

NeuroAxial Notes

CNMC Anesthesiology Grand Rounds

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⌚ github.com/aki-repo/Talks

INTRO
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EPIDURALS
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CAUDALS
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VARIATION
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Disclosures

Learning Objectives

- The case for confirmation
- Safety
- HowTo single injection caudals

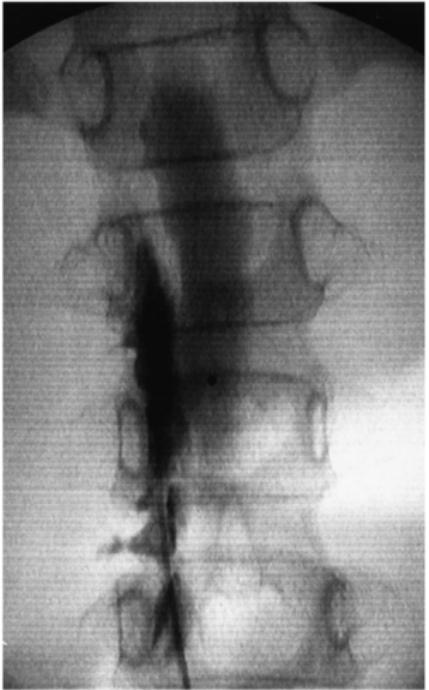


FIGURE 2. Anterior-posterior epidurogram with visualization of epidural catheter and epidural spread of contrast dye on the left and intrathecal spread of contrast (partial myelogram) due to malignant tumor breaking the integrity of the dura.

Andreas H. Taenzer; Inadvertent Spinal Anesthesia during Continuous Epidural Anesthesia in an Infant. *Anesthesiology* 2003; 98:1014–1015

Pediatric Anesthesia

Thoracic epidural catheters placed by the caudal route in infants: the importance of radiographic confirmation[†]

SONGYOS VALAIRUCHA MD , CHRISTIAN SEEFFELDER MD , CONSTANCE S. HOUCK MD

- retrospective chart review of caudal to thoracic catheters (n=86)
- 28/86 (32%) inadequate position
- 10/86 (12%) were high thoracic or cervical (and pulled back)
- 17/86 (20%) coiled lumbosacral, of which 15 were replaced
- 1/86 not in epidural space (sacral)
- no association with age, weight, type of catheter

Epidurograms for epidural catheters

ORIGINAL ARTICLE

Experience With 724 Epidurograms for Epidural Catheter Placement in Pediatric Anesthesia

Andreas H. Taenzer, MD, MS, FAAP, Cantwell Clark V, MD, MS,* and W. Daniel Kovarik, MD, FAAP†*

Results: Of a total of 724 epidurograms, 45.8% were caudal catheters, 9.6% were lumbar catheters, and 32.3% were thoracic catheters.

Epidurograms detected 12 (1.6%) unexpected misplacements: 4 were intrathecal, 3 were intravenous, and 3 were intraperitoneal.

Reg Anesth Pain Med 2010;35: 432-35

HowTo

TABLE 1. Iodine Concentration and Age

Age	<1 y	1–3 y	>3 y
Recommended iodine concentration (mg/mL), eg, Omnipaque for epidurography by authors	180	180 lumbar 240 thoracic	240
Recommended maximum doses of iodine for myelography (g)	0.36–0.72	0.72–1.44	0.9–1.8

0.5 - 1.5 ml

contrast

- confirms correct level
- confirms correct anatomic location
- rules out intravascular
- predicts analgesic efficacy

