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New Ambulatory Surgical Methods Using an Anatomical Classification of Urinary Dysfunction Improve Stress, Urge and Abnormal Emptying

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Abstract: The aim of the study was to introduce an anatomical classification for the management of urinary dysfunction based on the Integral Theory, a new connective tissue theory for female incontinence. Eighty-five unselected patients, aged 27–83 years, 12 with pure stress symptoms and 73 with mixed incontinence symptoms, were classified as having laxity in the anterior, middle or posterior zones of the vagina, using specific symptoms, signs and urodynamic parameters summarized in a pictorial algorithm. Special ambulatory surgical techniques, which included the creation of neoligaments, repaired specific connective tissue defects in the anterior (intravaginal slingplasty (IVS), n = 85), middle (cystocele repair, n = 6), or posterior zones (uterine prolapse repair, n = 31, or infracoccygeal sacropexy, n = 33). Almost all patients were discharged within 24 hours of surgery, without postoperative catheterization, returning to fairly normal activities within 7–14 days. At (mean) 21-month follow-up cure rates were: stress incontinence 88% (n = 85), frequency 85% (n = 42), nocturia 80% (n = 30), urge incontinence 86% (n = 74), emptying symptoms 50% (n=65). Mean objective urine loss (cough stress test) was reduced from 8.9 g preoperatively to 0.3 g postoperatively, and mean residual urine >50 ml from 110 ml to 63 ml, $P = <0.02$. Pre- and postoperative urodynamics indicated that detrusor instability was not associated with surgical failure. Two new directions, based on the Integral Theory, are presented for the management of female urinary dysfunction, an anatomical classification which delineates three zones of vaginal damage, and a series of ambulatory surgical operations which repair these defects. The operations are fairly simple, safe, effective and easily learnt by any practising gynecologist.

Keywords: Ambulatory; Detrusor instability; Incontinence; Intravaginal slingplasty; Stress; Surgery; Urge

Introduction

At present the management of urinary incontinence is based on two separate paradigms, both dependent on urodynamic testing. Bladder neck elevation is recommended for genuine stress incontinence (GSI), which is defined [1] as loss of urine on stress in the absence of urodynamically diagnosed detrusor instability (DI). Bladder neck elevation operations are major procedures, and are traditionally based on the concept that continence is achieved by pressure transmission to the proximal urethra [2]. These operations invariably require postoperative catheterization. Because of the high incidence of detrusor instability after bladder neck elevation surgery (up to 18% [3]), it is recommended [1,3] that patients with urodynamically diagnosed detrusor instability do not undergo surgery but rather be treated with drugs and other non-surgical methods [3]. These paradigms are potentially contradictory when applied to the most commonly affected group of patients, those with mixed incontinence.

More recently, an anatomical classification of urinary incontinence has been proposed [4,5]. This is based on a unifying connective tissue hypothesis, the integral theory [4–7], which proposes that symptoms of stress, urge and abnormal emptying mainly derive from laxity in the vagina or its supporting ligaments; furthermore, that

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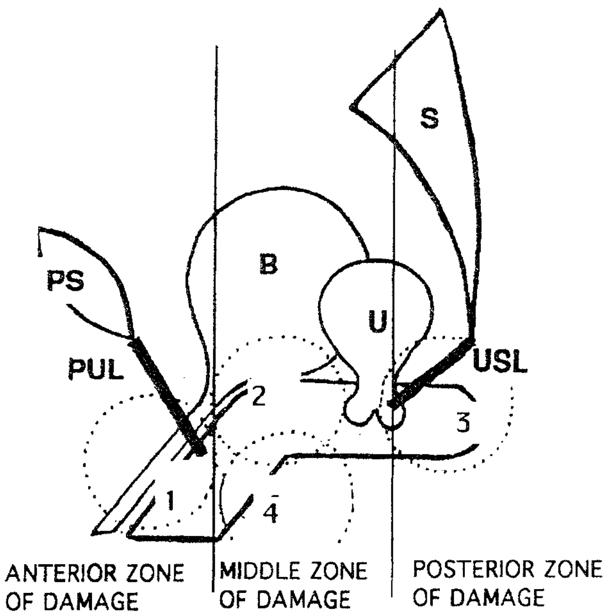

Fig. 1. Damage to vagina at childbirth. The circles represent the fetal head overstretching the connective tissue of the vagina and its supporting ligaments as it descends through the birth canal. 1, hammock and pubourethral ligament laxity; 2, cystocele and arcus tendineus fasciae pelvis defect; 3, uterine prolapse, enterocele; 4, rectocele.

