
Objectives: To investigate the status of functional oral intake for patients with severe traumatic brain injury (TBI) and time to return to unrestricted dieting; and to investigate whether severity of brain injury is a predictor for unrestricted dieting.

Design: Observational retrospective cohort study.

Setting: Subacute rehabilitation department, university hospital.

Participants: Patients age 16 to 65 years (N=173) with severe TBI (posttraumatic amnesia from 7d to >6mo) admitted over a 5-year period. Patients are transferred to the brain injury unit as soon as they ventilate spontaneously.

Intervention: Facial oral tract therapy.

Main Outcome Measure: Unrestricted dieting assessed by the Functional Oral Intake Scale (FOIS).

Results: We found that 93% of all patients had problems with functional oral intake at admission. Within 126 days of rehabilitation, 64% recovered to unrestricted dieting before discharge. The chance of returning to total oral diet depends on the severity of the brain injury and can be predicted by Glasgow Coma Scale (GCS; measured the day after cessation of sedation; Wald $\chi^2 = 42.78, P<.01$), Rancho Los Amigos Scale (RLAS) level (Wald $\chi^2 = 11.84, P = .01$), FIM instrument (Wald $\chi^2 = 44.40, P<.01$), and FOIS score at admission (Wald $\chi^2 = 82.93, P < .01$).

Conclusions: Impairment in functional oral intake was found to be very common for patients with severe TBI admitted to a subacute rehabilitation department. For those who recovered during hospital rehabilitation, return to unrestricted dieting happened within 126 days of rehabilitation. The chance of returning to unrestricted dieting depends on the severity of the brain injury and can be predicted by GCS score, RLAS level, FIM score, and functional oral intake at admission. These results are important when planning rehabilitation, giving information to patients and relatives, and designing efficacy studies of facial oral tract therapy, which are highly recommended.

Key Words: Brain injuries; Deglutition disorders; Rehabilitation.

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The purpose of the present study was to investigate the incidence, status, and time to recovery of functional oral intake (unrestricted dieting) for patients admitted to an early subacute brain injury rehabilitation unit and to investigate brain injury severity as a predictor for return to unrestricted dieting.

METHODS

This present study is a retrospective observational study using data collected from hospital records and chart reviews. This study was approved by the Danish National Committee on Biomedical Research Ethics (the Copenhagen regional committee) and the Danish Data Protection Agency.

Participants

From October 2000, the subacute rehabilitation of all severely injured patients with TBI in Denmark was centralized to 2 units, each with geographically defined uptake areas.

The present study includes patients from the uptake area of the Copenhagen center—that is, the eastern half of Denmark, Greenland, and the Faeroe Islands, with a total of 2.4 million inhabitants. All hospitals in the uptake area, and in particular the only 2 neurosurgical clinics in the area, agreed to refer patients fulfilling the following criteria: highest priority was given to patients who, after initial treatment in a neurosurgical or other clinic, had a GCS13 score in the range 3 to 12, 1 day after cessation of sedation. All such survivors were transferred as soon as they ventilated spontaneously. The median time spent in acute care was 15 days (range, 3–150d). The brain injury severity was confirmed by prospective assessment of the PTA period. All 177 patients age 16 to 65 years, admitted over a 5-year period, from October 2000 to December 2005, were evaluated for eligibility. We excluded patients on the basis of previously known swallowing problems because of neurologic diseases or other diagnoses. Four patients met these criteria, and 173 patients were included in the study. Patients younger than 65 years were excluded because swallowing function can be affected in older age groups of otherwise healthy people.14 According to the rehabilitation program of the brain injury unit,15 all patients are enrolled in an extensive around-the-clock rehabilitation program by interdisciplinary teams starting on the day of admission. Functional rehabilitation is based on the treatment concepts: Affolter and Stricker,16,17 Bobath,18 and Coombes.17,18 The emphasis lies on sensory stimulation, facilitating normal movements and daily activities even for patients in vegetative state. Discharge is decided on when the patient is (1) able to go home, (2) able to continue the rehabilitation in a local and less intensive setting, or (3) referred to a nursing home if no progress was made at all for a 3-month period.8

