

Factors associated with partial return to work after mild traumatic brain injury

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Research Article

Keywords: extracranial injuries, functional recovery, mild traumatic brain injury, partial return to work, post-concussion symptoms, return to work

Posted Date: October 22nd, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-11309560/v1>

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Additional Declarations: No competing interests reported.

Abstract

Objective

We investigated the characteristics of patients with mild traumatic brain injury (MTBI) who returned to work (RTW) partially, with a focus on RTW dynamics, lengths of partial working periods and extracranial injuries.

Methods

115 prospectively recruited individuals were evaluated in Brain Injury Clinic of Helsinki University Hospital. Post-Concussion Symptom Questionnaire (RPQ) and Glasgow Outcome Scale Extended (GOS-E) were completed one month after injury. Extracranial injuries were evaluated using modified Injury Severity Score (ISS). Partial and full RTW were continuously measured up to one year after injury.

Results

Median full RTW was 9.0 days after MTBI and full RTW-% after one year was 98%. 13 patients had a partial working period (median 42 days). They were older (48 vs. 38 years) and had more intracranial lesions (77% vs. 29%) and extracranial injuries (ISS 2.0 vs. 1.0), compared to patients without partial working period. They also had more post-concussion symptoms (RPQ 18.5 vs 7.0), worse functional recovery (GOS-E = 8, 22% vs. 59%) and delayed full RTW (66 vs. 7 days). Possible partial working arrangements were shortened hours (9/13) and lightened labour or other adjustments (4/13).

Conclusions

Partial RTW after mild traumatic brain injury is probably multifactorial. Extracranial injuries and intracranial lesions delay RTW and are associated with partial RTW, but post-concussion symptoms and occupational factors might play a role.

Introduction

Return to work (RTW) is a widely used outcome parameter that reflects functional recovery, in patients with mild traumatic brain injury (MTBI). RTW after MTBI is affected by many injury-related and pre-injury factors, including injury severity, pain, lower level of education, limited job independence and decision-making latitude [4].

Patients are advised to rest a few days after MTBI and gradually return to daily activities [3, 30]. Post-concussion symptoms (PCS) such as headache and fatigue are rather common after emergency unit discharge [34]. Adequate follow-up and psychoeducation after injury are recommended and clinically

feasible [5, 27, 39]. However, a minority of patients experience persisting PCS that influence successful RTW. Extracranial co-trauma is also common and causes delay in RTW [7, 35].

Partial return to work, e.g. shortened work hours or lightened labour, is scarcely documented in patients with MTBI [16, 26, 32, 37, 38], and all in all it has rarely been investigated [10]. To our knowledge, there are no studies that investigate lengths of partial working periods. Reported partial RTW rates range from 8 to 40% within a year after MTBI [10, 32, 37], although some studies have found work productivity loss and job accommodations in long-term follow-up [26, 38]. Partial RTW may be temporary or even permanent arrangement unless full RTW is found to be possible.

Regarding benefits of partial or gradual return to activities, past literature is mostly focused on young athletes and sports-related concussions. Shortened period of rest and gradual return to learn/school and sports are strongly supported in adolescents [1, 9, 18, 29, 36] and children [11]. Interventions and academic support are also recommended [24, 25]. Literature seems to support gradual RTW, since excessive rest is not advised [3, 23, 30, 31], early physical activity, aerobic exercise and reduced screen time are beneficial in early recovery [23], work adjustments might improve RTW in MTBI patients [15, 16] and in general [14] and work itself might be beneficial for recovery [33].

In our cohort study, we investigated the characteristics of patients with MTBI who return to work partially, focusing on partial RTW dynamics, lengths of partial working period and their eventual full RTW. We hypothesized that patients with partial working periods have more post-concussion symptoms and extracranial injuries, which is why we also investigated bodily injuries and injury severity in addition to MTBI.

Methods

Patients

131 consecutive working-age (16-68 years) patients with MTBI from Brain Injury Clinic of Helsinki University Hospital were included in our prospective cohort study. Patients were recruited between 2015 and 2018.

Exclusion criteria were alcohol or drug dependence, previously diagnosed schizophrenia or schizoaffective disorder, visual or auditory disability, contraindications for MRI imaging and not being a native Finnish speaker. Dependence was defined according to the Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV) criteria. In addition, patients who were not employed during the time of injury, were also excluded from this study. This resulted in a total of 115 patients diagnosed with MTBI.

