A review and critical analysis of historical operations for urinary stress incontinence. Part 1: vaginal surgery

BERNHARD LIEDL[1], FLORIAN WAGENLEHNER[2], PETER PETROS[3]

[1]Abteilung fur Urogenitale Chirurgie und Urologie, Beckenbodenzentrum München, Denningerstrasse 44, D-81679 München, Germany;
[2]Clinic for Urology, Pediatric Urology and Andrology, Justus-Liebig-University, Giessen, Germany, Rudolf-Buchheim Str. 7, 35392 Giessen, Germany
[3]UNSW St Vincent's Clinical School, Sydney, NSW, Australia

Abstract: Aim: To critically analyze the anatomical basis of historical vaginal operations for urinary stress incontinence (USI). *Materials and Methods:* Historical vaginal operations for cure of USI were critically analyzed as regards their modus operandi from an anatomical perspective using a 15 point system: 1. Minimal invasiveness. 2. Ease of performance. 3. Built-in safety of the procedure. 4. Short term complications. 5. Long term complications. 6. Applicability to obese patients and those with poor tissues. 7. Applicability to patients with previous operations for stress incontinence. 8. Blood loss. 9. Length of operation. 10. Early discharge from hospital. 11. Urinary retention. 12. Long-term continence. 13. Early resumption of normal activities. 14. Anatomical damage. 15. Physiological mode of action of the operation. *Results:* A critical analysis is given for each type of vaginal repair. *Discussion and Conclusions:* some surgeons, for example Ingelman-Sundberg believed that there was a very firm place for vaginal repair operation. Others such as Tanagho categorically stated that there was no place for vaginal repair, believing that a bladder neck elevation operation should be performed as a first choice operation.

Key words: Urinary Stress Incontinence (USI); Vaginal Operation; Anatomical Perspectives.

INTRODUCTION

As there have been at least 100 operations, Ingelman-Sundberg,[1] described for the cure of stress incontinence, it is reasonable to conclude that no one operation fully addresses the problems and complications associated with surgical cure of this condition. In the following sections, an analysis is made of the existing operations, as well as an assessment of their strengths and weaknesses. From this analysis, the main problems associated with existing operations are identified.

The three main categories of operation for stress incontinence are:

1 Vaginal Repair

2 Colposuspension

3 Sling

Evaluation of each category of operation with reference to a 15 point table is made. The most common variants of these operations are described. It will be assumed that the same limitations of the category (e.g. vaginal repair) apply to a greater or lesser extent also to the variations. Criticism will be based on logical analysis with reference to known anatomy, physiology etc, or on references in the literature. Important papers will be quoted in detail. An attempt will be made to evaluate each operation as to its modus operandi, referring specifically to the hypothesis. A loose fourth category of operation will be described for operations not fitting comfortably into the above classification, e.g. the Zacharin and Bailey operations.

Suggested criteria needing to be filled by the ideal operation:

1 Minimally Invasiveness.

2 Ease of Performance.

This allows the operation to be performed by less skilful surgeons. It also reduces the operating time and the potential complication rate.

3 Built-in Safety of the procedure.

In a methodological sense, the operation must have an in-built safety margin, if possible to avoid penetrating the various adjacent organs and to diagnose any perforations occurring. As part of this process, one should bear in mind the complicating presence of scar tissue from previous opera-

tions, and the fact that anatomical variations, especially of the ureters, not infrequently occur.

4 Short term complications.

There are complications associated with general anaesthesia, the presence of intercurrent disease (often a problem due to the high incidence of incontinence in the aged), thrombosis, haemorrhage, lung complications, and infection, especially as the operation is conducted in an area inhabited by the bladder, urethra, ureters and the blood vessels of the vesical plexus.

5 Long term complications.

Retention of urine is dealt with separately, but complications such as enterocoele formation and dyspareunia, pain at the site of artificial fibre insertion in the rectus sheath, herniation through the rectus sheath in, for example, Aldridge sling operations. Each operation has its specific complications. These complications will be attributed to the anatomical distortions associated with bladder neck elevation procedures.

6 Applicability to obese patients and those with poor tissues.

All suprapubic operations are difficult in obese patients, the open operations being particularly so. In the elderly patient, the diabetic, the obese with poor tissues where the integrity of the operation hangs on the suturing of tissue to either bone or ligament there is a risk of the suture tearing out of the tissue, usually the vagina.

