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CT imaging of the evolution of the post–traumatic intracerebral haematoma in children

Ewolucja pourazowych krwiaków śródmózgowych
u dzieci w obrazie tomografii komputerowej

Intracerebral haematomas in children constitute serious problems in diagnosis and treatment. Since they pose a threat to health or even life of the child, they require correct clinical evaluation and diagnostic algorithm. Most often, intracerebral haematomas are the result of craniocerebral trauma. Less frequently they develop in patients with vessel malformations, neoplasms and infarcts of brain tissue, as well as following multiple exposures of the brain to X–rays (3, 4, 9). Due to the tremendous growth of street traffic and car accidents, intracerebral post–traumatic haematomas are found, diagnosed and treated with increasing incidence.

OBJECTIVE

The study presents the results of observation of the cycle of changes in CT images of post–traumatic intracerebral haematomas in children. An attempt was made at defining the relationships between CT images of intracerebral haematoma immediately following the trauma, and those obtained one month and one year later.

MATERIAL AND METHODS

Clinical material consisted of 24 cases of children in whom intracerebral haematomas were diagnosed and treated between 1991 and 1997 at the Pediatric Radiology Department and the Pediatric Surgery Department of Medical University in Lublin. In all children CT of the head was performed immediately following the clinical evaluation, the indication being a Glasgow scale score lower than 15 points. Each of the cases was assigned to one of two groups depending on the size of brain trauma area shown in CT performed immediately after the trauma. Group 1 comprised children in whom the size of brain trauma was smaller than 2 cm. Group 2 included those children in whom the size of brain trauma was 2 cm and more. Follow–up CT examination carried out after one month and one year after the trauma focused on changes in size and structure of brain lesion area. The evaluation of changes shown in CT images was carried out together and separately in the two groups to allow comparative analysis. Most children (21 cases) were treated conservatively, while 3 cases were treated surgically, by carrying out craniectomy and evacuating the haematoma.

RESULTS

The analysed material comprised 13 boys and 11 girls between 2 months and 17 years , with school children prevailing. Haematomas were most often localized in the temporal, frontal, parieto–temporal and paraventricular regions. The localization of intracerebral haematomas studied by CT imaging is presented in Table 1.

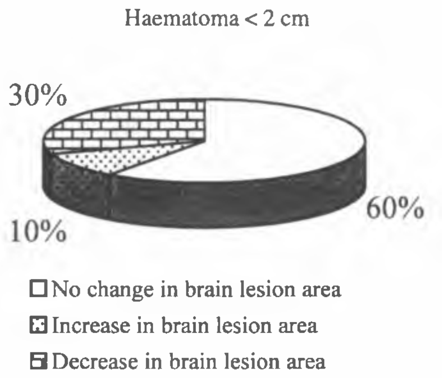
Table 1. Localization of post–traumatic intracerebral haematomas
f – number of cases

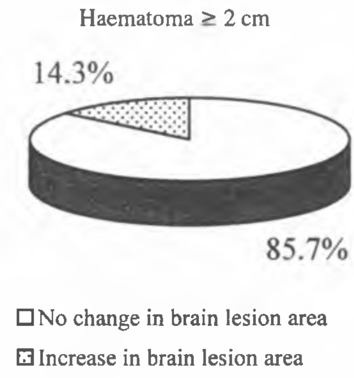
Region	Left f	Right f	Total f
Frontal	2	3	5
Temporal	4	3	7
Parietal	1	0	1
Parieto-temporal	3	1	4
Occipital	1	1	2
Cerebellum	1	0	1
Deep paraventricular	4	0	4
Total	16	8	24

All 24 cases of intracerebral haematomas were below 5 cm; 10 cases belonged to Group 1 (smaller than 2 cm) and the remaining 14 cases to Group 2 (2 cm and more).

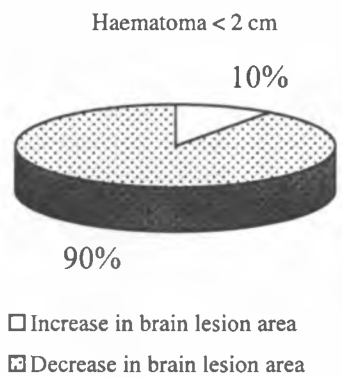
Figure 1 shows changes in the size of brain lesion area in follow–up CT examinations done after one month and one year after the trauma.

