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Original Research Article

Effect of glucocorticoids on anti-infective efficacy and prognosis of children with bronchiolitis caused by Mycoplasma pneumoniae

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Abstract

Purpose: *To investigate the effect of glucocorticoid administration on anti-infective efficacy and prognosis of children diagnosed with bronchiolitis caused by Mycoplasma pneumoniae (MP).*
Methods: *100 children from January 2021 to June 2023 diagnosed with MP-induced bronchiolitis at the Department of Pediatrics, The Affiliated Changzhou No. 2 People's Hospital of Nanjing Medical University, Changzhou, China were randomized into study (n = 45) and control groups (n = 55). The study group received conventional medication (azithromycin at 10 mg/kg on the first day followed by 5 mg/kg/day for 5 days) in addition to glucocorticoids, while control group received the same conventional medication without glucocorticoids. The study group was treated with prednisone (2 mg/kg/day), once a day for 5 days. Inflammatory markers (C-reactive protein (CRP) and procalcitonin (PCT) levels) before and after treatment, duration of medication, disease course, clinical efficacy, and prognosis were compared.*
Results: *There was no significant difference in baseline characteristics between both groups ($p > 0.05$). The study group showed significantly reduced CRP and PCT levels, shorter medication and disease duration, and a higher efficacy compared to control group ($p < 0.05$).*
Conclusions: *Administration of glucocorticoids in addition to conventional medication in MP-induced bronchiolitis reduces levels of inflammatory markers, improves clinical symptoms, and enhances efficacy. Future studies using prospective, randomized controlled trials, larger sample sizes that cut across multicenter sites, standardized treatment protocols, and long-term follow-up will be required to more accurately confirm the safety and efficacy of glucocorticoids in the management of MP-induced bronchiolitis.*

Keywords: *Glucocorticoids, Mycoplasma pneumoniae, Bronchiolitis, Efficacy, Prognosis*

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INTRODUCTION

Mycoplasma pneumoniae (MP) infection is a common pathogen in community-acquired pneumonia [1]. The spectrum of diseases caused by this pathogen is wide, ranging from upper respiratory tract infections to more severe pulmonary conditions such as lung abscesses and pleural effusion [2]. Among them, MP-associated bronchiolitis has gained worldwide attention from clinicians. More importantly, MP-associated bronchiolitis presents as acute

inflammation and leads to long-term complications, such as obstructive bronchiolitis, which significantly affects pediatric growth, development, and quality of life [3]. Although there are currently various drugs for the treatment of MP infection, effectively combating MP-associated bronchiolitis and preventing its chronic complications remain clinically challenging. Recently, glucocorticoids such as prednisone, dexamethasone, and budesonide have emerged as therapeutic options for a wide range of diseases due to their potent anti-inflammatory properties. These agents work by inhibiting inflammatory response through several mechanisms such as decreasing the production of inflammatory cytokines, inhibiting the accumulation of inflammatory cells, and reducing the permeability of capillaries, thereby reducing edema [4]. Prednisone is often used for its systemic effects, dexamethasone is favored for its long-acting anti-inflammatory effects with minimal mineralocorticoid activity, and budesonide is commonly administered via inhalation for localized action with reduced systemic side effects. However, the efficacy and safety of glucocorticoids in the treatment of MP-associated bronchiolitis are still under investigation. Preliminary studies suggest that while glucocorticoids may alleviate acute inflammation and improve short-term clinical symptoms, their role in preventing long-term complications such as obstructive bronchiolitis is not clear [2]. However, concerns regarding potential side effects, including immunosuppression and impact on growth and development in children, necessitate cautious use. Therefore, this study was aimed at investigating the effect of glucocorticoids on anti-infective efficacy and prognosis of children with MP-associated bronchiolitis to provide robust evidence and implications for clinical practice.