All included patients gave their written informed consent. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research

committee of Helsinki University Hospital (code 105/13/03/01/2014) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

MTBI classification

We used the World Health Organization (WHO) definition of MTBI [6]. These criteria include one or more of the following: 1) confusion or disorientation, loss of consciousness for 30 min or less, post-traumatic amnesia for less than 24 h, and/or other transient neurological abnormalities such as focal signs, seizure, and intracranial lesion not requiring surgery; and 2) Glasgow Coma Scale (GCS) score of 13–15 after 30 min post-injury or later upon presentation for healthcare. These manifestations of MTBI could not be due to drugs, alcohol, medications, caused by other injuries or treatment for other injuries (e.g., systemic injuries, facial injuries, or intubation), caused by other problems (e.g., psychological trauma, language barrier, or coexisting medical conditions), or caused by penetrating craniocerebral injury. MTBI was defined as complicated when a traumatic intracranial abnormality was present in CT or MRI imaging. Isolated skull fractures were not considered as complicated MTBI. Patients with more severe TBI were not included in the study.

Patients' evaluation and recruitment process

Patients were initially evaluated and recruited in Töölö Hospital, level I trauma center of Helsinki University Hospital (covering the treatment for initially suspected moderate-to-severe TBI in Southern Finland [catchment area 2.2 million people]), or a nearby Helsinki city hospital emergency unit (covering the treatment for initially suspected MTBI in Helsinki [catchment area 630,000 people]). GCS, loss of consciousness (LOC) and presence and length of post-traumatic amnesia (PTA) along with other relevant clinical findings were documented by emergency unit physicians, who also determined the initial sick leave length. Acute symptoms, such as headache and vomiting, were screened.

The severity of injuries in different anatomical regions were evaluated retrospectively from hospital records using Abbreviated Injury Scale (AIS), ranging from 0 to 6 (none to untreatable) [13]. For instance, AIS 2 represents moderate and AIS 3 serious injury. Injury Severity Score (ISS) sums the squared AIS points of the worst injured body regions, on a scale of 0 to 75 [7,13]. In addition, we excluded head injuries to determine extracranial ISS [7]. Cut-offs 4 and 9 (squared AIS 2 and 3) were used to determine whether an overall injury was moderate or serious.

At one month after injury, patients were evaluated by a board-certified neurologist in the Brain Injury Clinic of Helsinki University Hospital. Pre-injury illnesses and current medications were assessed using hospital records and by conducting a structured interview. Successful RTW was verified and time to RTW with possible partial working periods were documented. When deemed clinically requisite, sick leave was extended and additional appointments or telephone follow-ups were arranged in addition to the research protocol.

The presence and severity of post-concussion symptoms were assessed using the Rivermead Post-Concussion Symptoms Questionnaire (RPQ), a 16-item self-report questionnaire [22]. Functional recovery was assessed using Glasgow Outcome Scale Extended (GOS-E), a scale ranging from 1 (dead) to 8 (good recovery) [19]. Patients, who have fully returned to work, are generally considered GOS-E = 8, though some patients may work with minor post-concussion symptoms [38]. RPQ and GOS-E were also evaluated at one month after injury, with some missing data (table 1).

Return to work evaluation

Partial and full RTW were assessed retrospectively with one-day accuracy using clinic records. In addition to neurologists' follow-ups, patients' successful RTW was verified by a structured telephone interview at one year after injury, by the study author (AH). In Finland, the sick leaves are registered electronically and considered reliable [41], thus RTW could be documented with one-day accuracy.

Full RTW was determined days from injury to the first day back to full-time work, with no further significant sick leave in the follow-up period. Patients were not considered to have fully returned to work until their possible partial working period was over.

Partial RTW was defined as shortened hours or subjectively lightened labour, such as less strenuous or different tasks, or more off-days. Partial work consisted of less than 80% of the pre-injury work demands or time. Though partial RTW was arranged in collaboration with employers, ED physicians and neurologists generally gave recommendations regarding partial RTW, especially in cases of longer partial sick leave. Partial RTW period was determined days from first partial working day to first full-time working day, with no further significant sick leave in the follow-up period.