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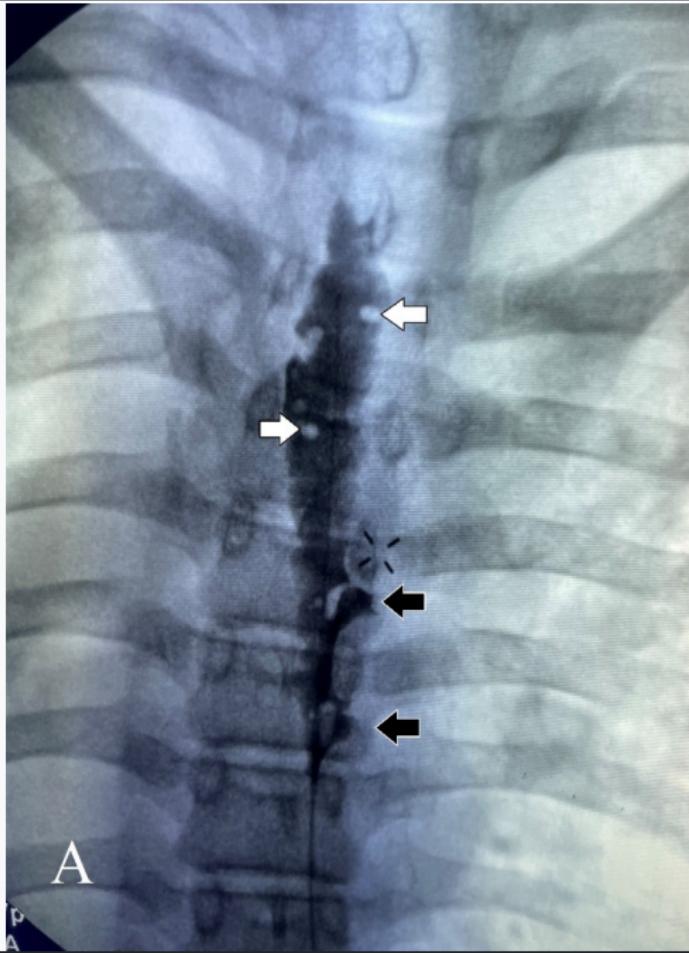
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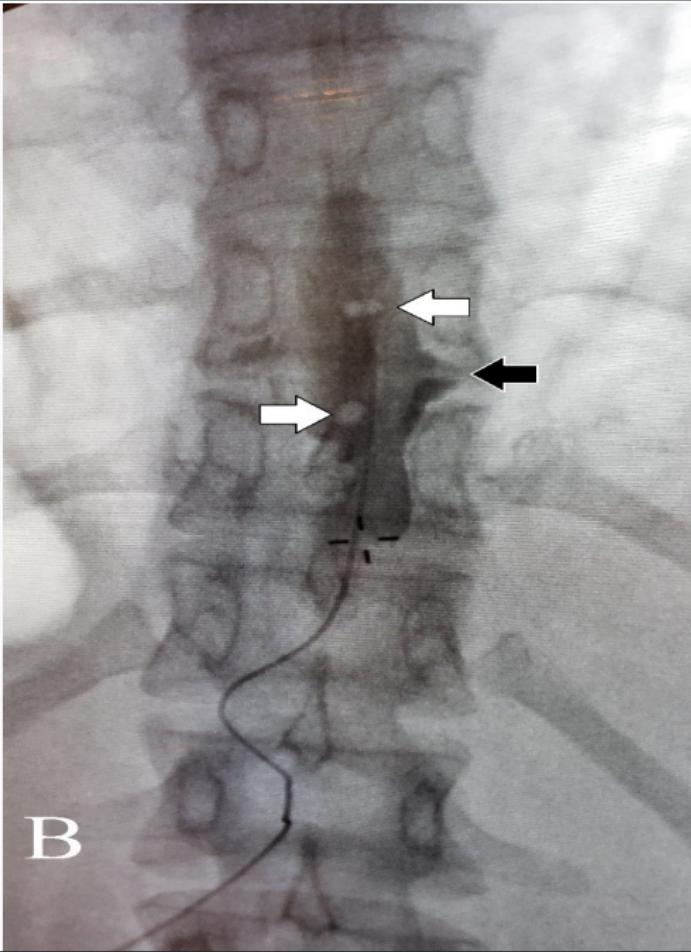
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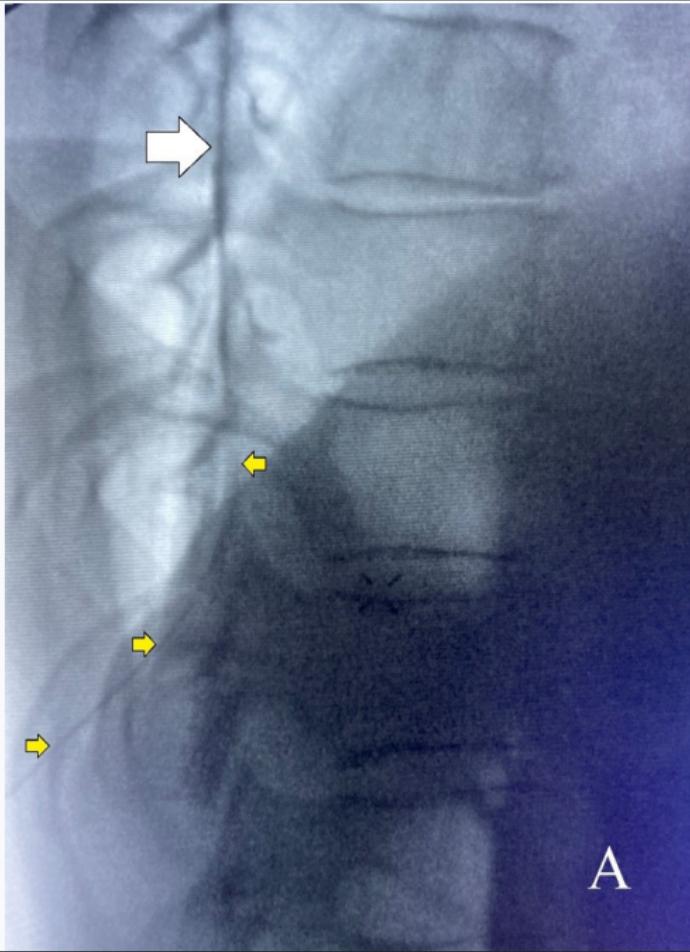
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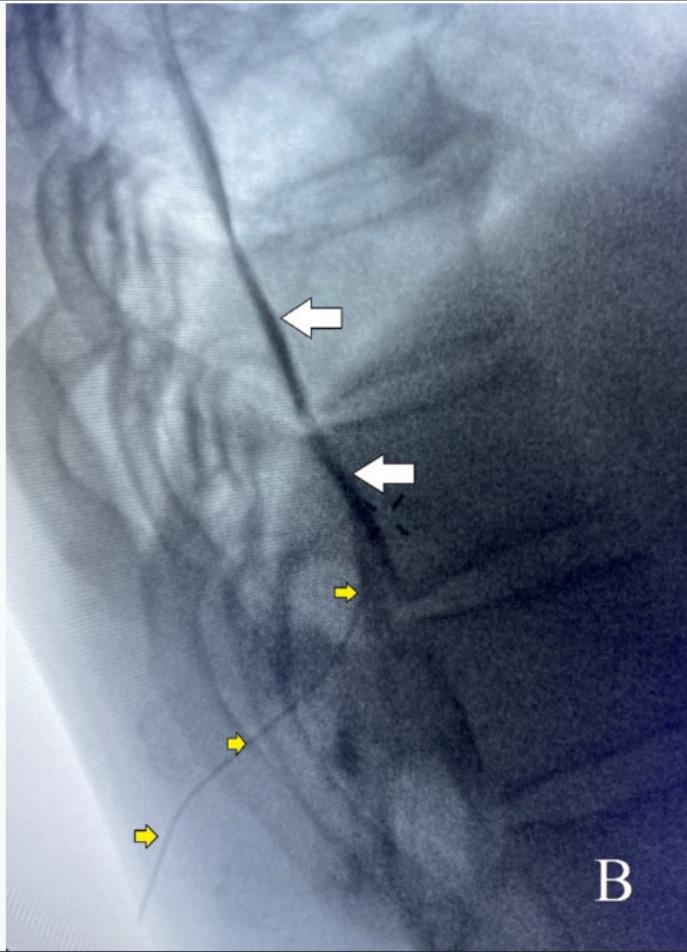
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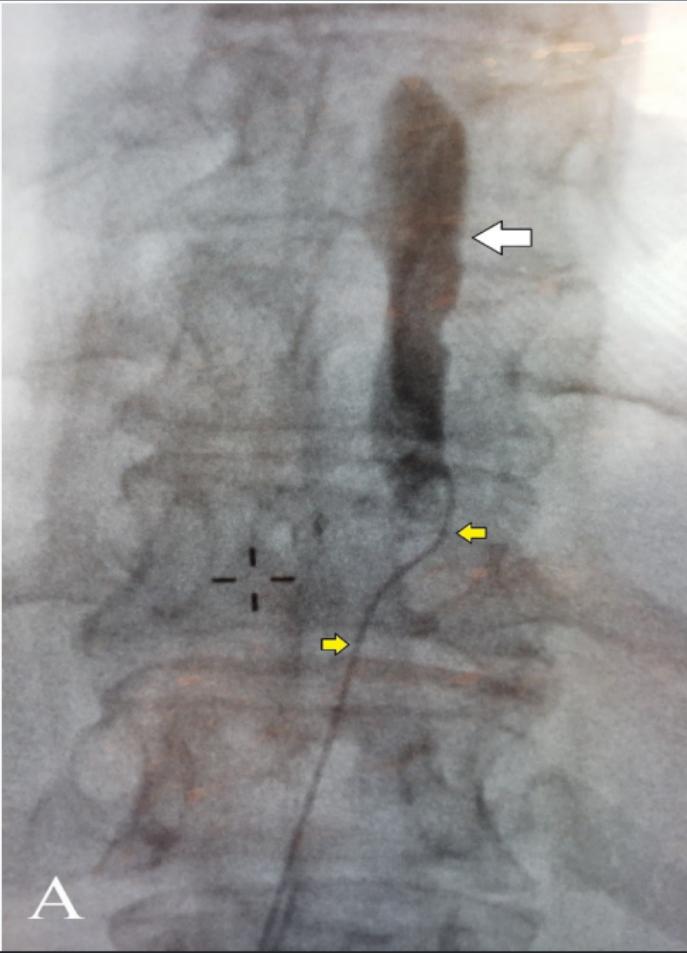
