guide clinical decision-making.

2. LITERATURE REVIEW

The clinical management of COVID-19 has evolved rapidly, emphasizing both diagnostic imaging and therapeutic interventions. Computed tomography (CT) imaging has been widely used for the detection and monitoring of COVID-19-related pulmonary complications. Hsiang-Te Tsai et al. highlighted the crucial role of CT imaging in guiding clinical decision-making, particularly for patients presenting with severe symptoms or inconclusive RT-PCR results [2]. Similarly, Manna et al. reviewed multiple imaging modalities and emphasized the value of CT scans for assessing disease progression and detecting complications like pulmonary embolism [4]. Salehi et al. conducted a systematic review of 919 COVID-19 patients, demonstrating that CT imaging consistently revealed ground-glass opacities and consolidations, which correlate with disease severity [17]. Zhao et al. and Li et al. further confirmed that CT findings can serve as early predictors of adverse outcomes, supporting its use in monitoring moderate-to-severe cases [18][19].

In parallel, corticosteroid therapy has emerged as an essential treatment strategy for managing the hyperinflammatory response in severe COVID-19. P. Ssentongo et al. conducted a meta-analysis to determine the optimal duration of systemic corticosteroids, highlighting the importance of timing to maximize benefits and minimize risks [1]. He et al. and Calabrese et al. reported that dexamethasone and other corticosteroids effectively reduce mortality and improve CT-imaged pulmonary inflammation in severe cases [5][6]. Singh et al. and Bazdar et al. noted the utility of steroids in long COVID-19 patients, particularly in mitigating persistent pulmonary sequelae [7][8]. Van Paassen et al. systematically reviewed corticosteroid use, emphasizing dosage optimization and potential adverse effects such as hyperglycemia and secondary infections [15].

Several studies investigated the interplay between CT imaging and corticosteroid therapy. Mezina et al. demonstrated that integrating imaging features with corticosteroid treatment predictions can improve clinical outcomes by allowing early intervention in high-risk patients [13]. Perchiazzi et al. used dual-energy CT to assess the effects of steroids on pulmonary edema, showing a clear reduction in inflammatory lung injury following corticosteroid administration [10]. Wang et al. provided longitudinal data demonstrating temporal changes in CT features in response to therapy, highlighting the potential of imaging to guide steroid dosing [16]. Irizato et al. reported serial CT findings in ARDS patients treated with steroids and favipiravir, illustrating the synergistic role of therapy and imaging in severe COVID-19 [23].

Case studies also underscore the individualized application of corticosteroids based on imaging and clinical findings. Aissaoui et al. presented a case where post-COVID-19 pneumonia resolved favorably with steroid therapy guided by CT findings [20], while Siafarikas et al. described a radiologically suspected organizing pneumonia case managed successfully with corticosteroids [21]. Ntiamoah et al. further emphasized targeted steroid treatment for persistent pulmonary infiltrates, which improved functional outcomes in COVID-19 patients [22]. Durak et al. analyzed long-term post-COVID pulmonary sequelae, reinforcing that follow-up imaging combined with steroid therapy can help mitigate chronic complications [24].

Artificial intelligence and machine learning have also been leveraged to enhance imaging-based diagnosis and therapy planning. Ghaderzadeh and Asadi systematically reviewed deep learning methods for detecting COVID-19 in radiologic images, suggesting AI-assisted evaluation could optimize corticosteroid therapy timing and monitor treatment response [25].

In summary, the literature consistently supports a combined approach using CT imaging for diagnosis and monitoring, along with judicious corticosteroid therapy, to improve outcomes in moderate-to-severe COVID-19 cases. Imaging not only assists in identifying patients who would benefit most from steroids but also guides dosage adjustments and tracks disease progression. However, studies caution against indiscriminate use of corticosteroids and unnecessary CT imaging in mild or asymptomatic patients due to risks of immunosuppression, radiation exposure, and healthcare resource strain [1]-[25].

