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IS A MOTORCYCLE SAFE FOR CHILDREN?

Infant, toddler , and preschooler Safety

- The preschool period corresponds to Piaget's preoperational (prelogical) stage, characterized by
  - egocentrism
  - perception-dominated thinking
  - magical thinking

- What is the minimum age for a child to ride as a pillion passenger on a motorcycle?
- Should toddlers are carried on motorcycle as a pillion?

- Toddlers are more mobile and coupled with increasing curiosity about the environment so they could quickly be in a danger.
- Owing to their cognitive immaturity, toddlers and preschool children are often impulsive and may frequently be unable to judge accurately the level of safety in situations. (Schwebel D C, Plumert J M, 1999)

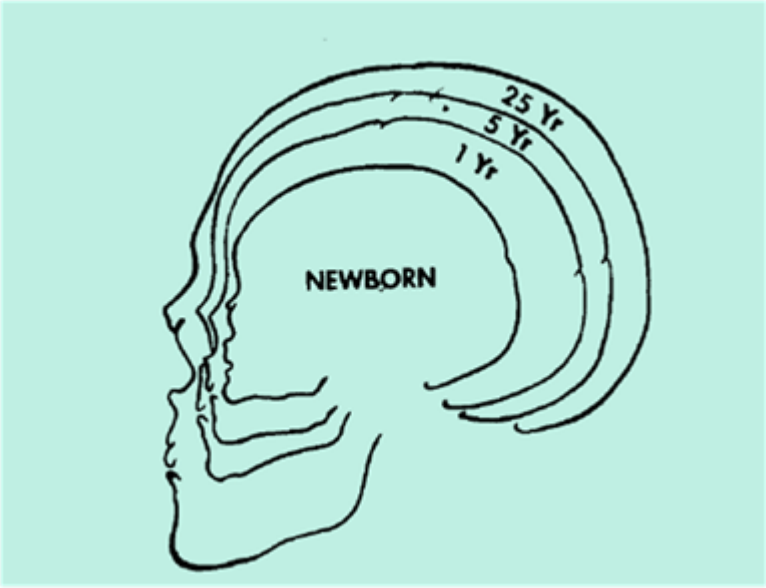
- Parents need to supervise the child at all times.
- Parents and caretakers need to take responsibility for managing the risks to children when travelling on motorcycle.

Infant, toddler , and preschooler risks on motorcycle

- Children at birth to 2 years of age have been identified as **“*a head neck injury prone group*”**.

Head mass

- Infant's head comprises 30% of body weight while the adolescent's head is only 6%
- Infant's head is 1/4 the total height, while an adolescent's head is 1/7 the total height.



Neck muscles

- Infant neck muscles are not well developed so most infants cannot hold up their heads until about three months.

- The relatively large head may particularly affect neck loads, as a larger proportion of mass is being supported by a smaller structure (Klinich KD, 1996).
- This may allow more cervical spine injuries if not properly supported.

Klinich KD, S. R. (1996). TECHNIQUES FOR DEVELOPING CHILD DUMMY PROTECTION REFERENCE VALUES. Child protective team .

- The atlas (C1) and the axis (C2) do not complete their joining until age 4 to 6.
- By puberty, the vertebrae reach their adult size, but do not finish developing until age 25.