7 Applicability to patients with previous operations for stress incontinence.

Previous operations tend to form fibrosis and even if the urethra is freed from the fibrotic tissue.

8 Blood loss.

There are very few reports in the literature which measure the amount of blood loss. The importance of blood loss relates to an accompanying increased incidence of thrombosis, infection, risks from transfusion and, of course, greater morbidity and increased length of stay in hospital. As an indication of the importance of this parameter, Stanton et al[2] recorded an average blood loss in the Burch operation of 377 ml, rising to an aggregate of 858ml with hysterectomy.

9 Length of operation.

This parameter partly impinges on 1), 2), 4), 6) and 8) above, and there is also wide variation here, depending on the patient and the surgeon. Certain operations, however, are inherently more complicated than others. For example, there is much more involved in an Aldridge sling or a Zacharin operation than there is in a Burch or Marshall-Marchetti operation.

10 Early discharge from hospital.

Over and above the economic factor of saving the cost of hospital days, an operation which allows early discharge almost certainly is a far more efficient, less traumatic and more desirable operation.

11 Urinary Retention.

"The most vexing problem has been incomplete voiding", referring to the complications of retropubic urethropexy. This needs to be stated as a specific complication. It is very discomforting to the patient, adds considerably to the cost of the operation and greatly predisposes to urinary tract infection.

12 Long-term Continence.

All operations have an increasing failure rate with time Very few series have properly defined objective criteria for assessment of post-operative results,[4] Thus this parameter has to be carefully examined. Many operations have very good short term results which, unfortunately, are not borne out when the patient is reassessed after two years.

13 Early resumption of normal activities such as housework, intercourse, sport. The operation can be painful and may require up to two weeks lying in bed with an in-dwelling catheter.

These are some of the most serious obstacles to young women with families undertaking a vaginal repair operation.

14 Anatomical damage.

It is important to avoid any damage which could hinder a successive operation should the primary operation fail. Specifically, fibrosis to the urethra and bladder neck must be avoided in the methodology of all operations.[5] This, of course, is not always possible, but certain operations do appear to be less likely to cause this problem, especially if large segments of vagina are excised.

15 Physiological mode of action of the operation.

The central criterion here will be whether there is anatomical distortion following operation, on the traditional basis that function follows restoration of normal anatomy.

Tanagho[5] discusses the importance of anatomical restoration as a prerequisite to restoration of function.

VAGINAL OPERATIONS

The early operations

Essentially, the vaginal repair consists of excision of vaginal tissue, and resuturing of the cut edges, thus tightening the suburethral vagina. This operation dates back to Schulte[6] in 1870. Kelly[7] in 1914 gave a report on 20 cases, 85% of whom had borne children. In a short literature review, he described two types of operative management:

1 Creation of an artificial channel

2 Operations which restored the urethra with the normal power of retention.

The first group were essentially diversionary operations, by creation of vesico-abdominal or rectovaginal fistulae. In the second group he described simple compression of the urethra by anterior colporrophy, or by the periurethral injection with paraffin. Kelly[7] described the following: an operation by Schultze,[8] whereby the lumen of the urethra and the vesical neck were narrowed by excision of vaginal skin 3cm x 1cm broad; Frank[9] excised a wedge-shaped piece from the posterior urethral wall, including vaginal and urethral mucosa; Wenkel & Engstrom[9] described similar procedures; Desnos[9] dissected the vaginal mucosa and placed a large catgut suture 2mm to 3mm from the neck of the bladder and tied it tightly over a catheter. He describes altering the external meatus below the clitoris by Pousson, Albarran and Dudley.[7] These procedures apparently did provide relief of the incontinence. The various operations in both groups are comprehensively listed by Ingelman-Sundberg.[9]

The Kelly operation[7]

Using a Pezzer catheter, the stem not over 5mm in diameter, introduced into the bladder, an incision is made in the vaginal wall down to the urethra and the bladder on the median line for about 3.5cm to 5 cm. The neck of the bladder should be at the centre of the incision. The vagina is detached on both sides for a distance of 2cm to 2.5cm. Using fine silk or linen 1.5cm of tissue is taken on either side of the bladder neck and approximated at the midline. A second suture is made in this fashion and then the catheter removed. Following this, excess vaginal skin is excised and the edges approximated. Kelly described four cases in which the operation was not successful. All were multiparae and three had previous operations on the vagina. He felt that prognosis was exceedingly unfavourable in all because of the presence of dense scar tissue in the vaginal vault and at the site of the vesical sphincter. Post-operatively, he felt the patients should not be catheterized unless it is imperative, although sometimes it must be done for several days or even for a week. Barnett,[10] summarized the modern application of the Kelly operation with specific reference to the formation of the urethrovesical angle.

