

# Pediatric Traumatic Brain Injury

Wasawat Muninthorn, MD Neurosurgery div., Dept of Surgery Ramathibodi Hospital, Mahidol University, Thailand April 4<sup>th</sup>, 2024

### Objectives

- Audiences of this presentation are mainly pediatric surgeon
- Trauma pediatric case evaluation in conjunction with neurosurgeon
- Detection of pediatric traumatic brain injury
- ...and improving the confidence to do so

#### Head Injury? Which one?



# เร่งล่าพ่อโหด

คลั่งยาตีหัวลูก 3 ขวบ

Ch7HD NEWS **●** ♥ ◎ ♥ ●





D. (04/04/67)

## Definition



Linda Wei Xu, Gerald A. Grant, and P. David Adelson

#### • Traumatic Brain Injury (TBI)

- Sudden, External, Physical assault....
- Causing damages to....
- the Brain...
  - $\rightarrow$  Neurons
  - → Memory, Function, Intelligence etc.
- **Results**: Transient/Permanent disruption in the normal function of the brain by an external force.



# Epidemiology - Global

- US CDC data for pediatric TBI
- 475,000 patients per year (age 0-14 years)
  - 420,000 (90%) return home with mild injuries
  - 37,000 (7%) hospitalized
  - 2,685 (0.5%) die
- Annual death rate: 5 per 100,000
  - Death rate is higher in <4y than 5-14y age.
- Hospitalization: predominantly in adolescent boy
- Abusive head trauma (age < 2 years) incidence:
  - 30 per 100,000 infants were hospitalized.







Slide 5/60

<u>Neurol Med Chir (Tokyo).</u> 2017 Feb; 57(2): 82–93. Published online 2017 Jan 20. doi: <u>10.2176/nmc.ra.2016-0191</u> PMCID: PMC5341344 PMID: <u>28111406</u>

Pediatric Traumatic Brain Injury: Characteristic Features, Diagnosis, and Management

Takashi ARAKI,<sup>1,2</sup> Hiroyuki YOKOTA,<sup>1,2</sup> and Akio MORITA<sup>2</sup>



# Epidemiology – Thai

J Neurosci Rural Pract. 2017 Oct-Dec; 8(4): 601–608. doi: <u>10.4103/jnrp.jnrp\_381\_17</u> PMCID: PMC5709885 PMID: <u>29204022</u>

Impact of Road Traffic Injury to Pediatric Traumatic Brain Injury in Southern Thailand

Thara Tunthanathip and Nakornchai Phuenpathom

- 2004-2015
- 948 casualties with 30 deaths
   = 3.2%
- Risk factors associated with death:
  - Base of skull fracture
  - Severe Head Injury













# Epidemiology – Thai

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Impact of Road Traffic Injury to Pediatric Traumatic Brain Injury in Southern Thailand

Thara Tunthanathip and Nakornchai Phuenpathom

- 2004-2015
- 948 casualties with 30 deaths
   (3.2%)

• Motorcycle accident especially presented with severe TBI (GCS < 8)







#### What is the difference between Adult and Child?

Pediatric Traumatic Brain Injury: Wasawat Muninthorn ,MD. (04/04/67)

Slide 10/60



## What is the important difference in child?

 1. Different pathophysiology and management
 → Specific pathological response



Synapses' density



REVIEW

#### A Biomechanical Analysis of the Causes of Traumatic Brain Injury in Infants and Children

Goldsmith, Werner  $PhD^*$ ; Plunkett, John  $MD^+$ 

Author Information⊗

The American Journal of Forensic Medicine and Pathology 25(2):p 89-100, June 2004. | DOI: 10.1097/01.paf.0000127407.28071.63

- Pediatric cerebral white matter contains lesser myelination
- Lesser fatty content
- More watery content
- Lesser shockwave transmission reduction

Unmyelinated brain
 = increased susceptibility to TBI





 $\ensuremath{\mbox{FIGURE}}$  3. Contact phenomenon and wave propagation in impact to the head.





