The Aldridge Fascial Sling : Am J Obstet Gynecol 1942; 44: 398-411

4. Kossmann, R. A., and Martin, A.: Handbuch der Krankheiten der weiblichen Adnexorgane, Leipzig, 1895, Eduard Besold 1: p. 92.
5. Michaud, L.: Beitr. z. Geburtsh. u. Gynäk. 12: 293, 1908.
6. Emelijanow, B. M.: Russkiy Vrach 10: 503, 1911; Zentralbl. f. Gynäk. 35: 1753, 1911.
7. Pozzi, S., and Bender, X.: Rev. de gynec. et de chir. abd. 18: 129, 1912.
8. Strong, L. W.: Arch. f. Gynäk. 101: 389, 1914.
9. Lehmacher, H.: Arch. f. Gynäk. 105: 280, 1916.
10. Reichelt, O.: Arch. f. Gynäk. 134: 666, 1928.
11. Bârcă, J.: Gynéc. et obst. 26: 344, 1932.
12. Foged, J.: Ugesk. f. laeger 103: 42, 1941.
13. Sacerdotti, C., and Frattin, G.: Virchows Arch. f. path. Anat. 168: 431, 1902.
14. Fischer-Wasels, B. in Handbuch der normalen und pathologischen Physiologie, Berlin, 1930, Julius Springer 14/2.
15. Dietrich, H. A.: Die Neubildungen der Eileiter, in Halban-Seitz, Biologie und Pathologie des Weibes, Wien, 1926, Urban und Schwarzenberg 5/1: p. 4.

TRANSPLANTATION OF FASCIA FOR RELIEF OF URINARY STRESS INCONTINENCE*

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WITHIN less than one hundred years, gynecologists have developed and perfected surgical techniques which can be relied upon to relieve most of the symptoms which are the result of birth injuries to the female sex organs. Factors which contribute to poor results or failures in vaginal plastic surgery include those that arise from:

1. Congenital underdevelopment of the injured structures.
2. Extensive loss of tissue substance resulting from the primary injury or from post-partum infection and tissue necrosis.
3. Increased tissue damage resulting from lack of judgment and skill in applying accepted gynecologic surgical techniques.

Efforts to repair a birth injury are not infrequently handicapped by the results of one or more previous unsuccessful attempts to cure the same condition.

One of the most difficult symptoms to relieve by vaginal plastic surgery is urinary stress incontinence. Statistics prove that 10 to 20 per cent of operations for conditions causing this symptom either fail or are only partially successful. It is with the group of cases in which one or more vaginal plastic operations have failed to cure urinary incontinence that this report is particularly concerned.

Unfortunately, we have not yet acquired either a complete knowledge of the anatomic structures in and about the female urethra or an entirely satisfactory explanation of the physiology of the delicate urethral sphincter mechanism which is responsible for the control of urination.

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Vaginal plastic operations to restore urinary continence invariably include two fundamental objectives:

1. To reduce the caliber of the overstretched lumen of the urethra to what is recognized as normal, including repair of the torn sphincter muscles.
2. To replace the urethra to its normal position beneath the pubic arch and to reconstruct a proper support from the surrounding tissues.

In some patients, in whom both of these objectives appear to have been accomplished, urinary incontinence is not entirely relieved. Some of the failures follow expert vaginal plastic procedures and satisfactory wound healing.

The importance of urinary tract infections as a factor in the etiology of urinary incontinence is well recognized. Elimination of inflammatory lesions of the bladder will stop leakage of urine in some cases in which it seems that vaginal plastic operations have failed. A routine preoperative investigation of the urinary tract before attempting to relieve urinary incontinence by surgical means might lead to a reduction in unsatisfactory results.

In some instances, the partial successes or failures are probably not due so much to faulty techniques as to the fact that there has been unusual destruction of the urethral sphincter muscles themselves and perhaps of their nerve and blood supply.

In the causation of urinary stress incontinence, the importance of birth injuries to the nervous mechanism which controls bladder function, probably has not received the attention it deserves. In their efforts to cure urinary stress incontinence by vaginal plastic surgery, operators have been accustomed to proceed on the assumption that it is essentially the result of trauma, over-stretching, and permanent relaxation of the urethral sphincter muscles themselves.

Our knowledge of the nerve supply to the bladder and urethra is fairly complete. However, except in cases in which urinary symptoms are caused by spinal cord lesions, we do not yet have the means to be certain that partial loss of urinary control is neurogenic in origin. In other words, we do not have diagnostic methods to determine the extent to which injuries to intrinsic nerves or to nerve endings supplying the urethral sphincter muscles may be responsible for urinary incontinence in any case under investigation. This is unfortunate as there is reason to believe that unrecognized nerve injuries may account for some of our surgical failures. In such circumstances or when the sphincter muscles have undergone too much destruction, complete restoration of function by the usual vaginal plastic procedures can hardly be expected.

With this in mind, various attempts have been made to utilize adjacent anatomic structures with the purpose of providing proper support for the urethra and of developing a substitute muscular sphincterlike action to replace the one that has been lost through birth injury.

Since 1900, numerous surgical techniques have been described in which transplantation of one of seven different muscles or the round ligaments has been recommended to relieve urinary incontinence. This presentation would hardly be complete without brief comments regarding some of these procedures.

