
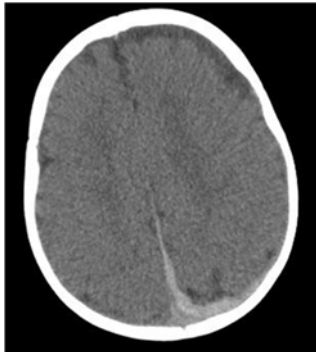


**兒虐鑑定：影像醫學的角色**


趙垂勳 教授/主治醫師  
高雄醫學大學附設醫院  
影像醫學部



**線索？ 4個月大，男**




◆ 抽搐，到院呼吸停止  
(Seizure, respiratory arrest)

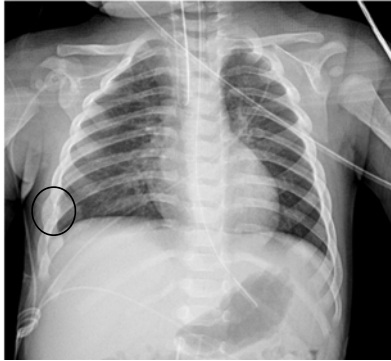


**Case 4個月大，男**

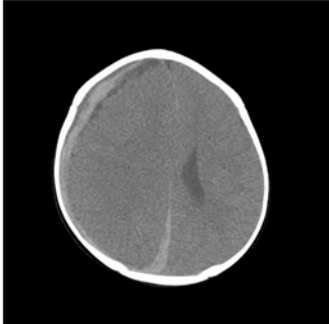


- ◆ 左頂-枕葉及大腦鎌傍急性硬腦膜下出血
- ◆ 無顱骨骨折
- ◆ 無頭皮腫脹或血腫
- ◆ 兩側視網膜下出血



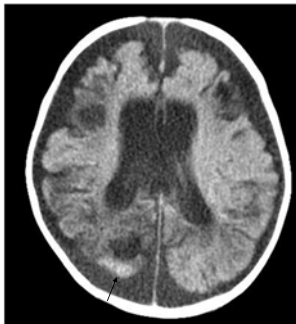
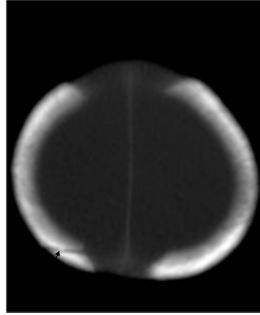
**證據？ 右第七肋骨舊骨折**





**10月，男**

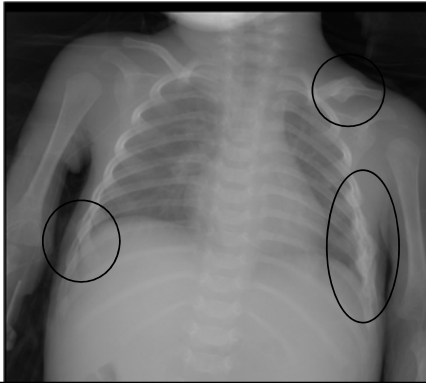
**5月，男**

2007-5-11



5月，男



## 兒虐影像學診斷

1. 骨折
2. 中樞神經傷害
3. 內臟傷害

## 傳統篩檢仰賴病史特徵 Indicators of Possible Abuse

- ◆ 受傷病史沒有交代，用輕微事故解釋嚴重受傷
- ◆ 孩子的年紀心智程度無法達到的行為
- ◆ 病史前後不一致，無法解釋發生原因、嚴重性及種類
- ◆ 歸咎於受傷他人造成，歸咎於另一兒童或兒童自傷
- ◆ 延遲就醫，事故現場無目擊者

## 篩檢標準

1. 超過三次以上急診外傷救醫記錄
  2. 病史不一致
  3. 病史和身體檢查不符
  4. 延遲就醫
  5. 一歲以下任何的骨折及頭部外傷
  6. 低處跌落(約150公分以下)後造成顱內損傷或骨折
- ◆ 只要符合一至四項的兩項，或單獨第五、第六項成立，就應通報兒童保護小組

## 影像醫學的角色

- ◆ 發現身體受虐，支持疑似受虐個案之診斷，發掘未被懷疑個案的特徵病變
- ◆ 以醫學上合理的確定性，去瞭解及推斷：傷害的機制，癒合的型態(日期)及可能傷害方式，提供檢調起訴之證據
- ◆ 用以排除真正意外性傷害，正常變異及其他與兒虐影像雷同之疾病

## 醫學影像在兒虐的應用

- ◆ X光、核醫影像、超音波、電腦斷層(CT)、磁振造影(MRI)
- ◆ 診斷身體受虐(physical abuse)
- ◆ CT及MRI主要診斷受虐頭部創傷(abusive head trauma)，包括嬰兒搖晃症候群(shaken baby syndrome)

# 骨折

## 兒虐骨折

- ◆ 發生率約0.6 骨折/受虐兒
- ◆ 嬰兒發生率最高，隨年齡銳減
- ◆ 好發部位
  - ◆ 0-1歲：
    - 下肢(33%) > 顱骨(26%) > 上肢/肩胛骨/鎖骨(20%) > 肋骨/胸骨(20%)
  - ◆ 1-2歲：
    - 顱骨(31%) > 上肢/肩胛骨/鎖骨(31%) > 下肢(23%) > 肋骨/胸骨(9%)

## 兒虐骨折

Table 2.2 Fractures due to abuse

Fracture location	Age				Total group
	<1 year No. (%)	1-2 years No. (%)	3-12 years No. (%)	13-20 years No. (%)	
No. patients	875 (49)	348 (39)	316 (18)	258 (14)	1794
Head/neck	370	81	16	21	488
Skull	202	56	12	19	289
Rib/sternum	159	16	4	1	180
Vertebra	9	6	0	0	15
Pelvis	0	3	0	1	4
Upper extremity	161	56	22	8	247
Clavicle/scapula	35	7	1	0	43
Humerus	74	28	6	3	111
Radius/ulna	51	17	13	2	83
Carpal/metacarpal	1	4	2	3	10
Lower extremity	257	41	16	4	318
Femoral neck/femur	150	26	12	1	189
Tibia/fibula/ankle	98	15	3	3	119
Tarsal/metatarsal	6	0	1	0	7
Multiple	3	0	0	0	3
<b>Total fractures</b>	<b>788</b>	<b>178</b>	<b>54</b>	<b>33</b>	<b>1053</b>

Reprinted with permission from Leder RT, Feinberg JR. Orthopaedic injuries in children with nonaccidental trauma: demographics and incidence from the 2000 kids' inpatient database. J Pediatr Orthop. 2007;27(6):421-6.

## 兒虐致死嬰兒之骨折分佈

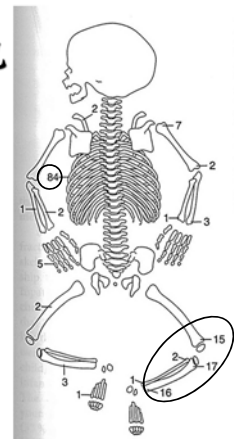


Figure 2.1 Distribution of 164 inflicted fractures on 31 infant fatalities. Single vertebral fracture is not shown. The skull fractures in 13 infants are not included in the analysis. (From Kleinman PK, Marks SC Jr, Richmond JM, Blackburne BD. Inflicted skeletal injury: a postmortem radiologic-histopathologic study in 31 infants. AJR. 1995;165:647-50.)

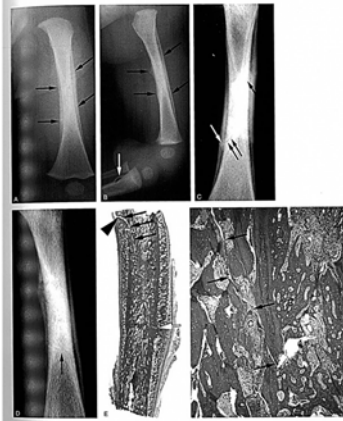
Paul K.Kleinman: Diagnostic imaging of child abuse (3<sup>rd</sup> ed) Cambridge

