**ORIGINAL RESEARCH**

# Strategic decision-making in pediatric traumatic brain injury: leveraging repeat ct scans for enhanced treatment planning

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**ABSTRACT**

**Introduction**: The complexity of TBI in the pediatric population is compounded by the dynamic nature of the developing brain, which responds differently to injury compared to the adult brain. **Objectives:** To assess the strategic decision-making in pediatric traumatic brain injury and leveraging repeat CT scans for enhanced treatment planning. **Methodology:**This randomized controlled trial (RCT) and a total of 324 patients were enrolled, with 162 patients assigned to each group. The sample size calculation was determined using appropriate power and effect size to ensure statistical reliability.Consecutive sampling was employed to recruit all eligible patients meeting the inclusion criteria until the desired sample size was reached. **Results:** Repeat CT scans led to significant treatment adjustments in the intervention group (45%) compared to the control group (18%, $p < 0.001$). GCS improvement was higher in the intervention group (mean increase of 3.5 vs. 2.1 points; $p = 0.004$), and complication rates were lower (15% vs. 25%; $p = 0.02$). The intervention group also had a shorter average hospital stay (8.2 vs. 10.4 days; $p = 0.01$). Mortality differences were not statistically significant ($p = 0.14$). **Conclusion**: It is concluded that scheduled repeat CT scans in pediatric TBI cases improve treatment planning by enabling timely adjustments, resulting in better neurological outcomes and shorter hospital stays.

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## INTRODUCTION

Pediatric traumatic brain injury (TBI) remains a significant public health concern, contributing to high morbidity and mortality rates among children worldwide. The complexity of TBI in the pediatric population is compounded by the dynamic nature of the developing brain, which responds differently to injury compared to the adult brain. Effective management of pediatric TBI is critically dependent on accurate diagnosis, timely intervention, and ongoing assessment to mitigate potential complications and optimize recovery outcomes [1].Head injury is now common in children as it is the most common reason for children to visit the emergency department, including severe and minor TBI/ Concussion. ciTBI is less than 1% in the pediatric patients with MHT, while cranial CT is extending its usage commonly. While CT scan in high risk group is an essential component in management, the use of CT scans in the low risk groups provides little diagnostic value and puts the child in jeopardy of getting a dangerous amount of radiation [2]. In EDs in the USA, as many as 69 % of children, who require emergency care are treated in hospitals that have less than 15 visits daily and poor or even fair quality of pediatric care. The strategies for advancing translated evidence-based pediatric emergency department care for improving general EDs ' pediatric readiness are collaborative initiatives of the American Academy of Pediatrics and the American College of Emergency Physicians [3].

One of the most pivotal tools in the assessment and management of TBI is computed tomography (CT) scanning. CT imaging provides rapid, detailed visualization of intracranial injuries, enabling clinicians to identify hemorrhages, contusions, fractures, and other critical pathologies that require immediate attention [4]. However, the utility of repeat CT scans in pediatric TBI remains a topic of debate, primarily due to concerns about cumulative radiation exposure and its long-term risks [5].Despite these concerns, repeat CT scans can play a crucial role in



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the strategic decision-making process, offering updated insights into the progression or resolution of intracranial injuries [6].

This is particularly important in the pediatric context, where initial scans may not fully capture the evolving nature of the injury, and clinical symptoms alone may not provide a complete picture. Repeat imaging can inform critical decisions regarding the need for surgical intervention, adjustment of therapeutic strategies, and the evaluation of potential complications such as delayed hemorrhage or swelling [7].

## OBJECTIVES

- To assess the strategic decision-making in pediatric traumatic brain injury and leveraging repeat CT scans for enhanced treatment planning

## METHODOLOGY

This randomized controlled trial (RCT) was conducted at---------- during----------. A total of 324 patients were enrolled, with 162 patients assigned to each group. The sample size calculation was determined using appropriate power and effect size to ensure statistical reliability.Consecutive sampling was employed to recruit all eligible patients meeting the inclusion criteria until the desired sample size was reached.

### Inclusion Criteria

- Patients aged <12 years
- Confirmed diagnosis of TBI based on clinical and imaging findings

### Exclusion Criteria

- Patients with severe contraindications to repeat CT scans
- Patients requiring immediate surgical intervention without delay

### Data Collection Procedure

After obtaining ethical clearance from the hospital's ethical review board, eligible patients who met the inclusion and exclusion criteria were recruited consecutively from the hospital's emergency department or trauma unit. Each patient's guardian provided informed consent before enrollment. Upon enrollment, demographic details such as age, sex, and relevant medical history were documented. An initial clinical assessment, including the Glasgow Coma Scale (GCS) score, was conducted, along with baseline CT imaging to confirm TBI and assess intracranial pathology.

### Randomization and Intervention

Participants were randomized into two groups:

1. **Intervention Group**: Patients underwent scheduled repeat CT scans at predetermined intervals to monitor intracranial changes and guide treatment decisions.
2. **Control Group**: Patients received a single initial CT scan without subsequent scheduled imaging unless clinically indicated.

Neurological assessments were conducted for all patients at baseline and follow-up intervals to track functional outcomes and changes over time.

### Statistical Analysis

Data analysis was conducted using SPSS version 17. Descriptive statistics summarized demographic and clinical data, while inferential statistics, including t-tests or chi-square tests, compared outcomes between the intervention and control groups. Multivariate analysis adjusted for potential confounders to evaluate the effect of repeat CT imaging on treatment planning effectiveness and overall patient outcomes. The primary outcome focused on whether repeat CT scans enhanced clinical decision-making, leading to improved neurological outcomes and reduced complications.

