*Aust. NZ J Obstet Gynaecol*
1996; 36: 4: 453

# The Intravaginal Slingplasty Operation, a Minimally Invasive Technique for Cure of Urinary Incontinence in the Female

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**EDITORIAL COMMENT:** *All readers surely believe that everyone with a new idea has a right to be heard although in the case of a journal this means passing scrutiny of the referees. In obstetrics the curse of all clinicians is prematurity. In gynaecology it is urinary incontinence. Stress incontinence is the urogynaecologist's delight with a specific diagnosis and a range of special procedures for its surgical treatment with high prospects of lasting cure. The enigma is detrusor instability and other forms of incontinence where there is no prolapse or evidence of stress incontinence clinically or on urodynamic investigation. Twenty years ago when the editor began attending the Repatriation General Hospital Gynaecology Clinic in Melbourne, which had a population of mainly elderly women, the overriding impression was of a group of miserable women with excoriated vulvas and urinary incontinence not amenable to surgery. Modern appliances provided in incontinence clinics and the widespread use of oestrogen has totally changed this picture but the problem of nonstress urinary incontinence remains. Many operations have been used for these patients. The present paper is written by an author with a passion for the management of women with urinary incontinence but with a frustration that this Journal has rejected his previous offerings after review by urogynaecologists with the editor's acceptance of their decisions. We have decided to publish this paper to give Dr Papa Petros a hearing. Some of the author's ideas are not easy to follow. Accordingly we asked him to encapsulate his philosophy concerning urinary incontinence in the female into about 800 words. This additional contribution is published as an epilogue to this paper; do not overlook it!*

*Summary:* The aim was to evaluate the intravaginal slingplasty operation, a minimally invasive technique for cure of urinary incontinence. Fifty-four unselected patients, aged from 26 to 79 years, mainly with mixed incontinence symptoms, underwent this procedure. It works by tightening the suburethral vagina ('hammock'), and by creating an artificial pubourethral neoligament. Where indicated, repair of uterine prolapse (24 cases), or infracoccygeal sacropexy (17 cases) was also performed. Almost all patients were discharged on the day of, or day after surgery, without requirement for postoperative catheterization, and returned to fairly normal activities, including jobs, within 7 to 14 days. At a mean follow-up time of 15 months, the cure rates for preoperative symptoms were, frequency 88%, nocturia 77%, urge incontinence 89%, stress incontinence (SI) 85%, symptoms of abnormal emptying, 77%, and reduction of mean residual urine from 67.5 mL to 32 mL. The objective cure rate (exercise pad testing) for stress incontinence was 88.6%; taking the group as a whole, urine loss was reduced from a mean of 11.6 g preoperatively to a mean of 0.5 g postoperatively. **Urodynamically diagnosed detrusor instability was not a predictor of surgical failure in this study.** According to the concepts presented here, symptoms of urinary dysfunction are mainly symptomatic manifestations of abnormal laxity in the vagina or its supporting ligaments. The surgical methods used to correct these defects are fairly simple, safe and easily learnt by any practising gynaecologist.

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Urethral closure at stress is said to occur by virtue of raised intraabdominal pressure closing off a proximal urethra correctly positioned in the pressure sphere of the intraabdominal cavity (1). The surgical cure of 'genuine stress incontinence' (GSI) by bladder neck elevation is based on this theory (1). GSI is a concept proposed by the International Continence Society (ICS) (2), and is the condition described as urine loss on effort in the absence of urodynamically diagnosed 'detrusor instability' (DI). Because of the high incidence of detrusor instability after bladder neck elevation surgery, up to 18% (3), it is recommended (2,3) that patients with urodynamically diagnosed detrusor instability not undergo surgery. The concept of detrusor instability has created considerable confusion, for many reasons, not least of which is that patients from the largest incontinence group, those with 'mixed' symptoms, frequently have both symptoms cured by surgery (4).

None of these limitations apply to the intravaginal slingplasty operation, which is based on a different concept of bladder function (5,6 figures 1 and 2). **According to this theory (5,6), symptoms of stress, urge, and abnormal emptying are mainly secondary manifestations of laxity in the vagina or its supporting ligaments.** The healthy vagina is essentially an elastic membrane, suspended from the bony pelvis by its ligamentous supports. At rest, the vaginal elasticity compresses the urethra from behind, functioning as a low energy closure mechanism. During stress (figure 1), and micturition (figure 2), the vagina is stretched by specific striated pelvic floor muscles to actively open and close the urethra. As an elastic supporting membrane, the vagina counteracts activation of the micturition reflex provoked by bladder distension. Destruction of elasticity by birth or age may cause laxity of the vaginal membrane (figure 3), interfering with the vagina's passive closure function, clinically expressed as symptoms of stress incontinence; the same loss in elasticity may fail to resist stretching of the micturition receptors 'N' (figure 3), resulting in premature activation of the micturition reflex, symptomatically expressed as frequency, urgency, nocturia, and urodynamically as 'detrusor instability'. All the above symptoms are potentially curable by correcting laxity in the vagina and/or its supporting ligaments (5,6).