Swallowing Therapy

A clinical evaluation of swallowing is performed on the day of admission in line with the treatment concept of facial oral tract therapy.17,18 This concept was developed by speech and language therapist Kay Coombes and provides a structured way to assess and treat disturbances in facial expression, movement of the jaw for eating and articulation, breathing, swallowing, and voice.17 Treatment methods include slow, organized touch of the jaw for eating and articulation, breathing, swallowing, and voice.17 Treatment methods include slow, organized touch of the patient’s hands, facilitating hand-to-hand and hand-to-face contact, together with specific oral stimulation, therapeutic oral hygiene routines, and facilitation of swallowing. Facial oral tract therapy does not require that the patients are capable of following instructions. Therefore, patients with a very low level of consciousness also receive facial oral tract therapy. For example, in the beginning, they will be given treatment with oral stimulation and therapeutic eating (small amounts of food given in the treatment session). In the evaluation of swallowing ad modum, Coombes covers 4 phases: the preoral phase (involves anticipatory saliva production in response to seeing and smelling food or drink, and bringing food and liquid to the mouth), the oral phase (bolus formation and transport to the back of the mouth), the pharyngeal phase (transport of bolus through pharynx from the mouth to esophagus), and the esophageal phase (transport of bolus through esophagus to the stomach).16 All patients with impairments in the mentioned areas are enrolled in a treatment program according to facial oral tract therapy. Occupational therapists at the department are all continuously trained in facial oral tract therapy. The number of therapy sessions is determined by the patient’s overall condition, severity of impairments, the patient’s responses to the interventions, and/or the relatives’ wishes for the rehabilitation. Each treatment is individually planned according to the evaluation of all professionals in the interdisciplinary team.

Dependent and Independent Variables

Dependent variable. FOIS11 was assessed retrospectively by the first author on the basis of a chart review. The scale consists of 7 levels. Levels 1 through 3 relate to varying degrees of nonoral feeding; levels 4 through 7 relate to varying degrees of oral feeding without nonoral supplementation.11 The scale was translated into Danish following recommended procedures.20 First the scale was translated into Danish by 2 health care professionals. They both have Danish as their mother tongue and are fluent in English. They agreed on 1 Danish version, which was back-translated into English by another health care professional who is fluent in Danish and has English as her mother tongue. The original first author, Crary,11 has given his consent that this translation sufficiently approximates the original version.

The chart review from the brain injury unit includes the following data on each patient: a transfer paper with information from acute care, documentation notes from the medical doctors at the brain injury unit (notes were made every time they consulted with the patient or made any decision regarding treatment), documentation of placement of the feeding tube, documentation notes from the occupational therapist made after every facial oral tract therapy intervention and of every clinical evaluation of swallowing, a general status of the patient noted every other week by the interdisciplinary team, and nutrition charts with information on the patient’s daily diet. By combining all this information obtained from the chart review, FOIS was scored on the day of admission to the brain injury unit, every other week until discharge, and at follow-up (follow-up time was 6 months after discharge for the first 3 years and at 1 year for the patients admitted during the last 2 years). At follow-up, the patient came back to the department for 1 day but did not go through an evaluation of swallowing. The FOIS score at follow-up was therefore based on the patient’s own information of daily dieting or information given from caregiver or relatives. Admission data of 60 patients were scored twice for quality control with 1 year in between.

Independent variables. GCS13 score (measured the day after cessation of sedation), time in acute care (time from injury until admission to subacute rehabilitation brain injury unit), FIM score,21 and RLAS level22 were all assessed at admission. LOS (time from admission to discharge at subacute rehabilitation brain injury unit) and PTA23 were assessed by neuropsychologists by means of the Galveston Orientation and Amnesia Test, and number of hours with swallowing therapy was assessed at discharge.
Endpoints

The primary endpoint of this study was the time from beginning of rehabilitation (measured in number of days) until the patient had an FOIS score of 7 (total oral diet with no restrictions). Censuring events were discharge or death.

Statistical Analyses

All data were analyzed using SPSS® package for Windows XP.

