Efficacy of a new parent and school-supported intervention after moderate and severe childhood traumatic brain injury

Andrea Palacio-Navarro, Anna López-Sala, Roser Colomé, Marc Turón, Laura Callejón-Póo, Marta Sanz-Palau, Anna Sans, Pilar Póo, Cristina Boix

Introduction. Traumatic brain injury is a common cause of acquired disability during childhood. Early interventions focusing on parenting practices may prove effective at reducing negative child outcomes.

Aim. To determine the efficacy of a new counselling program aimed at parents and schools compared to a control group.

Patients and methods. The main study sample was obtained from a paediatric hospital. The final sample consisted of 42 children aged between 6 and 16 years old.

Results. Comparing with normative data, pre-post comparisons between groups showed a significant improvement in the parent group with respect to the control group.

Conclusions. The superiority of the parental intervention group over those of the control group was not only statistically significant, but also clinically substantial and meaningful. The results of this study suggest that children with moderate to severe traumatic brain injury can benefit from an intensive supported family treatment.

Key words. Behavior. Cognition. Neuropsychology. Parent-supported family treatment. Pediatric brain injury. Traumatic brain injury.

Neurology Department. Hospital Universitari Sant Joan de Déu. Esplugues de Llobregat, Barcelona, Spain.

Corresponding author:
Andrea Palacio Navarro MD. Neurology Department. Hospital Universitari Sant Joan de Déu. Pg. Sant Joan de Déu, 2. E-08950 Esplugues de Llobregat (Barcelona).

E-mail:
apalacio@sjdhospitalbarcelona.org

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Introduction

In Spain it is estimated that as many as 235 out of every 100,000 people experience a head injury every year. Traumatic brain injury (TBI) is a common cause of acquired disability during childhood. In fact, at least 50% of patients are under 15, of which 79% will be considered mild TBI, 12% moderate TBI and 9% severe TBI [1].

In recent years, increased TBI survival rates have led to an increase in child patients with cognitive sequelae, and the need to reduce the morbidity of these patients and improve their short- and long-term functional outcomes has been highlighted. According to Anderson and Catroppa [2], children are particularly vulnerable to persistent deficits associated to TBI, which has a serious impact on cognitive performance and functional ability.

As in adult patients, in the paediatric population there is widespread evidence of the cognitive impact of acquired brain injuries. In the case of TBI, the most affected cognitive functions are general intellectual ability [3], memory [4,5], executive functions and attention [6-11], processing speed [12] and behaviour [13].

There is extensive evidence that cognitive stimulation is beneficial for adult people who have suffered TBI [14-16]. However, research on the effectiveness of cognitive rehabilitation in the paediatric population remains scarce [17]. Differences between adult patients and paediatric patients must be taken into account when working with children.

Behavioural changes are considered the most disturbing and persistent of all the problems that arise after TBI [18], causing an increase in family pressure. There is enough current scientific evidence of the efficacy of parental intervention with regard to ADHD. Many groups are extrapolating parental ADHD treatments to the field of TBI. The family plays a key role in the positive development of a child who has suffered a TBI [19].

The importance of parenting style for executive dysfunctions after a TBI in children has been studied. Early interventions focusing on effective parenting practices for families adjusting to recovery from TBI may prove effective at reducing negative child outcomes [20].

According to Braga et al [21], the indirect family-supported treatment group experienced better cognitive and functional outcomes following one year of treatment. There are three main objectives of intervention with the parents of children with acquired brain damage:

– *Psychoeducation of parents:* providing written information about the effects and symptoms of TBI to both parents and children [2,22].
– *Behaviour management strategies:* training parents in problem solving techniques improves performance and reduces child behaviour problems [23].
– *School psychoeducation:* provide detailed information to school professionals in order to facilitate the reintegration of children in school. Behaviour management strategies with teachers must be similar to those used for parents. After the acute phase of TBI, deficiencies are often invisible to the people who deal with the child [24].

