Child Abuse: Radiographic Findings at King Chulalongkorn Memorial Hospital

Panruethai Trinavarat MD*,
Patanee O'Charoen MD**

** Department of Radiology, Faculty of Medicine, Chulalongkorn University*
*** King Chulalongkorn Memorial Hospital, Thai Red Cross*

Objective : *To describe radiographic findings in physically abused children.*
Material and Method : *The physically abused children diagnosed in King Chulalongkorn Memorial Hospital from 1998 to 2002 were retrospectively reviewed of medical records and radiographic imaging.*
Result : *Eighteen of 30 physically abused children had positive radiographic findings and 15 of 18 were related to head injury. Subdural hematomas and skull fractures were the two most common findings found in 11 cases and 9 cases respectively. Seven of 11 cases of head injury had retinal hemorrhage. Fractures other than the skull were detected in 6 patients, located at the long bones, ribs and spines. The abused children with positive radiographic findings were more commonly found in younger infants and mucocutaneous lesions might be absent.*
Conclusion : *Inflicted head injury was the most common radiographic findings in the present series. Shaking-impact mechanism was likely to play a significant role in this group of patients.*

Keywords : *Child abuse*

J Med Assoc Thai 2004; 87 (Suppl 2): S175-8
e-Journal: *http://www.medassocthai.org/journal*

Severity in child abuse varies from mucocutaneous lesion to severe disability or death. Some of the injuries observed in battered children are relatively unique and highly suggestive of inflicted injury; including posterior rib fracture, metaphyseal fracture, interhemisphereic subdural hemorrhage, vertebral compression, and small bowel hematoma and laceration[1]. The majority of these injuries are detectable from imaging. Not many reports of child abuse in Thailand have been published, particularily in radiographic findings. This study was conducted to get information of radiographic findings in physically abused children diagnosed in our institution.

Material and Method

The authors retrospectively reviewed the medical records and radiographic imaging of physically abused children under 15 years old in King Chulalongkorn Memorial Hospital (KCMH) from January 1,1998 to December 31, 2002. The diagnoses of abuse were made by the Suspected Child Abuse and Neglect team of the hospital, considering physical examination, psycho-social history, and results of laboratory and radiographic investigation. The sexual abuse, neglect and inconclusive cases were excluded.

Radiographic findings, age, sex, mucocutaneous lesions, fundoscopic examination were reviewed from medical records and radiographs. In the case of lost films, the reported documents were used. Radiographic studies included plain radiographs, ultrasonography (US), computed tomography (CT), and nuclear scintigraphy. The location of trauma and radiographic findings were described.

Correspondence to : Trinavarat P.Department of Radiology, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand.

Results

Sixty-six cases of suspected child abuse and neglect in KCMH were recorded from January 1, 1998 to December 31,2002. Thirty-one of 66 cases were considered as physical abuse, 14 as sexual abuse, 14 as neglect, and 7 as inconclusive. One case of physical abuse was excluded because the parent escaped from the hospital with the patient before radiographic examination was performed.

In 30 physically abused children, their ages ranged from 0.8 months to 179.7 months. The median age was 9.3 months. Sixteen cases were boys and 14 cases were girls. Twenty-one children (70%) were under

2 years of age.

Radiographic investigation was performed in 27 cases (plain radiographs in 25 cases, CT brain scan in 20 cases, ultrasound of the abdomen in 1 case, and skeletal scintigraphy in 1 case) with positive results in 18 cases. Determination of performing and types of imaging studies were based on the physician's judgement concerning physical examination and patients' age. Children with positive radiographic findings were younger than those with negative findings. The median age was 6 months for the former and 54 months for the latter.

