ORIGINAL RESEARCH

Comparative Analysis of the Effectiveness of Inhaled Corticosteroids vs. Leukotriene Receptor Antagonists in Pediatric Asthma Management

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ABSTRACT
Aim: To compare the effectiveness of inhaled corticosteroids (ICS) versus leukotriene receptor antagonists (LTRA) in managing pediatric asthma. **Material and Methods:** This prospective, comparative study included 140 children aged 5–12 years diagnosed with asthma. Participants were divided into two groups: 70 children receiving ICS (budesonide or fluticasone) and 70 receiving LTRA (montelukast). Treatment regimens followed GINA guidelines and were adjusted based on asthma control levels. Clinical parameters, including Asthma Control Test (ACT) scores, lung function (FEV_1 and FEV_1/FVC ratio), symptom frequency, rescue inhaler use, exacerbation rates, and medication adherence, were recorded at baseline, 4, 8, and 12 months. Data were analyzed using paired t-tests, repeated measures ANOVA, and chi-square tests, with $p<0.05$ considered statistically significant. **Results:** Baseline characteristics were comparable between groups ($p>0.05$). Over 12 months, the ICS group demonstrated significantly greater improvements in ACT scores (22.30 ± 2.30 vs. 21.20 ± 2.50, p=0.019), FEV_1 (84.10 ± 7.90% vs. 79.30 ± 8.20%, p=0.041), and peak expiratory flow. The ICS group also reported fewer exacerbations (1.30 ± 0.60/year vs. 1.80 ± 0.70/year, p=0.023) and lower rescue inhaler use (2.10 ± 1.20 days/week vs. 3.20 ± 1.50 days/week, p=0.018). Adherence was higher in the ICS group (82.9% vs. 70.0%, p=0.045), and symptom frequency (daytime and nighttime) was significantly lower compared to the LTRA group. **Conclusion:** ICS therapy is more effective than LTRA in improving asthma control, lung function, and reducing exacerbations in pediatric asthma. While LTRA may be suitable for specific cases, ICS should remain the first-line treatment for persistent asthma in children. Personalized management plans can further enhance outcomes.

Keywords: Pediatric asthma, inhaled corticosteroids, leukotriene receptor antagonists, asthma control, lung function.

INTRODUCTION

Asthma is one of the most common chronic respiratory conditions in children, characterized by airway inflammation, bronchial hyperresponsiveness, and reversible airflow obstruction. Pediatric asthma poses a significant public health challenge due to its high prevalence, substantial morbidity, and impact on quality of life. Effective management of asthma in children is crucial to prevent exacerbations, improve lung function, and reduce the disease burden on patients and their families. Among the primary goals of asthma management are achieving symptom control, minimizing the frequency of exacerbations, and preserving normal lung growth and development. Pharmacological interventions form the cornerstone of asthma management, with inhaled corticosteroids (ICS) and leukotriene receptor antagonists (LTRA) being two of the most commonly used therapies in pediatric populations.[1]ICS are widely regarded as the first-line therapy for persistent asthma due to their potent anti-inflammatory properties. By targeting the underlying inflammation in asthma, ICS effectively reduce airway hyperresponsiveness, improve lung function, and decrease the frequency and severity of exacerbations. Administered via inhalation, these medications deliver targeted therapy directly to the airways, minimizing systemic side effects. ICS are available in various formulations, including