In 1910, Goebell[1] reported on the transplantation of the pyramidalis muscles. In his technique, the muscles were freed except at their attachment to the pubic crest. The free ends were passed backward above the pubic bone and sutured beneath the urethra at its junction with the bladder.

In 1914, Frangenheim[2] modified the Goebell technique by leaving the freed pyramidalis muscles attached to strips of the overlying fascia. These combined strips of muscle and fascia were then placed about the urethra by the same route as described in the original Goebell procedure. Frangenheim also recommended that strips of the rectus abdominis muscles be used when the pyramidalis muscles were found to be poorly developed.

In 1917, Stoeckel[3] recommended that the Goebell-Frangenheim procedure be combined with a vaginal plastic operation with plication of the muscular structures about the vesical neck. This procedure is now referred to as the Stoeckel or Goebell-Frangenheim-Stoeckel technique for urinary incontinence.

In 1907, Giordano[4] described a technique whereby enough of the distal end of the gracilis muscle was dissected free from the inner surface of the thigh to allow it to be transplanted to where it could be wrapped about the urethra and sutured in that position. In 1926, Deming[5] reported an excellent result by use of this method in a case of epispadias.

In 1911, Squier[6] recommended the use of the levator ani muscles. Various methods of using these muscles have been devised. One is to free strips of the mesial margins of these muscles and to suture them together between the urethra and vagina. Another is to detach partially a portion of the mesial border of one of the levator muscles and to transplant it between the urethra and vagina. Attempts have also been made to suture the mesial margins of the levator muscles together in the midline between the urethra and vagina without any detachment of their fibers.

In 1923, Thompson[7] transplanted strips of rectus muscle and fascia downward in front of the pubic bone and sutured them around the urethra and vulva. In 1932, Miller[8] recommended that strips of fascia and the pyramidalis muscles be used in a manner similar to that described by Thompson.

In 1929, Martius[9] described a procedure by which he mobilized the bulbocavernosus muscle and some of its surrounding fatty tissue. This muscle-fat pad was then transplanted between the urethral and vaginal walls.

The purpose in all of these techniques was to prevent the escape of urine by providing external pressure on the urethra as a substitute for the normal sphincter mechanism which had been destroyed or was congenitally absent. Transplantation of muscle is an important feature of every technique with the hope that its contractility will be retained and

sphincterlike action will be developed. From a careful study of all these procedures, it seems unlikely that the pyramidalis, strips of levator or recti muscles, the gracilis or bulbocavernosus muscles can be mobilized and displaced to the positions recommended without almost complete destruction of their nerve and blood supply. In addition to this, there is always uncertainty as to the development of the pyramidalis and bulbocavernosus muscles.

Through experience it has been found that in some cases of stress incontinence of urine, the production of a urethral stricture is sufficient to effect a cure. It seems fairly certain that the good results claimed for all the techniques briefly described above have been attained through improved support for the urethra and partial urethral strictures.

In 1933, Price[10] reported on a technique he used to relieve urinary incontinence in a young woman who had congenital absence of the coccyx and sacrum. Loss of urine was neurogenic and congenital in origin. The procedure that he worked out is of interest, because it incorporates the fundamental principle which has been employed in the new technique that I wish to present. In the technique he used, a strip of fascia lata was passed beneath the urethra by the suprapubic route and the free ends were fixed to the recti muscles 5 cm. above the pubic bone. He had great difficulty in passing the fascia beneath the urethra. Although he accidentally opened the bladder and the wound subsequently became infected, the patient was eventually cured of her urinary incontinence.

PROCEDURE

Fig. 1 (*a* and *b*) represents diagrammatically a new surgical procedure for the cure of female stress incontinence of urine. It is like the Stoeckel technique in that it utilizes strips of fascia from the aponeurosis of the oblique muscles of the abdomen which are displaced backward above the pubic bone and sutured beneath the urethra to form a supporting sling. Success of the Stoeckel technique is supposed to depend upon leaving the fascial strips attached to the pyramidalis muscles with the hope that by their contraction the urethra will be compressed thereby preventing the escape of urine from the bladder.

The technique to be described differs from the Stoeckel procedure in that the aponeurotic strips *A* are passed through instead of between the recti muscles *R* at about 4 cm. above the pubic bone *P* (Fig. 1, *a*), before they are sutured to form a sling beneath the urethra *U*. When the abdominal wall is relaxed, it settles backward toward the abdominal cavity. Upon straining, as with lifting, sneezing or coughing, it bulges forward. This has the effect of changing the location of the relaxed recti muscles (Fig. 1, *b*, R^1) to a position represented by the dotted line (Fig. 1, *b*, R^2). This automatically results in a compression of the urethra *U* through the pull of the recti muscles on the fascial sling *A*.