Of the18 patients with positive radiographic results (Table 1), trauma to the skull and its content was the most common finding, found in 15 cases with a mean age of 5.6 months. There were skull fractures in 9 cases, intracranial hemorrhage in 12 cases (7 of them associated with skull fractures), and findings suggestive of anoxic-ischemic brain injuries in 3 cases. In detail, fractures of the skull were depressed-linear in 5 cases, only linear in 3 and only depressed in 1. Most of the fractures were located at the parietal bones, which were found in 7 out of 9 cases. The 12 cases of intracranial hemorrhage were subdural hematoma (SDH) in 11, epidural hematoma in 1, subarachnoid hemorrhage in 1, and cortical hemorrhage in 3. Six cases of SDH showed chronic or multi-stages of bleeding. Common locations of SDH were at the parietal convexity and interhemisperic fissure. Findings suggestive of anoxic-ischemic brain injuries in all 3 cases were diffuse hypodensity of bilateral cerebral hemispheres with undifferentiated gray-white junction and sparing of basal ganglia and posterior fossa structures (reversal sign). Two of them were associated with SDH. Three of 15 cases of inflicted head injury also had fractures at other sites.

Fractures other than skull were detected in 6 patients. Five of them had fractures of the long bones, which were 1 physeal fracture, 1 spiral diaphyseal fracture, 1 transverse diaphyseal fracture, and 2 metaphyseal fractures. One case of metaphyseal fracture was detected at the proximal ulna only by skeletal scintigraphy. Rib fractures were found in 3 patients who had single rib, 7 rib and 12 rib fractures respectively. In two cases, rib fractures were posteriorly located, and one of them had chylothorax. No hemothorax or pneumothorax was detected in any case. Spine injuries were detected in 2 patients. One had T6 compression fracture combined with multiple rib fractures, chylothorax and chylous ascites. The other case of spinal injury had C1-2 subluxation and CT brain revealed diffuse cerebral hypodensity.

Fundoscopic examination was performed in 11 of 18 patients who had positive radiographic findings and retinal hemorrhage was detected in 7 patients.

Table 1. Eighteen cases of child physical abuse with positive radiographic findings

No.	Age(m)	Sex	MCL	RH	Fracture				Intracranial Lesion				
					Long bone	Rib	Spine	Skull	SDH	EDH	SAH	CH	DCH
1*	22	F	-	NI	✓	✓	✓	-	-	-	-	-	-
2	65	M	✓	NI	✓	✓	-	-			NI		
3	< 1	M	-	NI	✓	-	-	-	-	-	-	-	-
4	3	M	-	✓	✓	-	-	-	✓	-	-	-	-
5	6	M	✓	-	-	✓	-	✓	-	-	-	-	-
6	2	F	✓	✓	✓	-	✓	✓	✓	-	-	✓	✓
7	9	M	-	NI	-	-	-	✓	-	-	✓	✓	-
8	3	F	-	-	-	-	-	✓	-	-	-	-	-
9	5	M	-	✓	-	-	-	✓	✓	-	-	-	-
10	3	F	✓	✓	-	-	-	✓	✓	-	-	-	-
11	9	F	-	-	-	-	-	✓	✓	-	-	-	-
12	8	F	✓	NI	-	-	-	✓	✓	✓	-	-	-
13	< 1	M	✓	✓	-	-	-	✓	✓	-	-	✓	-
14	7	M	✓	NI	-	-	-	-	✓	-	-	-	-
15	6	F	-	-	-	-	-	-	✓	-	-	-	-
16	2	M	-	✓	-	-	-	-	✓	-	-	-	-
17	7	M	✓	✓	-	-	-	-	✓	-	-	-	✓
18	1	M	-	NI	-	-	-	-	-	-	-	-	✓

* Case 1 also had chylothorax and chylous ascites

(m) = month
MCL = mucocutaneous lesion
RH = retinal hemorrhage
SDH = subdural hematoma
EDH = epidural hematoma
SAH = subarachnoid hemorrhage
CH = cortical hemorrhage
DCH = diffuse cerebral hemorrhage
\- = not found
NI = not investigated

Mucocutaneous lesions were found in 8 patients who had positive radiographic findings. Types of lesions were ecchymosis, bruise, laceration, abrasion, nail print or scratch with or without scars.