## 兒虐之骨骼傷害

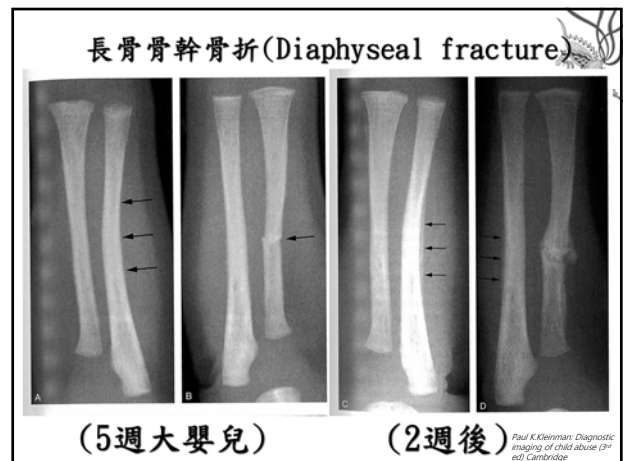
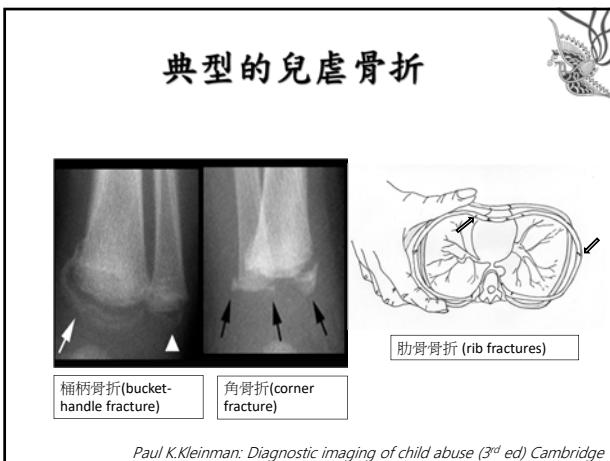
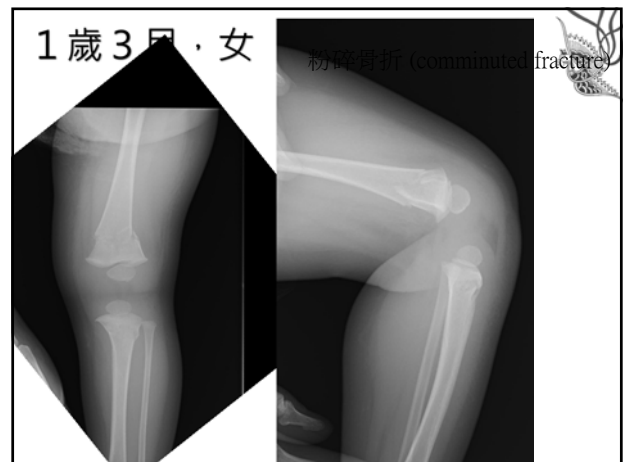
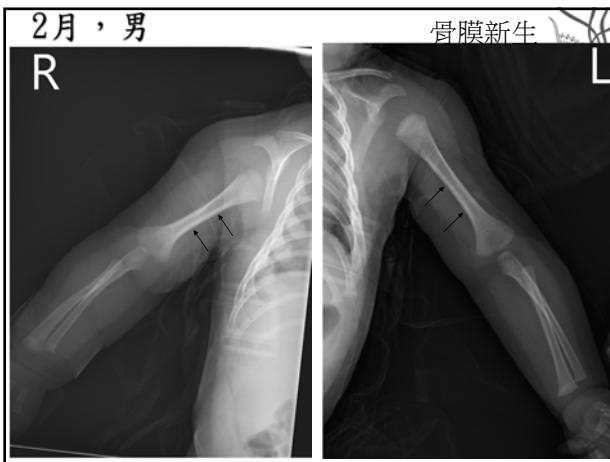
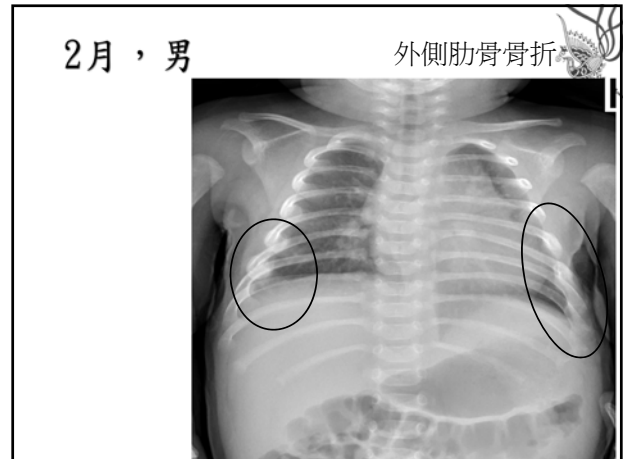
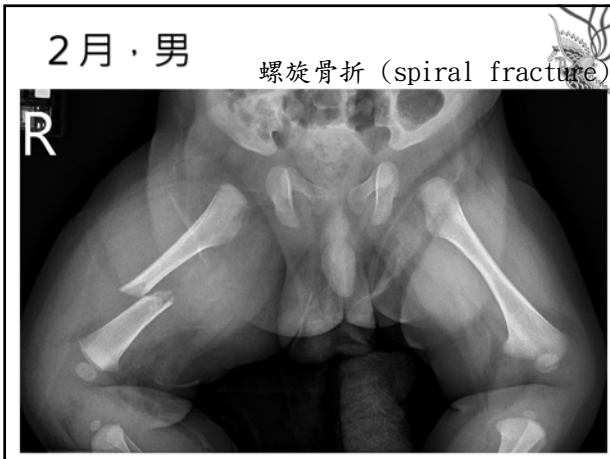
常見

- ◆ 多發性骨折(未被懷疑，異於其年齡)
- ◆ 典型幹骺端骨折
- ◆ 多發性肋骨骨折
- ◆ 骨幹骨折(尚未能行走之幼兒)
- ◆ 顱骨骨折
- ◆ 骨膜下骨質新生

## 多發性骨折 (7週)



Paul K.Kleinman: Diagnostic imaging of child abuse (3<sup>rd</sup> ed) Cambridge



### 兒虐之骨骼傷害

較不常見

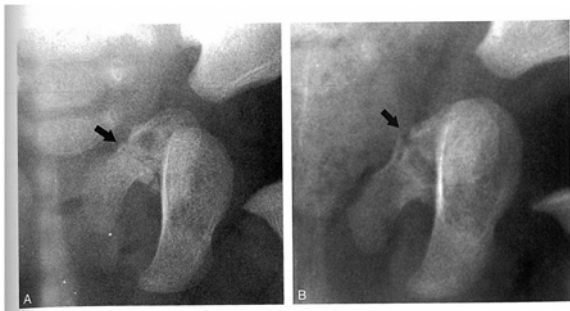
- ◆ 脊椎骨折
- ◆ 手足小骨頭之骨折
- ◆ 鎖骨骨折
- ◆ 脫臼及生長板之分離

### 兒虐之骨骼傷害

罕見

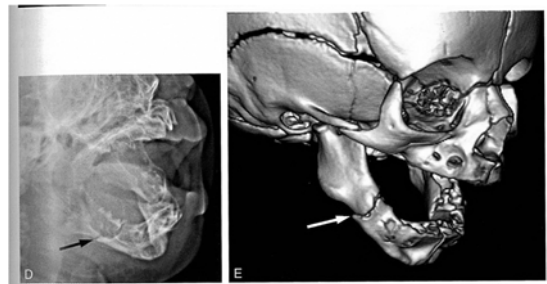
- ◆ 肩胛骨骨折
- ◆ 骨盆骨折
- ◆ 胸骨骨折
- ◆ 顏面骨及下顎骨折

### 耻骨骨折(Pubic fracture) (2月)



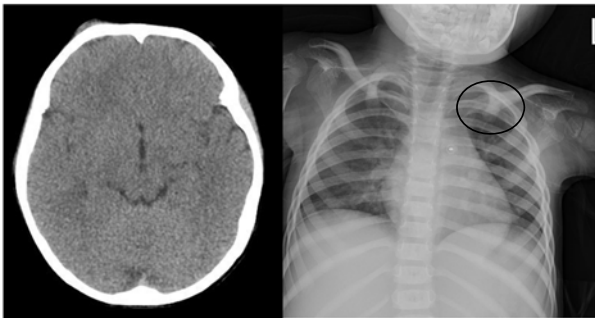
Paul K.Kleinman: Diagnostic imaging of child abuse (3<sup>rd</sup> ed) Cambridge

### 顎骨骨折 (Mandibular fracture)



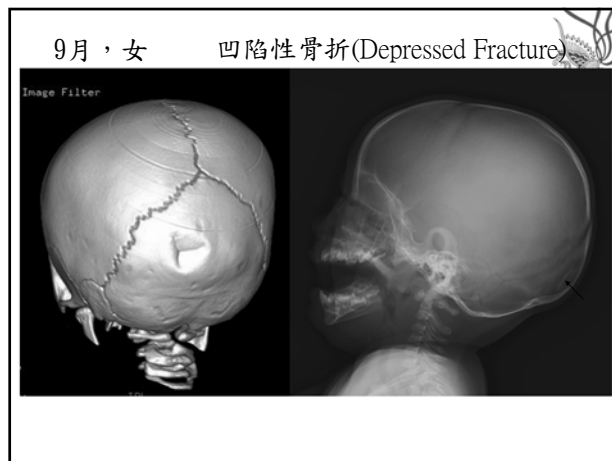
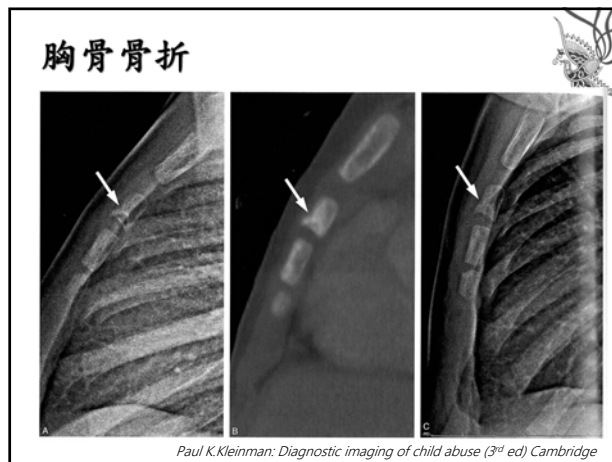
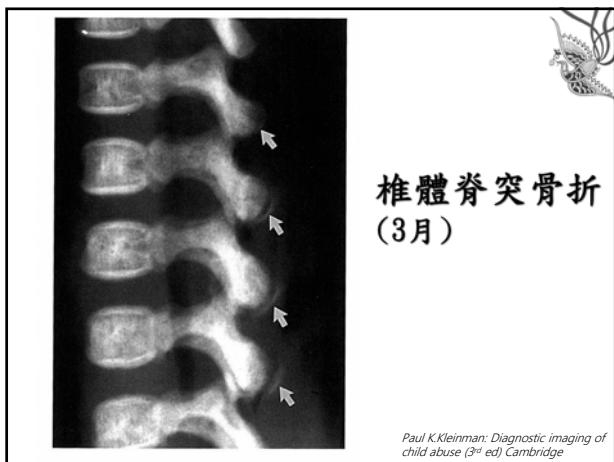
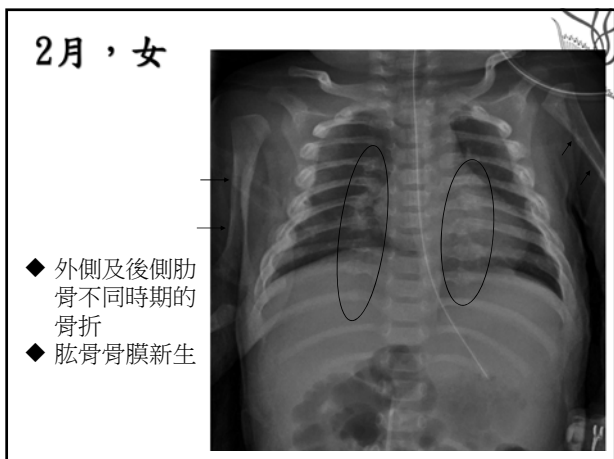
Paul K.Kleinman: Diagnostic imaging of child abuse (3<sup>rd</sup> ed) Cambridge

