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BLADDER REINNERVATION BY NERVE TRANSFER USING A PRIMARILY MOTOR DONOR NERVE (FEMORAL NERVE BRANCHES) INDUCES INCREASED SYMPATHETIC BLADDER INNERVATION

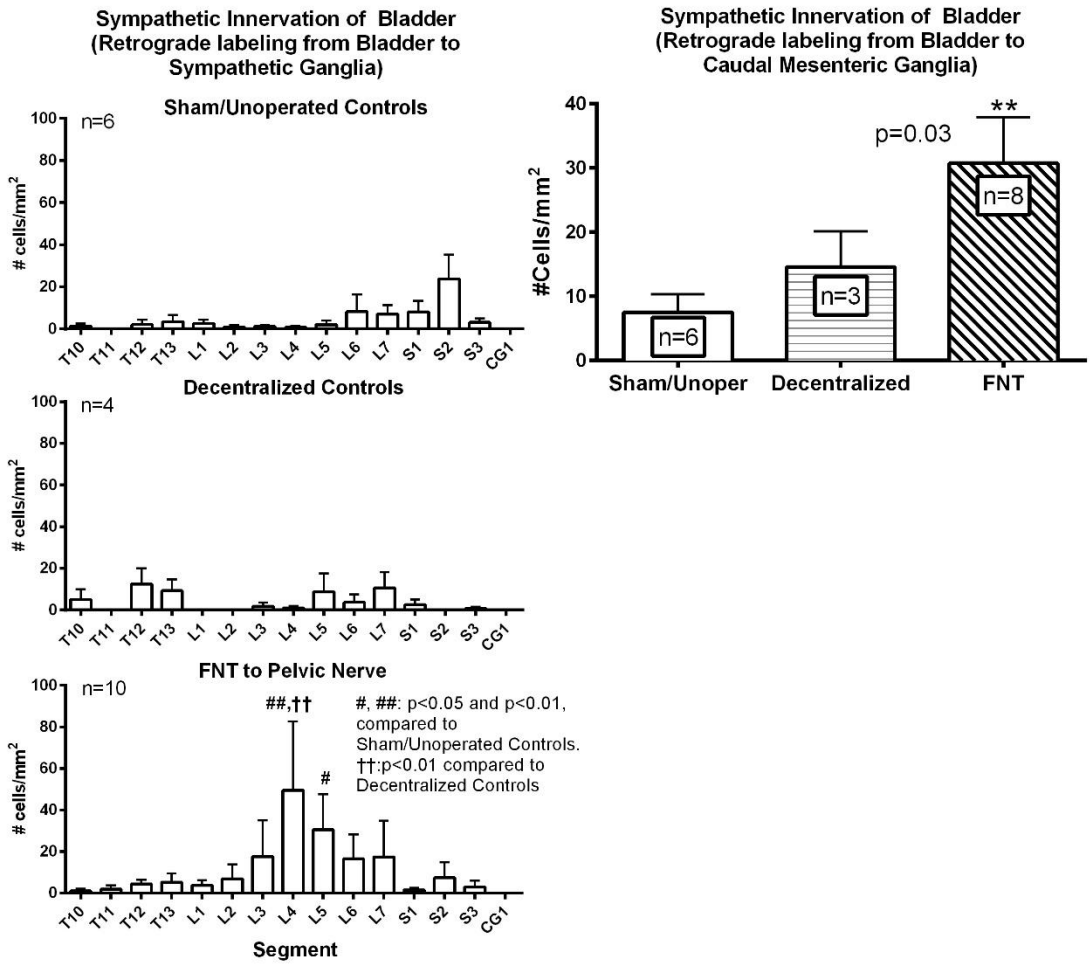
Hypothesis / aims of study
Preganglionic sympathetic axons to the pelvic viscera originate from lumbar neurons and contribute to both the sympathetic chain ganglia coursing the vertebral column length and the caudal (inferior) mesenteric ganglia. Postganglionic sympathetic axons to the urinary bladder originate mostly from L7-S2 sympathetic ganglia and the caudal (inferior) mesenteric ganglion (1,2). We tested the hypothesis that after bladder decentralization and transfer of a lumbar originating somatic nerve (motor branches of the femoral nerve) that postganglionic sympathetic axons will sprout from intact ganglia to reinnervate pelvic viscera, such as the urinary bladder. We also tested whether this surgery induces a similar increased sympathetic innervation of the external urethra sphincter and clitoris.