Bedell et al [25] recommend the establishment of a collaborative partnership with families to promote social participation and achieve better child and family outcomes. And when existing strategies are not viewed as effective, families may benefit from learning about strategies used by other families and theory-based approaches.

Some studies show good results of the implementation of web-based programs designed to teach problem solving strategies to such parents, trying to reduce distress in families with a child that has suffered a TBI [26-28].

Although these results might suggest that these interventions provide positive results, there is a lack of randomized studies evaluating the effectiveness of rehabilitation treatment in children with TBI. There have not been many recent class-A studies of this topic. Nevertheless, one study has shown good results with direct clinician-delivered and indirect family-supported rehabilitation with children under 12 [21].

The importance of paying careful attention to the inclusion of children with TBI at school is known. Dealing with pupils with TBI in today's schools is a challenging area because so few teachers understand the complex and unique issues faced by this population [29,30], especially because of the distance between education and health that, in some cases, can produce major disconnection between the services that medical professionals recommend and what schools can provide. Rehabilitation staff may contribute to adversarial school relationships by suggesting that medically based goals be incorporated into an education setting without considering school contexts, available resources and academic objectives [31].

The aim of this study was to determine the efficacy of a new counselling and education program aimed at parents and schools, and designed to generate a significant improvement in family strain, socialization level, self-esteem and internalizing and externalizing problems in the treatment group compared to a control group.

Patients and methods

Participants

The main study sample was obtained from a paediatric hospital, by reviewing discharges from the neurology, rehabilitation, neurosurgery and intensive care unit services. There were also several referrals from other hospitals in Catalonia and the Balearic Islands. We also received direct requests from families interested in the project, who obtained the information through the media.

After contacting 200 TBI patients by email and telephone, 68 were willing to participate. Five subjects were excluded beforehand due to their low intelligence quotient, and one subject because of linguistic constraints. Following a neuropsychological assessment, two other subjects were excluded after obtaining intelligence quotient results below 70. We also excluded four subjects because they were assessed to be neuropsychologically normal. The final sample consisted of 42 children aged between 6 and 16 years old.

Eligibility criteria

We included patients aged 6 to 16 years old who had suffered moderate or severe TBI more than 6 months prior to this study. Moderate TBI was defined as a Glasgow Coma Scale (GCS) of 9-12 or greater than 12 if accompanied by diffuse brain swelling, skull fracture or intracranial mass lesion; severe TBI was defined as a GCS score of 8 or less. We excluded those patients whose intelligence quotient was below 70. Patients with previous diagnosis of severe psychiatric disorder or patients with sensory impairments (significant vision, motor and hearing loss) were also excluded, as were patients who did not show any deficit and those whose parents declined to participate.

Procedure

Parents were informed about the aim of the study and the intervention, and gave written informed consent to receive the treatment. The study design was approved by the Human Subjects Protection Committee, the centre's research commission and

the local ethics committee, and was conducted according to the principles of the Declaration of Helsinki (1964) and Spanish Law 14/2007 on Biomedical Research. All participant data was treated in accordance with the Law on Protection of Personal Data 15/1999.

The parental intervention group (PIG) contained 22 subjects at outset and 14 at completion. Six families left the treatment before the sessions began and two families left during the treatment. There were 28 families in the control group.

The parents filled out the Child Behavior Checklist (CBCL), Family Strain Index (FSI) and Parental Style questionnaire and the children took the KINDL self-esteem test. We chose these questionnaires because they were ecological enough to appreciate changes in daily life.

A comprehensive neuropsychological evaluation was administered to the children prior to beginning the parental intervention program, which includes assessment of intelligence quotient and executive functions.

For ethical reasons, inclusion in the control group was not randomized and consisted of patients who at the time of the study were not able to access the treatment for scheduling, distance or other reasons.

Intervention procedures

Participants in the PIG underwent six months of a parental intervention program: 2 h/week (group), 48 h at completion. The control group did not receive any intervention.