frequency, urgency, nocturia and detrusor instability may be different expressions of the same prematurely activated micturition reflex [8], also caused by vaginal laxity. In this study, the original classification [4,5] has been simplified to specify damage in three zones of the vagina (Figs 1, 2). Based on empirical and other data [4,5,9], a pictorial algorithm (Fig. 2) has been constructed to guide the ambulatory surgical techniques introduced in this study. It has previously been demonstrated [10–12] that stress incontinence may be cured using the intravaginal slingplasty procedure (IVS), an operation that reconstructs laxity in the anterior zone. The aim of this study was to test the further predictions of this theory [4–7], that, where required, surgical tightening of vaginal laxity in these zones may also improve symptoms of stress, frequency, urgency, nocturia and abnormal emptying.

Patients and Methods

Eighty-five patients were referred with symptoms of urinary incontinence: 12 with stress incontinence only and 73 with mixed symptoms. Mean age was 51.6 years (range 27–83), parity 3 (range 0–9), mean weight 68 kg (range 48–110 kg). All patients were preoperatively assessed using a graded questionnaire, examination sheet, personal interview and radiological or ultrasound imaging to measure the amount of bladder neck descent on straining (>10 mm). In such patients, a virtual IVS operation is performed as an outpatient test. Under ultrasound control, an artery forcep tip is positioned exactly at the level of the midurethra on one side, and the patient is asked to cough or strain. This almost invariably prevents urine loss, funneling and excessive prolapse of the bladder base, also confirming the theory [6,7] on which the IVS is based, that the pubourethral ligament acts as a fulcrum for the closure forces acting around that point. Urodynamic tests were performed for detrusor instability, flow rate, residual urine, urethral pressure profile, cough and Valsalva transmission ratios. Exercise pad tests (coughing × 10 and star (scissor) jumps × 10) were used to quantify urine loss on stress. The results were entered into a pictorial algorithm, (Fig. 2) which, in turn, guided the surgeon as to which zone of the vagina required reconstruction. Other than the referral of patients for physiotherapy, this was the only selection criterion observed. There were no exclusion factors. Because of the precise nature of this type of surgery, Zeiss microscopic loups were used in all cases. Local anesthetic/midazolam was used in more than 50% of the patients, and spinal or general anesthesia in the remainder.

General Surgical and Anesthetic Guidelines[1] for the Ambulatory Operations

Laxity in the three zones of vagina was repaired applying the following surgical principles.

1. Recognition (a) that the vagina has no structural strength; (b) that a prolapsed vagina behaves much like an intussusception: the side walls must be buttressed; (c) that the suspensory ligaments (Fig. 2) provide structural support and transmit the three-directional forces to the pelvic girdle. Therefore the ligaments need buttressing where required by the algorithm. Damaged anterior (pubourethral) and posterior (uterosacral) ligaments, (Fig. 3) were confirmed by direct examination, and reinforced using precisely inserted tapes to create artificial collagenous neoligaments (Fig. 4). The tapes 'trick' the fibroblasts into creating a linear deposition of collagen during healing of the wound created by the tunneler, as demonstrated in experimental animals [4].

2. Avoiding excessive surgical tension and the introitus during surgery. Like the intestine, most of the vagina has an autonomic nerve innervation [13] and crushing or stretching may cause severe pain. Therefore, vaginal reconstitution and ligamentous approximation were carried out with minimal tension. So as to avoid shortening and dyspareunia, minimal vagina was excised, excess width being converted to length. Surgery within 1.5 cm of the introital area was avoided where possible, owing to its somatic innervation [13].

[1] As this is an entirely new surgical and theoretical approach, it is not possible to describe every aspect in detail. The surgical techniques, their relationship to the integral theory, and the theory itself, are described in much more detail* in a set of two videos, and in a comprehensive 100-page handbook, available (all formats) from Dept of Media, Edith Cowan University, Churchlands Campus, Pearson Rd, Churchlands, WA 6018, Australia. Fax: 61 8 92738029. Total cost is approximately A$300.

