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Research Article

# Effect of Damage Control Orthopedics versus Early Total Care on Mortality and Functional Outcomes in Polytrauma Patients: A Prospective Observational Study

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## ABSTRACT

**Background:** Polytrauma is a leading cause of morbidity and mortality in developing countries. Orthopaedic injuries are common in these patients and significantly influence survival and long-term functional outcomes. Two principal management strategies damage control orthopaedics (DCO) and early total care (ETC) are used based on patient physiology and injury severity.

**Aim:** To compare the effect of damage control orthopaedics versus early total care on mortality and functional outcomes in polytrauma patients presenting to a tertiary care referral centre in Bihar.

**Methodology:** This prospective observational study included 102 polytrauma patients over a 6-month period. Patients were managed using either DCO (n=52) or ETC (n=50) based on clinical status. Outcomes assessed included mortality, complications (ARDS, sepsis, MODS), ICU and hospital stay, fracture union, and functional outcome using the Lower Extremity Functional Scale at 3 months. Statistical analysis was performed using SPSS version 20.0 with $p < 0.05$ considered significant.

**Results:** Patients in the DCO group had significantly higher injury severity scores. Mortality was higher in the DCO group (23.1%) compared to ETC (12%). The DCO group had significantly longer ICU stay, ventilator days, and hospital stay, along with higher sepsis rates. Functional outcomes, time to union, and early mobilization were significantly better in the ETC group.

**Conclusion:** DCO is essential for physiologically unstable patients, whereas ETC offers better functional recovery and reduced hospital burden in stable polytrauma patients. A physiological status guided, individualized treatment approach is recommended.

**Keywords:** Polytrauma; Damage control orthopaedics; Early total care; Fracture fixation; Functional outcome.

## INTRODUCTION

Polytrauma remains one of the leading causes of morbidity and mortality worldwide, particularly among the economically productive age group. It is defined as multiple traumatic injuries occurring simultaneously, often involving at least one life-threatening lesion that requires urgent multidisciplinary management. The burden of polytrauma is disproportionately high in low and middle-income countries, where road traffic accidents, occupational hazards, and interpersonal violence contribute significantly to injury-related mortality [1]. In India, trauma accounts for a major proportion of emergency admissions, with increasing incidence in densely populated and rapidly urbanizing states such as Bihar.

Orthopaedic injuries, particularly long bone and pelvic fractures, are present in the majority of polytrauma patients and significantly influence both survival and long-term functional outcomes. The management of these fractures has evolved around two major strategies: Early total care (ETC) and damage control orthopaedics (DCO). ETC involves definitive fixation of major fractures within the early phase (usually within 24–48 hours), aiming to reduce pulmonary complications, immobilization and hospital stay. Conversely, DCO focuses on temporary stabilization (e.g., external fixation) to minimize the "second hit" phenomenon in physiologically unstable patients, with delayed definitive fixation once the patient is stabilized [2].

The concept of DCO emerged from the recognition that extensive surgical procedures performed during the acute inflammatory phase of trauma could exacerbate systemic inflammatory response syndrome (SIRS), leading to complications such as acute respiratory distress syndrome (ARDS), sepsis and multi-organ dysfunction syndrome (MODS) [3]. Therefore, DCO is particularly recommended for patients presenting with hemodynamic instability, coagulopathy, hypothermia, or severe associated injuries. However, for hemodynamically stable patients, ETC has been shown to provide superior functional recovery, earlier mobilization, and reduced ICU stay [3].

Despite widespread adoption, the relative benefits of DCO versus ETC remain controversial. Recent large cohort analyses have demonstrated that DCO does not necessarily confer a survival advantage over ETC and may be associated with higher rates of complications such as ARDS, acute kidney injury, sepsis, and deep

vein thrombosis [4]. Similarly, data from trauma registries indicate no significant reduction in mortality with DCO when compared to ETC after adjusting for injury severity [5]. In paediatric and traumatic brain injury cohorts, DCO has even been associated with increased mortality, prolonged hospital stay, and higher healthcare costs, possibly reflecting the greater baseline severity of injuries in these patients [6].

Conversely, selected studies have emphasized the importance of physiological stratification and individualized treatment decisions, suggesting that DCO remains the preferred strategy for unstable polytrauma patients with ongoing haemorrhage or metabolic derangement [3]. Thus, the decision between DCO and ETC remains nuanced and dependent on patient physiology, injury pattern, and institutional capability.

Bihar, one of the most populous states in India, faces a high burden of trauma due to rapid urbanization, poor road infrastructure, lack of strict traffic enforcement, and limited prehospital care systems. Most of the existing literature on DCO versus ETC originates from high-income countries or advanced trauma systems, where early resuscitation, imaging, and surgical resources are readily available. There is a paucity of prospective observational data from resource-limited settings such as Bihar, where patient characteristics, injury patterns, and hospital infrastructure differ significantly from Western populations.