Parental intervention

Parental intervention consisted of a 2 hours weekly session. Participants were subdivided into groups of four to six families, with a maximum of 12 parents.

The main objective of PIG was to improve parental management and make them aware of their children's cognitive deficits to enable them to use the correct behavioural strategies in each case. 22 treatment sessions were delivered as described in table I.

The sessions always started with the parents openly reviewing the main aspects of the week, such as whether they were able to practice any new strategies or if new problems had arisen. The therapist then explained the issue of the week in a brief presentation and then they did the practical work, which might consist of self-evaluation exercises, brain-storming, role-playing, discussions and so on. Sessions were delivered by an expert neuropsychologist.

School intervention

At the beginning of the treatment, we requested all families to provide the name of their school and teacher, psychologist or other contact persons. We also requested their permission to contact those professionals.

First, a letter was sent to the school explaining the objective of the study, brief theoretical information about TBI and its rehabilitation and practical recommendations to achieve better academic results in consideration of the cognitive deficits suffered by the child. They were particularly recommended to:

- Designate a figure to coordinate all actions related to the child. This person should be informed about all aspects of the pupil's progress.
- Establish flexible means of contact with the specialist, preferably via email.
- Regularly share the information about the pupil's evolution between the three parts (school coordinator, family and therapist).

On the other hand, specific recommendations to the teacher were delivered to minimize the TBI dysfunction in class:

- Reduce and simplify tasks or allow extra time to get over the lack of processing speed that they usually have.
- Designate personal tutors to help with the organization and time management to get over the executive dysfunction.
- Promote an organized and structured environment with a minimal number of distractions and if possible in small groups to get over the lack of attention control.

Lastly, an interview was held with the centre (teachers, psychologist, etc.), the objective of which was to offer specific information about the pupil, and his/her sequelae and academic performance (Table II).

Data analysis

The categorical variables are described by way of their frequency percentages, and the numerical ones by way of their mean and standard deviation.

Baseline homogeneity among the two groups was tested using the Mann-Whitney *U* test for numerical variables, and Fisher's exact test for the categorical ones.

Pre-post comparisons between groups were analysed using the non-parametric Mann-Whitney *U* test. It was also used for comparing, between the two groups, the distribution of the differences (be-

Table I. Parental intervention group treatment sessions.

1. Introduction: presentation, main objectives of treatment and family objectives
2. The brain: brain anatomy and functionality
3. Habits, limits and orders
4. How to increase positive behaviours
5. How to decrease negative behaviours
6. How to organize study
7. Literacy problems
8. How to work on literacy
9. Mathematics problems
10. How to work on mathematics
11. Academic skills
12. Memory
13. Problem solving
14. Anxiety management
15. Affective disorders
16. Cognitive restructuration
17. Social skills
18. Self-control/anger control
19. Self-esteem
20. Parents: emotional cures
21. Social work: information about legal and judicial issues that affect traumatic brain injury in childhood
22. Final session: summary of main issues and production of individual roadmap

tween pre and post time points) of the numerical scales. Pre-post intragroup comparisons were analysed using the Wilcoxon test for paired samples. It was used to compare the distribution of these scales between the pre and post time points, in the same group. Cohen's *d* was calculated to measure the effect size (large, $d > 0.80$).

Due to our small sample, we decided to also analyse the results of the parent group before and after the treatment without comparing them with the control group.

R 3.0.0 software was used for all statistical analyses, for which the *p*-value = 0.05. Results of tests with a p-value ≤ 0.05 were considered significant.

Results

We compared the improvement in performance before and after treatment between patients whose parents were included in the PIG and patients included in the control group.

There were no statistically significant differences between PIG and control group for gender, injury severity, cause of injury, neurosurgical interventions, days of admission, age at injury or parents' socioeconomic status. There was an almost statistically significant difference in age of evaluation. The parent group's mean age was 11.14 ± 2.86 years while the control group's was 13.10 ± 3.23 years ($p = 0.053$) (Table III).