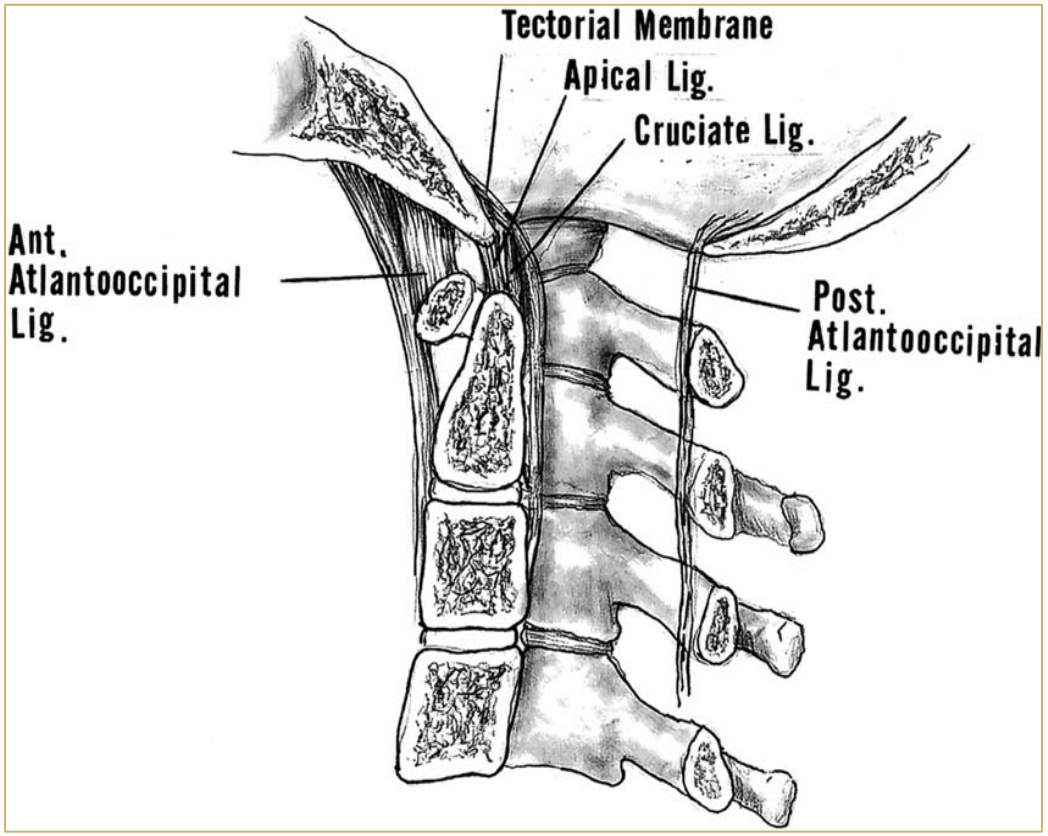
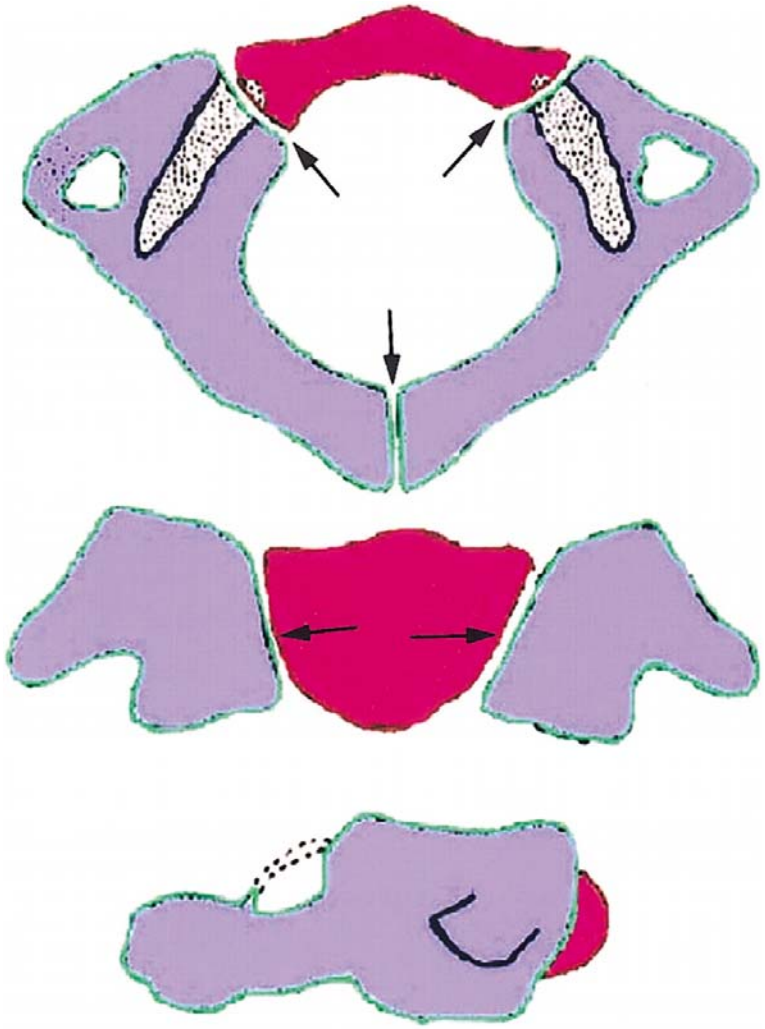


Figure 1a. Drawings (a) and axial computed tomographic (CT) scan (b) through C1 in an infant show the ossification centers of C1 with open synchondroses (arrows)



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RadioGraphics

Figure 2a. Drawings (a) and axial CT scan (b) through C2 in an infant show the ossification centers of C2 with open synchondroses (arrows).

