

A Nonsurgical Method of Increasing the Tone of Sphincters and their Supporting Structures

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1948**

Every physician has had occasion to observe that six months after a well performed vaginal repair with construction of a tight, long vaginal canal, the tissues, especially the perineum, will again become thin and weak. It was this repeated observation which first aroused the author's interest in the physiology of the pelvic musculature.

Everyone agrees that suitable exercises will improve the function and tone of weak stretched, atrophic muscles. A point in fact is the correction of faulty posture. Why then would it not be possible to restore through active exercise the normal anatomic relationships of pelvic structures, since they depend so largely for their support on various muscle groups? In the study of this problem, which we have carried out over a period of 18 years, we have become greatly interested in one muscle, the functional importance of which has been largely overlooked by anatomists, obstetricians, and gynecologists alike - the pubococcygeus. This muscle, when observed in emaciated cadavers, is in such a state of atrophy that it would seem to be capable of little function. As in Figure I, the surgeon who operates from below encounters only the more superficial muscles of the vulvar outlet and perineal diaphragm. This is true also of prophylactic episiotomy. Similarly, operations from above rarely include the pubococcygeus. It is for these reasons that the importance of this muscle has not been fully recognized.

Attention has been focused on the pubococcygeus by the studies of Barry J. Anson with Curtis and McVay who, in dissections of young female cadavers, demonstrated for the first time that the pubococcygeus gives off innumerable fibers which interdigitate and insert themselves into the intrinsic musculature of the proximal urethra, middle third of the vagina and rectum.

Our own study in the dissecting room, in surgery, and in animal experiments, as well as observations of the effect of exercise in several thousand patients, has led us to conclude that the pubococcygeus is the most versatile muscle in the entire human body. It contributes to the support and sphincteric control of all pelvic viscera and is essential for maintaining the tone of other pelvic muscles, both smooth and striated.

After having been stretched over a wider range than any other skeletal muscle, the pubococcygeus can regain physiologic tension and, as we have demonstrated, it is able to recover its function after many years of disuse and partial atrophy.

Palpation demonstrates that in a normal pelvis with the viscera in their normal position, the pubococcygeus and all of its components are well developed. However, when genital relaxation has occurred, this muscle is found to be weak and atrophied.

Genital muscle relaxation, as manifested by urinary stress incontinence, cystocele, or prolapse of the uterus as well as certain types of lack of sexual appreciation, is always associated with - even if not directly due to - dysfunction of the pubococcygeus. This fact has been borne out by the success of non-surgical treatment of these conditions, applying the general principles of muscle education and resistive exercise to the pubococcygeus as the pivotal structure of the pelvic musculature.

The fasciae are not discussed here for the reason that, whether injured or intact, they depend upon their muscular attachments for nourishment, viability, tone and tensile strength. When grossly disrupted they remain a surgical problem.

Diagnosis

A firm vaginal canal, well closed to a high level, indicates normal development of the interdigitating fibers of the pubococcygeus. Loss of tone and prolapse of the vaginal walls, as is found in genital relaxation, signify weakening and thinning of these minute branchings. The musculature of the middle third of the vagina is readily palpated by means of the index finger introduced up to about the second joint, or 3 to 5 cm beyond the introits.

In the normal vagina, the canal is tight and the tissues offer a degree of resistance from all directions. The walls close in around the finger as it is inserted, moved about, or withdrawn. Upon palpation, the walls of the middle third of the normal vagina feel firm throughout, and adjacent tissues give the impression of depth and good tone because the terminal fibers of the pubococcygeus are well developed and are attached to the intrinsic tissues of the vagina over a wide area.

In genital muscle relaxation on the other hand, the findings are decidedly different. Whether the introitus is gaping or tight, the vaginal canal in its middle third is short and roomy in all directions. The walls offer little resistance to the palpating finger and feel thin and loose, as if detached from the surrounding structures. The tissues between the palpating finger and the symphysis or rami of the ospubis are thin, tender, and of poor quality. From this it can be concluded that the muscular structures in the perivaginal regions are atrophied, particularly the terminal fibers of the pubococcygeus.