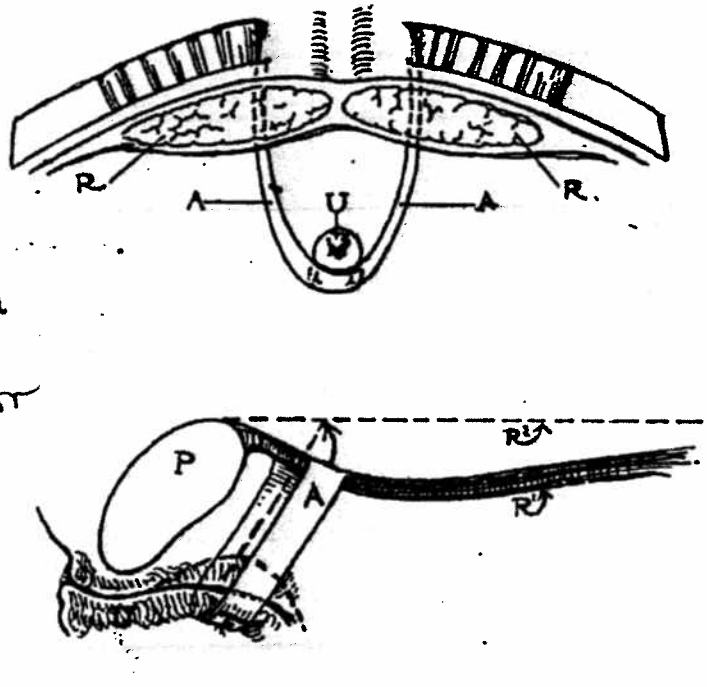
Success of this technique in curing urinary incontinence can probably be increased if it is combined with the usual vaginal plastic steps which are ordinarily employed to:

1. Reduce the caliber of a relaxed urethra to its normal size, including repair of its torn sphincter muscles.

2. Restore a displaced urethra to its normal position beneath the pubic arch.

Figs. 2 to 10, inclusive, show the consecutive steps of the new technique which was successfully used to cure urinary incontinence in a woman in whom two previous vaginal plastic operations had failed.

Fig. 2 shows the midline of the anterior vaginal wall being placed under tension with Allis clamps from the external urinary meatus to a point about halfway to the cervix. The dotted line indicates the line of the original incision used to expose the muscular walls of the urethra *U* and bladder *B*, as shown in Fig. 3.



* Notice position of sling at Mid-urethra

Fig. 1.—*a*, Diagrammatic representation of a technique of transplanting strips of rectus abdominis fascia for cure of urinary incontinence. *A*, Strips of rectus abdominis fascia; *U*, urethra; *R*, recti muscles. *b*, *U*, Urethra; *P*, pubic bone; *A*, rectus abdominis fascial sling; R^1, relaxed position of recti muscles; R^2, position of recti muscles when contracted as with straining.

This incision is carried through the vaginal mucous membrane, the entire thickness of the muscular wall of the vagina including a layer of connective tissue, Fig. 3, E^1, which can be seen as a smooth glistening layer intimately attached to its outer bladder surface. If the incision is carried to this plane of cleavage and the bladder is displaced, it will be noted that on either side of the midline there is another dense layer of connective tissue, Fig. 3, E^2, which is attached to the musculature of the bladder wall, Fig. 3, *B*.

There is still difference of opinion as to the origin of the layers of connective tissue E^1 and E^2, but they are probably no more than hypertrophied layers of the connective tissue which act as supporting structures for the muscle fibers of the vaginal and bladder walls. Between the vaginal and bladder walls and extending between the connective tissue layers E^1 and E^2, there is another thin layer of loose areolar tissue which is a part of the endopelvic fascia. It is in this layer of loose areolar

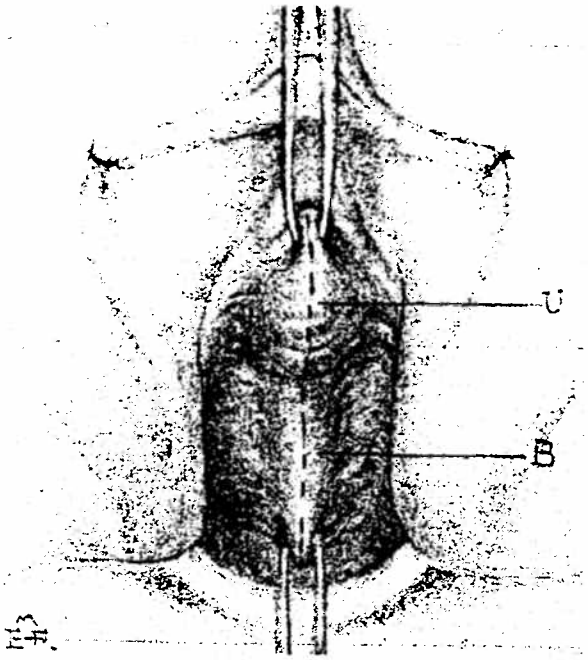


Fig. 2.—Dotted line shows location of original incision in anterior vaginal wall. *U*, Urethra; *B*, bladder.