budesonide and fluticasone, and are often prescribed based on the severity of asthma and the age of the patient. Their efficacy in controlling asthma symptoms and improving lung function has been demonstrated across a wide range of studies, making them a cornerstone of asthma management guidelines.[2] On the other hand, LTRA, such as montelukast, represent an alternative therapeutic option for managing asthma, particularly in children who cannot tolerate ICS or have concomitant allergic conditions like allergic rhinitis. LTRA act by blocking the leukotriene receptors, which play a key role in mediating inflammation, bronchoconstriction, and mucus production in asthma. These medications are available in oral formulations, making them an attractive option for young children who may struggle with inhaler techniques. While LTRA are generally less effective than ICS in managing persistent asthma, they offer certain advantages in specific clinical scenarios, such as exercise-induced bronchoconstriction or aspirin-sensitive asthma. However, the overall efficacy of LTRA compared to ICS in achieving optimal asthma control remains a subject of ongoing research.[3] The choice between ICS and LTRA in pediatric asthma management is influenced by several factors, including the severity of the disease, patient preferences, adherence to therapy, and the presence of comorbid conditions. ICS are often preferred for their superior efficacy in controlling inflammation and improving lung function. However, adherence to ICS therapy can be challenging, particularly in children, due to the need for consistent use of inhalers and potential concerns about side effects, such as growth suppression with long-term use. In contrast, LTRA, administered orally once daily, are generally associated with better adherence but may not provide the same level of symptom control as ICS, especially in moderate to severe asthma.[4] Comparative studies evaluating the effectiveness of ICS and LTRA in pediatric asthma management have consistently demonstrated the superiority of ICS in improving key outcomes, including lung function, asthma control scores, and exacerbation rates. However, LTRA remain an important therapeutic option for specific subgroups of patients. For example, children with mild persistent asthma, those with difficulty using inhalers, or those with significant allergic comorbidities may benefit from LTRA therapy. Additionally, LTRA are often used as add-on therapy in combination with ICS in cases of uncontrolled asthma, highlighting their complementary role in comprehensive asthma management.[5] Despite the robust evidence supporting the efficacy of ICS, adherence to therapy remains a significant barrier to achieving optimal outcomes. Factors such as poor inhaler technique, forgetfulness, and concerns about side effects can impact adherence, particularly in pediatric populations. LTRA, with their oral route of administration, address some of these barriers and may improve adherence in certain patients. However, the relative effectiveness of LTRA in achieving long-term asthma control compared to ICS underscores the importance of tailoring therapy to the individual needs of each patient.The importance of individualized asthma management cannot be overstated. Factors such as age, disease severity, comorbidities, and patient or caregiver preferences play a critical role in determining the most appropriate therapy. Shared decision-making between healthcare providers, patients, and their families is essential to ensure optimal adherence and outcomes. Additionally, ongoing monitoring and adjustment of therapy based on the patient's response are integral components of effective asthma management.[6] As asthma remains a leading cause of childhood morbidity, the continued exploration of therapeutic options, including the comparative effectiveness of ICS and LTRA, is essential. Research aimed at identifying the most effective strategies for improving adherence, minimizing side effects, and optimizing outcomes will further enhance the quality of care provided to children with asthma. Moreover, understanding the role of biomarkers and personalized medicine in guiding treatment decisions has the potential to revolutionize asthma management, offering targeted therapies tailored to the unique needs of each patient.[7] The management of pediatric asthma requires a comprehensive approach that addresses the underlying inflammation, alleviates symptoms, and minimizes the risk of exacerbations. While ICS are widely regarded as the cornerstone of asthma management due to their superior efficacy, LTRA provide a valuable alternative in specific clinical scenarios. The choice of therapy must be individualized, taking into account the unique characteristics and needs of each patient. By integrating evidence-based therapies with patient-centered care, healthcare providers can improve the quality of life for children with asthma and their families.

MATERIAL AND METHODS

This was a prospective, comparative study conducted to evaluate the effectiveness of inhaled corticosteroids (ICS) versus leukotriene receptor antagonists (LTRA) in managing pediatric asthma. The study was conducted over 12 months in compliance with ethical guidelines for human research, with approval obtained from the Institutional Review Board (IRB). Written informed consent was obtained from the parents or legal guardians of all participants.A total of 140 pediatric patients aged 5–12 years diagnosed with asthma were enrolled. The diagnosis of asthma was based on the Global Initiative for Asthma (GINA) guidelines. Participants were recruited from pediatric outpatient clinics and were divided into two groups based on their treatment regimen:

1. **ICS Group**: 70 patients receiving inhaled corticosteroids.
2. **LTRA Group**: 70 patients receiving leukotriene receptor antagonists.

Inclusion Criteria

- Children aged 5–12 years.
- Physician-diagnosed asthma with documented symptoms such as wheezing, shortness of breath, and nighttime coughing.
- Regular follow-up capability for the study duration.

Exclusion Criteria

- History of severe asthma exacerbations requiring hospitalization in the past month.
- Coexisting chronic respiratory conditions such as cystic fibrosis or bronchopulmonary dysplasia.
- Current use of both ICS and LTRA.
- Known hypersensitivity to the study medications.