4歲，女



### 骨折

- ◆ 高度懷疑兒虐之骨折：  
肋骨、肩胛骨、脊椎之脊突、胸骨、  
長骨終端、及枕骨凹陷性骨折。

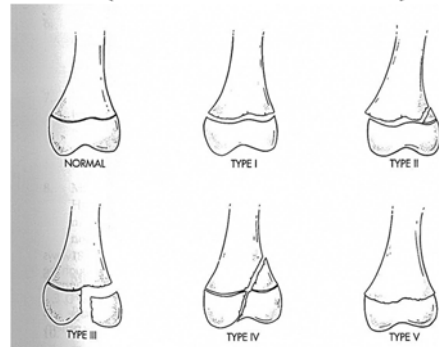


## 骨折

- ◆ 下列骨折亦應懷疑兒虐(中度特異性):
  - ◆ 多發性骨折(特別是雙側性)
  - ◆ 新舊不同時期之骨折
  - ◆ 骨骺端分離
  - ◆ 椎體骨折
  - ◆ 指趾骨折
  - ◆ 複雜性顱骨骨折

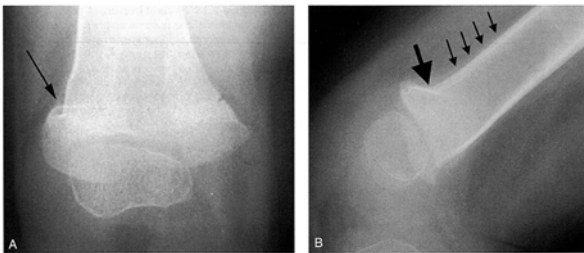


## 生長板骨折之型態分類 (Salter - Harris)



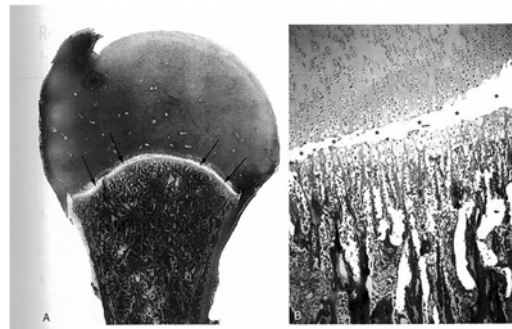
Paul K.Kleinman: Diagnostic imaging of child abuse (3<sup>rd</sup> ed) Cambridge

## SH第二型生長板骨折



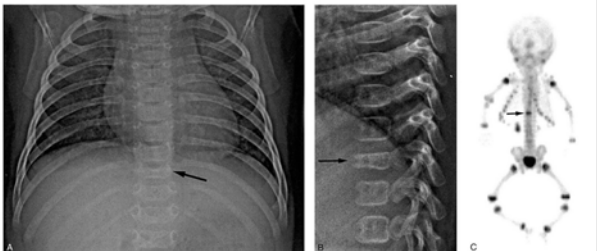
Paul K.Kleinman: Diagnostic imaging of child abuse (3<sup>rd</sup> ed) Cambridge

## 生長板骨折



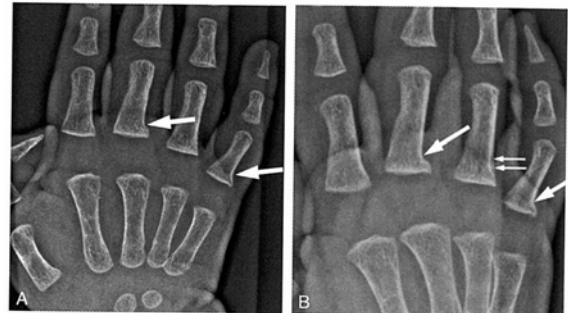
Paul K.Kleinman: Diagnostic imaging of child abuse (3<sup>rd</sup> ed) Cambridge

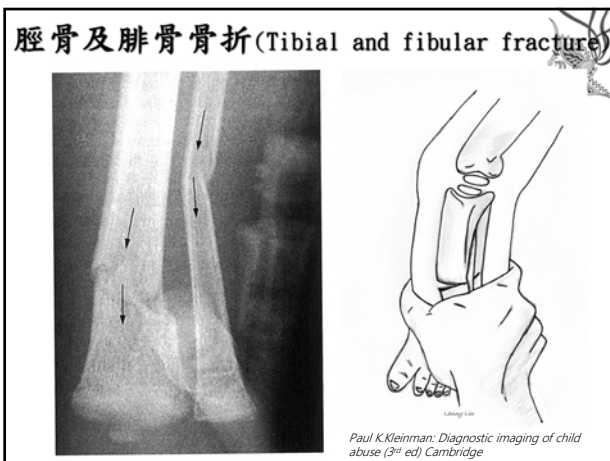
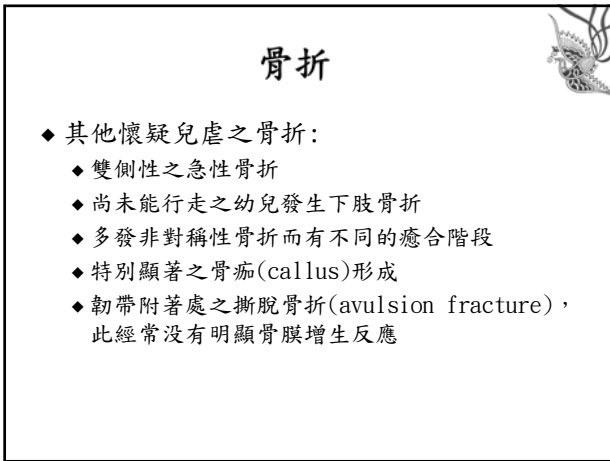
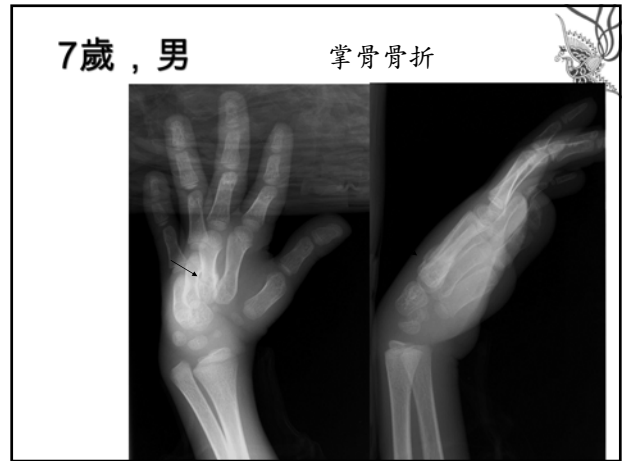
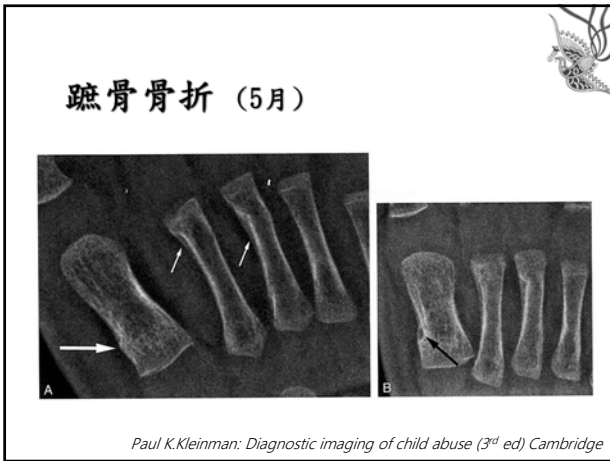
## 椎體骨折 (8週)



