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Original article

Changes in weight after traumatic brain injury in adult patients: A longitudinal study

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SUMMARY

Background & aims: Although changes in weight have been reported after traumatic brain injury (TBI), their frequency and underlying factors are little known. Our aim was to determine the prevalence of weight changes and the associated factors during the recovery phase after TBI.
Methods: Longitudinal follow-up of adults with TBI. Multivariate analysis was carried out on weight change, demographic data, dysexecutive syndrome, eating behavior, physical activity, therapeutic classes and metabolic complications.
Results: 107 patients (81 males/26 females), age 36 ± 13 yrs, baseline BMI 23.3 ± 3.9, followed for 38 (8–66) months, were included. In intensive care, patients lost a mean 11 ± 6 kg. End of follow-up, mean BMI was not different to pre-TBI BMI, but patients could be categorized in 3 groups: stable (30%), loss (28%, −8 ± 7 kg) and gain (42%, +9 ± 6 kg). Sex, age, severity of TBI, intensive care weight loss, physical activity, therapeutic classes and the occurrence of metabolic syndrome did not differ between the groups. Factors related to weight gain were hyperphagia, OR 4.5 (IC95%, 1.6–12.1) and presence of a dysexecutive syndrome, OR 2.5 (IC95%, 1.03–6.3). Factors related to weight loss were hypophagia, OR 4.1 (IC95%, 1.5–10.9) and higher pre-TBI BMI, OR 4.9 (IC95%, 1.7–14.0).
Conclusions: Over a median period of 38 months, 42% of TBI patients gained and 28% lost weight. Factors associated with these changes were the presence of a behavioral dysexecutive syndrome for weight gain, oral food intake and initial BMI, which were inversely associated with weight at end of follow-up. These findings highlight the importance of evaluating the time course of weight changes and providing specific nutritional care.

1. Introduction

Obese passengers are more likely to suffer a more severe head injury after frontal motor-vehicle crashes.[1] After traumatic brain injury (TBI), changes in weight and (or) food behavior have been reported in short studies[2,3] and various clinical case-reports.[4,5] Some reports have described hyperphagia and reduction of satiety.[6] Anorexia following TBI has also been reported.[7] A recent longitudinal study in 39 children with TBI showed that 15% were overweight 1 year after the TBI.[8] However, the frequency of weight changes and the underlying factors are currently unknown in adult patients. In a study of 20 TBI patients, the presence of other persons during meals, or the social factor, was a significant predictor of meal size for healthy control subjects, but not for brain-injured patients[2] indicating probable central involvement. In addition, a low prevalence (5.4%) of hypopituitarism, including GH deficiency and hypogonadism, which can contribute to obesity, was reported in a study of 112 adult TBI patients.[9] The same trend was observed in 39 children, with a prevalence of 2.5%.[8] A higher prevalence – 15% – was found in a cross-sectional study of 104 adult patients 13 months after TBI.[10] Modification of food behavior – and thus of weight – can be expected to occur after TBI, due to the presence of a dysexecutive syndrome and because the hypothalamus is the main brain center involved in food intake in both animal experimental models and humans.[11] Cognition and behavior can also be impaired in moderately severe TBI, and is related to a "post-concussion syndrome".[12]

Changes in nutritional intake after TBI appear to occur in two phases: a constant, prolonged and significant hypermetabolism during the stay in neurosurgical units and intensive care,[13,14] with a

Abbreviations: TBI, traumatic brain injury; BMI, body mass index; WHO, World Health Organization.

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risk of severe undernutrition despite nutritional support, followed by a recovery phase which may follow different patterns. To determine the prevalence of changes in weight after TBI in the recovery phase, and the associated factors, we performed a longitudinal study in a cohort of adult TBI patients followed in a specialized hospital for neurocognitive rehabilitation.

2. Patients and methods

2.1. Patients

This was a single center longitudinal study of a cohort of adult TBI patients. All the patients were initially cared for in different intensive care units and were then admitted to our physical medicine and rehabilitation (PMR) center between 2004 and 2009. The study protocol was approved by the local Ethics committee. Informed consent was obtained from the patients or their relations in compliance with the French regulations for observational clinical research.

Inclusion criteria were: age 18–70 years at the time of the TBI, isolated TBI assessed with the cerebral Marshall CT-scan classification[15] and the Glasgow coma scale (GCS) [mild (score 13–15), moderate (9–12), or severe (<9)] with no associated spinal cord injury or polytraumatic lesions of the viscera which required surgery. In addition, a follow-up of at least 6 months after the intensive care period and from the beginning of rehabilitation was mandatory.

