Obstructing ureteral stone during transcutaneous spinal stimulation therapy in a male with spinal cord injury

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Abstract

Context

A male with a C5 AIS C spinal cord injury (SCI) was enrolled in a clinical trial 14 months after injury.

Findings

The participant was enrolled into the transcutaneous spinal (TS) stimulation group in an IRB and FDA-approved clinical trial for assessing volitional motor function with stimulation. **Radiologist's interpretation of screening imaging revealed a nonobstructing 7 x 4 mm calculus within the right renal pelvis.** In addition, dual-energy X-ray absorptiometry of the lumbar vertebrae and femur revealed an osteoporotic status. The participant felt unwell following two days of TS therapy, which involved stimulation frequency and intensity adjustments. During the stimulation session he reported nausea, fever, and fatigue . Urinalysis returned positive for urinary tract infection (UTI). He was subsequently treated with antibiotics. Four days later, he presented to the emergency department with worsening symptoms and abdominal pain. Evaluation revealed the nonobstructing stone had become obstructing in the right proximal ureter with moderate to marked hydronephrosis and leukocytosis. The participant underwent right ureteral stent placement. Following ureteroscopic laser lithotripsy and stone removal, he resumed study-related activities 21 days later.

Conclusion/Clinical Relevance

At screening, the participant presented with several risk factors for renal stone formation including elevated bone resorption and hypercalciuria that occurs from chronic unloading, frequent UTIs, and indwelling catheter. The stone's progression is unlikely related to TS therapy due to its location upon screening; however, it is plausible that low frequencies used during spinal stimulation could influence stone progression resulting in symptomatic conditions. Utilization of specialty practice clinicians, i.e., neuro-urologists, would be impactful when determining management of SCI-related conditions.

Source of Funding

Mayo Clinic's Center for Regenerative Medicine

Learning Objectives

Objective 1: Describe SCI-related risk factors for renal stone development.

Objective 2: Discuss prevalence of renal stones in the SCI population.

Objective 3: Discuss recommendations for renal stone management in the presence of spinal cord electrical stimulation therapy.

Risks of Stone Development

Following SCI

- Osteoporosis, or low bone mineral density (BMD), prevalence rates as high as 61% have been reported in this population due to SCI-related bone loss combined with a sedentary lifestyle and chronic unloading of the lower extremities.
- Most of the bone loss occurs during the first year after injury
- Persons with SCI demonstrate hypercalciuria, hypocitraturia, and increased levels of specific gravity and urinary pH.
- Elevated bone resorption and hypercalciuria occur from chronic unloading, in combination with frequent UTI and presence of an indwelling catheter, contribute to renal stone formation.