Though we focused on partial RTW in this study, full RTW was also used as an outcome parameter to determine the end of partial working period. Partial and full RTW were assessed as continuous variables (time to RTW) with one-day accuracy and dichotomously (RTW-%) with predetermined cut-off points: 14, 30, 60, 90 and 180 days and one year after injury [10].

For this study, we did not consider < 7 days as partial working periods. Patients might have in theory had shorter non-reported 1-7 day arrangements in the workplace. However, we considered that using a strict 7-day cut-off, the patients' partial RTW periods were more closely followed, thus more reliable. This resulted in 13 patients who had partial working period for at least 7 days (Fig. 1).

Full-time students (n=13) and working patients with part-time studies (n=6) were also included in this study and their return to studies was comparable and included in RTW parameters.

Brain imaging

In order to detect traumatic intracranial lesions, all patients underwent subacute brain MRI imaging after MTBI (median 10 days). Control MRI scans were also acquired at three months after injury, but the results were not used in this study. All MRI scans were evaluated by a board certified neuroradiologist.

Lesions were assessed systematically by using Common Data Elements (CDE) for TBI neuroimaging [17].

All imaging was performed with 3T Siemens Magnetom Verio (Siemens, Erlangen) scanner with a 32-channel head coil. The imaging protocol consisted of fast localizer, T1 sagittal localizer, axial FLAIR, coronal T2, 3D T2 SPACE, 3D T1 MPRAGE and 3D gradient-echo susceptibility weighted imaging (SWI) sequence.

Statistical analysis

Skewed distributions were reported as medians with interquartile range (IQR) and normally distributed values in mean and standard deviation (SD). Skewed data were compared between groups using a non-parametric Mann-Whitney U test. Categorical variables were compared using a two-sided χ^2 test (Pearson Chi-Square test). Spearman correlation test was used to compare correlation between two continuous variables. A Kaplan-Meier log rank analysis was performed to investigate the time differences in RTW between groups. We considered p-values <0.05 as statistically significant. Valid n was used when certain parameters had missing data.

IBM SPSS Statistics 25 (IBM Corp., Armonk, NY, USA) was used to perform the analyses.

Results

Full RTW after MTBI

All patients with MTBI had a median full RTW of 9.0 days (IQR 4.0 – 30.0) and full RTW after one year was 98% (Fig. 2). One year after MTBI, one patient was still working partially, and one patient had not returned to work at all. Median full RTW was faster if patients were full-time students (4 vs. 10 days, $p=0.012$) or entrepreneurs (4 vs. 10 days, $p=0.026$), but other occupational factors found no significant difference.

Partial RTW after MTBI

13 patients with MTBI (11%) had a partial working period, with a median of 42.0 days (IQR 32.5 – 220.0, range 9 – 424). The median start of the partial working period was on day 15 (range 1 – 60) and end on day 66 (range 10 – 449). The highest number of patients ($n=8/13$) working partially was at one month after injury (Fig. 3).

MTBI patients with partial working periods had remarkably delayed median full RTW (66 vs. 7 days, $p<0.001$) compared to patients without any partial working periods. At pre-determined cut-points (table 1), their full RTW was significantly delayed, apart from one year after MTBI (92% vs. 99%, $p=0.081$).

Characteristics of patients with MTBI with partial working period (n=13)

Clinical characteristics of patients with MTBI are illustrated in table 1. MTBI patients with a partial working period were significantly older (48 vs. 38 years, $p=0.007$) and they had more extracranial injuries (median ISS 2.0 vs. 1.0, $p=0.020$) and traumatic intracranial lesions (77% vs. 29%, $p=0.001$) than patients without partial working period. In addition, they had more PCS (RPQ 18.5 vs 7.0 points, $p=0.018$) and their functional recovery was worse (GOS-E = 8, 22% vs. 59%, $p=0.036$), at one month after injury. There were no significant differences in occupational factors between groups, however, there were no students in the partial working group.

In addition to higher extracranial ISS, MTBI patients with partial working period ($n=13$) had more superficial injuries (external AIS ≥ 1 , 92% vs. 52%, $p=0.006$) than MTBI patients without partial working period. The number of serious (ISS ≥ 9) or at least moderate (ISS ≥ 4) extracranial injuries did not differ significantly.

