Neurourology and Urodynamics 7:569–583 (1988)

Surgical Treatment of Anatomical Stress Incontinence

Andrew L. Siegel and Shlomo Raz

UCLA Medical Center, Los Angeles

The condition Stress Incontinence may be classified as a) anatomical (AI) and b) due to intrinsic sphincter damage (ID). While anatomical incontinence is due to anatomical malposition of a normal sphincteric unit in intrinsic damage, the sphincteric unit is abnormal (damaged from multiple surgery, radiation, neurologic disease, etc). The goal of surgery for AI is to reposition the bladder neck and urethra in a high, fixed retropubic position without obstruction. With improvements in the surgical techniques and a better understanding of the anatomical landmarks a clear trend has evolved in recent years toward vaginal approach. Important principles of the vaginal approach include mobilization or the urethra and bladder neck, precise placement of the suspension sutures in sturdy tissue (endopelvic fascia), fingertip guidance of a ligature carrier through the retropubic space, cystoscopy control and tying the sutures without tension. The advantages are simplicity, less morbidity and providing equal or better results than the abdominal approach. AI is only a symptom of pelvic prolapse and concomitant pathology like rectocele, enterocele and uterine prolapse should be addressed at the time of surgical repair. The pathophysiology, classification and different modalities of treatment for anatomical incontinence are discussed.

Key words: stress incontinence, urinary incontinence

INTRODUCTION

It was recognized approximately half a century ago that the treatment of stress urinary incontinence due to hypermobility of the proximal urethra and bladder neck is based upon the repositioning of these structures into a high, supported position behind the pubic bone. Since Howard Kelly [Kelly and Dumm, 1914] described the ''Kelly plication'' in 1914 to the present time there have been numerous innovations and advancements in the understanding of the pathophysiology, diagnosis, and treatment of stress urinary incontinence. Clinical experience dictates that anatomic malposition of the sphincter seems to play an important role in the genesis of stress incontinence and that this situation is cured by surgical procedures which restore the anatomy. However, the exact pathophysiological factors underlying the restoration of position which are responsible for cure of anatomical incontinence are unclear and remain to be delineated.

Received for publication November 4, 1987; accepted July 18, 1988.

Address reprint requests to Shlomo Raz, M.D., 924 Westwood Blvd., Suite 520, Los Angeles, CA 90024.

PHYSIOLOGY OF FEMALE CONTINENCE

Normal continence in females is the result of a complex interaction of factors including urethral closing pressure, urethral length, urethral-trigonal anatomy, and effective transmission of forces to the urethra. Urethral closing pressure is contributed to by the smooth musculature of the urethra, the striated external sphincter, and the mucosal seal effect. The convolutions and infoldings of the urethral mucosa are surrounded by a rich, spongy, submucosal vascular plexus which is encased in a fibroelastic and muscular tissue, all of which play a very important role in female continence. These structures provide the necessary seal for continence, requiring low extrinsic pressures. This ''mucosal sphincter'' is under hormonal influence. Atrophy of this inner seal with menopause may explain the time gap between injury at the time of childbirth to the appearance of stress incontinence at a later age. Unfortunately there is no effective method of evaluating mucosal sphincter function.

The role of urethral length is unclear and debatable. The anatomical length of the urethra is approximately 3–4 cm with a functional length of 2.8 cm. Excision of the distal urethra when a well-supported intact sphincteric mechanism exists does not appear to affect continence adversely. There is no direct correlation among anatomical length of the urethra and urinary continence, incontinence, or retention. The functional length of the urethra is shortened in a majority of patients with anatomic incontinence, further so when the patient is studied in the standing position. The explanation for the reduction of functional length with standing is that the majority of patients with anatomic incontinence have an open bladder neck that opens further in the standing position, compromising urethral length. In general, surgical correction of anatomic incontinence will restore normal anatomical and functional length of the urethra.

Urethral-trigonal anatomy is an important factor in continence. Anatomical defects can affect the bladder base (cystocele), the bladder neck (funneling), and the urethra (urethrocele or urethral hypermobility). The bladder base is normally above the inferior ramus of the pubic symphysis and with stress maneuvers should not descend more than one centimeter. When the bladder base is hypermobile and descends below the inferior margin of the pubis, a cystocele exists. In the normal, continent female the bladder neck is closed. This closed bladder neck is demonstrated on radiological studies (during static cystography in the standing position in a lateral view with a small catheter or chain in the urethra) as a urethral-trigonal angle of 90°. When this angle is greater than 90° this signifies funneling of the bladder neck. A funneled or incompetent bladder neck may be due to neurogenic urethra; intrinsic damage due to radiation, trauma, or multiple surgeries; bladder instability; or an anatomical defect present with anterior vaginal wall prolapse. Funneling is a common finding in patients with anatomic incontinence, but is also found very often in patients with vaginal prolapse without incontinence; thus the presence of an obtuse urethro-trigonal angle should be interpreted with caution. If the bladder is stable and there is no history of prior multiple surgical procedures, trauma, or neurogenic lesions, this generally signifies an incompetent bladder neck secondary to anatomic incontinence. The best method to assess bladder neck incompetence is videourodynamics and not static cystography. The angle of inclination of the urethra (to the vertical axis with the patient in the standing position) is normally less than 30°, and when greater than 35° usually signifies urethral hypermobility.