The intravaginal slingplasty operation (IVS) irrespective of the precise form used, consists of 2 parts. 1) An artificial pubourethral neoligament (PUL) is created by precise insertion of a polyester tape in the position of the natural ligament; 2) the suburethral vagina (hammock) is tightened.

The IVS operation was first performed in 1987, and has been jointly developed in Australia and

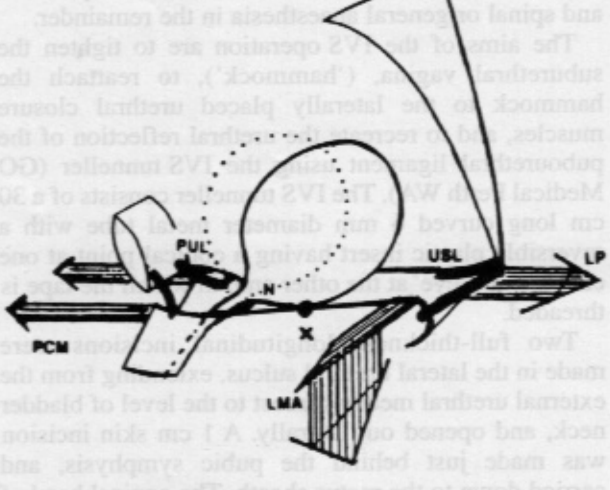


Figure 1. Urethral and bladder neck closure mechanisms. This represents a schematic 3 dimensional view of vagina, bladder, pubic symphysis anteriorly, and sacrum posteriorly. The arrows represent directional striated muscle forces. During stress, the forward force (PCM) stretches the 2 ends of the hammock forward to close off the urethra (urethral closure mechanism); the backward (LP) and downward (LMA) forces, stretch the vagina and bladder base backwards around PUL 'kinking' bladder neck (bladder neck closure mechanism). The pubourethral ligament (PUL) acts as an insertion point for the horizontal forces (LP,PCM); the uterosacral ligament (USL) acts as an insertion point for the downward force from the longitudinal muscle of the anus (LMA); PCM = pubococcygeus muscle; LP = levator plate; X = insertion of bladder base to vagina; broken lines represent normal resting postion of bladder; 'N' = stretch receptors at bladder base.

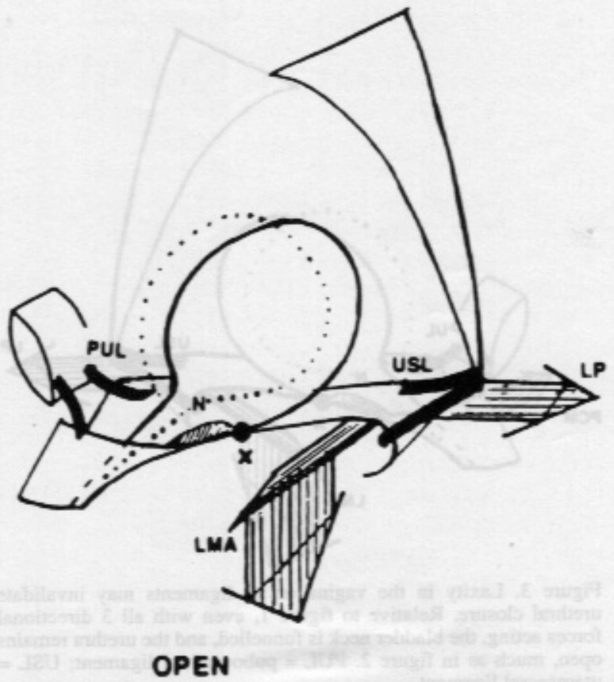


Figure 2. Micturition. With reference to figure 1, during micturition, PCM relaxes. The backward and downward forces 'funnel' vagina and bladder neck, sending the system into 'open mode'. Broken lines represent normal resting position of the bladder.

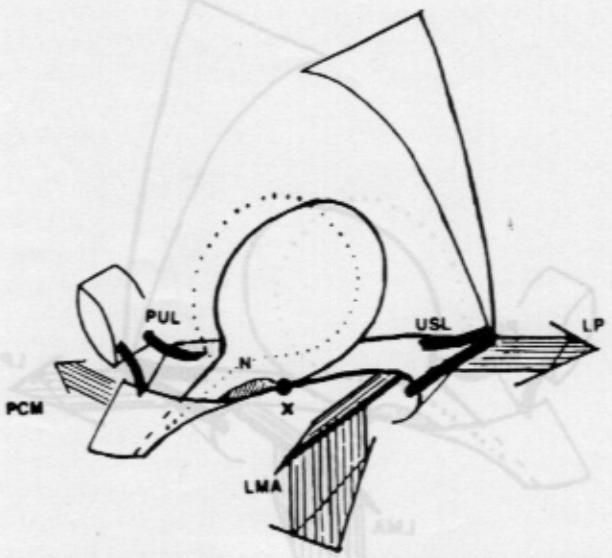


Figure 3. Laxity in the vagina or its ligaments may invalidate urethral closure. Relative to figure 1, even with all 3 directional forces acting, the bladder neck is funnelled, and the urethra remains open, much as in figure 2. PUL = pubourethral ligament; USL = uterosacral ligament.

