NEUROANATOMICAL CORRELATES OF DELUSIONS IN HEAD INJURY

S. SABHESAN\textsuperscript{1}, R. ARUMUGHAM\textsuperscript{2}, M. NATARajan\textsuperscript{3}

SUMMARY

Twelve patients with organic delusions during recovery from head injury were studied in comparison to a control of non-deluded head injured patients. Clinical data such as duration of unconsciousness, length of post traumatic amnesia and occurrence of brain-stem signs pointed to the presence of subcortical functional disruption in these patients. Clinical and psychometric data indicated that left hemispheric functions were more impaired than those of the right. Recent concepts in the biomechanics of head injury indicated that subcortical and left sided dysfunction following head injury was significantly associated with the occurrence of delusions.

Delusions which denote pathological conceptualizations, constitute a symptom common to both organic and functional disorders. Delusions in head injury have previously been described as late sequelae and a part of psychoses following trauma (Fahy et al. 1967; Achte et al. 1969), though the significance of delusions during the early recovery is being increasingly recognized (Lishman 1978; Bond, 1985). On the basis of differences in psychopathology, associated signs and management, delusions can be grouped as those during the acute stage, those related to subacute stage of recovery and those seen during the late follow-up. Delusions of the acute stage are transient and form a part of the post traumatic delirium and delusions of the late follow-up constitute a part of the functional psychoses. Delusions of the subacute stage of recovery conform to the definitions of the organic delusional syndrome.

Study of organic delusions has enabled the understanding of the anatomical substratum which could be related to the delusional disorder. Weinstein (1969) observed that lesions on either side of the brain provided sufficient conditions if they interrupted cortical-limbic-reticular connections. Cummings (1985) in a prospective follow-up of twenty cases of organic delusions concluded that the lesions, in common, disrupted limbic-cortical associations. Among disorders involving only one hemisphere, the delusions were more often associated with left sided lesions (Cummings, 1985, 1986). Heilman et al. (1971) noted that in closed head injuries, delusions were associated with aphasic disorders.

Anatomical localization of functional deficits in closed head injuries is difficult. Biomechanically, brain may be viewed as a spheroidal mass with the mesencephalon at the core (Ommaya and Gennarelli, 1974). Functional localization would be feasible if the depth of impairment and lateralization of impairment if any, could be made out. Even recent radio-imaging techniques might fail to delineate the widespread microscopic injury to the nerve fibres. White fibre injury may produce lateralized neuropsychological deficits in apparent contradiction to other findings in CT scan (Levin et al., 1982). Thus, use of neuropsychological tests could be a more reliable tool to investigate the lateralized functional impairment. In the
present study, clinical and psychometric data are used to investigate if organic delusions could be related to specific regional localizations.

**MATERIALS AND METHODS**

A total of 174 patients admitted in the Trauma Ward, Dept. of Neurosurgery, Govt. Rajaji Hospital, Madurai between Sept. 1984 and June 1985 were included in the study. Patients included as suffering from organic delusions satisfied the following criteria:

i. Delusions should satisfy the criteria of Jaspers,

ii. Delusions which were a part of post traumatic delirium were excluded,

iii. Delusions which were a part of post traumatic psychoses were excluded,

iv. Morbid beliefs, such as those due to known neurological deficits (e.g. in anosognosia) were excluded.

Twelve patients satisfied the above criteria. They were studied in comparison to other head injured controls with respect to two parameters: indices of severity of damage which pointed to the degree and depth of functional impairment and indices of lateralization of the functional impairment.

Severity of the disturbances was made out by the following measures:

i. Duration of coma: Coma was defined as the time taken by the patient after head injury to reach a Glasgow Coma Scale score of eight (Teasdale and Jennett, 1974; Giannotta et al., 1982). It was graded as mild, moderate and severe, if the duration of coma was below one hour, one to six hours and beyond six hours respectively.

ii. Post traumatic amnesia: This was defined as the lapse of time between the time of injury and the return of continuous memory (Jennett, 1977).

iii. Brain-stem signs: They included abnormal motor responses, eye movements, pupillary changes, etc., which denoted dysfunctions of brain-stem centres. Based on clinical identification, they were marked as either present or absent.

Lateralization of the functional disturbances was attempted with the following methods:

i. Soft tissue contusions on the head were noted at the time of admission.

ii. Early neurological deficits and early seizures which were observed at the time of hospitalization.

iii. Two tests were used for the assessment of neuropsychological functioning; one for measuring 'right hemisphere functions' and the other for 'left hemisphere functions' (Benton, 1968; Milner, 1969; Smith, 1974). The configurational score of Bender Gestalt Test was taken as a measure of right hemisphere function and Dissimilar Pair Verbal Retention test of P. G. I. Memory Scale was taken as a measure of left hemisphere function. As there were illiterates in the group, the scores were converted into 'z' scores, with the help of age and education controlled norms, obtained from the local population. Positive scores in the configurational scores indicated a poor performance, whereas positive scores in verbal retention related a better performance. Hence, the signs in the verbal retention test were reversed and a positive 'z' score pointed to a poor performance. As the comparison between the right hemisphere functions and left hemisphere functions involved the same individuals, statistical tests for correlated samples were used.