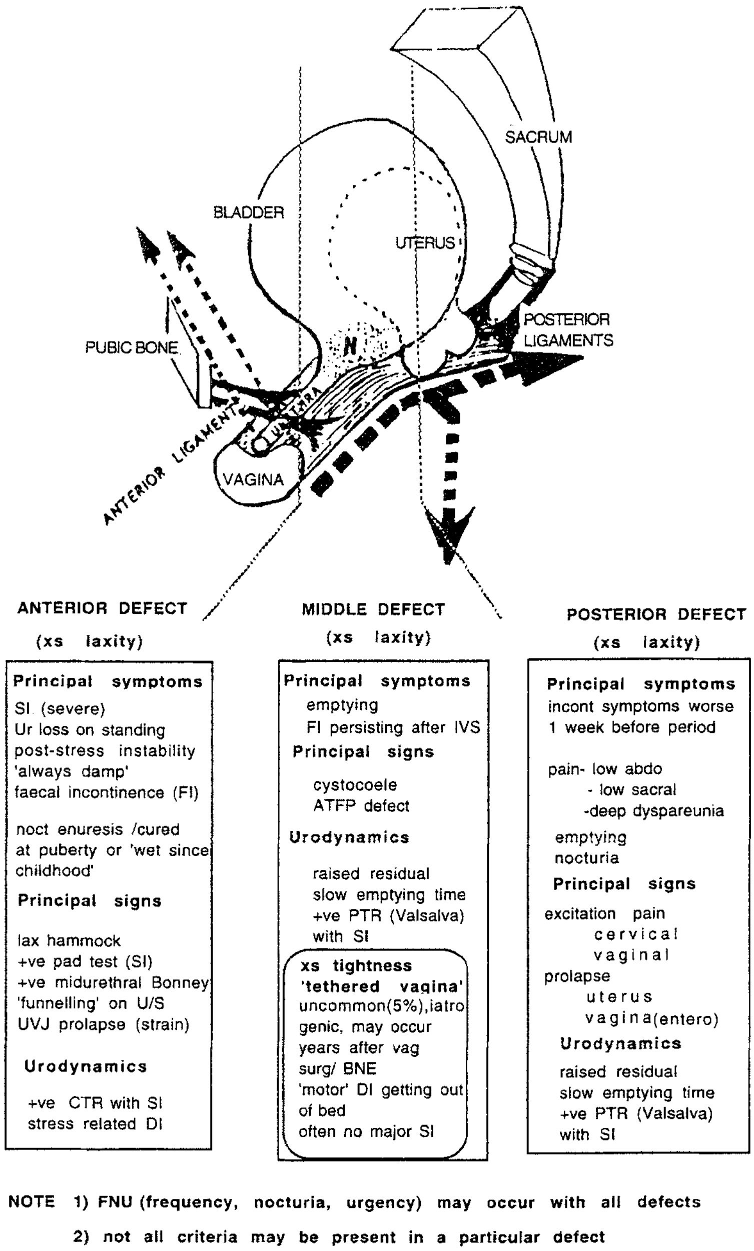

Fig. 2. Pictorial algorithm. This is a schematic three-dimensional view of the bladder supported by the vagina. The arrows represent directional striated muscle forces. During stress, the forward force (twin arrows) stretches the two ends of the hammock forwards to close off the urethra; the backward and downward forces stretch the vagina and bladder base backwards around the anterior ligaments, 'kinking' the bladder neck. The anterior ligaments transmit the forward and backward forces to the pubic bone; the posterior ligaments transmit the downward force to the coccyx and sacrum. N = stretch receptors at bladder base.

3. Postoperative urinary retention was avoided by ensuring that the bladder neck area of the vagina retained sufficient elasticity for the funneling required for micturition [6,7].

4. Recognition that the healing wound has no strength. Special refinements to surgical technique, such as the judicious use of transvaginal holding sutures, continuous running sutures, permanent and removable polyester tapes[1] are used.

5. Liberal use of local anesthetic even in patients undergoing general anesthesia. Xylocaine 1% diluted with three parts saline, i.e. 0.25%, 80–200 ml, depending on body weight, was directly infiltrated into the rectus sheath and paraurethrally, and 10 minutes allowed prior to the commencement of surgery. Midazolam up to an average of 8 mg, or propafol in 20 mg increments, generally with fentanyl up to 60–70 mg, was given in intermittent dosage by a specialist anesthetist.

Anterior Zone Repair

The IVS Operation. Irrespective of the precise form used, the IVS operation consists of two parts. (1) An artificial pubourethral neoligament is created by the precise insertion of a polyester tape at the midurethra, in the position of the natural ligament (Fig. 4); (2) the suburethral vagina (hammock) is tightened (Fig. 5). This is achieved by two paraurethral incisions [4,12] or a single suburethral incision [5,10,11]. Lateral incisions