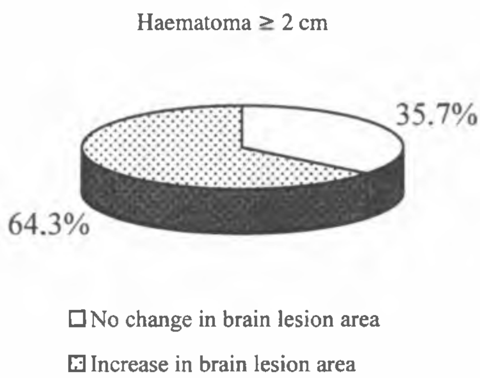
Change type in the brain lesion area after 1 month in CT control examination





Change type in the brain lesion area after 1 year in CT control examination





Follow–up CT examinations done after one month following the trauma have found out that in Group 1 (10 cases of haematomas smaller than 2 cm) in 3 cases (30%) the size of the brain lesion area decreased, in 6 cases (60%) the size of the area did not change, and in one case (10%) the size of the brain lesion area increased. In Group 2 (haematoma equal and larger than 2 cm) in 2 cases (14.3%) the size of the brain lesion area remained the same, and in 12 cases (85.7) it increased.

The direction of change in follow–up CT carried out a month after the trauma is significantly related to the size of the haematoma. In Group 1 (haematoma smaller than 2 cm) an increase of the size of the post–traumatic area was found only in 10% of the cases examined by follow up CT examination. In patients in Group 2 (haematoma equal and larger than 2 cm) the increase of the size of brain lesion area occurred in 85.7% of the cases ($\chi^2 = 13.47$; $p < 0.001$) examined by follow–up CT carried out a month after the trauma. In follow–up CT carried out a year after the trauma, the increase in the size of brain lesion area occurred in 10% of the cases of small haematomas (Group 1, smaller than 2 cm) and in 64% of the cases of haematomas equal to and larger than 2 cm (Group 2). The difference between the groups is statistically significant. Follow up CT examinations have revealed the presence of porencephaly ischaemic regions, post–traumatic cerebral atrophy and dilatation of ventricles.

Table 2 shows the evolution of intracerebral haematoma as visualised in follow–up CT examinations done one month and one year after the trauma.

Table 2. Post–traumatic brain lesions and their incidence in follow–up CT examinations performed one month and one year after the trauma

Image of the brain lesion area visualised in CT examination		Haematoma size in CT examination immediately following the trauma		Total
One month after the trauma	One year after the trauma	Haematoma < 2cm f	Haematoma ≥ 2cm f	f
Normal image of brain structure	Normal image of brain structure	2	0	2
Ischaemic region	Normal image of brain structure	7	0	7
Ischaemic region	Porencephaly	1	8	9
Ischaemic region	Porencephaly and dilatation of ventricles	0	1	1
Ischaemic region and porencephaly	Porencephaly	0	2	2
Ischaemic region and cerebral atrophy	Porencephaly and cerebral atrophy	0	1	1
Ischaemic region and dilatation of ventricles	Porencephaly and dilatation of ventricles	0	2	2
Total		10	14	24

f – number of cases

In follow–up CT examinations done one month after the trauma the following observations were made together in the two groups: 2 cases (8.3%) of normal brain structure: 17 cases (17.8%) of an ishaemic region, 1 case (4.2%) of an ischaemic region with porencephaly, 2 cases (8.3%) of an ischaemic region and dilatation of ventricles and 2 cases (8.3%) of an ischaemic region and porencephaly.

One year after the trauma, follow–up CT examinations revealed, jointly in the two groups 9 (37.5%) cases of normal appearance of the brain, 11 (45.8%) cases of porencephally, 3 (12.5%) of cases of porencephaly and dilatation of ventricles and in 1 case (4.2%), porencephaly and post–traumatic cerebral atrophy was found.

Normal brain structure in follow–up CT examinations done one month after the trauma was found only in 1 (4.2%) case and in those done after one year in 9 (37.5%) cases. Normalization of the image of brain structure was highly significantly related to the size of intracerebral haematoma. It occurred only in Group 1 that comprised patients with haematoma smaller than 2 cm. The statistical difference between the groups is highly significant ($\chi^2 = 16.50$; $p < 0.001$).