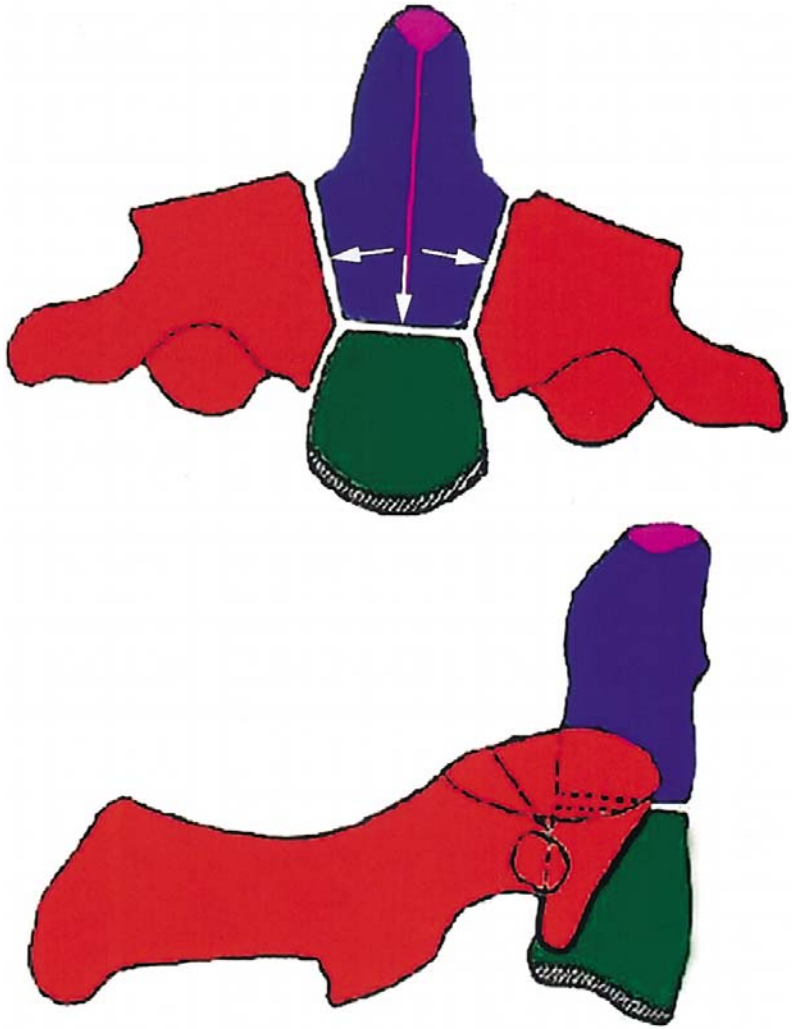

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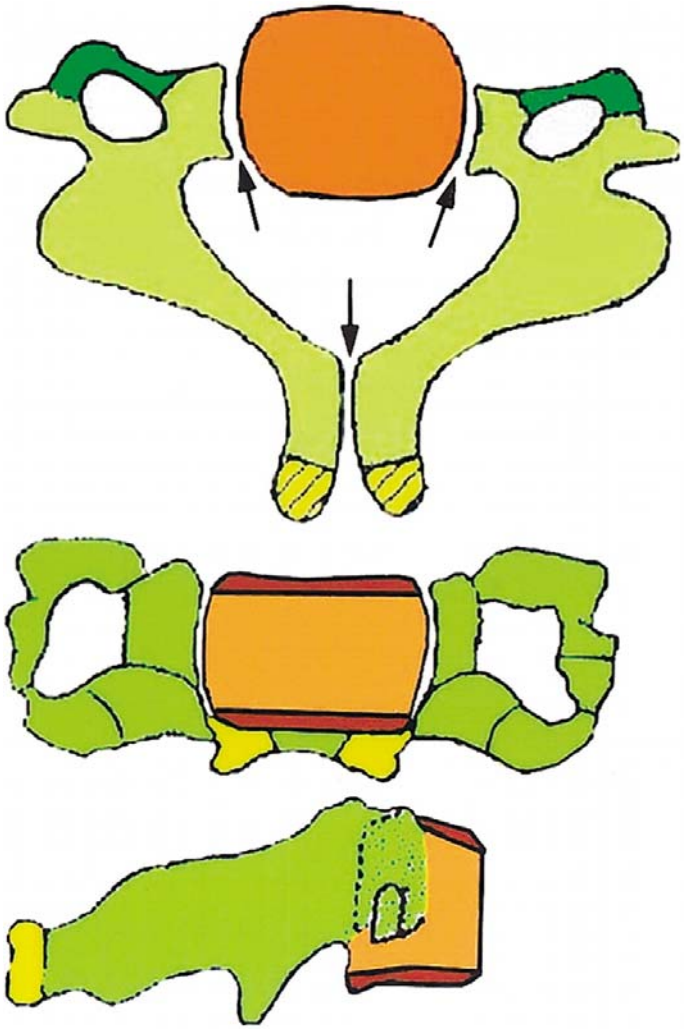
Figure 3a. Drawings (a) and axial CT scan (b) through C3 in an infant show the ossification centers of C3 with open synchondroses (arrows).



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Spinal cord injury without radiographic abnormality (SCIWORA)

- During the first year, the facet joints in the upper neck are nearly horizontal, allowing partial dislocation under minimal forces.
- Under impact, a child's flexible vertebrae can displace more without fracture, but allow the spinal cord to stretch.

Figure 10. Lateral radiograph of the cervical spine in a pediatric patient shows pseudosubluxation at the C2-C3 level (arrow).