The extent of the anatomical defect is perhaps the most critical factor upon which the decision of the specific type of surgical correction is based. Unfortunately, the physical examination of the bladder in the supine position is very inaccurate and subjective, but voiding cystourethrography provides an excellent tool to assess anatomical defects objectively. We feel that this imaging study is the equivalent of the physical examination of the bladder in the supine position.

The last factor is the ability of the urethra to increase its function with changes in intra-abdominal pressures. The normal urethra can compensate for changes in abdominal pressure by means of several mechanisms. With strain maneuvers such as cough, a reflex contraction of the pelvic floor musculature occurs which increases urethral pressure. In addition, because the normal urethra is in a well-supported retropubic position, the increase in pressure generated by the cough is favorably transmitted to both the bladder and the urethra, maintaining the pressure gradients. Furthermore, the normal anatomical location of the bladder neck is in a nondependent position and the locus of force generated with an increase in abdominal pressure will not be experienced at the bladder neck but at the bladder base, which is the most dependent structure. Finally, the impact of pelvic floor support is very important. Under normal circumstances, the well-supported pelvic floor will act as a "backboard" to the bladder such that adequate transmission of forces without damping will occur with strain maneuvers. Thus pelvic floor relaxation leads to ineffective force transmission, and based upon this is the importance of pelvic floor repair in the treatment of anterior vaginal wall prolapse and stress incontinence.

Childbirth, hysterectomy, menopause, and weakened pelvic support are contributory factors in the genesis of hypermobility, prolapse, and stress incontinence. A critical factor is the anatomic change resulting from the loss of pelvic support. Beyond this, the pathophysiology of stress incontinence is conjectural, with few hard facts. There is agreement on the importance of hormonal changes coincident with menopause which results in weakening of the inner seal of the urethra (mucosal sphincter) and facilitates the tendency for anatomical changes. There is agreement on the importance of anatomical changes and the fact that most of the cases with anatomic incontinence can be cured by a surgical procedure that restores the anatomy.

Anatomic abnormalities secondary to multiple vaginal deliveries, hormonal changes of menopause, and hysterectomy are common in asymptomatic patients. The most common anatomic abnormalities are hypermobility of the urethra and/or bladder and funneling of the bladder neck. However, only a small subset of patients with anatomic abnormalities will have stress incontinence. The answer probably lies in the fact that continence is determined by a balance of factors, of which anatomic position is only one. It would seem that with hypermobility of the bladder neck and proximal urethra, some of the compensatory and protective factors fail. When the bladder neck descends, it drops out of the realm of effective pressure transmission such that a pressure gradient is established between bladder and urethra resulting in incontinence. With hypermobility of the bladder neck, it often assumes the most dependent position and the locus of force generated by a strain maneuver seems to be directed right at the bladder neck with ensuing incontinence. Perhaps with sagging of the pelvic floor, there is inadequate transmission of forces because of a damping effect of lack of an effective "backboard."

TABLE I. Varying Degrees of Vaginal Wall Prolapse

Degree of change	Grade	Description
Minimal	I	Minimal hypermobility
Moderate	II	Bladder descends to introitus on strain
Severe	III	Bladder outside introitus on strain
	IV	Bladder outside introitus at rest

CLASSIFICATION

We do not agree with the classification of stress urinary incontinence based merely upon anatomical changes, since there is often no relationship between the degree of anatomical change and the degree of stress incontinence. Classification should be based upon etiology, anatomical changes, and degree of incontinence. Classification should serve to facilitate communication and should readily lead to a working treatment plan.

Urinary incontinence can be caused by bladder or sphincter dysfunction. Bladder-related incontinence may be caused by instability, poor compliance, small capacity, or incomplete emptying. Sphincter-related incontinence may be caused by either anatomic malposition of an intact sphincter unit or by intrinsic sphincteric damage when with or without an accompanying anatomic abnormality, the sphincteric unit is impaired. The most common reasons for intrinsic damage include multiple surgical procedures for incontinence, radiation therapy, pelvic trauma, neurogenic urethral dysfunction, and a congenital short urethra.

The most important factor which will impact on the type of surgery needed is the degree of vaginal wall prolapse. Vaginal prolapse may or may not be accompanied by stress incontinence. The presence of prolapse in no way implies stress incontinence and likewise the presence of stress incontinence does not imply prolapse. The degree of anatomical change (anterior vaginal wall prolapse) can be classified according to Table I.

The degree of stress incontinence can be classified as shown in Table II.

