

The usefulness of CBF brain SPECT in forensic medicine: the civil law code cases. A description of four cases

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Abstract

BACKGROUND: The aim of this report was to assess the usefulness of cerebral blood flow (CBF) scanning utilising the SPECT technique in forensic medicine cases in the area of civil law cases.

MATERIAL AND METHODS: CBF SPECT scanning was performed in four patients utilising ^{99m}Tc-ECD and a triple-head gammacamera. In the analysis both the asymmetry index and cerebellar normalisation were applied. Reference values were obtained by studying 30 healthy volunteers.

RESULTS: In those cases CBF SPECT scanning played an important role in forensic argument. It influenced the sentence and the amount of financial compensation.

CONCLUSIONS: CBF SPECT scanning may provide valuable information in forensic medicine argument in civil law cases, but only when taken together with psychometric tests and other neuroimaging methods (CT, MRI). The value of CBF SPECT scanning alone may be limited in judicial proceedings.

Key words: SPECT, cerebral blood flow, forensic medicine

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Introduction

Nuclear medicine CNS studies, SPECT and PET, in recent years have slowly but increasingly started to become a tool of forensic medicine, most often in the USA [1]. In our previous communication we described a series of cerebral blood flow (CBF) SPECT scanning applications in criminal cases [2]. These methods are starting to be applied in civil law cases as well, most often when insurance companies are being sued.

The most frequent cases involve the suing of those companies by the victims of head trauma, following car accidents and accidents at work. The insurance companies tend to underestimate the loss of health following such accidents, while the victims tend to overestimate this loss. Additional claims involve the cost of additional medical tests, physiotherapy etc.

Most often SPECT and PET are used in forensic argument in the USA [2–4]. The crucial point in post-traumatic brain injury is the frequent incidence of unspecific complaints, like vertigo, persistent headaches, memory loss, emotional disorders and sleep disturbances. CT and MRI scanning may be normal. On the other hand, the simulation of these disorders is frequent [5].

In the years 2000–2002 in our Department we performed about 30 CBF SPECT scans ordered by the Public Prosecutor's Office, prisons health service or Social Security. Ten of them were performed for subsequent use in civil law cases. We would like to present below the four most interesting ones.

Material and methods

CBF SPECT scanning was performed using three-head gammacamera Multispect-3 (Siemens, Erlangen, Germany) 1 hr post i.v. injection of 740 MBq of ^{99m}Tc-ECD (FAM, Łódź, Poland) using a low energy, ultra-high resolution collimator.

The data were collected into a 128 × 128 matrix, 4.8 mm per pixel. The raw data were smoothed with a Butterworth filter, cut-off frequency 0.35. Chang attenuation correction was not performed.

The images were reoriented in the axial, coronal and sagittal planes. The data were displayed on a 10-grade colour scale. Focal perfusion abnormalities were read twice by two independent observers. Their depth was assessed utilising an asymmetry index (AI): $AI = R - L / (R + L) / 2 \times 100\%$, where R and L are mean counts/pixel values in the right and left hemisphere, respectively.

Regional cerebral blood flow was assessed semiquantitatively by calculating the index of regional mean counts/pixel values divided by those in cerebellum.

As significant were considered focal perfusion deficits with asymmetry index values exceeding 2 standard deviations (SD) below the mean for the control group. As significant were considered regional cerebral blood flow deficits with regional/cerebellar ratio values 2 SDs below the mean in the control group.

Results

Case 1

Patient WT, aged 30, had a car accident with a short loss of consciousness. Initial diagnosis was brain stem concussion. There were no changes in CT scanning. Following this accident she became apathetic and mournful, had strong headaches, sleep disturbances and concentration problems, occasionally had blurred vision, hearing hallucinations and suicidal thoughts.

Her claims for financial compensation were rejected twice by the Social Security medical commission. The patient appealed to the court, which asked for more detailed forensic expertise.

Psychometric testing: Benton's tests, Bender test and MMPI testing argued for a functional dysfunction of CNS. CBF SPECT scanning revealed two fields of hypoperfusion in the right frontal lobe (asymmetry indices 14% and 23%) and the third one in the left temporo-occipital border (22%), perhaps following the *contre-coup*.

The psychiatric experts stated post-concussion syndrome with depression accompanied by some paranoid symptoms. The experts underlined the small probability of simulation, based on the patient's CV prior to the accident — she was a very active independent entrepreneur.

The hypothesis of organic brain lesion was supported by the results of psychometric testing and SPECT scanning. Finally, the patient won the case and obtained permanent financial compensation.

Case 2

Patient RS, aged 36, had a car accident with multiple injuries to the head, thorax and right arm and a mild right-side paresis.

Following discharge from the hospital, the patient had headaches, memory and concentration problems, right limbs weakness, he became apathetic and neurotic. The insurance company acknowledged a 30% health loss and paid corresponding financial compensation. The patient disagreed with this opinion and turned to the civil law court.

The forensic expertise confirmed the multiple body injury, particular in the thorax and thoracic lumbar spine column and mild right-side paresis.