Patient demographic variables were described by median, IQR, minimum and maximum values for continuous variables, and by number and percent for categorical variables. Further mean and SD were reported for time in acute care and LOS to allow comparison with other studies. We used the Wilcoxon signed-rank test to analyze the difference in FOIS at admission, discharge, and follow-up (the 4 patients who died at the brain injury unit are excluded in this analysis).

We used Kaplan-Meier plots to estimate the time until and the chance of reaching unrestricted dieting. Significance of difference between patients grouped by the scales were calculated using the log-rank test statistic, and we estimated the size of difference using the multiple Cox proportional hazards model.

RESULTS

Of the 173 patients in the study population, 45 were women and 168 men. They had a median age of 35 years (IQR, 24–51y; mean ± SD, 37 ± 15y), median GCS score (measured the day after cessation of sedation) was 11 (IQR, 9–13; mean, 11 ± 3), and 83% of all patients were in PTA more than 4 weeks. The distribution of PTA is presented in figure 1.

Median FIM score was 18.5 (IQR, 18.0–38.5), median time in acute care was 15 days (IQR, 10–24d; mean, 20 ± 20d), and LOS at brain injury unit 86 days (IQR, 53.5–163.5d; mean, 113.5 ± 84.0d). One patient did not respond in any manner at admission (RLAS level 1), 24% were in a vegetative state (RLAS level 2), and 27% were in a minimal consciousness state (RLAS level 3), beginning to respond adequately. Another 69 (44%) patients responded in a more stable way, and only 7 patients (4%) could cooperate relevantly in all situations (RLAS level 7–8). The RLAS levels at admission and discharge are presented in figure 2.

The median hours spent on each patient with swallowing therapy was 16 hours (IQR, 8–36h). At admission, 93% of all patients had problems with oral intake (FOIS score <7), 108 (63%) were dependent on tube feeding when admitted to brain injury unit, and 46% did not receive anything by mouth (FOIS score 1). Twenty-one percent had a tracheotomy tube during their rehabilitation, and 45% of all patients had a prolonged problem with eating and drinking and received a PEG tube. FOIS scores at admission, discharge, and follow-up are presented in figure 3.

Of the 173 patients, 110 (64%) returned to unrestricted dieting (FOIS score 7) before discharge. Of the 63 (37%) patients with an FOIS score less than 7 at discharge, half were dependent on a PEG tube. No patients were discharged with a tracheotomy tube. Follow-up data were obtained on 142 (82%) of the 173 subjects who participated in the study. Missing data were caused by lack of information of the specific diet level at the time of follow-up, or the patient had died (4 patients), or the patient did not choose to participate in the follow-up visit. At follow-up, none of the FOIS scores had decreased from discharge, and another 16 patients had returned to unrestricted dieting.

Fig 1. PTA distribution.

Fig 2. RLAS measured at admission and discharge.

Fig 3. FOIS measured at admission, discharge, and follow-up.
dieting. The differences between FOIS at admission, discharge, and follow-up are statistically significant ($P < .01$).

**Intrarater Reliability**

In the intrarater reliability test, there was agreement in 55 (92%) of the 60 patients, in 4 (7%) patients there was 1 level of disagreement, and in 1 patient (2%) 2 levels. Kaplan-Meier plot (fig 4) shows that after 56 days, the chance of having reached unrestricted dieting crossed 50%. Among those achieving unrestricted dieting, the median time from admission was 28 days, and after 126 days, no more patients fully recovered despite continuing swallowing therapy. The probability of having recovered to unrestricted dieting within 126 days was 68%. This result takes account of the patients who were discharged before 126 days with restricted dieting and the patients who were still on restricted dieting and not discharged from rehabilitation. Log-rank tests comparing the chance that the patients reached unrestricted dieting before discharge, grouped by their severity of brain injury, are also illustrated by Kaplan-Meier plots (fig 5).