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REVIEW

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- Thinner, more fragile skull
- Lesser shock absorption
- More damages transmitted to the brain inside



а



**FIGURE 7.** Skull failure stress for the neonate, young child and adult.<sup>8</sup> (Reproduced with permission from Ommaya AK, Goldsmith W, Thibault L. Biomechanics and neuropathology of adult and pediatric head injury. *Br J Neurosurg.* 2002;16: 220–242.)

thickness

4 mm

thickness

10 mm

thickness

1 mm

Outer table

Diploe

Inner table

## What is the important difference in child?

- 2. Children cannot communicate properly (at least, not well enough).
  - The exact event or mechanism
  - Crying





## What is the important difference in child?

- 3. Parental concern/worry
- 4. Possible Child Abuse Case





# Inflicted Child - Child Abuse Signs

- Gag marks
- Wrist binding marks
- Slap pattern on cheek
- Bite mark
- Cord marks on buttocks



#### Ocular and Adnexal Injuries













Commotio retinae from blunt injury to globe Traumatic retinal detachment Limitation of upward gaze due to blow-out fracture of orbit

Pediatric Traumatic Brain Injury: Wasawat Muninthorn ,MD. (04/04/67)



needed for full-thickness burn

#### Prolonged Neglect Child associated with repeated child abuse behavior

- Pallor (lack iron)
- Malnutrition (lack protein) abdominal distension
- Wasted buttocks

• Eye bruise – Repeated / Recent trauma



### **Glasgow Coma Scale in Children**

- Language/Communication ٠ capability
  - = Depends on Age

	C	Shared and CCC	Pediatric GCS		
	Score	Standard GCS	1-4 years	<1 year	
uage/Communication			Eye opening		
hility	4	Spontaneous	Open		
	3	To sound	To sound		
epends on Age	2	To pressure	To pain		
	1	None	None		
			Verbal response		
	5	Oriented	Oriented speaks, interact	Coos, babbles	
	4	Confused	Confused speech, consolable	Irritable cry, consolable	
	3	Words (inappropriate)	Inappropriate words, inconsolable	Persistency, inconsolable	
	2	Sounds (incomprehensible)	Incomprehensible, agitated	Moans to pain	
	1	None	No response	No response	
	Best motor response				
	6	Obey commands	Normal spontaneous movement		
	5	Localises pain	Localises pain		
	4	Normal flexion	Withdrawal to pain		
	3	Abnormal flexion	Decorticate flexion		
	2	Extension	Decerebrate extension	n	
Pediatric Traumatic Brain Injury: V	Vasawat	MuninthorpanaMD. (04/0	04/67) No response		

แนวทางเวชปฏิบัติสำหรับผู้ป่วยสมองบาดเจ็บประเทศไทย

James HE. Neurologic evaluation and support in the child with an acute brain insult. Pediatr Ann. 1986;15:16-22.

# Type of Head Injury

- Classified according to GCS = overall brain function as same as adults
  - Mild (GCS 13-15)
  - Moderate (GCS 9-12)
  - Severe (GCS 3-8)
- Predict Patient clinical course: survival and outcome
- Screening and treatment strategy planning

แสดงขั้นตอนการประเมินตารางกลาสโกว์ (ภาพประกอบจาก www.glasgowcomascale.org)

GLASGOW CO	MA SCALE :	Do it th	is way	GCS
	Institute of Neurologica	al Sciences NHS G	ireater Glasgow and Clyde	
?				
CHECK	OBSERVE		STIMULATE	RATE
For factors Interfering with communication, ability to respond and other injuries		of Sound: spoken or shouted Assign ts of request response Physical: Pressure on finger tip, trapezius or supraorbital notch		Assign according to highest response observed
Eye opening				
Criterion		Observed	Rating	Score
Open before stimulus		1	Spontaneous	4
After spoken or shouted request			To sound	3
After finger tip stimulus			To pressure	2
No opening at any time, no interfering fact	or	4	None	1
Closed by local factor		1	Non testable	NT
Verbal response				
Criterion		Observed	Rating	Score
Correctly gives name, place and date		1	Orientated	5
Not orientated but communication cohered	ntly	1	Confused	4
Intelligible single words		1	Words	3
Only moans / groans		1	Sounds	2
No audible response, no interfering factor		1	None	1
Factor interferring with communication		1	Non testable	NT
Best motor response				
Criterion		Observed	Rating	Score
Obey 2-part request		-	Obeys commands	6
Brings hand above clavicle to stimulus on head neck		1	Localising	5
Bends arm at elbow rapidly but features not predominantly abnormal		1	Normal flexion	4
Bends arm at elbow, features clearly predo	minantly abnormal	1	Abnormal flexion	3
Extends arm at elbow		1	Extension	2
No movement in arms / legs, no interfering	factor	1	None	
Paralysed or other limiting factor		1	Non testable	NT