Results of surgery for stress incontinence can be classified according to the scheme shown in Table III.

ASSESSMENT OF ANATOMICAL ABNORMALITIES

Stress urinary incontinence can be a symptom, a finding, or a condition. The symptom of stress incontinence may result from large residuals of urine, bladder instability, or urethral incompetence. The finding of stress incontinence results when physical examination of the patient demonstrates urinary incontinence during stress maneuvers. Assessing the degree of vaginal wall prolapse by physical examination is a subjective test, particularly in that stress incontinence and prolapse are phenomena of the standing position. Various methods of more objectively assessing anatomical incontinence have been devised, including the Q-tip test, cysto-urethroscopy, and radiological studies (VCUG). The ideal means of assessing anatomic incontinence is the VCUG performed in the standing position under fluoroscopic control while monitoring pressures (video-urodynamics). This allows one to know that specific anatomic changes (i.e., funneling) are not related to a change in bladder pressure.

TABLE II. Varying Degrees of Stress Incontinence

Rare	Occurs less than once per month; small volumes; no pads required
Minimal	Occurs only with severe stress maneuvers, not with normal activities; no pads required
Moderate	Occurs with normal activities; requires pads and/or frequent underwear changes
Severe	Occurs in the sitting, supine, and standing positions, with any stress maneuver; more than 5% of urinary output is in pads; requires constant protection

TABLE III. Results of Surgery for Stress Incontinence

Excellent	Dry; no pads; no medications; good support to anterior vaginal wall; Marshall test negative, no SUI on urodynamics; exercises without leakage
Good	Dry most of time; no pads; no medications; well supported; Marshall test negative; minimal leakage with strenuous exercise and none with normal activity
Improved	Wet with normal activities; requires pads; may require medication; not well supported; better than before surgery
Failed	As before surgery or worse; requires pads and medications; significant hypermobility; positive Marshall test

Cysto-urethroscopy with a zero degree lens is a useful tool to help assess anatomical changes as funneling and hypermobility are easily demonstrated by having the patient Valsalva.

HISTORICAL HIGHLIGHTS (see Table IV)

"The Kelly plication" [Kelly and Dumm, 1914], still the most commonly performed procedure for stress incontinence, involves an anterior vaginal wall incision, dissection of the vagina from the bladder neck, and the placement of two or three vertical mattress sutures to buttress the peri-urethral tissues (Fig. 1). This procedure may correct the prolapse but has only a 50% success rate for correction of the incontinence because of the failure of the plication to restore the bladder neck into a high, supported retropubic position without causing obstruction.

Albert Aldridge [1942] popularized the "fascial sling" technique proposed by several German gynecologists (Goebell-Frangenheim-Stoeckel technique) in the early 1900s. A rectus fascial strip left attached to the midline was used to suspend and sling the bladder neck, taking advantage of the favorable anatomic relationship of the rectus muscle to the urethra. This procedure was devised to repair the typical anatomic postpartum stress urinary incontinence but was also of clinical utility for incontinence due to intrinsic sphincteric damage.

Thomas Hepburn [1927] described the first retropubic suspension operation; this procedure was not used to treat stress urinary incontinence but was used for the treatment of urethral prolapse in children. Victor Marshall, Andrew Marchetti, and Kermit Krantz [1949] described and popularized the retropubic suspension operation for the treatment of stress incontinence. Of historical interest is that this procedure

TABLE IV. Bladder Neck Suspension Surgery: Historical Perspective

Year	Author	Gyne or GU	Innovation
1914	Kelly	Gyne	Plication
1942	Aldridge	Gyne	Fascial sling
1942	Marshall, Marchetti, and Krantz	Gyne and GU	Retropubic suspension vagina & urethral wall to symphysis
1959	Pereyra	Gyne	Needle bladder neck suspension
1961	Burch	Gyne	Retropubic suspension perivaginal fascia to Cooper's ligament
1965	Jeffcoate	Gyne	Principles of treatment of stress urinary incontinence
1965	Harer and Gunther	Gyne	Vaginal dissection to mobilize urethra; absorbable suture
1967	Pereyra and Lebherz	Gyne	Entered retropubic space; finger control
1967	Tauber and Wapner	Gyne	Visual control
1973	Stamey	GU	Cystoscopic control; Dacron buttress
1976	Winter	GU	No vaginal incision
1978	Cobb and Ragde	GU	Double-prong needle, barrell knot
1981	Raz	GU	Inverted-U incision, urethral mobilization, helical sutures, endopelvic/pubocervical fascia & vagina
1987	Gittes and Loughlin	GU	No incision

was first performed on a male patient with incontinence after an abdominal-perineal resection and a transurethral prostatectomy. When adapted to females, after retropubic dissection to mobilize the bladder and bladder neck, several pairs of No. 1 Chromic sutures are used to anchor the upper wall of the vagina and lateral wall of the urethra (extraluminally) to the pubic periosteum. When tied, the retropubic space is obliterated. Additional sutures are placed in the muscle of the bladder which is tacked to the rectus muscle. This procedure proved to be very effective and still remains the gold standard when describing results of any new surgery for stress urinary incontinence. A distinct disadvantage is that because the sutures are placed in a peri-urethral fashion, the potential for obstruction exists. Other disadvantages are the inability to correct a cystocele from this approach, the need for a laparotomy, and the potential occurrence of osteitis pubis because of suture placement in the pubic periosteum.

