INSIGHTS IN IMAGES

CLINICAL CHALLENGE: CASE 1

In each issue, *JUCM* will challenge your diagnostic acumen with a glimpse of x-rays, electrocardiograms, and photographs of conditions that real urgent care patients have presented with.

If you would like to submit a case for consideration, please email the relevant materials and presenting information to *editor@jucm.com*.

A 13-Year-Old Boy with Knee Pain After a Fall

Figure 1a.

Figure 1b.

Case

The patient is a 13-year-old boy who presents with knee pain after an awkward fall while playing basketball on an asphalt court. He is unable to walk due to pain and has a swollen knee.

View the x-rays taken and consider what your diagnosis and next steps would be.

THE RESOLUTION


Figure 2a.

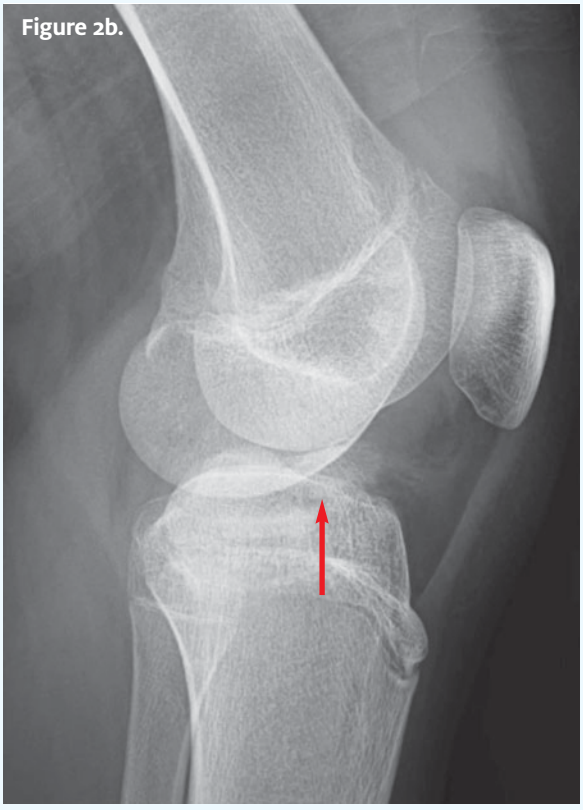


Figure 2b.

Differential Diagnosis

- Tibial eminence (spine) fracture
- Collateral ligament injury
- Tibial tubercle avulsion
- Meniscal tear
- Patellar sleeve fracture
- Tibial plateau fracture

Diagnosis

This patient experienced a tibial eminence (spine) fracture.

Learnings/What to Look for

- Tibial eminence (spine) fractures are unique to the growing skeleton and affect only three in 100,000 children who sustain injuries to the knee annually[1]
- This fracture is a variant and similar to an ACL injury, also caused by hyperextension of the knee with rotation of the femur on the tibia
- X-rays should be sufficient to visualize fractures through the tibial eminence
- MRI or CT may be useful in further categorizing injury. In addition, MRI can help in identifying pieces of chondral fracture of the tibial spines

Pearls for Urgent Care Management

- Large effusions with significant pain or limitation of flexion benefit from arthrocentesis of hemarthrosis for symptomatic relief
- Initial treatment should include knee immobilization with fiberglass splinting in full extension and non-weight bearing with crutches
- Follow-up with orthopedics is recommended in 2-3 days for casting and to assess if surgical therapy is necessary. Significantly displaced avulsions require closed or open reduction with internal fixation
- Emergency department referral is necessary for any concerns about neurovascular status or for pain out-of-proportion

Reference

1. Shin YW, Uppstrom TJ, Haskel JD, Green DW. The tibial eminence fracture in skeletally immature patients. *Curr Opin Pediatr.* 2015;27(1):50-57.