Controls were chosen from among the rest of the head injured patients. As all
patients with delusions had suffered from acceleration injuries, controls were chosen only from patients with similar injuries. Thus, 59 patients who had sustained contact injuries were not included as controls. Among those with acceleration injuries, two patients with affect-laden delusions were excluded. Hence, clinical signs were compared between 12 deluded patients and 101 controls.

RESULTS

Patients with contact injuries had suffered from essentially focal injuries. None of them had significant loss of consciousness or prolonged amnesia, in consonance with theoretical expectations. During surgical intervention, 19 were found to have cortical damage, involving frontal, parietal or temporal lobes. The damage was confined to cortex in all the patients. None of the 59 patients evinced delusions during recovery. Duration of coma in the deluded patients ranged from less than one hour to 60 hours, with a median of three hours. One patient had suffered from mild injury, six from moderate injury, three from severe injuries and in two GCS was not applicable because of aphasia. Compared to controls, the severity of the injury was not significantly more in the deluded patients (Fisher's sigma = .55; Not sig.).

Leaving out two patients with post traumatic amnesic syndrome, PTA in the rest of the deluded patients ranged from four to 35 days, with a median of 17 days and mean of 18.6 days. Compared with the mean PTA of all patients with acceleration injuries, the mean PTA of deluded patients was significantly longer (t test for comparison of sample mean with the mean of all patients with acceleration injuries : t = 2.46; d.f. = 9; p < .05). Brain-stem signs were observed in five of the deluded patients and seven in the controls. The incidence among the deluded patients was significantly more than in the rest (X^2 = 10.22; d.f. = 1; p < .01).

External marks of impact were noted in the right side of the skull in seven patients, on the left side in three patients and bilateral in one. In one patient, no external marks were noted. But, the possibility of contre-coup lesions in closed head injury made the finding an unreliable index for lateralization.

Neurological deficits were present in five patients and compared to 14 among the controls, the occurrence was statistically significant (X^2 = 4.11; d.f. = 1; p < .05). All patients with neurological deficits could be inferred to have a lesion on the left hemisphere, based on the side of neurological deficit. Among the three patients with early seizures, one had generalized seizures and the other two had right focal fits.

Neuropsychological test performances were compared using 'X' scores of the tests. Comparison of the impairment was done using t test for correlated samples (t = 5.14; d.f. = 11; p < .001) and using Wilcoxon Signed Rank test for paired observations (T = 0; N = 12; p < .01). The results indicated that the left sided impairment was more than the right.

DISCUSSION

The significance of the findings would be evident in the light of recent biomechanical concepts about concussion. Ommaya and Gennarelli (1974) state that with increasing severity of concussion, greater disturbance in level and content of consciousness is caused by mechanically induced strains affecting the brain in a centripetal sequence of disruptive effect on function and structure. The amnesic component was followed by impairment of consciousness, as the disruptive effects reached the mesencephalic core. Loss of consciousness, amnesia and brain-stem signs were indicative of the disruptive effects reaching the subcortical centres to a considerable degree. In the present study, prolonged PTA and the significantly higher
occurrence of brain-stem signs pointed to the deeper level of functional disruption among the deluded patients. Though duration of coma was not significantly different, only one patient among the 12 suffered from mild injury. The findings indicated that considerable degree of disruption of functions occurred in relation to the presence of delusions.

Disturbances at the subcortical level forewarned a greater disturbance at the surface of the cortex. But, among patients with contact injuries, none developed delusional disorder. Absence of unconsciousness and amnesia in these patients indicated that they did not suffer from significant disturbance to diencephalic-mesencephalic structures or their functions. Because of the mechanical strain, many of them suffered from cortical damage and in 19 of these patients, there was evidence of structural damage to the cortex. Total absence of delusions in these patients, coupled with the significance of mesencephalic functional impairment in those with delusions, emphasized that subcortical functional disruption was more important and a necessary condition for the emergence of the delusions. Cummings (1985) in a different context, observed that delusions were less common when pathological changes primarily involved neocortex as in Pick's disease or Alzheimer's disease, but, were more common when the disorder involved diencephalic structures mostly.

Evidence for lateralization of the functional impairment was derived from different types of data. Though external marks of impact had been used as evidence of functional deficit (Smith, 1974; Roberts, 1979), in closed head injuries the areas of functional impairment could be vastly unrelated to the site of impact. Occurrence of contre-coup lesions justified the disregarding of this index as a reliable one for lateralization.

Neurological deficits and early seizures pointed to the predominance of left hemisphere involvement. All five patients with neurophysical deficits had features of left hemisphere disturbance and the two patients with right sided convulsions also were included among these five. Though presence of statistically significant deficit could be shown in relation to left hemisphere, it did not rule out damage elsewhere also. A subclinical deficit elsewhere which could interfere with neuropsychological functions was a distinct theoretical possibility.

