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EVIDENCE FOR BLADDER FULLNESS SENSATION IN THE NEW NEURONAL PATHWAY ESTABLISHED BY GENITOFEMORAL OR FEMORAL NERVE TRANSFER TO AN ANTERIOR VESICAL PELVIC NERVE BRANCH IN A CANINE DECENTRALIZED BLADDER MODEL.

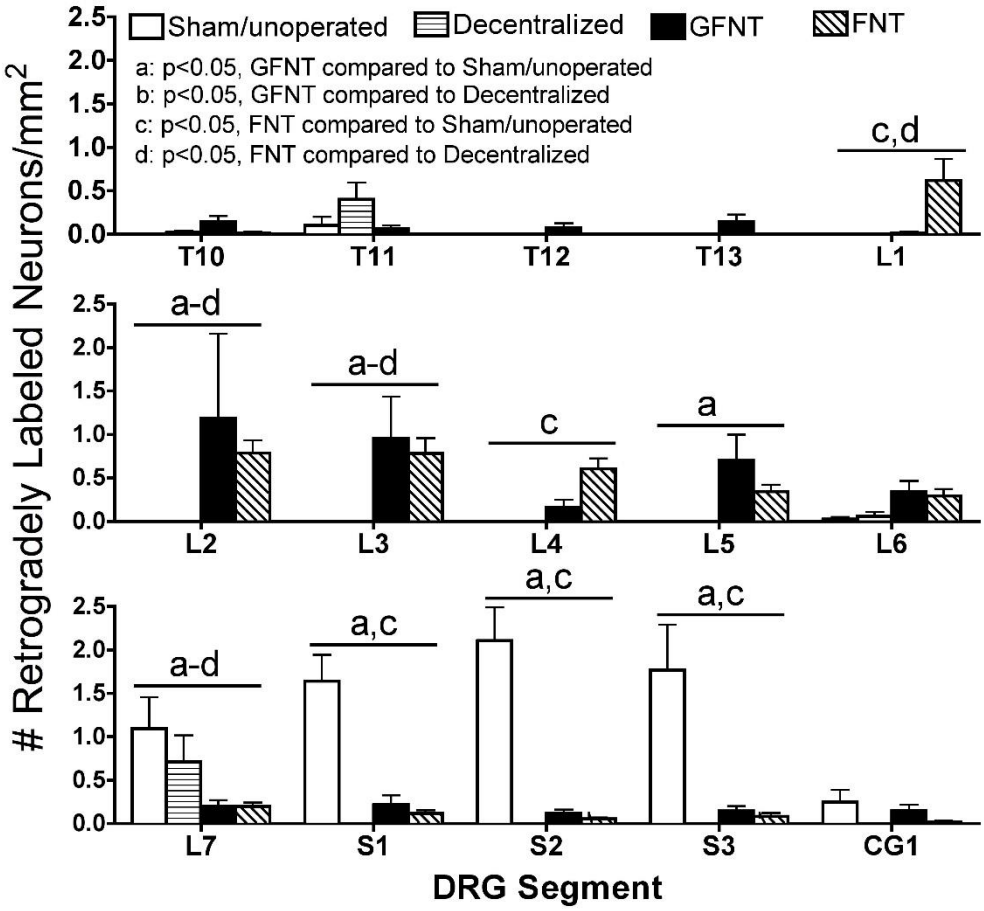
Hypothesis / aims of study
Previous studies established motor reinnervation of the bladder based on increased detrusor pressure induced by electrical stimulation of the transferred genitofemoral or femoral nerves in 21 of 28 animals [1]. The current study was designed to determine whether these new neuronal pathways created by nerve transfer to an anterior vesical branch of the pelvic nerve (PN) also results in sensory reinnervation capable of sensing bladder fullness.

Study design, materials and methods
A canine lower motoneuron lesioned bladder model was created by bilateral transection of all sacral nerve roots caudal to L7. Complete functional bladder decentralization was confirmed by root transection induced disappearance of increased detrusor pressure by electrical stimulation of the S1-2 sacral spinal cord. Two types of bladder reinnervation surgeries were performed in a total of 20 female mongrel hounds: 1) bilateral genitofemoral nerve (GFN) to bilateral PN transfer (GFNT: N=12); 2) left femoral nerve (FN) to bilateral PN transfer (FNT: N=8). Controls included sham operated (N=3), unoperated (N=3) and decentralized (N=5) animals. To determine whether the animals were able to sense bladder fullness, video surveillance cameras were installed over the housing cages to allow measurement of the frequency and duration of urination postures. Observers that were blinded to the surgical treatment reviewed 24-hour periods of these videos taken 6 months after the reinnervation surgeries. Three weeks prior to euthanasia, fluorogold retrograde nerve labeling dye was injected into the bladder wall lateral to the ureteral orifices. At euthanasia approximately 8 months after reinnervation surgery, functional reinnervation was evaluated by increased detrusor pressure induced by functional electrical stimulation (FES) of spinal cord segments, spinal roots or the transferred peripheral nerves. The number of dorsal root ganglia (DRG) cells retrogradely labeled with fluorogold from the bladder was counted from the 10th thoracic segment through the 1st coccygeal segment by observes that were blinded to the surgical treatment.

Results
Return of bladder function as determined by increased detrusor pressure in response to electrical stimulation was observed in 8 of the 12 GFNT dogs and 7 of the 8 FNT dogs after direct stimulation of the transferred nerves or stimulation of the spinal cord segment contributing to the transferred nerve origin. In the GFNT animals, a statistically significantly higher urination frequency (and assumption of urination posture) was observed ($p<0.05$), compared to the controls, whereas there was no statistically significant difference between the controls and the FNT animals. Results for the quantitation of DRG neurons retrogradely labeled from the bladder are shown in the figure. Retrograde labeling was observed in L7 DRG in the decentralized animals, roots that were not transected. In contrast, numbers of retrograde labelled neurons in L1-L4 DRG were significantly increased in FNT animals, and in L2, L3 and L5 of GFNT animals, compared to sham/unoperated and decentralized animals.

Interpretation of results
Return of functional electrical stimulation induced detrusor contractions in the majority of GFNT and FNT animals confirms successful motor reinnervation of the bladder. The fact that these reinnervated dogs assume the characteristic urination posture strongly indicates that they have the ability to sense bladder fullness. A near absence of retrograde labelled neurons in DRG from S1-S3 segments of decentralized, GFNT and FNT animals, compared to sham/unoperated, indicates successful decentralization of the bladder from sacral spinal cord segments. The latter result indicates regrowth of axons from upper and mid lumbar DRG through the transferred lumbar originating genitofemoral and femoral nerves to their new target, the bladder.

Concluding message
Thus, it seems very likely that the bladder fullness sensation is being transmitted by sensory afferents in the newly established neuronal pathway. Whether or not sufficient neuroplasticity develops to allow this sensation in the reinnervated pathway to initiate a detrusor contraction for bladder emptying or whether bladder emptying occurs by increasing abdominal pressure with Valsalva straining still needs to be investigated.



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Disclosures

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