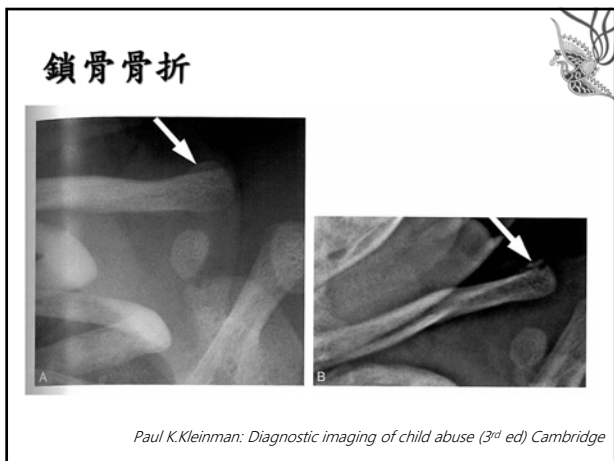
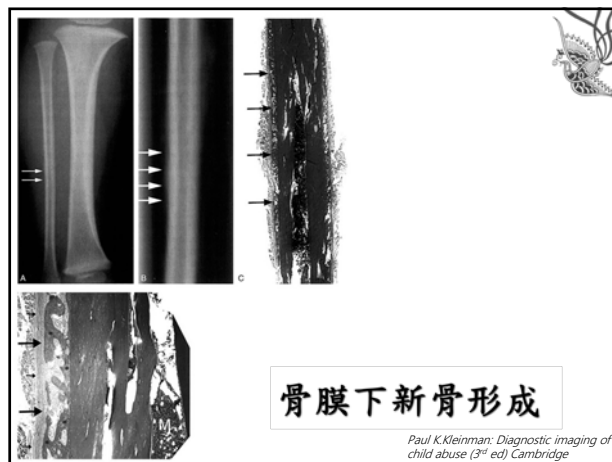
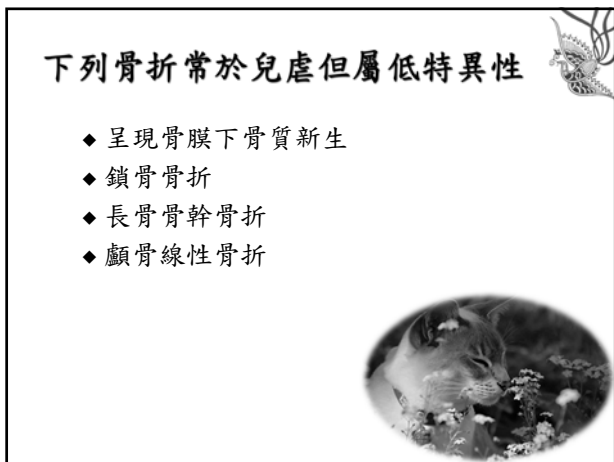
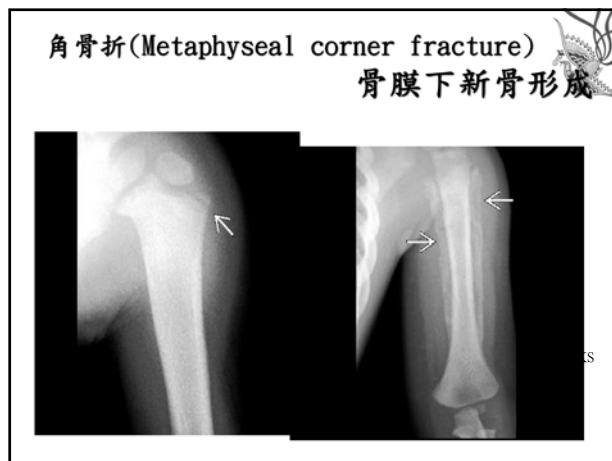
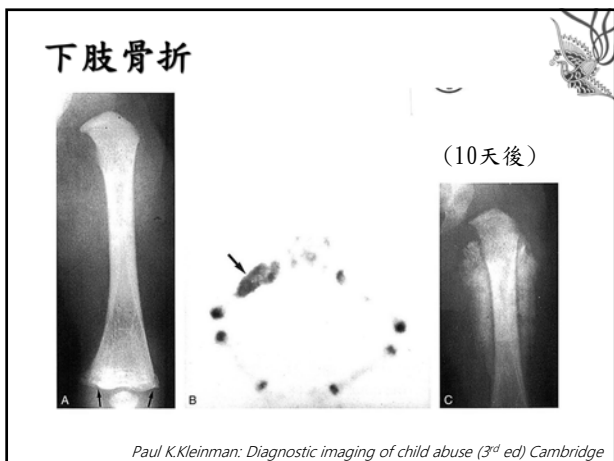
Paul K.Kleinman: Diagnostic imaging of child abuse (3<sup>rd</sup> ed) Cambridge

## 手指骨折









### 如何利用X光判定骨折的日期

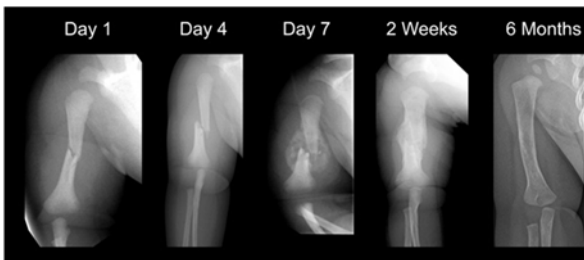
- ◆ 依年齡、營養狀態、骨折有否固定、有否反覆傷害及骨折部位而異
- ◆ 通常顱骨、脊椎及傳統幹骺端的骨折無法正確推斷骨折的日期
- ◆ 整體而言，小嬰兒骨膜下新骨增生較早且骨痂形成較快

### 兒童骨折X光變化之時間表

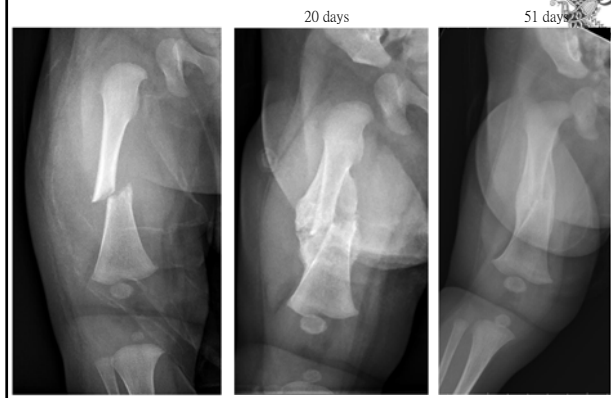
	早	尖峰	晚
軟組織消腫	2 - 5 天	4 - 10 天	10 - 21 天
骨膜下新骨增生	4 - 10 天	10 - 14 天	14 - 21 天
骨折線消失	10 - 14 天	14 - 21 天	
軟骨痂形成	10 - 14 天	14 - 21 天	
硬骨痂形成	14 - 21 天	21 - 24 天	42 - 90 天
骨重塑	3 個月	1 年	2 年-生長板癒合



### 兒童骨折X光變化

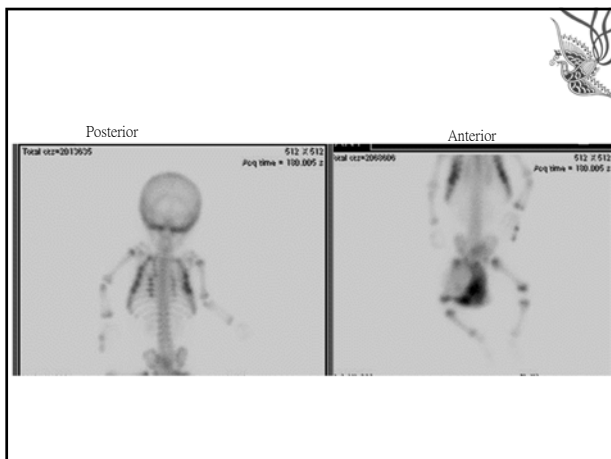


### 2月，男



### 如何檢查兒虐引起骨折

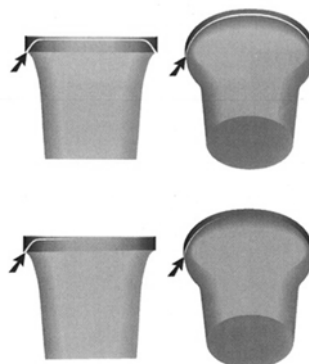
- ◆ 最佳影像工具：X光骨骼系列檢查
- ◆ 核醫學骨掃描有利於檢出骨骼傷害尚處於骨膜下出血而骨膜下骨質新生還不易發現的第一週；核醫學骨掃描亦有利於檢出肋骨骨折。
- ◆ 大於2歲幼兒如果高度懷疑兒虐，但X光骨折不明確時可做核醫學骨掃描



## 骨折

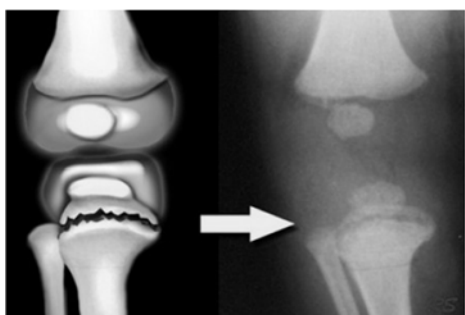
- ◆ 兒虐最俱診斷線索的骨折為長骨幹骺端 (metaphases) 的桶柄骨折(bucket-handle fracture)或角骨折(corner fracture)。
- ◆ 常見於股骨下端，脛骨上下端及肱骨上端。
- ◆ 嬰幼兒之骨骼在幹骺端-骨骺交接處 (metaphyseal-physeal junction) 最為脆弱。
- ◆ 拉扯或扭轉力量造成。

## 角骨折及桶柄骨折：延伸至骨-軟骨交界



Paul K.Kleinman:  
Diagnostic imaging of  
child abuse (3<sup>rd</sup> ed)  
Cambridge