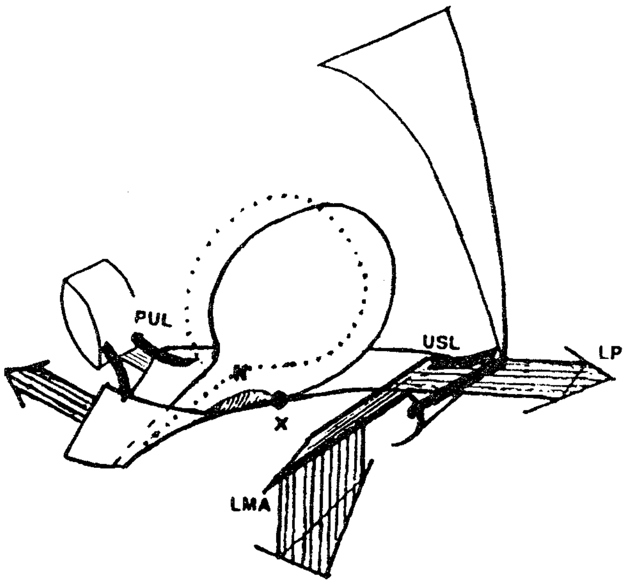

Fig. 3. Laxity in the vagina or its ligaments may invalidate closure. Schematic sagittal view. Relative to Fig. 1, even with all three directional forces acting, the bladder neck is funneled and the urethra remains open. X = insertion point of bladder base to vagina. PUL = pubourethral ligament; USL = uterosacral ligament; V = vagina; PCM = anterior portion of pubococcygeus muscle; LP = levator plate; LMA = longitudinal muscle of the anus.

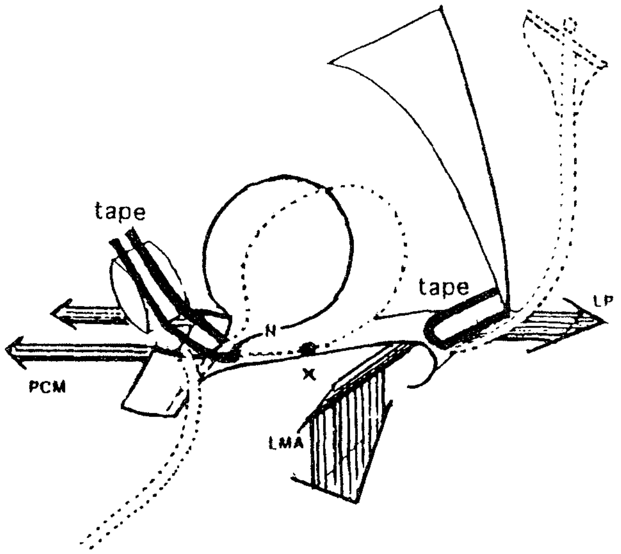

Fig. 4. Restoration of ligamentous attachments. Relative to Fig. 3, insertion of the tapes precisely in the positions occupied by the pubourethral ligaments (PUL) (IVS operation) and uterosacral ligaments (USL) (infracoccygeal sacropexy) restores the insertion points of all three directional forces, enabling them to stretch the vaginal membrane and restore closure. Broken lines represent the resting bladder position of a patient with vaginal or ligamentous laxity. The IVS tunneler is also outlined with broken lines, with its point touching its site of insertion.

were preferred in this study because they allow very precise reconstitution of the vaginal hammock closure mechanism, by attachment of the hammock to the

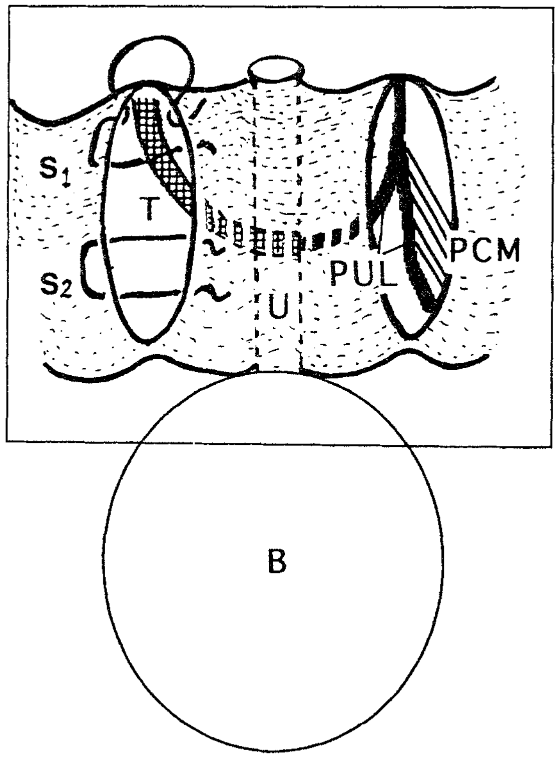

Fig. 5. IVS operation. Perspective: looking upwards into the anterior vaginal wall. The paraurethral incisions have been opened out. The right-hand side represents the normal anatomy. PUL = urethral and vaginal insertions of the pubourethral ligament; PCM = anterior portion of the pubococcygeus muscle. The left-hand side represents the tape (T), and the horizontal mattress sutures, S_1 attaching the hammock deep into the origin of PUL, and S_2 into the PCM.

