

Effect of Percutaneous Tibial Neuromodulation with the NURO System on Brain Activity

Justina Tam*, Kenneth Wengler, Kwan Chen, Chencan Zhu, Jie Yang, Xiang He, Jason Kim, Steven Weissbart
Department of Urology, Stony Brook Medicine
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Introduction

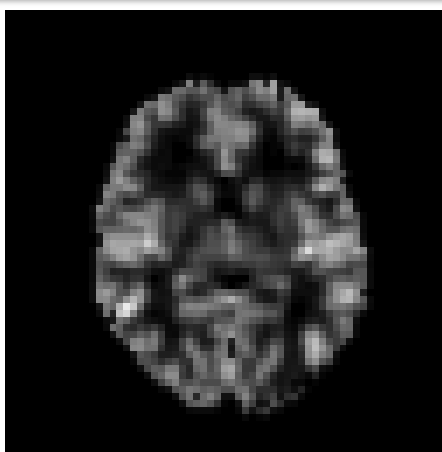
- Overactive bladder (OAB) affects 15% of women, and dramatically impairs quality of life.
- Many fail to improve with first and second line medical therapies.
- Therefore, third line therapies, such as neuromodulation, play a crucial role in the care pathway of women with OAB.
- PTNM is a third line therapy with proven efficacy. However, its mechanism of action is poorly understood. In this study, we use functional neuroimaging to investigate and quantify brain activity changes that may result from PTNM treatment.

Methods

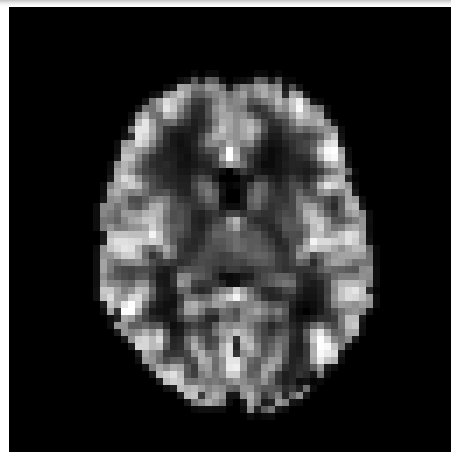
- The study included 13 women without bladder pathology and 12 women with refractory OAB.
- All participants completed voiding symptom questionnaires.
- All participants underwent an fMRI exam while their bladders were filled via a catheter at a rate of 50ml/minute.
- Images were obtained at pre-determined bladder volumes: 0mL, 50mL, 100mL, 200mL, 350mL, and 500mL
- Subjects were instructed to indicate when they experienced the first sensation of bladder filling, first desire to void, and strong desire to void.
- OAB subjects then received a PTNM treatment using the NURO™ system and a repeat fMRI series with bladder filling.



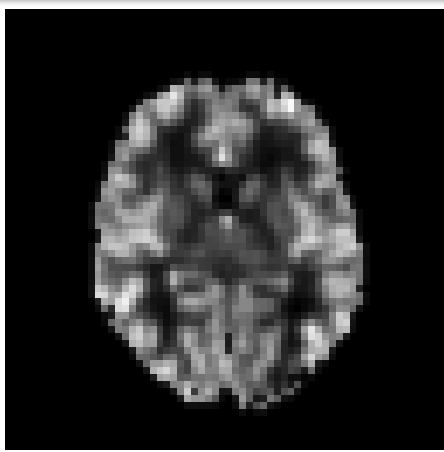
Results



Baseline



First desire to void



Strong desire to void

Figure 1: fMRI images of a control subject obtained at baseline and during bladder filling

Demographics (mean, SD)			
	Control (n=13)	OAB(n=12)	P-value
Age	24.00±7.00	51.00±35.00	< 0.01
BMI	24.87±6.00	30.25±9.76	0.04

Voiding Questionnaires (mean, SD)			
	Control (n=13)	OAB (n=12)	P-value
UDI6 total score	0.00±12.50	45.83±37.50	<0.01

Bladder volume at Bladder sensation Controls vs OAB (Median, IQR)			
Bladder Sensation	Controls	OAB	P-value
First Sensation	30.00±63.00	13.50±20.00	0.12
First Desire	100.00±90.00	50.00±16.50	<0.01
Strong Desire	290.00±210.00	50.00±50.00	<0.01
Full	300.00±186.00	100.00±97.00	<0.01

Bladder volume at Bladder sensation in OAB: Pre vs Post PTNM (Median, IQR)			
Bladder Sensation	Pre-PTNM	Post-PTNM	P-value
First Sensation	13.50±20.00	7.50±22.50	0.82
First Desire	50.00±16.50	65.00±50.00	0.41
Strong Desire	50.00±50.00	102.50±121.00	0.16
Full	100.00±97.00	168.50±100.00	0.50

Results

Bladder Sensation	Pre-PTNS vs Controls	P-value	Post-PTNM vs Pre-PTNM	P-value
Baseline (Empty)	↑Left Insula	P < 0.01		
	↓Left MCC	P = 0.03		
First Desire	↑Right ACC	P = 0.04	↓Right ACC	P = 0.02
	↑Right Insula	P = 0.02	↓Right Insula	P = 0.03
	↓Right DLPFC	P < 0.01		
Strong Desire	↑Left Insula	P = 0.03		
	↓Right SMA	P = 0.03	↑Right SMA	P = 0.03
Full	↑Right DLPFC	P < 0.01	↓Right Hippocampus	P = 0.01
			↓Right SMA	P = 0.03

Brain Region	Known Function
Insula	“seat of visceral sensation”
Hippocampus	Consolidation of short term to long term memory, spatial memory
Anterior Cingulate Cortex	Emotional response and motivational behaviors
Mid Cingulate Cortex	Nocifensive and awarded behaviors, orientation of head and body
Dorsolateral Pre-Frontal Cortex	Executive function, working memory, abstract reasoning
Supplemental Motor Area	Coordination of movement

Results

- Patients in the OAB group were older, had higher BMI, and reported worse voiding symptoms.
- OAB patients reported each bladder sensation at a lower bladder volume compared to controls.
- After treatment with PTNM, volumes at reported bladder sensations trended upward.
- Compared to healthy controls, patients with OAB demonstrated significant differences in cerebral perfusion during bladder filling in the insula, supplemental motor cortex, anterior cingulate cortex, middle cingulate cortex, and the dorsolateral pre-frontal cortex.
- After treatment with PTNS there was a significant reversal in these differences seen in the anterior cingulate cortex, insula, and supplemental motor area.



Conclusion

- Our study identified brain regions where activity changes after a single PTNM treatment.
- Future research is needed to assess how brain activity changes with longer term PTNM therapy.

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