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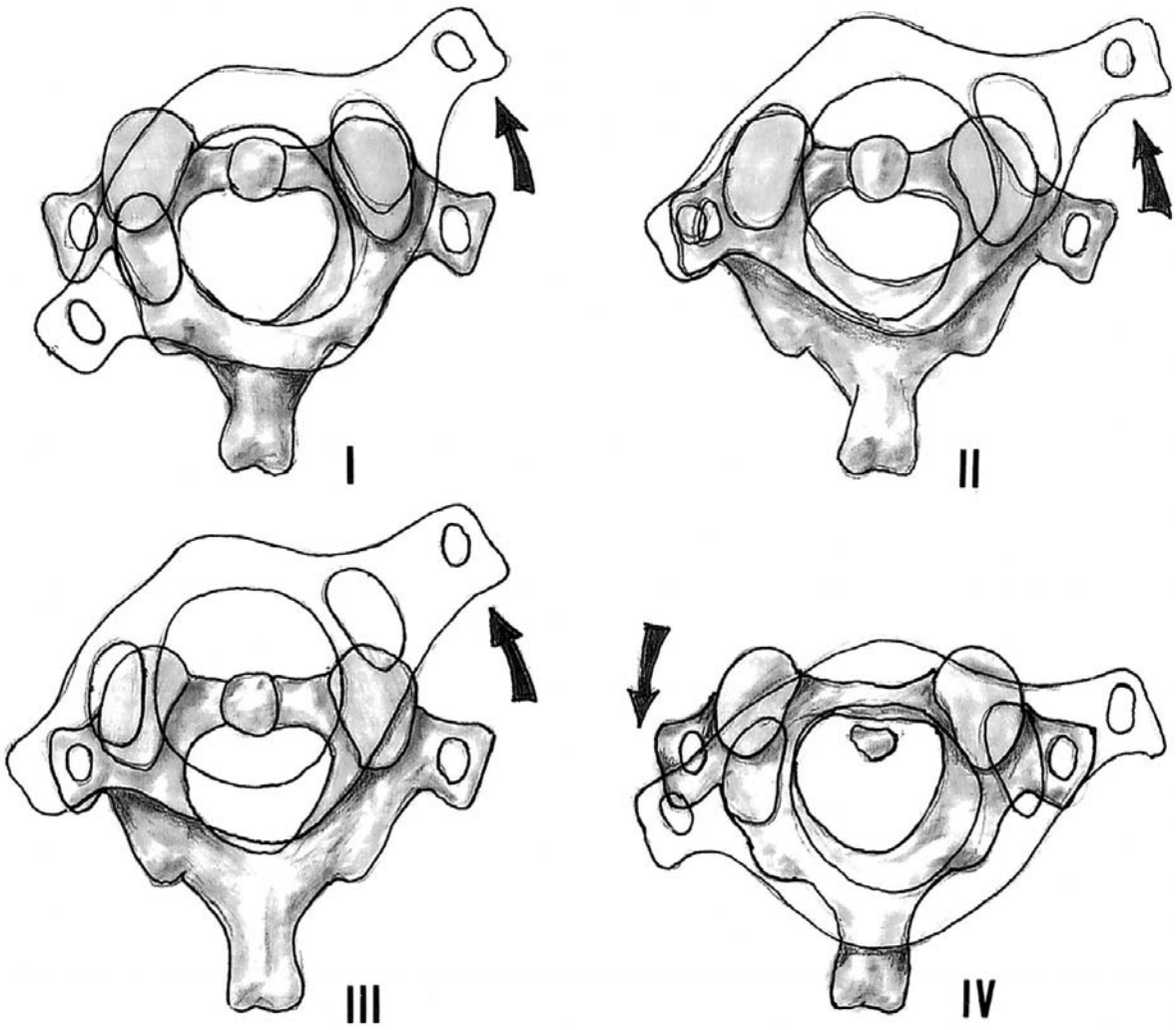
Figure 19. Drawings illustrate the Fielding classification scheme for atlantoaxial rotatory fixation



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- The retrospective analysis of 103 consecutive C-spine injuries in children by Brown revealed that SCIWORA occurred in 38% (Brown RL, Brunn MA, Garcia VF, 2001).

Brown RL, B. M. (2001). Cervical spine injuries in children: a review of 103 patients treated consecutively at a level 1 pediatric trauma center. *J Pediatr Surg , 36*, 1107-14.

Figure 12a. (a) Lateral extension radiograph of the cervical spine shows normal bone alignment

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Figure 12b. (a) Lateral extension radiograph of the cervical spine shows normal bone alignment

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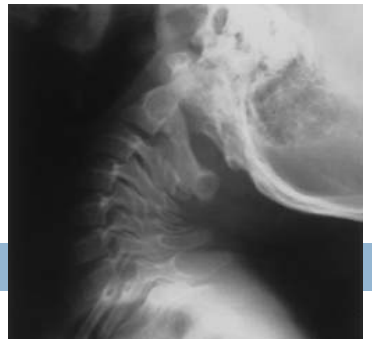
Natural neck pivot



- About 60-70% of pediatric cervical fractures occur at C1 or C2, compared to about 16% of adult cervical spine fractures (Brown RL, Brunn MA, Garcia VF, 2001) (Oluigbo CO, Gan YC, Sgouros S, et al., 2008)
- This occurs because the natural neck pivot of children is at C2 or C3, while in adults it occurs near C6.

•Brown RL, B. M. (2001). Cervical spine injuries in children: a review of 103 patients treated consecutively at a level 1 pediatric trauma center. *J Pediatr Surg , 36*, 1107-14.

•Oluigbo CO, G. Y. (2008). Pattern, management and outcome of cervical spine injuries associated with head injuries in paediatric patients. *Childs Nerv Syst , 24*, 87-92.

- C-spine injuries in toddlers and preschoolers most commonly involve the upper C-spine.
- The C-spine injury study of Brown found that overall mortality rate was 18.5%, most commonly motor vehicle related (95%), occurring in younger children (mean and median age 5 years) and associated with upper C-spine injuries (74%). (Brown RL, Brunn MA, Garcia VF, 2001)

Figure 20. Lateral radiograph of the cervical spine in a 16-year-old girl with a history of Down syndrome demonstrates atlantoaxial subluxation (arrow).