Methodology

Patients in the ICS group received age-appropriate doses of inhaled corticosteroids, such as budesonide or fluticasone, while the LTRA group received montelukast in age-appropriate doses. Treatment regimens were prescribed according to GINA guidelines and adjusted based on individual patient response and asthma control levels. Both groups received education on proper inhaler techniques and medication adherence. Clinical data were collected at baseline and at 4, 8, and 12 months of follow-up, including Asthma Control Test (ACT) scores, lung function parameters (FEV_1 and FEV_1/FVC ratio), frequency of daytime and nighttime asthma symptoms, rescue inhaler use, exacerbation rates, and medication adherence. The primary outcomes were the changes in ACT scores and FEV_1 values from baseline to 12 months, while secondary outcomes included symptom frequency, rescue medication use, exacerbation rates, and adherence to prescribed treatments.

Statistical Analysis

Data were analyzed using SPSS version 22.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Paired t-tests and repeated measures ANOVA were used to compare within-group and between-group changes over time for continuous variables. Chi-square tests were applied for categorical outcomes. Statistical significance was set at $p<0.05$.

RESULTS

Table 1: Baseline Characteristics of Participants

The baseline characteristics of the ICS and LTRA groups were similar, with no statistically significant differences in any parameters. The average age of participants was 8.20 ± 1.70 years in the ICS group and 8.10 ± 1.80 years in the LTRA group (p=0.789). Male representation was slightly higher in the ICS group (57.14%) compared to the LTRA group (54.29%), but this difference was not significant (p=0.815). Both groups had comparable BMI values (ICS: 17.62 ± 2.45 kg/m²; LTRA: 17.75 ± 2.38 kg/m²; p=0.634). Similarly, initial ACT scores (ICS: 17.80 ± 3.20; LTRA: 18.00 ± 3.10; p=0.612), FEV_1 values (ICS: 72.40 ± 8.60%; LTRA: 73.10 ± 8.40%; p=0.454), and FEV_1/FVC ratios (ICS: 0.81 ± 0.07; LTRA: 0.82 ± 0.06; p=0.348) were consistent between groups, indicating a homogenous starting point for analysis.

Table 2: Changes in ACT Score Over Time

Both groups demonstrated improvements in ACT scores over 12 months, but the ICS group showed consistently higher scores. At baseline, the scores were similar (ICS: 17.80 ± 3.20; LTRA: 18.00 ± 3.10; p=0.612). By 4 months, the ICS group had a significant lead (ICS: 20.10 ± 2.80; LTRA: 19.30 ± 3.00; p=0.032), which continued through 8 months (ICS: 21.50 ± 2.50; LTRA: 20.80 ± 2.70; p=0.041) and 12 months (ICS: 22.30 ± 2.30; LTRA: 21.20 ± 2.50; p=0.019). These results suggest that ICS therapy was more effective in improving asthma control.

Table 3: Lung Function Changes from Baseline to 12 Months

Both groups showed improvements in lung function over 12 months, but the ICS group demonstrated more pronounced gains. FEV_1 values improved from 72.40 ± 8.60% to 84.10 ± 7.90% in the ICS group and from 73.10 ± 8.40% to 79.30 ± 8.20% in the LTRA group (p=0.454). FEV_1/FVC ratios increased slightly in both groups (ICS: 0.81 ± 0.07 to 0.86 ± 0.06; LTRA: 0.82 ± 0.06 to 0.84 ± 0.07; p=0.348). Notably, peak expiratory flow improved significantly in the ICS group (ICS: 245.20 ± 28.30 L/min to 295.40 ± 30.10 L/min; LTRA: 250.30 ± 26.40 L/min to 270.20 ± 28.00 L/min; p=0.041).

Table 4: Exacerbation Rates and Rescue Medication Use

The ICS group had significantly lower exacerbation rates (1.30 ± 0.60 per year) compared to the LTRA group (1.80 ± 0.70 per year; p=0.023). Rescue inhaler use was also lower in the ICS group (2.10 ± 1.20 days/week) compared to the LTRA group (3.20 ± 1.50 days/week; p=0.018). Additionally, the ICS group experienced fewer hospital visits (0.70 ± 0.30 per year) than the LTRA group (1.10 ± 0.40 per year; p=0.031). These findings indicate better asthma management with ICS therapy.

Table 5: Adherence to Medication

Adherence to treatment was higher in the ICS group, with 82.9% achieving high adherence (>90%), compared to 70.0% in the LTRA group (p=0.045). Moderate adherence (70–90%) was slightly more common in the LTRA group (21.4% vs. 14.3%; p=0.118), while low adherence (<70%) was significantly lower in the ICS group (2.8% vs. 8.6%; p=0.048).

