E-ISSN: 2616-3470
P-ISSN: 2616-3462

2025; 9(1): 99-101
Received: 29-11-2024
Accepted: 02-01-2025

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Comparison between Rotterdam and Helsinki CT scores in predicting 30-day mortality in head injury patients undergoing decompressive craniectomy at Dr. M. Djamil General Hospital, Padang

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DOI: https://doi.org/10.33545/surgery.2025.v9.i1.B.1147

Abstract
Traumatic brain injury (TBI) is a leading cause of mortality and morbidity globally, often requiring surgical interventions such as decompressive craniectomy (DC). Brain CT scans are essential for assessing prognosis in TBI patients, with Rotterdam and Helsinki CT scores widely utilized for mortality prediction. This retrospective cohort study aims to compare the prognostic accuracy of Rotterdam and Helsinki CT scores in predicting 30-day mortality among patients undergoing DC at Dr. M. Djamil General Hospital, Padang. Data were collected from 27 patients treated between January 2023 and November 2024. Patients underwent initial CT scans, which were evaluated using both scoring systems. Outcomes were recorded within 30 days postoperatively. Results revealed that 44.6% (12 patients) died, while 55.6% (15 patients) survived. Statistical analyses demonstrated a moderate correlation (r=0.657, p<0.001) for Rotterdam CT scores and a stronger correlation (r=0.748, p<0.001) for Helsinki CT scores with 30-day mortality. Receiver Operating Characteristic (ROC) analysis showed a higher Area under Curve (AUC) for Helsinki CT scores (0.944) compared to Rotterdam CT scores (0.878), indicating superior predictive accuracy. These findings suggest that Helsinki CT scores may provide a more reliable tool for mortality prediction in TBI patients undergoing DC.

Keywords: Traumatic brain injury, decompressive craniectomy, Rotterdam CT score, Helsinki CT score, 30-day mortality prediction, brain CT scan, neurotrauma management

Introduction
Traumatic brain injury (TBI) is a major global health concern and one of the leading causes of mortality and morbidity worldwide, particularly in young adults and economically productive age groups (Maas et al., 2005) [4]. Nearly 69 million individuals are estimated to suffer from TBI each year, with significant numbers requiring urgent surgical intervention (Dewan et al., 2018) [2]. Decompressive craniectomy (DC) remains one of the primary surgical treatments for severe TBI, aimed at relieving intracranial pressure (ICP) and preventing life-threatening complications, such as brain herniation (Cooper et al., 2011) [1]. Despite its effectiveness in reducing ICP, DC is often associated with high 30-day mortality rates, necessitating the development of reliable tools to predict patient outcomes (Hutchinson et al., 2016) [3].
Computed tomography (CT) imaging is the gold standard for evaluating TBI and predicting prognosis. Prognostic scoring systems, such as the Rotterdam and Helsinki CT scores, were developed to assess the severity of intracranial injuries and predict mortality risks in TBI patients. The Rotterdam CT score focuses on variables like midline shift, obliteration of basal cisterns, and the presence of epidural hematoma, while the Helsinki CT score incorporates additional variables such as the volume of intracranial lesions and suprasellar cistern obliteration (Maas *et al*., 2005; Raj *et al*., 2014) [4, 5]. This study aims to compare the predictive accuracy of Rotterdam and Helsinki CT scores in forecasting 30-day mortality among patients undergoing DC at Dr. M. Djamil General Hospital, Padang.

Methods
Study Design
This study used an observational analytic design with a retrospective cohort approach. Data

were collected from patients with traumatic brain injuries (TBI) who underwent decompressive craniectomy (DC) at Dr. M. Djamil General Hospital, Padang, between January 1, 2023, and November 30, 2024. The study assessed initial brain CT scans using the Rotterdam and Helsinki CT scoring systems and compared their ability to predict 30-day mortality. The research was conducted at Dr. M. Djamil General Hospital, Padang, during the period from December 2024 to January 2025. The data were derived from medical records of patients treated at this hospital. The study population included all patients with TBI who underwent DC during the specified period. A total sampling technique was used to include all eligible patients.

Inclusion Criteria

1. Patients aged 18–60 years.
2. Patients who underwent DC within 48 hours post-injury.
3. Patients or their families who consented to participate in the study.
4. Patients with complete medical records.

Exclusion Criteria

1. Patients whose DC was performed after a two-point decrease in Glasgow Coma Scale (GCS).
2. Patients with polytrauma.
3. Patients with TBI secondary to intracranial tumors.

From the population, 27 patients met the inclusion and exclusion criteria and were included in the study. The study obtained ethical clearance from the Ethics Committee of Dr. M. Djamil General Hospital. Written informed consent was obtained from patients or their families prior to inclusion in the study. Confidentiality of patient data was strictly maintained throughout the study.