Therefore, it is crucial to evaluate real-world outcomes of DCO versus ETC in polytrauma patients. Such a study will help generate region-specific evidence to guide orthopaedic trauma care and improve survival and rehabilitation outcomes.

Therefore, the aim of this study was to compare the effect of damage control orthopaedics versus early total care on mortality and functional outcomes in polytrauma patients managed at a tertiary care referral centre in Bihar.

## MATERIALS AND METHODS

The present study was conducted at IGIMS, Patna, Bihar, India, which serves as a major referral centre for trauma patients from urban, semi-urban, and rural regions of the state and neighbouring districts. The institute is equipped with a dedicated emergency department, orthopaedic trauma unit, intensive care facilities, radiological imaging services, and multidisciplinary surgical teams. The hospital receives a high volume of polytrauma patients due to increasing road traffic accidents and industrial injuries in the region. All eligible patients were recruited from the Orthopaedics outpatient department (OPD), emergency and trauma department.

This study was designed as a prospective observational study conducted over a period of 6 months. Patients were categorized into two groups based on physiological status at presentation:

Group A (Damage Control Orthopaedics – DCO): Patients managed initially with temporary fracture stabilization such as external fixation, traction, or splintage, followed by delayed definitive fixation after physiological stabilization.

Group B (Early Total Care – ETC): Patients undergoing definitive fracture fixation (e.g., intramedullary nailing, plating) within 24–48 hours of injury.

No randomization or intervention allocation was performed by the investigators, as treatment decisions were made according to institutional protocols and clinical judgment.

### Inclusion Criteria

Patients aged 18–65 years of either sex. Patients presenting with polytrauma, defined as Injury Severity Score (ISS) ≥16 with involvement of at least two body systems. Patients having major orthopaedic injuries, including long bone fractures, pelvic fractures, or multiple fractures requiring surgical intervention. Patients reporting within 72 hours of injury to the tertiary care centre. Patients (or their legal guardians) providing informed written consent for participation and follow-up.

### Exclusion Criteria

Patients aged below 18 years or above 65 years**.** Patients with isolated orthopaedic injuries without associated systemic trauma. Patients with pathological fractures, malignancy, or metabolic bone disease. Patients with severe pre-existing comorbid conditions such as advanced cardiac failure, end-stage renal disease, or chronic liver failure.

The study sample comprised all eligible polytrauma patients presenting to the orthopaedic OPD, Emergency and trauma department and admitted here during the study period**.** A consecutive sampling technique was employed. Patients were randomly included based on their presentation sequence and eligibility criteria, ensuring representation of both DCO and ETC groups as per real-world clinical practice.

Based on the average monthly trauma load of the institution, an estimated sample size of 80 patients was anticipated during the study period, which was considered adequate to detect clinically meaningful differences in mortality and complication rates between the two management strategies.

## METHODOLOGY

### Initial Assessment

All patients underwent standardized trauma evaluation following Advanced Trauma Life Support (ATLS) guidelines. Primary survey, resuscitation, and stabilization were performed in the emergency department. Baseline data recorded included: Demographic details (age, sex, occupation), mechanism of injury (road traffic accident, fall, assault, etc.), time from injury to hospital arrival, Vital parameters and hemodynamic status, glasgow coma scale (GCS), Injury Severity Score (ISS), associated injuries (head, chest, abdomen, spine).

### Group Allocation

Patients were categorized into DCO or ETC groups based on physiological status and treating surgeon's decision:

### DCO Indications

Hemodynamic instability, hypothermia, coagulopathy, metabolic acidosis, severe chest or head injury.

### ETC Indications

Hemodynamically stable patients without major physiological derangement.

### Operative Management

DCO group**:** Temporary external fixation, pelvic binder application, traction, or splintage followed by delayed definitive fixation once stable.

ETC group**:** Early definitive fixation using intramedullary nailing, plating, or reconstructive procedures within 24–48 hours.

## Outcome Measures

*Primary outcomes*

Mortality rate (in-hospital mortality and 30-day mortality), Functional outcome, assessed using standardized scoring systems such as: Lower extremity functional scale (LEFS) or short musculoskeletal functional assessment (SMFA**)** at 3 months follow-up.

*Secondary outcomes*

Incidence of complications: ARDS, sepsis, MODS, deep vein thrombosis, pulmonary embolism, Duration of ICU stay, duration of mechanical ventilation, total hospital stay, time to fracture union (radiological and clinical), time to mobilization and return to daily activities.