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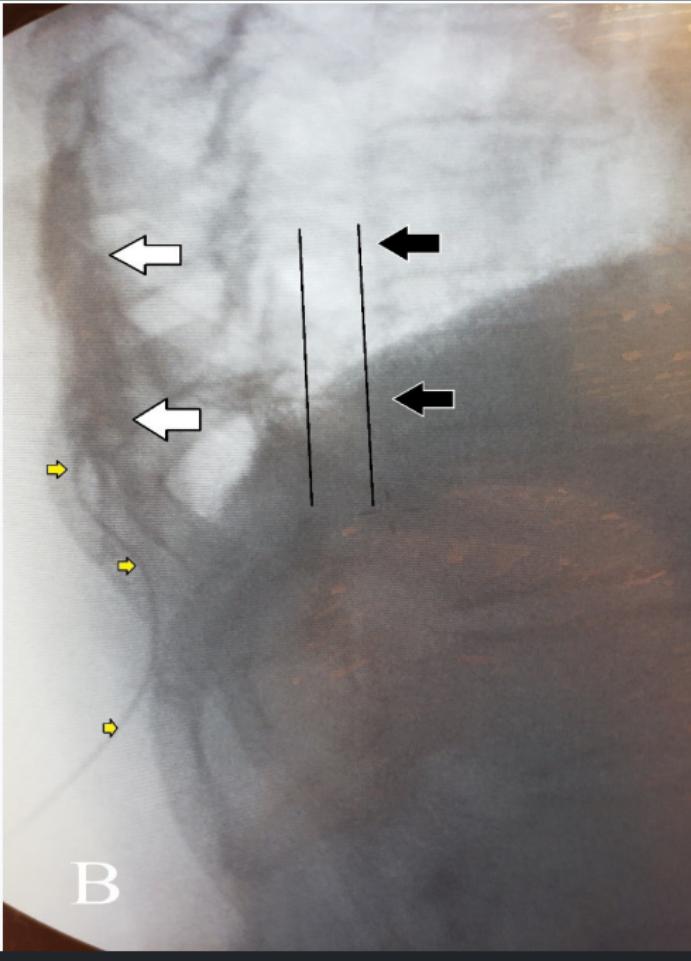
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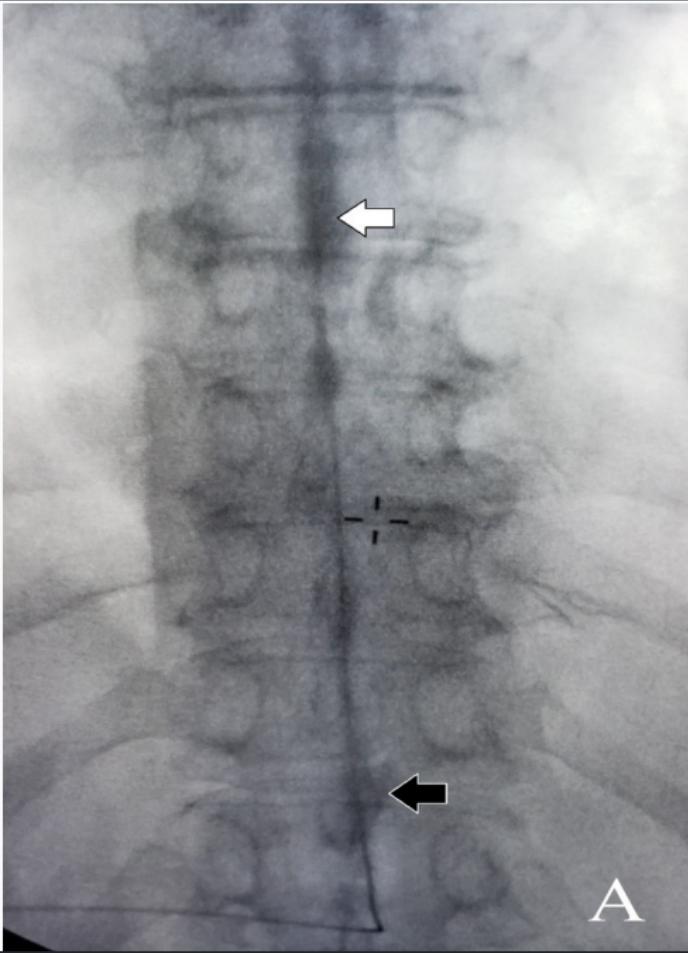
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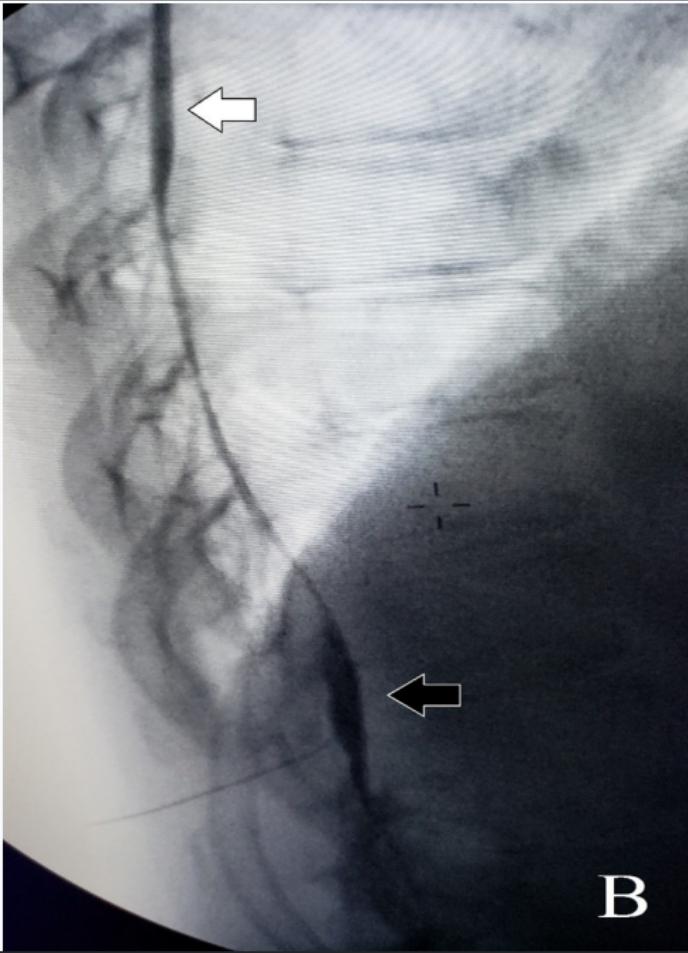
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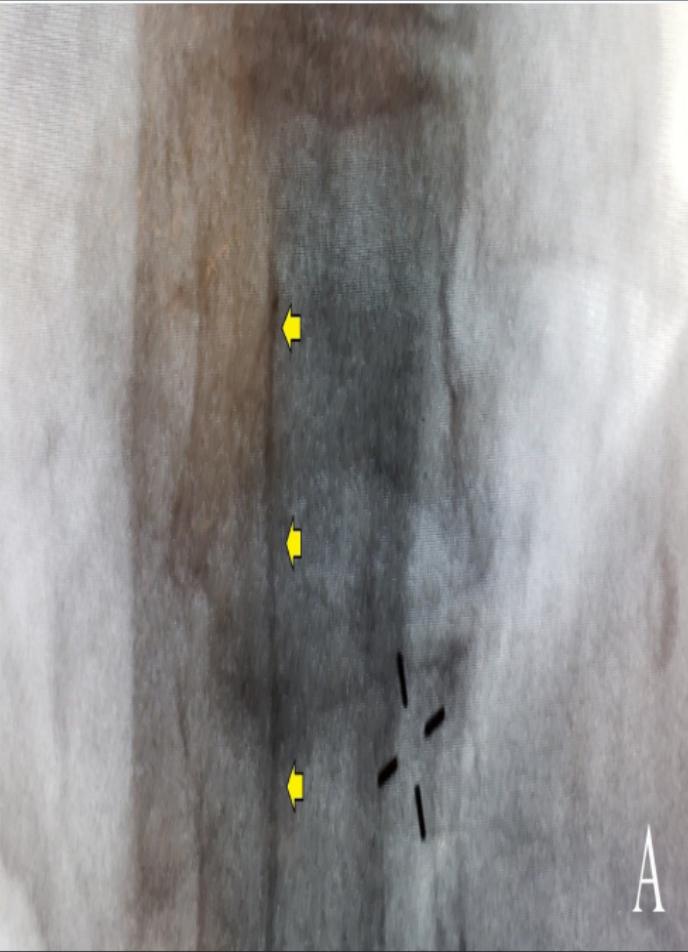
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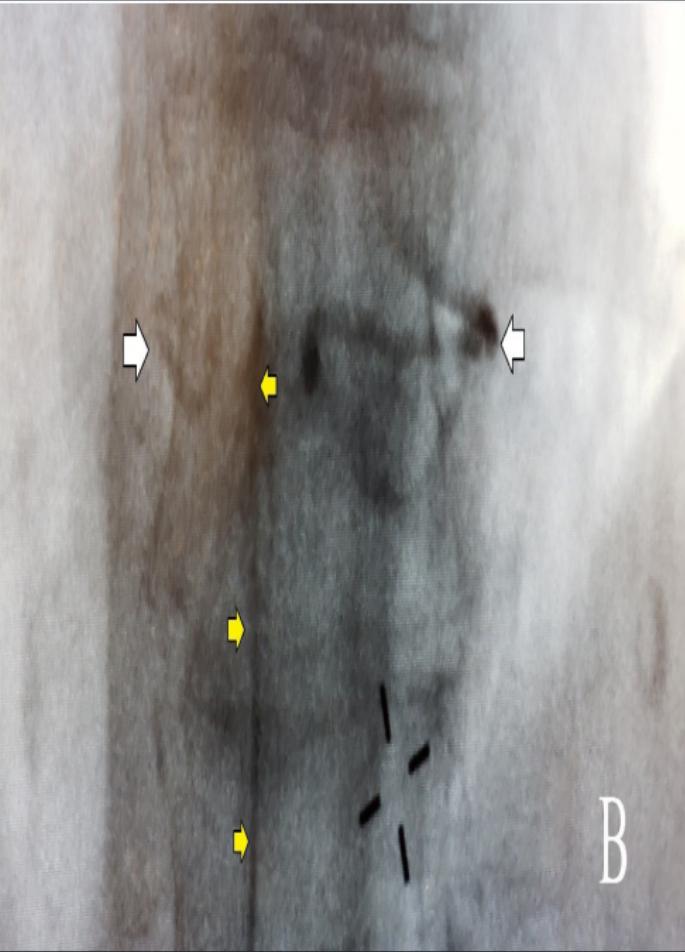
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"We present a 4-week-old, formerly preterm, 2.2-kg neonate who developed apnea after a bolus dose of the local anesthetic agent, 2-chloroprocaine, and was administered into a thoracic epidural catheter. Further investigation revealed the tip of the epidural catheter at a higher level than intended which resulted in a transient high motor blockade and apnea."

