The morphological characteristics of the bladder contraction in female

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Hypothesis / aims of study
We aimed to assess the bladder contraction patterns in female by contour extraction and tracking using fluoroscopic image sequences.
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We analysed the patterns and amount of the change of the graph at the time of permit to void (PV), onset of flow (OF), maximum flow rate (Qmax), end of flow (EF), maximum detrusor pressure (PdetQmax).
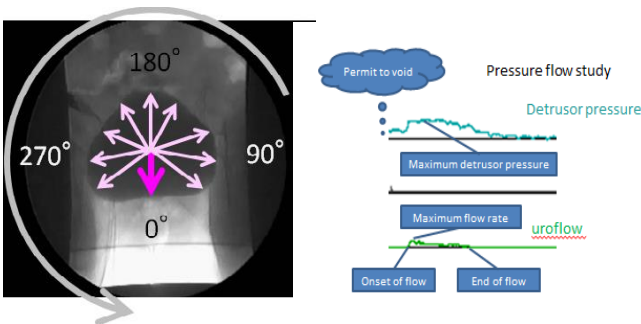

Figure1. Bladder contour and methods to make graph

Study design, materials and methods
We retrospectively identified 9 female patients who underwent videourodynamics at sitting position, according to ICS standards, in 2012 - 2013: mean age 56 – 73 years old, being normal observations. We extracted the bladder contour from X-ray fluoroscopic images during voiding using active contour method. Each pixel coordinate on the extracted contour was projected into a polar coordinate system, which expresses a distance from the centroid of bladder and an angle from the sagittal plane. The wave form of the projected points (graph) was defined as the morphological character of the bladder.

Results
The shape of bladder could be clustered into four patterns by the shape of wave form, two bimodal convex type, one bimodal concave type, four tri-modal convex type, two multimodal type were observed at the time of PV. During PV and OF, change of the morphological pattern became maximum in the voiding phase for most cases. The distance from the centroid around zero degree became long in five females, and the distance from the centroid around 290 degrees and 50-60 degrees became short in three females. The distance from the centroid around zero degree became long in all three females whose post void residual urine (PVR) was less than 50mL.
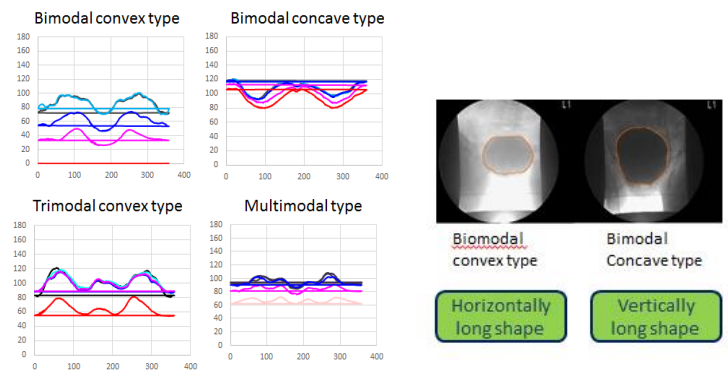

Figure2. The patterns of bladder contour graph

Interpretation of results
This is the first study to visualise bladder motion using videourodynamics (X-ray images) by an image contour extraction method. Previously, the bladder neck opening described as that preceded voiding. Similarly, this study showed by videourodynamics and contour extraction method, that bladder neck open prior to voiding. Since bladder neck and bladder base motion were recorded before voiding, the motion may be come from urethral longitudinal smooth muscle. In latter half of voiding, the bladder contour tended to become small concentrically. In addition, the graph-based bladder shape analysis might be useful to assess the bladder deformation and contraction.

Figure3.

The changes of bladder contour in a case of whose post void residual urine was less than 50mL.

Permit to void   Onset of flow   Maximum flow rate   End of flow
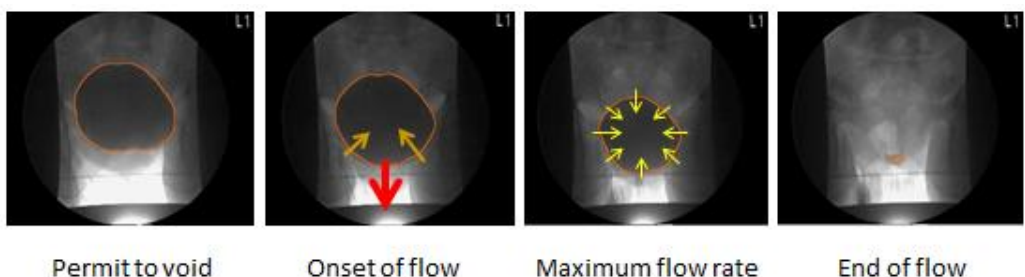
Concluding message
We showed that the change of bladder motion derived the graph using centroid of bladder contour by videourodynamics and contour extraction method. Since bladder neck and bladder base motion were recorded before voiding, the motion might be come from urethral longitudinal smooth muscle. This morphological analysis of bladder contraction may be beneficial to evaluate local detrusor motion and voiding function.