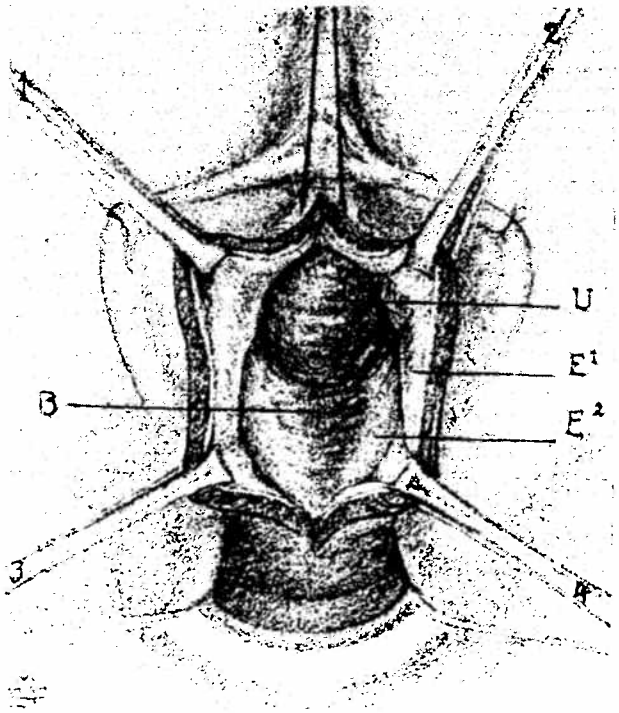


Fig. 3.—Anterior vaginal wall opened exposing the muscular walls of the urethra and bladder. *U*, Urethra; *B*, bladder; *E¹*, connective tissue layer on outer bladder surface of vaginal wall; *E²*, connective tissue layer on bladder wall.

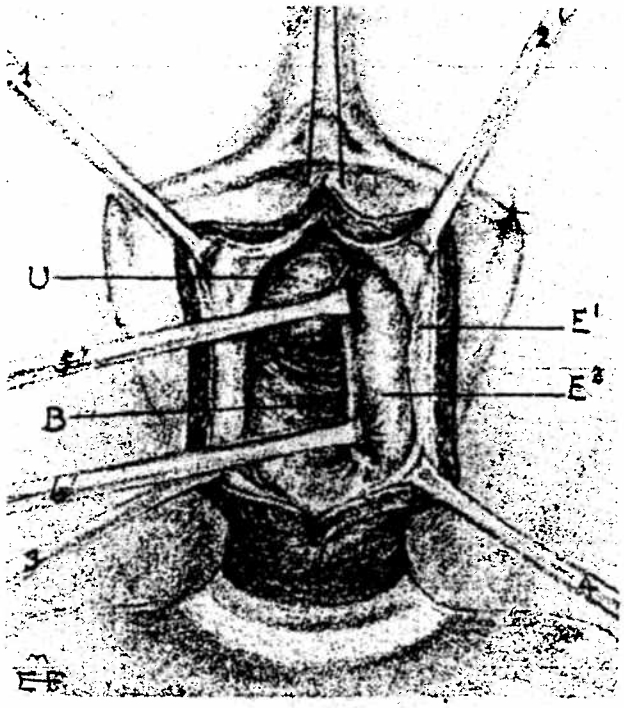


Fig. 4.—Connective tissue layers E^1 on the vaginal wall and E^2 on the bladder wall being held under tension by use of Allis clamps, 2 and 4, and 5 and 6.

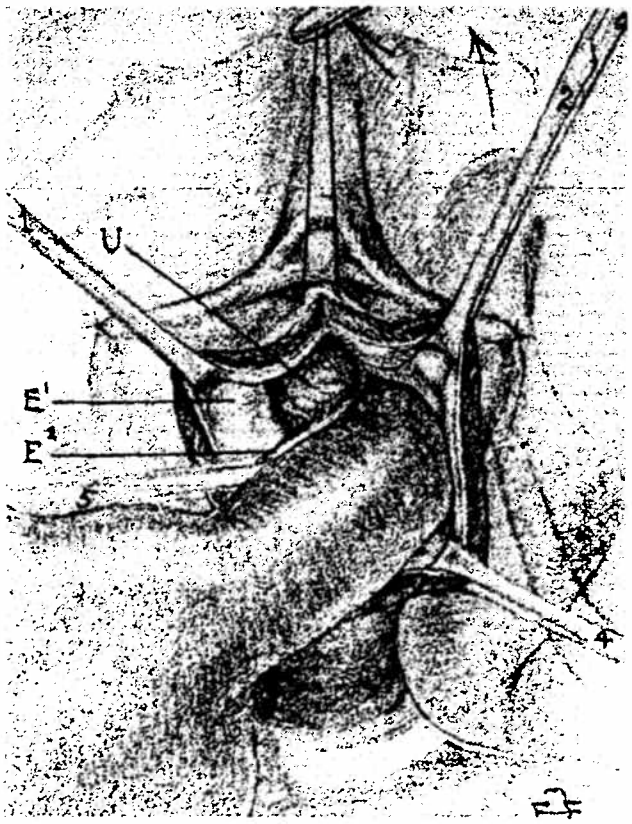


Fig. 5.—By blunt dissection the plane of cleavage between E^1 and E^2, shown in Fig. 4, has been opened laterally and forward. The finger is being passed through this opening forward and above the pubic bone at the left of the urethra U.

tissue that practically bloodless blunt dissection can be carried out in every direction. In fact, there is no other natural plane of cleavage in the anterior vaginal wall. Attempts at dissection in any other plane may result in hemorrhage which is troublesome and difficult to control.

