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Research Article

# Comparison of Morphology Production Skills in Trauma Brain Injury Patients with Healthy Persian-Speaking People

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**Abstract**

**Introduction:** Trauma Brain Injury (TBI) is nerve damage caused by mechanical forces such as linear forces with acceleration and deceleration, rotational forces (force created by the winds resulting from the explosion), and penetration of the object thrown to the head can cause impaired in various aspects of communication, cognitive, and language skills including the grammar and morphology. The present study aims to investigate and compare grammar production skills (morphology) in patients with TBI and healthy non-TBI people.

**Methods:** This study is of cross-sectional type and morphological skills (morphological derivations and tenses of verbs) of 20 patients with moderate severity (GCS=8-13) in the sub-acute phase (one to three weeks after the trauma) with healthy non-TBI people compared. The age range of people was 18-45 years old, and they were classified into four educational subgroups. The morphological derivations section of the bilingual aphasia test (BAT), the verb tense test and the Mann-Whitney statistical test were used.

**Results:** The results showed that there is a significant difference in the morphological derivations and the correct production of verb tenses in all three tenses (past, present, and future) between patients with TBI and healthy non-TBI people ($p<0.05$). In such a way, the skills required to produce correct verb tenses and morphological derivations are significantly lower in patients with TBI.

**Conclusion:** The correct production of verb tenses and morphological derivation skills are significantly impaired in patients with TBI compared to non-TBI people. Most problems with verb tenses in patients with moderate TBI were seen in the past tense and then the future tense, with a slight difference in the present tense of verbs. Impairing to these items can cause problems in the production of their daily speech and, as a result, reduce the communication skills of these patients.

**Keywords:** Trauma Brain Injury, Grammar (Morphology), Verb tense, Persian language.

## Introduction

A TBI is defined as nerve damage caused by mechanical forces to the head [1]. TBIs are classified into three categories: mild, moderate, and severe, using criteria such as GCS [2]. Most studies use GCS as a simple and standardized criterion to determine severity [3].

TBI is a common disorder in children, teenagers, and the elderly [4]. The prevalence of this injury in the United

States is estimated at two and a half million people per year, of which 87% are treated [5]. Also, in the investigation of the prevalence of this injury in Tehran city, it has been determined that for every hundred thousand people, 15 to 144 people suffer from TBI [6].

A TBI can have long-term effects on various aspects of a person's life, education, career, and health [7, 8]. It is also the main cause of language, cognitive, communication, and behavioral disorders [9]. A review of studies has determined that the language disorders of these patients can be observed in various areas, such as listening comprehension, naming, discourse, reading, writing, grammar, and pragmatics [1].

Grammar includes two areas: syntax and morphology. Morphology is related to the formation and internal structure of complex words. Disturbance in the field of morphology can be observed in the form of deletion or substitution of morphemes that make up the word. Complex words are decomposed into their parts, and the process of deletion or substitution occurs in each of the decomposed components. For example, in the derived word prepay, pre as a prefix can be removed or replaced by another morpheme [10]. The tense of verbs is among the things that are also examined in the field of morphology. The tense of the verbs indicates the time frame of the person's speech and the time of the desired event. In languages with tense, the tense of verbs is determined by connecting the morpheme to the verb and using adverbs of tense in the sentence [11].

Morphological production skills can be assessed using speech samples or designed tests. Due to these patients' short sentences, spontaneous speech may not be able to show all their speech characteristics [12]. Therefore, it is necessary to use designed tests for more detailed investigation. Among the tests available in the Persian language, we can refer to the BAT [13] test and the verb tense of Mehri et al. (2010) [14].

Considering the impact of TBI on various aspects of communication and a person's life, as well as the high prevalence of this disorder, it is essential to investigate different linguistic and communication areas. In addition, damage to grammar can disrupt the transfer of concepts in the form of words and sentences [14]. Also, minimal studies have been conducted to examine the morphology production of TBI patients. Peach and Schand (1986) showed that TBI patients have errors in verb tense production [15]. Peach (2013) stated that these patients omit grammatical morphemes [16]. However, no one has investigated these mistakes and the reason for their existence, especially by using standard and designed tests. Salehnejad et al. (2022) investigated the tense of verbs and concordance of verbs in patients with Broca's aphasia and grammatical symptoms caused by an accident. Their results showed that the tense of verbs is more damaged than the concordance of verbs [17]. In their study, there were patients with aphasia (Broca's and grammatical symptoms). No study has been conducted in Persian to investigate the morphology (morphological derivations and tense of verbs) in patients with TBI, especially patients without aphasia. Also, no study has investigated the nature, type of damage, and related causes of damage to grammar (morphology) production skills. For example, none of them mentioned what type of present tense was damaged, nor did they investigate the cause of this type of damage. Since speech is mostly damaged in moderate and severe severity of these patients and the ultimate goal of the treatment is to improve the speech of the person in the communication environment and grammar (morphology) is one of the necessary skills to make an effective speech, so the purpose of this study is to examine the field of production grammar skills (morphology) in a patient with TBI without aphasia. In addition, to provide more effective therapeutic interventions in these patients, all language domains should be examined with comprehensive and valid language tools. Considering the dependence of these skills on the type of language, it is necessary to carefully examine production skills using tests designed in the Persian language.

