ISSN: 2577-2996

PROGRESS IN MEDICAL SCIENCES, 2025
VOL 9, NO. 3, PAGE 1 – 5
DOI: doi.org/10.47363/PMS/2025(9)232

RESEARCH ARTICLE

Open Access

Three Years follow up after Early Diagnosis of Cognitive Impairment in Mild Traumatic Brain Injury

Sofia Mandalà[1,2], Manfredi Martorana[1], Maria Luisa Capuana[3] and Giorgio Mandalà[3]*

[1]U.O.C. Physical and Rehabilitation Unit, Buccheri La Ferla Fatebenefratelli Hospital Palermo, Italy

[2]Healthcare and Rehabilitation Center ARESS Fabiola Termini Imerese, Palermo, Italy

[3]U.O.C. Neurorehabilitation, Villa delle Ginestre Hospital, Provincial Health Authority Palermo, Italy

ABSTRACT

Background: Traumatic brain injury (TBI) is the first cause of death and disability in the young and active population. In the context of TBI, Mild Traumatic brain Injury (m-TBI) is frequent and it is often associated with transient cognitive disorders.

Aim: The aim of this study was to promote the early diagnosis of cognitive and behavioral disorders in patients with m-TBI and to prevent under-diagnosed and long-term symptoms, reducing the risk of a decline in patient's quality life.

Design: A Longitudinal observational study was conducted on subjects who received diagnosis of m TBI in emergency department along a period of time between October 2018 and June 2021.

Setting: Patients were primarily evaluated in Emergency Department of the Buccheri La Ferla Hospital in Palermo. Rehabilitation and follow-ups were conducted in Physical and Rehabilitation Medicine Unit of the same medical center.

Population: 520 patients were registered with a diagnosis of Head Trauma in Emergency Rooms during the observational period. 65 patients (12,5%) had a diagnosis of non-commotional head injury and therefore the possibility of being part of the study. 49 patients were included, 9 patients were excluded, 4 patients refused to be part of the study. The average age was 46,7 years.

Methods: a first neuro-psychological evaluation of the patient with m-TBI was conducted within 48 hours of the event. Anamnestic data were collected and standardized neuro-psychological screening tests were administered. Patients were followed up by a team of doctors and neuro-psychologists for a period of 12 months in order to monitor cognitive and behavioral condition. Patients with a cognitive deficit underwent to neuro-psychological rehabilitation.

ARTICLE HISTORY

Received May 09, 2025
Accepted May 13, 2025
Published May 20, 2025

Introduction

Traumatic Brain Injury (TBI) is the leading cause of death and disability in the young and active population [1,2]. Brain injuries, especially severe ones, are the cause of high healthcare costs and loss of productivity [3]. In the context of TBI, mild- Traumatic Brain Injury (m-TBI) is the most common and it is often associated with transient cognitive disorders. Mild injuries can cause persistent cognitive and / or behavioral deterioration [4].

According to the A.C.R.M., patients with minor head injury have physiological disruption of brain function trauma-induced. Patient with diagnosis of m-TBI can show one of the following symptoms: loss of consciousness; memory loss for events immediately preceding or following the accident; disorientation and confusion; transient or persistent focal neurologic deficits. Generally the severity of injury does not exceed unconsciousness of 30 minutes or less; a Glasgow Coma Scale (GCS) of 13–15 points after 30 minutes; post-traumatic amnesia (PTA) not exceeding 24 hours [5]. The aim of the trial was to build a protocol for the early diagnosis of cognitive and / or behavioral deficits in patients with m-TBIin the hours following the event. The cognitive assessment protocol was tested on a sample of patients from the hospital emergency room.

The study has been conducted in order to promote early diagnosis and secondary prevention of underdiagnosed or later onset symptoms and to reduce the risk of a decline of the patient's quality of social, work and family life.

Materials and Methods

Preliminary analysis was obtained on expected results (expected results/research objective), characteristics of the context

Contact: Giorgio Mandala, U.O.C. Neurorehabilitation, Villa delle Ginestre Hospital. Provincial Health Authority, Palermo Italy.

(opportunities and limits), roles and resources available (higher work experience, availability, financial resources, time, etc.). Possible actions, resources, times have been identified. The team assessed expected outcomes, context, available resources, and structured the project objectives and evaluation protocol.