Neither were there statistically significant differences between the intellectual quotient of both groups: 92 ± 17.39 in controls and 94 ± 17.23 in PIG ($p = 0.68$).

All subscales of the Achenbach questionnaires (parent's version), the Vineland Social subscale, the FSI, KINDL self-esteem test, Parenting Style test and Behavior Rating Inventory of Executive Function (BRIEF) questionnaire (parent's version) were compared.

Tables IV and V show descriptive statistics (mean, standard deviation and sample size) for each group and moment and intragroup comparisons, respectively.

In the Achenbach thought problems subindex, a significant improvement in the PIG with respect to the control group and large effect sizes were observed ($p = 0.012$; $d = 0.886$). A negative result in this index means that there was an improvement in post evaluation compared with pre-evaluation.

In the Achenbach externalizing behaviour subindex, the PIG obtained better results after the treatment than the control group. This difference is not significant ($p = 0.131$) but the effect size is moderate ($d = 0.499$) (Table IV). In the Vineland Social Scale, parents also obtained better results after the treatment. Although these results are not significant ($p = 0.158$), the effect size is also considerable ($d = 0.536$). In FSI, the results were also successful, as the parents improved their scores less than the controls did, which means that they had fewer family strain problems. This difference tended towards sig-

nificance (p = 0.060) and the effect size was also quite large (d = 0.672) (Table IV). In the BRIEF, we also observed better results for parents than controls, but these results were only slightly significant (p = 0.076; d = 0.432). Table IV shows the results of other variables, such as anxiety and depression (p = 0.673; d = 0.080), social problems (p = 0.360; d = 0.151), attention problems (p = 0.647; d = 0.288) and internalizing behaviour (p = 0.661; d = 0.225) in the CBCL.

In a second analysis, the distribution of each index at the pre and post moment within the same group was compared (Table V). In this analysis, we used the typical scores from each of the tests to make a better interpretation. The scores from the assessed tests have a clinical normality of 100 ± 15. However, the CBCL questionnaires have a clinical normality of typical scores < 65.

We obtained some outstanding results from comparing the parent group before and after the treatment without comparing them with the control group (Table V).

We observed successful results for thought problems in the CBCL (p = 0.035; d = –0.624). On the other hand, in the BRIEF variable, parents obtained significantly worst results after the treatment (p = 0.001; d = 1.373). In the Vineland Social Scale, we also observe worst scores after the treatment in the parent group, but these results are only slightly significant (p = 0.063; d = –0.575).

Another outstanding result was found when comparing results for the control group before and after the non-treatment without comparing them with the parent group. Pre-post intragroup comparisons within the control group showed a significant increase in FSI scores (difference: 5.8; p = 0.001; d = 1.45), ultimately suggesting an increase in family strain problems.

Table II. Some example of exercises suggested to teachers.

Difficulties	What to do?
Difficulties to initiate tasks, lack of interest, unmotivated...	Structured daily routine Simplify tasks Divide tasks into simple steps and finish them one by one Use diaries and calendars Set deadlines to deliver homework Praise him/her when he/she begins unaided
Difficulties to perform, plan, organize work...	Start with realistic projects Plan the activities with the child Divide complex tasks or new tasks into small easy steps Repeat and explain the sequence of activities as often as necessary Give more time to do the tasks
Difficulties to learn new things, lack of memory...	Reduce the amount of information that must be learned Write information in an orderly manner Organize the day's activities and write them down so they know which activity comes next Us mnemotechnic devices Use external aids; calendars, notebooks, diaries to facilitate memory

Table III. Sample data.