*Follow-up protocol*

Patients were followed at 4, 8 and 12 weeks post-discharge in the OPD. Functional outcome scores and radiological healing were assessed during each visit.

A pre-designed, semi-structured case record form (CRF) was used for data collection. Data were entered into a secure database and cross-verified for accuracy. All clinical assessments were performed by trained orthopaedic residents under consultant supervision to ensure uniformity. Data were analyzed using Statistical Package for Social Sciences (SPSS) version 20.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize demographic and clinical characteristics: Mean ± standard deviation (SD) for continuous variables and Frequency and percentages for categorical variables. Independent t-test was done for continuous variables and Chi-square test was done for categorical variables. Kaplan–Meier survival curves were used to compare mortality between groups. A *p-value* <0.05 was considered statistically significant.

## RESULTS

A total of 102 polytrauma patients fulfilling the inclusion criteria were enrolled during the study period. Among them, 52 patients (50.9%) were managed with damage control orthopaedics (DCO) and 50 patients (49.1%) underwent early total care (ETC).

**Table 1:** Baseline demographic and injury characteristics

| *Variable* | *DCO (n=52)* | *ETC (n=50)* | *p-value* |
|---|---|---|---|
| Mean age (years) | 36.8 ± 12.4 | 34.5 ± 11.7 | 0.31 |
| Male (%) | 40 (76.9%) | 37 (74%) | 0.72 |
| Mean ISS | 28.6 ± 6.8 | 24.2 ± 5.9 | 0.001 |
| GCS < 8 (%) | 14 (26.9%) | 8 (16%) | 0.18 |
| Chest Injury (%) | 21 (40.4%) | 16 (32%) | 0.36 |
| Head Injury (%) | 25 (48.1%) | 19 (38%) | 0.29 |

**Table 2:** Mortality outcomes

| *Outcome* | *DCO (n=52)* | *ETC (n=50)* | *p-value* |
|---|---|---|---|
| In-hospital mortality | 12 (23.1%) | 6 (12%) | 0.11 |
| 30-day mortality | 10 (19.2%) | 5 (10%) | 0.17 |

**Table 3:** Complications and hospital course

| *Variable* | *DCO (n=52)* | *ETC (n=50)* | *p-value* |
|---|---|---|---|
| ARDS | 11 (21.2%) | 5 (10%) | 0.09 |
| Sepsis | 13 (25%) | 6 (12%) | 0.04 |
| MODS | 9 (17.3%) | 4 (8%) | 0.12 |
| Mean ICU stay (days) | 8.6 ± 3.2 | 5.1 ± 2.7 | <0.001 |
| Ventilator days | 5.9 ± 2.8 | 3.2 ± 1.9 | <0.001 |
| Hospital stay (days) | 21.4 ± 6.5 | 16.2 ± 5.8 | 0.002 |

**Table 4:** Functional and recovery outcomes

| *Outcome* | *DCO (n=52)* | *ETC (n=50)* | *p-value* |
|---|---|---|---|
| Mean LEFS score (3 months) | 52.4 ± 11.6 | 64.8 ± 10.2 | <0.001 |
| Time to union (weeks) | 18.6 ± 4.3 | 15.2 ± 3.9 | 0.001 |
| Time to mobilization (days) | 12.8 ± 4.6 | 7.3 ± 3.1 | <0.001 |
| Return to daily activity (%) | 30 (57.7%) | 39 (78%) | 0.02 |

The mean age of patients in the DCO group was 36.8 ± 12.4 years, while in the ETC group it was 34.5 ± 11.7 years**.** Males constituted the majority of cases in both groups (DCO: 76.9%, ETC: 74%). The most common mechanism of injury was road traffic accidents in both groups [Table 1].

Patients in the DCO group had a significantly higher injury severity score (ISS) compared to the ETC group, indicating that DCO was more frequently used in more severely injured and physiologically unstable patients**.**

The overall mortality rate was 17.6% (18/102)**.** Mortality was higher in the DCO group **(**23.1%**)** compared to the ETC group **(**12%**),** although this difference did not reach strong statistical significance.

Mortality was higher in the DCO group, likely reflecting the greater baseline injury severity and physiological compromise of these patients. However, ETC patients showed relatively better survival outcomes [Table 2].

The DCO group had a higher incidence of systemic complications, including ARDS, sepsis, and MODS, along with longer ICU and hospital stays.

The DCO group demonstrated significantly longer ICU stay, ventilator dependency, and hospital stay, along with a higher rate of sepsis, indicating a greater systemic inflammatory burden and delayed recovery compared to ETC [Table 3].

Functional outcomes at 3 months were significantly better in the ETC group. Time to fracture union and return to mobilization were also shorter with ETC [Table 4].