Recruitment and Evaluation

Patients were recruited within 24–48 hours of ER admission. Those with abnormal test results began neuropsychological rehabilitation and all underwent follow-up. The team structured the project deciding its specific objectives and structuring patients' evaluation protocol. Research sample was recruited within 24/48 hours from the patient's arrival at the emergency room. Patients with subnormal test results started neuropsychological rehabilitation treatment and subsequent follow-up for all patients.

Project timeline

1st year: patient recruitment, cognitive assessment and eventual rehabilitation; strict follow-up.

2nd year: follow-up, reporting.

3nd year: follow-up, reporting.

Assessment tools

The assessment of cognitive-behavioral deficits was made by the team of neuropsychologists using a battery of cognitive tests in association with a general screening test for the presence of any psychiatric symptoms at the emergency room.

- Informed consent and patient information guide
- Symptom Checklist-90-Revised (SCL-90R) for behavioral assessment (as needed)
- Anamnestic questionnaire
- Galveston Orientation and Amnesia Test (GOAT)
- Mini Mental State Examination (MMSE)
- Esame Neuropsicologico Breve 2 (ENB2)
- Frontal Assessment Battery (FAB)
- Telephone interviews

From October 2018 to November 2019, 520 patients were registered with a diagnosis of head injury in the emergency room of our hospital. But only 12.5% (65 patients) had a diagnosis of non concussive head injury and therefore the possibility of being part of the study. But 9 patients were excluded based on the established criteria, 4 patients refused to participate in the research project. The remaining 49 patients (32 men and 17 women) were recruited and subjected to neuropsychological evaluation.

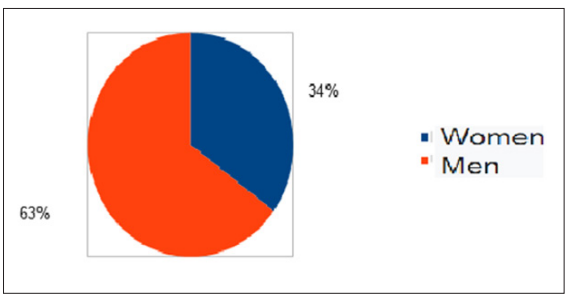

Figure 1: Distribution of the sample by gender (percentage values)

Inclusion Criteria

- o Non-concussive TBI-m
- o TBI-m loss of consciousness less than 24h
- o Age from 16 to 79

Exclusion criteria

- o Dementia
- o Psychiatric disease
- o Neurodegenerative diseases
- o Intellectual disabilities

Sample Characteristics

- 49 patients (32 men, 17 women); average age 46.7 years
- Low educational level (mean 8.73 years of schooling)

The group of patients evaluated had an average age of 46.7 years; the average age of male sample was 43.66 years; the average age of female one was 53.35 years. Furthermore, the sample has a low level of education (average 8.73); specifically, the average schooling of the male sample is 8.81 and the female one is 8.82.

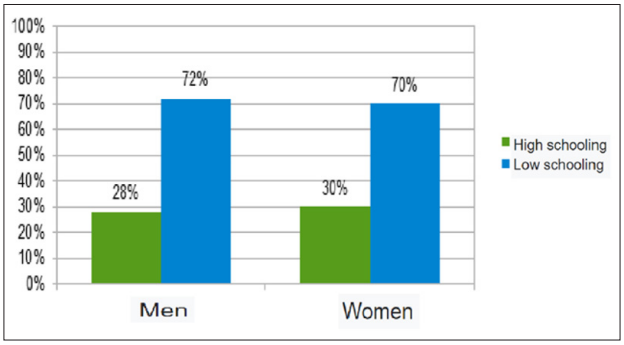

Figure 2: Level of Education of the Sample Divided by Gender (Percentage Values)

Causes of Injury

The causes of m-TBI were: road accidents (25 cases), domestic accidents (15 cases), scuffle (3 cases), workplace accident (2 cases), other (4 cases).

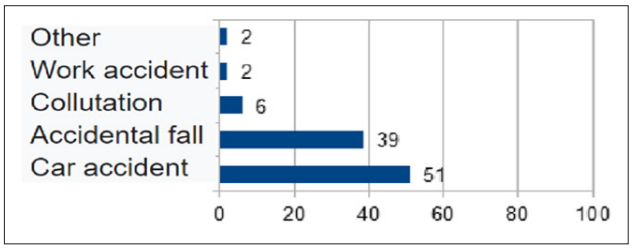

Figure 3: Subdivision of the Sample (N49) by Cause of Minor Head Injury (Percentages)

Within 48 hours of admission to the emergency room, patients were administered tests for the neuropsychological and behavioral assessment. The neuropsychologists evaluated the possibility of starting a cognitive rehabilitation process based on the scores obtained on the cognitive testingtools administered, focusing on rehabilitation of cognitive functions that were found to be deficient.