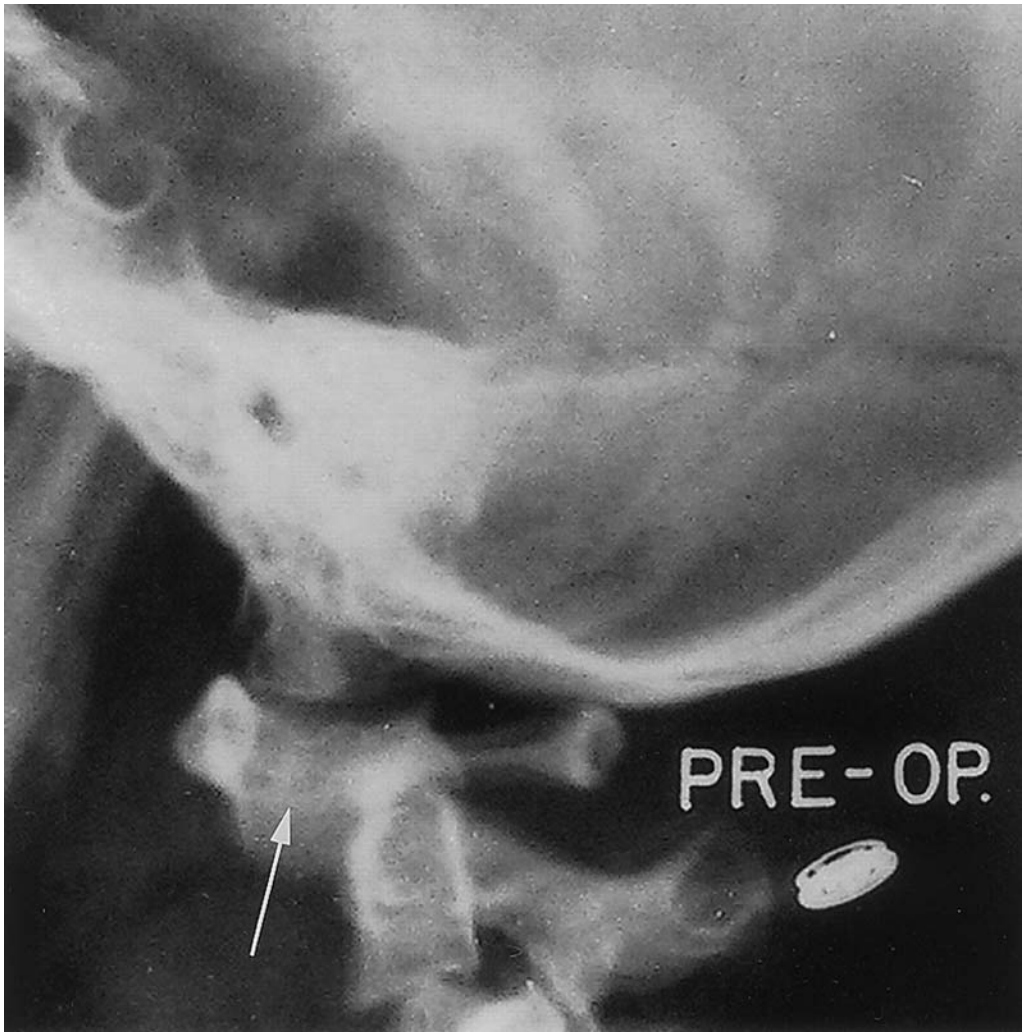


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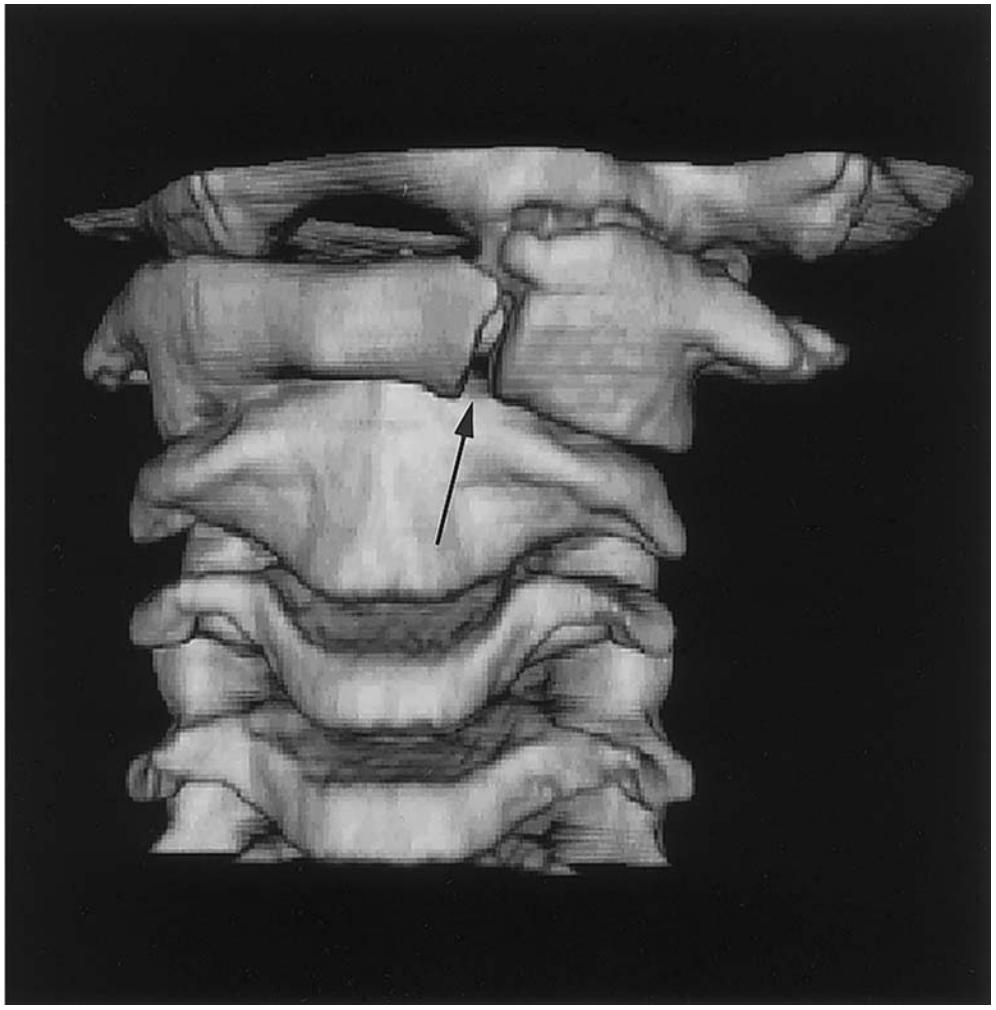
Figure 16b. Axial CT scan through C1 (a) and three-dimensional (3D) reformatted CT scan of the upper cervical spine (b) obtained in a 6-year-old boy show anterior and posterior ring fractures of C1 (arrows).



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Lateral radiograph (a) and sagittal T1-weighted MR image (b) of the cervical spine show bilateral facet dislocations of C4 on C5 (arrow).

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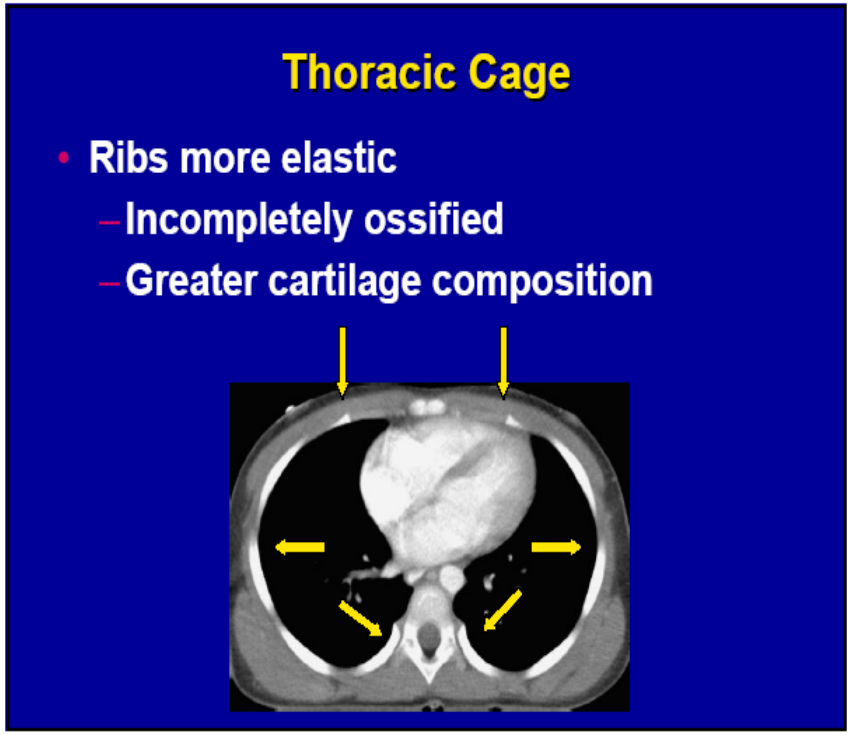
Physical Differences in Children

- A child's ribs are more flexible than those of adults, therefore intra-thoracic organ damage from compression was more common than rib fracture
- pulmonary contusion, ARDS might be developed without any rib fracture.



Physical Differences in Children

- Toddlers and preschool children are more likely to suffer a higher incidence of intra-abdominal organ injuries because their liver and spleen are not as protected by the rib cage as they will be later in life.
  - Liver is not covered by the rib cage.
  - Less muscle mass to abdominal wall.
  - Less subQ tissue to absorb the injury.

Metabolic Differences in Kids

- Children have a higher metabolic rate
- Children "shock out" differently
  - Children compensate better initially
    - May show minimal signs and symptoms.
  - Children have less reserves than adults
    - *Platinum half-hour* in trauma resuscitation
    - Rapid intervention critical
    - Once reserves are exhausted, Bad Things Happen

Implication for motorcycle safety

- Because of infants' immature neuro-behavioural development, parents or caretakers should assume full responsibility for children on motorcycle.

- In most developing countries, infants can be carried on motorcycles.
  - They were carried by the driver or another passenger.
  - Some who were around one year of age sat in front of driver
  - Some sat or stood between the driver and the passenger.