Patients admitted with a GCS score less than 9 had a 41% chance of returning to unrestricted dieting in subacute rehabilitation, and patients admitted with a GCS score greater than 12 had a chance of 90% (the groups were statistically significantly different; $P < .01$). The more severe the brain injury at admission to rehabilitation (low GCS score), the lower the chance of reaching an FOIS score of 7. This was also reflected in RLAS levels. Patients admitted with RLAS level 1 to 2 had a chance of only 24% of reaching restricted dieting at the brain injury unit, whereas 77% of the patients admitted in minimal consciousness state, RLAS level 3; 88% patients with RLAS level 4 to 5; and 100% of the patients with an RLAS level 6 to 8 reached unrestricted dieting at the brain injury unit ($P < .01$). The difference between the groups graduated by different time in acute care was rather small. Patients with time in acute care less than 24 days had a 56% chance of reaching an FOIS score of 7, and patients with time in acute care less than 7 days an 80% chance (differences between the groups are also significant; $P = .04$). Functional independence reflected in FIM shows that patients with a minimal functional independence (FIM score < 19) at admission had a 50% chance of reaching unrestricted dieting, while higher levels of FIM were not very discriminative ($P < .01$). Finally, we investigated whether the patient’s oral intake at admission could predict whether the patient would reach unrestricted dieting before discharge. We found a clear association showing that of the 79 patients admitted with an FOIS score of 1, 39% reached unrestricted dieting; of the patients admitted with an FOIS score of 2 to 3, 81% reached unrestricted dieting; and of the patients admitted with no feeding tube, FOIS score of 4 or higher, almost all (98%) reached unrestricted dieting before discharge ($P < .01$).

The Cox proportional hazards model is presented in table 1. Statistical significance was found in all variables, confirming that the more severe the brain injury, the lower the chance of reaching unrestricted dieting before discharge. GCS score (measured the day after cessation of sedation; Wald $\chi^2 = 42.78$, $P < .01$), RLAS level (Wald $\chi^2 = 11.84$, $P < .01$), FIM score (Wald $\chi^2 = 44.40$, $P < .01$), and FOIS score at admission (Wald $\chi^2 = 82.93$, $P < .01$) were found to be good predictors for FOIS score of 7 before discharge.

**DISCUSSION**

The method used in this study is a retrospective collection of data of the functional oral intake reflected in the FOIS by Crary et al.$^{11}$ It could be expected that there would be some inaccuracy when scoring the data. However, we believe the factual error is small because of the extended documentation made by the occupational therapists in their own charts, and the medical charts and the diet information charts they make for each patient. Moreover, the authors of the FOIS used retrospective chart reviews successfully. $^{11}$ None of the patients who returned to unrestricted diet had any complications in terms of aspiration pneumonia during hospitalization, and no patients went back to restricted dieting, nor were they discharged back to acute care.

This study found a very clear association between severity of brain injury and the chance of reaching unrestricted dieting before discharge. At admission, 93% of the patients had problems with eating and/or drinking, and 64% reached unrestricted dieting before discharge within a maximum time of 126 days. Our study included the most severely injured patients from a defined geographical area. The severity was confirmed by the PTA distribution, and we have found no other directly comparable group described in the literature. As mentioned, Mackay et al.$^5$ found that 61% of patients with TBI admitted to a level I trauma center had abnormal swallowing that affected oral intake, and that the severity of swallowing impairment was associated with lower GCS scores, lower RLAS levels, presence of tracheotomy, and ventilation time longer than 2 weeks$^5$ (because they did not report any PTA distribution, we cannot say whether that patient group is comparable to our group). Ward et al.$^6$ investigated predictors of oral intake in patients with TBI in acute care and found that patients with severe brain injury (GCS range, 3–8) took a longer time to reach initiation of oral intake than patients with less severe injury (GCS range, >8). Other studies support that low cognition level is associated with poor oral intake in adults with TBI$^1$ and also in children.$^7$ We investigated several factors focusing on different aspects, such as coma score (GCS), cognitive level (RLAS), time in acute care, level of functioning (FIM), and FOIS score at admission.