Four patients had serious extracranial injuries (extracranial ISS ≥ 9) and related pain, with none-to-minor post-concussion symptoms. Regarding these cases, extracranial injuries were considered the primary reason for partial working period. Median start of partial working period in this subgroup was 6 days (range 1 – 15), duration 38.5 days and full RTW 47 days (range 10 – 94).

One patient, with no symptoms after the acute phase, had temporary suspension of professional driving license for three months due to minor intracranial lesions shown in the subacute MRI.

Other 8 patients had a median partial working period of 31 days (range 9 – 60), with a duration of 91 days and full RTW in 136.5 days (range 44 – 449). This group reported higher RPQ (median RPQ 26, range 14 – 44) than other subgroups.

Among these 13 patients, in 9 cases (70%), partial working consisted of shortened hours or more days off work, and in 4 cases (30%), lightened labour or other kinds of adjustments in the workplace.

Extracranial injuries in all patients with MTBI

There were 25 patients (22%) who had at least a moderate extracranial injury (extracranial ISS ≥ 4), and among these, there were 17 patients (15%) who had at least one serious extracranial injury (extracranial ISS ≥ 9), in addition to MTBI. Apart from AIS 1 injuries, all other patients ($n=90$, 78%) were considered to have isolated MTBI.

Patients with at least moderate extracranial injuries had delayed RTW (median full RTW 23 vs. 7 days, $p=0.004$) compared to patients with isolated MTBI, and the difference was most noticeable at two weeks after injury (RTW-% 24% vs. 72%, $p<0.001$). Patients with serious extracranial injuries also had delayed RTW (median full RTW 30 vs. 7 days, $p=0.005$). There were no significant differences in either of the groups at one month or later.

There was a significant weak-to-moderate correlation between RTW and extracranial ISS ($+0.329$, $p<0.001$) and total ISS ($+0.460$, $p<0.001$). RTW also correlated with head AIS ($+0.398$, $p<0.001$),

extremities & pelvis AIS (+0.189, $p=0.043$) and external AIS (+0.261, $p=0.005$).

Delayed median full RTW was also found in patients with facial fractures (AIS 2 or 3, $n=14$, 19.5 vs. 7.0 days, $p=0.039$) and patients with superficial injuries (external AIS ≥ 1 , $n=65$, 14 vs. 7 days, $p=0.009$), compared to their uninjured counterparts. However, patients with fractures in the extremities or pelvis (AIS 2 or 3, $n=11$) did not have significantly delayed full RTW (median RTW 25 vs 8 days, $p=0.056$).

There were no significant differences in RPQ or GOS-E between any of the examined groups.

Discussion

According to our results, the presence of extracranial injuries and intracranial lesions in MTBI clearly affect RTW dynamics and is associated with partial RTW. Partial RTW after MTBI is complex, being probably multifactorial. Post-concussion symptoms and occupational factors, such as work-place related circumstances most likely play a role.

Overall, the cohort showed favourable outcome and dynamics of recovery (median full RTW 9 days). Entrepreneurs (4 days) and full-time students (4 days) had even faster full RTW, probably due to different tendencies to use sick leave, differences in the nature of the work and perhaps intrinsic motivation differences. Patients with MTBI typically return to work within 13–93 days with 90% RTW percentage at one year after injury [2]. RTW figures in MTBI patients have logarithmic pattern, with the majority returning to work early with minor to none post-concussion complaints, and within the course of time, an ever-smaller minority fails to RTW. However, patients with a partial working period had remarkably delayed full RTW (66 days).

Patients with a partial working period were more likely to be older and have traumatic intracranial lesions. They also featured two major determinants for their inability to work full-time: PCS and extracranial injuries. Regarding patients with PCS, recovery and full RTW were delayed for several months (median full RTW 136.5 days) and partial working periods were long (median 91 days). In past studies regarding MTBI patients with measured partial RTW, PCS has been associated with poorer RTW dynamics [37], productivity loss [32] and other work limitations [38].

In a study by de Koning et al., where partial RTW was analysed as a special subgroup, early posttraumatic complaints (PTC) and psychological distress were predictors of problematic work resumption [10]. At six months, patients who had partial RTW experienced more PTC than patients with complete RTW. In addition, occupational factors (such as manual labor) were particularly relevant in short-term work resumption, whereas extracranial injuries were considered a risk factor for long-term work resumption [10].