Mathias J, Couser D, Martin DP, Tobias JD. Postoperative Apnea in a Neonate Following an Epidural Bolus Dose Through a High Thoracic Epidural Catheter. J Med Cases. 2021 Dec;12(12):485-490. doi: 10.14740/jmc3814. Epub 2021 Dec 2. PMID: 34970371; PMCID: PMC8683109.

Summary

Standard of Care

Standard Practice at many Children's Hospitals.

Solid Documentation of 20-40% failure rate in children and adults.

You are giving a potentially life threatening toxic drug w/o knowing where it goes?

Not doing it does not align with standard medical practice anymore.

Just do it

It creates buy-in and support from nursing staff and surgical colleagues.

It increases job satisfaction for you and your pain team.

- history
- anatomy
- HowTo
- US and dermatomes
- Gaps



History

- originally described 1933 for cystos
- 1951 series of 6,500 children
- revived in the late 80s

Ecoffey C, Dubousset AM, Samii K. Lumbar and thoracic epidural anesthesia for urologic and upper abdominal surgery in infants and children. *Anesthesiology*. 1986;65:87–90.

Murat I, Delleur MM, Esteve C, Egu JF, Raynaud P, Saint-Maurice C. Continuous extradural anaesthesia in children. Clinical and haemodynamic implications. *Br J Anaesth*. 1987;59:1441–50.

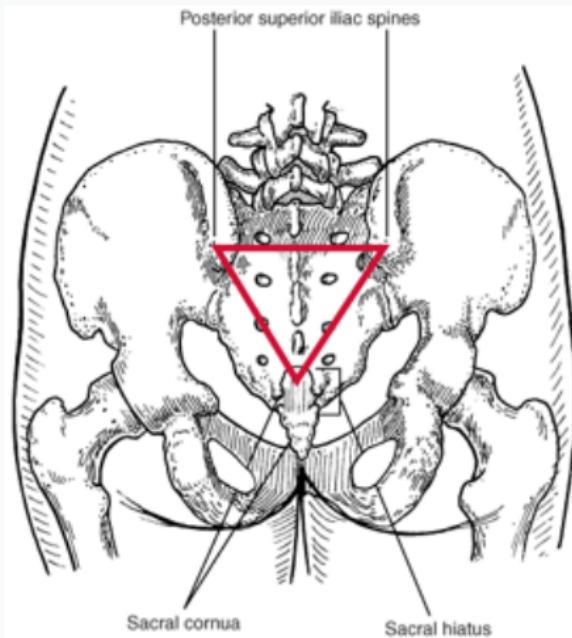
Hannallah RS, Broadman LM, Belman AB, Abramowitz MD, Epstein BS. Comparison of caudal and ilioinguinal/iliohypogastric nerve blocks for control of post-orchiopexy pain in pediatric ambulatory surgery. *Anesthesiology* 1987;66(6):832-834.

Anatomy

- Large variation in sacral anatomy independent of gender and ethnic background.
- The antero-posterior depth of the sacral canal may vary from less than 2 mm to greater than 1 cm (adults).
- Individuals with sacral canals having antero-posterior diameters less than about 3 mm may not be able to accommodate anything larger than a 21-gauge needle (5% of the population in adults)
- The median volumes of the epidural space per vertebral segment were:
Thoracic: 0.60 ml (95%CI 0.38-0.75); Lumbar: 1.18 ml (95%CI 0.94-1.43) and Caudal: 0.85 ml (95%CI 0.56-1.18).

J Forestier, P Castillo, T Finnbogason, M Lundblad, S Eksborg, P A Lönnqvist, Volumes of the spinal canal and caudal space in children zero to three years of age assessed by magnetic resonance imaging: implications for volume dosage of caudal blockade, BJA: British Journal of Anaesthesia, Volume 119, Issue 5, November 2017, Pages 972-978

How to find the hiatus?



- Do Not find the cornua!
- Instead palpate the hiatus directly.
- Left - Right (laterally). Hard ridge.