		Control group (n = 28)	Parent group (n = 14)	p
Gender (male)		20 (71.43%)	11 (78.57%)	0.723
Age at TBI (years) [a]		8.71 ± 4.01	7.28 ± 4.39	0.420
Age at evaluation (years) [a]		13.10 ± 3.23	11.14 ± 2.86	0.053 [b]
Socioeconomic status	Low	32.14%	28.57%	0.566
	Medium	50%	64.26%	
	High	17.86%	7.14%	
Level of education	Basic	42.86%	35.71%	0.841
	Secondary	32.14%	42.86%	
	Superior	25%	21.43%	

TBI: traumatic brain injury. [a] Mean ± standard deviation; [b] p < 0.1.

Discussion

The primary purpose of this study was to explore the effectiveness of parent-supported intervention after moderate and severe childhood TBI. We hypothesized that a parent-supported intervention could ameliorate family strain, socialization level, self-esteem and internalizing and externalizing problems. We hypothesised significant improvement in the following ratings: FSI, Achenbach's scales (internalizing and externalizing index), Vineland Adaptive Behaviour Scale (socialization index) and self-esteem.

The aim of the study was to analyse whether the children in the PIG would experience better outcomes following six months of treatment, and this was partially confirmed. The superiority of the PIG's outcome measures over those of the control group was not only statistically significant, but also clinically substantial and meaningful.

The hypothesis that children in PIG would experience a greater decrease in the FSI following six months of treatment was confirmed. The intensity of the family training, combined with the increased

Table IV. Results of the comparisons (mean ± standard deviation).

	Control group	Parents group	ES	*p*
Thought problems in the CBCL	0.80 ± 5.46	−5.21 ± 8.35	0.886	0.012 [a]
Anxiety and depression in the CBCL	−2.55 ± 7.27	−3.21 ± 9.59	0.080	0.673
Social problems in the CBCL	0.20 ± 5.17	−0.71 ± 7.12	0.151	0.360
Attention problems in the CBCL	0.45 ± 7.19	−2.14 ± 11.14	0.288	0.647
Externalizing behaviour in the CBCL	2.15 ± 9.26	−2.29 ± 8.32	0.499	0.131
Internalizing behaviour in the CBCL	−0.35 ± 7.32	−1.93 ± 6.57	0.225	0.661
Vineland: social scale	0.78 ± 12.94	−5.57 ± 9.69	0.536	0.158
Family Strain Index (FSI)	5.80 ± 4.00	0.93 ± 9.59	0.672	0.065 [b]
Behavioral Regulation Index (BRIEF)	18.86 ± 11.87	14.00 ± 10.20	0.432	0.076 [b]
KINDL self-esteem: family	−1.44 ± 25.79	−9.38 ± 17.80	0.361	0.2821

BRIEF: Behavior Rating Inventory of Executive Function; CBCL: Child Behavior Checklist; ES: effect size, large ($d \geq 0.80$), moderate ($d = 0.50$-0.79) or small ($d = 0.20$-0.49). [a] $p < 0.05$; [b] $p < 0.1$.

Table V. Pre-post parent group (mean ± standard deviation).

	Pre	Post	ES	*p*
Thought problems in the CBCL	62.21 ± 7.36	57.00 ± 7.97	−0.624	0.035 [a]
Anxiety and depression in the CBCL	60.00 ± 6.64	56.79 ± 6.84	−0.335	−3.214
Social problems in the CBCL	62.29 ± 6.31	61.57 ± 7.54	−0.100	−0.714
Attention problems in the CBCL	65.00 ± 11.79	62.86 ± 9.85	−0.192	0.783
Externalizing behaviour in the CBCL	61.14 ± 6.92	58.86 ± 10.53	−0.275	0.257
Internalizing behaviour in the CBCL	61.07 ± 7.89	59.14 ± 9.81	−0.294	0.314
Vineland: social scale	96.07 ± 13.67	90.50 ± 8.06	−0.575	0.063 [b]
Family Strain Index (FSI)	109.29 ± 10.43	110.21 ± 13.96	0.097	0.754
Behavioral Regulation Index (BRIEF)	62.86 ± 9.38	76.86 ± 7.62	1.373	0.001 [a]
KINDL self-esteem: family	71.88 ± 17.97	62.50 ± 26.06	−0.527	0.067 [b]