John Burch [1961] described a retropubic suspension procedure in which three pairs of No. 2 Chromic sutures were used to tack the perivaginal fascia and vaginal wall excluding the epithelium to Cooper's ligament (Fig. 2). This is facilitated by a finger in the vagina which elevates the perivaginal fascia. This procedure evolved

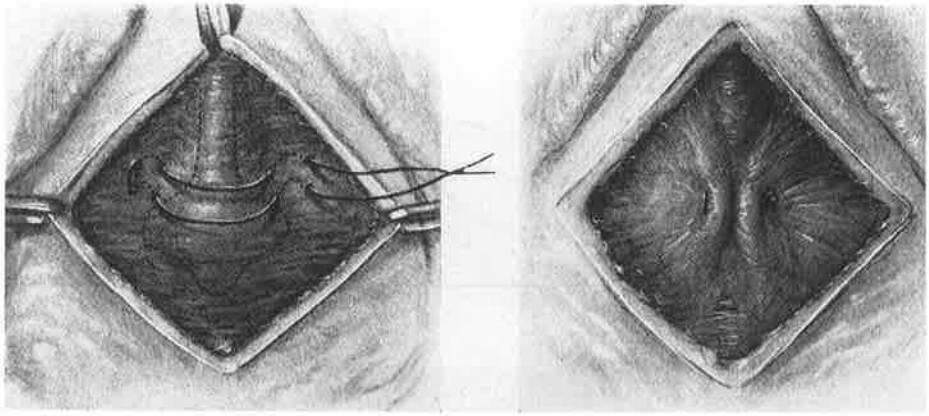

Fig. 1. Diagram showing the technique of Kelly plication of the bladder neck for urinary incontinence.

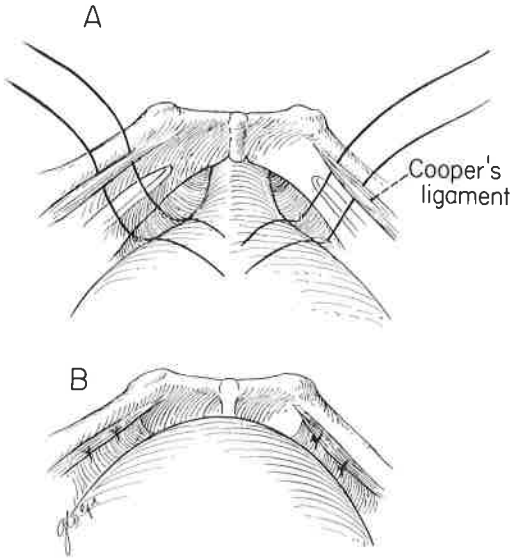

Fig. 2. Diagram of the Burch bladder neck suspension **A:** before sutures are tied; **B:** after sutures are tied to Cooper's ligament. The sutures include the whole vaginal wall, at the level of the bladder neck, but lateral as possible to avoid urethral obstruction or compression. The urethra is free in the retropubic space.

when the pubic periosteum was found to be insufficient to hold suture adequately. Advantages of the Burch colposuspension include lateral placement of the suspension sutures, thus obviating urethral obstruction, ability to correct mild cystoceles, and the reliability of Cooper's ligament as a strong anchoring tissue.

It is now almost 30 years since Armand Pereyra's [1959] important contribution of the original needle suspension technique, the first description of an alternative technique to that of the abdominal suspension procedures (Fig. 3). This innovation

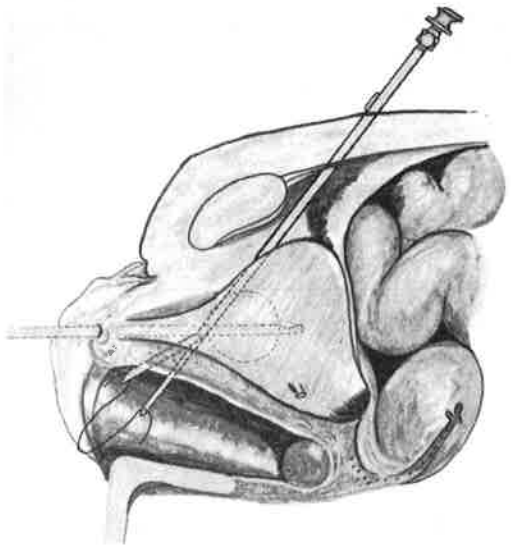

Fig. 3. Diagram of the original Pereyra procedure using a special cannula and trocar to transfer the suspending sutures.