natural closure muscle, PCM (Fig. 5), which is not possible with the central incision. Exactly at the midurethra a tunnel was created in the fibrous tissue binding vagina and urethra, and the tape configured as a 'U' below the urethra. The IVS tunneler (Pacific Health Care, Perth, WA) was used to bring a 6 mm nylon tape from the vaginal incisions up to a single 1 cm suprapubic skin incision as previously described [5,12], (Fig. 5). The hammock was then tightened using interrupted 0 PDS horizontal mattress sutures to attach it deep into the pubourethral ligament, and the proximal part to the pubococcygeus muscle on either side (Fig. 5). One strand of the PDS knot was left long to facilitate postoperative removal should the patient have urinary retention. The vaginal incisions were approximated by 00 Vicryl as a continuous running suture, for hemostatic purposes. Finally, the two ends of the tape were cut and left free, without suturing, at the level of the rectus sheath, i.e. the tape is not fixed anywhere along its course. The skin was sutured with 00 Vicryl.

Posterior Zone Repair

Uterine Prolapse; Enterocele and Vault Prolapse Repair. The aim was to restore the structural integrity of the posterior fornix of the vagina. In general, nylon tapes (Fig. 4) were only used in patients who had undergone previous hysterectomy (vault prolapse, enterocele).

Uterovaginal Prolapse. The cardinal and uterosacral ligaments were approximated. A transverse incision was made at the midpoint of the posterior fornix herniation and opened out with a Sim's speculum. Where required, minimal dissection of the (unopened) peritoneum allowed easy location of the uterosacral (USL) and cardinal (CL) ligaments. Where the cervix was large, a wedge was removed posteriorly between 4 and 8 o'clock, facilitating approximation of the supporting cardinal and uterosacral ligaments (USL), without tension, with no. 1 PDS sutures.

Where the uterus had been removed USLs were almost invariably atrophied. Therefore, artificial neoligaments were created in the precise position of the uterosacral ligament (Fig. 4). This was done by infracoccygeal insertion of 6 mm nylon tapes as a 'U' along the anatomical path of the USL, using the IVS tunneler inserted infracoccygeally (Fig. 4). The remnants of the cardinal and uterosacral ligaments were approximated with transvaginal no. 1 PDS holding sutures, incorporating the nylon tape. The vaginal edges were then sutured side to side with no. 1 Vicryl, or, where this was not possible, as a 'Y'. Finally, the two ends of the tape were cut and left free, without suturing, at the level of the coccyx. The skin was sutured with 00 Vicryl.

Posterior Wall 'bridge' Repair. This was also performed in almost all cases, so as to buttress the side wall of the prolapse and lessen the possibility of future apical prolapse. A bridge was created by two full-thickness parallel incisions in the posterior vaginal wall. The lateral edges were then approximated over the bridge, thereby reinforcing the midpoint, the weakest part of the herniated vagina.

Middle Zone Repair

Cystocoele and lateral vaginal (ATFP) defects were repaired by reconstitution of lateral and/or midline defect.

Criteria for Cure

Pre- and postoperative urodynamics, cough stress pad testing [5], and a graded self-administered questionnaire form [5] were used. The ICS criterion for urine loss during pad testing [14], 2 g, was considered excessive. A loss greater than 0.4 g, corresponding to a small stain, was taken as a positive test; frequency <9 per day; nocturia <3 per night.

Except where otherwise stated the definitions and terminology used in this study correspond to those of the International Continence Society [1].

Results

Mean follow-up time was 21 months (range 9–36 months). Of the 85 patients, 36 had undergone prior hysterectomy and 23 a total of 31 previous incontinence operations. The IVS operation was performed on 85 patients, simultaneously with repair of uterine prolapse in 33 patients, infracoccygeal sacropexy for vaginal vault prolapse in 31 patients, and cystocele repair in 6 patients. Mean operating time was 25 minutes (range 15–45 minutes) for the IVS operation, and 40–80 minutes with simultaneous repair of uterine prolapse or sacropexy. The uterine or vaginal prolapse was equally distributed between first and second degree. In those patients who had undergone hysterectomy the uterosacral ligaments were conspicuously thin.