Vaginal examination as described up to this point differs little from the usual technique practiced for the past hundred years. The physical status of the perivaginal tissues has thus been ascertained, but the cause of weakness and atrophy has not been determined. To this end it is necessary to investigate the functional status of the supportive and sphincteric muscles of the pelvic outlet, especially of the pubococcygeus.

The first step in the examination for function is to observe whether by voluntary effort the patient is able to retract, draw up, or draw in the perineum. Next, the index finger is introduced into the middle third of the vagina, and the patient requested to contract upon it. Normal patients will respond immediately, and a firm grip upon the finger is felt over a wide area.

Others, lacking awareness of function of the pubococcygeus, will not respond to the instruction and will often state that they did not know that it was possible to contract vaginal muscles. It is in this group of patients that palpation demonstrates the atrophy of disuse.

The digital method of ascertaining the presence of contractions of the perivaginal muscles should be supplemented by the diagnostic use of the Perineometer. With this instrument, strength of contractions in the middle third of the vagina as well as the width of the contracting area can be measured and a progress chart of record kept to follow the results of therapy.

The Perineometer is a simple, pneumatic apparatus consisting of a vaginal resistance chamber connected with a manometer calibrated from zero to 100 mm. Hg. The resistance chamber measures 2 cm. in diameter and 8 cm. in length and is formed by a cylindrical rubber diaphragm stretched to a specific tension between two flanges on a metal stem. The vaginal parts of the Perineometer conforms to the approximate dimensions of the normal vagina and is so designed that pressure over a wide area will result in higher readings than pressure of identical strength applied to a narrow area. The vaginal chamber is compressible, without significant compensatory expansion.

The specifications of this simple apparatus were established after 18 years of experimentation with more than 30 different types of instruments. Only in rare cases, when the vagina has

been greatly shortened through surgical intervention or radium therapy, will it be found necessary to reduce the size of the vaginal chamber of the instrument.

When the resistance chamber is introduced, a slight rise on the scale of the manometer will be noted even before the patient exerts any effort. This represents the static pressure which in a normal vagina amounts to 15 to 20 mm. Hg. and indicates good muscle tone and tissue resistance over a wide area.

In genital relaxation, muscle tone is poor and tissue resistance is limited to a narrow area. Consequently, in such cases the initial pressure is low, about 10 mm. Hg.

Contractions of a normally developed pubococcygeus are registered by a prompt increase in manometric reading to 20 mm. Hg. or more above the initial static pressure. Lack of awareness of function and degrees of atrophy of the pubococcygeus are reflected by a small or almost imperceptible increase in pressure, usually less than 5 mm. Hg. Intermediate readings may be obtained in patients having awareness of function but only a narrow, poorly developed or partially atrophied pubococcygeus muscle. *In measuring function of the pubococcygeus, it must be made certain that the patient is not using extraneous muscles, such as those of the abdominal, gluteal, or introital regions.*

Therapy

Physiologic therapy of genital muscle relaxation is divided into two phases or steps: (1) specific muscle education and (2) resistive exercises of the pubococcygeus and its visceral extensions.

Specific Muscle Education

The first and most important step in therapy is muscle education. This is directed toward establishing adequate awareness of function of the pubococcygeus, which is the pivot of all supportive and sphincteric structures of the pelvis.

At the first office visit, approximately one third of all patients will be unable to contract the pubococcygeus voluntarily, or to only a questionable degree. When such is the case, palpation is continued until the examiner finds among the contiguous muscles, one which is under the patient's control. With this as a starting point, contractions of the contiguous muscle are continued and varied until the pubococcygeus itself is affected by such muscular movements.

The contractility of the pubococcygeus can be determined most readily in its anterior portion, where the fibers converge toward attachment to the os pubis, and posteriorly near the coccyx. In order to demonstrate contractions near the pubis, the postero-inferior margin of the symphysis is identified with the index finger, which is inserted only to the second joint. The tip of the finger is passed laterally from the midline for about 0.5 to 1.0 cm. until the tendinous medial margin of the pubococcygeus is encountered; the margin is then followed downward for a short distance, approximately to the level of the urethra. At this point, contractions of the pubococcygeus, if present, are felt as a tensing of its medial margin, which may feel like a thin sheath, or it may be as broad as thick as a finger.