Discussion

A neurological problem was the most common cause bringing abused children under 1 year old to the hospital in the present series. Injuries to the skull and its content were the most common radiographic findings, found in 15 of 18 abused children with positive imaging results (83%). Most of them had depressed-linear skull fractures and SDH. Patterns and location of skull fractures and SDH were not different from those described in previous literature. Plain skull radiographs were superior to CT scans for the detection of skull fractures, while CT were excellent for acute intracranial hemorrhage. The high incidence of skull fracture and SDH in this group supports a significant role of impact injury in the shaken baby syndrome. The definition of shaken infant syndrome today includes cases where impact trauma was involved [2-4], changing from the whiplash shaken infant syndrome described by Caffey in 1972 [5] and 1974 [6]. An experiment in an infant model revealed that the magnitude of angular deceleration reached injury thresholds at the moment of impact [3]. When impact on a hard surface (usually uncarpeted floor in Thai houses), skull fracture occurs as well as the brain itself decelerates rapidly. The sudden angular (rotational) deceleration experienced by brain and cerebral vessels results in intracranial injury. Intracranial injury without skull fracture in the shaken infant syndrome have been explained by many theories; direct cranial trauma from shaking [5,6], high cervical spinal cord trauma from shaking [7], strangulation during shaking [8], and also shaking-impact mechanism [3,9]. The shaking-impact theory explains that when the surface is soft, the force of the impact is widely dissipated and may not be associated with visible signs of surface trauma, even though the brain decelerates rapidly, resulting in the intracranial injury.

Diffuse hypodensity of bilateral cerebral hemispheres with loss of gray-white differentiation and sparing of basal ganglia and posterior fossa structures (reversal sign) were found in 3 cases, and 2 of them were associated with SDH. Diffuse cerebral hypodensity was suggested to be from anoxic-ischemic cerebral injury [10], probably apena induced by shaking [11] or vessel occlusion from concomittent strangulation [8]. Inflicted head injuries with bilateral diffuse hypodensity on CT scans have a poor prognosis with dismal outcomes [9-11].

The incidence of concurrent intracranial and skeletal trauma (cranial and/or extracranial) in the present series was 61.5% with a high incidence (54%) of cranial fracture. This number is not different from the literature with concurrent intracranial and skeletal trauma ranging 30%-70% [2,4]. Retinal hemorrhage was detected in 7 of 11 (64%) patients with eye examination, also not significantly different from previous reports of 65%-95% [9,12].

It is well known that skeletal injury is the most common abuse-related injury, excluding pure soft tissue injuries such as bruising. The prevalence of fractures varies 11%-55% of physically abused children [1], and most of them were the long bone fractures. However, inflicted long bone fractures in the present series were less common than inflicted head injury, probably there were more fractures but they did not reach the hands of medical personel. The typical bucket handle metaphyseal fractures were infrequent in the presented patients.

There was a high incidence of inflicted head injuries in the present series, particularly in younger infants, and mucocutaneous lesions might be absent. Because radiographic findings of inflicted head injuries also could be found in cases of accidental injuries, awareness of child abuse in young infants with SDH and/or skull fractures is very important. Multi-stages of SDH, interspheric location of SDH, and depressed or depressed-linear skull fractures should be suspicious of abuse. Scrutinized history taking and physical examination, including fundoscopic examination are necessary. The future safety of a child rests on the physician's ability to diagnose.

References

1. Lonergan GJ, Baker AM, Morey MK, Boos SC. Radiographics 2003;23:811-45.
2. Merten DF, Osborne DR, Radkowski MA, Leonidas JC. Craniocerebral trauma in the child abuse syndrome: radiological observations. Pediatr Radiol 1984;14:272-7.
3. Duhaime AC, Gennarelli TA, Thibault LE, Bruce DA, Margulies SS, Wiser R. The shaken baby syndrome. A clinical, pathological, and biochemical study. J Neurosurg 1987;66:409-15.
4. Lazoritz S, Baldwin S, Kini N. The whiplash shaken infant syndrome: has Caffey's syndrome changed or have we changed his syndrome? Child Abuse Negl 1997;21: 1009-14.
5. Caffey J. On the theory and practice of shaking infants: its potential residual effects of permanent brain damage and mental retardation. Am J Dis Child 1972;124:161-9.
6. Caffey J. The whiplash shaken infant syndrome: manual shaking by the extremities with whiplash-induced intracranial and intraocular bleedings, linked with residual permanent brain damage and mental retardation.