Data Management

Patient data were stored securely and privacy protected. Informed consent and explanatory materials were provided.

A database of patients in excel format has been prepared, kept using passwords, to protect of privacy. An informed consent form and an explanatory guide on the risks of m-TBI were prepared for emergency room patients. Team meetings were held to monitor the progress of the project.

Materials, Tests and Cognitive Tools used at T0 and during follow up

- informed consent.
- Information guide for the patient on m-TBI with a list of possible symptoms that may show up later, both cognitive, physical and psychological symptoms, suggesting the patient to go to the emergency room in the in case he noticed any of these symptoms.
- Symptom Checklist-90-Revised, SCL 90R (Prunas A. and Derogatis LR, 2011), used only if the neuropsychologist wants to investigate behavioral functioning.
- Questionnaire for anamnestic data.
- Galveston Orientation and Amnesia Test, GOAT (Levin et al. 1979; Crovitz, 1987; MacMillan et al. 1996).
- Neuropsychological Screening Test 15-79years:

o Mini Mental State Examination, MMSE (Measso G., Cavarzeran F., Zappalà G. et al. 1993);

o Esame neuropsicologico breve 2, ENB2 (Mondini, Mapelli, Vestri, Arcara e Bisiacchi, 2011);

o FrontalAssessmentBattery, FAB (Apollonio I, et al. 2005).

- Telephone interview.

Results

At baseline (T0), 41% of patients showed cognitive deficits. At all, 41% of the 49 patients at T0 (first evaluation carried out in the emergency room) presented deficient scores for some of the cognitive functions evaluated.

- **Main Deficits**
- Executive functions (34.7%)
- Auditory-verbal memory, divided attention, comprehension (31%)
- Abstraction (14%)
- Cognitive estimates (29%)
- Patients with lower education showed more frequent deficits in memory, comprehension, and praxis.
- No behavioral deficits were detected.
- 30% of cognitively impaired patients accepted neuropsychological rehabilitation (one session/week).
- Follow-up every three months; rehabilitation stopped upon normalization of results.
- Dropout rate: 20% (mainly due to perceived lack of symptoms or COVID-19 restrictions).
- Project suspended March–May 2020 due to COVID-19; follow-up resumed by telephone in 2021.
- Telephone follow-up (49 patients):
- 51% reported no disturbances
- 18% reported depressive symptoms
- 16% reported attention/memory difficulties
- 8% declined to answer
- 6% untraceable

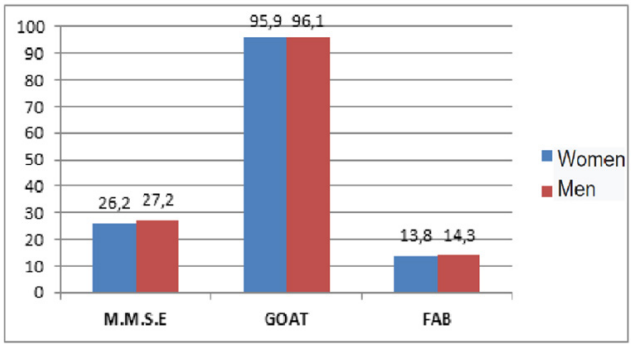

Figure 4: Test Results Divided by Gender, Average Values (MMSE; GOAT; FAB)

Raw analysis of patients's evaluation showed

o deficit of executive functions (measured by the Frontal Assessment Battery test)in 34.7% of the patients evaluated

o deficits in auditory-verbal short and long-term memory (m. deferred prose), divided attention (Trial B) and understanding (Token test) in 31% of cases

o deficit of abstractionin 14% of cases

o deficient results in the sub-test of cognitive estimatesin 29% of the patients evaluated.

Differences in deficits were also found between subjects with high and low educational attainment. Patients with low schooling present with greater frequent deficits regarding cognitive functions of memory, understanding and praxis skills. None of the patients exhibited behavioral deficits.