## 桶柄骨折(Bucket-handle fracture)

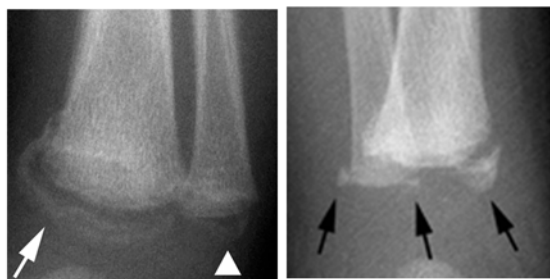


Paul K.Kleinman: Diagnostic imaging of child abuse (3<sup>rd</sup> ed) Cambridge

## 桶柄骨折(Bucket-handle fracture)



## 桶柄骨折(bucket-handle fracture) 角骨折(corner fracture)

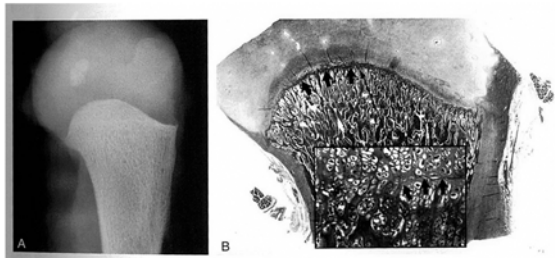


6月，男

柄桶骨折



### 急性典型幹骺端骨折 (2月)

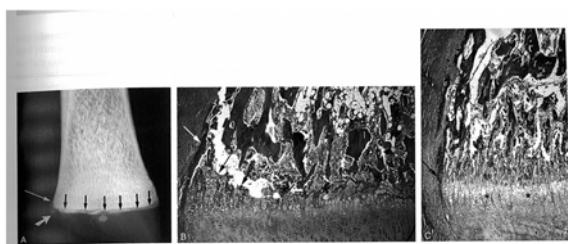


Paul K.Kleinman: Diagnostic imaging of child abuse (3<sup>rd</sup> ed) Cambridge

### 角骨折 (Metaphyseal corner fracture)

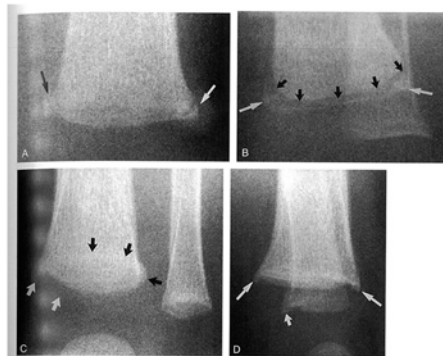


### 典型幹骺端骨折 (4月)



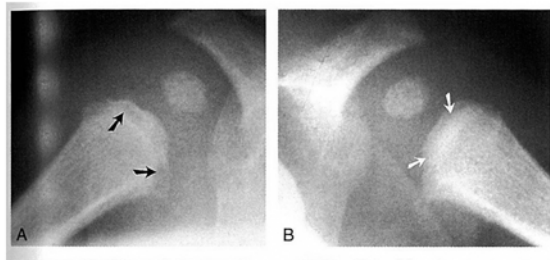
Paul K.Kleinman: Diagnostic imaging of child abuse (3<sup>rd</sup> ed) Cambridge

### 雙側脛骨典型幹骺端骨折 (3月)



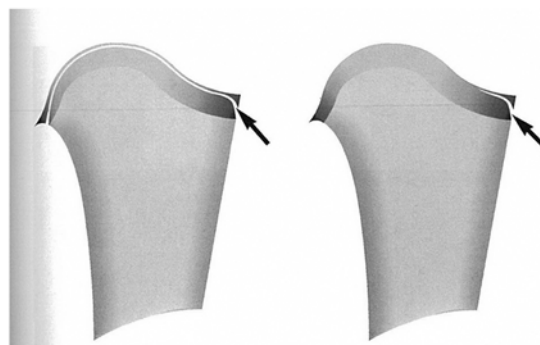
Paul K.Kleinman: Diagnostic imaging of child abuse (3<sup>rd</sup> ed) Cambridge

### 上臂典型幹骺端骨折



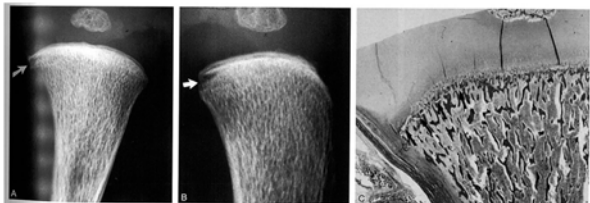
Paul K.Kleinman: Diagnostic imaging of child abuse (3<sup>rd</sup> ed) Cambridge

### 上臂典型幹骺端骨折



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不完全之典型幹骺端骨折 (1月)



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鑑別診斷 (Differential Diagnosis)

- ◆ 外傷性骨折 (Traumatic fractures)
- ◆ 成骨不全症, 玻璃娃娃 (Osteogenesis imperfecta)
- ◆ 佝僂症 (Rickets)
- ◆ 白血病 (Leukemia)

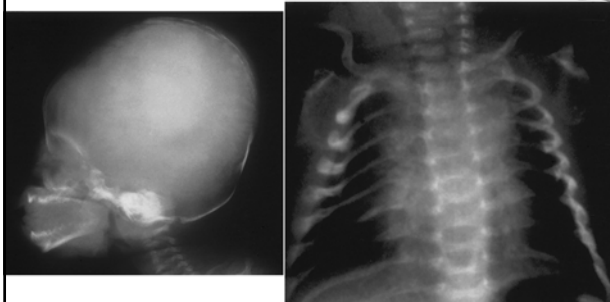
骨幹螺旋骨折 (Diaphyseal spiral fracture)



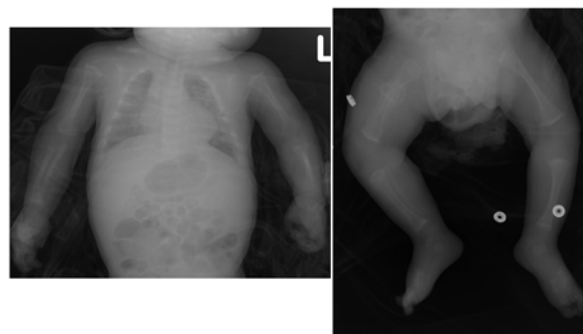
2週, 女 產傷: 右鎖骨骨折

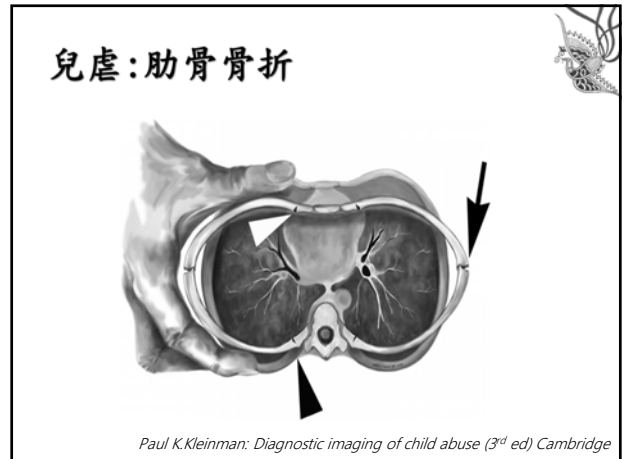


成骨不全症 (Osteogenesis Imperfecta)



佝僂症 (Rickets): 早產兒營養性



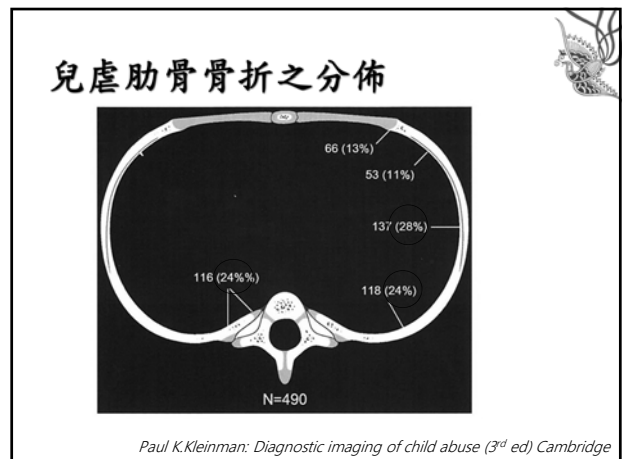
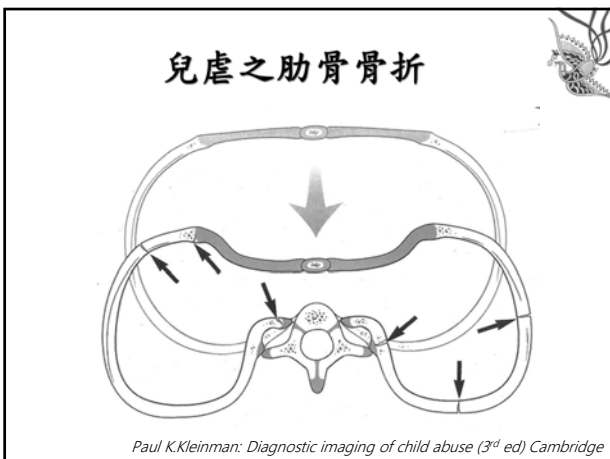


**肋骨骨折**

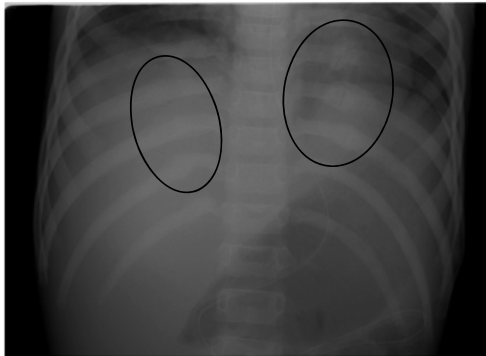
- ◆ 嬰幼兒非兒虐外傷造成肋骨骨折較為少見，據統計1歲以下肋骨骨折中，後側肋骨骨折(特別是胸椎橫突傍的位置)，82%為兒虐造成，為最俱診斷兒虐之線索。
- ◆ 兒虐引起之肋骨骨折亦可發生在肋骨前面及側面，但以後側骨折為俱特异性(小於3歲，正向預測值95%)
- ◆ 兒虐中有29%，肋骨骨折為其僅有影像學發現。
- ◆ 肋骨骨折佔所有兒虐骨傷害之48%。

**肋骨骨折**

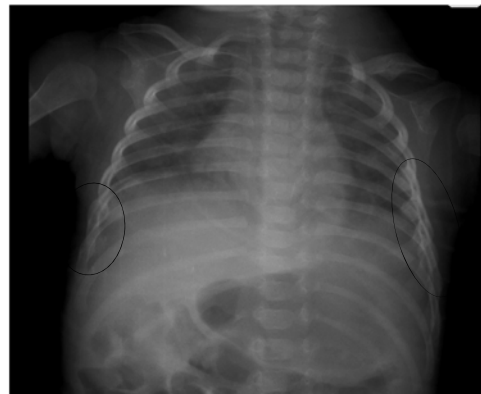
- ◆ 急性肋骨骨折X光有時不易檢出，特別是：骨折未有移位，不完全骨折，或與其他骨骼構造重疊時。
- ◆ 診斷有疑慮則可於二週後再重覆X光檢查，此時會出現骨膜下骨質增生，或做核醫學骨掃描。



後側肋骨骨折(Posterior rib fractures)



外側肋骨骨折(Lateral Rib Fractures)



何時應施行全面骨骼X光檢查 (skeletal survey)?