Scandinavia. The process for creation of an artificial pubourethral neoligament (7) was inspired by the concepts of Robert Zacharin (8). However, creation of an artificial pubourethral neoligament alone resulted in only a 50% cure rate (9). It was previously demonstrated (9), and also in this study, that an adequately tight vaginal hammock was equally important for the restoration of continence. The original versions of the IVS involved a removable sling, because of potential problems associated with permanent implantation of foreign materials (10). However, it was found, especially in older patients with poor tissues, that a permanent polyester tape positioned below the midurethra gave 10% superior results (6) to the removable sling.

The second part of the IVS, tightening the suburethral vagina, has been achieved either by 2 paraurethral incisions, or a single suburethral incision (6). In the procedure evaluated here, no vagina is excised, and a formal attachment of the vaginal hammock on each side to the pubourethral ligament, and anterior portion of pubococcygeus muscle is made. Lateral incisions were preferred to a midline incision, as it was felt that even in patients with suboptimal results, scar tissue contracture would tighten the hammock over time, thereby improving continence. This, in fact, has been found to be so. Where indicated, laxity in the posterior vagina (enterocele) and the posterior ligaments (uterovaginal prolapse) was repaired, in order to test other claims of the theory (5,6) that symptoms of bladder instability and abnormal emptying are also potentially curable surgically.

## PATIENTS AND METHODS

Fifty-four unselected patients were referred because of symptoms of urinary incontinence. Mean age was 49.6 years (range 26-79), parity 2.9 (range 0-9); mean weight was 68 kg (range 48-110 kg).

All patients were preoperatively assessed using a structured questionnaire, examination sheet, and the pictorial algorithm (appendix). In addition, radiology, and several urodynamic parameters were assessed, including detrusor instability, fall in proximal urethral pressure on handwashing provocation, flow rate, residual urine, urethral pressure profile, cough and Valsalva transmission ratios. Exercise pad tests [coughing x 10 and star (scissor) jumps x 10] were used to quantify urine loss on stress.

The criteria for cure were 1) symptomatic cure, which was entirely patient-based. 2) pad testing; cure of SI was defined as less than 0.3 g urine loss following 10 coughs and/or star jumps.

### *Surgical methods*

Two main surgical principles were followed: 1) minimal vaginal excision, and tissue reconstitution without tension; 2) creation of artificial neoligaments (7) using polyester tapes and a special tunneller inserted via a 1 cm skin incision. Local analgesia/midazolam was used in more than 50% of the patients, and spinal or general anaesthesia in the remainder.

The aims of the IVS operation are to tighten the suburethral vagina, ('hammock'), to reattach the hammock to the laterally placed urethral closure muscles, and to recreate the urethral reflection of the pubourethral ligament using the IVS tunneller (GO Medical Perth WA). The IVS tunneller consists of a 30 cm long curved 6 mm diameter metal tube with a reversible plastic insert having a conical point at one end, and an 'eye' at the other end, in which the tape is threaded.

Two full-thickness longitudinal incisions were made in the lateral urethral sulcus, extending from the external urethral meatus almost to the level of bladder neck, and opened out laterally. A 1 cm skin incision was made just behind the pubic symphysis, and carried down to the rectus sheath. The conical head of the IVS tunneller was inserted into the vaginal incision (figure 4), and keeping the point pressed against the posterior part of symphysis pubis, brought out to the skin incision. The insert was withdrawn and reversed. A 4 mm polytetrafluoroethylene tape was threaded into the 'eye' of the insert, which was, in turn, pulled down through the tube of the tunneller. A tunnel was created between vagina and urethra at the midurethral level using dissecting scissors, and the tape pulled through to the contralateral incision. The tunneller was now inserted into the second incision, and brought out again to the skin incision. Having checked with a 30 or 70 degree cystoscope that there

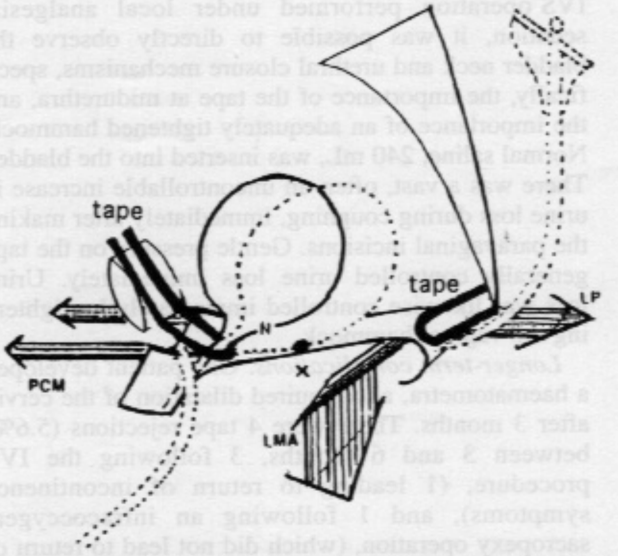


Figure 4. Restoration of the ligamentous attachments to pubic bone. Relative to figure 3, insertion of tapes precisely in the positions occupied by 'PUL' (IVS operation) and 'USL' (infracoccygeal sacropexy) restores the insertion points of all 3 directional forces. Broken lines represent the resting bladder position of a patient with vaginal or ligamentous laxity. The IVS tunneller is also outlined with broken lines, with its point touching its site of insertion.