GCS score, RLAS level, FIM score, and FOIS score were all found to be statistically significant in predicting time to recovery of functional oral intake, showing that levels of consciousness, cognitive level, and functional measures can be used when predicting return to unrestricted dieting. These results are important when planning rehabilitation and giving information to the patients and relatives. Patients admitted with an RLAS...
level of 1 to 2 only had a 24% chance of reaching unrestricted dieting, whereas a patient with an RLAS level of 3 (patients in a minimal conscious state) had a 77% chance. Therefore, even though patients with an RLAS level of 3 are at a very low functioning state at admission, they do have a very good prognosis regarding oral diet. It could be interesting in later studies aiming to investigate the effect of swallowing therapy to use the different categorizations of brain injury severity to give the patients different treatment intensities in the different groups, in line with Carnaby et al. This information could contribute to more efficient use of resources (therapist time) in planning rehabilitation of oral functioning.

Fig 5. Kaplan-Meier plot showing the time to reach unrestricted dieting. Data tabulated by severity of head injury measured at admission (predictive measures). Censored denotes that the patient has been under surveillance for a period, but has not yet experienced the event. Abbreviation: TAC, time in acute care (from injury to admission to subacute rehabilitation).
A more surprising result is that time in acute care was not found to be a strong predictor for recovery of oral functioning, even though time in acute care had earlier been found to predict functional outcome. This could be because the time our patients stayed in neurosurgical clinics was relatively short (median, 15d), because they were admitted to a brain injury unit right after cessation of sedation. In the study by Whyte et al,26 the patients had a median time from injury to enrollment (time in acute care) of 40.5 days. Obviously, this difference means that several aspects can influence the results, such as other medical complications in the patients and so forth. We also found that after 56 days (8wk), the chance of returning to unrestricted dieting crossed 50%, and after 126 days, 64% of our group of patients returned to unrestricted dieting and another 9.2% had recovered at follow-up. Second, if unrestricted dieting was not reached within 126 days from admission, and no patient had a lower level of oral intake at follow-up. Because the therapist did not perform a clinical evaluation of swallowing of each patient at follow-up, we do not know whether the follow-up results reflect improvement in the patients’ oral functioning or the fact that other therapist and care practices outside the hospital use different assessments for evaluation of swallowing and/or have other criteria for when the patient can eat and drink. Despite this, it seems reasonable to conclude that in the 82% of the patients seen for follow-up, the level of function of oral intake gained during brain injury unit did not decrease over time. Implementation of a similar method for evaluation of swallowing and criteria for oral diet is recommendable in all phases of rehabilitation, as well as a description of a standardized swallowing therapy that can be used for both experienced and less experienced therapists and caregivers. We hope in the next years to publish such a guideline describing how to use facial oral tract therapy.

Results from this study are important for clinical practice in a subacute rehabilitation department. First, deficient oral intake was found in 93% of our group of patients with very severe TBI. However, functional oral intake significantly improved, so that 64% recovered to unrestricted dieting before discharge and another 9.2% had recovered at follow-up. Second, if unrestricted dieting was not reached within 126 days from admission to rehabilitation, it was not reached before discharge. Third, recovery to unrestricted dieting can be predicted using variables concerning level of consciousness (GCS), cognitive functioning (RLAS), functional ability (FIM), and FOIS, all assessed at admission to rehabilitation. Fourth, the patient group with an RLAS level of 1 to 2 at admission had a 24% chance of recovery, patients with an RLAS level of 3 had a
CONCLUSIONS

Impairment in functional oral intake was found to be very common, occurring in 93% of a group of 173 patients with very severe TBI admitted to a subacute rehabilitation unit. Return to unrestricted dieting occurred within a maximum of 126 days of rehabilitation. After 56 days, the chance of having reached unrestricted dieting crossed 50%. The chance of returning to total unrestricted dieting was found to depend on the severity of the brain injury and could be predicted in particular by RLAS level at admission, but also by GCS score, FIM score, and functional oral intake at admission. These results are important when planning rehabilitation, giving information to patients and relatives, and designing efficacy studies of facial oral tract therapy, which are highly recommended.

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References


Supplier

a. Version 13.0; SPSS Inc, 233 S Wacker Dr, 11th Fl, Chicago, IL 60606.