By keeping the layers of connective tissue E^1 and E^2 on the bladder and outer surface of the vaginal wall under tension with Allis clamps, *1* and *3* and *5* and *6*, as shown in Fig. 4, it is possible by blunt dissection to open an almost bloodless space between E^1 and E^2 which can be extended forward on either side of the urethra.

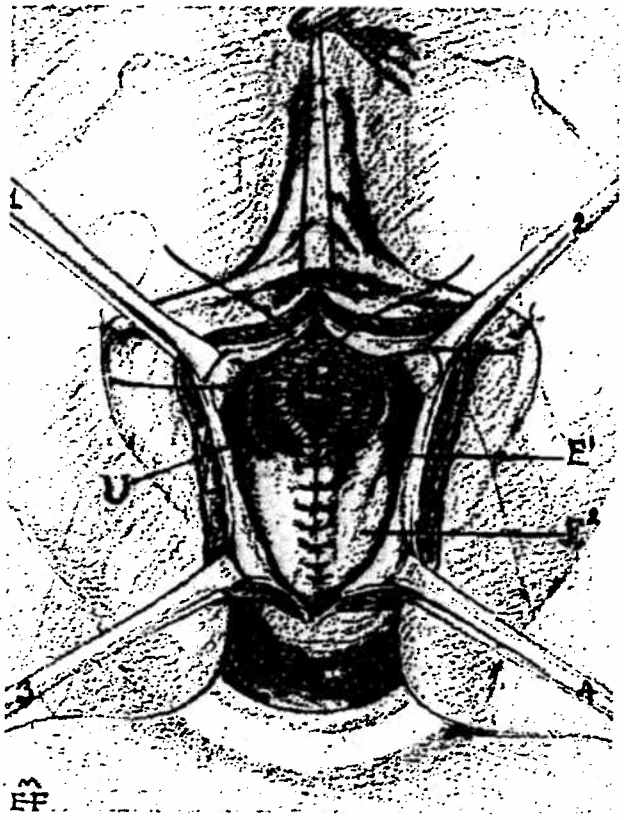


Fig. 6.—The wall of the urethra *U* is being infolded with mattress sutures to reduce its caliber and to reunite the torn ends of the sphincter muscles. The mesial margins of the connective tissue layer E^2 on the bladder have been brought into apposition with chromic catgut sutures.

Starting in this plane of cleavage, it is easily possible, as shown in Fig. 5, to pass a finger upward behind and above the pubic bone nearly to the point of attachment of the abdominal muscles to the pubic crest without risk of injury to the bladder or urethra and with very little bleeding.

Fig. 6 shows the lumen of the overstretched urethra being reduced in size by mattress sutures of fine chromic catgut which infold its wall and bring into apposition the torn ends of the urethral sphincter muscles.

Figs. 6 and 7 also show how the thinned-out mesial margins of the connective tissue E^2 on the bladder wall are united in the midline by interrupted sutures of fine chromic catgut to provide additional support for the bladder and urethra.

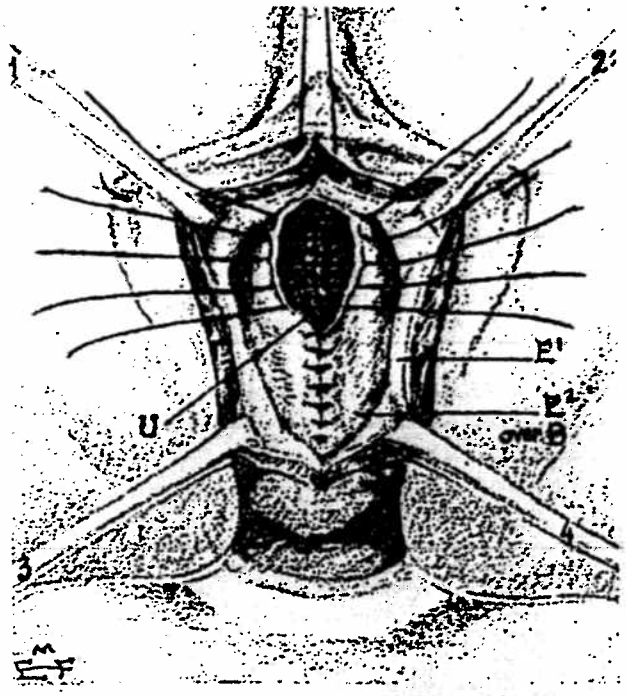


Fig. 7.—Apposition of the mesial margins of the connective tissue layers E^2 is being carried forward over the urethra for additional support.