## Methods

### Participants

In this cross-sectional study, the production morphology skills of 20 patients with TBI were compared with 50 non-TBI of the same age, gender, and education in Sina Hospital Tehran. The patients had TBI with moderate severity (GCS=8-13) in the sub-acute stage (one to three weeks after the trauma), which was confirmed by a neurosurgeon, also in the age range of 18 to 45 years, Persian speaking and without dysarthria and without hearing and vision problems. Patients who scored 86 or higher in the Persian Diagnostic Aphasia Battery-Bedside version (P-DAB-1) and also scored in the Montreal Cognitive Assessment (MoCA) range of 23±2 (mild cognitive impairment) were included in the study.

Non-TBI people should not have a history of concussions that led to hospitalization and should not have a history of neurological or cognitive problems. People who could not participate in the study or did not want to cooperate were excluded. After selecting people according to the entry criteria, production morphology skills were checked.

### Assessment tests

Two variables, the ability to correctly produce verb tenses and morphological derivations, were used to investigate the ability to produce morphology.

### Correct production of verb tenses:

Verb tenses in 3 past tenses (simple،Present perfect ، continuous, and perfect past), present, and future tenses were examined in both written and visual parts. For this purpose, 36 sentence completion tasks (6 sentences each time) were used. The written part includes 18 sentence completion tasks. In this section, a sentence without a verb with three options was presented to the individual, and he was asked to choose the correct verb from among the options and put it in the blank. For example, the written sentence "Yesterday you got a new dress from the store..." along with three options" buy, will buy, and bought," were presented to the person, and the correct answer (bought) had to be chosen by the person. The picture section contains 18 sentence completion tasks with pictures. In this section, the person was presented with a picture of the verb and the sentence without the verb, and the person was asked to express the correct verb. Then, each correct verb expression was given one, and each wrong answer was given 0 [14].

### Morphological derivations:

The sub-section of morphological derivations of the BAT [13] test was used to investigate morphological derivations. This part of the test consists of two 10 sub-tests. In the first sub-test, the person had to express the appropriate adjective for the word provided by the examiner (competent → competence), and in the second sub-test, the person made a word with the opposite meaning for the word provided by the examiner using dependent morphological morphemes (clean → unclean). A score of 1 was given to each correct answer, and a score of 0 was given to each wrong answer.

### Statistical tests

After collecting the data, they were analyzed using SPSS version 25 software. The Mann-Whitney test was used to compare the results of the data in TBI patients with healthy non-TBI people.

## Results

This study included 20 TBI patients (18 men and two women) and 50 healthy non-TBI (46 men and four women). The age range of the participants was 18 to 45 years (X=1.30, SD=11.08 for patients and X=14.9, SD=9.31 for healthy non-TBI people). Also, people were classified into four educational sub-groups: 1-5, 11-6, 14-12, and >15 years of education. Demographic information related to the age of two groups with TBI and non-TBI is shown in Table 1. In examining the homogeneity of non-TBI people with patients, it was found that these people do not differ significantly in age, gender, and education. The people of the two groups are homogeneous with each other in terms of demographic characteristics (P value>0.05) (Table 2).

Mann-Whitney test was used to compare the ability to produce morphological derivatives and the correct production of verb tenses among patients with TBI and non-TBI people. The results show that there is a significant difference between TBI patients and non-TBI people (P value <0.05) (Table 3).

Also, the Mann-Whitney test was used to compare the mean of past, present, and future tenses in each group. The results show that there is a significant difference in the three main tenses, i.e., past, present, and future, as well as a significant difference in different past tenses, i.e., uncomplicated, Present perfect, continuous, and perfect past, in patients with TBI and non-TBI people (P value <0.05) (Tables 4 and 5).