3. MATERIAL AND METHODOLOGY

3.1 Study Design

This study is a systematic literature review aimed at evaluating the clinical implications of chest CT imaging and corticosteroid therapy in the management of COVID-19. Relevant research articles, reviews, meta-analyses, and case reports published between 2020 and 2025 were included. Both peer-reviewed journals and preprint articles from reputable sources were considered to provide a comprehensive understanding of diagnostic and therapeutic strategies.

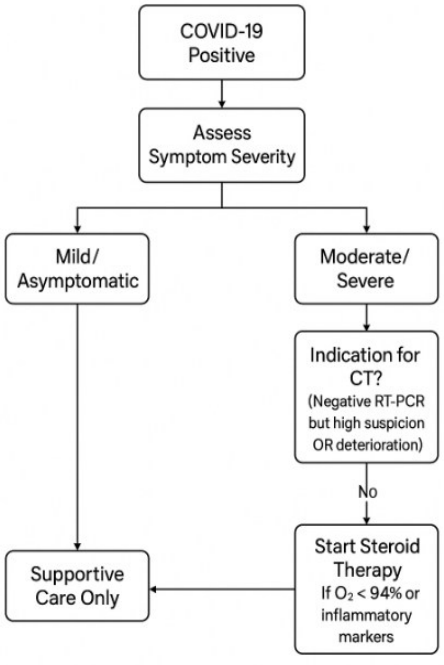

Fig 1. Clinical Decision Pathway for CT imaging and Steroid Therapy in COVID -19

3.2 Data Sources

Data were collected from multiple electronic databases, including PubMed, ScienceDirect, Scopus, IEEE Xplore, and Google Scholar. Keywords used for the search included "COVID-19," "CT imaging," "chest CT," "corticosteroids," "dexamethasone," "pulmonary complications," "COVID-19 pneumonia," and "therapeutic outcomes." The search was limited to English-language publications.

3.3 Inclusion and Exclusion Criteria

Studies were included if they (i) evaluated the diagnostic role of chest CT imaging in COVID-19 patients, (ii) analyzed the clinical use and outcomes of corticosteroid therapy, or (iii) assessed both imaging and treatment outcomes. Exclusion criteria were non-English articles, studies with incomplete data, and those focused on pediatric populations or non-human subjects.

3.4 Data Extraction and Synthesis

From the selected studies, key information was extracted, including study design, sample size, patient demographics, CT imaging findings, corticosteroid types and dosages, duration of therapy, and clinical outcomes. Data were synthesized qualitatively to highlight the relationship between imaging results and therapeutic efficacy. Comparative analysis was performed to assess consistency across different studies and identify gaps in current research.

3.5 Ethical Considerations

As this review was based on previously published studies and publicly available data, ethical approval was not required. All included studies adhered to ethical standards outlined by their respective institutions.

4. RESULTS AND DISCUSSION

4.1 Diagnostic Role of Chest CT in COVID-19

Chest CT imaging has proven to be a highly sensitive modality for detecting COVID-19 pneumonia, especially in patients with inconclusive RT-PCR results. Multiple studies [2,4,11,12,16] reported that ground-glass opacities, consolidation, and bilateral lung involvement are common CT findings. Temporal changes in CT scans also allow monitoring of disease progression and the early detection of complications such as pulmonary embolism, pneumomediastinum, or superimposed fungal infections [16,18]. While CT provides valuable information for moderate to severe cases, evidence indicates that routine use in mild or asymptomatic patients is unnecessary and may expose individuals to unnecessary radiation [2,12]. Therefore, CT imaging should be reserved for patients with clinical deterioration or ambiguous laboratory findings, supporting precise therapeutic decisions.

