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Title: MAGNETIC RESONANCE IMAGING IN UROGYNECOLOGY

Aims of the study:

The aim of the study was to review the use of the MRI in urogynecology and to describe an original method for the construction of 3D computer models of pelvic floor. Since Mansfeld scanned a part of human body for the first time in the 1976 (a hand finger), the MRI has gone long way. There are three major ways of the use of the method in urogynecology:

1. Static planar imaging

2–dimensional (planar) images can be obtained. Modern scanners offer the resolution, which is superior to any other imaging method. The majority of researchers use axial planes, but virtually whatever plane can be evaluated. The advantage is the use in vivo, without cadaveric changes and without the distortion of the tissue by endoluminal probes or contrast materials. Consecutive slices as thin as 1 millimeter without gap can be analyzed. Unfortunately, several problems hinder the use of planar images. Firstly, it is hard to set a "standard" plane. The inclination of the pelvis differs – it depends on the spine curvature, support of the legs and the tension of various muscle groups. Furthermore, the relation of soft tissues to the bones is very variable. Secondly, the structure of the analyzed organs does not talk about their function and the anatomical proximity of two structures doesn't describe the function of the connection. For example, the thickness of levator muscle in one slice is not equivalent to the strength of the pelvic floor. This also depends on the strength and the position of involved ligaments and on the quality of neuromuscular junctions. Single planar images itself do not contain enough information for correct scientific analysis. At the time, static planar imaging can be mainly used for research and for evaluation of specific difficult cases.

2. Dynamic planar imaging

Modern scanners can obtain signal from one plane with very short time of acquisition. It means, that we can have sharp images of moving organs during various dynamic maneuvers (squeezing, Valsalva). The position and mobility of pelvic floor and other organs can be described with great accuracy. The cornerstone of urogynecology, the urethral mobility, can be analyzed not only in its proximal part (bladder neck), but in its whole course. It is also possible to record the rectal equivalent of the intraabdominal pressure simultaneously. The main drawback is, that we can only scan one plane at a time.

3. 3-dimensional modeling

It's clear from the physical principle of the MRI, that the system works with spatial coordinates (three dimensions). In practice, certain properties are assigned to a unit of space, whose position is precisely described in space. The technology of spatial computer modeling has been used for long time in industry and in some

medical specialties. Computer can create a model almost automatically, if there is enough contrast. This can be either natural (bone, lung) or artificial after application of contrast media. Because the soft tissue of female pelvis give only small contrast, the method has not been widely used in urogynecology. Computer cannot trace the contours of different organs automatically, but the experienced human assistance is necessary. Apart from the definite criteria given by signal density, the logic of the curves has to be followed. This is a source of inaccuracy, but it seems to be the only way to use the potential of the MRI at the time.

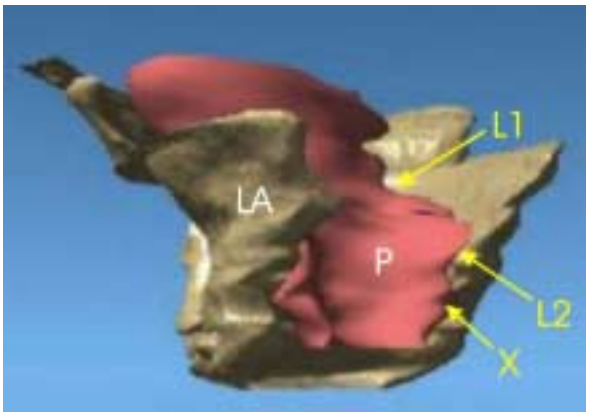
Methods:

After signing informed consent, 5 patients with genuine stress incontinence were involved. Axial images from the level of uterine cervix to the distal anal sphincter were used (Siemens 1.0 T, pelvic phased array coil, slice thickness 3 mm, gap 0.9 mm, T2-weighted images). After emptying via catheter, the urinary bladder was filled with 300 cc of sterile saline. No other contrast media was used. We used the Rhinoceros 1.1© software (Bob McNeel and Associates, Inc.) for computer modeling. At first, each slice is assigned to its real position. Secondly, the contours of the followed organs are drawn in each slice (bony pelvis, urinary bladder, urethra, vagina, uterus, rectum, levator ani muscle, obturator internus muscle, sphincter ani externus muscle and urogenital diaphragm). The virtual surfaces of the followed organs are created from the contours by “lofting”. This is a widely used standard surface modeling routine.

Results:

3-dimensional models were used to study many details that can be hardly visualized by any other method. Both different views and movie clips can be generated. Each organ can be described by its mass, thickness, geometry and relation to other structures. A sample view is shown in the figure 1.

Figure 1 – The relation of the vagina to the levator ani muscle



P – vagina (red), LA – levator ani muscle, L1 – DeLancey level I, L2 - DeLancey level II, X – the level of urogenital diaphragm.

Conclusions:

MRI is a method, which has the potential to answer many questions about function of female pelvic floor. It offers data that can be mathematically analyzed. The next step in the research seems to be the combination of spatial model with dynamic examination. This would enable to evaluate the biomechanics of whole organs. Because the MRI is non invasive and can be freely repeated, we can thoroughly study not only normal and pathological

situations, but also the effect of various surgical procedures. Hypothetically, the described methods could be used for virtual surgery planning in the future.

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