was something akin to the development of transurethral prostatectomy as an alternative technique to open prostatectomy, achieving the same results while substantially reducing morbidity. Pereyra used a pair of No. 30 stainless steel wires to suspend the para-urethral tissues to the abdominal fascia. He introduced a special cannula to permit suture insertion requiring only a stab wound in the suprapubic area and avoiding an extensive abdominal incision. This cannula is passed blindly from the suprapubic stab through the retropubic space and the para-urethral tissues 2–3 cm posterior to the urinary meatus to emerge through the anterior vaginal wall. A trocar component of the cannula is then advanced through the anterior vaginal wall at the level of the bladder neck. The cannula and trocar tips are then threaded with the steel wire, transferred to the suprapubic area, disengaged, and clamped. After the contralateral side is approached in similar fashion, the suspension wires are tied. The para-urethral tissues are cauterized at several points along the proximal urethra about 1 cm lateral to the urethra, so that support would be rendered by fibrous tissue long after the wires cut through the soft para-urethral tissues.

Each modification of the original Pereyra procedure has resulted in the progressive evolution of the technique. W. Harer and Ronald Gunther [1965] modified Pereyra's technique by introducing a vaginal incision for the purpose of mobilizing the urethra and approximating the para-urethral tissues across the midline. Additionally, they performed the suspension with No. 1 Chromic sutures and transferred the sutures in such a way as to create a sling on each side of the bladder neck which is tied across the rectus tendon.

Pereyra in conjunction with Thomas Lebherz [1967] introduced the concept of entering the retropubic space by opening the lateral para-urethral tissue. This allowed for fingertip guidance of the passage of the cannula which avoided blind passage from the suprapubic to the vaginal region with its attendant risks of penetration of the

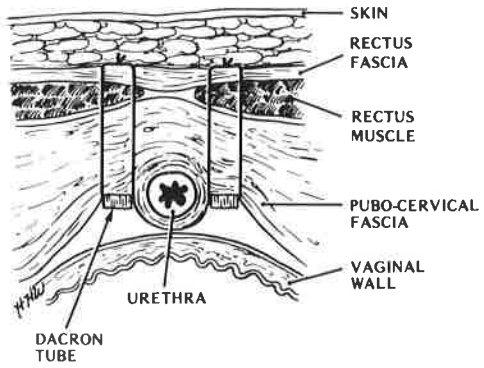

Fig. 4. Diagram of the Stamey suspension. The periurethral dacron graft and suspending sutures allow support of the urethra and bladder neck.

bladder and urethra. They also adopted the vertical mobilization incision, the para-urethral plication, and use of absorbable sutures as described by Harer and Gunther. Pereyra and Lebherz emphasized the importance of peri-operative pelvic floor exercises as well as parenteral estrogen replacement. After being greeted with an initial enthusiasm, the surgery was not widely accepted because of complications of bleeding, obstruction, and recurrent incontinence.

Robert Tauber and Paul Wapner [1967] introduced the concept of placement of suspension sutures under direct visual control. A midline anterior vaginal wall incision is made to expose the pubocervical fascia, and a pair of No. 0 nonabsorbable sutures are placed in the pubocervical fascia at the level of the bladder neck under direct visual guidance. The free end of each suture is tied, forming a loop around the encircled portion of the fascia. The sutures are then transferred to the suprapubic area by means of a special needle and tied to each other over the rectus fascia, after which the vaginal incision is closed.

Thomas Stamey [1973] contributed several novel concepts to needle suspension. He introduced the concept of cystoscopic control which allowed for accurate suture placement at the vesical neck and visualization of vesical neck closure with elevation of the suspension sutures. In addition, Stamey contributed the concept of bolsters used to support the bladder neck. A ''T''-shaped anterior vaginal incision is made and the vaginal wall dissected off the urethra. The Stamey needle is introduced through the anterior rectus fascia via a stab wound and directed through the retropubic space and out the vaginal incision at the level of the bladder neck. The Foley catheter is removed and cystoscopy confirms movement of the bladder neck with motion of the needle and lack of penetration of the bladder lumen or wall. A No. 2 nylon suture is threaded through the needle and transferred suprapubically. The needle is then passed through the same stab wound about 1 cm lateral to the original entry in the rectus fascia, through the retropubic space, exiting the vaginal incision about 1 cm distal to the nylon suture. Cystoscopy is repeated, and prior to transferring the suture, the nylon suture is passed through a 1-cm tube of 5 mm Dacron arterial graft, to buttress the vaginal loop (Fig. 4). The same procedure is repeated on the contralateral side of the bladder neck. Endoscopic examination while applying traction on the nylon sutures will demonstrate vesical neck closure. After placement of a suprapubic

tube, the vaginal incision is closed prior to tying the nylon sutures with tension. The suprapubic tube is generally clamped on the fourth postoperative day and removed on the following day.