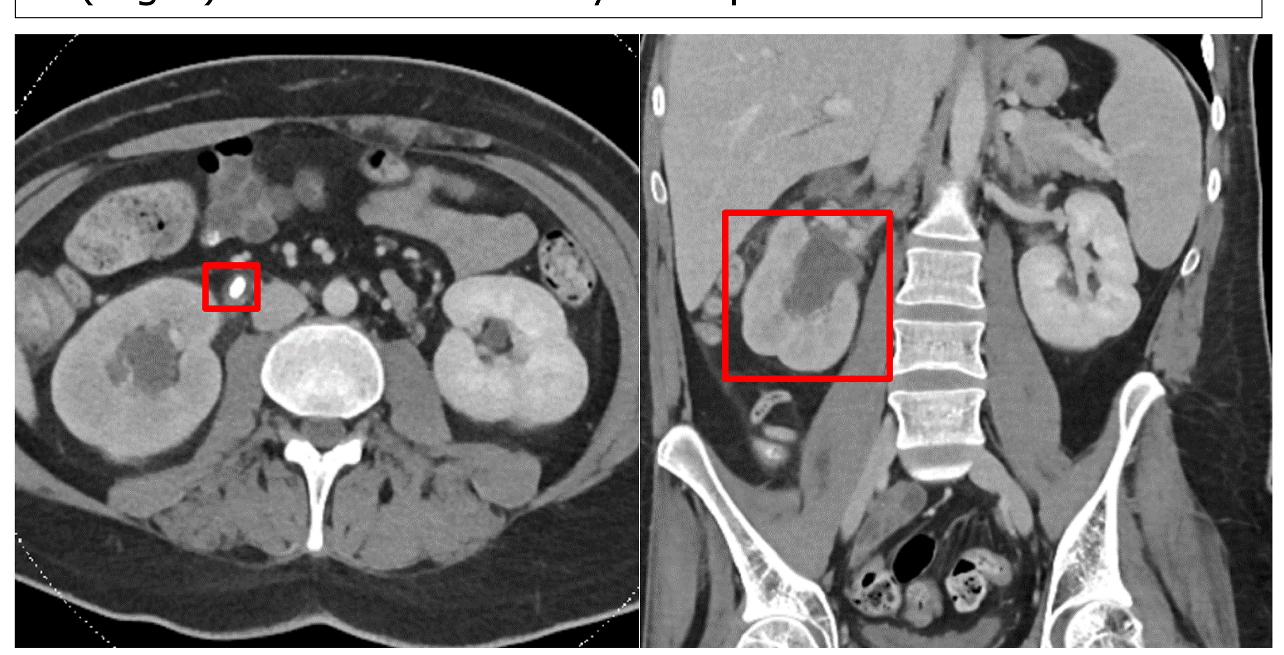
Case Presentation

Left Femur	BMD (g/cm^2)	Young-Adult (%)	Young-Adult T-score	Age-Matched (%)	Age-Matched Z-score	BMC (g)	Area (cm^2)
Neck	0.701	66	-2.8	66	-2.7	3.86	5.51
Upper Neck	0.487	53	-3.3	54	-3.2	1.34	2.76
Lower Neck	0.916	*	*	*	*	2.52	2.75
Wards	0.511	53	-3.5	54	-3.4	1.72	3.37
Trochater	0.371	40	-5.1	41	-4.9	4.16	11.23
Shaft	0.693	*	*	*	*	11.56	16.67
Spine	**BMD (g/cm^2)**	**Young-Adult (%)**	**Young-Adult T-score**	**Age-Matched (%)**	**Age-Matched Z-score**	**BMC (g)**	**Area (cm^2)**
T12	0.867	*	*	*	*	8.81	10.16
L1	0.734	63	-3.5	65	-3.3	8.55	11.65
L2	0.827	67	-3.4	68	-3.2	10.06	12.17
L3	0.807	65	-3.6	66	-3.4	11.71	14.51
L4	0.794	64	-3.7	65	-3.5	12.39	15.61

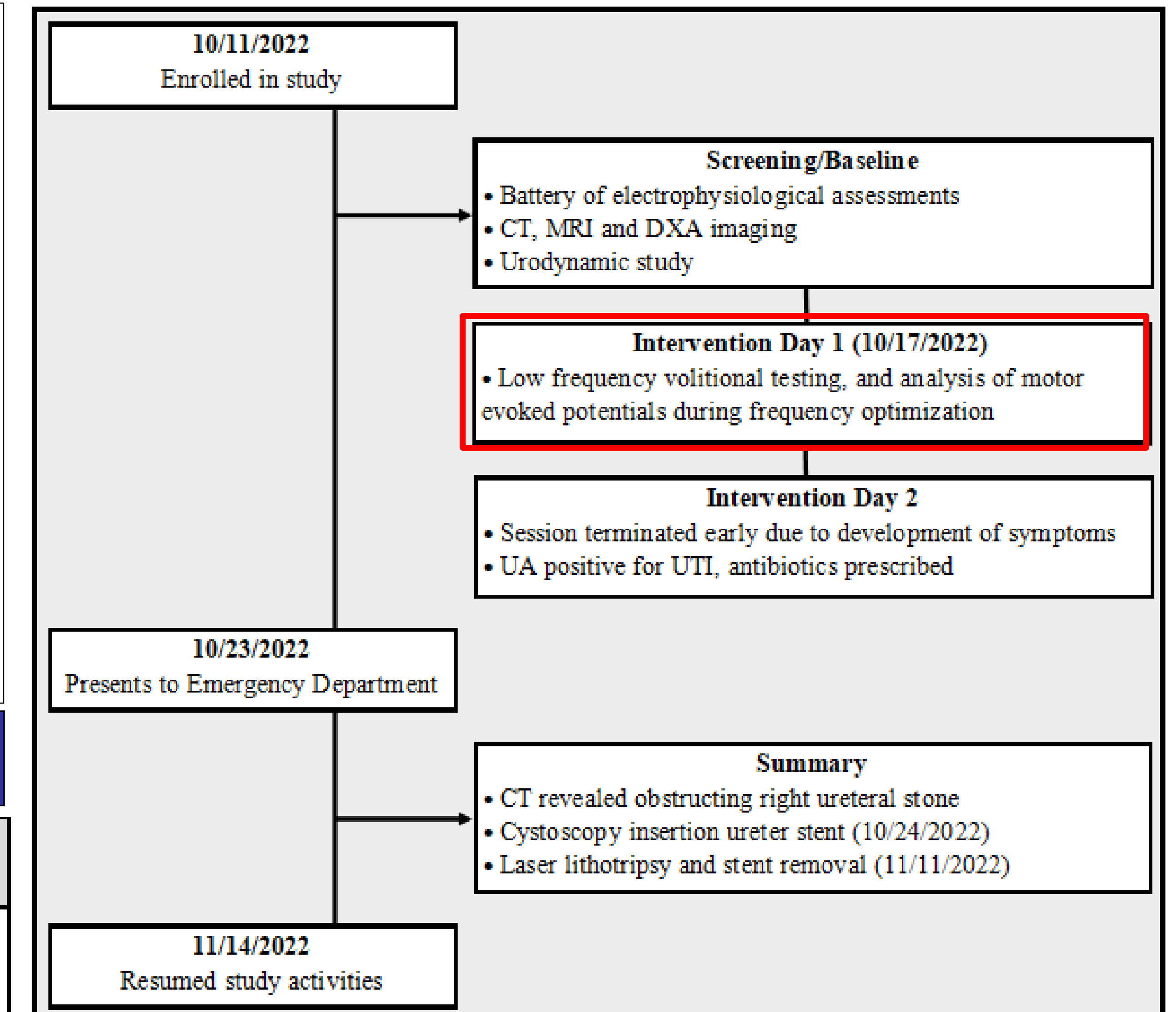
Abbreviations: BMC = bone mineral content; BMD = bone mineral density, * value not provided