- ◆ 當X光發現下列任何變化:
  - ◆ 不同癒合階段之多處骨折
  - ◆ 幹骺端之角骨折
  - ◆ 後側肋骨骨折
  - ◆ 肩胛骨骨折
  - ◆ 胸腰椎壓迫性骨折
  - ◆ 脊椎之脊突骨折



懷疑兒虐施行的全面骨骼X光檢查應涵蓋下列部位:

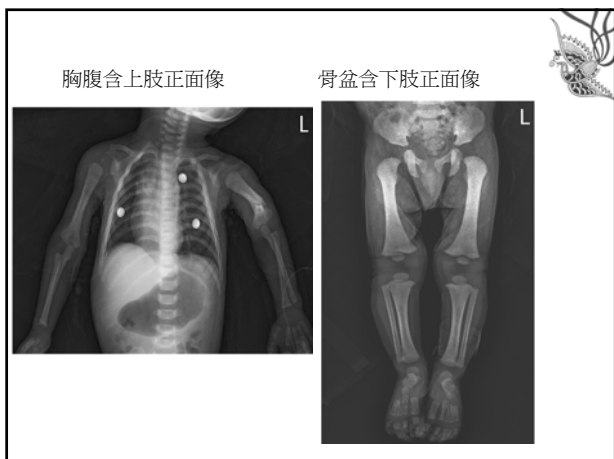
- ◆ 胸部正側面像
- ◆ 顱骨正側面像
- ◆ 腹部及骨盆正面像
- ◆ 雙側上臂、前臂、手
- ◆ 雙側大腿、小腿、踝、足

懷疑兒虐全面骨骼X光檢查之攝影部位及術式

SKELETAL SURVEY*
Anteroposterior (AP) and lateral of skull
AP and lateral of spine
AP and both obliques (right posterior, left posterior of chest)
AP of pelvis and hips
AP and frog lateral of lower extremities
AP of upper extremities (Shoulder through wrist)
Posteroanterior of hands
AP of feet
Lateral of sternum
* Additional collimated projections are recommended for all questioned Follow-up survey films in 10 to 14 days often confirm or refute questionable

簡化型骨骼檢測 (skeletal survey)

- ◆ 胸部及兩側上臂仰臥正面像(Thorax + upper arms AP supine)
- ◆ 前臂正面像，兩側分別照 (Separate films of each forearm AP)
- ◆ 骨盆及兩側股骨仰臥正面像 (Pelvis + femurs AP supine)
- ◆ 雙腳合併一張正面像 (Both lower legs on one film PA)
- ◆ 顱骨側面像 (Skull lateral)

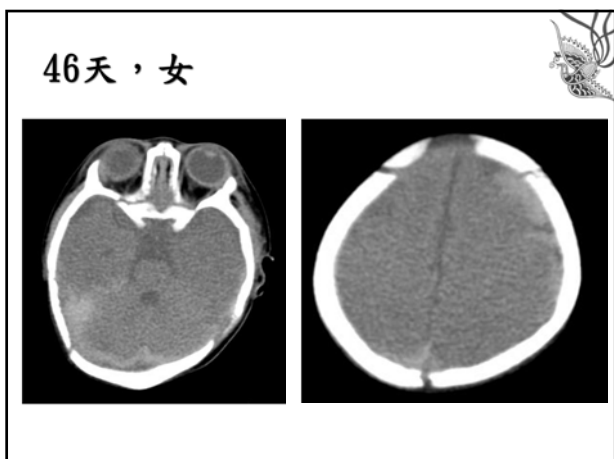
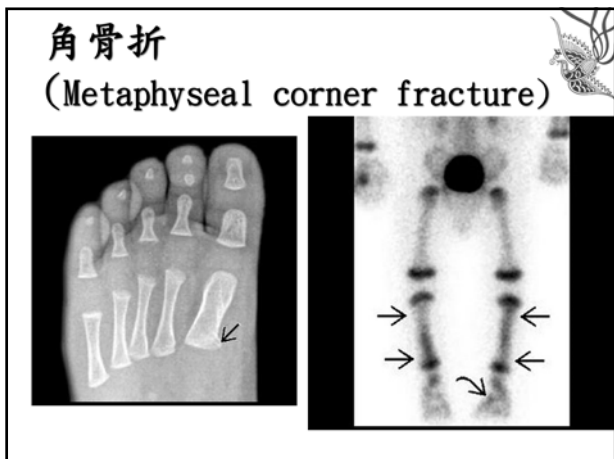


**Table 14.2** Imaging recommendations for skeletal injury

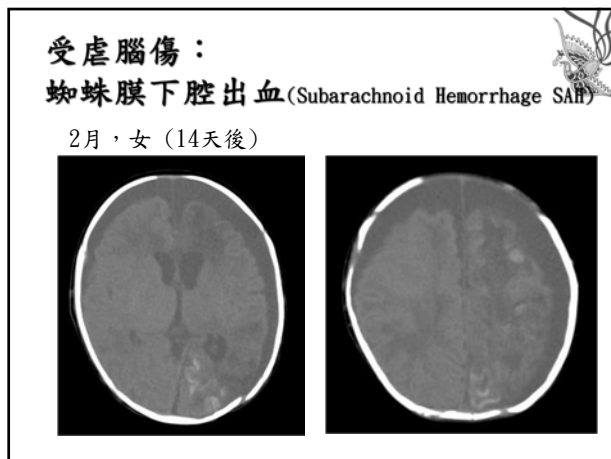
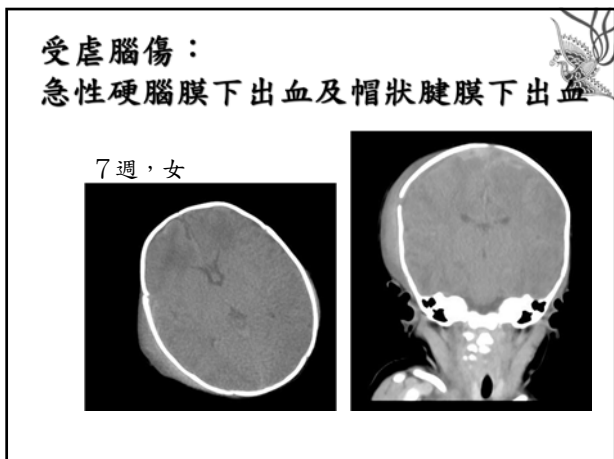
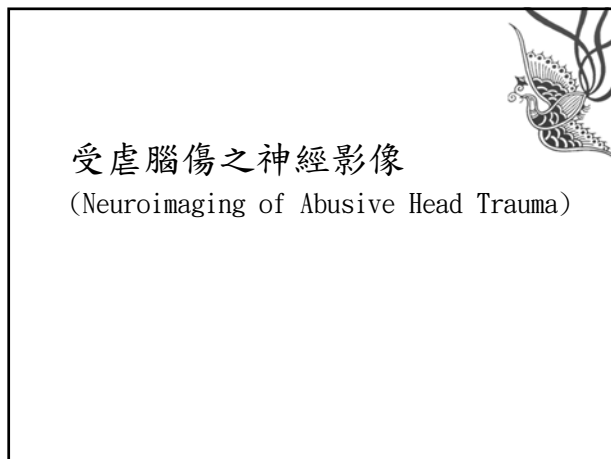
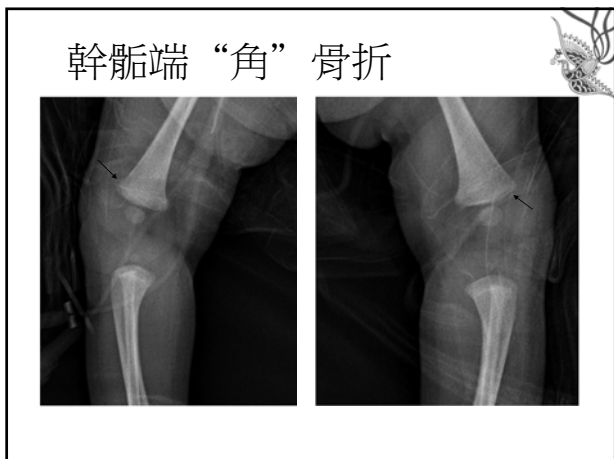
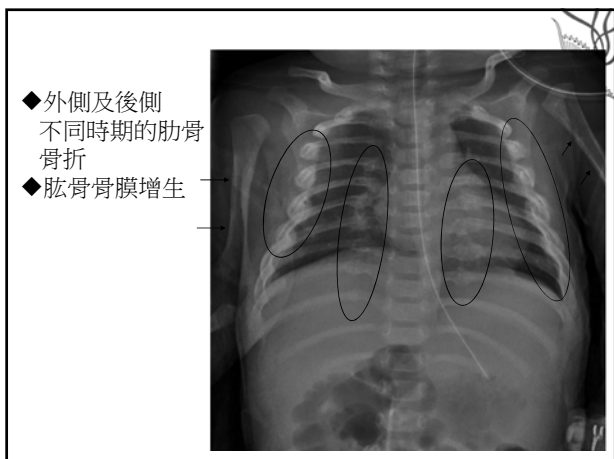
<b>0 to 12 months</b>	Skeletal survey* Follow-up skeletal survey (2 weeks)
<b>12 months to 2 years</b>	Skeletal survey >>scintigraphy
<b>2-5 years</b>	Skeletal survey >>scintigraphy in selected cases where physical abuse is strongly suspected
<b>5 years and older</b>	Radiographs of individual sites of injury suspected on clinical grounds

\* Scintigraphy added in selected cases – see discussion in text.