The pubococcygeus is palpated for function on both sides. Occasionally, unilateral impairment due to injury is revealed. In identifying the pubococcygeus, it should be remembered that congenital variations occur in its aponeurotic attachments.

Posterior contractions of the pubococcygeus are identified by inserting the finger deeply into the vagina or rectum. When palpating in the midline, the pubococcygeus can be felt near its attachment to the coccyx. With the finger in contact with the muscle, the patient is requested to contract it. Normally it will be noted that the posterior portion of the muscle has the ability to rise upward for a distance of 2 to 4 cm.

If there is lack of awareness of function of the pubococcygeus, no such voluntary action can be elicited. The patient is then requested to draw up or draw in the anus as though checking a bowel movement. Pressure may also be applied with the tip of the finger to aid the patient in identifying and contracting the pubococcygeus. If no response is forthcoming, pressure is increased to the point of discomfort, and the patient instructed to pull the muscle against the finger. In obstinate cases, reflex contractions may be produced by pricking the skin lateral to the anus. Repetition of any such action of the pubococcygeus for several minutes will usually enable the patient to continue the same contractions through voluntary effort. To make certain that the contractions elicited are those of the pubococcygeus and not of the iliococcygeus, they are followed anteriorly until they can be felt as tensing of the medial margins of the muscle at the level of the urethra.

Under the guidance of the physician, the patient who initially lacked awareness of function of the pubococcygeus has at this point learned that the muscle can be contracted voluntarily. Since therapeutic results can be expected only from frequent repetition of active contractions of the pubococcygeus, these efforts are now described in terms of muscular functions of which the patient is cognizant.

With his finger on the medial margin of the pubococcygeus at the level of the urethra, the physician instructs the patient to (1) squeeze the vaginal muscles upon the palpating finger; (2) draw up or draw in the perineum; (3) contract or draw up the rectum as though checking a bowel movement; (4) contract as though interrupting the flow of urine while voiding.

The examiner makes sure that while performing these movements the patient is actually contracting the pubococcygeus and not merely muscles around the orifices. It must be emphasized that woman with poor function of the pubococcygeus have all their lives compensated for this deficiency by depending for support upon the fasciae and the more superficial muscles.

If the pubococcygeus is not functioning the following will be observed:

1. When an effort is made to draw up or draw in the perineum, no actual retraction occurs. Instead there is a tightening of the gluteal muscles together with sphincteric action which is confined to the introital group of muscles, including the bulbocavernosus, the transverse perinei, and the superficial pillars of the levator ani.
2. In the effort to contract as though to stop the flow of urine, only a slight twitching of the meatus of the urethra is observed, without retraction of the urethra itself or of the vaginal tissues overlying it. These shallow, superficial contractions are in themselves of no value in the prevention and treatment of genital relaxation and urinary stress incontinence.
3. When contracting as though to check a bowel movement, the action is limited to puckering of the anus, and no retraction of the anus is observed.

The patient may be permitted to repeat these superficial contractions temporarily, but she is urged to try to transfer them to a higher level of the pelvic outlet, until contractions of the pubococcygeus muscle are felt by the palpating finger.

Approximately 75 percent of patients will respond after 10 to 20 minutes of instruction. In other instances, considerable patience is required and the instructions must be repeated at weekly intervals, occasionally over a period of many months, before the patient learns to contract the pubococcygeus. In exceptional cases, the attempt to establish awareness of function fails completely. This is usually due to concomitant lesions of the central nervous system.

Establishment of awareness of function of the pubococcygeus is essential. No clinical results from physiologic therapy can be expected without activation of this muscle.

Resistive Exercises

Very few women who initially lack awareness of function of the pubococcygeus will be able to continue correct contractions of this muscle at home after instruction in the office. Since they are unable to coordinate their muscles through the usual reflexes, it is necessary to establish a connection between contractions of the pubococcygeus and the sense of sight. Also, unless given an opportunity to repeat their efforts under visual control, thereby noting any progress they may make, patients are apt to become discouraged. A simple, direct, and reliable means to overcome these difficulties is the Perineometer. The last phase of office procedure is devoted to instructing the patient in the use of this apparatus.