DISCUSSION

On account of children's high physical activity and unaccomplished motor development, children are much more frequently exposed to head injury. Head injuries take place, most frequently, in car accidents. Craniocerebral injuries are most frequent consequences of head trauma. Even though the impact and the mechanism of head trauma is known, because of the unaccomplished development of the brain, it is difficult to predict the results of intracranial injury after head trauma in children. It is also difficult to make proper clinical evaluation because some neurological symptoms can be delayed even in cases of multiple hemorrhages (6). Proper clinical examination is facilitated by the evaluation according to the Glasgow Coma Scale. This evaluation enables us to choose a proper diagnostic method of imaging the post–traumatic changes.

Cerebrocranial injuries can be manifested as brain contusion and oedema, epidural, subdural and intradural hemorrhages, and foreign body and skull fractures. Intracerebral hemorrhages occur frequently in younger children, below the age of 5 years (7). In clinical material presented here, school children were the most numerous group. In the clinical evaluation, children scoring below 15 points on the Glasgow Coma Scale should undergo a computer tomography examination. Using CT as the first method of examination, we protect children from an additional traumatisation which can occur when screening radiography is made. Unfortunately, radiography is only too often used as the first diagnostic method serving to evaluate the consequences of head trauma. At present, many authors discuss the usefulness of radiography in head trauma. They suggest that radiography should be avoided as a routine plain skull X–ray, and in the justified cases, children should be referred to CT examination (5). In all cases we have presented, CT as the first choice method was used in the case of intracerebral hemorrhages. A CT examination enables us to determine the localisation and extensiveness of the hemorrhagic lesion. Immediately after the trauma, on CT scans, intracranial hemorrhages are visible as lesions with increased density. The size of a hemorrhage on a CT scan depends on the amount of blood extravasation. In the present paper, cases of intracerebral hemorrhage whose size ranged between 0.8 cm to 5.0 cm were analysed. Among them, the largest hemorrhages were localised in the frontal lobes. Such hemorrhagic lesions were surrounded by a swelling zone, as an irregular area of decreasing density (up to 20 Hu). Large hemorrhages can exert a "mass effect", which manifests itself as compression and dislocation of the cerebral ventricle, or with a decrease in the cranial reserve volume. In the cases of large blood extravasation, perforation of the hemorrhage into the cerebral ventricle or to the subarachnoid space occurs. In brain structures, as a result of the capillary vessel damage, small focal hemorrhages usually develop on the border of varying density centers, e.g. in basis brain nuclei.

In the analysed cases, the hemorrhages localized in this area were not larger than 2 cm. The CT scan of intracerebral hemorrhages underwent transformation corresponding to the period of time that elapsed after the trauma. On first days after the trauma, around the hyperdense focal of the hemorrhage, a swelling zone began to appear which decreased the density of the hemorrhage periphery.

Progressively, as a result of hemoglobin metabolism of bleeding, the scan of the hemorrhage shows an area of non–homogeneous density. Small size interacranial hemorrages usually underwent complete resorbtion within 10–30 days. In the cases under study, normalization of the picture of the brain structure was observed only in hemorrhages smaller than 2 cm, and within the time span longer than 30 days. In the cases of hemorrhages of larger sizes seen on CT scans of control examination, scars, cavities, segmental or generalized atrophic changes and extension ventricle system of brain can follow as consequences (2). In the cases analysed here, the most frequent consequences observed in the control examinations were post–hemorrhage cavities and cavities coexistent with the extension of the ventricle system. In part of the cases analysed, we have found on control CT scans an area of brain damage increased in comparison to the size of intracerebral hemorrhage which was seen immediately after trauma. The increase of this pathological changes occurs more frequently in the case of larger hemorrhages. It is connected with the disturbance in blood supply to the brain tissue in close contact with the hemorrhage.

The evaluation of structural damage of brain on CT scans did not allow to estimate the effect of the injury of the brain on behavioral status. Estimation of their behavioral baselines is only possible on the basis of a complex analysis of the results of neurological and psychological examinations, and also of additional imaging examinations such as MR and PET (1, 8).

CONCLUSIONS

1. It was found that the size of the post–traumatic brain lesion area shown in follow–up CT examinations done one month and one year after the trauma depends on the size of the lesion immediately after the trauma.

2. A decrease in the size of brain lesion area was observed only in patients with haematoma smaller than 2 cm.

3. Normalization of brain structure image in follow–up CT examinations was found only in haematoma smaller than 2 cm.

4. Porencephaly with associated dilatation of ventricles or post–traumatic cerebral atrophy occurred in follow–up CT examinations exclusively in the group of patients in whom the size of the haematoma was equal to, or larger than, 2 cm.