Table 1: Comparison of age in two groups of patients with TBI and non-TBI

| subject | mean | standard deviation | P-Value |
|---|---|---|---|
| TBI | 30/1 | 11/08 | **0/4** |
| non-TBI | 31/9 | 9/14 | |

Table 2: Comparison of gender and levels of education between patients with TBI and non-TBI

| variable | | subject | | $x^2$ | df | P-value |
|---|---|---|---|---|---|---|
| | | patient | healthy | | | |
| **gender** | men | 18 | 46 | 0/073 | 1 | 0/78 |
| | woman | 2 | 4 | | | |
| **education** | 1-5 | 4 | 9 | 0/074 | 3 | 0/99 |
| | 6-11 | 7 | 17 | | | |
| | 212-14 | 8 | 21 | | | |
| | >15 | 1 | 3 | | | |

Table 3: Comparison of the mean score of the morphological derivations and correct verb tenses in patients with TBI and non-TBI

| variable | | median | min | max | Mann whitney | Z score | P-value |
|---|---|---|---|---|---|---|---|
| **Morphological derivations** | TBI | 13 | 3 | 17 | 76/500 | -5/566 | 0/000 |
| | non-TBI | 17 | 10 | 19 | | | |
| **Correct verb tenses** | TBI | 25 | 6 | 31 | 138/000 | -4/729 | 0/000 |
| | non-TBI | 31 | 15 | 35 | | | |

Table 4: Comparison of the mean past, present and future tenses in patient with TBI and non-TBI

| variable | | Mean rank | Mann whitney | Z score | P-value |
|---|---|---|---|---|---|
| **Mean past tense** | TBI | 18/05 | 151/000 | -4/574 | 0/000 |
| | non-TBI | 42/48 | | | |
| **Mean present tense** | TBI | 21/40 | 218/000 | -4/425 | 0/000 |
| | non-TBI | 41/14 | | | |
| **Mean future tense** | TBI | 20/13 | 192/500 | -4/625 | 0/000 |
| | non-TBI | 41/65 | | | |

Table 5: Comparison the mean score of different types of past, present and future tenses in patient with TBI and non-TBI

| variable | | Mean rank | Mann whitney | Z score | P-value |
|---|---|---|---|---|---|
| **Past simple** | TBI | 25/03 | 290/500 | -3/039 | 0/002 |
| | non-TBI | 39/69 | | | |
| **Present perfect** | TBI | 24/30 | 276/000 | -2/994 | 0/003 |
| | non-TBI | 39/98 | | | |
| **Past continuous** | TBI | 23/45 | 259/000 | -3/265 | 0/001 |
| | non-TBI | 40/32 | | | |
| **Past perfect** | TBI | 22/50 | 240/000 | -3/533 | 0/000 |
| | non-TBI | 40/70 | | | |
| **present** | TBI | 21/40 | 218/000 | -3/910 | 0/000 |
| | non-TBI | 41/14 | | | |
| **future** | TBI | 20/13 | 192/500 | -4/625 | 0/000 |
| | non-TBI | 41/65 | | | |

## Discussion

Grammar examines the structure of the sentence, such as the tense of the verbs and the relationship between the components of the sentence [12]. The ability to produce the verb tense is considered a component to check the communicative competence of everyday speech [18]. Verbs and grammatical and semantic features related to them give the listener much information about the grammatical and semantic status of the sentence [19]. Also, verbs have different aspects, such as number, person, aspect, tense, negation, etc, which may not be affected by the same pattern in all people [18]. Therefore, the present study was conducted to investigate the production skills of the correct production of verb tenses and morphological derivatives in patients with TBI with moderate severity and compare it with healthy non-TBI people. The data analysis showed a significant difference between patients and healthy non-TBI people regarding morphological skills (the ability to correctly produce verb tenses and morphological derivatives). However, no study has been conducted on patients with TBI without aphasia to compare the data results. In the following, the hypothesis of this research is examined.

The present study showed a significant difference in the total score of verb tenses between patients with TBI and healthy non-TBI people. Also, a significant difference was observed between the three main tenses and different past tenses among patients with TBI and non-TBI. So far, no study has been conducted to investigate the exact cause of verb tense damage in patients with TBI. Therefore, it is impossible to compare the study results with other studies. The studies conducted were mainly on patients with aphasia. For example, Salehnejad et al. (2022) have stated that verb tense is damaged in patients with Broca's aphasia who have grammatical symptoms [17]. Studies conducted on patients with aphasia have stated that such a problem can be related to decreased syntactic comprehension, difficulty in sentence processing, defects in selecting or implementing diacritical features, and vocabulary during phonological decoding [14]. Also, such damage can be attributed to the damage to phonological, semantic, and lexical fields, which have different effects on the production of verb tenses [20].

In the current study, patients with TBI showed the most problems in the past tense, and then they had problems in the future tense with a slight difference in the present tense. Verbs are classified into three categories based on the type of coordination between the speech and the time of occurrence of the verb: past, present, and future [18]. The cause of more damage to the past tense in patients with TBI than in healthy non-TBI people can be related to the lack of time coordination of the past verb with the present discourse time. The time spent doing the work has ended, but in the present tense, there is harmony between the verb and discourse tense. Like the past tense, the future tense lacks harmony with the discourse. However, the difference is that the event has not happened yet. This lack of coordination leads to an increase in the processing load and, as a result, a decrease in the ability to produce past and future tenses compared to the present tense in patients with TBI [11].

