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To study the methylprednisolone effects during cardiac surgery

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Abstract

Introduction and Background: Heart surgeries, especially those requiring cardiopulmonary bypass (CPB), are associated with an increased risk of postoperative consequences include organ failure and longer recovery times due to inflammatory reactions. The anti-inflammatory corticosteroid methylprednisolone has been studied for its ability to reduce these reactions. The purpose of this research is to determine whether or not methylprednisolone is safe and effective in lowering inflammation after heart surgery and enhancing clinical outcomes.

Materials and Methods: A randomised controlled experiment was done with 120 adult patients undergoing elective heart surgery with cardiopulmonary bypass (CPB). This study was conducted at the department of Anaesthesia, Surabhi Institute of Medical Sciences, Siddipet-Husnabad, Mundrai, Telangana, India from November 2020 to October 2021. Participants were randomly assigned to two groups: a methylprednisolone group (n = 60), administered 30 mg/kg intravenous methylprednisolone preoperatively and intraoperatively, and a control group (n = 60), receiving a placebo. The primary outcomes encompassed inflammatory indicators and surgical complications. The secondary outcomes included the duration of ICU stay, time to extubation, and 30-day mortality rate. Data were analysed utilising suitable statistical procedures, with $p < 0.05$ deemed significant.

Results: Methylprednisolone markedly diminished inflammatory indicators, resulting in decreased CRP and IL-6 levels in the intervention group relative to the control group. Patients receiving methylprednisolone had reduced ICU durations and expedited extubation intervals. The occurrence of postoperative complications was reduced in the methylprednisolone group, especially regarding respiratory dysfunction. No substantial variations in 30-day mortality were seen between the groups.

Conclusion: The injection of methylprednisolone during heart surgery significantly diminishes inflammatory responses, lowers ICU duration, and enhances early recovery outcomes without elevating mortality risk. Methylprednisolone may serve as a beneficial adjuvant in the perioperative care of patients undergoing heart surgery.

Keywords: Methylprednisolone, cardiac surgery, inflammation, cardiopulmonary bypass, postoperative recovery, corticosteroids

Introduction

Cardiac surgery, especially operations utilising cardiopulmonary bypass (CPB), is fundamental to contemporary cardiovascular treatment. Nonetheless, although cardiopulmonary bypass (CPB) is lifesaving, it elicits a systemic inflammatory response syndrome (SIRS) that markedly exacerbates postoperative problems. The interaction between blood and the non-physiological surfaces of the CPB circuit, ischemia-reperfusion injury, surgical trauma, and the release of endotoxins from the gastrointestinal tract are primary instigators of this inflammatory cascade^[1-3]. This response entails the activation of complement mechanisms, leukocytes, and the secretion of pro-inflammatory cytokines, including interleukin-6 (IL-6), tumour necrosis factor-alpha (TNF- α), and C-reactive protein (CRP). These inflammatory mediators may result in tissue damage, organ impairment, and extended recovery periods, hence elevating morbidity and healthcare expenses^[2-4].

Postoperative consequences associated with this inflammatory response encompass acute respiratory distress syndrome (ARDS), renal impairment, cardiac damage, and infections. These problems not only extend intensive care unit (ICU) durations but also elevate mortality risk and diminish long-term quality of life for patients. Consequently, regulating the inflammatory response during and post-cardiac surgery is essential for enhancing patient outcomes^[4-6].

Methylprednisolone, a synthetic glucocorticoid with significant anti-inflammatory and

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immunosuppressive effects, has been thoroughly investigated in several clinical contexts to mitigate inflammatory reactions. It functions by regulating the transcription of pro-inflammatory cytokines, stabilizing cellular membranes, and preventing the activation of leukocytes and other inflammatory cells. In cardiac surgery, methylprednisolone has demonstrated efficacy in lowering inflammatory biomarkers such as IL-6, CRP, and TNF- α , potentially mitigating systemic inflammation [5-7].

The routine application of methylprednisolone in cardiac surgery is contentious, despite its possible advantages. Concerns have been expressed regarding its safety profile, specifically the dangers of hyperglycemia, heightened vulnerability to infections, impaired wound healing, and possible immunosuppression. Moreover, although numerous trials indicate decreases in inflammation, the evidence for clinical endpoints such as ICU length of stay, extubation time, organ dysfunction, and mortality is still ambiguous [6-8].

This prospective randomised trial aims to assess the efficacy and safety of methylprednisolone in individuals undergoing elective heart surgery with cardiopulmonary bypass. The study is to furnish thorough data on the advantages and disadvantages of methylprednisolone in this high-risk patient population by assessing both inflammatory indicators and clinical outcomes. Furthermore, it aims to tackle the persistent discourse on the habitual administration of corticosteroids in perioperative cardiac management. This study's results may significantly influence the optimisation of perioperative treatment regimens in cardiac surgery, especially in balancing the advantages of mitigating systemic inflammation against the possible detrimental effects of corticosteroid medication [7-9].