Ultrasound - Long Axis

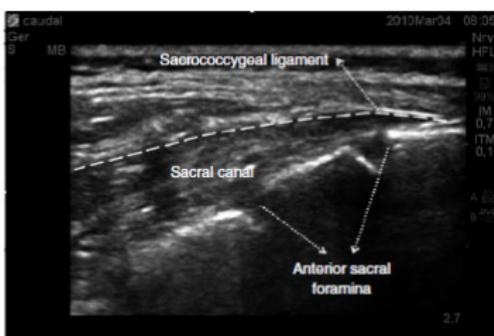
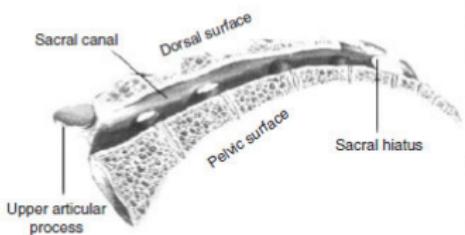


Figure 3 – Anatomical Illustration of the Sacral Canal and the Longitudinal Ultrasound View of the Sacral Canal.

Anaesthesia, 2006, 61, pages 946–949

J. H. Park *et al.* • Optimum caudal needle angle in children

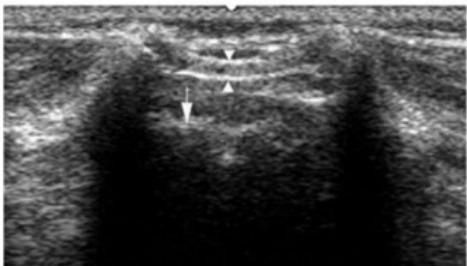


Figure 1 Ultrasound image of the caudal space in transverse view. The white arrow indicates the posterior bony wall of the sacrum. Small arrowheads indicate sacrococcygeal ligament.

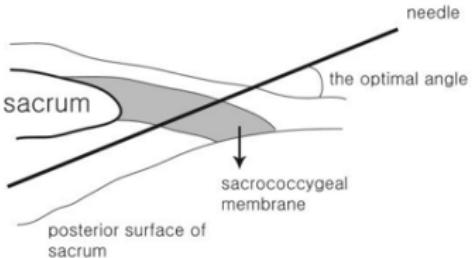


Figure 3 Schematic drawing showing how the optimal angle was estimated.

20 degree angle, not 45!

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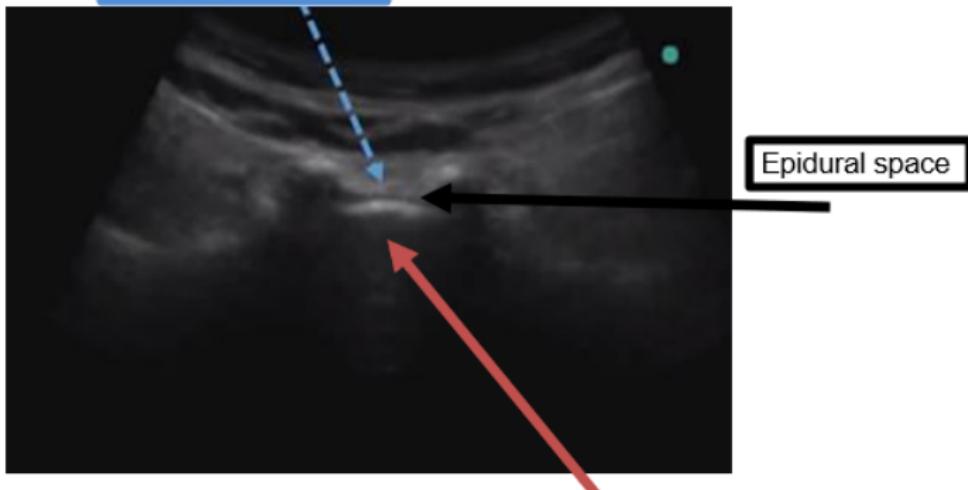
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Caudals & Pt outcomes

Do caudals reduce:

Metric	Bias	Evidence
Mortality	No	No
Adverse Events	May be	No
LOS	No	No
Re-Admissions	No	No
Cost	No	No

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Do caudals improve:

Metric	Bias	Evidence
Surgical results	May be	No
Pain Scores	Yes	Yes
less opioids	Yes	Yes
Anes satisfaction	Yes	No

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Caudal epidural block versus other methods of postoperative pain relief for circumcision in boys (Review)

Cyna AM, Middleton P



THE COCHRANE
COLLABORATION®

Caudals for inguinal hernia and circumcision operations
No difference between caudals, PNB, local infiltration or nothing
regarding N/V or additional analgesics.
No data for meaningful outcomes

Asleep Versus Awake: Does It Matter?

Pediatric Regional Block Complications by Patient State: A Report From the Pediatric Regional Anesthesia Network

Andreas H. Taenzer, MD, MS,* Benjamin J. Walker, MD,† Adrian T. Bosenberg, MBChB, FFA(SA),‡
Lynn Martin, MD,‡ Santhanam Suresh, MD,§ David M. Polaner, MD, FAAP,¶
Christie Wolf,# and Elliot J. Krane, MD**

More than 10 years ago, Bromage and Benumof¹ asserted that placement of epidural catheters under general anesthesia (GA) is contraindicated. They based their statement on a single closed-claim case report of a spinal cord injury from a thoracic epidural placed in an adult with spine pathology under GA. Since this publication, there has been considerable debate on the topic, with a notable lack of evidence on either side of the debate. Krane

Motivation through (en) Unhappiness

"The placement of regional anesthetic blocks in pediatric patients under GA is as safe as placement in sedated and awake children. Our results provide the first prospective evidence for the pediatric anesthesia community that the practice of placing blocks in anesthetized patients should be considered safe and should remain the prevailing standard of care. Prohibitive recommendations based on anecdote and case reports cannot be supported."