In patients with MTBI, the most common type of extracranial injuries are extremity (60%) and facial injuries (36%) [35]. On the other hand, up to 40% of patients with proximal upper extremity fracture might

have concomitant MTBI [20]. Extracranial injuries in itself are also associated with delayed RTW [7, 10, 35, 41], with and without concomitant MTBI [21].

In our cohort, extracranial injuries were associated with delayed RTW. Four patients with serious extracranial injuries (ISS ≥ 9) returned to work partially. Their partial and full RTW ranged from days to weeks, being markedly faster than in patients with PCS. They were able to work partially because of various occupational accommodations.

The most common (70%) type of working solution was part-time work (shortened hours or more days off work), but other adjustments such as lightened labour were also adopted (30%). However, no significant differences were found in occupational factors, most likely due to the small sample size. The reasons, solutions and length of partial working periods were individually determined.

In our cohort, patients who had long partial working periods were clearly more injured than patients who had straightforward full RTW, probably due to using high 7-day cut-off for partial working period. However, literature seems to support different forms of progressive or gradual RTW [3, 30], though not all studies have found beneficial effects [40]. Patients view gradual RTW, modified duties and other accommodations as useful on RTW, though they might benefit from these accommodations unequally [16]. In TRACK-TBI study, employer assistance (modified schedule, different tasks, mentorship) was positively associated with RTW [15]. Regarding occupational factors, limited job independence and decision-making latitude are associated with delayed RTW [4]. It seems that patients who are given the opportunity and flexibility at the workplace to work partially or with particular and favourable occupational modifications, might eventually achieve full RTW.

A well-timed RTW is crucial to obtain optimal outcome. Patients may be obliged to RTW despite persisting symptoms, for instance, due to financial reasons [15, 28]. RTW too early may lead to onset or worsening of psychological and physical symptoms, which results in failed RTW, and may be emotionally frustrating, frightening and unbeneficial for recovery. Failed RTWs are rather common (up to 20–30%) and temporary accommodations likely prevent these and facilitate a successful RTW [32]. Even though RTW reliably reflects overall functional recovery, it might show overoptimistic appearance of recovery, as patients still struggle with PCS and objective work productivity loss after RTW [8, 32]. In case of too late RTW, patient may lose the positive rehabilitative aspect offered by work itself [12, 33].

The strengths of our study are that RTW parameters were definite and continuous with up to one-day accuracy, and that the study group was well-defined with clinical and neuroradiological evaluation. To our knowledge, this was the first study to evaluate partial working periods continuously in patients with MTBI.

Our study had a few limitations. First of all, our sample size was small, mostly due to using relatively high 7-day cut-off for partial working period in our analysis. This likely resulted in selection of the most injured patients in the partial working group. Also type II errors are possible. Secondly, most of the patients were recruited from a large trauma hospital, thus likely to experience more extracranial injuries than other

settings. In addition, we had only one time point for RPQ and GOS-E assessment. Finally, our analysis could have benefitted from workplace or productivity assessments, for instance Lam Employment Absence and Productivity Scale (LEAPS) [32].

Conclusion

Patients with MTBI who return to work partially appear to experience significant difficulties regarding their post-injury recovery, often related to post-concussion symptoms or extracranial injuries. Partial RTW still remains understudied, although some indication has been found for the benefits of gradual RTW after MTBI. Further study is needed on the effects of partial RTW. Nevertheless, prognosis after MTBI remains favourable.

Declarations

The authors state no disclosures, competing interests or other conflicts of interest in the subject matter or materials discussed in this manuscript.

Acknowledgements

The authors thank Simo Vanni (MD, PhD) and Aarne Ylinen (MD, PhD) for their contribution to this article. Written permissions were obtained.

Compliance with Ethical Standards

In case of funding, this study was supported by grants from Dorothea, Jarl Walter and Karl Walter Perklén's foundation, Päivikki and Sakari Sohlberg's foundation, the Maire Taponen foundation, and the Helsinki University Hospital (HUS) Neurocenter.

The authors state no disclosures, competing interests or other conflicts of interest in the subject matter or materials discussed in this manuscript.