Acknowledgment: *Images and case presented by Experity Teleradiology (www.experityhealth.com/teleradiology).*

CLINICAL CHALLENGE: CASE 2

A 34-Year-Old Female with a Syncopal Episode but No Remarkable History

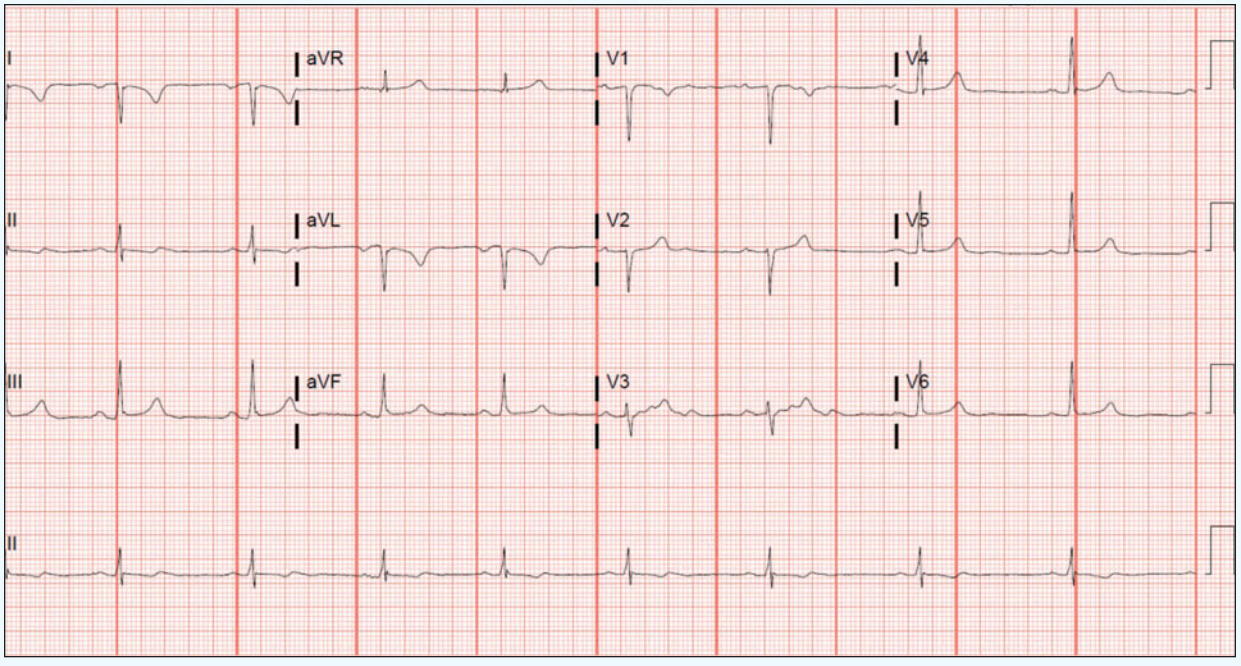


Figure 1.

Case

A 34-year-old female with no reported medical history presents to urgent care after a syncopal episode. She describes standing up rapidly to answer the phone, followed by a sensation of lightheadedness and nausea with subsequent collapse.

On evaluation, her vital signs are normal, she appears well, and she is currently asymptomatic.

View the ECG taken and consider what your diagnosis and next steps would be.

(Case presented by Tom Fadial, MD, The University of Texas Health Science Center at Houston.)