- Check:
- สภาพของผู้ป่วยก่อนการบาดเจ็บ เช่น ความผิดปกติทางระบบ ประสาทที่มีอยู่ก่อน, ปัญหา การได้ยิน, ปัญหาการพูด รวมถึง ภาษาและวัฒนธรรมของผู้ป่วย
- ผลจากการรักษาเบื้องต้น เช่น การใส่ท่อช่วยหายใจ, การได้รับยา บางชนิด
- มีการบาดเจ็บหรือความผิดปกติระบบประสาทอื่นร่วมด้วย เช่น กระดูกใบหน้าหัก,
- ภาวะ **dysphasia** หรือ **hemiplegia** และมีการบาดเจ็บ ไขสันหลัง
- Observe: สังเกตการลืมตาสาระการพูด (content of speech) และการเคลื่อนไหวของร่างกายซีกซ้ายและขวา
- Stimulate: การกระตุ้นด้วยเสียงพูด หรือตะโกนออกคำสั่ง ถ้าไม่ตอบสนองจึงจะกระตุ้นด้วย ความเจ็บปวดโดยการกดที่ ปลายเล็บ กล้ามเนื้อ trapezius ตรงบริเวณหัวไหล่ด้านหลัง หรือ ขอบตาบน (supraorbital notch)
- Rate: ให้คะแนนจากการตอบสนอง<u>ที่ดีที่สุด</u>ดังตารางแสดง Glasgow Coma Scale

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3	Abnormal flexion	Decorticate flexion	197		
2	Extension	Decerebrate extension	n		
1	PediationeTraumation	Brain Iniury Wasawat Munin	thorn MD (04		

- Verbal Response
- V5 Coos / Babbles



- V4 Consolable มารดาพอปลอบให้เงียบหยุดร้องได้
- V3 Inconsolable ปลอบไม่ได้ ร้องไม่หยุด
- V2 Moans to pain (consciousness reduced)

\*\*Facebook: His Cherished Ones International Ministry

04/67)

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   Death due to Intracranial
   Hemorrhage!!
- Predict Pat
- Screening and treatment strategy planning

## **Risk** of Intracranial Hemorrhage



#### Radiation Exposure in Childhood Exactly, how much serious is it? – A review

New York State Department of Health 1-800-458-1158 www.nyhealth.gov/radiation

#### What is a CT scan?

CT scans use X-rays generated from a source that is rotated around the body to create 3-dimensional pictures of the body. CT studies can provide critical information for the care of your child, but obtaining the images results in more radiation exposure for the study than a single X-ray.

#### How much radiation is used in these exams?

We all are exposed to small amounts of radiation daily from soil, rocks, building materials, air, water, and cosmic radiation. This is called naturally occurring background radiation. The radiation used in X-rays and CT scans has been compared to background radiation we are exposed to daily. This comparison may be helpful in understanding relative radiation doses to the patient.

#### Radiation source

Days background radiation

Background	1 day
Chest X-ray (single)	1 day
Head CT	up to 8 months
Abdominal CT	up to 20 months

 Depending on the machine settings, the organ being studied typically receives a radiation dose in the range of 15 millisieverts (mSv) (in an adult) to 30 mSv (in a neonate) for a single CT scan.