was no perforation, the outer sheath of the tunneller was removed, and the tape insertion completed by pulling up the second limb of the 'U' into the skin incision using the tunneller insert. That part of vagina below the urethra (hammock) was tightened by suturing the distal part deep into the pubourethral ligament and the proximal part to the pubococcygeus muscle on both sides. The tape was left entirely free, its purpose being to act as a template for the neoligament (7), its 2 ends cut at the level of the rectus sheath and left unfixed (figure 4), without any elevation of bladder neck whatsoever.

The aim of the uterine prolapse repair was to tighten the posterior fornix of vagina, uterosacral and cardinal ligaments, thereby correcting the prolapse. The enterocele was transversely incised at its apex. A wedge of cervix was excised between the insertion points of the cervical ligaments at 4 and 8 o'clock, carried down to the vaginal incision. Insertion of a Sims speculum with or without sharp dissection of adherent enterocele exposed the cardinal (CL) and uterosacral ligaments (USL). These were apposed without tension, and the vaginal tissues reconstituted by suturing them vertically.

In women with enterocele and everting posthysterectomy vault prolapse, the aim was to tighten the posterior fornix of vagina, to appose the remnants of the cardinal and uterosacral ligaments (USLs), and to create neoligaments in the precise position of the USLs, by insertion of polyester tapes along their anatomical path (figure 4). A 5-6 cm transverse incision was made at the apex of the prolapsed vagina, and opened out anteroposteriorly as previously described. A 1 cm skin incision was made below the coccyx. The IVS tunneller was inserted (figure 4), and swept around the external anal sphincter and rectum into the vaginal incision. Polyester tapes were brought down from the vaginal incision by reversing the insert as described above, creating a 'U'. The loop of the 'U' was fixed at one end only, to the remnants of the cardinal ligaments. The 2 limbs of the 'U' were cut 1 cm below the skin, and left free.

## RESULTS

The mean follow-up time was 15 months (range 9 to 24 months). Twenty patients had undergone prior hysterectomy, and 14 patients a total of 25 previous operations for their incontinence. The IVS operation was performed on all 54 patients. Where indicated, repair of uterine prolapse (24 patients), infracoccygeal sacropexy for vaginal vault prolapse (17 patients), and cystocele repair (1 patient) were also performed. Mean operating time was 25 to 30 minutes for the IVS operation, and 45 to 60 minutes when the IVS was combined with repair of uterine prolapse or sacropexy. No postoperative catheterization was needed in any patient. All but 1 patient were discharged on the day of or day after surgery. There was minimal postoperative pain. However, in spite of taking precautions to tie the uterosacral/cardinal ligament sutures loosely, in 1 patient who had IVS plus uterine prolapse repair, the pain was severe, and the cardinal/uterosacral ligament suture had to be revised 48 hours postoperatively. Almost all patients returned to fairly normal activities, including jobs, within 7 to 14 days. Blood loss was generally less than 100 mL. However, losses of up to 500 mL were recorded. No transfusions were required, and the blood loss did not prevent early discharge.

*Stress Incontinence (SI).* A total of 52 patients with SI symptoms were surgically treated, 5 with symptoms of pure SI, and 47 with mixed symptoms.

The symptomatic cure was 85%. Of the 8 symptomatic failures, 1 patient assessed herself as being more than 50% cured, another 70%.

On objective testing (exercise stress testing) cure rate was 88.6%; 35 of 54 patients lost a total of 407 g preoperatively. Taking the group as a whole, mean urine loss was reduced from 11.6 g preoperatively to 0.5 g postoperatively. Thus 19 of 54 patients lost no urine, or less than 0.3 g of urine on preoperative objective testing, their principal symptom being urge incontinence; postoperatively, 4 patients lost a total of 21.5 g of urine. Even these patients reduced their urine loss from a preoperative mean of 22 g to a postoperative mean of 5.4 g. Urodynamically diagnosed detrusor instability (DI) was present in 27 of 54 patients preoperatively, and in only 4 of 8 patients with failed procedures. DI was not predictive of surgical failure with the IVS procedure.

*Urge Incontinence (UI).* Forty-nine patients gave a history of urge incontinence, and in 14 of these, urge symptoms predominated, with no urine loss detected on objective testing. All but 5 (89%) were surgically cured. Of these 5, 2 assessed their symptomatic improvement as being more than 60%. Two patients had only urge incontinence symptoms, with no SI whatsoever. Both were surgically cured. There was no 'de novo' incidence of UI in the longer-term. Only 23 of these 49 patients had 'detrusor instability' on preoperative urodynamic testing.

*Urodynamically diagnosed detrusor instability (DI).* It is emphasized that this is entirely a diagnosis made by a machine. Symptoms of urge, frequency and nocturia were not necessarily found to be associated with DI in this study. DI was present in 27 of 54 patients preoperatively, and in only 4 of 8 patients with failed procedures. Of the 36 patients consenting to postoperative urodynamic cystometry testing, 15 had preoperative DI, and DI was present postoperatively in 5. There was a 'de novo' incidence of DI in 2 patients, both being entirely asymptomatic postoperatively.