THE RESOLUTION

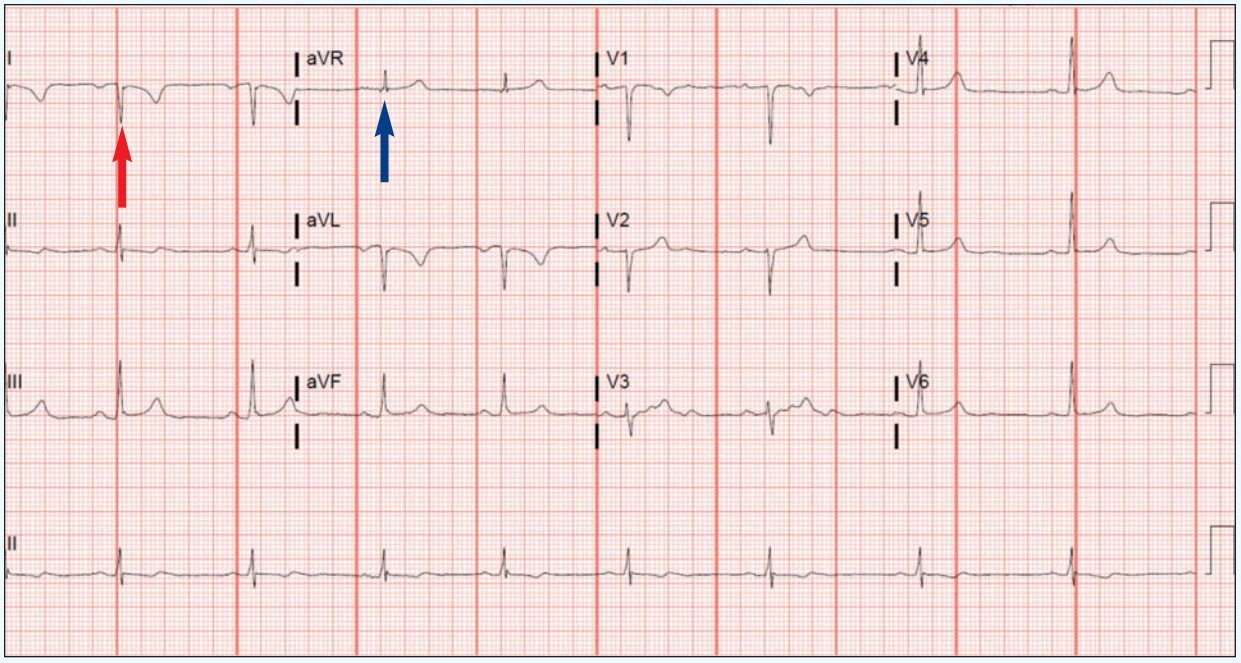


Figure 2.

Differential Diagnosis

- Ectopic atrial rhythm
- Myocardial ischemia
- Myocardial infarction
- Limb lead reversal

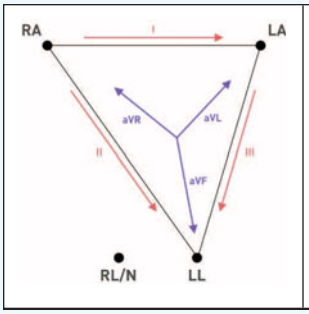
Diagnosis

The ECG shows a regular, narrow-complex rhythm at a ventricular rate of 54 bpm. A QRS-complex follows every P-wave; however, the P-wave axis is abnormal—with an inverted P-wave in lead I and upright in aVR (where the inverse would be expected for sinus node origin). There are T-wave inversions in leads I and aVL, suggestive of myocardial ischemia.

This ECG illustrates a limb lead reversal (LLR).

The presence of negative P-QRS complexes in lead I (red) is unusual for this young patient with no significant medical history. If the finding were to represent a real underlying condition (such as severe pulmonary disease), some corroboration in the precordial leads would be expected. Moreover, the bizarre positive P-QRS complexes in aVR (blue) suggest an alternative diagnosis—limb lead misplacement.

Between 0.4% and 4% of ECGs obtained in various settings demonstrate features of lead misplacement.[1] Lead misplacement may either obscure important findings or simulate the appearance of ectopic rhythms, conduction disturbances, chamber abnormalities, and ischemia/infarction, resulting in unnecessary and potentially invasive testing.[2]



Surface Electrodes

- LA: left arm
- RA: right arm
- LL: left leg
- RL/N: right leg (neutral)

Limb Leads

- Bipolar: I, II, III
- Augmented: aVL, aVR, aVF

Figure 3.

The key ECG findings suggestive of lead misplacement are dependent on the leads involved. The relationship between limb leads and surface electrodes are defined by Einthoven's triangle (**Figure 3**).

Limb lead reversals distort Einthoven's triangle and result in predictable changes in the ECG.[3]

When lead reversals involve RL or the neutral electrode, a more

Table 1. ECG changes resulting from limb lead reversal.

Reversal	I	II	III	aVR	aVL	aVF
LA/RA	-I	III	II	aVL	aVR	–
LA/LL	II	I	-III	–	aVF	aVL
RA/LL	-III	-II	-I	aVF	–	aVR