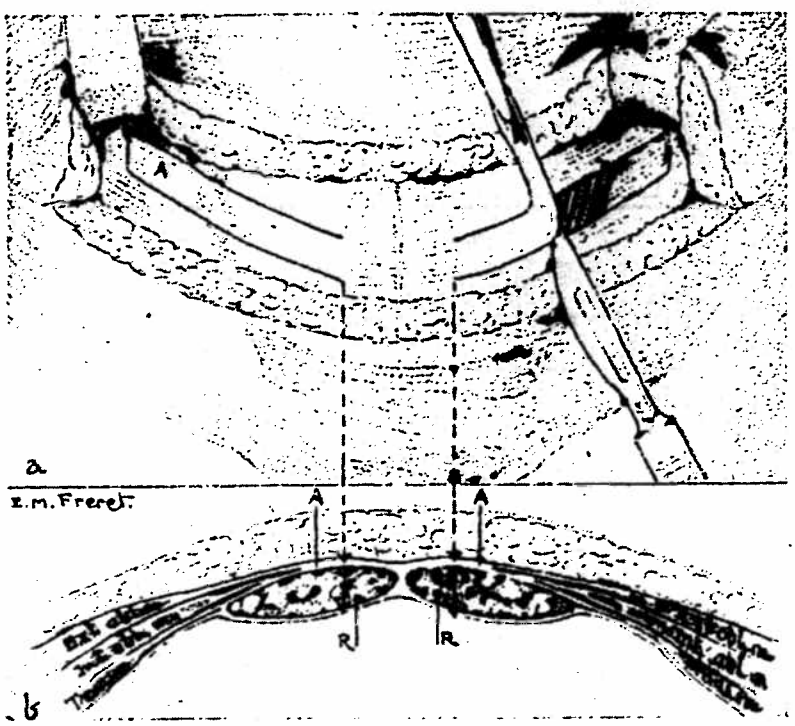


Fig. 8.—*a*, Fascial strips *A* from the aponeurosis of the oblique muscles are being separated through a Pfannenstiel incision. *b*, The dotted lines indicate points about 2 cm. from the mesial margins of the recti muscles *R* through which the fascial strips *A* are passed backward before encircling the urethra.

Having completed these steps in the vaginal part of the procedure, the aponeurosis of the oblique muscles of the abdomen is exposed through a Pfannenstiel incision as shown in Fig. 8, *a*.

A strip of the aponeurosis *A*, about 6 cm. in length and 1.5 cm. in width is then dissected free, starting at the outer end on either side and carrying the dissection to within about 2 cm. of the midline where it is

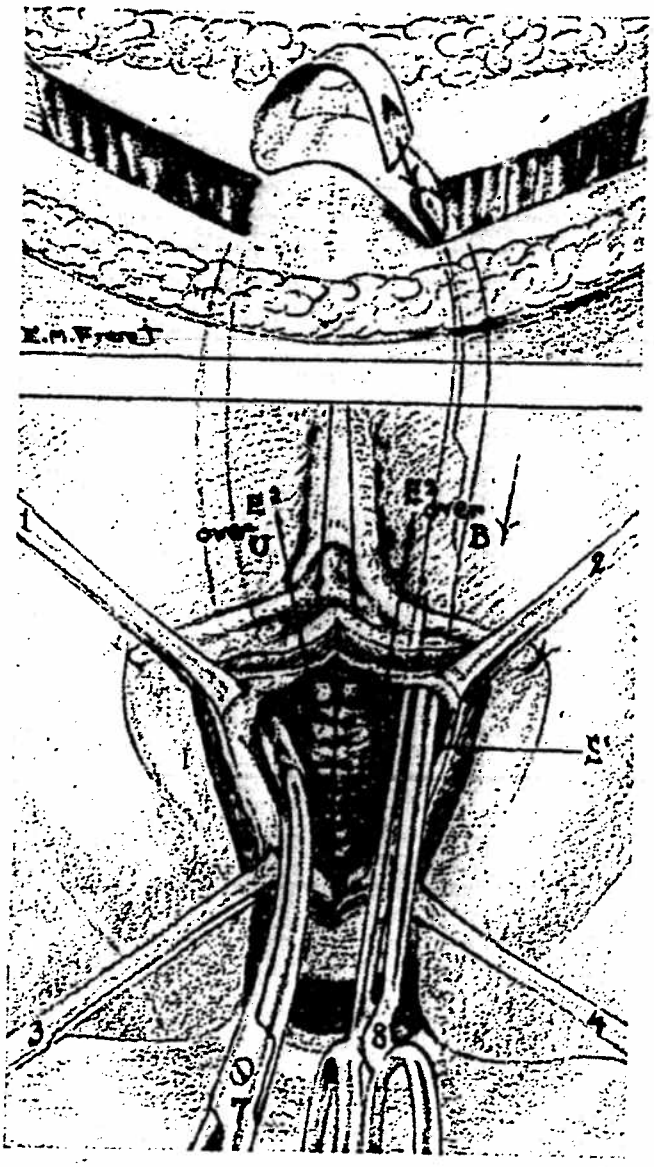


Fig. 9.—Clamps 7 and 8 passed forward in the spaces opened by finger dissection as shown in Fig. 5 are being used to grasp the fascial strips *A* and to draw them into the vaginal wound with one on either side of the urethra.

left attached. The arrows on the dotted lines projected from the attached ends of the aponeurotic strips *A*, to the cross section of the abdominal wall in Fig. 8, *b*, indicate points about 2 cm. from the inner margins of the recti muscles *R*, through which the strips are passed as they are drawn backward along either side of the urethra.

Fig. 9 shows how clamps *7* and *8* are passed forward above the pubic bone through spaces opened by finger dissection as shown in Fig. 5. Clamp *8* has been forced gently forward through between the fibers of the rectus muscle and is about to pick up the tip of the aponeurotic strip *A*. By use of clamp *7*, the fascial strip has been drawn backward into the vaginal wound. After the fascial strips have been brought into the vaginal wound on either side, they are placed under the urethra as shown in Fig. 10, and are sutured together with sufficient tension to slightly elevate the urethra at about the point at which it connects with the bladder.