Patients treated with ETC showed significantly better functional recovery, earlier mobilization, and faster fracture healing. DCO patients had delayed rehabilitation, likely due to staged procedures and higher systemic complications.

## DISCUSSION

The present prospective observational study compared damage control orthopaedics (DCO) and early total care (ETC) in polytrauma patients presenting to a tertiary care referral centre in Bihar. The

findings demonstrate that while DCO was preferentially used in physiologically unstable and severely injured patients, ETC was associated with better functional recovery, shorter hospital stay, and fewer complications. Mortality was higher in the DCO group; however, this likely reflects the greater baseline injury severity rather than the treatment strategy itself.

In the current study, patients managed with DCO had significantly higher injury severity scores and a greater prevalence of associated head and chest injuries. This is consistent with existing literature where DCO is reserved for patients with hemodynamic instability, coagulopathy, or systemic inflammatory response, as performing extensive definitive surgery in such patients may precipitate a "second hit" phenomenon [1,2]. Von Lübken et al. demonstrated that DCO is frequently selected in patients with severe injuries and unstable physiology, highlighting its role as a life-saving temporizing measure rather than a definitive strategy [2].

Mortality in our study was higher in the DCO group compared to ETC, although the difference did not reach strong statistical significance. Similar observations have been reported in recent registry-based and cohort studies. Coimbra *et al.*, found no significant survival advantage of DCO over ETC after adjusting for confounders, suggesting that the apparent higher mortality in DCO cohorts reflects patient severity rather than treatment effect [3]. Likewise, large trauma database analyses have shown that when physiological parameters are accounted for, mortality differences between DCO and ETC diminish [4].

The incidence of complications such as sepsis, ARDS, and multi-organ dysfunction was higher in the DCO group in the present study. This is consistent with the concept that patients selected for DCO already have a higher inflammatory burden and are more prone to systemic complications [5]. Nandi *et al.,* demonstrated elevated inflammatory biomarkers in DCO-treated patients compared to ETC, indicating persistent systemic stress and delayed physiological recovery [5]. However, it is important to note that early definitive fixation in unstable patients may worsen inflammatory responses and increase complications, thereby justifying the use of DCO in carefully selected cases [1].

In contrast, the ETC group in our study demonstrated significantly better functional outcomes, earlier mobilization, and shorter time to fracture union. Early fixation allows restoration of limb alignment, early physiotherapy, and reduced immobilization-related complications. Previous studies have similarly reported improved rehabilitation and reduced ICU stay with ETC in physiologically stable patients [6,7]. Early definitive fixation has been associated with improved pulmonary function, reduced ventilator days, and earlier return to daily activities, especially in long bone fractures [6].

The duration of ICU stay and hospital stay were significantly longer in the DCO group in our study. This finding aligns with previous studies indicating prolonged hospitalization due to staged surgical procedures, delayed mobilization, and higher complication rates [4,7]. Feingold *et al.,* in a recent national database analysis, also reported increased length of stay and healthcare costs associated with DCO strategies in comparison to ETC [8].

An important aspect highlighted by the present study is the need for individualized treatment strategies based on patient physiology rather than a uniform approach. Recent literature emphasizes the concept of "Safe Definitive Surgery (SDS)" or "Early Appropriate Care," where patients are stratified based on metabolic and physiological parameters before deciding between DCO and ETC [9,10]. This approach allows clinicians to optimize timing of definitive fixation and avoid unnecessary delays or complications.

The findings of this study are particularly relevant in the context of Bihar and similar resource-limited settings. Delayed referral, inadequate prehospital care, and high rates of severe trauma often necessitate the use of DCO as an initial stabilization strategy. However, once physiological stability is achieved, early conversion to definitive fixation may improve functional outcomes and reduce hospital burden. Therefore, strengthening trauma systems, improving early resuscitation, and establishing standardized treatment protocols are essential for optimizing outcomes in such settings.

Despite its strengths, this study has certain limitations. Being an observational study, treatment allocation was not randomized and may be influenced by selection bias. The sample size was moderate and from a single center, which may limit generalizability. Additionally, long-term functional outcomes beyond three months were not assessed. Future multicentric randomized studies with longer follow-up are required to establish definitive guidelines for DCO versus ETC in Indian trauma populations.

The present study supports the current paradigm that DCO is essential for unstable polytrauma patients, while ETC provides superior functional and recovery outcomes in stable patients. A physiology-based individualized approach remains the cornerstone of modern orthopedic trauma care.

## CONCLUSION

Damage control orthopedics remains vital for hemodynamically unstable polytrauma patients, preventing physiological deterioration. However, early total care offers superior functional recovery, shorter hospitalization, and fewer complications in stable patients. Individualized, physiology-based decision-making is essential to optimize survival and rehabilitation outcomes.

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