Stress, Urge and Detrusor Instability

Objective Testing. All patients underwent postoperative pad testing, but only 61/85 agreed to full urodynamic testing. For stress incontinence (SI), objective urine loss during cough stress pad testing (including those patients with failed surgery) was reduced from a mean of 8.9 g preoperatively to a mean of 0.3 g postoperatively. At a cutoff point of >0.4 g, objective cure was 94% for SI. Urodynamically diagnosed detrusor instability (DI) was present in 36/85 patients preoperatively (42%) and in 13/61 postoperatively (21%). Of these 13 patients 12 had no incontinence symptoms whatsoever. Of the 5 operative failures who were tested postoperatively, 4 had a stable detrusor, i.e. DI was neither predictive of nor associated with surgical failure in this study. There was no incidence of de novo symptoms of bladder instability.

Symptomatic Cure. The cure rates for symptoms were: frequency 85% (n = 42), nocturia 80% (n = 30), urge incontinence (n = 74), 86% plus 2 improved, stress incontinence (n = 85) 88%. The latter did not include 3 patients who claimed 50%–70% cure. Pad test losses for these 3 were 0, 0.9 and 2 g.

Four abnormal emptying symptoms were assessed, namely 'Does your bladder empty properly?' 'Do you have a slow stream?' 'Does your stream involuntarily stop and start?' 'Do you have difficulty starting flow?' A total of 159 abnormal emptying symptoms was reduced to a total of 83 postoperatively. Mean residual urine in the 38 patients with residuals >50 ml was reduced from 110 ml (SD ± 128 ml) to 63 ml (SD ± 97 ml), P = <0.02, paired t-test.

Maximal urethral pressure (MUP) preoperatively was 37.3 cmH_2O (range 5–72 cmH_2O, SD ± 16.4), and postoperatively 34.5 cm (range 12–74 cmH_2O, SD I 14.9); this was not statistically significant.

Low maximal urethral pressure (MUP): 11 patients registered MUP 20 cmH_2O or less preoperatively. All reported surgical cure. Mean preoperative urine loss on cough stress testing was 18.8 g, mean postoperative urine loss being 0.07 g. Mean preoperative MUP was

15.5 cmH_2O (range 5–20 cmH_2O). Mean postoperative MUP was 19.5 cmH_2O (range 12–28), i.e. not statistically significant.

Peak flow rate was measured in 65 patients postoperatively. Preoperative mean value for this group was 29.5 ml/s (range 8–52 ml/s), and postoperative mean 30.4 ml/s (range 18–56 ml/s), i.e. not statistically significant. Mean bladder volume preoperatively was 447 ml and postoperatively 465 ml.

Confirmation of the Urethral and Bladder Neck Closure Mechanisms

The local anesthetic methodology permits direct observation of the closure mechanisms. There was a vast, often uncontrollable, increase in urine loss during coughing, immediately after making the paravaginal incisions. Gentle pressure on the tape generally controlled urine loss immediately (bladder neck closure mechanism [4–7], as did tightening of the vaginal hammock (urethral closure mechanism [4–7]).

Postoperative Course

Two patients were unable to pass urine spontaneously for 24 hours postoperatively. Cutting one of the two PDS sutures attaching the proximal part of the hammock to the anterior portion of the pubococcygeus muscle immediately restored their ability to pass urine spontaneously. In and out catheterization was needed in 3 more patients, but only within the first 8 hours of surgery. All but 1 patient were discharged with 24 hours of surgery. Generally, there was minimal postoperative pain. However, in 2 patients who had IVS plus uterine prolapse repair the pain was severe, and the cardinal/uterosacral ligament suture had to be revised 48 hours postoperatively. The pain was attributed to excessively tight approximation of the cardinal and uterosacral ligaments. Almost all patients returned to fairly normal activities, including jobs, within 7–14 days. There were no bladder perforations. Blood loss during the IVS operation 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. One patient with uterine prolapse repair was readmitted with secondary hemorrhage due to infection of the cervix.

Longer-Term Complications

One patient developed a hematometra. There were five tape rejections (5.8%) between 3 and 6 months, but only one led to a return of incontinence symptoms. Rejection of the tape was usually associated with a thick yellow discharge, negative bacteriology, a preponderance of macrophages, paucity of polymorphonuclear leucocytes (pnls) and apyrexia, much as previously described in experimental animals [14] and in humans [15]. Exteriorization of the tape was far more common than total rejection. With total rejection the tape was removed simply by gently pulling on it. With partial rejection the extruded portion was grasped with an artery forceps while a pair of scissors was pushed upwards against the vaginal mucosa to a depth of 1 cm, then the tape was cut. All the above were accomplished virtually painlessly as office procedures. In all cases, discharge cleared within 48 hours.

