Abstract Reproduction Form B-1

Author(s): Lennox Hoyte, Eboo Versi, Julia R. Fielding, Carl Kolvenach, Ron Kikinis

Double Spacing

Institution City Country: Brigham and Womens Hospital, Harvard Medical School

Double Spacing

Title (type in CAPITAL LETTERS): MR-BASED 3D MODELING OF THE FEMALE PELVIC FLOOR VIDEO PRESENTATION

Introduction

Although many studies have been performed to unravel the mechanisms underlying the genesis of prolapse and genuine stress incontinence due to hypermobility (GSI), the role of the levators remains poorly understood. Nontheless, the levators remain the focus of many non-surgical therapies for the treatment of this condition, but with varying degrees of success [1].

Conventional 2D magnetic resonance imaging (MRI) has been used to assess the anatomy of the female pelvic floor. [2-5]. However, the pelvic surgeon is obliged to operate in a small space in which 3D anatomic relationships are critical to the outcome In order to facilitate a better understanding of the 3D relationships involved in the genesis of pelvic floor dysfunction, we built and analyzed interactively rendered 3D models of living women.

In order to better understand the specific anatomic defects which may be at issue here, we evaluated the morphology of pelvic floor support muscles using 3 dimensional (3D) MR based models of 3 living women: 1) continent, 2) GSI only. 3) prolapse with GSI. Our results are presented in the form of an animated video which shows the reconstructed images from different angles of view.

Aim of Study

This study aims to demonstrate and compare 3D bladder, urethra, and levator ani muscle morphology in living women, using MR-based 3D pelvic floor models.

Methods

Three subjects were enrolled in the study. One subject was a 28 year old para 3 without complaints of prolapse or urinary incontinence. The second subject was a 44 year old para 3 with urodynamically proven GSI. The third was a 79 year old para 7 with a grade IV vaginal prolapse and occult GSI.

Abstract Reproduction Form B-2

Author(s): Lennox Hoyte, Eboo Versi, Julia R. Fielding, Carl Kolvenbach, Ron Kikinis

Each subject underwent an MRI scan in the supine position according to the following protocol: T2-weighted source images were obtained in the axial and sagittal planes using a 1.5T magnet (General Electric Medical Systems, Milwaukee, WI) and a torso phased array coil wrapped around the pelvis. The following imaging parameters were employed: TR=4200msec, TE(eff) =108msec, 128 phase encodes, 24cm field of view, 3mm slice thickness, no gap, 2 acquisitions. The entire sequence was repeated adjusting the slice locations to obtain contiguous images 1.5mm in thickness. Total scanning time was approximately 19 minutes.

After the MRI was completed, data were electronically transferred to the Sun workstation and interleaved. The data were first segmented into anatomically significant components, including bladder, urethra, uterus, vagina, rectum, muscles, and bones and then labeled using a combination of semi-automated and manual editing. From these images, 3D renderings of the pelvic viscera as well as supporting muscle and bones were reconstructed using the marching cubes algorithm and a surface rendering method. 3D surface models were generated, and final results were viewed on a computer workstation. Selected groups of images were then animated and copied onto videotape for presentation.

Results

Many anatomic insights were gained from the interactive 3D images. For example, the reconstructed levator ani muscles appeared to be curved bilaterally, with upward facing convexities. Additionally, the vagina appeared to be H-shaped distally, and flattened in the antero-posterior dimension as it traverses from hymen to fornix. Examples of a 2D axial MR image and a 3D reconstructed view are given in Figures 1 and 2 respectively. Full animation is presented in the video.

Conclusion

Reliable 3D reconstruction of the living female pelvis are possible. They permit unique insight into the the complex anatomy of the female pelvic floor, and may be useful in helping to elucidate causative anatomic defects which may be associated with pelvic organ dysfunction.

References

1. Bo K, *et al.*, *Pelvic floor re-education*, in *Pelvic Floor Re-education: Principles and Practice*, Schussler B, *et al.*, Editors. 1994, Springer-Verlag: London. p. 157-182.
2. Kirshner-Hermanns R, *et al.*, *The contribution of MAgnetic Resonance Imaging of the pelvic floor to the understanding of urinary incontinence.* Br J Urol, 1993. **72**: p. 715-18.
3. Klutke C, *et al.*, *The anatomy of stress incontinence: Magnetic Resonance Imaging of the female bladder neck and urethra.* J Urol, 1990. **143**: p. 563-6.
4. Huddleston HT, *et al.*, *Magnetic Resonance imaging of defects in DeLancey's support levels I, II, and III.* Am J Obstet Gynecol, 1995. **172**: p. 1778-84.
5. Strohbehn K, *et al.*, *Magnetic Resonance Imaging of the levator ani with anatomic correlation.* Obstet Gynecol, 1996. **87**: p. 277-85.