THE RESOLUTION

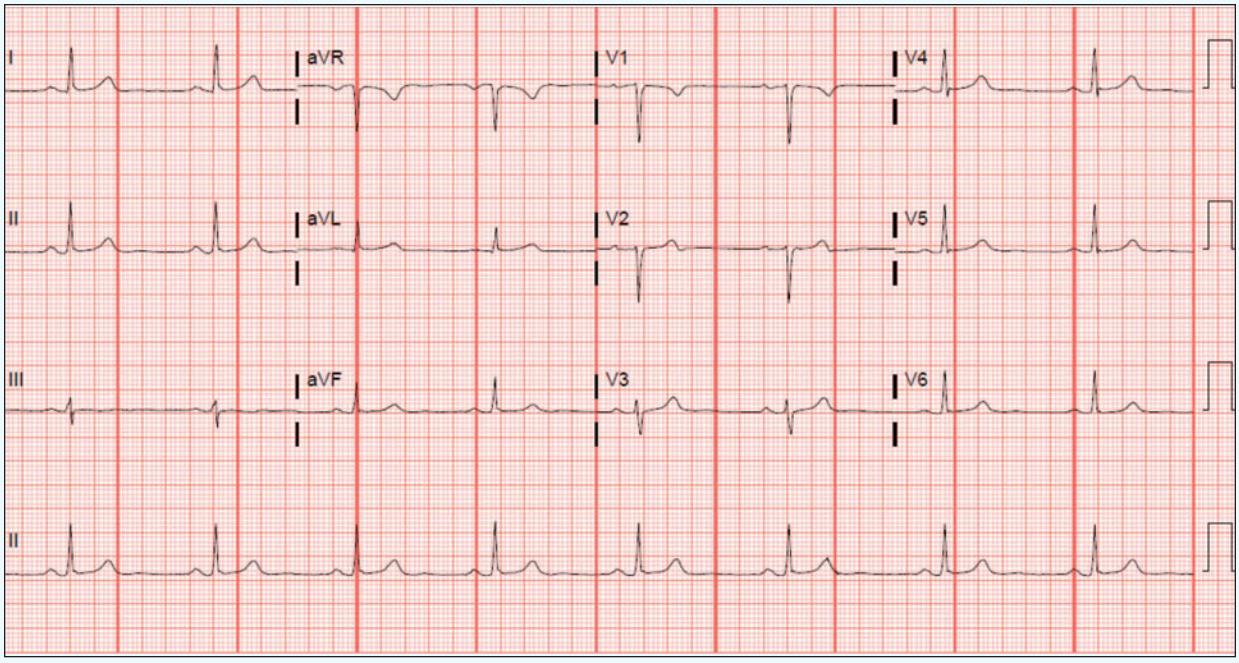


Figure 4.

dramatic distortion of Einthoven's triangle occurs such that one of the bipolar limb leads is conspicuously flat.

In this patient, the presence of negative P-QRS-T complexes in lead I combined with positive deflections in aVR are suspicious for LA/RA reversal. A repeat ECG was obtained (**Figure 4**).

Learnings/What to Look for

- Some key electrocardiographic features of limb lead reversal are:[4,5]
  - Opposing directions of P-QRS complexes between I and V6 (limb and precordial leads with shared axes)
  - Positive P-QRS in aVR
  - Extreme axis deviation (between +180° and -90°)
  - P-wave amplitude greater in lead I than II
  - Very-low amplitude in isolated limb lead (I, II, III)

Pearls for Urgent Care Management

- Trust your clinical impression—a bizarre-appearing ECG with some of the features above warrants a repeat with careful attention to lead placement prior to definitive action

References

1. Rudiger A, Hellermann JP, Mukherjee R, et al. Electrocardiographic artifacts due to electrode misplacement and their frequency in different clinical settings. *Am J Emerg Medicine*. 2007;25(2):174–178.
2. Batchvarov VN, Malik M, Camm AJ. Incorrect electrode cable connection during electrocardiographic recording. *Ep Europace*. 2007;9(11):1081–1090.
3. Harrigan RA, Chan TC, Brady WJ. Electrocardiographic electrode misplacement, misconnection, and artifact. *J Emerg Medicine*. 2012;43(3):1038–1044.
4. Rosen AV, Koppikar S, Shaw C, Baranchuk A. Common ECG lead placement errors. part I: limb lead reversals. *Int J Medical Students*. 2014;2(3):92–98.
5. Pérez-Riera AR, Barbosa-Barros R, Daminello-Raimundo R, Abreu LC. Main artifacts in electrocardiography. *Ann Noninvas Electro*. 2018;23(2):e12494.

Acknowledgment: JUCM *appreciates the assistance of ECG Stampede (www.ecgstampede.com) in sourcing content for electrocardiogram-based cases for Insights in Images each month.*

ECG STAMPEDE

Correction: In the Insights in Images department that appeared in the March issue of *JUCM*, we printed an incorrect version of an ECG in the "reveal" portion of the cardiology case. To view the full case including the correct version of the image, visit: https://www.jucm.com/a-96-year-old-male-with-palpitations-and-a-history-of-cad/.