ORIGINAL ARTICLE

Traumatic brain injury and its implications on cognition and quality of life

Bruna Petrucelli Arruda[1], Patricia Yumi Funagoshi Akamatsu[1], Andreza Pereira Xavier[1], Regina Celia Villa Costa[1], Gláucia Somensi de Oliveira-Alonso[2], Iracema Maceira Pires Madaleno[3]

ABSTRACT

Traumatic brain injury is one of the main causes of mortality in children or young adults. Patients with moderate or severe TBI can present motor, cognitive, emotional, behavioral, and social functionality sequelae, causing an adverse impact on the individual, his family, and on society. **Objective:** To investigate the impact that severe traumatic brain injury caused to the life of patients who suffered the injury during childhood and youth, considering cognitive, emotional, and quality of life questions, as well as, to verify whether there are differences with respect to age at the time of injury. **Method:** A quantitative, qualitative, cross-sectional study carried out at the Ibirapuera unit of the Rehabilitation Center of the Association for Assistance to Disabled Children (AACD). Thirteen patients with severe traumatic brain injury from São Paulo state, participated in the study between January of 2010 and March of 2014. The instruments utilized were: a sociodemographic questionnaire, the Short Form Health Survey (SF-36), the Raven's Progressive Matrices, and the Pfister Colored Pyramid Test. The data collected were evaluated in the overall sample and then divided into two groups based on their age at the time of injury, with group 1 (3 to 7 years and eleven months old) and group 2 (8 to 16 years and eleven months old). **Results:** On the Raven's test, 76.9% of the participants showed signs of mental impairment. All participants had a good quality of life assessment. In the emotional aspects, there was good adaptability and interaction. Upon comparison, there was no difference between groups. **Conclusion:** The results were consistent with studies that indicate cognitive impairment and good perception of quality of life.

Keywords: Brain Injuries, Cognition, Quality of Life

[1] Psychologist, Association for Assistance to Disabled Children.
[2] Physiatrist, Coordinator of the Pediatric Acquired Brain Injury Clinic, Association for Assistance to Disabled Children.
[3] Psychologist, Rehabilitation Supervisor of the Child Psychology sector, Association for Assistance to Disabled Children.

Mailing address:
Associação de Assistência à Criança Deficiente (AACD)
Bruna Petrucelli Arruda
Avenida Ascendino Reis, 724
São Paulo - SP
CEP 04027-000
E-mail: bruna.petrucelli@hotmail.com

Received on October 20, 2014.
Accepted on April 29, 2015.

DOI: 10.5935/0104-7795.20150012

INTRODUCTION

Traumatic brain injury (TBI) is one of the main causes of mortality in children and young adults. The incidence of TBI is estimated at approximately 10 million people per year and it is greater in countries with medium to low income. The incidence rate in Latin America and Sub-Saharan Africa ranges from 150 to 170 per 100,000 people, respectively, while worldwide the rate is around 106 per 100,000 people.[1]

People who survive a TBI may be left with permanent sequelae that include motor, sensory, cognitive, speech, emotional, and/or behavioral deficits. Studies indicate that approximately 50 to 75% of TBI patients present cognitive and behavioral alterations. These sequelae cause a great impact on the individual, his family, and on society.[2]

This is a condition that varies in terms of etiology, severity, and prognosis. In Brazil, traffic accidents are the main cause of TBI, followed by falls and urban violence, constituting a public health problem with great importance and impact on the morbidity and mortality of the population.[3,4] In addition, in Brazil, it is the main cause of mortality for children over five years old and responsible for 50% of the deaths in adolescence.[4]

As for severity, the most often used classification is based on the level of consciousness according to the Glasgow Coma Score (GCS) measured during the first examination. By this classification, the TBI is considered light if it reaches the score between 15 - 13, moderate if between 13 - 9, and severe if ≤ 8. This classification is also used for the time the coma lasts, with the TBI being considered light if the coma lasts less than 20 minutes, moderate if it lasts up to six hours, and severe if it lasts more than six hours.[5]