 Natural Effective Radiation Dose Not exceed 0.01 mSv / day

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<u>Ann Ib Postgrad Med.</u> 2010 Dec; 8(2): 118–126. doi: <u>10.4314/aipm.v8i2.71823</u>

PMCID: PMC4111023 | PMID: 25161479

#### RADIATION DOSE IN PAEDIATRIC COMPUTED TOMOGRAPHY: RISKS AND BENEFITS

G.I. Ogbole



Pediatric Traumatic Brain Injury: Wasawat Muninthorn ,MD. (04/04/67)

Effective Dose Comparisons 8.

Diagnostic Procedure	Typical effective Dose (mSv)	Number of Chest X- rays (PA film) for equivalent effective dose <sup>1</sup>	Time Period for Equivalent Effective Dose from Natural Background Radiation <sup>2</sup>
Chest x- ray (PA film)	0.02	1	2.4 days
Skull x- ray	0.07	4	8.5 days
Lumbar spine	1.3	65	158 days
Upper G.I. exam	3.0	150	1.0 year
Barium enema	7.0	350	2.3 years
CT head	2.0	100	243 days
CT abdomen	10.0	500	3.3 years

 $^{1}$ Assuming average effective dose from chest x-ray (PA) of 0.02 mSv  $^{2}$ Assuming average effective dose from natural background

radiation of 3 mSv per year

## **CT Radiation Risks: Greater in Children?**

- In general, the doses and risks to children from CT examinations are not well understood.
- In a 2002 editorial, Slovis et al noted that there is an increased sensitivity to radiation in children compared to adults of up to 10 times, with girls being more radiosensitive than boys.
- Also, the lifetime radiation risks are higher for children because they have more expected years of life after the radiation exposure than adults

#### Facts

- For every 1,000 children, 200-250 will eventually die of cancer if never exposed to medical radiation.
- The estimated increased risk of cancer over a person's lifetime from a single CT scan is controversial but has been estimated to be a fraction of this risk (0.03-0.05%).

### **Concept for Children Radiation Exposure**

- the ALARA (As Low As Reasonably Achievable) principle.
- Researches suggested a statistically significant, increased risk of fatal cancer from low-dose radiation in the range of <u>50 to 100 mSv.</u> (2-3 times++ CT Brain scan)
- They reported that the estimated lifetime cancer mortality risks attributable to the radiation exposure from a CT examination of a one year old are 1 in 550 for a single abdominal CT, and one in 1500 for a head CT.

Brenner DJ, Elliston CD, Hall EJ, Berdon WE. Estimates of the cancer risks from pediatric CT radiation are not merely theoretical. Med Phys. 2001;28:2387– 2388. Pediatric Traumatic Brain Injury: Wasawat Muninthorn ,MD. (04/04/67)

#### National Institute for Health and Care Excellence 2014

Indications for CT Brain Screening in Pediatric TBI

**BOX 224-2** Indications for Screening Computed Tomography in Pediatric Traumatic Brain Injury<sup>26,31</sup>

Head injury and any of the following risk factors:

- Inflicted trauma
- Posttraumatic seizure
- GCS score of <14 or for children <1 year old, GCS score of <15</li>
- GCS score of <15 after 2 hours
- Suspected open or depressed skull fracture
- Tense fontanelle
- Signs of basilar skull fracture
- Focal neurological deficit
- If less than 1 year old, bruising, swelling, or laceration >5 cm on the head

Head injury and more than one of the following risk factors:

- Loss of consciousness for >5 min
- Abnormal drowsiness
- More than three episodes of vomiting
- Dangerous mechanism of injury
- Amnesia for >5 min

Pediatric Traumatic Brain Injury: Wasawat Muninthorn ,MD. (04/04/67)

 An efficient and useful way to identify patients who do not need imaging.

#### \*SEVERE MECHANISMS



Pediatric Emergency **Care Applied** Research Network (PECARN)







DECARN 褖 ALIEM canaditent

Pediatric Traumatic Brain Injury: Washington MD. (04/04/67)

### Anterior Fontanelle Examination

- Closed at 1.5 years old
- Bulging Anterior Fontanelle

may be contributed by Intracranial Hypertension *ddx Hematoma, brain edema* 

- Crying
- Hyperparathyroidism
- Hypervitamin A
- Steroid Therapy



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- Closed at 1.5 years old
- Bulging Anterior Fontanelle

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- Crying
- Hyperparathyroidism
- Steroid Therapy







# Clinical evidence of skull fracture

- The incidence of skull fracture in children following head injury ranges from 2% to 20%,
- Scalp hematoma area > 5 cm may indicate underlying skull fracture
- Isolated subgaleal hematoma is not and does not contribute to the risk of developing any intracranial hemorrhage.