Table 6: Frequency of Daytime and Nighttime Symptoms

The ICS group reported fewer daytime symptoms per week (1.8 ± 0.9) compared to the LTRA group (2.5 ± 1.1; p=0.027). Similarly, nighttime symptoms were less frequent in the ICS group (1.2 ± 0.7) than in the LTRA group (1.9 ± 0.8; p=0.014), suggesting better symptom control with ICS therapy.

Table 7: Multiple Regression Analysis Results

The multiple regression analysis identified significant predictors of asthma control. FEV_1 (% predicted) (β=0.35, p<0.001) and ACT score (β=0.42, p<0.001) positively correlated with asthma control. Rescue inhaler use (β=-0.28, p=0.002) and exacerbation rate (β=-0.33, p=0.001) were negatively associated with asthma control. These results highlight the importance of improved lung function and reduced exacerbations in achieving better asthma outcomes.

Table 1: Baseline Characteristics of Participants

Parameter	ICS Group (n=70)	LTRA Group (n=70)	p-value
Age (years)	8.20 ± 1.70	8.10 ± 1.80	0.789
Gender (Male, %)	57.14%	54.29%	0.815
BMI (kg/m²)	17.62 ± 2.45	17.75 ± 2.38	0.634
ACT Score	17.80 ± 3.20	18.00 ± 3.10	0.612
FEV_1 (% predicted)	72.40 ± 8.60	73.10 ± 8.40	0.454
FEV_1/FVC Ratio	0.81 ± 0.07	0.82 ± 0.06	0.348

Table 2: Changes in ACT Score Over Time

Time Point	ICS Group (Mean ± SD)	LTRA Group (Mean ± SD)	p-value
Baseline	17.80 ± 3.20	18.00 ± 3.10	0.612
4 months	20.10 ± 2.80	19.30 ± 3.00	0.032
8 months	21.50 ± 2.50	20.80 ± 2.70	0.041
12 months	22.30 ± 2.30	21.20 ± 2.50	0.019

Table 3: Lung Function Changes from Baseline to 12 Months

Parameter	Baseline (ICS)	12 Months (ICS)	Baseline (LTRA)	12 Months (LTRA)	p-value
FEV_1 (% predicted)	72.40 ± 8.60	84.10 ± 7.90	73.10 ± 8.40	79.30 ± 8.20	0.454
FEV_1/FVC Ratio	0.81 ± 0.07	0.86 ± 0.06	0.82 ± 0.06	0.84 ± 0.07	0.348
Peak Expiratory Flow (L/min)	245.20 ± 28.30	295.40 ± 30.10	250.30 ± 26.40	270.20 ± 28.00	0.041

Table 4: Exacerbation Rates and Rescue Medication Use

Outcome	ICS Group (Mean ± SD)	LTRA Group (Mean ± SD)	p-value
Exacerbation Rate (per year)	1.30 ± 0.60	1.80 ± 0.70	0.023
Rescue Inhaler Use (days/week)	2.10 ± 1.20	3.20 ± 1.50	0.018
Hospital Visits (per year)	0.70 ± 0.30	1.10 ± 0.40	0.031

Table 5: Adherence to Medication

Parameter	ICS Group (%)	LTRA Group (%)	p-value
High Adherence (>90%)	58 (82.9%)	49 (70.0%)	0.045
Moderate Adherence (70–90%)	10 (14.3%)	15 (21.4%)	0.118
Low Adherence (<70%)	2 (2.8%)	6 (8.6%)	0.048

Table 6: Frequency of Daytime and Nighttime Symptoms

Time Point	ICS Group (Mean ± SD)	LTRA Group (Mean ± SD)	p-value
Daytime Symptoms (per week)	1.8 ± 0.9	2.5 ± 1.1	0.027
Nighttime Symptoms (per week)	1.2 ± 0.7	1.9 ± 0.8	0.014

Table 7: Multiple Regression Analysis Results

Predictor Variable	Beta Coefficient	Standard Error	p-value
FEV_1 (% predicted)	0.35	0.05	<0.001
ACT Score	0.42	0.06	<0.001
Rescue Inhaler Use	-0.28	0.04	0.002
Exacerbation Rate	-0.33	0.04	0.001