Materials and Methods

A prospective, randomised controlled experiment was performed with 120 adult patients undergoing elective heart surgery with cardiopulmonary bypass. This study was conducted at the department of Anaesthesia, Surabhi

Institute of Medical Sciences, Siddipet-Husnabad, Mundrai, Telangana, India from November 2020 to October 2021. Participants were randomised into two groups: a methylprednisolone group (n = 60), administered 30 mg/kg intravenous methylprednisolone preoperatively and intraoperatively, and a control group (n = 60), receiving a placebo. The primary outcomes encompassed inflammatory indicators and surgical consequences. The secondary outcomes included the duration of ICU stay, time to extubation, and 30-day mortality rate. Data were analysed utilising suitable statistical procedures, with $p < 0.05$ deemed significant.

Inclusion Criteria

- Patients aged 18-75 years undergoing elective cardiac surgery
- Patients classified as ASA Physical Status II-IV.
- Patients willing to provide informed consent and participate in the study.
- No known contraindications to corticosteroid therapy.

Exclusion Criteria

- Patients with known hypersensitivity or allergy to corticosteroids.
- Pre-existing severe renal dysfunction
- Severe hepatic impairment or liver cirrhosis.
- Pregnancy or breastfeeding.
- Emergency cardiac surgeries or those requiring circulatory arrest.
- Patients with a history of malignancy within the past 5 years.

Results

The trial comprised 120 individuals randomised into two cohorts: the methylprednisolone cohort (n=60) and the control cohort (n=60). The two groups had identical baseline demographic and clinical features (Table 1).

Table 1: Baseline Characteristics of the Study Groups

Characteristic	Methylprednisolone Group (n=60)	Control Group (n=60)	p-value
Age (years, mean \pm SD)	58.3 \pm 8.1	59.7 \pm 9.0	0.42
Gender (Male: Female)	45:15	43:17	0.68
BMI (kg/m ² , mean \pm SD)	26.5 \pm 3.2	27.1 \pm 3.4	0.37
ASA Status (II/III/IV)	25/30/5	23/32/5	0.81
LVEF (%)	55.8 \pm 6.5	56.1 \pm 6.8	0.74

The methylprednisolone group demonstrated significantly lower levels of postoperative inflammatory markers compared to the control group.

Table 2: Comparison of Inflammatory Markers

Marker	Preoperative	Postoperative (6 hrs.)	Postoperative (24 hrs.)	p-value (24 hrs.)
CRP (mg/L)	M: 6.5 \pm 2.3	M: 50.2 \pm 8.7	M: 38.4 \pm 7.2	<0.001
	C: 6.7 \pm 2.4	C: 82.1 \pm 9.6	C: 65.7 \pm 8.8	
IL-6 (pg/mL)	M: 15.4 \pm 5.6	M: 120.7 \pm 22.3	M: 72.4 \pm 19.2	<0.001
	C: 15.9 \pm 6.1	C: 185.6 \pm 25.7	C: 124.3 \pm 20.5	

(M = Methylprednisolone Group, C = Control Group)

Patients in the methylprednisolone group exhibited faster recovery and fewer complications.

Table 3: Clinical Outcomes

Outcome	Methylprednisolone Group (n=60)	Control Group (n=60)	p-value
ICU Stay (days, mean \pm SD)	2.3 \pm 0.6	3.1 \pm 0.8	<0.001
Time to Extubation (hours)	8.5 \pm 2.1	12.3 \pm 3.2	<0.01
Incidence of ARDS (%)	8 (13%)	15 (25%)	0.04
Postoperative Renal Injury (%)	6 (10%)	14 (23%)	0.03
30-day Mortality (%)	2 (3%)	3 (5%)	0.65

Discussion

This study demonstrates the effectiveness of methylprednisolone in diminishing systemic inflammation and enhancing clinical outcomes in patients having cardiac surgery with cardiopulmonary bypass (CPB). The findings correspond with previous research that has shown the anti-inflammatory effects of corticosteroids, especially in regulating the increased inflammatory response linked to CPB [10-12].

Cardiopulmonary bypass induces a systemic inflammatory response via multiple pathways, such as blood interaction with the non-physiological surfaces of the CPB circuit, ischemia-reperfusion injury, and endotoxin release. This response is facilitated by the activation of inflammatory pathways, leading to increased levels of cytokines such as interleukin-6 (IL-6) and acute-phase proteins like C-reactive protein (CRP). In our investigation, methylprednisolone markedly decreased the levels of both CRP and IL-6 after 24 hours postoperatively relative to the control group, indicating its efficacy in attenuating this inflammatory response [12-14]. Methylprednisolone's capacity to suppress the activation of nuclear factor-kappa B (NF- κ B) and the transcription of pro-inflammatory cytokines likely underlies its reported effects. These data corroborate the concept that corticosteroids can mitigate the inflammatory response linked to CPB and diminish the likelihood of inflammation-related consequences [13-15].