Discussion

Other than a prior pelvic floor rehabilitation regimen there was no patient selection, i.e. urodynamically diagnosed detrusor instability was not a contraindication for surgery. The pictorial algorithm (Fig. 2) guided the surgeon as to which operation to perform. Figure 2 classifies urinary dysfunction as being caused by three zones of laxity in the anterior vaginal wall: anterior, middle or posterior. The scientific rationale for this classification is described elsewhere [6,7]. Connective tissue damage to these zones [7] (Fig. 1) may inactivate the three directional closure forces hypothesized to close the urethra [6], diagrammatically demonstrated in Fig. 3. Fig. 4 demonstrates the importance of reconstituting the insertion points of these forces. Symptoms of stress, urge, frequency, nocturia and abnormal emptying were improved by targeted connective tissue reconstruction. This appears to sustain the hypothesis of connective tissue dysfunction [4–8] being a major factor in the pathogenesis of urinary incontinence in the female, not the position of the proximal urethra [2] or muscle paralysis [16]. Clearly, a paralysed muscle cannot be surgically cured. Reconstitution of the hammock mechanism by IVS [4,5] is consistent with alternative theories for continence, anchoring the urethra for closure by intra-abdominal pressure transmission [2,17]. The cause of bladder instability is said to be unknown [18]. Surgical tightening of the vaginal membrane appears to support the hypothesis of a peripheral cause for bladder instability [4,5,8]: the lax vaginal membrane cannot adequately support the filling bladder; the stretch receptors at the bladder base fire off at a lower bladder volume; this is manifested as frequency, nocturia and urgency, essentially different expressions of the same prematurely activated (but otherwise normal) micturition reflex [8].

Cure of Low MUP (<20 cmH_2O) Incontinence

Low MUP is partly secondary to a sagging, non-elastic hammock [4,5]. The low-energy urethral closure mechanism requires normal vaginal elasticity [4,5]. Precise attachment of the hammock to the anterior portion of the pubococcygeus muscle may allow slow twitch muscle contraction to compensate for the low-energy closure force compressing the urethra from behind in the normal patient [4,5]. Bladder neck elevation and alternative IVS methods using the midline approach [5,10,11] cannot achieve this.

Comparison with Conventional Mesthods

There was no selection of patients in this study, i.e. patients with low MUP, detrusor instability, advanced age and low tissue elasticity were not excluded as recommended [3,19]. Tightening the vagina and restoring its supporting ligaments [4,5], is clearly a different ideology from the restoration of pressure transmission by bladder neck elevation [3,19]. The comparisons that follow, therefore, encompass methodology, not cure rates. The use of local analgesia and sedation with the IVS technique [5,10,11] has been especially useful in old and frail patients, potentially reducing lung complications, thrombosis and embolism. Older patients have inelastic tissues [20]. Unlike the Burch operation, there is no diminution in postoperative urine flow [3,19], postoperative catheterization [3,19] is rarely required, and the surgical success rate in older patients [19] is not diminished. Patients return to the ward without a catheter, usually return home in a day, and to fairly normal activities, including jobs, within 7–14 days. Ureteric damage [21] is impossible, as the tape is inserted at the level of the midurethra.

Correlation of the Algorithm with Pelvic Anatomy

With reference to Figure 2, the forward and backward forces are transmitted to pubic bone via the anterior (pubourethral) (PUL) ligaments, and the downward force to the coccyx via the posterior (uterosacral) (USL) ligaments. Therefore, ligamentous laxity may weaken the appropriate opening or closure muscle forces, causing symptoms of abnormal opening or closure [6,7].

Anterior Zone. The IVS operation was inspired by the anatomical work of Robert Zacharin [22], although our interpretation is different [4,5]. Laxity in the anterior ligaments or the hammock may invalidate the forward (urethral) closure forces (Fig. 3), preventing the hammock closing off the urethra from behind during stress, clinically expressed as stress incontinence [6,7]. Unilateral pressure at the midurethra (Bonney test) may control supine urine loss by mimicking the function of the anterior (PUL) ligament, the insertion point for the closure forces. Fecal incontinence has been consistently cured in more than 95% of patients following the IVS operation [23]. Urine loss on standing is attributed to unopposed stretching of the backward and downward forces, exactly as occurs during micturition [6,7]. In this instance these events are caused by lax anterior ligaments, not by relaxation of the forward force [6,7]. Urodynamically, lax anterior ligaments may allow excessive stretching and narrowing of the proximal urethral lumen [5a], registering a high PTR in the proximal urethra in the presence of stress symptoms [4,5].