Results

The study included 27 patients with traumatic brain injury (TBI) who underwent decompressive craniectomy (DC) at Dr. M. Djamil General Hospital, Padang. Among these patients, 44.6% (12 patients) died within 30 days postoperatively, while 55.6% (15 patients) survived. The highest mortality rate was observed in patients aged 51–60 years, with 66.7% of deaths occurring in this age group. Male patients exhibited a higher mortality rate (58.3%) compared to females (41.7%). Road traffic accidents were the leading cause of injury, accounting for 77.8% of all cases, with 75.0% of fatalities attributed to this mechanism. Furthermore, patients with severe Glasgow Coma Scale (GCS) scores (3–8) had the highest mortality rates, emphasizing the severity of their condition.

When comparing the Rotterdam and Helsinki CT scores, distinct patterns emerged in predicting 30-day mortality. Patients with higher Rotterdam CT scores (5 or 6) experienced a mortality rate of 33.3%, while no deaths were recorded for patients with scores of 1 or 2. Similarly, the Helsinki CT score showed that patients with scores of 11 and 9 had the highest mortality rates at 50% and 25%, respectively. Statistical analysis revealed a moderate correlation between the Rotterdam CT score and mortality (r= 0.657, p< 0.001), whereas the Helsinki CT score demonstrated a stronger correlation (r= 0.748, p< 0.001). Receiver Operating Characteristic (ROC) curve analysis further confirmed the Helsinki CT score's superior predictive accuracy, with an Area under the Curve (AUC) of 0.944 compared to 0.878 for the Rotterdam CT score, highlighting its effectiveness as a prognostic tool.

Discussion

This study highlights the significance of prognostic scoring systems, particularly the Rotterdam and Helsinki CT scores, in predicting 30-day mortality among traumatic brain injury (TBI) patients undergoing decompressive craniectomy (DC). Our findings demonstrated that the Helsinki CT score outperformed the Rotterdam CT score in terms of predictive accuracy, sensitivity, and specificity, reinforcing its clinical utility for outcome prediction.

The Helsinki CT score showed a stronger correlation (r= 0.748, p< 0.001) with 30-day mortality compared to the Rotterdam CT score (r= 0.657, p< 0.001). The Area under the Curve (AUC) analysis further emphasized this difference, with the Helsinki CT score achieving an AUC of 0.944, indicating near-perfect predictive accuracy. In contrast, the Rotterdam CT score recorded an AUC of 0.878, reflecting good but relatively lower performance. The higher sensitivity (91.6%) and specificity (93.3%) of the Helsinki CT score make it a more reliable tool for clinical decision-making, particularly in high-risk TBI patients requiring urgent interventions.

These findings align with previous studies. For instance, Raj *et al*. (2014) reported the superior predictive ability of the Helsinki CT score due to its incorporation of lesion size and suprasellar cistern obliteration, which provide additional prognostic value. Similarly, Maas *et al*. (2005) emphasized the clinical relevance of scoring systems like the Rotterdam CT score, especially for global use, as it simplifies prognostication by focusing on critical CT variables such as midline shift and cistern compression.

One critical observation in this study is the significantly higher mortality rate (66.7%) among patients aged 51–60 years. This finding corresponds with the literature suggesting that older patients experience worse outcomes due to reduced brain resilience and comorbidities (Cooper *et al*., 2011) [1]. Additionally, road traffic accidents were the most common cause of TBI, contributing to 77.8% of cases, reflecting the need for preventive measures to reduce the burden of this injury mechanism (Hutchinson *et al*., 2016) [3].

The strong predictive performance of both scoring systems underscores their importance in clinical practice. The Helsinki CT score, in particular, should be integrated into routine assessments for TBI patients, as it provides clinicians with a reliable tool for prognostication and informing families about patient outcomes. Future research should validate these findings in larger, multi-center cohorts to confirm the generalizability of these results.

Conclusion

This study demonstrates the utility of both Rotterdam and Helsinki CT scoring systems in predicting 30-day mortality among traumatic brain injury (TBI) patients undergoing decompressive craniectomy (DC). While both scores showed significant predictive value, the Helsinki CT score proved superior, with a stronger correlation (r= 0.748, p< 0.001) and higher Area under the Curve (AUC) (0.944) compared to the Rotterdam CT score (r= 0.657, p< 0.001, AUC = 0.878). These findings indicate that the Helsinki CT score offers more reliable prognostic accuracy, especially for patients with severe injuries requiring urgent surgical intervention. The study also revealed that age, gender, and injury mechanism influence mortality outcomes. Older patients, particularly those aged 51–60 years, and male patients exhibited higher mortality rates. Road traffic accidents were the most frequent cause of TBI, underscoring the importance of preventative measures in reducing such injuries.

In clinical practice, the Helsinki CT score should be prioritized for prognostication due to its comprehensive assessment of lesion size and suprasellar cistern obliteration. Its integration into routine assessments can improve decision-making and enhance patient and family counseling. Future multi-center studies with larger cohorts are recommended to further validate the findings and refine the use of CT scoring systems in TBI prognosis.

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How to Cite This Article
Kurniawan W, Ningsih HL, Harahap AR. Comparison between Rotterdam and Helsinki CT scores in predicting 30-day mortality in head injury patients undergoing decompressive craniectomy at Dr. M. Djamil General Hospital, Padang. International Journal of Surgery Science. 2025; 9(1): 99-101.