# Scalp Hematoma / Subgaleal Hemorrhage



- Indication for CT Brain; Signs that may indicate underlying skull fracture.
- Especially scalp hematoma area > 5 sq.cm

- Depressed fracture is usually caused by a direct blow to the head and requires a neurosurgical opinion. A depressed skull fracture can sometimes be referred to as a ping-pong fracture.
- Open fracture carries a high risk of infection.
- Basal fractures involve any of the bones of the base of the skull. Basal fractures are more complicated due to underlying structures such as cranial nerves and sinuses which can lead to hearing loss, facial paralysis, or decreased sense of smell. They also can pose a risk for meningitis, with the most common causative organism being Streptococcus pneumoniae.
- Diastatic fractures occur when there is a separation of the cranial sutures, most commonly with the lambdoid suture.
- A growing fracture describes herniation of the brain through the broken dura following a skull fracture (often diastatic). It usually presents later and grows as the brain herniates through the gap, as a persistent swelling or pulsatile mass. It is uncommon.





Ping pong on crying

#### LINEAR FRACTURE

DIASTATIC FRACTURE

#### **DEPRESSED FRACTURE**



#### **BASILAR FRACTURE**

**Basilar skull fractures** 

## Signs of Base Skull Fracture





Raccoons eye

NI 1141-1-

- Postauricular ecchymosis
- CSF Rhinorrhea
- CSF Otorrhea

### **Treatment of Skull Fracture**

- Management of skull fractures depends on the location and type of fracture along with the presence (or absence) of underlying brain injury.
- Most skull fractures that are simple linear fractures without underlying brain injury will require no intervention.
- Observation periods or close outpatient follow-up. •
- Younger patients, and symptomatic patients, should be admitted to the hospital for an observation period.
- CT of the head had been performed to rule out an underlying brain injury
- Indications for a neurosurgical elevation of a depressed fracture include depression of 5 millimeters or more, dural injury, underlying hematoma, or gross contamination.
- An open fracture will likely require exploration and washout with antibiotic coverage. Basal skull fractures are usually managed conservatively unless there is persistent CSF leakage.
- A patient with a basal skull fracture should not have a nasogastric tube or nasal cannula.
- There is no evidence to support the role of prophylactic antibiotics in preventing meningitis, although, persistent CSF leak may increase the risk of meningitis. → Sx repair

**CSF** rhinorrhea required Sx repair CSF leak

#### Depressed skull $fx > 5mm \rightarrow Sx$



## Projectile vomiting....Myth? What type of vomit should you concern?



#### • Only in theory

- Intracranial Hypertension → stimulate overall sympathetic tone and Vagus surge to medulla → Vomiting center
- Pathological forceful projectile vomiting
- In Practice: Any vomit would be concerned → CT Brain







## CT Brain negative... safe? What is the incidence of delayed ICH?

- Mild TBI GCS 14-15 with no focal findings
  - Only 1% of the patients required surgical intervention
- GCS 15 + no LOC + no signs of skull fracture + no scalp hematoma + low-risk mechanism
  - 0.05% 0.2% of the patients found clinically significant CT findings
- The chance is very low. "2000 คนจะมีสักคนนึง หมอเลยคิดว่าไม่คุ้มที่จะรับรังสี"
- Mx: Home observation + Parent Education for 24 hours

Kuppermann N, et al. Identification of children at very low risk of clinically-important brain injuries after head trauma: a prospective cohort study. Lancet. 2009;374:1160-1170.

Osmond MH, et al. CATCH: a clinical decision rule for the use of computed tomography in children with minor head injury. CMAJ. 2010;182:341-348.