Imaging

- (Left) Axial view of right ureteral stone
- (Right) Coronal view of hydronephrosis



Transcutaneous Stimulation



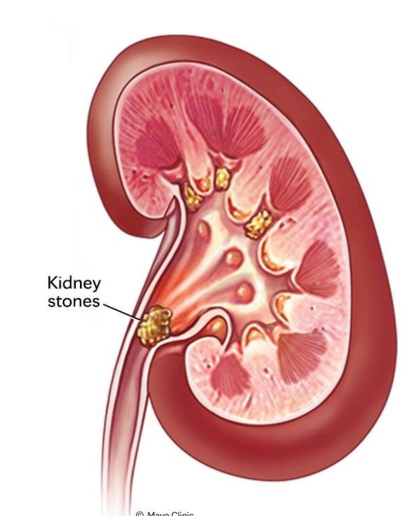
Plausible Connection

PRIOR REPORTS

No reports of TS vibration causing an obstructing stone the following day

STONE MOVEMENT

Stones located in the renal pelvis found to be high risk of stone progression



PROXIMITY

Transcutaneous stimulation was applied T10 – L2

Kidneys located T10 – L2

ACUTE TIMELINE

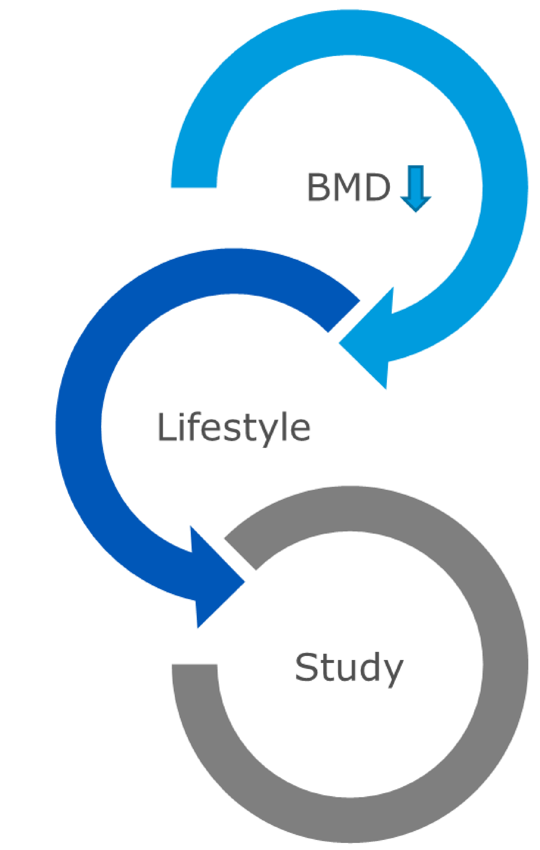
10/12/22: Imaging

10/17/22: Low-frequency

10/18/22: Stimulation Day 2

Plausible Connection

Did TS cause the renal stone to progress?



Spinal Cord Injury
Persons with SCI at higher risk for renal stones due to loss of BMD

Risk Factors
Osteoporosis, frequent UTIs, indwelling catheter

Spinal Stimulation
Low-frequency stimulation causes whole-body pulsation

Neuro-urologist's Interpretation: The stone was not located in the renal pelvis upon screening. The stone was located in the right ureter and was destined for obstruction regardless of study-related activities.

Future Considerations

Due to the prevalence of renal stones in persons with SCI, should we capture renal images prior to applying stimulation?

STONE LOCATION
Are there locations that are "high-risk" for stone progression?

ENROLLMENT
Should "high-risk" stones be resolved prior to enrollment in stimulation studies?

FREQUENCIES
Should certain frequencies be avoided all together for participants with renal stones?

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