According to Mendes,[6] few individuals after a severe TBI are able to resume their normal activities with independence. In addition, a study by Silva et al.[7] points out the effects that a severe TBI can have on the satisfaction and wellbeing of the patient's quality of life (QL). The main findings indicate that educational level and social adjustment were the factors that most influenced the perception of a better QL, while social class and form of locomotion did not show great relationships. A previous study evaluated the return to productivity after TBI and found a linear relationship between educational levels and return to work.[8]

Studies on the intellectual level of children who had suffered a TBI report lower capabilities in patients with severe TBI when compared to patients with moderate or light TBI. However, another important factor to be considered is their age at the time of injury. Clinical evidence demonstrates that a TBI in children aged from three to seven years old provokes greater cognitive sequelae when compared to TBI in children aged from eight to 12 years old.[9] Junqué, Bruna, and Mataró[10] state that neuropsychological impairment as well as deficit severity vary according to the chronological age at the moment of the trauma, considering that there is greater vulnerability among younger children to post-traumatic damage and cognitive changes than among older ones.

OBJECTIVE

The objective of this study was to investigate the impact that a severe TBI caused on the life of patients who suffered the injury in childhood and adolescence, considering cognitive and quality of life questions, as well as to confirm whether there are differences in relation to the age at the time of the injury.

METHOD

The present study is cross-sectional with a quantitative and qualitative approach; it was developed at the Rehabilitation Center in the Ibirapuera unit of the Association for Assistance to Disabled Children and approved by the Committee for Ethics in Research under protocol Nº 794.140.

The population studied was made up of victims of serious traumatic brain injury (TBI) who were seen at the Pediatric Acquired Brain Injury (PABI) clinic between January of 2010 and March of 2014.

The inclusion criteria were: being at least 18 years of age; having the injury for at least 2 years; being injured between the ages of 3 years and 16 years eleven months; having the injury classified as serious according to the length of the coma given in the medical chart; and residing in São Paulo.

Patients were excluded who had received TBI stemming from a firearm-related injury (FRI) or beating, and those who were not able to respond to all the instruments.

There were 739 medical charts evaluated from the PABI clinic. From those, 664 were excluded as follows: 462 were under the age of 18 and 152 had injuries from other diagnoses. Seven patients were excluded with a diagnosis of TBI from FRI, and one for beating. Of the 117 remaining patients, 29 were classified as light to moderate seriousness, 6 were under 3 years of age at the time of injury, and 7 came from other states, leaving 75 patients.

Invitations were made through telephone contact and by mail. Of the 75 qualified patients, 48 did not show up, 4 refused to participate, and 10 could not respond to all the instruments. Hence 13 patients with serious TBI participated in the study; they were of both genders and current ages between 18 and 30 years.

The instruments used were: a sociodemographic questionnaire, the Short Form Health Survey (SF-36) quality of life scale, the RAVEN Progressive Matrix Test (General Scale), and Pfister's Color Pyramid test.

The SF-36 is a generic instrument, evaluating physical and mental health, and validated in the Portuguese language. The choice of this instrument was based on its being easy to administer and to comprehend.[11] In addition, it is an instrument that presents correlation and is sensitive to the health problems of TBI victims.[5]

The scale assesses 8 domains with scores between 0 (worst result) and 100 (best result), and one question on the perception the individual has of his own health as compared to one year earlier, which was not evaluated in this study.

The RAVEN Progressive Matrix Test (General Scale) evaluated the intellectual development of the individual. It was designed for subjects between 12 and 65 years of age. It is divided into 5 series (A, B, C, D, and E), each with 12 problems. The scores obtained on the tests can be classified by the results and levels as follows: superior intelligence (I), definitely superior to average intelligence (II+), superior to average intelligence (II), average intelligence (III+), average intelligence (III-), inferior to average intelligence (IV), definitely inferior to average intelligence (IV-), and indication of mental deficiency (IV).[12]

The Pfister's Color Pyramid scale is a projective test that helps give information on emotional-affective dynamics. Its instructions are easily understood and can be applied to individuals aged 6 years and older. The results can be interpreted based on 4 items: modes

of execution and placement, types of formation, chromatic formula, and colors and syndromes.[13] The present study assessed modes of execution and placement in addition to colors.

The data was analyzed using the following softwares: SPSS 17.0, Minitab 16, and Excel Office 2010. A test for Equality of Two Proportions was used for the RAVEN distribution and comparison between the groups in this instrument. The Mann-Whitney test the SF-36 scores for the groups.

