

Pediatric Spinal Cord Injury

Trauma Management for Rural EMS and Community Hospitals
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1

Disclosures

- Nothing to disclose

2

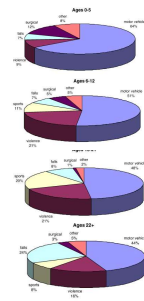
Learning Objectives

- Identify differences in the pediatric population with spinal cord injury
- Learn how to best fit a rigid c-collar on a pediatric patient
- Recognize SCIWORA and describe why this occurs

3

Epidemiology

- Pediatric Spinal cord injury (SCI) after trauma is relatively uncommon
 - Contributes 1-10% of all SCI
- Majority: Age 15-18 year old, M>F
- Mechanism:
 - Most common: MVC
 - Others: birth-related injury, sport-related, falls, NAT, GSW
- Most common location:
 - Cervical spine: 60-80%
 - Thoracolumbar spine: 5-30%



Reisman D et al. "Pediatric Spinal Cord Injury: Clinical and Pathologic Correlations." 2010. New York, NY: Springer; 2010. 100-101.

4

Anatomy

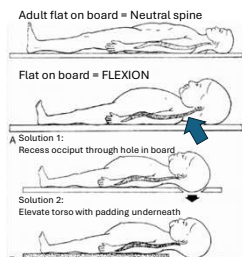
- Maturation of the pediatric spine results in changes over time
 - Significant anatomical and biomechanical differences
- Infants:
 - Increased mobility / elasticity, underdeveloped neck muscles, incompletely calcified bones, large head size
 - more likely to have **high cervical injury**
- Older children:
 - Maturation starts at upper c-spine and progresses down, usually completed by ~14 yo
 - more likely to have **lower cervical injury**
- Multiple imaging modalities may be needed to evaluate
 - X-ray, CT, MRI

Bookman D. "Pediatric Spinal Trauma." Handbook of Pediatric Neurosurgery (2010) Thieme, New York, 2010. 200-201.

5

Initial Management

- Initial evaluation:
 - All patients should be assumed to have a SCI until proven otherwise
 - Immobilization in a hard collar and back board
 - Strict logroll precautions, minimize spine manipulation
- Trauma ABCs and Neuro exam
 - Palpation of entire spine to detect any bony "step off" or point tenderness






Reisman D et al. "Pediatric Spinal Trauma." Handbook of Pediatric Neurosurgery (2010) Thieme, New York, 2010. 200-201.

6

Fitting a child in a cervical collar

- Is the chin supported?
- Are the ears free?
- Do the front and back parts overlap?