Ethical approval: All procedures performed in studies involving human participants were approved by and in accordance with the ethical standards of the institutional research committee of Helsinki University Hospital (code 105/13/03/01/2014) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent: All included patients gave their written informed consent.

Data availability: The data is available upon reasonable request.

Author contributions

Authors AH, IM, HI, RR, TN and SM designed the study, and all authors contributed to study execution. Data was collected by AH, IM, KM and AK, and data analysis were performed by AH. All authors

interpreted the relevant data of their respective fields.

Author AH led the writing, and all other authors contributed to the text and accepted the final version of the manuscript. All authors meet the ICMJE requirements for authorship.

Acknowledgements

The authors thank Simo Vanni (MD, PhD) and Aarne Ylinen (MD, PhD) for their contribution to this article. Written permissions were obtained.

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Table

Table 1 is available in the Supplementary Files section.

Figures

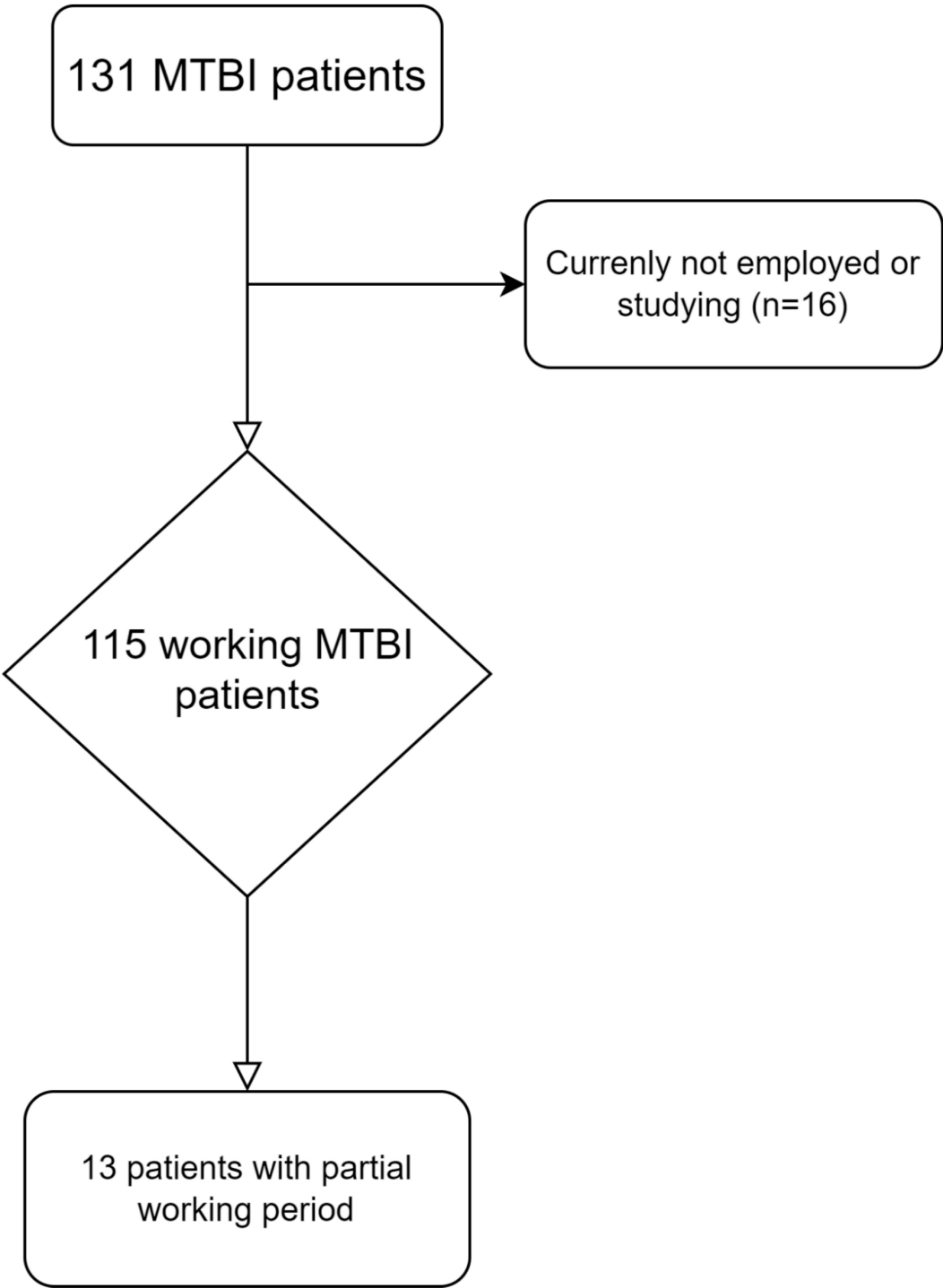


Figure 1

Inclusion of the working subgroup of the study.