RESULTS

The analyses were initially done with a general sample and later divided into two groups: group 1 with people who had been injured between the ages of 3 years and 7 years eleven months, and group 2 between the ages of 8 and 16 years eleven months.

Twenty-three individuals came in for evaluations. Of these, ten were not able to respond to all of the instruments due to motor and cognitive impairments stemming from their TBI. Of the ten participants, five were placed in group 1 and five in group 2.

The study was then carried out with 13 participants averaging 23.9 years of age. Most of the participants were male (69.2%), single (92.3%), with a high school education (84.6%), with no gainful employment (76.9%).

In the sociodemographic questionnaire, there was an open question for the participant to talk about their social activities and how often they took place. The same standard responses were seen, indicating a life limited to a family ambit.

Table 1 deals with the analysis of a general sample of Raven scores. The results indicate the statistically significant prevalence of Mental Deficiency.

Table 2 presents data from the general sample for the SF-36, indicating a good quality of life in all domains, with a lower index for Limitations for Emotional Aspects (average of 70.5) and a greater index for Social Aspects (average of 90.4).

The results from the Pfister's Color Pyramid test showed a predominant choice of blue and green for the general sample.

In the modes of execution, 46.2% showed ordered execution, *versus* 38.5% methodical, and 15.4% disorderly. During the placement, there was homogeneity for the ascending (46.2%) and descending (53.8%) modes, with combination of direct placement mode for most participants (53.8%).

Table 1. Frequency distribution regarding Raven scores

Raven	N	%	*p*-value
Indication of mental deficiency	10	76.90%	Ref.
Intelligence definitely lower than average	2	15.40%	0.002
Average intelligence	1	7.70%	< 0.001

Table 2. Full description of the SF-36 scores

SF 36	Average	Standard Deviation
Functional Capacity	75	22.8
Limitations for Physical Aspects	82.7	31.3
Pain	73.7	28
General State of Health	89.3	8.4
Vitality	71.9	17.3
Social Aspects	90.4	19.2
Limitation for Emotional Aspects	70.5	43.1
Mental Health	76.9	17.3

The sample was divided into two groups with group 1 having 6 participants and group 2 having 7.

Comparing the groups via the SF-36 instrument, there was no statistically significant difference for any of the domains assessed, with only a tendency towards a difference in the social aspects ($p = 0.081$).

As for the Raven results, there was a slight difference between the groups: group 1 showed a 67% index of mental deficiency, whereas group 2 showed an 86% indication, however this difference was not statistically significant.

Correlating between the SF-36 and the Raven, there was an inversely proportional statistical significance in the domains of Pain ($p = 0.023$) and General State of Health ($p = 0.017$) in group 1, and for Limitation for Emotional Aspects ($p = 0.046$) in group 2, as shown in Table 3.

In the Pfister instrument, there was also no significant difference between the groups in terms of modes of execution and in analysis of colors.

DISCUSSION

The main results presented in the study indicate good perception in the QL and indications of mental deficiency in the majority of the population.

The low cognitive results obtained from the participants in this study indicate a low cognitive recuperation after their serious TBI reported by researchers.[14-16] Studies suggest that, although there may be an improvement in cognitive function two years after the moderate or severe trauma, these functions still remain impaired.[17]

The QL deals with the subjective perceptions of different aspects, being of a personal and mutable nature varying according to the individual's context, interests, and values. Evaluating the quality of life of patients with brain damage becomes an even more complex task due to the tendency of the patients to give a better evaluation of their quality of life.

Researchers have proven that the seriousness of an injury must be considered when evaluating the QL, concluding that patients with serious brain injuries give better responses regarding their QL when compared with those with light or moderate TBI.[18] Although the present study did not compare the seriousness of the lesions, the results here were compatible with those studies.

According to studies, patients with serious TBI tend to be more emotionally vulnerable, with a reduced capacity for social exchange and interactions. The present study gave qualitatively compatible results. The hypotheses surveyed point out that mental deficiency combined with the infantilized behavior witnessed during the evaluations can contribute to the reality of low socialization.