*Frequency* (more than 8 times per day) was present in 25 patients preoperatively, and in 3 postoperatively. The improvement rate was 88%.

*Nocturia* (more than twice per night) was present in 17 patients preoperatively, and in 4 postoperatively. The improvement rate was 77%.

*Abnormal emptying symptoms.* These were taken from the 4 questionnaire questions on abnormal emptying. 'Does your bladder empty properly?' 'Do you have difficulty starting?' 'Is it a slow flow?' 'Does the stream stop and start by itself during the flow?' Thirty-nine patients gave a total of 95 abnormal emptying symptoms preoperatively; 8 patients reported no improvement, 1 worsened emptying, and 30 improvement; the improvement rate was 77%.

*Residual urine.* Median value reduced from 39.5 mL preoperatively, to 20 mL postoperatively. Taking 50 mL as signifying raised residual urine, 17 patients had a mean preoperative residual urine of 67.5 mL (range 50 to 275 mL), reducing to a mean of 32 mL postoperatively (range 0 mL to 300 mL), $p < 0.006$, Wilcoxon paired ranks.

*Peak flow rate.* Forty-three patients had postoperative peak flow rates performed. Mean value was 30 mL/second preoperatively, and 32 mL/second postoperatively. Preoperative mean value for this group was 32 mL/second (range 8 to 56 mL/second), and postoperative mean 34 mL/second (range 18 to 56 mL/second), $p < 0.23$, Wilcoxon paired ranks.

*Confirmation of the urethral and bladder neck closure mechanisms.* In those patients who had the IVS operation performed under local analgesia/sedation, it was possible to directly observe the bladder neck and urethral closure mechanisms, specifically, the importance of the tape at midurethra, and the importance of an adequately tightened hammock. Normal saline, 240 mL, was inserted into the bladder. There was a vast, often an uncontrollable increase in urine loss during coughing, immediately after making the paravaginal incisions. Gentle pressure on the tape generally controlled urine loss immediately. Urine loss was likewise controlled immediately by tightening the vaginal hammock.

*Longer-term complications.* One patient developed a haematometra, and required dilatation of the cervix after 3 months. There were 4 tape rejections (5.6%) between 3 and 6 months, 3 following the IVS procedure, (1 leading to return of incontinence symptoms), and 1 following an infracoccygeal sacropexy operation, (which did not lead to return of incontinence symptoms). In all instances, the tape was removed per vaginam as an office procedure.

## DISCUSSION

A high cure rate for symptoms of bladder dysfunction not normally considered curable by surgical means was noted, specifically frequency, urge incontinence, nocturia, symptoms of deficient bladder opening and raised residual urine. These results appear to support the concepts (5,6) underlying this method (figures 1-4). The cure rate for stress incontinence in this study appears to be comparable to that for open or laparoscopic bladder neck elevation techniques (11).

Comparison of this method's results with those of other surgical methods cannot be totally meaningful, as the 2 methods are based on entirely different ideologies, one elevating vagina (1), the other tightening it and restoring its ligaments (5,6). Comparisons which follow are therefore limited to methodology only. The use of local analgesia with sedation with the IVS technique has been especially useful in old anf frail patients, potentially reducing lung complications, thrombosis, and embolism. Older patients have inelastic tissues (12). Unlike bladder neck elevation procedures, age, urodynamically diagnosed 'detrusor instability' (3), and lack of tissue elasticity (13) are not contraindications to surgery with the new methodology. Unlike the Burch operation, there is no diminution in postoperative urine flow (3), postoperative catheterization (3) is rarely required, and the surgical success rate in older patients (4) is not diminished. Patients return to the ward without a catheter, usually return home in a day, and to fairly normal activites including jobs within 7-14 days. All the above, confirmed by Falconer et al (14), are attributed to precise restoration of anatomy, as opposed to what may often be imprecise elevation of the vagina and bladder neck with conventional techniques. Falconer et al (14) reported 89% cure rate for stress incontinence at 18 months for the IVS operation in a series of 75 patients.

A recently reported laparoscopic method (11) gave the following results, (this study's results in brackets): almost 10% cystotomy rate (nil), 10% catheterization for longer than 48 hours (nil), 10% laparotomy conversion rate (nil), 108 minutes mean operating time (25-30 minutes), 8% symptoms of de novo bladder instability (nil), 3 abdominal incision points (1), hospital stay of 2.5 days (1 day), general anaesthesia 100% (50%), tissue rejection of tape, nil (5.6%).

Urodynamically diagnosed 'detrusor instability' was not found to be a predictor of surgical failure in this study. In spite of this, recommendations for not performing bladder neck elevation surgery in patients with DI (3) are consistent with the concepts (5,6) on which the IVS operation is based. According to (5,6), retropubic attachment of the vagina during bladder neck elevation stimulates the stretch receptors ('N', figure 1), by exerting pressure from below, causing premature activation of the micturition reflex, expressed as symptoms of bladder instability, frequency, nocturia and urgency.