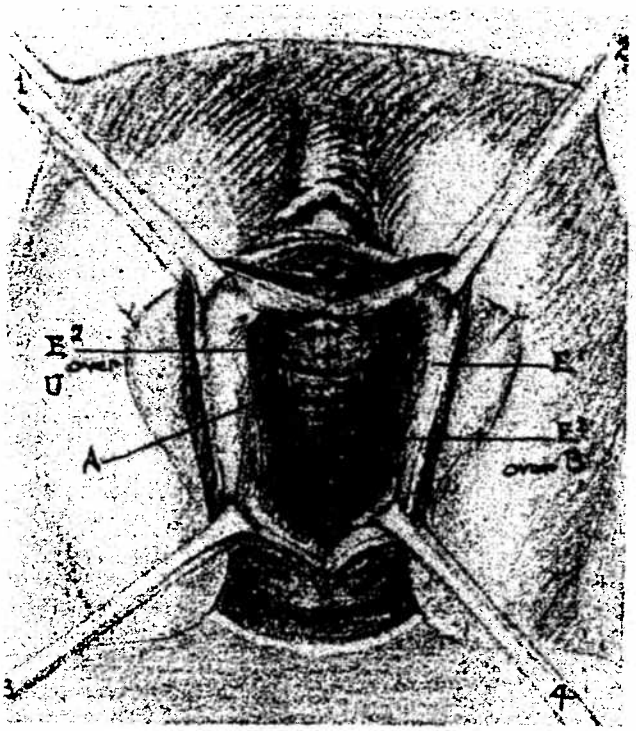


Fig. 10.—The fascial strips *A* have been united in the midline to form a fascial sling beneath the urethra at its junction with the bladder.

When this has been accomplished any excess tissue is excised from the anterior vaginal wall and the incised margins of the wall are brought into apposition in the midline with interrupted chromic catgut sutures. The abdominal incision is carefully closed in layers to prevent the development of an incisional hernia. Sulfanilamide powder is placed in the abdominal wound, as it is obvious that with this technique there is some risk that infection may be carried into the wound from the vagina.

In the technique as described, aponeurotic fascial strips were developed through a low transverse abdominal incision. If preferred, longitudinal rectus abdominis fascial strips, obtained in the same manner through a low midline incision, may be used. When the opportunity presents itself, it is proposed to try the use of a strip of the fascia lata of the thigh. If this was done, it would seem wise to draw the ends of the strip forward through the vaginal wound and between the fibers of the recti muscles. They could then be united between the recti muscles and

its overlying fascia, leaving a loop of fascia as a sling beneath the urethra. Theoretical advantages of using a strip of fascia lata are:

1. It would avoid difficulties encountered in getting fascial strips in patients who have scars of previous abdominal incisions.
2. By avoiding the necessity of excising any abdominal fascia and eliminating the necessity for a rather long abdominal incision, the chances of wound infection and postoperative incisional hernia might be reduced.
3. By use of a fascia stripper, an adequate strip of fascia lata could be obtained through two small skin incisions of the thigh.

COMMENT

The new procedure that has been described was devised primarily with the hope of curing post-partum, urinary stress incontinence in women in whom vaginal plastic surgery seemed inadequate. As pointed out, surgical failures by the vaginal route may be due either to excessive damage to the urethral sphincter muscles or possibly to unrecognized injuries to the nervous mechanism which controls the functions of the urethra and bladder. If, by further experience, it can be shown that it is reasonably successful in such cases, it is hoped that the same technique can be used to develop urinary continence in women in whom it is necessary by plastic surgery to construct a urethra. This includes women in whom the urethra is partially or completely absent as a result of congenital malformations or destruction from birth injuries.

The disadvantages of the procedure are that it requires a painstaking technique which should not be undertaken by a surgeon who has not acquired a modern conception of the anatomic structures in the anterior vaginal wall about the urethra and bladder. Dissection in this region is safe and nearly bloodless if carried out in the planes of cleavage described above. If these tissue planes are not followed, blood loss may be excessive and the bladder and urethra may be subjected to serious damage. Difficulties in the dissection are increased by the fact that this technique is particularly suited to patients who have had one or more previous unsuccessful vaginal plastic operations for the same condition. In such circumstances, considerable scar formation is likely to be encountered.

It seems fair to state that the new procedure which has been described has certain advantages over those previously recommended, in that:

1. It utilizes the rectus abdominis muscles which are always well developed and easily accessible.
2. It involves no displacement of the recti muscles or possible loss of function through damage to their nerve or blood supply.
3. It develops a fascial sling in a position and manner which provides additional support and external pressure to the urethra at the point where it is likely to be most effective, i.e., at the junction of the urethra and bladder.

4. It takes advantage of the favorable anatomic relationship of the recti muscles to the urethra. By utilizing the normal variation in position of these muscles, in response to changes in intraabdominal pressure, compression of the urethral lumen is automatically increased at the exact times when it is most necessary in order to prevent leakage of urine.