Wrong fit: Too Small Too Large

Size	Age	Weight	Height
PS1	1-18 months	10-20 lbs	24-30 in
PS2	18-24 months	20-30 lbs	30-36 in
PS3	2-3 years	30-40 lbs	36-42 in
PS4	3-4 years	40-50 lbs	42-48 in
PS5	4-5 years	50-60 lbs	48-54 in
PS6	5-6 years	60-70 lbs	54-60 in
PS7	6-7 years	70-80 lbs	60-66 in
PS8	7-8 years	80-90 lbs	66-72 in
PS9	8-9 years	90-100 lbs	72-78 in
PS10	9-10 years	100-110 lbs	78-84 in
PS11	11-12 years	110-120 lbs	84-90 in
PS12	12-13 years	120-130 lbs	90-96 in
PS13	13-14 years	130-140 lbs	96-102 in
PS14	14-15 years	140-150 lbs	102-108 in
PS15	15-16 years	150-160 lbs	108-114 in
PS16	16-17 years	160-170 lbs	114-120 in
PS17	17-18 years	170-180 lbs	120-126 in
PS18	18-19 years	180-190 lbs	126-132 in
PS19	19-20 years	190-200 lbs	132-138 in
PS20	20-21 years	200-210 lbs	138-144 in
PS21	21-22 years	210-220 lbs	144-150 in
PS22	22-23 years	220-230 lbs	150-156 in
PS23	23-24 years	230-240 lbs	156-162 in
PS24	24-25 years	240-250 lbs	162-168 in
PS25	25-26 years	250-260 lbs	168-174 in
PS26	26-27 years	260-270 lbs	174-180 in
PS27	27-28 years	270-280 lbs	180-186 in
PS28	28-29 years	280-290 lbs	186-192 in
PS29	29-30 years	290-300 lbs	192-198 in
PS30	30-31 years	300-310 lbs	198-204 in
PS31	31-32 years	310-320 lbs	204-210 in
PS32	32-33 years	320-330 lbs	210-216 in
PS33	33-34 years	330-340 lbs	216-222 in
PS34	34-35 years	340-350 lbs	222-228 in
PS35	35-36 years	350-360 lbs	228-234 in
PS36	36-37 years	360-370 lbs	234-240 in
PS37	37-38 years	370-380 lbs	240-246 in
PS38	38-39 years	380-390 lbs	246-252 in
PS39	39-40 years	390-400 lbs	252-258 in
PS40	40-41 years	400-410 lbs	258-264 in
PS41	41-42 years	410-420 lbs	264-270 in
PS42	42-43 years	420-430 lbs	270-276 in
PS43	43-44 years	430-440 lbs	276-282 in
PS44	44-45 years	440-450 lbs	282-288 in
PS45	45-46 years	450-460 lbs	288-294 in
PS46	46-47 years	460-470 lbs	294-300 in
PS47	47-48 years	470-480 lbs	300-306 in
PS48	48-49 years	480-490 lbs	306-312 in
PS49	49-50 years	490-500 lbs	312-318 in
PS50	50-51 years	500-510 lbs	318-324 in
PS51	51-52 years	510-520 lbs	324-330 in
PS52	52-53 years	520-530 lbs	330-336 in
PS53	53-54 years	530-540 lbs	336-342 in
PS54	54-55 years	540-550 lbs	342-348 in
PS55	55-56 years	550-560 lbs	348-354 in
PS56	56-57 years	560-570 lbs	354-360 in
PS57	57-58 years	570-580 lbs	360-366 in
PS58	58-59 years	580-590 lbs	366-372 in
PS59	59-60 years	590-600 lbs	372-378 in
PS60	60-61 years	600-610 lbs	378-384 in
PS61	61-62 years	610-620 lbs	384-390 in
PS62	62-63 years	620-630 lbs	390-396 in
PS63	63-64 years	630-640 lbs	396-402 in
PS64	64-65 years	640-650 lbs	402-408 in
PS65	65-66 years	650-660 lbs	408-414 in
PS66	66-67 years	660-670 lbs	414-420 in
PS67	67-68 years	670-680 lbs	420-426 in
PS68	68-69 years	680-690 lbs	426-432 in
PS69	69-70 years	690-700 lbs	432-438 in
PS70	70-71 years	700-710 lbs	438-444 in
PS71	71-72 years	710-720 lbs	444-450 in
PS72	72-73 years	720-730 lbs	450-456 in
PS73	73-74 years	730-740 lbs	456-462 in
PS74	74-75 years	740-750 lbs	462-468 in
PS75	75-76 years	750-760 lbs	468-474 in
PS76	76-77 years	760-770 lbs	474-480 in
PS77	77-78 years	770-780 lbs	480-486 in
PS78	78-79 years	780-790 lbs	486-492 in
PS79	79-80 years	790-800 lbs	492-498 in
PS80	80-81 years	800-810 lbs	498-504 in
PS81	81-82 years	810-820 lbs	504-510 in
PS82	82-83 years	820-830 lbs	510-516 in
PS83	83-84 years	830-840 lbs	516-522 in
PS84	84-85 years	840-850 lbs	522-528 in
PS85	85-86 years	850-860 lbs	528-534 in
PS86	86-87 years	860-870 lbs	534-540 in
PS87	87-88 years	870-880 lbs	540-546 in
PS88	88-89 years	880-890 lbs	546-552 in
PS89	89-90 years	890-900 lbs	552-558 in
PS90	90-91 years	900-910 lbs	558-564 in
PS91	91-92 years	910-920 lbs	564-570 in
PS92	92-93 years	920-930 lbs	570-576 in
PS93	93-94 years	930-940 lbs	576-582 in
PS94	94-95 years	940-950 lbs	582-588 in
PS95	95-96 years	950-960 lbs	588-594 in
PS96	96-97 years	960-970 lbs	594-600 in
PS97	97-98 years	970-980 lbs	600-606 in
PS98	98-99 years	980-990 lbs	606-612 in
PS99	99-100 years	990-1000 lbs	612-618 in
PS100	100-101 years	1000-1010 lbs	618-624 in

Aspen Pediatric Line Sizing Guide

1. Proper fit: The collar should be snug but not tight. The front and back parts should not overlap. The chin should be supported. The ears should be free.

