BIKE Syndrome: Biking Induced Kinetic Electroshock Syndrome

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Introduction

Patients with transient symptoms pose diagnostic dilemmas and may even be misdiagnosed with Functional Neurologic Disorder or somatization. We present a case of a patient with transient neuromuscular symptoms while cycling under a powerline. While this phenomenon is not reported in the clinical neurological or musculoskeletal literature, several online forums related to cycling describe bicyclists experiencing a similar sensation. To further investigate, we searched for all instances of microshocks occurring in cyclists using the following search term in Google: "electrical" AND ("bicycle" or "cycle") AND ("microshock" or "shock"). Between 2006-2021, we identified 51 unique reports across 18 blog forums of cyclists describing microshocks in their groin or upper extremity while traversing under high voltage power lines (**Table 1**). In 11 of 18 forums, at least one of the posts described friends or family members characterizing the experiences as "impossible" or "hallucinations." After an initial posting, additional shared experiences of microshock by other cyclists were offered in 12 forums. Seven forums speculated about short- and long-term health effects, while 13 forums specifically inquired about the etiology of the symptoms. Based on this review, electrical microshocks while cycling under high voltage powerlines may be more common than suspected *a priori* and are likely to be dismissed by close contacts or healthcare workers. These events commonly generate questions about health effects and potential causes for symptoms. Such questions are likely to be better addressed by healthcare providers or peer-reviewed literature as compared to unverified blog postings by anonymous authors.[1] This is the primary reason why we present this case.

Clinical Case

A 33-year-old man with migraines presented for evaluation of intermittent burning, "electric" radiating perineal and groin pain while road cycling over the last 6 months. The pain was unrelated to the duration or intensity of the ride. He denied radicular pain in the arms or legs, or neck or low back pain. He denied paresthesias in his feet, weakness, sexual dysfunction, and bowel/bladder dysfunction. Notably, he reported that the sensation occurred only when he was fully seated while riding his bike under a specific powerline. On focused exam of his right lower extremity, he had full range of motion in his hips, knees, and ankles. He denied tenderness to palpation over his greater trochanter, ischial tuberosity, and coccyx. His neurologic exam was normal; specifically, he had normal large and small fiber sensation in his legs and groin, reflexes were normal and symmetric throughout, and he had no weakness. Provocative testing for hip pathology was performed: (1) his log roll test was negative, (2) he denied sacroiliac, groin, or posterior hip pain with passive hip flexion, abduction, and external rotation (FABER test), and (3) he denied hip pain with passive hip flexion, adduction, and internal rotation (FADIR test). Given the presentation, reassurance was provided, and no further testing was ordered including nerve conduction studies/electromyogram (NCS/EMG), hip x-ray, lumbosacral spine MRI, or laboratory studies for neuropathy. The key to this patient's diagnosis is the finding of transient 'electric' pain specifically while cycling under a powerline in a seated position. We described this as a new clinical phenomenon, Biking Induced Kinetic Electroshock (BIKE) syndrome.

Discussion

In this clinical scenario, we present a previously unreported clinical phenomenon related to biking and local power grid lines, which we describe as a Biking Induced Kinetic Electroshock (BIKE) syndrome. The key to the correct diagnosis and management is an understanding of the clinical story, physical exam, and electromagnetic physics.

For this reason, it is critical to systematically work through differential diagnoses for anterior hip and groin pain along neurologic peripheral and musculoskeletal axes.

The history and physical make a diagnosis along the neurologic peripheral axis unlikely, including lumbosacral radiculopathy, focal mononeuropathy (e.g. ilioinguinal, genitofemoral, pudendal, perineal nerves), and generalized large or small fiber neuropathy. Musculoskeletal causes for hip pain, including femoroacetabular impingement, labral tear, greater trochanteric bursitis, and piriformis syndrome are also unlikely given normal hip range of motion and negative physical exam findings. Cycling is associated with non-traumatic injuries, typically handlebar palsy (ulnar neuropathy at the wrist), carpal tunnel syndrome

Table 1: Results of search for all instances of microshocks occurring in cyclists using the Google search terms: "electrical" AND ("bicycle" or "cycle") AND ("microshock" or "shock")

Blog/Forum Title	Year	Number of Patients	Symptoms Dismissed as "Impossible/ Hallucination/etc."	Additional Shared Experiences Provided	Inquiry about Health-related Effects	Inquiry about Etiology
Bike Forums	2006	6	No	Yes	No	Yes
MTBR	2009	11	Yes	Yes	Yes	Yes
BC Hydro	2010	1	No	No	Yes	Yes
Roadbike Review	2011	9	Yes	Yes	Yes	Yes
Physics-StackExchange	2012	1	Yes	No	Yes	Yes
Veritas	2012	1	Yes	No	No	Yes
DailyMail	2014	1	Yes	No	Yes	No
Singletrack	2014	3	Yes	Yes	No	No
ThumperTalk	2016	2	Yes	Yes	No	Yes
Reddit/Shocked	2017	2	Yes	Yes	No	Yes
Reddit/Bicycle	2017	2	Yes	Yes	No	Yes
CycleChat	2017	2	Yes	Yes	No	Yes
Bike Forums	2019	2	No	Yes	No	Yes
EMTB Forums	2019	1	No	No	No	No
The Cabin	2020	2	Yes	Yes	No	No
Adventure Rider	2020	3	No	Yes	Yes	Yes
NBC_Ark	2020	1	No	Yes	No	Yes
BayNews	2021	1	No	No	Yes	No

(median neuropathy at the wrist), sciatic neuropathy, dorsal pudendal neuropathy, ischial tuberosity pain, and orthopedic injuries related to overuse, poor biomechanics, or compression from incorrect rider-cycle fit. However, in this case, while a compressive neuropathy could be possible from poor bicycle fit that resolved after the compression was relieved, the association with the power line suggests an alternate pathology related to electromagnetic stimulation.