Learning from bicycle safety recommendation

- Learning from bicycle safety recommendation in several developed countries, infants are not allowed to be carried on by the two main reasons.

- First, even bike seats for children have been developed and commonly used, but it is not recommended for infants because infants are just learning to sit unsupported at about 9 months of age and they have not developed sufficient bone mass and muscle tone to enable them to sit unsupported with their backs straight.

- Second, even helmets have been proved to prevent or lessen the severity of brain injury during a bicycle crash and produced in soft shell-light-small sizes for correctly placing and securing on the infants' head, but increasing head mass by helmet would increase risks for cervical spine fracture because of relatively large heads and poorly developed neck and upper body musculature of infants, compounded by incomplete growth of their cervical vertebrae.

- For bicycle safety, the American Academy of Pediatrics recommended that children under age 1 should not be passengers on a bicycle under any circumstance. (AAP, TIPP-The injury prevetion program: about bicycle helmet, 1994)
- The U.S. Consumer Product Safety Commission agrees that children under 1 year of age should not be on bicycles. (CPSC, 1998)

New York's bicycle safety law

- **"1238. Passengers on bicycles under one year of age prohibited; passengers and operators under fourteen years of age to wear protective headgear**
- ***1. No person operating a bicycle shall allow a person who is under one year of age to ride as a passenger on a bicycle nor shall such person be carried in a pack fastened to the operator.***

Georgia bicycle safety law

- "(c) No person shall transport a child under the age of one year as a passenger on a bicycle on a highway, roadway, bicycle path, or sidewalk; provided, however, ***that a child under the age of one year may be transported on a bicycle trailer or in an infant sling so long as such child is seated in the bicycle trailer or carried in an infant sling according to the bicycle trailer's or infant sling's manufacturer's instructions***

EU recommendation on child seat for bike

- For EU recommendation, children should not be carried unless they are within the weight range for the seat and they can sit up unaided for at least the length of the cycle journey.
- EU standard applies to seats for the transport of children, weighing from 9 up to 22 kg.
- This more or less corresponds to the age group of 9 months up to 5 years, provided that the child is capable of sitting unaided. They should no longer be carried in the seat when they are above the maximum weight. (ETRA, 2009)

What should it be recommended for developing countries?

Motorcycle related lower limb injuries and motorcycle spoke injuries

- Lower limb injuries have been identified as a common form of injury among motorcycle riders involved in traffic accident.
- Lower limb injuries often lead to extended and costly medical treatment and permanent disability.

- The study from developed countries, legs and feet are also common site of injury among children under 15 years on motorcycle.
- The study from Victorian Injury Surveillance System between 1989 and 1993 found that 43% of injuries involved the legs and feet. (Virginia Routley, 1994)
- The study in Singapore found that of the 1,809 motorcyclists studied, 1,056 (58.3%) sustained lower limb injuries. (Lateef F, 2002)

- The study in Pakistan to determine the spectrum and severity of injuries seen in child passengers, who get their feet entangled in the spokes of bicycle and motorcycle wheels, including 92 consecutive patients, found that the average age was 3.9 years, (Safdar CA, 2005)
  - 80 children had their injury while riding a bicycle,
  - the rest had their feet entangled in motorcycle spokes.
  - Motorcycle injuries caused more severe than bicycle.

- Bicycle spoke injuries were found 1:15 in general population.
- MC : BC spoke injuries = 1:8

Leg and foot entrapment

- ก่อนเกิดเหตุนายสุทินได้พาครอบครัว ซึ่งประกอบด้วยนายสุทิน นางบุญมา ลูกสาว และลูกชาย ไปทำบุญตักบาตร ที่วัดดอนตะโก โดยนางบุญมา ซึ่งเป็นแม่ของเด็ก จะอุ้มลูกน้อยซ้อนท้าย
- แต่ครั้งนี้ไม่ทราบว่าผ้าขนหนูที่ใช้ห่อตัวทารกน้อยนั้น หลุดลงไปพันกับโซ่รถได้อย่างไร จึงทำให้โซ่ดึงตัวทารกหลุดจากมือแม่ แล้วเข้าไปติดกับโซ่รถทันที ทำให้รถหยุดอย่างกระทันหัน โดยทั้งสองคนพยายามที่จะช่วยดึงลูกออกมา
- ในเบื้องต้นนั้นเด็กต้องถูกตัดขาขวาออกไป

เจ้าหน้าที่ช่วยเหลือ ด.ช.รณเกรียง บุญเกื้อ หนูน้อย เคราะห์ร้ายวัย เดือนเศษ หลังแม่พาไปนั่งซ้อนท้าย รถจยย.พ่อแล้วผ้าขนหนูหลุด เข้าไปในโซ่ ถูกเฟืองโซ่พันผ้าดึงร่าง เข้าไปติด อยู่ในล้อขาขวาขาดสะบั้นอาการปางตาย.

Children as Pillion

The Story:

6 year old boy riding as a pillion with his father who is a driver on the freeway around 100km/h. Suddenly he shrieked, shouted to stop the bike, and his body pulled to the left of the bike as if he was getting off. His father grabbed him with his left hand and stop the bike safely with no clutch hand.