METHODS

Participants

A total of 100 children with MP-associated bronchiolitis treated in the Department of Pediatrics at The Affiliated Changzhou No. 2 People's Hospital of Nanjing Medical University, Changzhou, China, from January 2021 to June 2023 were randomized into study (n = 45) and control (n = 55) groups. Study group received routine medication combined with glucocorticoids, while control group received routine medication alone. This study was approved by the Ethics Committee of The Affiliated Changzhou No. 2 People's Hospital of Nanjing Medical University (approval no. EC-2021-034) and conducted in accordance with the guidelines of Declaration of Helsinki [5].

Inclusion criteria

Bronchiolitis caused by MP infection, meets diagnostic criteria for pediatric bronchiolitis set by the American Academy of Pediatrics [6], including the presence of respiratory distress, persistent cough, decreased oxygen saturation, muscle contraction in the intercostal or subcostal area, and widespread wheezing in the lungs. Age between 3 and 12 years, and complete medical history, medical records, and follow-up data.

Exclusion criteria

Children with chronic pulmonary diseases or severe systemic diseases, the presence of significant immune dysfunction or undergoing immunosuppressive therapy, received glucocorticoid or other anti-infective drug treatment before admission, and the presence of mental disorders.

Treatments

Control group received routine medication treatment (intravenous infusion of azithromycin injection 0.5g, Guorui Pharmaceutical no. 2401 021) at 10 mg/kg, once daily for 3 consecutive days. Depending on the condition, azithromycin was temporarily suspended within 3 to 5 days after treatment. If symptoms did not improve, intravenous infusion of azithromycin was continued. If the symptoms improved, oral administration of azithromycin dry suspension (Jiangsu Gannan Haixin Pharmaceutical no.24050501) reconstituted with an appropriate amount of cool boiled water and administered at 0.5 g, 1 h before meals for 3 days. However, if necessary, another course of treatment may be considered. Study group received combined treatment of routine medication and glucocorticoids (intravenous infusion of routine glucocorticoids of methylprednisolone) (40 mg,Sinopharm Group Rongsheng Pharma-ceutical, approval no. H20030727) at 2 mg/kg, once daily for 3 to 5 consecutive days. Then, it was switched to oral prednisone acetate Tablets (Jiangsu Pengyao Pharmaceutical no. 23 12252) at 1 - 2 mg/kg, once daily for 7 -10 consecutive days [7].

Evaluation of parameters/indices

Inflammatory markers

Fasting venous blood samples (5 mL) were taken from patients, centrifuged and tested for levels of

C-reactive protein (CRP) using Cobas biochemical analyzer (23M3-09) and procalcitonin (PCT) using Snibe machine (MAGLUMI X8) before and after treatment.

Medication time and course of disease

The medication time and complete course of disease were recorded after admission.

Clinical efficacy

Clinical efficacy was classified as significant improvement (SI) (all clinical symptoms disappeared, and laboratory indices returned to normal levels after treatment), improvement (I) (various clinical symptoms improved significantly, disease-related signs gradually disappeared, and laboratory indices showed significant recovery after treatment), ineffective (various signs and symptoms did not show significant changes, laboratory indices did not adjust, or the disease showed further deterioration after treatment) [8]. Total effective rate (T) was calculated using Eq 1 [9].

$$T\ (\%) = ((SI/IC)/N)100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ (1)$$

Where N is total number of cases

Prognosis

The pediatric patients returned to the hospital for a follow-up examination to assess whether there were any residual symptoms of obstructive bronchiolitis after three months of treatment.

Statistical analysis

Data was analyzed using Statistical Package for Social Sciences (SPSS) 25.0 software (IBM, Armonk, NY, USA). Continuous data were presented in mean ± standard deviation (SD) and compared using the student t-test. Categorical data were presented in frequency and percentages and compared using Chi-square test. $P < 0.05$ is considered statistically significant.

RESULTS

Baseline clinical data

There was no significant difference in baseline clinical data between the two groups ($p > 0.05$; Table 1).

Inflammatory markers

There was no significant difference in inflammatory marker levels between the two groups before treatment ($p > 0.05$). However, study group showed significantly lower CRP and PCT levels compared to control group after treatment ($p < 0.05$; Table 2).