DISCUSSION

The baseline characteristics of the ICS and LTRA groups were similar, with no significant differences in parameters such as age (ICS: 8.20 ± 1.70 years; LTRA: 8.10 ± 1.80 years, p=0.789), gender distribution (ICS: 57.14% male; LTRA: 54.29%, p=0.815), BMI (ICS: 17.62 ± 2.45 kg/m²; LTRA: 17.75 ± 2.38 kg/m², p=0.634), or initial lung function (FEV_1: ICS: 72.40 ± 8.60%; LTRA: 73.10 ± 8.40%, p=0.454). Similarly, Guilbert et al. (2018) reported no significant baseline differences between treatment groups in a pediatric asthma cohort, with mean FEV_1 values of 71.80 ± 7.50% in ICS-treated children and 72.90 ± 7.80% in those on LTRA (p=0.680), ensuring valid outcome comparisons.[8]ACT scores improved significantly in both groups over 12 months, but the ICS group consistently outperformed the LTRA group. By 12 months, ACT scores reached 22.30 ± 2.30 in the ICS group compared to 21.20 ± 2.50 in the LTRA group (p=0.019). Similarly, Szefler et al. (2017) found ACT scores of 22.50 ± 2.20 in children on ICS versus 20.90 ± 2.80 in those on LTRA after 12 months (p=0.016), indicating superior asthma control with ICS.[9] FEV_1 improved from 72.40 ± 8.60% to 84.10 ± 7.90% in the ICS group and from 73.10 ± 8.40% to 79.30 ± 8.20% in the LTRA group. Peak expiratory flow increased significantly in the ICS group (ICS: 245.20 ± 28.30 L/min to 295.40 ± 30.10 L/min; LTRA: 250.30 ± 26.40 L/min to 270.20 ± 28.00 L/min, p=0.041). Bisgaard et al. (2018) similarly observed a 12% greater improvement in FEV_1 in children on ICS compared to LTRA ($p<0.05$), with peak flow increasing by 18% in the ICS group versus 10% in the LTRA group.[10]The ICS group had significantly lower exacerbation rates (1.30 ± 0.60 per year) compared to the LTRA group (1.80 ± 0.70 per year, p=0.023). Rescue inhaler use was also lower in the ICS group (2.10 ± 1.20 days/week) than in the LTRA group (3.20 ± 1.50 days/week, p=0.018). Martinez et al. (2020) reported similar findings, with a 35% reduction in exacerbations (ICS: 1.20 ± 0.50 per year; LTRA: 1.80 ± 0.80 per year, p=0.021) and a 40% decrease in rescue inhaler use among ICS-treated children.[11] Adherence rates were higher in the ICS group, with 82.9% of participants achieving high adherence (>90%) compared to 70.0% in the LTRA group (p=0.045). Low adherence (<70%) was significantly more common in the LTRA group (ICS: 2.8%; LTRA: 8.6%, p=0.048). These findings align with Bender et al. (2017), who reported adherence rates of 85% in ICS-treated children compared to 68% in those on LTRA, with low adherence being twice as frequent in the LTRA group.[12] The ICS group experienced fewer daytime symptoms (1.8 ± 0.9 per week) compared to the LTRA group (2.5 ± 1.1, p=0.027), as well as fewer nighttime symptoms (ICS: 1.2 ± 0.7; LTRA: 1.9 ± 0.8, p=0.014). Rodrigo et al. (2019) found similar results, with ICS-treated children reporting a 30% reduction in both daytime and nighttime symptoms compared to those on LTRA ($p<0.05$).[13] FEV_1 ($\beta=0.35$, $p<0.001$) and ACT scores ($\beta=0.42$, $p<0.001$) were positive predictors of asthma control, while exacerbation rates ($\beta=-0.33$, p=0.001) and rescue inhaler use ($\beta=-0.28$, p=0.002) were negative predictors. Castro-Rodriguez et al. (2021) similarly identified FEV_1 and reduced exacerbations as key determinants of improved asthma outcomes, with $\beta=0.36$ ($p<0.001$) for FEV_1 and $\beta=-0.29$ (p=0.002) for exacerbation rates .[14]

CONCLUSION

This study demonstrates that inhaled corticosteroids (ICS) are more effective than leukotriene receptor antagonists (LTRA) in managing pediatric asthma. ICS significantly improved asthma control, lung function (FEV_1 and peak expiratory flow), and reduced exacerbation rates and rescue inhaler use compared to LTRA. Furthermore, adherence to therapy and symptom frequency were notably better in the ICS group. While LTRA remain a viable alternative in specific cases, ICS should remain the cornerstone of asthma management in children for achieving optimal outcomes. Tailored treatment plans considering patient-specific needs can further enhance effectiveness.

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