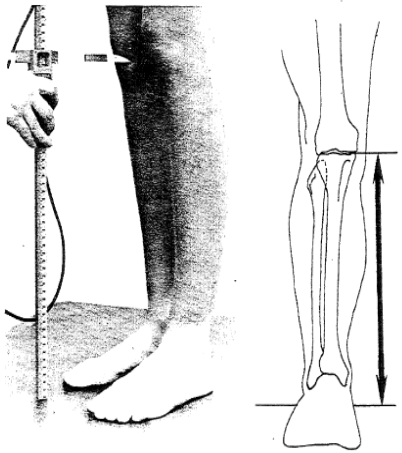
Boot was entrapped between the tyre and the chain with the chain guard. The hard rubber and leather of the boot prevented the tyre and chain from "Grabbing" the child shoe/foot. Severe burn and soft tissue damage to toe area where the Chain rubbed against the Boot!!

Lesson learnt:

The advice when considering riding with a child as a passenger:

- Child must be stable on the Bike
- Specific training course for the driver to ride with a passenger, and a child passenger
- Educate the Pillion: this is a responsibility of driver and should be done by the knowledgeable driver who passed the specific training course of "Riding with as passenger"

Tibial height (Snyder RG, 1977)



TIBIALE HEIGHT (cm)
(Males and Females)

Age (yrs)	N	Mean	s.d.	Min	5th	50th	95th	Max
2.0-3.5	67	22.3	1.9	17.7	18.8	22.3	25.0	27.1
3.5-4.5	79	24.0	1.9	20.4	20.8	23.8	27.4	28.1
4.5-5.5	76	26.4	1.8	22.5	22.7	26.2	29.1	30.2
5.5-6.5	77	28.9	1.9	23.7	25.7	28.6	31.6	34.9
6.5-7.5	76	31.2	2.2	26.1	27.6	31.0	34.7	37.1
7.5-8.5	64	32.6	2.1	26.5	29.3	32.7	36.0	37.8
8.5-9.5	81	34.8	2.0	29.0	31.0	35.0	37.8	39.4
9.5-10.5	74	36.4	2.3	31.8	32.7	36.1	39.8	43.0
10.5-11.5	97	38.1	2.5	31.6	34.0	37.8	42.3	43.4
11.5-12.5	95	40.0	2.7	32.8	35.6	39.8	44.7	47.0
12.5-13.5	100	41.3	2.9	34.0	37.0	40.9	45.9	50.2
13.5-14.5	82	42.1	2.8	33.0	37.3	42.1	45.9	48.0
14.5-15.5	87	42.9	2.6	36.0	38.5	42.7	47.2	47.9
15.5-16.5	63	44.1	3.4	37.5	39.0	44.5	48.6	52.4
16.5-17.5	73	44.0	3.1	37.4	38.4	44.0	48.6	49.9
17.5-19.0	46	44.2	3.9	37.4	38.5	43.5	50.7	55.5

Motorcycle regulation for child pillion in some specific countries

Country	Motorcycle/Scooter	Sidecar
Austria	**Minimum 12 years** Feet must reach foot peg and handles.	**No age limit** Small kids under 12 must have child seat safely fitted. Tall kids under 12 must wear a seat belt. The sides of the sidecar must be at kid's chest height. 2 children at the same time is permitted.
Belgium	**Minimum 3 years** Kid must wear approved helmet. Feet must reach foot pegs.	**Minimum 3 years** Children between 3 and 12 years must sit in a special kids seat and use safety belt if available
Czech Republic	**Minimum 12 years** Kid must wear approved helmet. Feet must reach foot pegs.	**No restrictions or limits**

France	**No age limit** You are allowed to carry only 1 child. Kid must wear approved helmet. Children under 5 must use approved seat incorporating handles and foot pegs. Children above 5 must reach foot pegs.	**No age limit** Maximum 2 children if approved by the manufacturer. Must use safety belt if there is one and wear an approved helmet.
Greece	**No age limit**	**No age limit**
Germany	**No age limit** Children under 7 must use special seat. Must wear a helmet, but it does not need to be approved.	**No age limit** Must wear a helmet, but it does not need to be approved.
Ireland	**No age limit** Kid must wear approved helmet.	**No age limit** Kid must wear approved helmet.

Recommendations for safe passenger

- Do not transport children under 1 year on motorcycle
- Child passenger aged of 1-5 years or weight 9 to 18 kg should be transported in a child seat mounted above the rear wheel, behind the driver.

Child seat?? Needed research from corporation

- The child passenger aged of 1-5 years should always be belted into the child seat.
- The child seat should include spoke protectors for the child's feet.
- The back of the seat should be high enough to provide adequate head support for the child.
- The seat should be designed to protect head from laterally projected forces when the motorcycle falls over.

If no a new designed MC child seat..

- Using motor-tricycle as a safer mode instead of motorcycle, child passenger aged of 1-5 years or weight 9 to 18 kg could be transported in a protective passenger room with a child seat and a crash-tested helmet.

- If no any new invented
- Corporation should take role to prevent a child under 6 on motorcycle
  - Prohibit any marketing to promote MC as a mode of transportation for a child under 6 or for family uses
  - Invest to change consumer life style to stop using MC for children under 6 by several strategies