Use of neuropsychological tests could clearly indicate the lateralization of the functional deficit. In the West, paired associate verbal learning had been used as a test of left hemisphere functioning (Benton, 1968; Smith, 1974). An equivalent test which was a sensitive indicator was the verbal retention of dissimilar pairs subtest of P. G. I. Memory Scale (Pershad, 1977; Sabhesan et al., 1989). Similarly, visuospatial tests have been used for testing the right hemisphere functions. Benton (1968) had used copying designs test for testing right hemisphere functions. Configurational score of Bender-Gestalt test denoted the visuospatial functions and hence, used as an indicator of right hemisphere functions. Difficulties in comparison of tests of divergent nature were circumvented by converting the scores into z scores, in comparison with local norms. Normal attendants of the patients of comparable age, educational attainment etc., were tested to obtain comparable norms (Sinha, 1984). The results of comparison confirmed that in deluded patients, functional disturbances were lateralized to the left hemisphere more than the right.

The findings indicated that subcortical involvement was a necessary condition for the delusions to occur and that in these patients, the disturbances were predominantly on the left side.

Acknowledgement

This study was a part of the ICMR financed project on Adjustmental problems
of head injured patients conducted in the Dept. of Neurosurgery, Govt. Rajaji Hospital Madurai. The authors thank the ICMR and the Dean, Madurai Medical College, Madurai for their permission to publish the data. The authors also thank Mr. D. K. Subbakkrihsna, Asst. Professor of Bio-statistics, NIMHANS, Bangalore for his help in the statistical analysis.

REFERENCES

Achte, K. A., Hillbom, E. and Aalberg, V. (1969). Psychoses following war brain injuries. Acta Psychiatrica Scandinavica, 45, 1-18.

Benton, A. L. (1968). Differential behavioral effects of frontal lobe disease. Neuropsychologia, 6, 53-60.

Bond, M. (1983). The psychiatry of closed head injury. In: (Eds.) Brooks, N., Closed head injury: psychological, social and family consequences. Oxford: Oxford University Press, 148-178.

Cummings, J. L. (1985). Organic delusions: phenomenology, anatomical correlations and review. British Journal of Psychiatry, 146, 184-197.

Cummings, J. L. (1986). Organic psychoses. Delusional disorders and secondary mania. The Psychiatric Clinics of North America, 9, 293-311.

Fahy, T. J.; Irving, M. H. and Miller, P. (1967). Severe brain injuries. A six-year follow-up. Lancet, ii, 475-479.

Gianoutsos, S. L., Weiner, J. M. and Cerverha, B. B. (1982). Prognosis and outcome in severe head injury. In (Ed.) Cooper, P. R., Head injury. Baltimore: William and Wilkins, 377-406.

Heffman, K. M., Safran, A. and Geschwind, N. (1971). Closed head trauma and aphasia. Journal of Neurology, Neuurosurgery and Psychiatry, 34, 265-269.

Jennett, B. (1977). An introduction to neurosurgery. III Ed, London: William Heinemann.

Levin, H. S., Benton, A. L. and Grossman, R. G. (1962). Neurobehavioral consequences of closed head injury. New York: Oxford University Press.

Lishman, W. A. (1978). Organic psychiatry—The psychological consequences of cerebral disorder. Oxford: Blackwell, 191-261.

Mihler, B. (1969). Residual intellectual and memory deficits after head injury. In: (Eds.) Walker, A. E., Caveness, W. F. and Critchley, M. The late effects of head injury. Springfield: Charles C. Thomas, 84-97.

Ommaya, A. K. and Gennarelli, T. A. (1974). Cerebral concussion and traumatic unconsciousness. Brain, 97, 633-654.

Perosh, D. (1977). The construction and standardization of a clinical test of memory. Agra: National Psychological Corporation.

Roberts, A. H. (1979). Severe accidental head injury: An assessment of long-term prognosis. London: Macmillan.

Sabbesan, S.; Arumugham, R. and Natarajan, M. (1989). Recovery of memory in closed head injury. Paper presented in Annual IPS Conference at Cuttack.

Sinha, O. (1985). Psychology in rural areas: The case of a developing country. In: (Eds.) Diaz-Guerrero, R., Cross cultural and national studies in social psychology. Vol. 2, Amsterdam: North-Holland, 431-457.

Smith, E. (1974). Influence of site of impact on cognitive impairment persisting long after severe closed head injury. Journal of Neurology Neurosurgery and Psychiatry, 37, 719-726.

Teasdale, G. and Jennett, B. (1974). Assessment of coma and impaired consciousness: a practical scale. Lancet, ii, 81-84.

Weinstein, E. A. (1969). Patterns of reduplication in organic brain disease. In: (Eds) Vinken, P. J. and Bruyn, G. W., Handbook of Clinical Neurology. Vol. 3, Amsterdam: North-Holland, 251-257.