CASE REPORT

The case that I wish to report is that of Mrs. M. McD. (Hospital No. 35233), 53 years of age, and of medium weight and stature. Her past history revealed nothing of importance with the exception of conditions which had occurred incidental to her pregnancies.

During thirty years of her life, she had a rather remarkable experience from the obstetric and gynecologic point of view. Between the ages of 23 and 41 years, a period of 18 years, she had 14 pregnancies. The patient may be excused for loss of memory regarding the details of some of her deliveries, but so far as could be determined from her statements and the available hospital records, the outcome of her pregnancies was as follows:

1. Six full-term pregnancies with one forceps delivery and five spontaneous deliveries.
2. Two premature, spontaneous deliveries at five months' gestation.
3. Five spontaneous abortions.
4. A laparotomy with removal of one tube for ruptured ectopic pregnancy.

The birth weights of 5 of her full-term babies ranged from 8 pounds 11 ounces to 9 pounds 9 ounces.

At 34 years of age, after her fifth full-term pregnancy, she had a vaginal plastic for birth injuries and an operation for retroversion. At 47 years of age, a complete vaginal plastic operation was done at a hospital in Flushing, Long Island. At the same time, the body of the uterus was removed by supravaginal hysterectomy for fibroids. This operation failed to relieve her chief complaint of incontinence of urine.

Four years later, at 51 years of age, another complete vaginal plastic was done at the Woman's Hospital. Following this operation, the anatomic result appeared to be excellent but her most troublesome symptom, incontinence of urine, still persisted.

On June 17, 1941, she was readmitted to the Woman's Hospital for the combined vaginal and abdominal operation described in this report. She was catheterized during the first three postoperative days. From then until her sixteenth postoperative day, when she was discharged, recovery was quite uneventful. She was continent and remarkably free from any bladder symptoms. Now at nearly eight months following this operation, the anatomic result appears to be good. The patient declares that she has had no leakage of urine since the day of her operation and that she is entirely free of any bladder symptoms.

From the patient's statements she had incontinence of urine continuously for 29 years. It began as stress incontinence following delivery of her first baby by forceps at 23 years of age, and finally relieved by the operation described at 52 years of age. Following the birth of her last baby at 37 years of age, she had constant leakage both day and night

and for this reason rarely left her home. She was unimproved following the two vaginal plastic operations at 47 and 51 years of age, but declares that her last operation was a complete success.

In conclusion it may be stated that:

1. A woman who, through loss of urethral sphincter control, had had partial urinary incontinence for twenty-nine years was cured by a new surgical technique after two vaginal plastic operations for the same condition had failed.

2. The new surgical procedure was devised primarily for the relief of urinary stress incontinence. It may prove to be of value as a step toward developing urinary continence whenever it is necessary by plastic surgery to construct a urethra that is absent as a result of congenital malformations or destructive birth injuries.

3. Ultimate success of the new procedure which has been described must depend upon whether the mechanical and surgical principles involved are sound.

REFERENCES

1. Goebell, R.: Ztschr. f. Gynäk. u. Urol. 2: 187, 1910.
2. Frangenheim, P.: Verhandl. d. deutsch. Gesellsch. f. Chir. 43: 140, 1914.
3. Stoeckel, W.: Zentralbl. f. Gynäk. 41: 11, 1917.
4. Giordano, D.: Twentieth Congress, Franc. de Chir. p. 506, 1907.
5. Deming, C. L.: J. A. M. A. 86: 822, 1926.
6. Squier, J. B.: Med. Rec. 79: 803, 1911.
7. Thompson, R.: Brit. J. Dis. Child. 20: 146, 1923.
8. Miller, N.: J. A. M. A. 98: 628, 1932.
9. Martius, H.: Chirurg. 1: 769, 1929.
10. Price, P. B.: Arch. Surg. 26: 1043, 1033.

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DISCUSSION

DR. THOMAS C. PEIGHTAL.—Dr. Aldridge has devised an admirable means by which the newly constructed periurethral fascia support is re-inforced at the point of greatest strain on the sutures. Thus, for instance, by his rectus fascia sling, the Kennedy operation may be strengthened at the weakest area where the tissues beneath the midurethra most often break down. This is a notable advance in the surgery of stress incontinence and we shall do well to utilize it.

DR. GEORGE F. HOCH.—Dr. Aldridge and I had a patient in common who had two unsuccessful attempts at correction. After the second operation a mass of scar tissue along the urethra acted as a barrier. For a time the result was perfect but soon this tissue disappeared and her incontinence returned. What caused this change? Very likely poor blood supply of this devitalized tissue. The use of live tissue should correct this error.

I believe in all these conditions teamwork between the gynecologist and urologist should decide whether the patient is suffering from an incontinence or an urgency secondary to some urologic disease, before any operative procedure is done. It may prevent some unsuccessful operations.

DR. BENJAMIN P. WATSON.—I am especially interested in the technical aspects of this procedure.

I and some others saw Dr. Miller do one of those fascial support operations, using vertical strips from the two recti muscles; it is quite a formidable procedure. I was impressed by the simplicity of Dr. Aldridge's transverse incision technique, taking two fascial strips laterally from the rectus sheath.