Chester Winter [1976] introduced a modification of the Pereyra method in which a straightened 3-in curved needle with a swedged No. 2 plastic suture is passed from the vagina along the side of the bladder neck to the lower abdominal wall adjacent to the symphysis and the tip grasped with a clamp. The needle attached to the other end of the suture is passed in similar fashion 1 cm parallel to the first. The contralateral side is approached in identical fashion. A small suprapubic incision is made between the needles and carried down to rectus fascia, after which the sutures are tied snugly.

Oliver Cobb and Haakon Ragde [1978] introduced the double-prong ligature carrier, which minimized the number of passes necessary for suspension and allowed for a sufficient fascial bridge to support the suspension sutures. They also contributed the concept of a barrel knot tied in a nylon suture to support the para-urethral tissues, an alternative to the Dacron graft buttress as described by Stamey. The double-pronged needle is passed from a suprapubic stab through the retropubic space and allowed to exit through the anterior vaginal wall adjacent to the bladder neck. Cystoscopy is performed to exclude needle penetration, after which the vaginal epithelium between the needle shafts is incised, the needles are threaded with a No. 2 nylon suture with a centrally tied barrel knot, and the sutures are transferred suprapubically. The contralateral side is aproached similarly. The vaginal incision is closed, and the nylon sutures are tied snugly while the assistant elevates the vagina towards the symphysis.

Raz [1981; 1984] introduced another modification of the needle suspension technique. In the Raz procedure, an inverted "U" incision is made in the anterior vaginal wall, and the plane between the vagina and the glistening periurethral fascia is entered as dissection is directed laterally towards the pubic bone. The retropubic space is entered either bluntly or sharply between the pubic bone and the endopelvic fascia. The endopelvic fascia is freed from its lateral attachments from the level of the pubic bone to the ischial tuberosity which allows for adequate mobility of the urethra, bladder neck, and vaginal wall. A No. 1 Prolene suture is placed in helical fashion in the vaginal wall (excluding the epithelium), the pubocervical fascia, and the medial edge of endopelvic fascia (Fig. 5). Traction on the suture tests the integrity of the anchoring tissue. The contralateral side is approached similarly. The anterior rectus sheath is exposed through a 3-cm suprapubic incision, and a double-pronged ligature carrier is guided through the retropubic space by the surgeon's finger and out the vaginal introitus. The sutures are threaded and transferred suprapubically. After cystoscopy, the vaginal incision is closed with a running nonabsorbable suture and the Prolene suspension sutures are tied without tension. The urethral Foley and vaginal packing are removed on the first postoperative day, and the suprapubic tube is removed when voiding resumes and residuals become negligible. Hospital discharge is generally accomplished on the second postoperative day.

Several principles were introduced with this surgery. The inverted-U vaginal epithelial incision was devised to allow for dissection to be lateral to the urethra and bladder neck, thus avoiding dissection directly beneath the urethra and bladder neck, avoiding the need for mobilization of a vaginal flap, and facilitating entrance into the retropubic space. The pubocervical and endopelvic fascias are conveniently ap-

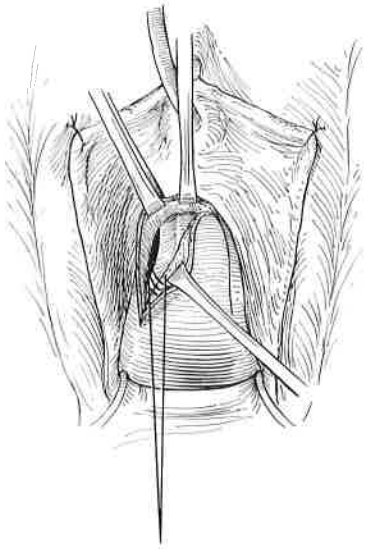

Fig. 5. Diagram of the Raz needle suspension. The anchoring sutures include the whole vaginal wall without the epithelium, the pubocervical fascia and (most important) the medial edge of the deep endopelvic fascia. The sutures are at the level of the bladder neck but lateral as possible.

proached from the limbs of the inverted U. We believe that the medial edge of the endopelvic fascia, detached from the pubic bone when the retropubic space is entered, is the most important and reliable structure for suspension. A potential complication of the Marshall-Marchetti-Krantz, original Pereyra, and Stamey procedures is urethral obstruction secondary to the close proximity of the suspending sutures to the urethra itself, which prevents satisfactory funneling and shortening of the vesical neck during voiding. Our principle is similar to that of the Burch suspension in that the sutures are placed laterally, obviating obstruction. We feel that it is important to enter the retropubic space not merely to facilitate fingertip control of the ligature carrier, but to mobilize the urethra and vesical neck sufficiently from adhesions and scars prior to performing the suspension. This is a sine qua non in the patient who has had prior procedures, either retropubic or vaginal, to suspend the bladder neck. We routinely use cystoscopy after administration of intravenous indigo carmine to insure bilateral ureteral efflux, lack of suture penetration of the urethra and bladder, and adequate suspension of the bladder neck when minimal traction is placed on the suspension sutures. The purpose for cystoscopy in the Stamey procedure is to observe the proper placement of the sutures at the level of the bladder neck. However, our procedure does not rely upon cystoscopy for suture placement since the sutures are placed under direct observation.