### CT Brain Negative..... But shows symptoms Diagnosis of "Cerebral Concussion"

- A subset of mild head injuries is classified as concussion, defined by a rapid onset, transient neurological impairment that resolves without intervention. It is thought that these symptoms are due to a transient disturbance in function rather than a true structural injury.
- Commonly, patients experience loss of consciousness (LOC), disorientation, headaches, amnesia, emotional lability, and sleep disturbance.
- By convention, concussion is not associated With Any Imaging Findings On Computed Tomography (CT), although in general, 5% of patients with mild TBI have a finding on CT such as a skull fracture or intracranial abnormality.
- Patients with concussion and CT findings are classified as having complicated mild TBI.



### Beware of Second Impact Syndrome

- Two separated head injury event.
- First Diagnosis: **Cerebral Concussion**
- Rapid brain edema developed on top of recent brain injury.
- Sudden collapse and death (Washington 2009)









#### School of hard knocks

A concussion occurs when a violent blow to the head causes the brain to slam against the skull beyond the ability of the cerebrospinal fluid to cushion the impact. Between 1996 and 2001, NFL teams reported nearly 900 concussions.

- When a football player takes a hit to the head, speeds
  - range from 17 to 25 miles per hour with a force averaging 98 times the force of gravity.

A study commissioned by the NFL revealed most hits occurred from a blow to the side of the head, often on the lower half of the face.

Confusion Amnesia

Delayed

Irritability

- The shock wave passes through the brain And bounces back off the skull. The concussion usually occurs at the opposite side from the point of impact.
- The impact can cause > bruising of the brain, tearing of blood vessels and nerve damage.



# Management on Mild TBI with CT Brain Negative

#### • At ER:

- PECARN for CT Brain indication
- Admit Observe even CT Brain negative in symptomatic case at least 24 h

- At Sport Stadium/Field:
  - Use concussion grading system
  - Duration of Confusion/Disorientation
  - Presence of Loss of Conscious
  - Return to Play period

Grade I		Grade II	Grade III	Return to Play (RTP)
ImPACT	Mental status changes (disorientation, amnesia) for <15 min	Mental status changes for >15 min	Any loss of consciousness (LOC)	ImPACT testing – computerized testing of: Verbal memory Visual memory Reaction time Processing speech Impulse control Postconcussion symptom s No return to play until values retu baseline
Colorado Medical Society Guidelines	Confusion	Confusion and amnesia	LOC	Grade I: First time—15 min Second time—1 wk Grade II: First time—1 wk Second time—2 wk with physician approval Grade III: First time—1-6 mo, based of severity of LOC Second time—6 mo to 1 yr physician approval
American Academy of Neurology Guidelines Fourth International Congress of Concussion	No LOC and <15 min confusion No grading guidelines	No LOC and >15 min confusion	LOC Summary of how to progress through stepwise RTP: Must be asymptomatic for 24 hr in each step If any symptoms occur, drop back to previous step at which patient was asymptomatic At least 1 week to progress through entire protocol Absolutely no same-day RTP if any concussion occurs	As summarized in the Colorado Medical Society Guidelines Stepwise RTP: • Stage 1: No activity—rest w goal of recovery • Stage 2: Light aerobic exercise—goal of increasing heart rate • Stage 3: Sport-specific exercise—training drills with head impact • Stage 4: Noncontact trainin drills—complex training drills with resistive training of Stage 5: Full-contact practii medical clearance to partici in normal training with goal

#### Parental Concern

#### Will this injury cause an IQ-related problem in the future?

- 23 children who suffered inflicted or noninflicted TBI vs 21 community group
- Ages of 4 and 71 months
- Prospective, longitudinal cohort study.
- Their mean age at injury was 21 months
- Their mean age at assessment was 89 months.
- Severity TBI, postresuscitation GCS, No# of Lesions → Risk factor for lower IQ
- 48% of the TBI group had IQs below the 10th percentile.
- Results: Traumatic brain injury sustained early in life has significant and persistent consequences for the development of intellectual and academic functions and deleterious effects on academic performance.