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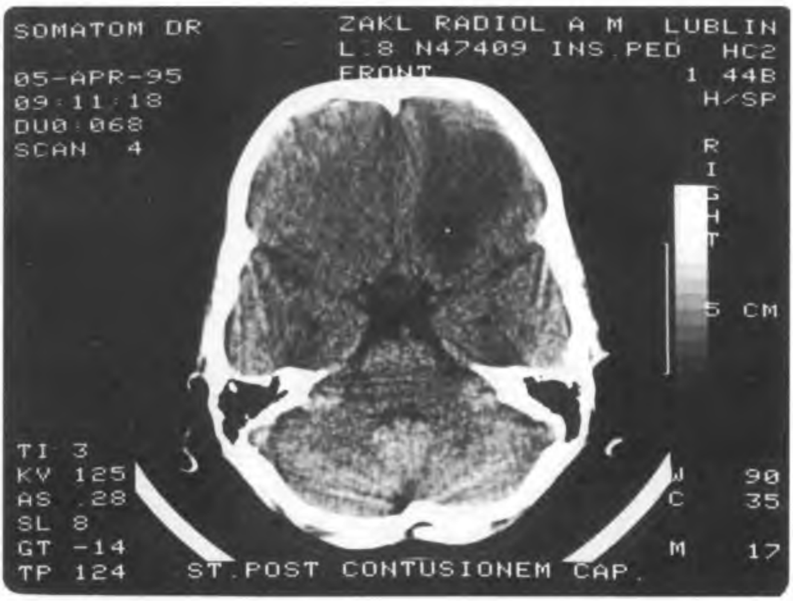
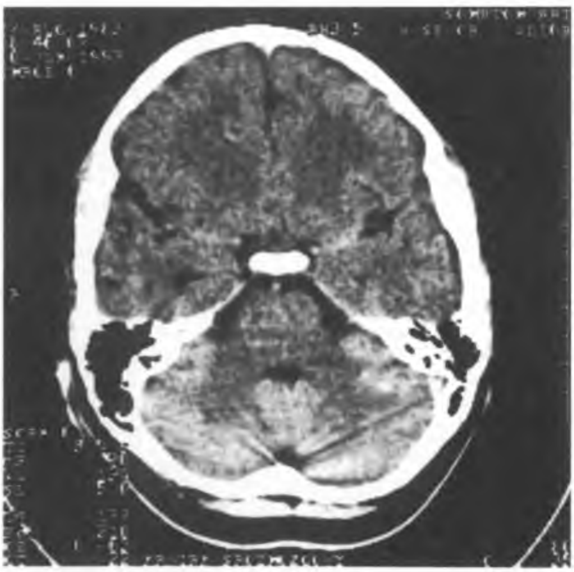
Fig. 1. A 9-year-old boy sustained head injury in an automobile accident
a) CT scan executed immediately after the trauma shows the haematoma
in the right frontal lobe



b) CT scan executed after 1 month shows brain
ischemic area in the right frontal lobe

c) CT scan executed after 1 year. The post–traumatic cavity in the right frontal lobe is visible

Fig. 2. A 14–year old boy sustained head
injury in an automobile accident
a) CT scan executed immediately after the trauma
shows haematoma in the right frontal lobe



b) CT scan executed after 1 month
shows normal brain structure

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STRESZCZENIE

Krwiaki śródmózgowe u dzieci są poważnym problemem diagnostyczno–leczniczym. Krwiaki te są najczęściej wynikiem urazu czaszkowo–mózgowego. W pracy przeanalizowano materiał kliniczny obejmujący 24 przypadki dzieci, diagnozowanych i leczonych od r. 1991 do r. 1997 w Zakładzie Radiologii Dziecięcej i Klinice Chirurgii Dziecięcej AM w Lublinie z powodu krwiaków śródmózgowych. U wszystkich dzieci wykonano badanie TK głowy, niezwlocznie po dokonaniu oceny stanu klinicznego dziecka. Badania TK umożliwiły określenie lokalizacji strefy uszkodzenia mózgu oraz jej wielkości. Analizie poddano zmiany wielkości i struktury strefy uszkodzenia mózgu w kontrolnych badaniach TK, wykonanych po upływie jednego miesiąca i jednego roku od chwili urazu.