We feel that corrective surgery is indicated if the prolapse is symptomatic with stress incontinence, obstruction, introital mass, or hydronephrosis (Table VI). All of the anatomical components of the prolapse, including urethrocele, cystocele, enterocele, rectocele, uterine prolapse, and pelvic floor relaxation are corrected at the same time. For grade I prolapse, we perform a needle bladder neck suspension. Grade II prolapse is treated with a four-corner bladder and bladder neck suspension in which

TABLE V. Summary of Techniques of Bladder Neck Suspension

Year	Author	Carrier	Suture	Vaginal incision	Needle direction[a]	Anchoring tissue	Results (%)
1959	Pereyra	"Pereyra"	Steel	None	SP—vag	Paraurethral	90
1965	Harer and Gunther	"Pereyra"	Chromic	Vertical	SP—vag	Paraurethral	86
1967	Pereyra and Lebherz	"Pereyra"	Chromic	Vertical	SP—vag guided	Paraurethral	95
1967	Tauber and Wapner	"Inco"	Chromic	Vertical	SP—vag	Pubocervical fascia	n/a
1973	Stamey	"Stamey"	Nylon; Dacron buttress	"T" Incision	SP—vag	Pubocervical fascia	91
1976	Winter	"Curved needle"	Plastic	None	vag—SP	Pubocervical fascia; vagina	88
1978	Cobb and Ragde	"Double prong"	Nylon; barrel knot	Minimal	SP—vag	Paraurethral	90
1981	Raz	"Raz double prong"	Prolene	Inverted "U"	SP—vag guided	Vagina, endopelvic fascia, pubocervical fascia	96
1987	Gittes and Loughlin	"Stamey"	Prolene or nylon	None	SP—vag	Vagina	87

[a]SP = suprapubic; vag = vaginal.

TABLE VI. Surgical Techniques Based Upon Classification Scheme

Type of incontinence	Degree of prolapse (grade)	Therapy
Anatomic incontinence	I	Needle bladder neck suspension
	II–III	Four-corner bladder and bladder neck suspension
	IV	Formal cystocele repair and needle bladder neck suspension
Intrinsic damage		Vaginal wall sling Periurethral Teflon

four suspension sutures are utilized to suspend the bladder base in addition to the bladder neck. The two bladder base sutures incorporate the vaginal wall, excluding the epithelium, pubocervical fascia, and anterior extension of the cardinal ligaments. Grades III and IV prolapse are treated with needle bladder neck suspension and classic cystocele repair consisting of approximation of the pubocervical fascia.

Ruben Gittes and Kevin Loughlin [1987] described a "no-incision" modification of the Pereyra technique (Fig. 6). Without making a vaginal incision, a Stamey needle is passed from a suprapubic stab wound through the retropubic space and out the anterior vaginal wall at the level of the bladder neck. A heavy nylon or Prolene suture is threaded and withdrawn suprapubically; a second pass of the needle is made and advanced out the anterior vaginal wall about 2 cm away from the first puncture

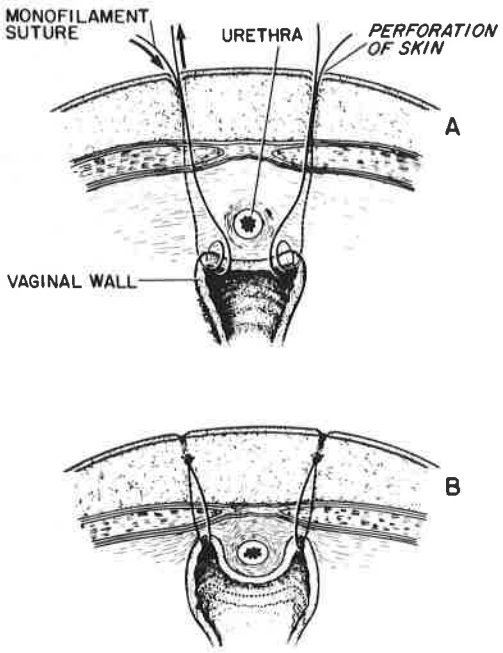

Fig. 6. Diagram of the Gittes suspension **A:** before sutures are tied; **B:** after sutures are tied. The sutures include the whole vaginal wall at the level of the bladder neck. No incision is required in the vaginal wall or in the suprapubic area.

site; and prior to threading the suture, a full-thickness helical bite of the vaginal wall is taken between the first and second vaginal perforations. The suture is threaded, transferred, and after the contralateral side is approached and cystoscopy performed, the sutures are tied down with tension to bury the knots in the fat of the suprapubic puncture sites. This procedure relies upon the suspension sutures breaking through the vaginal epithelium and becoming incorporated.