BRIEF: Behavior Rating Inventory of Executive Function; CBCL: Child Behavior Checklist; ES: effect size, large ($d \geq 0.80$), moderate ($d = 0.50$-0.79) or small ($d = 0.20$-0.49). [a] $p < 0.05$; [b] $p < 0.1$.

perception of control in the families, resulted in parents who were more competent at managing everyday household problems and who were less stressed about them. The hypothesis that these parents would have considerably lower scores for the Achenbach internalizing and externalizing scales was partially confirmed. Children in the treatment group only underwent a greater decrease in the Achenbach externalizing scale. The hypothesis that children in the treatment group would have better scores in the Vineland Scale socialization index is not confirmed. We attribute these results to an increase in parent's insight due to the treatment. Finally, the hypothesis that children in the treatment group would have better self-esteem after six months of treatment measured with the KINDL scale was also confirmed in our sample but only when comparing the results of the parent group before and after the treatment without comparing them with the control group.

The results of this study are generally optimistic because they suggest that children with moderate to severe TBI can benefit from an intensive supported family treatment. The results are also consistent with Catroppa et al [19], who found that the family plays a key role in the positive development of the child who has suffered a TBI. Braga et al [21] also found superior cognitive and functional outcomes following one year of treatment in the indirect family-supported treatment group.

The results of this study are consistent with many studies proving good efficacy of treatments aimed at families with children with moderate to severe TBI [19-21,25,27,28,32].

Methodological strengths of this study include the following:

- The therapists were the same for all treatment groups.
- Parental intervention was a group intervention but was adapted to the educational level of the parents.
- Parents or children from the treatment or control group who were following some pharmacological or non-pharmacological treatment continued such treatment during the study.
- The study includes measures of the child's behavioural and social outcome to ensure ecological validity.

Methodological weaknesses of this study include the following:

- The small sample size in the treatment group made it difficult to find statistically significant results.
- Groups are not homogeneous in terms of TBI age and in years since the TBI.
- Some families left the study because of the dedication required.

An important limitation of this study was the small sample size in both groups. This means that possible clinically relevant differences may not be statistically significant due to the low statistical power of the tests used.

In conclusion, this controlled trial has shown the efficacy, for this sample, of parent-supported intervention after moderate and severe childhood TBI. Future studies should be conducted in a way that takes into account the strengths and weaknesses of the current study, probably through multi-centre and possibly multi-national trials.

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Eficacia de una nueva intervención de apoyo a padres y escuelas después de un traumatismo craneoencefálico moderado o grave

Introducción. El traumatismo craneoencefálico es una causa habitual de discapacidad adquirida durante la infancia. Las intervenciones tempranas que se centran en la participación de los padres pueden resultar efectivas para reducir las disfunciones del niño.

Objetivo. Determinar la eficacia de un nuevo programa de asesoramiento dirigido a padres y escuelas en comparación con un grupo control.

Pacientes y métodos. La muestra principal del estudio se obtuvo de un hospital pediátrico. La muestra final consistió en 42 niños de 6 a 16 años.

Resultados. Comparando con los datos normativos, las comparaciones pre y post intragrupos mostraron una mejora significativa en el grupo de intervención parental con respecto al grupo control.

Conclusiones. La superioridad del grupo de intervención parental sobre el grupo control no sólo fue estadísticamente significativa, sino también clínicamente sustancial y relevante. Los resultados del estudio sugieren que los niños con traumatismo craneoencefálico moderado o grave pueden beneficiarse de un tratamiento familiar intensivo de apoyo.

Palabras clave. Cognición. Conducta. Intervención parental de apoyo. Lesión cerebral pediátrica. Neuropsicología. Traumatismo craneoencefálico.