<u>J Neurosurg.</u> Author manuscript; available in PMC 2009 Jan 8 *Published in final edited form as:* J Neurosurg. 2006 Oct; 105(4 Suppl): 287–296. doi: 10.3171/ped.2006.105.4.287 PMCID: PMC2615233 NIHMSID: NIHMS23194 PMID: <u>17328279</u>

Late intellectual and academic outcomes following traumatic brain injury sustained during early childhood

Linda Ewing-Cobbs, Ph.D., <u>Mary R. Prasad</u>, Ph.D., <u>Larry Kramer</u>, M.D., <u>Charles S. Cox, Jr.</u>, M.D., <u>James Baumgartner</u>, M.D., <u>Stephen Fletcher</u>, D.O., <u>Donna Mendez</u>, M.D., <u>Marcia Barnes</u>, Ph.D., <u>Xiaoling Zhang</u>, M.S., and <u>Paul Swank</u>, Ph.D.

Case Reports > Am J Forensic Med Pathol. 2001 Mar;22(1):1-12. doi: 10.1097/00000433-200103000-00001.

Fatal pediatric head injuries caused by shortdistance falls

J Plunkett<sup>1</sup>

- United States Consumer Product Safety Commission database for head injury associated with the use of playground equipment.
- 18 fall-related head injury fatalities during 1988-1999

Fatal Falls: 60-cm to 300-cm

- A 23-month-old girl, weighed 12.9 kgs
- Falling from 1.07 m height
- Unconscious after 5 mins
- Acute SDH 100 ml, no skull fracture
- Bilateral Retinal Hemorrhage
- a well-distributed impact load against a flat surface
- She died 2 days later from refractory cerebral edema after craniectomy











### **Dangerous Mechanism** Three feet tall – a door knob height



Slide 53/60





## Indication for Decompressive Craniectomy

- 1. Diffuse swelling on computed tomography scan
- 2. Patient within 48 hours of initial injury
- 3. No episodes of sustained intracranial pressure of >40 mm Hg before surgery
- 4. Glasgow Coma Scale score of >3 at some point after injury
- 5. Secondary deterioration after initial good clinical presentation
- 6. Evidence of herniation



Fluid

Organizing subdural hematoma (weeks)

Organized clot mistaken for atrophic brain tissue on CT scan

Fresh subdural hematoma (acute)

Subdural hematomas



CT scan. Radiolucent area (arrows) shows fluid and brain atrophy typical of chronic subdural hematoma



CT scan. Left-sided hyperdense area (arrows) typical of acute subdural hematoma



Organized subdural hematoma (months)



#### STATPEARLS STATPEARLS StatPearls [Internet]. Show details Search this book

#### Pediatric Skull Fractures Ailbhe McGrath; Roger S. Taylor. Author Information and Affiliations Last Update: January 23, 2023.

- Growing skull fracture, also known as posttraumatic bone absorption or leptomeningeal cyst
- A very rare complication of a traumatic brain injury.
- 90% occur in children under 3 years of age.

**Growing Skull Fracture** 





Figure 3: Computerised tomography of brain, at 18 months, showing the type III growing skull

fracture. Slide 58/60

British Association for Child and Adolescent Public Health and British Association of General Paediatrics



G333(P) Case report: growing skull fracture- A rare complication of paediatric head injuries

KY Lee, PAG Galloway, J Phillips







### Take Home Messages

- Unique different pathophysiology of the pediatric brain; more susceptibility to injury and skull fracture.
- Always look for Child Abuse sign
- Pediatric GCS
- Assess PECARN score before Pediatric CT scan; CT Brain only when necessary
- Should admit+observe 24h in symptomatic mild TBI with CT Brain negative
- Scalp hematoma > 5 cm2 may indicate skull fracture (indicate for CT scan)
- Isolated subgaleal hematoma is not and does not contribute to the risk of developing any intracranial hemorrhage.
- Bulging anterior fontanelle examination
- Dangerous mechanism (จำรูปไปซักประวัติ)
- Skull Fractures occur at age below 1-3 years; required routine follow-up; watching out for growing skull fracture





PRECARN ALIEM CANADING SECARN ALIEM CANADING