*Paul K.Kleinman: Diagnostic imaging of child abuse (3rd ed) Cambridge*







## 受虐腦傷(Abusive Head Trauma)

- ◆ 美國每年690,000案例
- ◆ 嬰兒嚴重頭部外傷最常見的原因
- ◆ 佔腦性麻痺及智能障礙成因的10%

## 危險因子

- ◆ 小於1歲
- ◆ 年輕母親、未婚生子、低教育水平、低社經狀態、失能、行為及情緒障礙、多產。
- ◆ 加害者依序：母親→ 雙親→ 父親→ 男性親戚

## 傷害機制

- ◆ 搖晃(shaking)及撞擊(impact)
- ◆ 直接揮擊頭部(direct blow to the head)
- ◆ 壓制(compression)
- ◆ 掐勒(strangulation)
- ◆ 貫穿傷害(penetrating injuries)
- ◆ 悶蓋(smothering)
- ◆ 窒息(suffocation)

## 臨床症狀

- ◆ 抽搐
  - ◆ 腦症
  - ◆ 視網膜出血
  - ◆ 意識障礙而外表無頭部外傷證據
- ※ 死亡率超過15%

## 搖晃傷害(shaking injury)

- ◆ 抓住嬰兒胸部或肩膀用力搖晃
- ◆ 加速及減速造成動能改變
- ◆ 大腦半球以不同速度前後晃動
- ◆ 嬰兒頭大頸軟
- ◆ 剪力加上胸部壓迫造成顱內靜脈壓力上昇，使視網膜靜脈及腦靜脈破裂，造成視網膜出血及硬腦膜下出血

## 搖晃傷害(shaking injury)

- ◆ 角動量或旋轉剪力造成瀰漫性軸突損傷(diffuse axonal injury)，好發於大腦失狀傍白質
- ◆ 大腦自律控制失調使腦血流增加，及血管受損液體滲出，造成腦水腫。而嬰兒未成熟的腦更易於形成腦水腫

### 腦部傷害

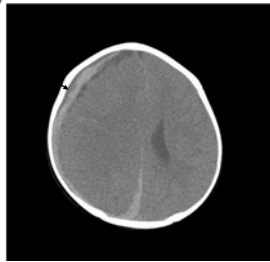
- ◆ 頭部X光通常較電腦斷層易於檢查顱骨骨折
- ◆ 電腦斷層攝影(CT)為主要評估兒虐的初始檢查
- ◆ 腦部實質傷害通常併發於嬰兒搖晃傷害
- ◆ 磁共振造影(MRI)有助於檢出較不明顯之硬腦膜下出血，蜘蛛膜下出血及腦實質傷害
- ◆ 嬰兒顱部超音波檢查有助於評估腦血流、腦壓變化及臨床追蹤

### 懷疑受虐腦傷建議影像學檢查

- ◆ 到院當天：頭部CT
- ◆ 1-2 天：頭部X-光及超音波
- ◆ 3-4 天：初始CT正常或不明確變，頭部MRI

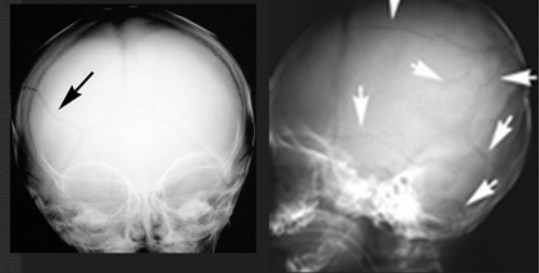
*Jespan et al.: Clin Radiol 2003; 58:44-5*

10月，男

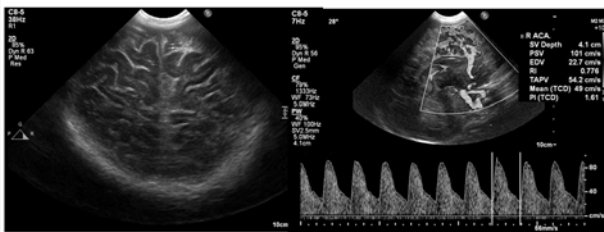


右側急性硬腦膜下出血併腦水腫及鑷下腦疝

顱骨骨折



### 嬰兒顱部超音波檢查

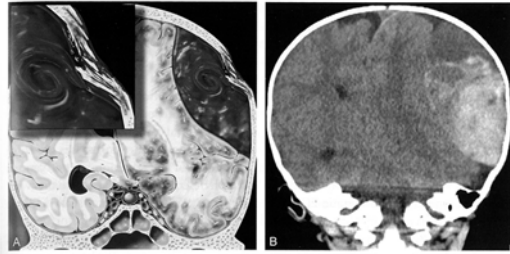


*Paul K Kleinman: Diagnostic imaging of child abuse (3<sup>rd</sup> ed) Cambridge*

### 神經影像學特徵

- |          |          |
|----------|----------|
| ◆ 受虐腦傷   | ◆ 非受虐腦傷  |
| ◆ 硬腦膜下出血 | ◆ 硬腦膜外出血 |
| ◆ 腦水腫    | ◆ 頭皮腫脹   |
| ◆ 視網膜出血  | ◆ 局部顱骨骨折 |
| ◆ 顱骨骨折   |          |

急性硬腦膜外出血(Acute Epidural Hemorrhage)



Paul K Kleinman: Diagnostic imaging of child abuse (3<sup>rd</sup> ed) Cambridge

硬腦膜外出血(Epidural Hemorrhage EDH)

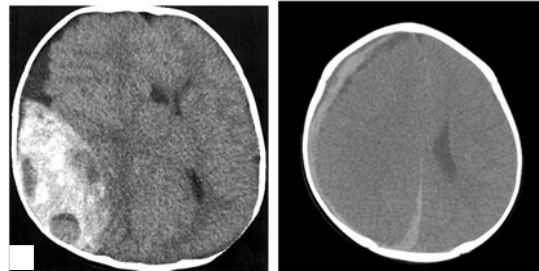
- ◆ 動脈性EDH
  - ◆ 最常見(~ 90%)
  - ◆ 好發於顳頂葉
  - ◆ 80-95% 合併顳骨骨折
  - ◆ 通常會被骨縫合侷限
  - ◆ 漩渦徵(swirl sign)：活動性出血

硬腦膜外出血(Epidural Hemorrhage EDH)

- ◆ 靜脈性 EDH
  - ◆ 較少見( ~10%)
  - ◆ 橫跨靜脈竇
  - ◆ 通常合併顳骨骨折

硬腦膜外出血  
(3歲, 意外)

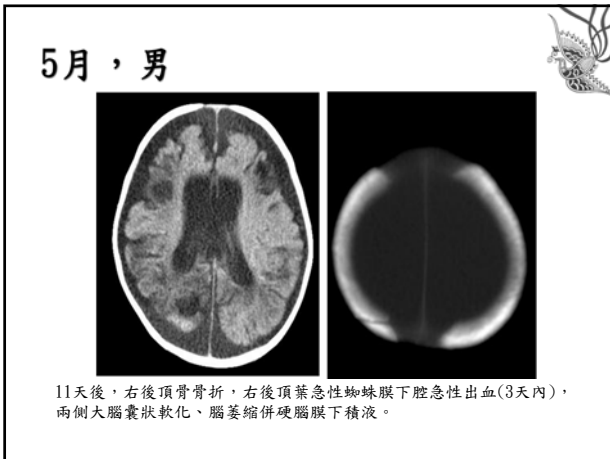
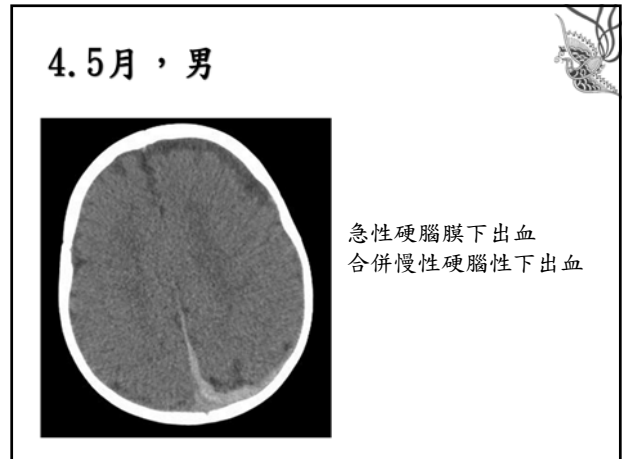
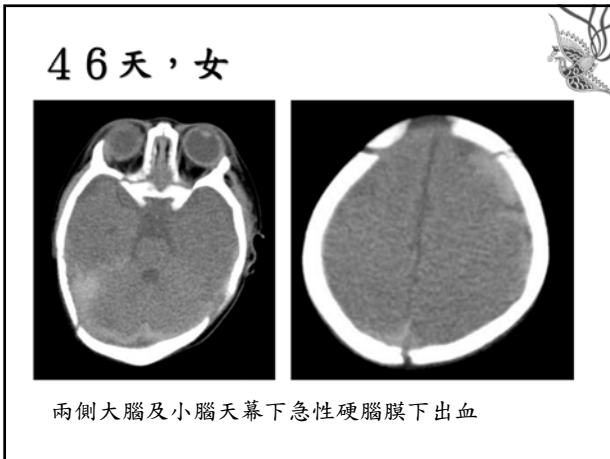
硬腦膜下出血  
(10月, 受虐)



硬腦膜下出血CT及MRI變化

硬腦膜下出血CT密度之變化

時間	分期	CT值
< 3小時	超急性	低 至同密度
3小時至 3天	急性	高或混合高低
3天至7-10天	早期亞急性	高
7-10天至3週	晚期亞急性	同密度
> 3 週	慢性	低
當血色素 8 - 10 mg/dL, 在超急性期呈現同密度		