Asleep or Awake *Rethinking "Safety"*

Bernard Dalens, MD, PhD, and Natalie Albert, MD, FRCPC

(Reg Anesth Pain Med 2014;39: 267–268)

The article by Taenzer et al¹ in this issue of *Regional Anesthesia and Pain Medicine* provides important information concerning the management of pediatric patients undergoing regional anesthesia, prompting us to grapple with the critical question of safety in anesthesia. Although the study strongly supports the fact that performing a block in an anesthetized child is certainly not unsafe, it encourages us to consider these findings in a broader context: The word “safety” refers, of course, to “safety of the patient,” but as human beings, we cannot deny that we constantly consider our own safety, too, especially from a medicolegal point of view. Even the term “patient safety” is ambiguous. All regional anes-

than 90% of which were performed in fully anesthetized infants and children. This study reported an extremely low rate of complications, all minor and short-lasting. In 2003, Horlocker et al³ reported epidural catheter placement in 4298 fully anesthetized patients undergoing thoracic surgery with no neurological complication. Of course, the population size of these studies is not sufficient to definitively exclude any potential harm, especially if we are examining neurological complications, due to techniques performed in unresponsive patients. Nevertheless, these numbers are reassuring given that the risk is less than 1 in more than 25,000 patients. The outstanding multicentric study of Taenzer et al¹ in this issue now suggests that the potential for such a risk, if any, is considerably less.

Are Caudal Blocks for Pain Control Safe in Children? An Analysis of 18,650 Caudal Blocks from the Pediatric Regional Anesthesia Network (PRAN) Database

Santhanam Suresh, MD,* Justin Long, MD,* Patrick K. Birmingham, MD,* and Gildasio S. De Oliveira, Jr, MD, MSc†

Table 2. Incidence of Specific Complications In Caudal Block

	Incidence (95% confidence interval)
Block failure	1% (0.8 to 1.1)
Blood aspiration	0.6% (0.5 to 0.8)
Positive test dose	0.1% (0.1 to 0.2)
Dural puncture	0.08% (0.005 to 0.01)
Cardiac arrest	0.005% (– to 0.002)
Seizure	0.005% (– to 0.002)
Sacral pain	0.005% (– to 0.002)
Muscle spasm	0.005% (– to 0.002)

Variation Between and Within Hospitals in Single Injection Caudal Local Anesthetic Dose: A Report From the Pediatric Regional Anesthesia Network

Andreas H. Taenzer, MD, MS,* Matthew Hoyt, MD,* Elliot J. Krane, MD, FAAP,†‡
Benjamin J. Walker, MD,§ Sean Flack, MBChB, FCA(SA),|| Adrian Bosenberg, MBChB, FFA(SA),||
Navil F. Sethna, MD, MA (Hon.), FAAP,¶ Andrew D. Franklin, MD, MBA, FASA,# and
David M. Polaner, MD, FAAP,|| for the PRAN investigators

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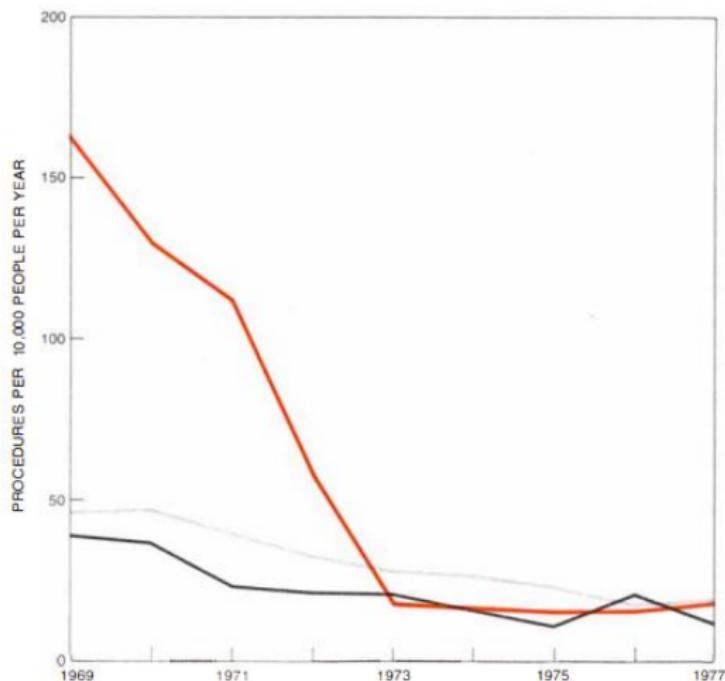
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Variations in Medical Care among Small Areas

The amount and cost of hospital treatment in a community have more to do with the number of physicians there, their medical specialties and the procedures they prefer than with the health of the residents

by John Wennberg and Alan Gittelsohn

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TONSILLECTOMY RATE in Vermont demonstrates the strong influence of physicians' preferences on how often a surgical procedure is done. The colored line is for the hospital area with the highest tonsillectomy rate in the state. The gray line shows the state average. The solid black line is for the area with the lowest rate in the state. In 1971 physicians in the area with the highest rate were told of that fact. They established the practice of obtaining a second opinion before a tonsillectomy was done, and the rate fell to a level roughly equal to the lowest in the state. (The decline before 1971 followed a single physician's leaving the hospital area.)