Middle Zone. It has been demonstrated radiologically that the backward and downward forces (Fig. 2), stretch the upper part of the vagina to 'funnel' the outflow tract during micturition. A cystocele or lax arcus tendineus fasciae pelvis (ATFP) may inactivate the backward force and so cause deficient bladder emptying, i.e. abnormal opening symptoms, slow emptying times or raised residual urine. Excessive tightness in the middle part of the vagina is a fairly uncommon condition, described as the 'tethered vagina syndrome' [4,5]. It is entirely iatrogenic and is caused by scarring from vaginal surgery or excessive bladder neck elevation. It is characterized by excess tightness in the middle section of vagina. This tightness 'tethers' the opposite directional forces (Fig. 2). The more powerful backward and downward forces may overcome the weaker forward (urethral closure) forces, so that the urethra is pulled open when given the signal to close. This condition is cured by restoration of elasticity to the bladder neck area of the vagina with a skin graft [5].

Posterior Zone. It has been demonstrated that repair of posterior fornix (USL) laxity may cure pelvic pain of otherwise unknown origin, deep dyspareunia and low sacral pain [9]. Therefore, such pain is exclusively attributed to the posterior zone in the algorithm. Uterine or vaginal vault prolapse is caused by laxity in the posterior (USL) ligaments, the insertion point of the downward force. Thus abnormal opening symptoms, slow emptying times or raised residual urine may also be attributed to the posterior zones.

Biomechanical and Urodynamic Correlations. Vaginal laxity in any zone may prevent the three directional forces stretching the vaginal membrane to counteract activation of the stretch receptors from the hydrostatic pressure of the distending bladder; the stretch receptors at bladder base ('N', Fig. 2) fire off at a lower volume, a premature activation of an otherwise normal micturition reflex [8]. Therefore, symptoms of such an event – urge, frequency, nocturia, fall in urethral pressure and rise in detrusor pressure – may occur with laxity in any of the three zones. In those patients with urge symptoms, gentle support of the cystocele with sponge-holding forceps, or without cystocele, the midurethral Bonney test, frequently causes the urge to disappear. Restoration of these muscle forces alters the geometry of the urethral tube, and this in turn is reflected by changed pressure transmission ratios [4,5]. More comprehensive biomechanical correlations for the urodynamic parameters of the algorithm are described elsewhere [5a].

All zones are functionally interrelated, and affect each other. With reference to Fig. 1, it is clear that the damage caused by the fetal head may vary from zone to zone. Surgical cure of one defect may predispose to the formation of another at a later date, e.g. enterocele formation after bladder neck elevation surgery. Often post-hysterectomy stress incontinence is cured by repair of the posterior zone only [5], i.e. improvement in the downward force may stretch the vaginal hammock in a backward direction sufficiently to restore closure. Abnormal emptying symptoms may improve after

IVS operation (anterior zone repair), as a firm anterior ligament may also improve the backward opening force.

How to Use the Algorithm. For the practical surgeon the part of the algorithm consisting of symptoms and signs is sufficient as a working guide. To use the pictorial algorithm, simply copy it and tick off the various parameters. The diagnosis becomes pictorially evident. The columns represent symptoms and signs specific to each anatomical region, anterior, middle and posterior. Multiple defects may coexist, and it is important to note that there is no correlation between the degree of prolapse and symptoms. Often the algorithm may predict a defect which may not be visible on vaginal examination but is confirmed later during surgery.

Conclusion

A new system for the management of urinary dysfunction is presented based entirely on an anatomical classification which specifies laxity in three zones of the vagina as the ultimate cause of this dysfunction. The ambulatory surgical operations designed to correct these defects are fairly simple, safe, effective, and easily learnt by any practising gynecologist.

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EDITORIAL COMMENT: This study is very interesting and opens a series of stimulating concepts. The authors report 85 cases of women with incontinence due to different etiologies; most of these individuals underwent ambulatory surgery that strengthened the supporting structures of the urethra using an artificial tape without elevating the bladder neck. The tape was implanted at the level of the midurethra in the retropubic area, without being sutured to surrounding structures. The procedure also 'tightened the vaginal hammock' and corrected other pelvic support defects when necessary. This group of patients had a high success rate (>80%) for cure and/or improvement of their incontinence, urgency, frequency and nocturia. All this was hypothesized to be the consequence of correcting 'laxity of the vagina and its supporting ligaments'. This group of patients had a wide spectrum of lower urinary tract pathologies and with the data presented in this manuscript the conclusions of the authors goes beyond the available evidence. The high success rate, easy technique, low morbidity and the short recovery time make this procedure very attractive for the practising gynecologist and urologist. We would like to see the data presented in this article confirmed by prospective comparative studies.