BRIEF REPORT

EFFECTS OF A MAGNETIC FIELD ON PELVIC FLOOR MUSCLE FUNCTION IN WOMEN WITH STRESS URINARY INCONTINENCE

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Context • Magnetic fields have been found to affect neuromuscular function.
Objective • To study the effect of a magnetic field on measurements of urethral function in women with stress urinary incontinence.
Design • Observational comparative study.
Setting • Consecutive patients in a continence center.
Patients or other participants • Twenty-six consecutive women with diagnosis of stress urinary incontinence (SUI).
Evaluation • History and physical examination, neurologic exam, urothrocystoscopy, urodynamic testing with water-filling cystometry, urethral profilometry at rest, during coughing, and during coughing while performing a levator ani contraction (knack maneuver).
Intervention • The same urodynamic procedures were performed again after the subjects were asked to step on specifically designed magnets (magnetic cushion device).
Statistical analysis • Two-tailed student t test.
Main outcome measures • Urethral pressure at rest, during coughing, and during coughing while performing a levator ani contraction.
Results • Mean age was 58.3 years (range: 36-81), mean parity 2.8 (range: 0-8). The urodynamic parameters measured without and with the use of the magnetic cushion device were not found to be different except for the knack maneuver. The pressure in the urethra during the knack maneuver while the subjects were stepping on the magnetic device was significantly higher than the 1 obtained without the magnetic field.
Conclusion • In our patient population, a magnetic field increases the efficacy of voluntary levator ani contractions. (Altern Ther Health Med. 2004;10(3):70-72)

Stress urinary incontinence (SUI) affects 13 million Americans a year, at a cost of $16 billion.¹ The US Department of Health and Human Services recommends that nonsurgical treatment may be attempted before surgical options are employed, reserving surgical treatment modalities for patients unable to respond to conservative procedures.² Nonsurgical modalities include pelvic muscle training, devices such as pessaries,³ urethral plugs,³ as well as supportive rings,³ and electrical and magnetic stimulation.³

The correct performance of Kegel exercises is time-consuming and intense, because it requires detailed instructions and consistent commitment by the patient and health care provider. For clinically significant results, lengthy training involving frequent repetition is needed for adequate results.³ While electrical stimulation may increase the efficacy of such exercises, it has not gained popularity in the United States perhaps due to the discomfort felt upon insertion of electrodes or needles into the pelvis.

Treatment with a magnetic field has been recently introduced as an additional tool in the management of SUI. This is administered while the patient is sitting on a chair that delivers rapidly changing magnetic impulse.⁴ The cost of the chair and the need for biweekly sessions may be obstacles for a widespread use of this technology. As an alternative, a new concept of simple magnetic field stimulation has recently emerged. A magnetic device worn as a shoe cushion (Nikken USA, Irvine, Calif.) can create a constant magnetic field that may affect the muscle tone in a different manner than does electrical stimulation or the magnetic chair, which uses electric or magnetic energy in a pulsatile fashion.

The purpose of this study was to test the effect of the magnetic shoe cushion device on the urethral sphincter function of women with SUI.

MATERIALS AND METHODS

Twenty-six consecutive women who presented over a 3-month period at the Gynecology and Continence Center, Encino, Calif., and were diagnosed with urodynamic SUI agreed to participate in the study. The evaluation included history and physical examination (with special emphasis on neurologic screening tests of S2 and S4 lower micturition center), negative urine culture, cotton swab test (change of cotton swab angle between resting and straining, measured with an orthopedic goniometer with patients in the lithotomy position), dynamic water urothrocystoscopy, standing provocative water urothrocystometry (at filling rate of 60 ml/min), and urethral profilometry. Pressures in the abdomen (approximated by vaginal recording), bladder, and urethra were measured simultaneously with two microtip (4Fr in diameter) pressure transducers (models...
Urethral pressure profilometry was measured with a symptomatically full bladder at rest in the sitting position, at maximal pelvic floor muscle contraction (the woman was asked to "hold her urine"), during repeated coughing, and during coughing while contracting the pelvic floor muscles in an attempt to hold urine (knack maneuver). Urethral pressure profilometry, using the same maneuvers, was then repeated while the patient stepped on the specifically designed magnets. Each of the different phases of the urethral profilometry was repeated 3 times, and the mean value was calculated. Prior to the urodynamic testing, each patient was instructed on the correct performance of the levator ani contractions and the knack maneuver. The test was started only after each patient was able to perform the task. Pressure transmission ratio was calculated by dividing the urethral pressure (measured at midurethra) by the bladder pressure and multiplying the result by 100.

All terminology conform to that proposed by the International Continence Society except where specifically mentioned. Two-tailed paired t test was used for statistical analysis of the data.

## RESULTS

All twenty-six women completed the study. The mean age of patients studied was 58.3 years (+14.5) (range 36–81). Mean parity was 2.8 (+1.4) (range 0–8). Mean weight: 163 lb (range 122–204 lb). Nineteen of the 26 were postmenopausal, 10 of whom were on estrogen replacement therapy. Six subjects had undergone incontinence surgery in the past. None of the subjects was found to have intrinsic sphincteric deficiency, defined as a maximum urethral closure pressure < 20 cm of water.

The urodynamic parameters measured with and without the use of the magnetic cushion device were not found to be different, except during the knack maneuver (Table 1). When subjects performed the knack maneuver while standing on the magnetic cushion device, the pressure transmission ratio was significantly higher than the 1 obtained without the device (Table 2).