We excluded patients below the age of 18 or above the age of 70, pregnant women, patients with paraplegia, tetraplegia and those in a persistent vegetative state, patients with no indications for rehabilitation and patients with previous surgery to the digestive system, in order to eliminate possible interference with the regulation of food intake.

Analyses of hypothalamic and pituitary hormones were carried out in patients for whom there was a clinical or biological suspicion of deficiency, such as polyuria or hypernatremia.

Enteral nutrition adapted to their needs in terms of energy and protein (1500–1800 kcal/d, 56–67 g of proteins) was given to each patient in intensive care units by a nasogastric tube or gastrostomy and was continued during the transfer to PMR. Reduction and weaning from enteral nutrition was carried out under the supervision of the dietician during the stay in PMR (4 months in average) when the patient regained the ability to swallow without difficulty. A mixed feeding program was put into place, with a nocturnal enteral intake until oral intake became sufficient, with an energy intake goal of 1600–1800 kcal/d for patients who were overweight before the TBI and 1800–2000 kcal/d for those who were not.

2.2. Data collection

Weight was noted at different time points: before the TBI (W1 i.e. usual weight recorded in previous medical files or noted during interviews with the patients or their relatives), at admission to, (W2) and discharge from (W3) the PMR center, and at the end (W4) of the follow-up period. BMI (body mass index) was calculated at each of these time points. The following potential explanatory factors were noted: age, sex, initial GCS score, duration of coma and stay in intensive care, level of physical activity according to the WHO (World health organization) criteria[16] and therapeutic classes of drugs taken by the patients. Quantitative oral food intake was noted according to three categories which were relative to pre-TBI levels: lower, i.e. hypophagia (<1500 kcal/d), similar, and higher, i.e. hyperphagia (>2500 kcal/d). This was based on a dietary inquiry, verbal or visual analogue scales and eating behavior (number of meals per day, eating between meals, taste preferences (sweet or savory), binge eating and nocturnal eating) during the stay in PMR and following return home. No patients took topiramate[17] as an antiepileptic drug or were treated for a binge eating disorder. Oral food intake and eating behavior were determined during dietary inquiries with the patients and their families, at least twice in a 2-month period during a medical consultation or a phone call by a dietician and a physician. In addition, alcohol and tobacco abuse, presence or absence of addictions since TBI and before TBI, were recorded. The presence of a behavioral dysexecutive syndrome was scored dichotomously (yes/no) during the stay in PMR by an experienced neuropsychologist, based on the patient's performance on a standardized test.[18] Metabolic complications which were present before the TBI and any occurring during the follow-up after TBI were recorded: arterial hypertension, diabetes mellitus or glucose intolerance and dyslipidemia.

2.3. Statistics

Data from all the patients included were used in the initial analysis. For this analysis, three classes of BMI were used: below 20 (underweight), 20 to 25 (normal), and above 25 (overweight). Data were evaluated at four time points: W1: weight prior to TBI, W2: admission to PMR, W3: discharge from PMR and W4: end of the follow-up period. In a posthoc analysis, patients were categorized in three groups according to the amount of weight change at the end of the follow-up compared with pre-TBI weight: group 1 (weight loss), group 2 (weight stabilization: ±3%) or group 3 (weight gain). Student *t* tests and ANOVAs were used for quantitative data comparisons, and chi-squared tests for qualitative data. To study independent associated factors in relation to weight change, a logistic regression was used. SPSS software version 11.5 was used for the statistical analysis. Statistical significance was set at $P < 0.05$.

3. Results

During the period from 2004 to 2009, among the 280 patients admitted to our PMR center and classified as post-TBI, 107 patients met the inclusion criteria. Median duration of follow-up was 38 (8–66) months from the end of the intensive care period.

3.1. Baseline

Patient characteristics relating to the severity of TBI are listed in Tables 1 and 2. Neurosurgical interventions were carried out in 28 patients (26%), mostly for compressive intracranial hematoma. A diffuse cerebral injury on the initial cerebral X-ray or MRI according to Marshall classification was found in 79 patients (74%) and was associated with a prefrontal lesion in 74 (69%) patients.

3.2. End of follow up

At the end of follow-up, 104 patients (97%) were discharged home and 3 (3%) were admitted to a specialized institution for patients

Table 1
Baseline characteristics of patients ($n = 107$) before traumatic brain injury.

Sex ratio: M/F	81/26
Age (mean ± SD)	36 ± 13
Weight (mean ± SD)	71 ± 13.5
BMI (mean ± SD)	23.3 ± 3.9
BMI classes:	
BMI < 20	22 (21%)
BMI between 20 and 25	61 (57%)
BMI > 25	24 (22%)
Metabolic disorders (*n*)	15 (15%)