Best Video Abstract

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COMPUTATIONAL FLUID DYNAMICS SIMULATION OF MALE VOIDING: A NOVEL METHOD USING REAL-TIME MAGNETIC RESONANCE IMAGE

Hypothesis / aims of study

To study the mechanism of the urine stream during micturition, we developed a noninvasive magnetic resonance image (MRI) protocol that simulates computational fluid dynamic (CFD) of male voiding.

Study design, materials and methods

MRI uroflowgraphic assessment was done during urinary voiding in the lateral position. To visualize the entire pelvis and urethra, a sagittal plane image was obtained such that a line connecting the coccyx and pubic symphysis could be observed during micturition. In addition, 2 more images were collected, bilaterally, 1 cm from the midplane. Three coronal planar imaging, at the midplane including centerline of urethra, and 1cm back side and front side were performed. We were collected the intermitted images until the end of voiding. Using the total 6 planar MRI digital imaging and communications in medicine (DICOM) files, we created a multiple 3D models during voiding. We created 7 models of normal volateer, to span the duration from initiation to terminal voiding. Those multiple intermitted models were converted to a serial dynamic model with special software. Pressure and velocity of the 3 different sites in the bladder simulation model were measured by CFD software. Those CFD results were compared with simple model. This simple model was artificially made in a shape resembling a balloon.

Results

Deformation of the bladder neck of real model appeared to be very complicated. FCD result showed real-time changes in stream, pressure, and velocity. The actual 3D dynamic model created from MRI data of normal volunteer showed highly intricate urine flow compare with simple model. We measured intravesical pressure in the 3 different site, green point is posterior site, blue point is anterior site and red point near the bladder neck. The intravesical pressures were different depend on the site. The intravesical pressure of the posterior site was highest, and the bladder neck was lowest.

Interpretation of results

We presume the difference of the intravesical pressure depend on the sites in the bladder may produce the stream direction as vortex.

Concluding message

A dynamic 3D model can be created from MRI data using CAD software. This new method is noninvasive and involves no radiation exposure. This dynamic model can be used for computational fluid dynamics simulation. This new method is useful in improving our understanding of the mechanism of urinary voiding.

Disclosures

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