## DISCUSSION

Our data suggest that the magnetic cushion device increases the efficacy of pelvic muscle contraction performed while coughing (knack maneuver). The magnetic cushion has little effect on other urethral parameters, such as urethral pressure at rest, during maximal contraction, and while coughing. Likewise, the pressure-transmission ratio during cough was similar with or without the magnetic cushion.

The weakening of the urethral sphincter and its support is one of the factors leading to SUI. Anatomic support to the bladder neck and urethra is provided by the endopelvic fascia, attached on each side of the pelvic wall to the arcus tendineus fasciae pelvis. The striated urethral sphincter is functionally integrated with the levator ani muscle complex. According to Delaney's theory, a hammock effect involving these fascial structures and muscles maintains continence during stress. In continent women, when the intra-abdominal pressure increases, the urethra is pushed against a well-supported endopelvic fascia, the urethra collapses, and urine is held inside the bladder. In addition, coughing seems to start a reflex contraction of the urethral sphincter complex. Therefore, intact endopelvic fascia and adequate urethral sphincter are very important to maintaining continence.

Fast-twitch muscle fibers contract during coughing, while slow-twitch muscle fibers sustain contraction around the urethra and add basic muscle tone to the pelvic floor. Performance of pelvic muscle exercises (Kegel exercises) strengthens the levator ani muscles by repetitive voluntary contractions. These exercises strengthen slow-twitch muscle fibers only, unless the patient is instructed to alternate slow tonic contractions with fast ones.

Electrical stimulation has been used to excite pelvic floor muscle fibers, leading to muscle contraction and urethral closure. It has been shown that electrical stimulation can aid in restoring continence by stimulating the pudendal nerves and activating pelvic floor muscles. Electrical currents can be delivered intravaginally with a vaginal plug, percutaneously with a surface electrode or needle, or intra-rectally with an anal electrode. General

| TABLE 2 Comparison of pressure transmission ratios generated in the urethra during the knack maneuver with and without the magnetic cushion device |
|---------------------------------|-----------------|-----------------|-----------------|
|                                 | Without magnet | With magnet     | p               |
|                                 | (mean ± SD)    | (mean ± SD)    |                 |
| PTR* Knack cm of water          | 106.03(± 16.77)| 119.30(± 18.66)| 0.0003          |

* pressure transmission ratio

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success rates of 50% to 90% have been reported for electrical stimulation treatment of stress incontinence.26

Two main problems limit the usefulness of electrical stimulation therapy. First, insertion of electric probes is often uncomfortable for the patient. Second, electric currents induced by electrical stimulation weaken due to the impedance of the tissues between the electrodes and the target nerves. This decrease in magnitude is marked in bone-encased nerves, such as nerves of the spinal cord or of the motor cortex of the brain, but is also significant when the current must pass through skin and subcutaneous tissues, both of which have high impedance values. To counteract the decrease in electrical magnitude, strong electrical currents must be used during therapy, activating pain receptors and leading to discomfort. Unlike electrical fields, magnetic fields penetrate all body tissues without alteration, decreasing in magnitude proportionally to the inverse of the square of the distance between the target tissue and the magnetic source.

Magnetic stimulation, therefore, promises distinct advantages over electrical stimulation to induce muscle contraction. Assuming charged particles are present, a changing magnetic field will lead to a flow of electrons, inducing current in human tissue. Subsequent depolarization of motor nerves triggers release of neurotransmitters, leading to muscle contraction. While the overall mechanism by which magnetic stimulation causes muscle contraction is similar to the mechanism by which electrical stimulation achieves the same goal, magnetic nerve stimulation is noninvasive and painless. Since magnetic fields penetrate clothing and are undetected by impeding tissues, they can penetrate into deep nerves without alteration of field strength.23

Continuous magnetic stimulation has the potential to be effective in treating SUI.23 This technique, when applied to the pelvic area, was found by Yamanishi et al to increase the maximum intraurethral pressure during stimulation as well as the maximum urethral closure pressure after treatment in healthy, young volunteers (mean age: 24.5 years). Our data suggest that while magnetic stimulation affects dynamic parameters such as the efficacy of the knack maneuver, it has little impact on other parameters, such as urethral closure pressure at rest, urethral closure pressure during pelvic muscle contraction, and pressure-transmission ratio while coughing. The different findings in these 2 studies may be explained by the different methods of delivering the magnetic energy (to the pelvis versus in the planter region) and by the different mean age of the subjects (58.3 vs 24.5 years). With our findings the objection may be raised that the higher pressure generated with the knack maneuver with the magnets in place may be the result of the training of the subjects with the repetition of the maneuver. We tried to minimize such a possibility by repeating the measurement of each parameter 3 consecutive times with and without the magnets in place. Because of such repetitions, it is also possible that the subjects were fatigued when the second set of measurements (with the magnets) took place, thus actually strengthening the value of our results. Unfortunately, with the data available, we cannot prove either condition.

The mechanism of action of the magnets is not clear. It can be hypothesized that the magnets may affect energy meridians or work by retrograde potentials through peripheral nerves. This last hypothesis may be associated with the findings that posterior tibial nerve stimulation is effective in the treatment of urge incontinence.24

CONCLUSIONS

In our study population, we found that even if the magnetic shoe cushion device does not stimulate a pelvic floor contraction, it appears to increase the efficacy of the knack maneuver; in essence, what the shoe cushion device achieves is an enhancement of the contraction of the pelvic floor muscles during coughing. This provides adequate support of the urethra when it is most needed. The long-term effects, as well as the precise electrophysiological mechanism by which muscle contraction is affected by the magnetic field, should be subject for future study.

References