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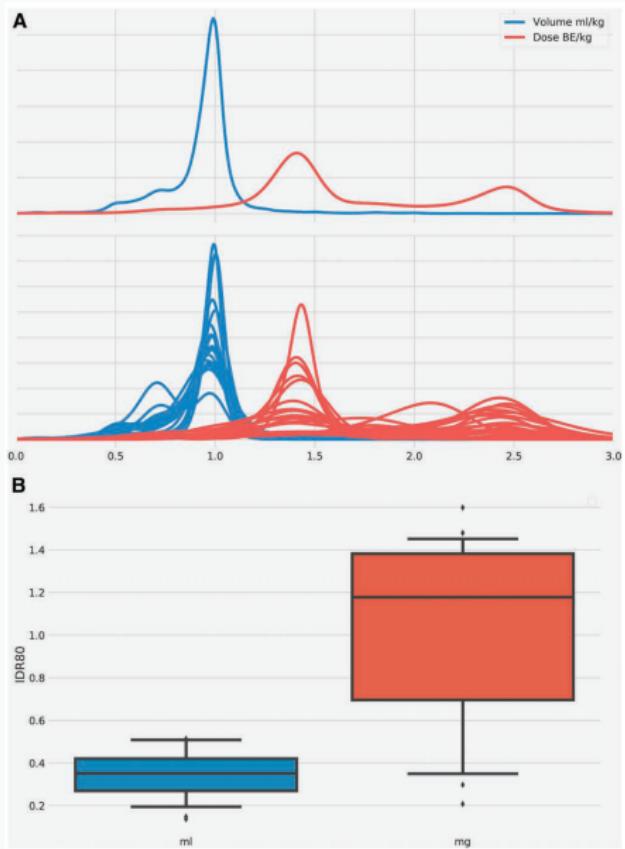
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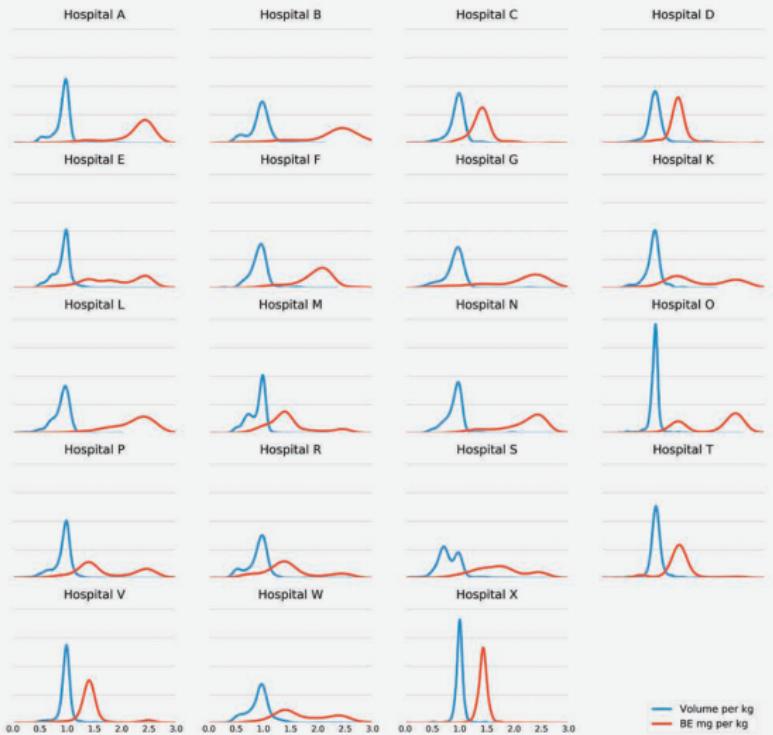
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Density Plot of Dose and Volume by Hospital



How much

One way

$$\text{Vol} = 0.05\text{ml} * \text{levels} * \text{weight[kg]}$$

Another way

"0.5 mL/kg for coverage of sacral dermatomes (S1-S5), 1 mL/kg for the inguinal canal and lower abdomen below the umbilicus (T10 and below) and 1.25 mL/kg for thoracic dermatomes (T6 and below)" per RH and MY

Simplified Math

Goal is to block up to L1: S5 - S1 + L5 - L1 = 10 levels

$$Vol = 0.05 * 10 * weight[kg] = 0.5 * weight[kg]$$

Goal is to block up to T8: S5 - S1 + L5 - L1 + T12 - T8 = 15 levels

$$Vol = 0.05 * 15 * weight[kg] = 0.75 * weight[kg]$$

Goal is to block up to T3: S5 - S1 + L5 - L1 = 20 levels

$$Vol = 0.05 * 20 * weight[kg] = 1 * weight[kg]$$

Takasaki M. Dosage of lidocaine for caudal anesthesia in infants and children. Anesthesiology 1977; 47: 527-9

US for dermatomal coverage

Numerous papers evaluating US for dermatomal spread.

"However, the cranial spread of local anesthetics within the spinal canal as assessed by immediate ultrasound visualization was found to be in poor agreement with previously published predictive equations that are based on actual cutaneous dermatomal testing."

Lundblad M, Lönnqvist PA, Eksborg S, Marhofer P. Segmental distribution of high-volume caudal anesthesia in neonates, infants, and toddlers as assessed by ultrasonography. *Paediatr Anaesth*. 2011 Feb;21(2):121-7. Epub 2010 Dec 15. PMID: 21159024.

Block Duration and concentration

Concentration (%)	Duration (min)	Motor Block (%)
0.125	60	20
0.25	158	40

TR Vetter, D Carvallo, JL Johnson. A comparison of single-dose caudal clonidine, morphine, or hydromorphone combined with ropivacaine in pediatric patients undergoing ureteral reimplantation. Anesthesia & Analgesia, 2007

Clonidine as an additive

- Prolonged avg time until first rescue morphine from 3.9 - 8 hrs
- Does not prolong block when already using epinephrine
- similar block prolongation as morphine, dexmedetomidine, ketamine or epi
- fewer side effects than morphine and ketamine

PA Tripi, JS Palmer, S Thomas, JS Elde. Clonidine increases duration of bupivacaine caudal analgesia for ureteroneocystostomy: a double-blind prospective trial. The Journal of Urology, 2005

Wheeler M, Patel A, Zdesh S, Roth AG, Birmingham PK, Heffner CL, Coté CJ. The addition of clonidine 2 mcg kg⁻¹ does not enhance the postoperative analgesia of a caudal block using 0.125% bupivacaine and epinephrine 1:200,000 in children: a prospective, double-blind, randomized study. Paediatr Anaesth. 2005 Jun;15(6):476-83.

Wang Y, Guo Q, An Q, Zhao L, Wu M, Guo Z, Zhang C. Clonidine as an Additive to Local Anesthetics in Caudal Block for Postoperative Analgesia in Pediatric Surgery: A Systematic Review and Meta-Analysis. Front Med (Lausanne). 2021 Sep 14;8:723191

Thank you,
For Attending!



<https://github.com/aki-repo/talks>