With such a multitude of different procedures to chose from, what is a reasonable approach for the clinician? Is a vaginal approach superior to a retropubic approach? Is a ''no-incision'' technique better than a technique which requires a vaginal incision? Is there a limitation on the maxim that simpler is better? The answers to these questions can be approached by a comparative analysis of the results and the advantages and disadvantages of the individual techniques. Results of the various techniques in achieving resolution of stress urinary incontinence are remarkably comparable. Clearly, if similar results can be achieved with retropubic and vaginal approaches, it would be in the best interest of the patient to undergo the procedure which results in the least pain, morbidity, and risk and which results in the shortest hospital stay and most rapid return to a productive lifestyle. In this regard, the vaginal needle suspension procedures confer a distinct advantage. Additionally, the ability simultaneously to correct concomitant vaginal pathology is in favor of the vaginal approach. As long as basic principles and tenets are strictly adhered to, the choice of a particular technique is of little importance. The fundamental principles include the following:

1. Mobilization of the urethra and bladder neck from fixation and tethering such that a suspension without tension can be performed (especially important in secondary procedures).

2. Placement of the suspension sutures in hardy tissue.

3. Precise placement of the suspension sutures in the proper location. Too distal can result in urethral kinking, too proximal can result in ineffective suspension, too medial can result in urethral obstruction, too lateral can result in ineffective suspension and possibly pain from a suture in the levator complex.

4. Satisfactory securing of anchoring tissue. Helical securing of anchoring tissue seems to confer advantages over securing only a loop of tissue, or use of a barrel knot, or a buttress.

5. Fingertip guidance of passage of ligature carrier through the retropubic space. This method will prevent inadvertent penetration of the bladder or urethra.

6. Use of a double-pronged ligature carrier. This will reduce by one-half the number of passes necessary as well as provide a 1 cm fascial bridge over which the suspension sutures are tied.

7. Cysto-urethroscopy after administration of intravenous indigo carmine in order to document bilateral ureteral efflux of urine, proper elevation of the bladder neck when gentle traction on the suspension sutures is applied, and to confirm lack of suture penetration of the bladder and urethra.

8. Tying the suspension sutures over the fascia without tension. Individual sutures are placed on each side; if one suture breaks, the other will usually be sufficient to keep the bladder neck adequately suspended.

Any surgical procedure that can satisfy the aforementioned criteria will work, providing that the proper diagnosis has been made.

REFERENCES

Aldridge AH (1942): Transplantation of fascia for relief of urinary stress incontinence. Am J Obstet Gynecol 44:398–411.

Burch JC (1961): Urethrovaginal fixation to Cooper's ligament for correction of stress incontinence, cystocele, and prolapse. Am J Obstet Gynecol 81:281–290.

Cobb OE, Ragde H (1978): Simplified correction of female stress incontinence. J Urol 120:418–420.

Gittes RF, Loughlin KR (1987): No-incision pubovaginal suspension for stress incontinence. J Urol 138:568–570.

Hadley HR, Zimmern PE, Staskin DR, Raz S (1985): Transvaginal needle bladder neck suspension. In Raz S (ed): "Urologic Clinics of North America." Vol. 12, No. 2. Philadelphia: Saunders, pp 291–303.

Harer WB, Gunther RE (1965): Simplified urethrovesical suspension and urethroplasty. Am J Obstet Gynecol 91:1017–1021.

Hepburn TN (1927): Prolapse of the urethra in female children. 44:400–401.

Jeffcoate TNA (1965): The principles governing the treatment of stress incontinence of urine in the female. Br J Urol 37:633–643.

Kelly HA, Dumm WM (1914): Urinary incontinence in women, without manifest injury to the bladder. Surg Gynecol Obstet 18:444–450.

Marshall VF, Marchetti AA, Krantz KE (1949): The correction of stress incontinence by simple vesicourethral suspension. Surg Gynecol Obstet 88:509–518.

Pereyra AJ (1959): Simplified surgical procedure for the correction of stress incontinence in women. West J Surg 67:223–226.

Pereyra AJ, Lebherz TB (1967): Combined urethrovesical suspension and vaginourethroplasty for

Raz S (1981): Modified bladder neck suspension for female stress incontinence. Urology 17:82–85.
Stamey TA (1973): Endoscopic suspension of the vesical neck for urinary incontinence. Surg Gynecol Obstet 136:547–554.
Stamey TA (1980): Endoscopic suspension of the vesical neck for urinary incontinence in females. Ann Surg 192:465–471.
Tauber R, Wapner P (1967): Surgical repair of severe and recurrent urinary incontinence. Obstet Gynecol 30:741–744.
Winter CC (1976): Unilateral and bilateral bladder neck suspension operation for stress urinary incontinence. J Urol 116:47–48.