MRI scanning revealed a small ischaemic focus (2–3 mm) in left temporal area. CBF SPECT scanning showed a diffuse left prefrontal perfusion deficit (13%) and a second one in right central area (9%). The counter-argument of the barrister of the sued side was that it could not be surely stated that those changes

could be attributed to the accident. His hypothesis was that they could not be distinguished from e.g. ones caused by brain arteriosclerosis. This hypothesis was rejected by the court on the basis of forensic medicine expertise.

The case has not been closed to this day on the grounds of other formal objections.

Case 3

Patient WT, aged 65, a medical doctor working in the Emergency Unit, had a car accident involving his medical ambulance. There was no loss of consciousness.

Following the accident, the patient developed vertigo, stubborn headaches, cognitive and memory impairment, sleep problems. The insurance company acknowledged a 34% health loss and paid corresponding financial compensation. The patient disagreed with this opinion and turned to the civil law court.

The court asked the forensic medicine experts three questions:

- what injuries directly related to the accident had the patient had;
- what was the health of the patient after the incident;
- what had been the health loss connected with the accident?

Neurological evaluation stated cognitive impairment. CT and EEG were normal. CBF SPECT scanning revealed a diffuse hypoperfusion of the left part of the frontal lobe and the frontal part of the left frontal lobe (AI mean 13%) with a sharply-bordered focus of hypoperfusion in the back part of the left frontal lobe (AI 33%).

The final verdict stated that the loss of health was not 34%, as in the initial opinion, but 70%. The court agreed that the present complaints were connected with the car accident and not with the patient's previous health state.

Case 4

Patient DS, aged 18, had multiple body injuries following a car accident. He had a fracture of the thoracic spine column, subluxation in cervical spine, head and lung contusion, aseptic necrosis of heel bone. Following hospital discharge he had memory problems and his school learning results deteriorated. The patient became moderately depressed and kept obsessively thinking about this accident.

The insurance company stated a 28% loss of health. The patient disagreed with this opinion and turned to the civil law court. The court asked the medical experts about the present state of health, its connection with the car accident and the patient's prognosis.

The psychologist stated a persistent mood disorder and memory problems, which did not exclude learning at school, but which made learning more cumbersome. In the expert's opinion the patient needed long-term psychological help.

CT scanning revealed fractures of the 2nd and 3rd cervical vertebrae but no changes within the CNS. There was no paracerebral haematoma. CBF SPECT scanning revealed a diffuse hypoperfusion of the right frontal lobe (12%) and left occipital lobe (22%). A small focal deficit of perfusion (AI = 20%) was seen in the left prefrontal area. A diffuse hypoperfusion of the left cerebellar hemisphere might reflect a crossed cerebellar diaschisis.

The court supported the patient's claims, focusing on his learning problems. The final verdict stated that the loss of health was

not 28%, as in the initial opinion, but 35%. This decision was in part based upon CBF SPECT scanning results.

Discussion

The role of functional neuroimaging is increasing. The crucial problem in its utility in medico-legal argument is the too small number of controlled studies, insufficiently precise sensitivity and specificity and the lack of analysis and interpretation standardisation [1, 6–8].

In the USA PET and SPECT scanning results are accepted as evidence in mild head trauma, if forensic medicine experts can credibly describe in court the technique of scanning, interpretation of results and their help in the particular case [9].

SPECT scanning is a well-established tool in evaluating the sequelae of head trauma [10, 11]. As a tool in forensic expertise they have been used in the USA since the early 1990s [1, 3, 4].

In 1993 the Supreme Court of the US, in the case of *Daubert versus Merrill Dow Pharmaceuticals*, accepted a series of medical tests (including PET scanning), which did not fulfil the traditional rules: s.c. “Frye test” and rule No. 702 of federal law concerning the court evidence [4, 12, 13].

The Supreme Court ruled that the following facts about the methods accepted as evidence should be established [4]:

- whether the particular method or theory presented by the expert can be tested;
- whether the known and/or potential pitfalls of the method are established;
- whether there is sufficient scientific evidence about the method;
- whether there is a “wide acceptance” for the particular method in the scientific world?

Therefore, US courts have transparent rules on new methods of scientific evidence.

In Poland the civil law accepts evidence either as regulated by the Civil Code or on the basis of cases ruled by the Polish Supreme Court, but there is no general regulation of the assessment of scientific evidence in forensic processing. Some criteria can be met in particular verdicts.

In verdict II CR 898/74, dated Feb. 25th 1975, the Polish Supreme Court advised the use of even the newest scientific achievements, if they were proven for sure. In verdict III CRN 305/74 (Dec. 12th, 1974) the Supreme Court argued, that the evidence might be accepted if it is based on a uniform and well tested evidence [14].

Coming back then to our cases, the question as to whether functional neuroimaging fulfils the criteria of judicial evidence and what will be the future of those methods is open. For sure, the number of such cases will grow, but due to its insufficient specificity SPECT scanning will remain only an auxiliary method together with CT, MRI and psychometric testing. In some cases, however, its role will probably be very important.

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