Patients receiving methylprednisolone exhibited markedly reduced ICU durations and expedited extubation times relative to the control group. This enhancement can be ascribed to the reduction of inflammation, which frequently leads to problems including respiratory impairment and protracted recuperation. The occurrence of acute respiratory distress syndrome (ARDS) was markedly reduced in the methylprednisolone cohort [16-18]. The occurrence of renal impairment was diminished, presumably owing to the preventive properties of corticosteroids on microvascular inflammation and renal perfusion. These findings are therapeutically relevant, as abbreviated ICU durations and expedited extubation not only diminish healthcare expenditures but also improve patient happiness and overall recovery [17-19].

A principal worry about the utilisation of corticosteroids in cardiac surgery is their safety profile. Some studies have identified adverse effects, including hyperglycemia, heightened vulnerability to infections, and delayed wound healing. In our investigation, the incidence of these problems did not substantially differ between the methylprednisolone and control groups, suggesting that the medicine was well-tolerated at the provided dose. This aligns with recent research indicating a generally safe profile of methylprednisolone in cardiac surgery when utilised judiciously. The 30-day mortality rate was similar between the two groups (3% vs. 5%, $p=0.65$), indicating that methylprednisolone does not elevate the risk of early mortality [18-20].

The results of this investigation align with prior research. Dieleman *et al.* (2012) [2] revealed reduced inflammatory markers and a reduction in morbidity associated with corticosteroid use in heart surgery. A meta-analysis by Whitlock *et al.* (2007) [1] indicated enhancements in certain clinical outcomes, including extubating duration and ICU length of stay, associated with corticosteroid administration. Nonetheless, certain studies have demonstrated inconsistent findings, especially concerning long-term mortality and infection risk. The inconsistencies may arise from differences in corticosteroid dose, timing of administration, and patient demographics [20-22].

This study's conclusions have considerable significance for the perioperative management of patients undergoing heart surgery. Methylprednisolone can be regarded as an effective adjuvant for diminishing systemic inflammation and enhancing short-term recovery outcomes. Nonetheless, its application must be tailored to the individual, considering the patient's risk profile, including pre-existing diseases like diabetes or ongoing infections. Additional extensive, multicenter trials are necessary to confirm these results and investigate the long-term impacts of methylprednisolone on survival and quality of life. Furthermore, research ought to concentrate on determining the ideal dosage and time of administration to enhance benefits while reducing dangers [22-24].

Methylprednisolone administration in cardiac surgery significantly diminishes inflammatory markers, enhances recovery metrics, and lowers the occurrence of certain problems, including ARDS and renal impairment. This study's findings endorse the inclusion of methylprednisolone in perioperative treatment guidelines for cardiac surgery patients, with meticulous attention to individual patient risks. Subsequent study should focus on elucidating long-term consequences and better delineating the role of corticosteroids in this scenario [24-26]. This study illustrates that the injection of methylprednisolone in patients undergoing cardiac surgery with cardiopulmonary bypass (CPB) markedly diminishes systemic inflammation, as indicated by reduced levels of inflammatory markers such as CRP and IL-6. Furthermore, the administration of methylprednisolone correlates with enhanced clinical outcomes, encompassing reduced ICU durations, expedited extubation periods, and a diminished occurrence of sequelae, including acute respiratory distress syndrome (ARDS) and postoperative renal impairment [25-27].

The administration of methylprednisolone did not elevate the risk of adverse events, including infections, delayed wound healing, or 30-day mortality, indicating its efficacy and safety at the investigated dosage. The findings endorse the potential utility of methylprednisolone as a significant adjuvant in the perioperative care of patients having cardiac surgery, especially for alleviating the inflammatory response linked to cardiopulmonary bypass (CPB) [26-28]. Nonetheless, due to the heterogeneity in individual patient responses and the continuing discourse surrounding corticosteroid

utilisation, additional multicenter trials with bigger sample numbers are necessary to corroborate these findings, evaluate long-term outcomes, and optimise dose techniques. The administration of methylprednisolone should be customised according to the unique requirements and risk assessments of each patient ^[28-30].

Conclusion

This study illustrates that administering methylprednisolone to patients undergoing cardiac surgery with cardiopulmonary bypass (CPB) markedly diminishes systemic inflammation, as indicated by reduced levels of inflammatory markers such as CRP and IL-6. The administration of methylprednisolone correlates with enhanced clinical outcomes, including reduced ICU durations, expedited extubation, and a diminished occurrence of sequelae such as acute respiratory distress syndrome (ARDS) and postoperative renal impairment. Nonetheless, due to the heterogeneity in individual patient responses and the continuing discourse surrounding corticosteroid utilisation, additional multicenter trials with bigger sample numbers are necessary to corroborate these findings, evaluate long-term outcomes, and optimise dose techniques. The administration of methylprednisolone must be customized according to the distinct requirements and risk assessments of each patient.

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None

Conflict of Interest

None

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