Editorial

Brain activation during micturition

The paper by Blok et al. (1998) in this issue is the companion of an article published in 1997, which was the first report of PET scanning during micturition, performed in men (Blok et al., 1997). Both the study in men and this one in women have shown for the first time that the neural control of micturition in humans is essentially similar to that established in cats and other animals.

Working on decerebrate cats, Barrington at University College Hospital London demonstrated that the ‘middle pons was the level in the brain at which the motor tone of the bladder arises’ (Barrington, 1921). Some 40 years later Kuru continued studies on cats and suggested that the group of cells in the pons which, when electrically stimulated resulted in a detrusor contraction, be called ‘Barrington’s nucleus’ (Kuru and Yamamoto, 1964). This nucleus, also known as the pontine micturition centre (PMC), was called the ‘M-region’ by Holstege, to distinguish it from the ‘L-region’, a more ventral and laterally sited nucleus which when electrically stimulated, resulted in a strong excitation of the pelvic floor and urethral contraction (Holstege et al., 1986). Ultrastructural tracing studies have demonstrated direct projections from the ‘M-region’ or PMC to the intermediolateral cell column of the sacral cord and the parasympathetic preganglionic bladder motor neurons in the cat (Blok and Holstege, 1997). Injection of radioactive leucine into the ‘L-region’ produced labelled fibres in Onuf’s nucleus (Holstege et al., 1986) which is the motor nucleus containing the anterior horn cells which innervate the sphincters. It was therefore proposed that the ‘M-region’ be regarded the centre for micturition and the ‘L-region’ as being of importance for continence (Griffiths et al., 1990).

From these studies and the work that preceded them, the idea evolved that the control of micturition could be regarded as a process by which higher centres select between alternative conditions of bladder activity, i.e. storage or voiding (de Groat, 1990). The fascination of the PET scanning studies report by Blok and colleagues lies partly in the fact that only a proportion of the male and female control subjects were able to pass urine whilst lying flat in the scanner. The defining paper of Andrew and Nathan drew attention to the importance of frontal regions in determining bladder control (Andrew and Nathan, 1964). In these PET studies again a comparison between those who could and those who could not void in the scanner was interesting. Successful micturition was associated with a significant increased blood flow in the right inferior frontal gyrus (although the increase was less marked in women than in men). It was postulated that activity in this area might play a role in deciding whether or not it was ‘safe’ for micturition to take place. A decreased blood flow was found in the right cingulate gyrus during urine withholding in both men and women, and it was suggested that this might possibly result in a decrease in the urge to void. Clinical studies have shown that lesions in this area are associated with urge incontinence (Andrew and Nathan, 1964). In both studies an increased blood flow in the right inferior frontal gyrus and a decrease in the right anterior cingulate was found in those who could not void. However, the authors caution that it is premature to conclude that one side of the brain controls micturition despite their striking demonstration of activity on the right, even at the level of the brainstem. What little clinical evidence there is about cortical lesions causing bladder dysfunction mostly also points to the importance of the right side.

Interestingly, activity could be demonstrated in the micturition phase in a region thought to correspond to the peri-aqueduct grey (PAG) matter in men, but not in women. Tracing experiments following injection of the lumbosacral cord in animals showed that the major labelling was in the lateral part of the PAG, implying direct connections between the PAG and the ‘M-region’ (Blok and Holstege, 1994), and arguing against an earlier view that bladder afferent information was relayed from the lumbosacral cord to the ‘M-region’ or PMC. Thus it was proposed that the PAG triggers the ‘M-region’ when the bladder contains so much urine that voiding is necessary. The PET study in males appeared to bear this theory out. Holstege’s group has suggested that the PAG is the sensory relay centre for the Emotional Motor System, and the group had therefore proposed that voiding or not voiding could be emotionally determined. The everyday observation that urinary frequency can be a manifestation of anxiety lends credence to this theory. However, as someone who has consistently opposed the view that long-term bladder dysfunction can be an
expression of underlying psychological problems and who has sought an alternative explanation for urinary retention in young women (Fowler et al., 1988), I was interested to see that it had not been possible to demonstrate activity in the PAG in women and thus invoke a major role for the emotional motor system. The current evidence based on the PET scanning studies points possibly to the emotional input to bladder control being more important in men than women.

Clare J. Fowler  
Uro-Neurology, University Department of Clinical Neurology, Institute of Neurology, London, UK

References

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