Study design, materials and methods
A canine lower motoneuron lesioned bladder model was created by transecting all sacral nerve roots that induce increased detrusor pressure using intraoperative electrical stimulation, and all nerve roots caudal to S1. Thirteen female mongrel hounds underwent this bladder decentralization and then femoral nerve branch transfer (FNT) to the anterior vesicle branch of the pelvic nerve (n=10), or remained decentralized (n=3). Six more animals served as sham/unoperated controls (n=3 each). Bladder reinnervation surgeries were performed by transferring branches of the left femoral nerve (FN) to both the right and left anterior vesicle branches of the pelvic nerve in animals with vesicostomy (FNT-V: n=5), or without vesicostomy (FNT-NV: n=5). Bladder emptying in animals without vesicostomies was accomplished by the Credé maneuver during the 8 month recovery period (242±6.2days). Three weeks prior to euthanasia, retrograde nerve labeling dyes were injected: fluorogold into the bladder wall lateral to ureteral orifices, fast blue into the urethral sphincter, and nuclear yellow into the clitoris. At euthanasia, T10 through coccygeal sympathetic ganglia and the caudal mesenteric ganglia were collected and examined for retrogradely labeled neuronal cell bodies.

Results
No significant differences were observed between the FNT-V and FNT-NV animals; therefore, their results were combined. Significantly increased numbers of fluorogold labeled cell bodies were observed in sympathetic ganglia of L4 and L5 segments for the transferred FN in FNT animals, compared to Sham/unoperated controls (L4 $p<0.01$, L5 $p<0.05$). Numbers of fluorogold labeled cell bodies were also higher in L4 related sympathetic ganglia in FNT animals, compared to decentralized controls ($p<0.01$). Low numbers of fluorogold labeled cell bodies were also visible in S1-S3 sympathetic ganglia of decentralized and FNT animals that was not significantly lower than sham/unoperated controls. The caudal mesenteric ganglia contained increased numbers of fluorogold labeled cell bodies from the urinary bladder in FNT animals, compared to sham/unoperated controls ($p<0.01$). Numbers of fluorogold labeled cell bodies from the urinary bladder were slightly higher in decentralized versus sham/unoperated control animals, but not statistically significantly higher. Labeled cell bodies from the external urethral sphincter or clitoris were not significantly different in FNT animals, compared to decentralized or unoperated/sham control animals, and were not observed in the caudal mesenteric ganglia.

Interpretation of results
Transfer of the femoral nerve to the anterior vesicle branch of the pelvic nerve leads to increased sympathetic innervation of the bladder from L4 and L5 postganglionic sympathetic ganglia, segments that did not contribute innervation in sham/unoperated controls and increased sympathetic innervation from the caudal mesenteric ganglion. In the L4 segment, this increase sympathetic innervation in FNT animals was greater than decentralized animals indicating that the process of reinnervation of the bladder by the femoral nerve may induce the bladder to produce factors that stimulates sympathetic nerve sprouting to reinnervate the bladder. Femoral nerve transfer to the anterior vesicle branch of the pelvic nerve did not rescue sympathetic innervation of the external urethral sphincter or clitoris.

Concluding message
This surgical approach may be useful for patients with lower motor spinal cord injury to accomplish bladder emptying, improving their quality of life.



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Disclosures

Funding: The project described was supported by Award Number NS070267 to MRR and MFB from the National Institute of Neurological Disorders and Stroke. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institute of Neurological Disorders and Stroke or the National Institutes of Health. **Clinical Trial:** No **Subjects:** ANIMAL **Species:** Canine **Ethics Committee:** Temple university Institutional Animal Care and Use Committee in accordance with the guidelines of both the American Association of Laboratory Animal Care and the United States Department of Agriculture.