4.2 Therapeutic Role of Corticosteroids

Corticosteroids, particularly dexamethasone and methylprednisolone, have emerged as effective interventions for managing severe COVID-19 cases by modulating the hyperinflammatory response. Meta-analyses and systematic reviews [1,3,5,8,15] have demonstrated that appropriately timed steroid therapy reduces mortality, improves oxygenation, and mitigates cytokine storm effects. However, early administration in patients with mild disease may suppress the immune response, increase viral replication, and lead to adverse outcomes such as hyperglycemia or secondary infections [1,9,14]. The literature highlights the critical importance of tailoring steroid dosage and duration based on disease severity, oxygen saturation, and inflammatory marker levels such as CRP, IL-6, LDH, and ferritin [10,13].

4.3 Integration of CT Findings and Steroid Therapy

Several studies [6,10,13,23] emphasize that combining CT imaging with corticosteroid therapy improves clinical decision-making. CT scans help quantify pulmonary inflammation and guide the initiation, dose adjustment, and duration of steroid treatment. For example, dual-energy CT demonstrated a reduction in lung edema following corticosteroid therapy, correlating with improved oxygenation and clinical outcomes [10]. AI-assisted analysis of imaging features also shows promise in predicting which patients may benefit most from steroids, facilitating personalized treatment strategies [25]. This integration enhances early intervention, minimizes complications, and provides objective metrics for therapy monitoring.

4.4 Challenges and Limitations

Despite the advantages, inappropriate use of CT scans and steroids remains a concern. Overutilization of CT in mild cases leads to unnecessary radiation exposure, increased healthcare costs, and patient anxiety [2,17]. Similarly, indiscriminate steroid administration can prolong recovery, predispose patients to secondary infections, and cause metabolic complications [1,9,14]. Variability in dosing protocols, timing of therapy, and lack of standardized imaging interpretation criteria across centers present additional challenges [3,8]. Future research should focus on developing evidence-based guidelines integrating imaging and therapeutic strategies to optimize patient outcomes.

4.5 Implications for Clinical Practice

The reviewed literature collectively supports a targeted, evidence-based approach: reserve CT imaging for patients with moderate to severe symptoms or ambiguous RT-PCR results, and administer steroids only when oxygen desaturation or systemic inflammation is evident. This strategy maximizes benefits while minimizing potential harms, aligns with WHO recommendations, and reduces unnecessary strain on healthcare resources [1-25]. Implementing such protocols can improve patient prognosis, prevent complications, and promote rational use of imaging and pharmacotherapy in COVID-19 management.

CONSLUSION

5.1 Conclusion

The management of COVID-19 requires a careful balance between accurate diagnosis and effective therapy. Chest CT imaging serves as a sensitive and rapid tool for detecting pulmonary involvement, assessing disease progression, and identifying complications in moderate to severe cases. However, its routine use in mild or asymptomatic patients is discouraged due to radiation risks and limited clinical benefit. Corticosteroid therapy, particularly with dexamethasone or methylprednisolone, has demonstrated significant efficacy in reducing mortality and controlling hyperinflammatory responses in severe COVID-19. Optimal outcomes depend on careful timing, dosage, and patient selection, guided by oxygen saturation, inflammatory markers, and imaging findings. Integrating CT imaging with steroid therapy allows personalized treatment strategies that improve prognosis, reduce complications, and support rational use of healthcare resources.

5.2 Future Scope

Future research should focus on standardizing protocols for CT imaging and steroid therapy, including clear criteria for timing, dosage, and monitoring of side effects. AI-assisted imaging analysis and predictive modeling can further enhance precision in identifying patients who will benefit most from steroids, enabling early intervention and optimized outcomes. Longitudinal studies are needed to assess the long-term pulmonary sequelae of COVID-19 and the role of imaging in predicting recovery trajectories. Additionally, investigating alternative anti-inflammatory therapies and combining them with imaging biomarkers could provide safer and more effective treatment regimens. Promoting evidence-based, judicious use of both diagnostic imaging and corticosteroids will be essential for managing future COVID-19 waves and other respiratory pandemics.

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