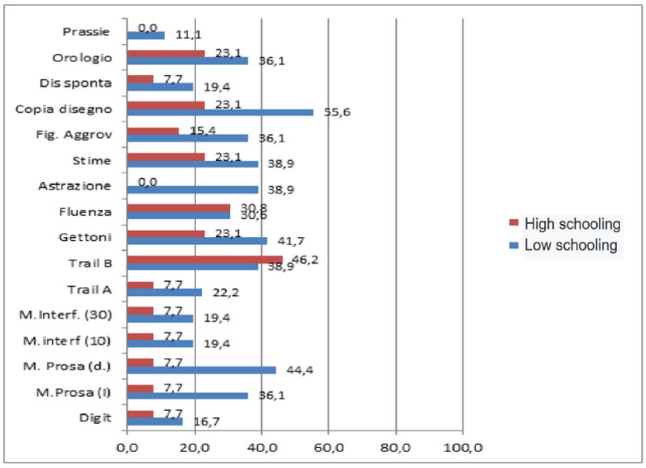

Figure 5: Presence of cognitive deficits in ENB-2 sub-tests in subjects with low education (1 - 10) and with high schooling (11-17), percentage values

Among patients with cognitive impairment, the 30% accepted the proposal to undergo a neuropsychological rehabilitation treatment. They did one hour of therapy at week with a neuropsychologist, member of the research project team. An evaluation follow-up was carried out every three months to evaluate the cognitive functioning of the patients. The rehabilitation process was

interrupted when the result was normal.

During the months of the study, a dropout percentage was detected at the various follow-up phases. 20% of patients did not deem it necessary to carry out subsequent neuropsychological assessments, stating that they do not have cognitive disorders or do not want to go to hospital due to the restrictions derived from the covid-19 health emergency.

In the months of March, April, May 2020 the project was suspended due to the Covid-19 health emergency. In recent months, many patients should have had a follow-up one year after the event. From June 2020, a follow-up neuropsychological evaluation was offered to the patients, but they refused to follow up for fear of hospitals during the COVID-19 pandemic.

During the first half of the year 2021, the work team contacted the patients by telephone to obtain information on their psycho-physical health. The data collected by neuropsychologists by telephone from patients (49 pcs):

- 51% not reported any disturbances in the year following the traumatic event;
- 18% of patients described depressive behavioral symptoms;
- 16% said of attention and memory difficulties;
- 8% did not want to answer the telephone interview;
- 6% of patients were not tracked.

Discussion

TBI remains a significant health challenge, with outcomes influenced by injury severity and psychological factors. m-TBI is heterogeneous and post-concussion syndromes are often underrecognized. Early neuropsychological assessment enables identification and intervention for cognitive/behavioral sequelae. The study confirms the need for standardized, multidisciplinary evaluations and large-scale, longitudinal research to clarify risk factors and optimize management. The COVID-19 pandemic significantly impacted follow-up compliance.

Traumatic brain injury (TBI) is a public health problem. After a brain injury, treatment and degree of recovery vary between patients based on the severity of the trauma. Psychological factors such as emotional distress, maladaptive coping strategies and mental health problems experienced soon after TBI are predictive of a bad outcome.

Head trauma is a heterogeneous pathology. Syndromes post m-TBI are difficult to recognize and treat. Early evaluation of these patients allows to recognize if there are temporary and reversible alterations of brain functions.

In cases of m-TBI, early intervention by the neuropsychologist makes it possible to prevent cognitive and/or behavioral effects, secondary to the trauma. Research shows that both single and multiple m-TBI induce pathophysiological changes in the brain, but the high degree of heterogeneity in the results supports the need to define the m-TBI classification systems.

Some patients do not realize or admit the extent of their symptoms until their psychosocial functioning is compromised [6-15].

Progress in understanding has often been hampered by inconsistent classification and varying assessment procedures. Need to be explored mechanisms underlying post-concussion symptoms and the role of pre- and post-injury factors

In these terms, neuropsychological tests after m-TBI could support the diagnosis of post-concussion symptoms. It would be necessary to ensure complete and multidisciplinary evaluations for patients.

We need trials to address challenges in studying post-concussion symptoms, multidimensional longitudinal and large-scale prospective, as they would allow subgroup analyzes. The goal should be to identify patients at risk of developing persistent symptom and to allow an accurate diagnosis and management of the different manifestations of m-TBI, considering the overall incidence of the disorder (42 million people every year all over the world) and the different therapeutic implications [16-24].

References

[1] Buki A, Kovacs N, Czeiter E, Schmid K, Berger RP, et al. Minor and repetitive head injury. Adv Tech Stand Neurosurg. 2015; 42: 147-192.