This concept was directly demonstrated in the prototype IVS operation (9), which comprised an adjustable suburethral sling located inside the vaginal cavity itself. The bladder neck was elevated by tightening the sling intraoperatively. Immediately postoperatively, 23 of 30 patients complained of frequency, nocturia, urgency, and difficulty with emptying. Sequential lowering of the sling over a period of a few days resulted in all these symptoms disappearing. It was hypothesized at the time, that the sling had caused stimulation of the bladder neck stretch receptors from below ('N', figure 1), causing premature activation of the micturition reflex, expressed as symptoms of bladder instability, frequency, nocturia and urgency. In this context, detrusor instability was designated as a urodynamic expression of the same, prematurely activated micturition reflex. This concept was subsequently confirmed by urodynamic studies (15). **Subsequent versions of the IVS demonstrated that elevation of the bladder neck was not required to restore continence.** Cure of stress incontinence by bladder neck elevation surgery is explained by longitudinal stretching of the vaginal membrane, or where lateral sutures are inserted during open Burch surgery, lateral tightening of the hammock also.

*Cure of symptoms of frequency, urgency, nocturia, and abnormal emptying.* It is clear from figures 3 and 4, that the ability of the vaginal membrane to remained stretched and supportive of 'N', depends on adequate tension in the whole anterior wall of the vagina. Laxity in the posterior part of the vaginal membrane (enterocele) may also fail to support 'N', causing premature activation of the micturition reflex. Neither will a lax vagina permit the backward (LP) and downward (LMA) forces, figure 3, to assist opening out of the outflow tract. This may result in symptoms of abnormal emptying, and raised residual urine.

It is emphasized that the minimal nature of this technique does not preclude occurrence of almost any complication reported to date with existing techniques for uterovaginal prolapse or incontinence surgery. **According to the concepts presented here, symptoms of urinary dysfunction are mainly symptomatic manifestations of abnormal laxity in the vagina or its supporting ligaments.** The surgical methods used to correct these defects are fairly simple, safe and easily learnt by any practising gynaecologist.

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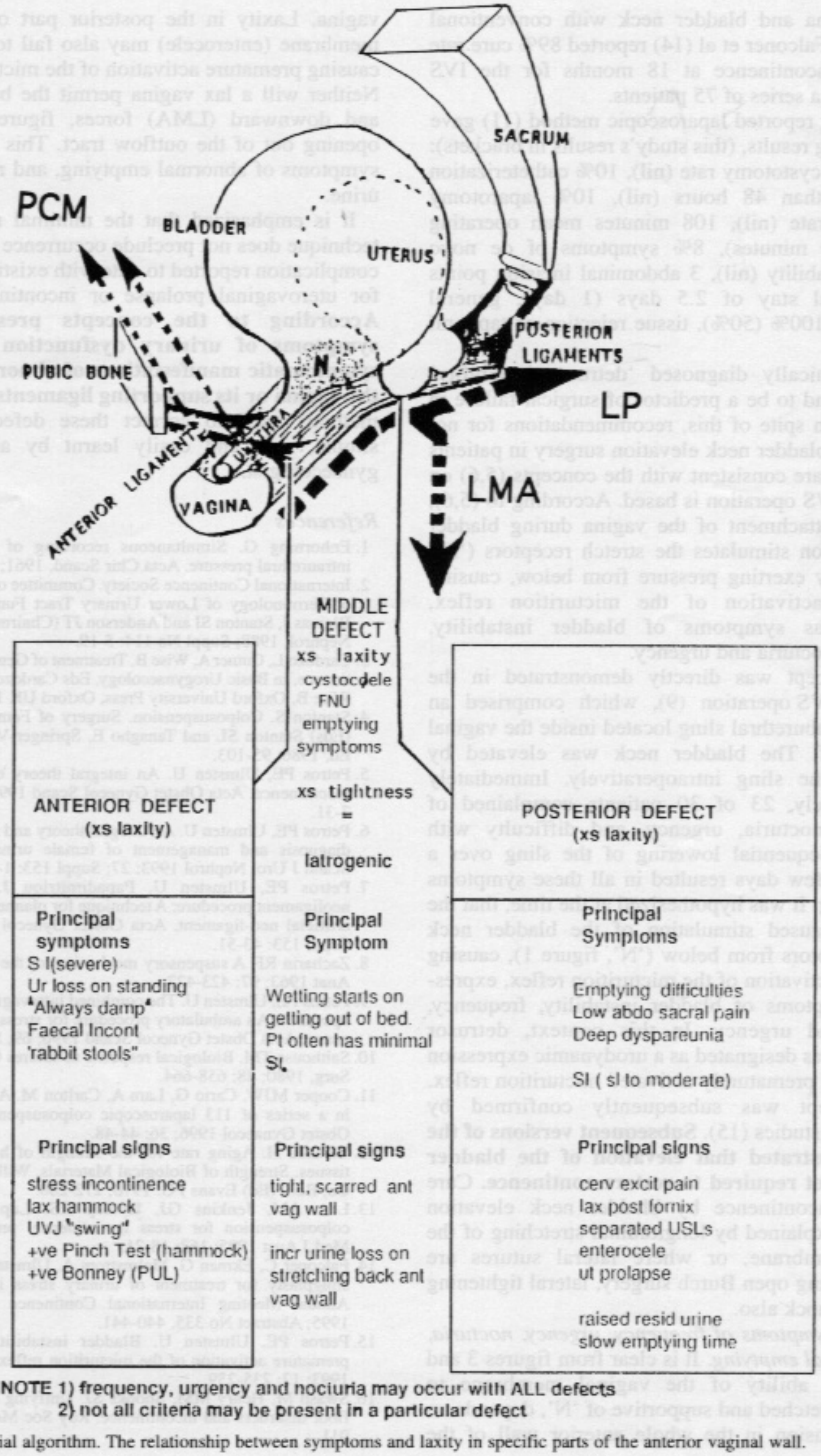