Fig 1: Representative axial MRI slice

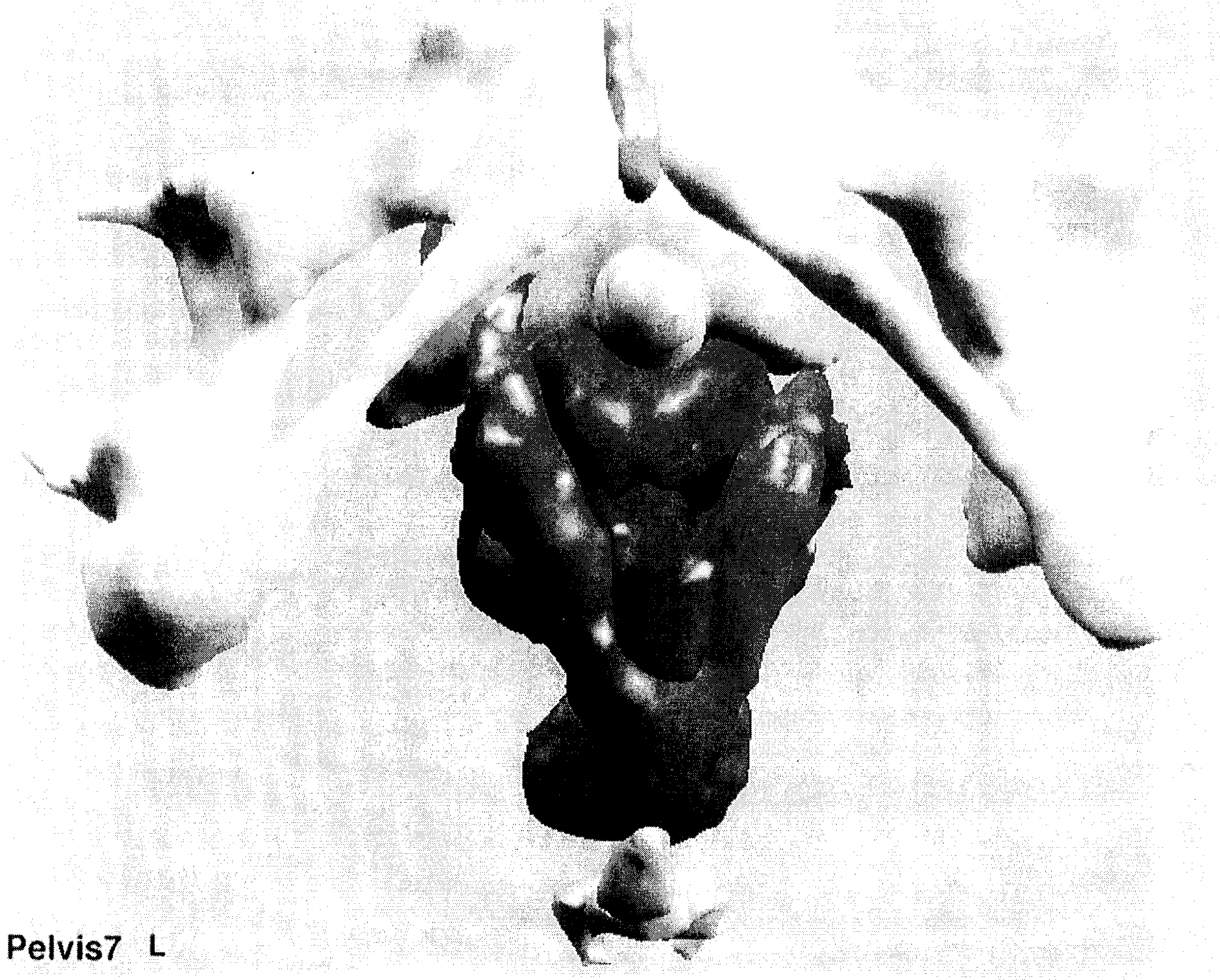

Figure 2: Reconstructed view from the dorsal lithotomy position
Color Legend:

Pelvic bones: white, *Symphysis*: gray, *Bladder*: Yellow
Vagina: fuscia, *Levators*: brown, *Rectum*: blue. *Coccyx*: Beige
(other pelvic structures removed for clarity)