In addition to visual control, this instrument provides a means of contracting the perivaginal muscles against resistance. Resistive exercises of this type have proved most effective in all branches of muscle therapy for the correction of disuse atrophy and for restoration of normal function. Resistive exercises are designed to strengthen the pubococcygeus in all its components, especially the minute end-fibers which, in genital relaxation, have undergone atrophy. This muscle is not accessible to any other therapeutic measure, and its function is rarely improved by surgical procedures.

With the vaginal chamber of the Perineometer in place, the physician watches the manometer while the patient repeats for several minutes those efforts of which had been found to result in contractions of the pubococcygeus muscle. If the patient who had previously lacked normal awareness of function uses the pubococcygeus, only irregular and weak contractions can be expected. The indicator will show only a slight rise, between 1 and 5 mm. Hg.

The patient herself watches the manometer while continuing the same efforts. If contracting correctly, she is instructed to continue the same exercises at home for 20 minutes three times daily.

In addition to these exercises, the patient is advised to repeat the same contractions without the apparatus many times a day. The more frequently correct contractions are repeated, the sooner will the muscular function be established as a reflex that does not require any further voluntary effort.

About 50 percent of all patients who start their exercises correctly will, during the first few weeks, lapse back into the old habit of using extraneous muscles instead of the pubococcygeus. Therefore, it is necessary to re-examine and re-instruct at weekly intervals for one month, and thereafter as often as necessary to insure correct use of the Perineometer. In this respect, a progress chart kept by the patients is of great value.

Complaints of fatigue, aching muscles of the back and abdomen, and nervous irritability following exercises are usually due to unnecessary use of extraneous muscles.

OBJECTIVE EVIDENCE OF IMPROVEMENT

In patients who exercise correctly and diligently, the following progressive changes will occur:

1. Establishment of awareness of function of the pubococcygeus.
2. Slight, gradual increase in initial manometric readings from a level of 1 to 5 mm. Hg. to as high as 20 to 40 mm. Hg. or more.
3. Muscular contractions can be felt in areas where none could be demonstrated before, especially in the anterior and lateral quadrants of the vaginal wall.
4. Contractions of the pubococcygeus which at first were weak and irregular became strong and sustained.
5. Improvement in tone and texture of all musculofascial tissues of the pelvic floor and outlet takes place.
6. Increased bulk of the pubococcygeus and its visceral extensions becomes evident.

7. Changes occur in the position of the perineum, introitus, urethra, bladder, neck, and uterus in relation to an ideal line drawn between the os pubis and coccyx.
8. The vaginal canal becomes tighter and longer.
9. The vaginal walls, which formerly were flaccid, improve in tone and firmness.
10. Bulging of the anterior vaginal wall (often diagnosed as moderate cystocele) becomes less pronounced.
11. Prolapsus of a freely movable uterus, when present, with cervix presenting near the level of the introitus is usually improved, and in some instances the cervix has ascended to as high as 5 to 7 cm. above the introitus.
12. Supportive pessaries, worn for as long as ten or more years, can usually be discarded without return of discomfort.
13. Patients can be fitted with smaller contraceptive diaphragms, whereas diaphragms of larger size formerly slipped out of place.

Therapy

Urinary Stress Incontinence

Muscle education and resistive exercise with the Perineometer produce dramatic results in the treatment of true urinary stress incontinence. This type of incontinence must be distinguished from urge incontinence caused by various pathologic conditions involving the upper urinary tract, such as infections, strictures of the ureter, stones, diverticula, developmental anomalies, etc.; incontinence due to fistulae; and spastic incontinence due to spinal cord changes following injuries, poliomyelitis, multiple sclerosis, etc.

In simple urinary stress incontinence, control of the urinary outlet is partially lost with coughing, sneezing, laughing, or other sudden strains. In the past, women tolerated this annoying and embarrassing condition with all its undesirable psychological effects because it was felt that the conditions did not warrant surgical intervention.

With physiologic therapy, complete relief from simple urinary stress incontinence has been consistently obtained in a series of over 700 cases of this type.