Kennedy,[11,12] modification of the Kelly operation.

The urethra is widely separated from the pubic rami, thoroughly mobilized at the urethrovesical junction, adhesions lysed, and the urethra and bladder neck plicated by a series of interrupted mattress sutures. Approximation of the pubococcygeus muscles may or may not be performed.

Modified Kelly procedure
Strengthening pubourethral ligaments vaginally.

There are many variants of this operation Nichols & Milley,[13] identified the pubourethral ligaments in a transvaginal surgical approach. Warrell[14] uses the suburethral fascia and approximates it. Kralj (personal communication 1992) & Lohadny (personal communication 1992) use a technique which involves the identification of the puborurethral ligament and their plication in the mid-line vaginally. Retropubic vaginal urethropexy for the treatment of genuine stress incontinence with prolapse: Inglesi et al (1992), reported a new procedure which involves the creation of two central longitudinal flaps extending downwards from the urethra as follows:

Taking a 4cm incision downwards from the external urethral meatus, a flap is created 3cm wide, which is ultimately divided into two strips 1.5cm wide x 4cm long, these flaps are then stitched into the periosteum of the lower portion of the pubis about 3cm to each side of the mid-line. Standard vaginal repair is then performed. Follow-up of 41 patients was between 1 and 5 years and 95.1% were cured. One patient had urinary retention, 1 urinary infection, 3 had vaginal bleeding and 1 haematuria. Most patients voided between the 4th and 6th post-operative day. It is claimed that this technique elevates and supports the urethrovesical junction.

Injectable type operations

Kelly (1914)[7] described the periurethral injection of paraffin. Horn's Operation[15] (1975), artificially provides an elevation at the UVJ via the vaginal route by implantation of a fibrin "bean" which ultimately fibroses, creating scar tissue in this area.

Gax-Collagen injection: Appell et al[16] in 1989 injected up to 14mls Gax-collagen (glutaraldehyde cross- linked collagen) either peri or transurethrally. Review up to 12 months later gave 80.8% success rate in females. Urodynamically, the leak point pressure rose an average of 34cm in patients rendered continent. It is claimed that the bovine collagen is replaced by endogenously produced collagen. This is a variation of the Teflon injection technique by Politano[17] in 1982, and the periurethral injection of paraffin described by Kelly (1914). Collagen injection, Eckford,[18] demonstrated that of 15 patients without previous surgery, 9 patients were completely continent, three patients improved and 3 failed. Of 20 with previous surgery, 15 were completely continent, 2 improved, 3 failed. Patients were reviewed at six months. In another study, Stricker[19] demonstrated that of 17 female patients, each with an average of 3.2 operations and Type III incontinence were treated, objectively tested with 200mls in the bladder. Eleven of the 17 were dry, 3 improved, average number of rejection was 2 over a two and a half month period.

Comment on injectables

Peacock[20] states that interspecies homology of collagens from the same tissue may be 85% to 95%. The difference may involve simply one amino acid base pair in the DNA molecule. Despite the increased cross- linking from glutaraldehyde, the antigenic nature of the collagen does not alter. The question of collagen formation to foreign bodies is thoroughly examined elsewhere in this thesis. The question is, does the antigenically different collagen behave as a foreign body, much as a carageenan granuloma does,[21] i.e., is it ultimately completely removed by macrophages? At 150 days, the granuloma induced by the carrageenan was minimal in size.[21] Histologically, there were large clusters of fat cells interspersed with thick bundles of collagen and macrophages. Nevertheless, the induced fibrous tissue is also ultimately absorbed. If the above holds, then it may be predicted that Gax-collagen injections would fail over a period of say 2-3 years. The injection of Teflon[17] is a different matter, however. The Teflon would act as a plastic sponge, so that the fibrous tissue reaction induced would at least theoretically be permanent. It has been found that such Teflon injections are ultimately broken down and scattered away from the original site.