**Figure 5.** Pictorial algorithm. The relationship between symptoms and laxity in specific parts of the anterior vaginal wall.

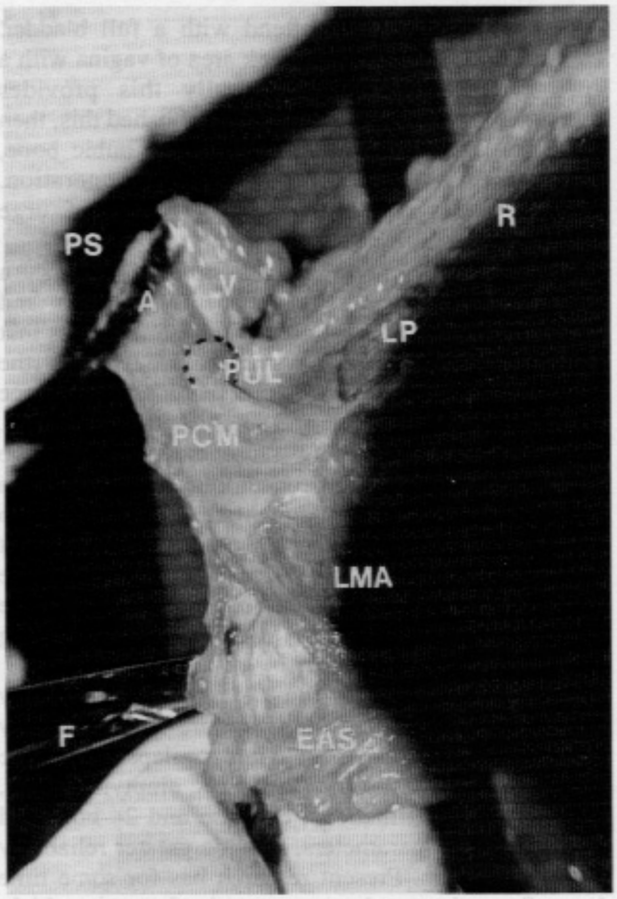


Figure 6. Anatomy of the opening and closure muscles. This is a fresh anatomical specimen from a normal continent female cut away from its bony insertions. The broad flat pubococcygeus muscle (PCM) sweeps around laterally from its anterior insertion point at pubic symphysis (PS) to insert into the contralateral muscle posteriorly forming part of the levator plate (LP). Rectum (R) is attached to LP at its posterior wall. PUL = pubourethral ligament; V = vagina; A = anterior portion of PCM attached to the lateral wall of vagina (V); LMA, the longitudinal muscle of the anus, a striated muscle complex deriving its fibres from LP posteriorly, and PCM anterolaterally. It sweeps downwards mainly over the posterior wall of rectum, but also, anteriorly, to insert into the deeper fascial layers, and the deep portion of external anal sphincter (EAS); an artery forceps (F) is inserted into the perianal space, a clear areolar space separating LMA from the anus; EAS = deep portion of external anal sphincter. With reference to figures 1-5, 'A' generates the forward muscle force, LP the backward muscle force, and LMA the downward muscle force.

## APPENDIX

*The Relationship between Symptoms and Anatomical Defects in the Anterior Vaginal Wall*

There is a presumed relationship between specific symptoms, signs, and anatomical defects sited in the front (F), middle (M) and posterior (P) parts of the anterior vaginal wall, as summarized in the pictorial algorithm, figure 5.

*How to use the pictorial algorithm*

Simply copy figure 5, and tick off the various parameters. The columns pictorially represent symptoms and signs specific to each anatomical region, front, middle, and posterior. Because the control mechanisms of the body are complex, no particular symptom is necessarily present on any particular day. Similarly, it may be possible to wrongly assess laxity in any particular part of the anterior vaginal wall. This especially applies to a small enterocele, always present with laxity in the uterosacral ligaments. Therefore, one arrives at a diagnosis using a combination approach. As they were beyond the scope of this paper, pelvic pain of otherwise unknown origin, and faecal symptoms were excluded from the IVS data, but are included in the algorithm. Pain may indicate laxity in the posterior vaginal wall (6), and faecal incontinence and narrow constipated stools ('rabbit stools') laxity in the anterior ligaments and vaginal hammock. Both symptoms are included in the pictorial algorithm.