2. Wrong fit: Too Small. The front and back parts overlap. The chin is not supported. The ears are not free.

3. Wrong fit: Too Large. The front and back parts overlap. The chin is not supported. The ears are not free.

7

Different injuries that occur

- SCI patterns that occur in the pediatric population:
 - SCIWORA
 - Atlanto-Occipital dislocation
 - Atlanto-axial Rotatory subluxation

8

SCIWORA

- Spinal Cord Injury Without Radiographic Abnormality
 - Wide range of incidence due to differences in reporting: 5-70% (~20%)
- The pediatric spine is hypermobile compared to the adult
 - Able to move without sustaining damage
 - Movement is at the expense of protective function to the spinal cord
 - Movement results in stretch / compression on spinal cord resulting in symptoms
- Proportionally large head mismatched against neck musculature
 - Predisposed to wider swings when subjected to similar external forces

Reimann, D. "Pediatric Spinal Trauma." *Handbook of Pediatric Neurosurgery* (2015). Thieme, New York, 2016. 286.

9

SCIWORA

- Radiographic evaluation:
 - Patients will likely need CT and MRI scans of the spine as soon as feasible
 - Need to rule out any potentially causative injury
 - However, SCIWORA will have normal imaging across all modalities
- Treatment:
 - Immobilization, activity restriction → prevent another SCI

Peng D and Shao S "Spinal Cord Injury Without Radiographic Abnormality (SCIWORA) in Children" *Textbook of Pediatric Neurosurgery*, (2020) Springer Nature Switzerland, Vol 5, Ch 151, p 2852-2862

10

Atlanto-Occipital Dislocation

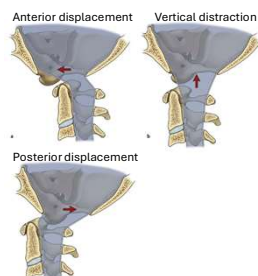
- Traumatic disruption of the structures responsible for stability between the skull and C1
- Most common etiology: high energy impact
 - MVC, bicyclist / pedestrian vs. car, sports related (football, horseback riding), boat accidents, hanging
- Overall uncommon cause of SCI
- Due to high SCI location, patient have high risk of mortality
 - Overall incidence probably underreported

Wang YJ and Peng D "Traumatic Atlanto-Occipital Dislocation in Children" *Textbook of Pediatric Neurosurgery*, (2020) Springer Nature Switzerland, Vol 5, Ch 152, p 2863-2865

11

Atlanto-Occipital Dislocation

- Initial management similar: spinal precautions, thorough imaging
 - Avoid any traction on the head
- Imaging findings:
 - CT: widening of the joint space between occiput and C1
 - MRI: ligamentous injury or hematomas between occiput and C1
- Treatment:
 - Occiput-cervical fusion (at least O-C1-C2)

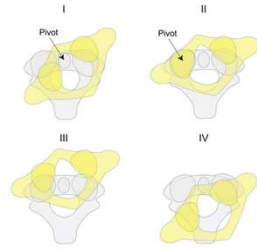


Wang YJ and Peng D "Traumatic Atlanto-Occipital Dislocation in Children" *Textbook of Pediatric Neurosurgery*, (2020) Springer Nature Switzerland, Vol 5, Ch 152, p 2863-2865

12

Atlantoaxial Rotatory Subluxation

- Rotational injury at C1-C2
 - C1/2 allow ~ 45 deg rotation, "center of mobility" = high risk for instability
- Symptoms:
 - Neck pain, often neurologically intact
 - Torticollis / head tilt → difficult to correct to midline
- Treatment:
 - Depending on the type
 - Reduction → immobilization +/- fusion



Goal: A "Torticollis and rotary atlantoaxial subluxation: A Clinical Review" J Orthopaedic Research Society (2019) 10(2): 17-27.
Figure: Aortic B "Torticollis and rotary atlantoaxial subluxation: Type IIa" Neurospine.org (2019) <https://doi.org/10.1007/s00067-019-00000-0> and <https://doi.org/10.1007/s00067-019-00000-0>

13

Conclusions

- Assume trauma patients have a SCI until proven otherwise
- Pediatric patients require different positioning on a backboard because of their larger head size
- It's important to have the appropriate fit of a rigid cervical collar in a pediatric patient
- There are anatomic differences in the anatomy of the cervical spine in the pediatric population that predisposes these patients to a different pattern of injury compared to adults

14

Thank you!

- Any Questions?

15

References

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- Figure: Yashar M et al "Injuries to the Cervical spine (2016) <https://neuropsychkey.com/injuries-to-the-cervical-spine/#f0035>
- Goel A "Torticollis and rotatory atlantoaxial dislocation: A Clinical Review" J Craniovertebr Junction Spine (2019) 10(2): 77-87.
- Figure: Amini B "Fielding and Hawkins classification of atlantoaxial rotatory subluxation. Case study" Radiopaedia.org (2016) <https://radiopaedia.org/cases/fielding-and-hawkins-classification-of-atlantoaxial-rotatory-subluxation>