Pediatrics 1974;54:396-403.
7. Hadley MN, Sonntag VK, Rekate HL, Murphy A. The infant whiplash-shake injury syndrome: a clinical and pathological study. Neurosurgery 1989;24:536-40.
8. Bird CR, McMahan JR, Gilles FH, Senac MO, Apthorp JS. Strangulation in child abuse: CT diagnosis. Radiology 1987;163:373-5.
9. Duhaime AC, Christian CW, Rorke LB, Zimmerman RA. Nonaccidental head injury in infants- the "shaken-baby syndrome". N Engl J Med 1998;338:1822-9.
10. Han BK, Towbin RB, De Courten-Myers G, McLaurin RL, Ball Jr WS. Reversal sign on CT: effect of anoxic/ischemic cerebral injury in children. AJNR 1989;10: 1191-8.
11. Johnson DL, Boal D, Baule R. Role of apnea in nonaccidental head injury. Pediatr Neurosurg 1995;23:305-10.
12. Feldman KW, Bethel R, Shugerman RP, Grossman DC, Grady MS, Ellenbogen RG. The cause of infant and toddler subdural hemorrhage: a prospective study. Pediatrics 2001;108:636-46.

ความผิดปกติจากภาพทางรังสีวิทยาของผู้ป่วยเด็กถูกทารุณกรรม ที่ตรวจพบในโรงพยาบาลจุฬาลงกรณ์

ปานฤทัย ตรีนวรัตน์, พัธนี โอเจริญ

วัตถุประสงค์ *: บรรยายความผิดปกติทางรังสีวิทยาที่ตรวจพบในเด็กถูกทารุณกรรมทางร่างกาย*

กลุ่มศึกษาและวิธีการศึกษา *: ผู้ป่วยเด็กถูกทารุณกรรมทางร่างกายที่เข้ารับการรักษาที่โรงพยาบาลจุฬาลงกรณ์ ระหว่าง พ.ศ. 2541-2545 ได้รับการศึกษาย้อนหลังด้วยการทบทวนเวชระเบียนและภาพรังสีวิทยา*

ผลการศึกษา *: พบผู้ป่วยเด็กที่ถูกทารุณกรรม 30 ราย โดยผู้ป่วย 18 ราย มีผลตรวจจากภาพรังสีผิดปกติ การบาดเจ็บที่ศีรษะพบ 15 ราย โดยพบภาวะเลือดออกใต้ชั้น dura 11 ราย และกะโหลกศีรษะแตก 9 ราย การตรวจตาของผู้ป่วยเด็กที่บาดเจ็บที่ศีรษะ 11 ราย พบว่ามีภาวะเลือดออกที่จอประสาทตา 7 ราย พบกระดูกหักในตำแหน่งอื่นนอกจากกะโหลกศีรษะในผู้ป่วย 6 ราย ที่กระดูกยาว กระดูกซี่โครง และกระดูกสันหลัง ผู้ป่วยที่มีความผิด ปกติที่ตรวจพบจากภาพรังสีส่วนใหญ่เป็นผู้ป่วยที่มีอายุน้อย และอาจไม่พบร่องรอยถูกทำร้ายที่อื่นตามร่างกายได้*

สรุป *: ความผิดปกติที่พบได้มากที่สุดจากภาพรังสีวิทยาในกลุ่มศึกษานี้คือการบาดเจ็บที่ศีรษะ ซึ่งน่าจะเกิดจากการจับทารกเขย่าอย่างแรง ร่วมกับศีรษะถูกกระแทกด้วย*