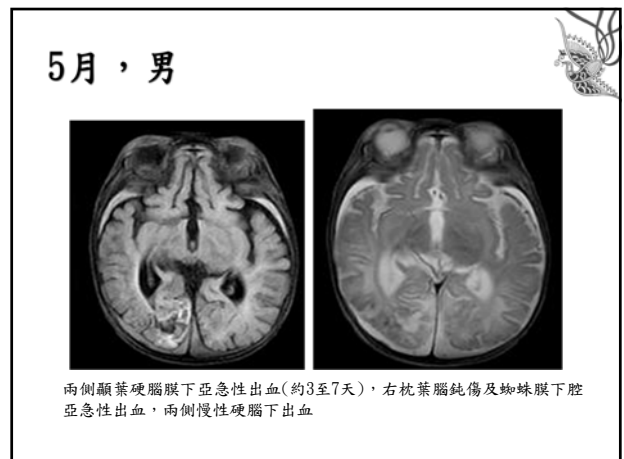
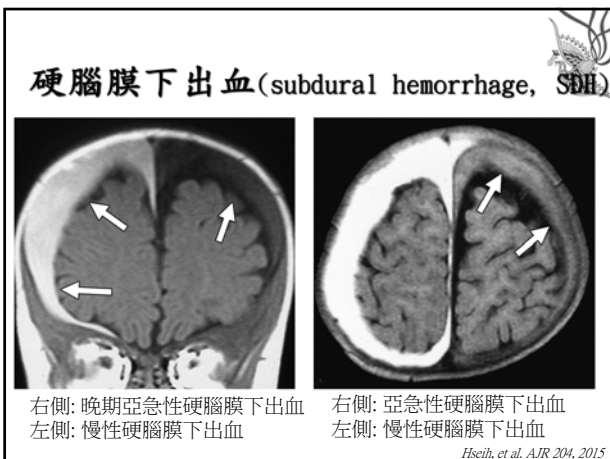


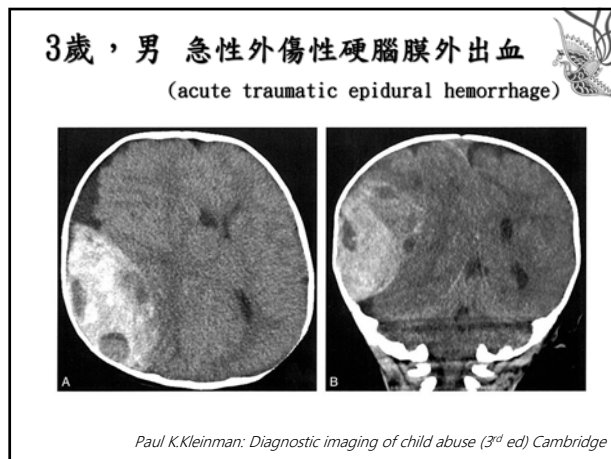
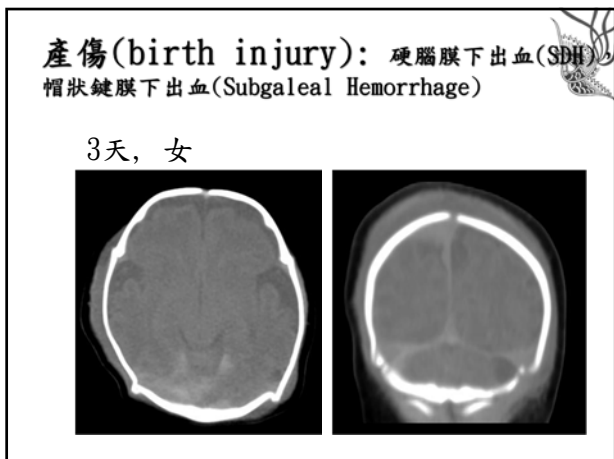
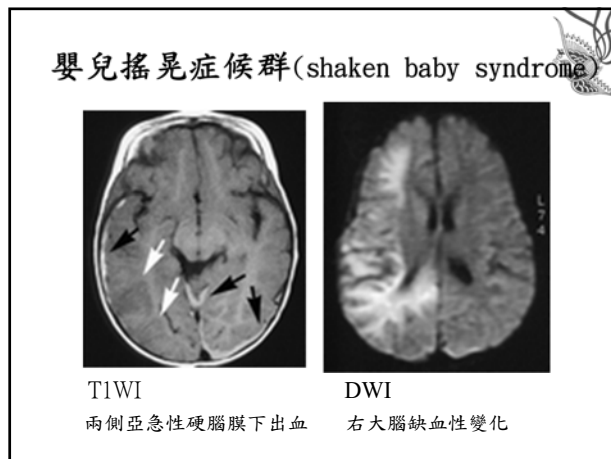
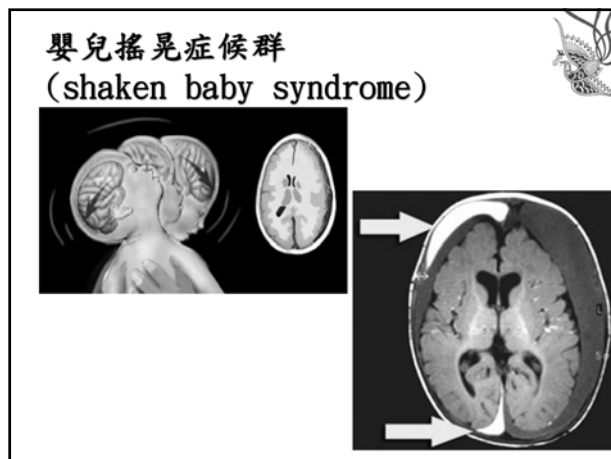
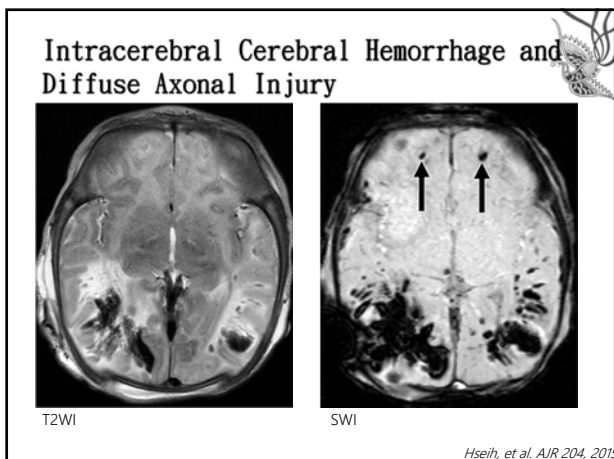
顱內出血磁振造影的訊號強度變化

Table 18.2 MRI signal characteristics of hemorrhage (subdural and intracerebral)

	Acute (Hours—3 days)	Early subacute (3—10 days)	Late subacute (10 days—3 weeks)	Chronic (over 3 weeks)
<b>Subdural hemorrhage</b>				
T1	Isointense	↑	↑	↓
T2	↓	Iso → ↑	↑	↑
Hemoglobin	Deoxyhemoglobin	Methemoglobin (intracellular)	Methemoglobin (extracellular)	Hemosiderin
<b>Intracerebral hemorrhage</b>				
T1	Iso → ↑	↑	↑	Isointense
T2	↓	↓	↑	↓
Hemoglobin	Deoxyhemoglobin	Methemoglobin (intracellular)	Methemoglobin (extracellular)	Hemosiderin

Modified with permission from Tung GA. Imaging of abusive head trauma. Jenny C, ed. Child Abuse and Neglect. Philadelphia, PA: W. B. Saunders; 2011.

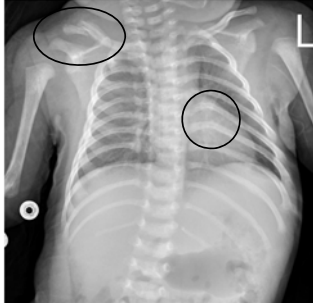






30天，女

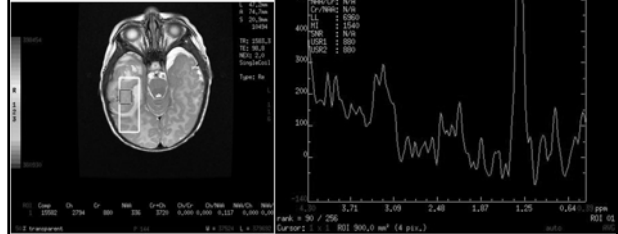
右鎖骨骨折、左側第6、7肋骨骨折



30天，女 受虐腦傷：腦血腫

MR Spectroscopy

Lactate peak (1.33 ppm)  
Low NAA(2.0 ppm)



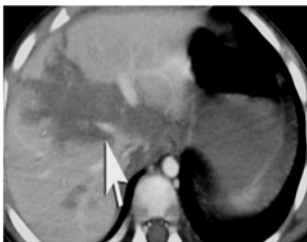
### 兒虐造成之內臟傷害

- ◆ 兒虐造成死亡的第二常見原因
- ◆ 拳打脚踢腹部
- ◆ 年齡通常大於二歲
- ◆ 肝、胰、脾、腎、肺之挫傷或撕裂傷
- ◆ 外傷性胰臟假性囊腫
- ◆ 胃或小腸破裂
- ◆ 十二指腸或空腸血腫

### 內臟傷害 (Visceral Organ Injury)

- ◆ 肝 Liver
- ◆ 脾 Spleen
- ◆ 胰 Pancreas
- ◆ 十二指腸 Duodenum

### 肝撕裂傷(Liver laceration)



### 胰撕裂傷(Pancreatic laceration)





## 結語

- ◆ 影像醫學除在臨床上幫忙發掘兒童身體受虐個案，對於疑似受虐個案提供體內傷害的診斷；並由影像學呈現之特徵，以醫學上合理的確定性，去推斷傷害可能的機制或方式，以及傷害發生的可能時間，協助提供檢調偵查及起訴之證據。

謝謝聆聽