[2] Wouter P, van den Brande R, Polinder S, Brazinova A, Steyerberg EW, et al. Epidemiology of traumatic brain injury in Europe. Acta Neurochir. 2015; 157: 1683-1696

[3] Kraus MF, Susmaras T, Caughlin BP, Walker CJ, Sweeney JA, et al. White matter integrity and cognition in chronic traumatic brain injury: a diffusion tensor imaging study. Brain. 2007; 130: 2508-2519.

[4] Kay T, Harrington DE. Definition of mild traumatic brain injury Developed by the Mild Traumatic Brain Injury Committee of the Head Injury Interdisciplinary Special Interest Group of the American Congress of Rehabilitation Medicine. J Head Trauma Rehabil. 1993; 8: 86-87.

[5] Benson C. Diffuse Axonal Injury. Encyclopedia of the Neurological Sciences (Second Edition). 2014; 998-999.

[6] Cavatorta S. Inquadramento clinico e approccio riabilitativo del trauma cranico lieve. Rivista Medica. 1999; 5: 1-2.

[7] Nelson LD, Temkin NR, Dikmen S, Barber J, Joseph T Giacino, et al. Recovery After Mild Traumatic Brain Injury in Patients Presenting to US Level I Trauma Centers a Transforming Research and Clinical Knowledge in Traumatic Brain Injury (TRACK-TBI) Study Article Information. JAMA Neurol. 2019; 76: 1049-1059.

[8] Stocker R, Letta C. Minor Head Injury- a Silent Epidemic. Praxis (Bern 1994). 2016; 105: 569-575.

[9] McInnes K, Friesen CL, MacKenzie DE, Westwood DA, Boe SG. Mild Traumatic Brain Injury (mTBI) and chronic cognitive impairment: A scoping review. PLOS ONE. 2017; 14: 11.

[10] Mandel S. Minor head injury may not be 'minor'. Postgrad Med. 1989; 85: 213-217.

[11] Auxéméry Y. Mild traumatic brain injury and postconcussive syndrome: a re-emergent questioning. Encephale. 2012; 38: 329-335.

[12] Prince C, Bruhns ME. Evaluation and Treatment of Mild Traumatic Brain Injury: The Role of Neuropsychology. Brain Sci. 2017; 7: 105.

[13] Colin T. Post concussion syndrome. Meets Patient's. Feb 2017

[14] Thompson HJ, McCormick WC, Kagan SH. Traumatic Brain Injury in Older Adults: Epidemiology, Outcomes, and Future Implications. J AmGeriatrSoc. 2006; 54: 1590-1595.

[15] Wilberger JE, Mao G. Trauma cranico. Manuale MSD Versione per i professionisti

a. 2008; https://journals.sagepub.com/doi/abs/10.1177/19714009080210S215.

[16] Niogi SN, Mukherjee P, Ghajar J, Johnson CE, Kolster R, et al. Structural dissociation of attentional control and memory in adults with and without mild traumatic brain injury. Brain. 2008; 131: 3209-3221.

[17] Mandala G, Capone D, Ajovalasit D. Early Diagnosis of Cognitive Impairment in Mild TBI. J Clin Stud Med Case Rep. 2023; 10: 0156.

[18] Mandalà G, Capone D, Mandalà S. Prevention project of the chronicity of cognitive-behavioral complications of mild head traumatic brain injury. 2024; AJMCRR 3: 1-9.

[19] Mandala G. Rehabilitation of motor and cognitive functions in patients with right cerebral hemisphere stroke. AJMCRR. 2023; 2: 1-4.

[20] Guger C, Spataro R, Pellas F, Allison B, Heilingher A, et al. Assessing command-following and communication with vibro-tactile P300 brain computer interface tools in patients with unresponsive Wakefulness syndrome. Frontiers in neuroscience. 2018; 12: 423.

[21] Mandala G, La Mantia V. Alien Hand: bibliographic review and description. Academia Letters, Article. 2022; 5584.

[22] Spataro R, Xu Y, Xu R, Mandalà G, Allison BZ, et al. How brain-computer interface technology may improve the diagnosis of the disorders of consciousness: A comparative study. Front. Neurosci. 2022; 16: 959339.

[23] Mandalà G, Sarullo FM, Ficile S, Maltese S, Lupo F, et al. Cognitive impairment in cardiovascular diseases: Preliminary data. AJMCRR. 2023; 2: 1-2.

[24] Sofia T, Maria LC, Giuliana G, Maria SM, Sofia M, et al. Bilateral Cranioplasty in Severe Acquired Brain Injuries. Techniques, Outcomes, and Clinical Case Report. Applied Medical Research. 2025; 5: 1–4.