PHYSIOLOGICAL HYPERINNERVATION OF THE BLADDER

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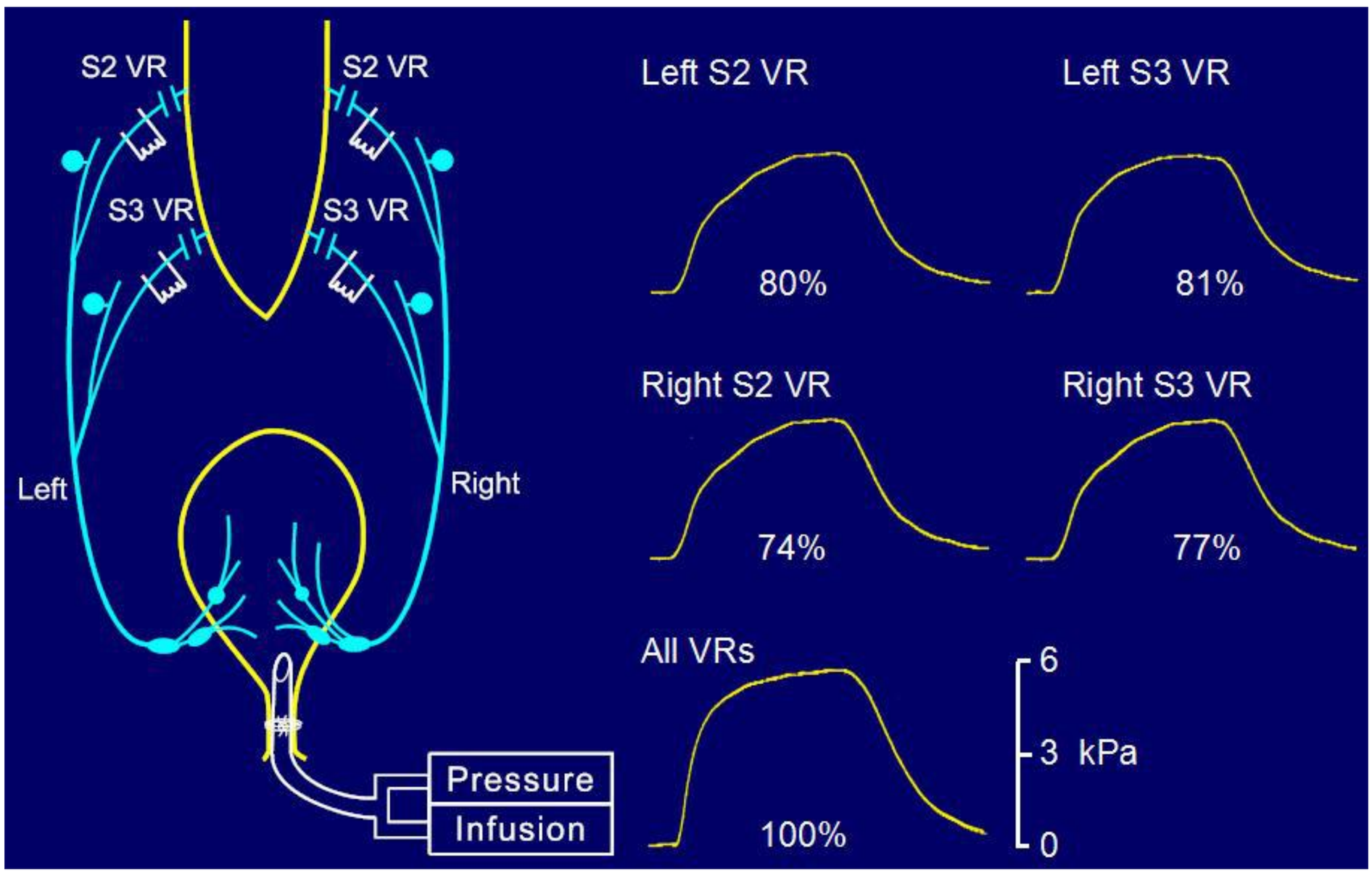
AIMS OF STUDY

Ventral root stimulation is becoming an important procedure to induce controlled bladder evacuation in patients with complete spinal cord lesions [1, 2]. To optimize such treatments it is desirable to better understand the normal motor innervation of the bladder. The aims of the present study was to compare bladder contractions elicited by stimulation of individual ventral roots with that evoked by maximal stimulation of all effective roots. As far as we know, this is the first report on this issue.

Methods and Materials

Adult cats, anaesthetized by alfa-chloralose, were used for the experiments. The bladder was catheterized through a slit in the proximal urethra to allow for fluid infusions and isovolumetric pressure recordings. The S1-S3 roots were exposed by a laminectomy of the L6 and L7 vertebrae and transected close to the spinal cord. The distal ends of the appropriate ventral roots were mounted for electrical stimulation, either individually or together. The stimulation intensity and frequency were adjusted to give maximal detrusor contractions (typically 100 uA, 20 Hz). To eliminate effects of abdominal straining the cats were paralyzed by gallamine and artificially ventilated during the recording sessions.



Results

In cats, the motor innervation of the bladder is provided by the S1-S3 ventral roots, with the S2 roots typically being the most effective. Unilateral stimulation of a single root, either S2 or S3, produced bladder pressures larger than 75 % of the maximal response obtained by bilateral simultaneous stimulation of all effective roots. The algebraic sum of the responses produced by individually stimulated roots was 2-3 times larger than the observed maximal response in the same animal. The non-linear summation (occlusion) of the contractile responses became even more evident if the S2 and S3 roots were subdivided into several rootlets. In such a case the summed effect could exceed the maximal response by a factor of 4-5.

Conclusions

The normal motor innervation of the cat bladder is highly redundant. If the same occurs in humans, only a fraction of the motor fibres would be required to obtain bladder contractions that would be accepted as normal. This possibility should be taken into account when lower motor neurone lesions are evaluated. Effective bladder evacuation by ventral root stimulation may be obtained without a complete set of roots.

Reference

1, Schmidt RA，Jonas U，Oleson KA，et a1．Sacral nerve stimulation for treatment of refractory urinary urge incontinence．Sacral Nerve Stimulation Study Group[J]．J Urol，1999，162(2)：352·357．

2, Schmidt RA．The winding path to sacral foramen neural modulation：a historic chronology. Int Urogynecol J，2010，21(s2)：S431-438．