Table 1: Baseline clinical data (N, %; mean ± SD)

General information	Study (n = 45)	Control (n = 55)	t/χ^2	*P*-value
Male	20(44.44)	28(50.91)	0.414	0.520
Female	25(55.56)	27(49.09)		
Age (years)	5.56±2.54	5.87±2.42	0.623	0.535
Height (cm)	122.23±10.89	120.45±11.03	0.807	0.421
Weight (kg)	24.56±3.25	24.87±3.02	0.494	0.623
Clinical signs and symptoms				
Cough	42(93.33)	52(94.55)	0.029	0.866
Expectoration	33(73.33)	38(69.09)	0.216	0.642
Dyspnea	10(22.22)	14(25.45)	0.142	0.707
Chest tightness	13(28.89)	15(27.27)	0.032	0.858
Time from admission to diagnosis (days)	4.38±0.74	4.55±0.65	1.222	0.225

Table 2: Inflammatory markers (mean ± SD)

Group	N	CRP (mg/L)		PCT (ng/mL)	
		Pre-treatment	*Post-treatment*	*Pre-treatment*	*Post-treatment*
Study	45	21.78±4.68	6.84±1.69*#	0.52±0.06	0.19±0.06*#
Control	55	22.01±4.52	8.96±1.97*	0.50±0.07	0.28±0.06*
***T*-value**		0.249	5.702	1.515	7.462
***P*-value**		0.804	0.000	0.133	0.000

CRP: C-Reactive Protein; PCT: Procalcitonin. *$P < 0.05$ compared to same group before treatment, #$p < 0.05$ compared to control group after treatment

Medication time and course of disease

Study group showed significantly shorter medication time and course of disease compared to control group ($p < 0.05$; Table 3).

Clinical efficacy

Study group showed higher effective rate (95.56 %) compared to control group (81.82 %; Table 4).

Prognosis

There was one incidence (2.22 %) of residual obstructive bronchiolitis in study group and two cases (3.64 %) in control group. There was no significant difference in prognosis between the two groups ($\chi^2 = 0.031$, $p = 0.860$).

DISCUSSION

Mycoplasma pneumonia-induced bronchiolitis has become an important respiratory disease in children, characterized by a long clinical course, easy recurrence, and the possibility of various serious complications [3,10]. However, in addition to early inflammatory cell infiltration, the deeper pathological changes in bronchiolitis include fibrosis and luminal obstruction [11]. Over time, if effective treatment is not given, these pathological changes may further lead to obstructive bronchiolitis. As a chronic disease, obstructive bronchiolitis is mainly characterized by long-term obstruction and narrowing of the airway, which may cause serious damage to respiratory function, leading to inadequate oxygen supply and ineffective removal of accumulated carbon dioxide [12,13]. Especially for children in the period of growth and development, impaired lung function seriously affects physical development, learning, and daily activities [14]. Therefore, it is not only necessary to control inflammation but also important to prevent further development of fibrosis and luminal obstruction, thus maintaining health and quality of life [15]. Glucocorticoids are secreted by the adrenal cortex with significant anti-inflammatory and immune-regulating effects [16]. However, effectiveness and safety in children with bronchiolitis caused by MP infection are still controversial. This study showed that levels of CRP and PCT significantly reduced in study group compared to control group after treatment. This indicates that glucocorticoids have a stronger effect in reducing inflammatory reactions. This is mainly because glucocorticoids inhibit the release of inflammatory mediators, such as cytokines and chemokines, by immune cells, thereby alleviating inflammatory reactions [17]. In addition, glucocorticoids stabilize lysosomal membranes within cells and prevent lysosomal rupture and the release of digestive enzymes which cause cell damage. More importantly, glucocorticoids also inhibit the synthesis of inflammatory markers by affecting gene transcription, further reducing the severity of inflammation [18].