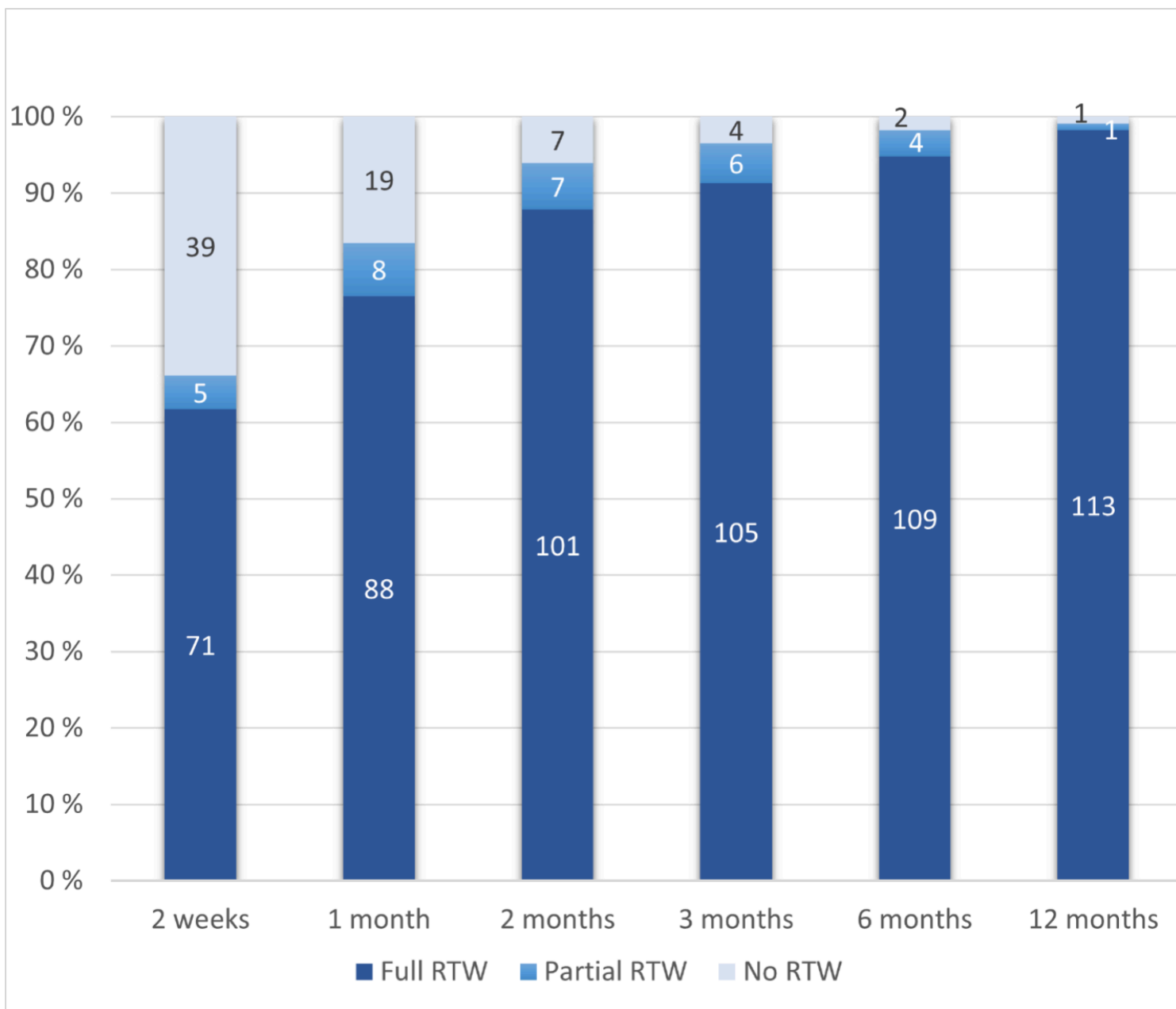


Figure 2

Full and partial return to work after mild traumatic brain injury (n=115).