## RESULTS

Data were collected from 324 patientswith 162 patients in both the intervention and control groups. The mean age of participants was comparable between groups, with the intervention group averaging 6.5±1.23 years and the control group 6.7±0.98 years. Gender distribution was similar as well, with males comprising 51% and 52% of the intervention and control groups, respectively, and females representing 49% and 48%.

**Table 1: Demographics and Baseline Characteristics**

| Characteristic | Intervention Group (n=162) | Control Group (n=162) |
|---|---|---|
| **Number of Patients** | 162 | 162 |
| **Mean Age (years)** | 6.5±1.23 | 6.7±0.98 |
| **Male (%)** | 51% | 52% |
| **Female (%)** | 49% | 48% |

The intervention group showed a significantly higher rate of treatment adjustments compared to the control group, with 45% (73 patients) experiencing changes in treatment plans versus 18% (29 patients) in the control group. Adjustments in ICU monitoring were notably more frequent in the intervention group at 25% (40 patients), compared to 10% (16 patients) in the control group. Similarly, medication adjustments occurred in 15% (24 patients) of the intervention group versus 6% (10 patients) in the control group. Early surgical interventions were also slightly more common in the intervention group, with 5% (9



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patients) compared to 2% (3 patients) in the control group.

**Table 2: Primary Outcome - Changes in Treatment Decisions**

| Outcome | Intervention Group (n=162) | Control Group (n=162) |
|---|---|---|
| **Treatment Decision Changes (%)** | 45% (73) | 18% (29) |
| **ICU Monitoring Adjustment (%)** | 25% (40) | 10% (16) |
| **Medication Adjustment (%)** | 15% (24) | 6% (10) |
| **Early Surgical Intervention (%)** | 5% (9) | 2% (3) |

The intervention group demonstrated a greater improvement in Glasgow Coma Scale (GCS) scores, with a mean increase of 3.5 points compared to 2.1 points in the control group. The complication rate was lower in the intervention group at 15% (24 patients) versus 25% (40 patients) in the control group, indicating that repeat CT scans may have contributed to better patient management and reduced adverse events. Mortality rates were slightly lower in the intervention group at 4% (6 patients) compared to 7% (11 patients) in the control group, though this difference was not statistically significant.

**Table 3: Secondary Outcomes - Neurological and Complication Rates**

| Outcome | Intervention Group (n=162) | Control Group (n=162) |
|---|---|---|
| **Mean GCS Score Improvement** | 3.5 | 2.1 |
| **Complication Rate (%)** | 15% (24) | 25% (40) |
| **Mortality Rate (%)** | 4% (6) | 7% (11) |

The average hospital stay was significantly shorter for patients in the intervention group, with a mean duration of 8.2 days compared to 10.4 days in the control group. This reduction in length of stay suggests that repeat CT scans may have facilitated more effective treatment adjustments, allowing for quicker recovery and discharge.

**Table 4: Length of Hospital Stay**

| Outcome | Intervention Group (n=162) | Control Group (n=162) |
|---|---|---|
| **Average Hospital Stay (days)** | 8.2 | 10.4 |

## DISCUSSION

This randomized controlled trial assessed the value of repeat CT scans in pediatric patients with traumatic brain injury (TBI), focusing on how scheduled imaging impacts treatment planning and patient outcomes. The study is an indication that a successive CT scan can cause more frequent changes to the treatment plan and in the process enhance the patients' quality of care. Treatment modifications were ten times more frequent among the intervened group compared to the control group, significantly more so when repeated imaging revealed the necessity (45% vs 18%). Follow-up scans enabled clinicians to identify changes in brain injuries over time and adapt cellular processes of IC usage and medications [8]. They showcase that multiple CT scans, although often criticized, are useful to capture alterations in intracranial pathology not visible on the first scan that might inform further therapies and prevent secondary conditions [9].That it was achieved in a shorter time, and there was a marked improvement in GCS in the intervention group, may well point to the effectiveness of repeat CT imaging in monitoring brain injuries and their management. Moreover, the subject in the intervention group has significantly less complicate, such as seizure and intracranial pressure [10]. Again, due to insufficient sample size, statistical differences in mortality rates were not seen in the study; notwithstanding, the lower complication incidence in the intervention arm implicates that repeat imaging can be protective in the detection of potentially lethal, fatal conditions and translate to more aggressive therapeutic strategies. The actual decrease in mean hospital stay for the repeat CT scan patients (8.2 against 10.4 days) proves that improved surveillance can enhance the healing process as complications can be acted upon immediately [11]. This is clinically practiced since it enhances patient success besides efficaciously managing total hospital stay cutting down costs and resource utilization. Based upon these findings, it may be seen that a protocol with repeat scans may be beneficial for pediatric TBI cases, as long as imaging is done in a carefully planned manner without significantly raising radiation levels [12]. The age of paediatric patients makes them especially sensitive to radiation; therefore, establishments that use scans should strive to ensure scans are administered based on the need thereof. Future studies could probably focus on differential indications for repeat imaging, how the severity of clinical symptoms or GCS changed or worsened to make Imaging more mill better defined [13].

There are however some limitations in this study which include the following. First, the patients were recruited from a single institution and this kind of restricts the generalization of results. Second, although the number of patients enrolled set us up to



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find large differences, a multicenter clinical trial could give clearer data about the number of patients' deaths. Future work should also look at a longer follow-up to understand how repeat CT imaging influences neurological status and recovery profiles in kids with TBI. Furthermore, improvement in imaging techniques that emit minimum radiation can make repeatability of CT scan more standard in pediatric trauma.

## CONCLUSION

It is concluded that scheduled repeat CT scans in pediatric TBI cases improve treatment planning by enabling timely adjustments, resulting in better neurological outcomes and shorter hospital stays. The findings support the strategic use of repeat imaging to enhance patient monitoring and care, though further research is recommended to optimize imaging intervals and protocols.

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