*Pelvic examination.* Specific anatomical defect sites within the anterior vaginal wall ar marked, F, M, P.

| | | |
|---|---|---|
| **F** | Suburethral Hammock | normal loose very loose |
| **M** | Tight Anterior Wall or Tight Scar Over Bladder Neck | yes/no |
| **M** | Cystocele/Anterior Wall Prolapse | (degree) ( ) |
| **P** | Enterocele/High Rectocele | (degree) ( ) |
| **P** | Uterine Prolapse | (degree) ( ) |
| **F** | **pinch test** ( ) +ve = urine loss during coughing controlled by taking a 1-sided fold of the vaginal hammock between the ends of a large artery forceps. | |
| **F** | **1-sided Bonney test at midurethra** ( ) +ve = urine loss during coughing controlled by a closed artery forcep point pushed upwards unilaterally next to the midurethra. | |
| **P** | **cervical excitation pain: YES/NO** | |

## EPILOGUE

*A Urogynaecologist's philosophy of bladder function and dysfunction*

According to the concepts introduced in this paper, uterovaginal prolapse and symptoms of stress, urge, abnormal emptying, even urodynamically diagnosed 'detrusor instability', all constitute, in the main, different manifestations of laxity in the vagina or its supporting ligaments. Symptomatic cure by surgical tightening of the vaginal membrane indicates that connective tissue laxity, not muscle damage (16) is likely to be the major cause of urinary incontinence. Connective tissue in the pelvis is hormonally sensitive, and loses elasticity with age. It is known that relaxin in combination with other hormones causes depolymerization of collagen and alters the proportions of the different types of glycosaminoglycans during pregnancy and labour. This may cause laxity of the vaginal membrane, also explaining the onset of virtually any dysfunctional urinary symptom during pregnancy, cure by application of a ring pessary (6), and the disappearance thereof postnatally. Many nulliparous females, have been cured of urinary dysfunction by reconstruction of the anterior and posterior supporting ligaments, indicating genetic differences in structure, and perhaps even within the components of connective tissue. All the above indicates the crucial role of connective tissue in the aetiology of female urinary incontinence. **With reference to figures 1 and 2, it is evident that a certain amount of vaginal laxity may be compensated for by increasing the contractile efficiency of the pelvic floor muscles with exercises.** The high rate of symptom recurrence with time is consistent, however, with age related loss of tissue elasticity (12) further emphasizing the role of connective tissue in urinary dysfunction.

The above are consistent with this theory's (5,6) concepts for opening and closure of urethra and bladder neck. Once the elastic limit of the vagina has been reached by stretching (6), the vagina transmits the 3 directional forces to the lower 2/3 of urethra and bladder base for closure with stress (figure 1). The only substantive difference between urethral closure (figure 1), and micturition, (figure 2), is relaxation of the forward force. A lax vagina may cause dysfunction in urethral closure (stress incontinence) or micturition (abnormal emptying symptoms), by deficient transmission of the directional forces (figure 3); the same laxity may fail to support the stretch receptors at the bladder base, resulting in their premature activation, decreasing bladder capacity, symptomatically expressed as frequency, nocturia, urgency. This hypothesis can be tested directly. In a patient with stress incontinence, take up a unilateral fold of vagina between the ends of an open artery forceps alongside the urethra, and ask the patient to cough ('pinch test'). In a separate maneouvre, press the closed forceps unilaterally upwards exactly at the midurethral level. These manoeuvres, alone or in combination, almost invariably control urine loss with stress. Ask a patient with urge symptoms to attend with a full bladder. Gently support the bladder neck area of vagina with a sponge-holding forcep. Generally this provides immediate relief of urge. Having established this, then press the forcep gently up towards the pubic bone, simulating a bladder neck elevation operation. Generally this causes significant return of urge symptoms.

Conservation of the uterus is important as a preventative measure for urinary dysfunction and vault prolapse. Examination of figure 5 indicates that the cervix potentially plays a role much like the keystone of an arch. It transmits the downward force (LMA) to the cardinal and uterosacral ligaments. Removal of the uterus and transverse suturing of the vaginal vault potentially concentrate these forces on the rather weak vaginal membrane, predisposing to vaginal laxity in the form of enterocele and vault prolapse. Subsequent laxity may fail to support the stretch receptors at the bladder base. This explains the symptoms of stress, urge, and abnormal emptying reported after hysterectomy.

The pictorial algorithm explains why many symptoms of urinary dysfunction are simultaneously cured by operations for vaginal prolapse. Pressure transmission ratios, urine flow rates, emptying times, residual urine estimations, exercise and 24-hour pad tests, and other parameters, provide greater reliability to the algorithm. Present research has for some time been directed towards a computerized system which, it is hoped, in time, will give a probability rating to each parameter by feeding back surgical results. A computerized elastometer is under development to assess pre and intraoperative vaginal elasticity. It is hoped to predict the results of the surgical operations listed in this paper by performing 'virtual operations' i.e., observing the effects on pressure transmission and urethral closure by tightening various parts of the vagina under ultrasound control.