As some degree of awareness of function is initially present, the response to muscle education is prompt. Symptoms usually show improvement within two weeks after starting resistive exercises using the Perineometer. Lasting relief, however, depends on firm establishment of muscle reflexes and strengthening of muscular structures.

In severe urinary stress incontinence, dribbling is constant or intermittent. Patients with this degree of incontinence have ceased to make an effort to control the flow of urine, depending on pads and tampons. The normal reflexes of urination have been practically lost.

In these cases, because the pubococcygeus has been little used for many years, the muscle is atrophied. Often there is a history of so-called "bladder weakness" dating from childhood, aggravated by childbirth, severe illness, injury, menopause, senile changes, or pelvic surgery. Cases of this type have in the past been treated by surgical intervention, often with disappointing results.

The first step of physiologic therapy, muscle education, must be carried out meticulously and with great patience in this group. It is often necessary to repeat instructions at weekly intervals for many months.

Since these patients are trying to contract muscles which they probably have never before in their lives used voluntarily, they are likely to employ those of the abdominal and gluteal regions. It is therefore necessary to re-instruct patients carefully during weekly office visits and, at the same time, prevent them from becoming discouraged in their efforts.

As awareness of function and strength of the atrophied visceral end-fibers of the pubococcygeus returns, Perineometer readings will increase slightly and gradually.

Approximately two months of diligent exercise is required before improvement of symptoms is noted. In a few cases satisfactory relief was not attained until after a year of concentrated effort.

Severe urinary stress incontinence has been treated by physiologic therapy in a series of 212 patients, the majority of whom had previously undergone one or more unsuccessful surgical interventions to relieve incontinence. Good urinary control was established in 84 percent of this group.

These patients were able to discontinue the use of pads and have remained continent under normal circumstances. Recurrences have occurred after debilitating illnesses, prolonged spells of coughing, etc., but these could usually be controlled by resumption of resistive exercises for a few weeks.

While all cases of simple urinary stress incontinence were relieved, only partial relief or failure occurred in 16 percent of patients with severe urinary stress incontinence. These failures could be traced to local or general complications. Local conditions included marked shortening and scarring of the anterior vaginal wall due to previous surgical procedures or radium therapy. In three instances, however, good results were obtained following surgical release of restricting fibrous bands. Also, it appears that exercises of the pubococcygeus cannot succeed where the connections between this muscle and bladder neck and proximal urethra have been severed. Among the general conditions accounting for failures are neurologic changes, mental deficiency, senility and advanced diabetes.

When urinary stress incontinence coincides with a large cystocele, the incontinence is first relieved by active exercises and the cystocele corrected later through surgical repair.

Additional Measures in the Treatment of Urinary Stress Incontinence: Patients suffering from urinary incontinence usually have formed the habit of restricting fluid intake. In order to increase use of the bladder outlet, they are advised to drink at least 8 to 10 glasses of water a day and to interrupt the flow of urine several times while voiding. If successful, the contractions which resulted in interrupting the stream should be remembered and immediately duplicated during exercises with the Perineometer. The use of vaginal tampons and pessaries which exert pressure upon the bladder neck to control the urine is discontinued, since they interfere with the urinary reflex and contribute to atrophy of the pubococcygeus. For the same reason perineal pads to absorb the urine are reduced in size and eliminated as quickly as possible.

Genital Relaxation

The widest field of application of Perineometer exercises is in the treatment of genital relaxation during the childbearing and early menopausal years. While the results obtained are less dramatic than in the treatment of urinary stress incontinence, many more women (over 30 percent) complain of this annoying condition.

In the past, no conservative treatment has been available. Women in their child-bearing and most active years, therefore, had to endure discomforts and pelvic fatigue due to genital relaxation, usually described by the patient as bearing down, fullness, or "falling-out" sensations, until surgical intervention became advisable after the menopause.

This type of genital relaxation is recognized clinically by marked roominess of the middle third of the vagina and the presence of some degree of *cysto-urethrocele*, *uterine prolapse*, *rectocele*, and *bulging or lax perineum*. It has been found that these conditions are associated with poor function of the pubococcygeus, and that when function of this muscle is restored, complaints are often relieved and the clinical findings ameliorated.