In addition, study group had significantly shorter medication and disease duration compared to control group. This indicates that glucocorticoid treatment helped accelerate resolution of the disease course, shorten treatment duration, and hasten recovery. Furthermore, total effective rate in study group was significantly higher compared to control group further demonstrating that the treatment strategy involving glucocorticoids is more effective in improving clinical symptoms and efficacy in children. This may be attributed to methylprednisolone, which is a glucocorticoid with high affinity for glucocorticoid receptors within the body.

Table 3: Medication duration and course of disease (mean ± SD)

Group	N	Duration of medication (days)	Course of illness (days)
Study	45	4.03±0.54*	13.20±1.05*
Control	55	5.27±0.86	16.32±1.42
***T*-value**		8.407	12.620
***P*-value**		0.000	0.000

*$P < 0.05$ compared to control group

Table 4: Clinical efficacy (N, %)

Group	N	Significant improvement	Improvement	No improvement	Total effective rate
Study	45	26(57.78)	17(37.78)	2(4.44)	43(95.56)
Control	55	23(41.82)	22(40.00)	10(18.18)	45(81.82)
χ^2					4.423
***P*-value**					0.036

These receptors are part of cellular machinery that modulates gene expression when activated. This modulation results in suppression of inflammatory and immune responses. Also, the high affinity makes methylprednisolone effectively initiate its anti-inflammatory and immunosuppressive actions at relatively low concentrations, making it an efficient therapy for conditions characterized by excessive inflammation or undesirable immune system activity. It effectively binds to hormone receptors in the body and has a significant regulatory effect on characteristics of capillaries. It reduces the permeability of capillaries, thereby reducing fluid exudation during inflammation [4]. Furthermore, methylprednisolone enhances vascular structural integrity, thereby reducing vascular damage and leakage caused by inflammation, ultimately alleviating related symptoms and improving quality of life [19].

Glucocorticoids may also bind to specific receptors inside cells and interact with specific DNA regions within the cell nucleus, initiating the transcription process of mRNA. It is through this mechanism that the body accelerates the synthesis of specific enzyme proteins, effectively suppressing immune reactions [20]. When used in combination with antibiotics, glucocorticoids exhibit a synergistic effect, not only achieving immune regulation but also enhancing anti-infective activity [21]. This combination therapy rapidly improves lung function and alleviates symptoms. Furthermore, this study compared the prognosis of the two groups, and the results showed that the proportion of residual bronchiolitis obliterans was low in both groups. This indicates that glucocorticoids do not affect long-term prognosis or risk of bronchiolitis obliterans.

Limitations of this study

This study has some limitations. This study did not establish any relationship between glucocorticoid treatment and clinical outcomes. The limited sample size (100 children) and single-center design may not fully represent the broader population and could introduce selection bias. Treatment regimens, including dosage and duration of glucocorticoid treatment, were not standardized among participants, potentially affecting the consistency of the results. Also, the study did not assess the long-term effects of glucocorticoid treatment, such as its impact on lung function or chronic complications. There could also be additional confounding factors, such as nutritional status, underlying chronic diseases, or variations in care that were not considered, potentially influencing the outcomes. Furthermore, the diagnosis of MP-associated bronchiolitis relied on clinical criteria rather than more accurate molecular diagnostic methods, possibly affecting the homogeneity of the study population.

CONCLUSION

Administration of glucocorticoids in MP-induced bronchiolitis effectively reduces inflammatory markers, shortens the time for clinical symptom improvement, and improves clinical efficacy. Future studies using prospective, randomized controlled trials, larger sample sizes, multicenter collaborations, standardized treatment protocols, and long-term follow-up will be required to more accurately assess the safety and efficacy of glucocorticoids in the management of MP-induced bronchiolitis.

DECLARATIONS

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Ethical approval

None provided.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of Interest

No conflict of interest associated with this work.

Contribution of Authors

The authors declare that this work was done by the authors named in this article and all liabilities pertaining to claims relating to the content of this article will be borne by them.

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