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Letter to the Editor

Female urethra is actively opened out by an external striated muscle mechanism during micturition, exponentially reducing intraurethral resistance to flow

I am writing to support the findings of Watanabe *et al.*, who showed that the urethra actively opens from the very beginning of micturition.¹ This is important work, as the overwhelming concept at the moment is that the pelvic muscles relax before and during micturition. I present our own work in this field.

In 1990, the integral theory described three vectors acting around the pubourethral ligament: forward, backwards and downwards to activate urethral closure, shown in Figure 1. The theory predicted that immediately before the commencement of voiding, the forward closure vector (pubococcygeus muscle) relaxed.² This allowed the posterior vectors (levator plate and the conjoint longitudinal muscle of the anus) to contract against the uterosacral ligaments to actively open the posterior urethral wall before detrusor contraction, as shown by Watanabe *et al.*¹ X-ray evidence of this external opening mechanism was presented in the second exposition of the theory in 1993,³ and further X-ray and electromyography evidence in 1997.^{4,5}

This external striated muscle mechanism causes the urethra to funnel, exponentially lowering the resistance to flow immediately before the expulsive action of the detrusor, resistance to flow being exponentially determined inversely to the fifth power of the radius.⁶ To find a clinical imperative for such a mechanism, one need look no further than paraplegics: cord transection removes the ability of the pelvic floor muscles to actively open out the urethra; resistance remains high; the head

of pressure generated by the detrusor is insufficient to drive the urine through the urethra.

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Conflict of interest

None declared.

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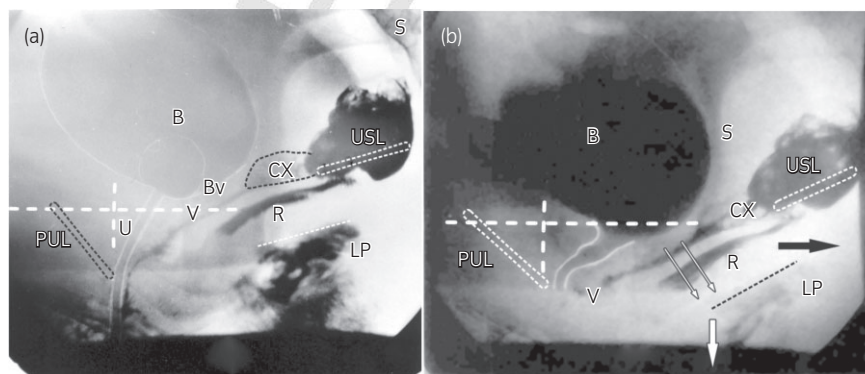


Fig. 1 Normal patient. X-rays (a) at rest and (b) during micturition, the same patient in a sitting position. At rest, slow twitch contractions angulate the bladder (B), urethra (U), vagina (V) and rectum (R) around the insertion of the pubourethral ligament (PUL) at the midurethra; 10 mL of radiopaque material has been injected into the levator plate (LP), vagina and rectum. Vertical and horizontal broken lines indicate bony co-ordinates. (b) During micturition, the urethra has moved backwards and actively opened out, suggesting relaxation of the forward vector and an active mechanism, which stretches the posterior urethral wall backwards. The vagina and rectum appear to have been stretched backwards by a backward vector (arrow). The anterior part of the LP has been angulated downwards, apparently by the downward vector (white arrow) acting against the cervix (CX)/uterosacral ligament (USL) complex. The backward/downward vectors create a diagonal vector force, which seems to be pulling open the posterior urethral wall. S, sacrum.