Another noteworthy point is that people do not follow the rules related to the construction of the future tense and use the form of the present tense to produce the future tense [14]. This factor can justify the slight difference between the present and the future in patients with TBI. In the comparison of different types of past tense among patients with TBI and healthy non-TBI people, it was found that patients with TBI have little difference in different types of tenses, which, in order of the most to the least problem, include perfect, continuous, Present perfect and simple past tenses. In addition to the mentioned cases, the cause of such damage can be attributed to the problem when passing from semantic to morphological representation. In this way, the person has a problem in representing the verb. As a result, it chooses and expresses the most accessible form of the verb, removes the complex verbs associated with that tense, and replaces it with a more straightforward verb tense. The Persian language also has various morphemes to make the Present perfect tense and the perfect past tense, so it is expected that these two types of past tense are more complex and challenging than the simple and continuous past tenses. As a result, the problem in the tense of patients' verbs can be seen as a mistake in the inflection of related grammatical morphemes or a mistake in the time frame of the discourse [21]. In addition, the past tense has a broader range and less usage than the present and future tenses. Therefore, the problem shows itself in this tense more than in another tense.

The present study showed a significant difference in the production of morphological derivatives between

patients with TBI and healthy non-TBI people. Peach (2013) stated that these patients omit grammatical morphemes [16]. However, no study has paid attention to the detailed examination and the cause of such damage in these patients. As mentioned before, to make derived words, the dependent morphemes in the form of prefixes or suffixes are added to the main root of the word and make the desired word. The study of patients with TBI found that these patients delete or replace dependent morphemes in the form of prefixes. The cause of such a problem can be related to the fact that the prefix precedes the root of the word, and the main root of the word cannot act as a moderator for producing morphemes [10]. For this purpose, the additional burden of processing imposed on the person causes the removal or replacement of this morpheme. Another reason is that the ability to produce morphological derivatives can be influenced by various factors such as conceptual complexity, semantic value, frequency of occurrence, and the level of involvement of syntactic skills [22]. For example, some people used other words like "aet" instead of saying "edible" when making an adjective for the word "eat." It can be concluded that the word "edible" was not familiar and was widely used by the person, and the person used the most available form, i.e., the infinitive of the desired verb. The expression of the word "edible" was more complicated and less frequent for him, so he replaced it with a more straightforward word.

In the present study, it was found that patients with moderate severity of TBI have problems producing verb tenses and morphological derivatives compared to healthy Persian-speaking non-TBI people. These damages can be affected by various factors. Klencklen et al. (2017) stated that working memory capacity decreases with age [23]. This reduction in working memory capacity can reduce the ability to produce morphological skills. Since the patients of this study had mild cognitive impairment, the decrease in production ability can be related to damage to different cognitive skills, including working memory. So far, there has been no study on patients with TBI, especially in the Persian language, using valid tests. The present study can introduce more and more detailed investigations in this field. The noteworthy point is that different damage patterns can be observed. Therefore, controlling various factors such as the type of damage, the location of the damage, the severity of the disorder, the accompanying cognitive and language disorder, age, the type of test, etc., is of particular importance. Therefore, other studies should pay attention to each of these cases. For example, the ability to produce grammar (morphology) can be checked in patients with mild and severe conditions, in the acute and chronic phase, and in the age group of children and the elderly. Patients with mild cognitive impairment participated in the present study. However, such skills can also be checked in patients with moderate and severe cognitive impairment. Since the speech in these patients is mainly damaged in moderate and severe severity, examining and analyzing the grammar (morphology) production skill in the sample of spontaneous speech is possible.

## Limitations

Due to a lack of time and strict entry criteria, fewer patients were examined in this research, and different results may be obtained in a larger sample size. Also, this study was conducted in Sina Hospital, Tehran, and if the obtained results are to be generalized to other patients with TBI, this should be done with caution and sufficient knowledge.

## Conclusion

The correct production of verb tenses and morphological derivation skills are significantly impaired in patients with TBI compared to non-TBI people. Most problems with verb tenses in patients with moderate TBI were seen in the past tense and then the future tense, with a slight difference in the present tense of verbs. Impairing to these items can cause problems in the production of their daily speech and, as a result, reduce the communication skills of these patients.

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## Conflict of Interest Disclosures

There is no conflict of interest.

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## Authors' Contributions

Not cleared.

## Declaration of Generative AI and AI-assisted technologies

Not cleared.

## Ethical Statement

The present study was approved by the ethics committee of Tehran University of Medical Sciences-Sina Hospital (IR.TUMS.SINAHOSPITAL.REC.1402.051). The patients gave written informed consent to participate in the research.

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