Although Silva et al.[7] referred to the means of locomotion not having any relation to the QL in their research, the present study saw the majority of patients being physically independent and competent for the personal activities of daily life, something that could have bolstered an improved perception of QL, according to other researchers.[16]

Table 3. Correlation between the SF-36 and the Raven

Raven x SF-36	Group 1 (3 y - 7 y 11m)		Group 2 (8 y - 16 y 11m)	
	Corr (r)	*p*-value	Corr (r)	*p*-value
Functional Capacity	-13.10%	0.804	32.10%	0.483
Limitation for Physical Aspects	-49.20%	0.322	16.70%	0.721
Pain	-87.40%	0.023	33.80%	0.459
General State of Health	-89.20%	0.017	-52.50%	0.227
Vitality	-37.00%	0.47	10.30%	0.826
Social Aspects	- x -	- x -	-56.9%	0.182
Limitation for Emotional Aspects	-42.20%	0.405	-76.40%	0.046
Mental Health	-28.20%	0.588	21.20%	0.648

Authors report that patients with serious TBI have deficiencies in social integration, a tendency towards depression, mood swings, frequent anxiety symptoms, loss of temper, infantile behavior, and a low tolerance to frustration.[16,19] These deficits were not found in the results obtained from Pfister's Color Pyramid Scale.

Regarding the colors most often chosen in these results, blue and green were prevalent with the participants' predilection being blue. In this regard, it is possible to say that the subjects in this study showed the capacity of control and adaptation to situations and performed well in emotional relationships.

Other items evaluated in this test were modes of execution and placement of colors. In modes of execution, the individuals showed organization and meticulousness with a tendency towards rigidity. The modes of placement are divided into ascending and descending. While the first suggests an elevation of the indices of intellectual development, the idea of stability and maturity, the other can indicate instability, immaturity, and insecurity, respectively. Evaluation of this aspect showed no significant difference between the modes of placement, making a precise analysis of maturity difficult for the individuals. The combination of other types of placement points to direct placement is more usually found in the population studied.

It is important to highlight that neurological alterations can intensify emotional disturbances, interfering with the individual's perceptions, producing greater disorganization regardless of their age and intellectual potential.[13]

Regarding the two groups, research has shown that the younger the individual at the time of trauma, the better the prognosis for adaptation to the organic sequelae caused by the TBI. Evidence currently shows that older children generally show better results than younger, in both motor and cognitive impairments.[16] Clinical indications demonstrate that TBI in children aged between 3 and 7 years cause greater cognitive sequelae than in those aged between 8 and 12, affirming that both neurological impairment and seriousness of the deficit vary according to the age at the time of the trauma.[9,10]

The results obtained in this study showed no significant differences between the groups, for any of the instruments used, which indicated homogeneity.

The inverse proportional correlation between the Raven and the SF-36 indicates that the perceptual deficit shown in the Raven (indication of mental deficiency) may have had a positive influence on their QL, coinciding with studies showing that patients who had a significant improvement in motor function had a good functional state, but continued with behavioral and cognitive deficits.[16]

A limiting factor in this study was the small sample size that did not allow consistent conclusions in the comparison between the groups. Although the number of patients from within São Paulo was considerable, as determined by the inclusion criteria, and devised to facilitate their appearance, the sample size was small due to poor attendance. This raises the following questions: Is it possible to consider that only patients with more cognitive impairment will attend, maybe with expectations of new treatments? Is it possible that only people with better QL evaluations will show up? Or does the distance between the time of injury and the time of the study influence whether most of the patients will attend?

Future studies with a longitudinal approach, with a larger sample, and neuropsychological evaluation can contribute with broader results.

CONCLUSION

Individuals with serious TBI present cognitive impairment and high QL evaluations. As for emotional aspects, it was not possible to obtain a precise analysis from the sample. These emotional results are believed to be related to the region of the brain affected by the TBI, which was not approached in this study.

In comparing between the groups, there was no statistically significant difference for any of the instruments used. Presumably, a larger sample will achieve results that are more relevant and compatible with other studies.