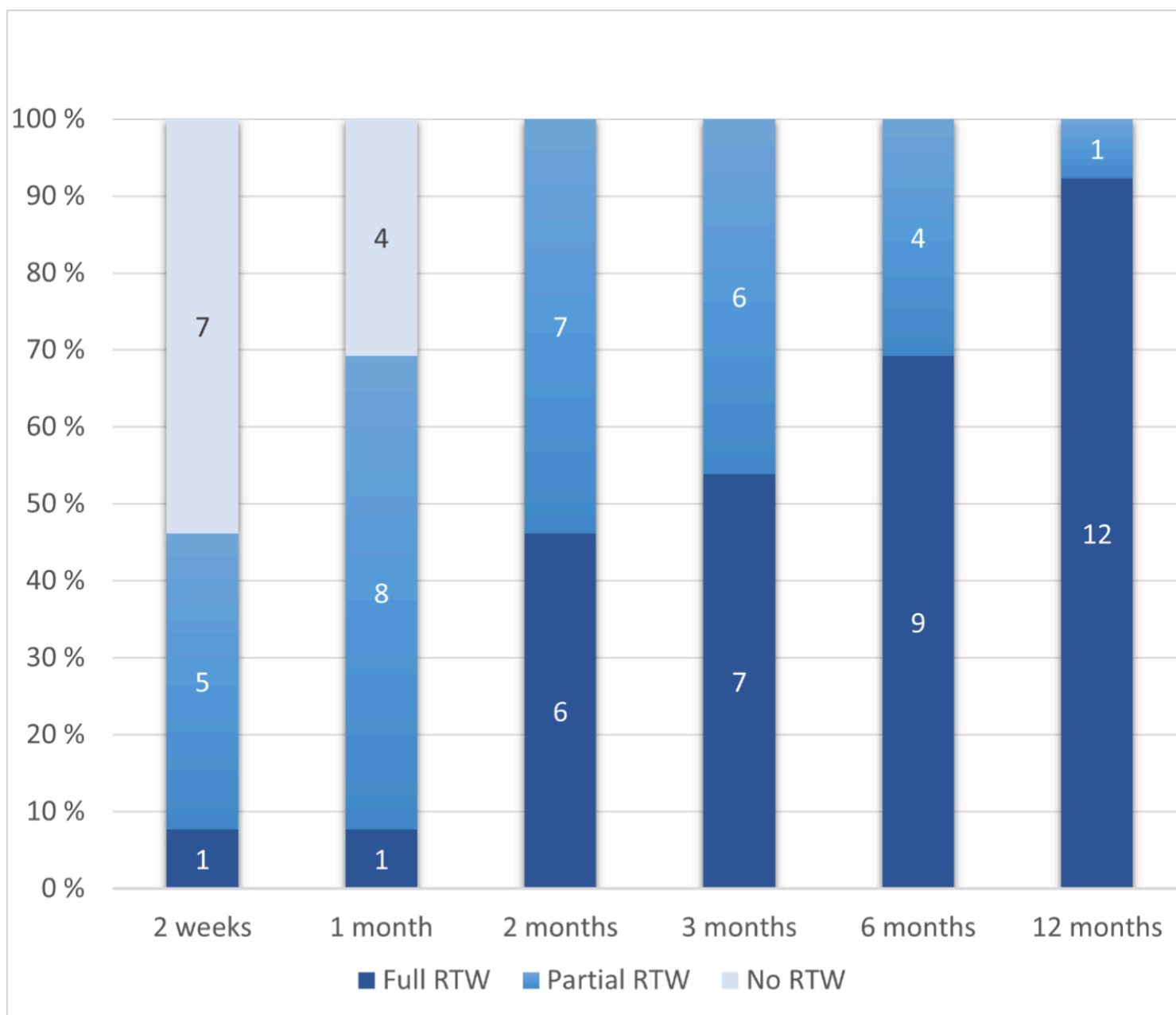


Figure 3

Patients with partial working period (n=13) and their RTW progression.

Supplementary Files

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- [Table1.docx](#)