To provide evidence for such phenomenon, we asked the rider to cycle with a different bicycle, which then led to the same sensation. A different rider rode both bicycles in question as well as a third unrelated bicycle across the electric field and received the same shock. Lastly, a third rider tried all three bicycles and did not receive a shock. The difference between the riders was that the rider who did not receive a shock had smaller diameter thighs that did not contact the saddle rails. With a multimeter, we measured 1.2 mA at the saddle rails when moving the bicycle through the field at 3.5 mph. Thus, a current is present on the bicycle through the field at a level that is physiologically detectable and explained by contact with the saddle rails.

High-voltage direct current lines are increasingly the technology of choice for transport of large amounts of energy over long distances. These lines produce static electric fields that may interact with people during activities of daily living.[2,3] In addition, humans are able to perceive electric fields and ion currents, especially as intensity increases.[3,4] As a result, government regulatory bodies typically create guidelines for exposure of the public to electric and magnetic fields during construction of high voltage powerlines.[5] Microshocks are a type of indirect effect that are covered within these regulations. Indirect effects occur when an electric field induces charges on the surface of a conducting object. These charges then either interact with the electric field, or are transferred to another object.[5] Microshocks are a transfer of charge that occurs when a charged person who is well insulated from the ground touches a conductive grounded object, or when a grounded person touches a charged object that is well insulated from the ground.[6] In practice, microshocks can feel like "static shock" and are typically only relevant with high-voltage (>275 kV) overhead powerlines.

Applying this knowledge to the case of our patient and cycling, when a cyclist is riding under a powerline, if he is electrically isolated from the bicycle (e.g. holding rubber handlebar grips or wearing insulating gloves) a differential charge can build up between the rider and the bicycle. While the full physics is complicated, this scenario can be simplified by thinking of the patient as one end of a capacitor. In this setting, the difference in charge (current) that would be expected to be discharged is most simply expressed as: $i = C\frac{dV}{dt} = \left(\frac{\varepsilon A}{d}\right) * \frac{dV}{dt}$, where i = current, C = capacitance, $\frac{dV}{dt}$ = instantaneous rate of voltage change over time, ε = material permissivity, A = parallel plate area, and d = distance between plates. Using this equation, we can see the possibility for a microshock if conducting surfaces of the rider and bicycle touch, thereby resulting in an equalization of potentials across the gap between the rider and bicycle. This microshock typically occurs on a small area of skin resulting in tingling or pain.[5] The most common places for this to occur are the fingers as they brush against the brake level or on the inside of the upper thigh as it comes close to the top of the seat pillar below the saddle or to the saddle rails during a pedal revolution. Factors that can alter the likelihood of electrical current perception or occurrence of a microshock include bike/rider size, gender, traveling velocity, distance from powerline, and meteorological conditions.[4]

Microshocks are not known to have long-term health effects or cause discernable skin damage.[5] A recent systematic review found that while humans and animals are able to perceive the presence of static electric fields, such as those generated from power lines, at high voltage levels, minimal adverse biological effects have been observed.[2]

Based on the diagnosis of BIKE syndrome, the patient was counseled to either avoid the specific route, maintain electrical contact with the metal part of the bicycle (e.g. handlebar, saddle rails) at all times, or insulate completely from the bicycle (e.g. change the seat or wear more insulating shorts). He opted to avoid the route, which relieved the issue. Given the very brief transient nature without deficits on exam, we relayed his good prognosis to him. No further testing was ordered.

In summary, transient neurologic symptoms can present diagnostic dilemmas and a clear history with associated symptoms and context can reveal the diagnosis without costly tests. This case demonstrates an unusual phenomenon of electrical microshocks from nearby powerlines while cycling leading to transient neurologic symptoms, i.e. a BIKE (Biking Induced Kinectic Electroshock) syndrome.

References

1. Bissonnette-Maheux V, Provencher V, Lapointe A, et al. Exploring Women's Beliefs and Perceptions About Healthy Eating Blogs: A Qualitative Study. *Journal of Medical Internet Research*. 2015;17(4):e3504. doi:10.2196/jmir.3504. PMID: 25858777; PMCID: PMC4407018.
2. Petri A-K, Schmiedchen K, Stunder D, et al. Biological effects of exposure to static electric fields in humans and vertebrates: a systematic review. *Environmental Health*. 2017;16(1):41. doi:10.1186/s12940-017-0248-y. PMID: 28416002; PMCID: PMC5393013.
3. Blondin JP, Nguyen DH, Sbeghen J, et al. Human perception of electric fields and ion currents associated with high-voltage DC transmission lines. *Bioelectromagnetics*. 1996;17(3):230-241. doi:10.1002/(SICI)1521-186X(1996)17:3<230::AID-BEM9>3.0.CO;2-4. PMID: 8809363.
4. Leitgeb N, Schröttner J, Cech R. Perception of ELF electromagnetic fields: excitation thresholds and inter-individual variability. *Health Phys*. 2007;92(6):591-595. doi:10.1097/01.HP.0000243128.29337.aa. PMID: 17495660.
5. Power Lines: Control of Microshocks and other indirect effects of public exposure to electric fields. Published online July 2013. Accessed August 10, 2021. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/224766/powerlines_vcop_microshocks.pdf
6. Dawson TW, Stuchly MA, Kavet R. Electric fields in the human body due to electrostatic discharges. *IEEE Transactions on Biomedical Engineering*. 2004;51(8):1460-1468. doi:10.1109/TBME.2004.828047. PMID: 15311833.