REFERENCES

1. Hyder AA, Wunderlich CA, Puvanachandra P, Gururaj G, Kobusingye OC. The impact of traumatic brain injuries: a global perspective. NeuroRehabilitation. 2007;22(5):341-53.
2. Mattos P, Saboya E, Araujo C. Post-traumatic brain injury behavioural sequelae: the man who lost his charm. Arq Neuropsiquiatr. 2002;60(2-A):319-23.
3. Serna ECH, Sousa RMC. Depressão: uma possível consequência adversa do trauma crânio-encefálico para o cuidador familiar. Acta Paul Enferm. 2005;18(2):131-35.
4. Carvalho LFA. Affonseca CA, Guerra SD, Ferreira AR, Goulart EMA. Traumatismo cranioencefálico grave em crianças e adolescentes. RBTI. 2007;9(1):98-106.
5. Settervall CHC, Sousa RMC. Escala de coma de Glasgow e qualidade de vida pós-trauma cranioencefálico. Acta Paul Enferm. 2012;25(3):364-70. DOI: http://dx.doi.org/10.1590/S0103-21002012000300008
6. Mendes RMN. Avaliação cognitiva em traumatizados crânio-encefálicos ligeiros [Tese]. Aveiro: Universidade de Aveiro; 2011.
7. Silva CB, Dylewski V, Rocha JS, Morais JF. Avaliação da qualidade de vida de pacientes com trauma cranioencefálico. Fisioter Pesq. 2009;16(4):311-5.
8. Silva CB, Brasil ABS, Bonilha DB, Masson L, Ferreira MS. Retorno à produtividade após reabilitação de pacientes deambuladores vítimas de trauma cranioencefálico. Fisioter Pesq.2008;15(1):6-11. DOI: http://dx.doi.org/10.1590/S1809-29502008000100002
9. Anderson V, Catroppa C, Morse S, Haritou F, Rosenfeld J. Functional plasticity or vulnerability after early brain injury? Pediatrics. 2005;116(6):1374-82.
10. Junqué C, Bruna O, Mataró M. Traumatismos cranioencefálicos: uma abordagem da neuropsicologia e fonoaudiologia. São Paulo: Santos; 2001.
11. Ciconelli RM, Ferraz MB, Santos W, Meinão I, Quaresma MR. Tradução para a língua portuguesa e validação do questionário genérico de avaliação de qualidade de vida SF-36 (Brasil SF-36). Rev Bras Reumatol. 1999;39(3):143-50.
12. Raven J. Matrizes progressivas: escala geral. 3 ed. Rio de Janeiro: CEPA; 2002.
13. Marques M. O teste de pirâmides coloridas de Max Pfister. São Paulo: EPU; 1988.

14. Conklin HM, Ashford JM, Di Pinto M, Vaughan CG, Gioia GA, Merchant TE, et al. Computerized assessment of cognitive late effects among adolescent brain tumor survivors. J Neurooncol. 2013;113(2):333-40. DOI: http://dx.doi.org/10.1007/s11060-013-1123-5
15. Miotto EC, Cinalli FZ, Serrao VT, Benute GG, Lucia MC, Scaff M. Cognitive deficits in patients with mild to moderate traumatic brain injury. Arq Neuropsiquiatr. 2010;68(6):862-8. DOI: http://dx.doi.org/10.1590/S0004-282X2010000600006
16. Sinha S, Gunawat P, Nehra A, Sharma BS. Cognitive, functional, and psychosocial outcome after severe traumatic brain injury: a cross-sectional study at a tertiary care trauma center. Neurol India. 2013;61(5):501-6. DOI: http://dx.doi.org/10.4103/0028-3886.121920
17. Schretlen DJ, Shapiro AM. A quantitative review of the effects of traumatic brain injury on cognitive functioning. Int Rev Psychiatry. 2003;15(4):341-9. DOI: http://dx.doi.org/10.1080/09540260310001606728
18. Brown M, Vandergoot D. Quality of life for individuals with traumatic brain injury: comparison with others living in the community. J Head Trauma Rehabil. 1998;13(4):1-23. DOI: http://dx.doi.org/10.1097/00001199-199808000-00002
19. Lazcano MM, Murga FM, Martin JMB, Morales DR, León-Carrión J. Cambios emocionales después de um traumatismo cranioencefálico grave. Rev Esp Neuropsicol. 1999;1(4):75-82.