Functional and structural improvement of the pubococcygeus has been demonstrated to have indirect influence on the support of the uterus. It has been observed that with increasing tone of the pubococcygeus the smooth muscle diaphragm, which is the chief support of the uterus,

becomes strengthened - again demonstrating the pivotal importance of the pubococcygeus muscle.

Subjectively, patients describe relief of their complaints as feeling stronger in the pelvic, groin, and lower back regions and report that they are able to be on their feet for long periods of time and do their housework without having to lie down at frequent intervals.

Since the discomforts of genital relaxation are not as incapacitating as those in urinary stress incontinence, women in this category are apt to be haphazard in their exercises. It is, therefore, common experience that it takes longer before definite and enduring results are obtained. Diligent patients usually begin to notice symptomatic relief after 2 to 4 weeks of resistive exercises. Structural changes are, at this time, too slight to be palpable. In order to be of lasting benefit, exercises must be continued until improvement in tone and strength of the muscle can be clinically demonstrated.

PROPHYLACTIC USE

After the beneficial effect of resistive exercises on atrophy of the pubococcygeus muscle had been satisfactorily established, it was logical to prescribe Perineometer exercises *before* major degrees of pelvic relaxation had occurred.

Obstetrics

The usefulness of these exercises during pregnancy has been extensively investigated by Bushnell. His experience, which now includes more than 500 patients, indicates that about 30 percent of all pregnant women have a weak, thin perineum and poor contractions of the pubococcygeus.

By exercises with and without the Perineometer, the muscles become stronger, thicker, and firmer. Postpartum repair is facilitated, and fewer sutures are required. As soon as the effect of anesthesia has worn off, these patients are able to perform strong contractions of the perivaginal muscles, especially at the level of the middle third of the vagina. Pain and edema are less frequently observed.

The incidence of early postpartum relaxation of genital muscles was greatly reduced. One would expect that in later years urinary stress incontinence, cystocele, urethrocele, uterine prolapse, and malposition of the uterus will develop less frequently in these patients. However, no definite statement to this effect can be made until after additional years of observation.

Taken as a group, young expectant mothers are most diligent in their exercises of the pubococcygeus muscle. Their cooperation is easily obtained once they understand the relationship of a strong pelvic musculature to sexual appreciation and the avoidance of later so-called female complaints.

Postoperative

The value of postoperative exercises for restoration of normal function has been firmly established in all other plastic and orthopedic procedures for repair of neuromusculofascial-tendinous structures.

Physiologic therapy of the pubococcygeus permits application of the same principle to surgical reconstruction of the tissues of the pelvic outlet.

Because of the great friability of the muscles, the surgery of the pelvic repair is limited to anatomic approximation of the fasciae. Whatever reconstruction of the muscles can possibly be achieved is incidental to repair of the fasciae.

Restitution of muscular function, essential to maintenance of the surgical result, can only be obtained by the subsidiary technique of active exercises of the pubococcygeus. Thus, these exercises are indicated *following perineorrhaphy* and in *anterior repair* to improve elastic support of the bladder, including all types of surgical procedures for the correction of urinary

stress incontinence. As Collins has pointed out: "It is a good idea in all cases that have been operated on for prolapse of the vagina vault or uterus, or in every postpartal woman to teach them how to contract the vaginal musculature and let them use this as a prophylactic measure."

CONCLUSION

Experience with muscle education and resistive exercises of the pubococcygeus has proved gratifying whenever these procedures have been applied to conditions due to, or connected with, impaired function of the pelvic musculature. On the basis of therapeutic results achieved, it seems possible that other ill-defined complaints referable to the genital tract in women might profitably be studied from the standpoint of muscular dysfunction. For instance, it has been found that dysfunction of the pubococcygeus exists in many women complaining of lack of vaginal feeling during coitus and that in these cases sexual appreciation can be increased by restoring function of the pubococcygeus. The field of physiologic therapy of the pelvic muscles is thus much wider than at first suspected.

In the present paper, only the essential points of diagnosis and therapy of genital muscle relaxation have been presented.

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