Repair of vaginal fascial defects

Baden and Walker[22] described various defective anatomical fascial supports as causing Stress Incontinence (SI). These were first described by White and include:
(1) Midline (pre and post cervical defects).
(2) Lateral (paravaginal) defects.
(3) Supravaginal, (uterosacral and lateral cervical) defects.
Vaginal route repair of (1) and (2) gave 60% and 77% cure rates respectively, while the abdominal aproach gave 83% and 87% cure rates. Repair of (3) by either route gave 80% cure rates. Diagnosis involved a complicated scaling classification from 1-4 involving urethrocoele, cystocoele, cervical prolapse, enterocoele, rectocoele and perineal laceration. This grading is, by the authors' own admission, highly subjective. Richardson[23] used a similar approach to Baden in cure of SI, but mainly used the suprapubic approach.

Ingelman-Sundberg operation[24]

Essentially, this is a Kelly type repair combined with sectioning the pubococcygeus muscles vaginally in the middle, suturing the anterior halves suburethrally, and joining the posterior halves to the ischiocavernosus muscles.

Indications: All types of SI, especially in obese patients and operative failures, whether suprapubic or vaginal.

Urethrocleisis

Frewen[25] narrowed the urethra combined with a free urethral graft taken from the external oblique aponeurosis. Subsequently Payne (1983) omitted the graft and simply performed the urethrocleisis using nonabsorbable sutures. He reported satisfactory results from 60/62 patients.

General Comments

Kelly's classical description outlines the cardinal principles of vaginal operations for stress incontinence. All other vaginal operations are essentially variations of the Kelly procedure. The Kennedy and other modifications actively recreate the urethrovesical angle, especially if, as recommended by Martius[26] and Kennedy (1937, 1941) himself, the pubococcygeus muscles are approximated in the midline below bladder base. The sutures, however, tend to tear out with this modification. Alternatively, the muscles become atrophied (Obrink).[27] The Ingelman-Sundberg operation retains the nerve and blood supply of the pubococcygeus muscle. Severing it and reanastomosing it ensures that there is no pressure necrosis or atrophy. A 30% fall in urethral pressure has been reported (Bunne).[28] Technically, however, this operation is difficult, as the pubococcygeus muscles need to be sufficiently mobilized so as to be able to be approximated. Postoperative retention and pain were a problem. Though the results as published by others were equivalent to colposuspension, this operation was performed by very few surgeons.

Within the scope offered by the surgical principles of the Kelly operation, various points of surgical detail appear to influence the results. Barnett (1969)[10] pointed out the importance of primarily building up the tissue below the urethrovesical junction (UVJ) with the available tissue prior to suturing the urethra from either end.

Other techniques of ensuring that the bladder neck is plicated include that of Reynolds,[29] who inserted sutures into the periosteum on either side of the urethra vaginally. The exact position of the bladder neck needs to be properly defined if the UVJ is to be accurately plicated.

Barnett[30] suggested pulling down the balloon of the Foley catheter. This method may be inaccurate if the proximal urethra is dilated (funnelling). The use of non-absorbable sutures appears to give a significantly higher success rate, 65% vs 46%, but is associated with sinus formation (Cullen).[31] Baden's work specifies different anatomical defects in the fascial supports. He proceeds to specifically correct these. The Kelly repair (Kennedy variant) would automatically repair the midline and paravaginal defects of Baden, but would not correct the cervical or uterosacral defects. Baden gives no rationale whatsoever for the success of his operation. He simply states that these are defects of pelvic fascia.

The Reynolds technique seems in some ways preceded the midurethral sling concept, though the initial results, 65% indicate that the attachment of urethra to the symphysis may not have been at the correct midurethral point.

As regards the Frewin urethrocleisis operation, given the inverse exponential relationship between urethral diameter and urine flow, this operation can only work by causing obstruction and therefore a poor stream. Lack of uptake of such a simple operation indicates it was not effective in the longer term.

Site specific repair (Baden Walker) is attractive as regards cure of cystocele and rectocele, but it cannot restore the suspensory ligaments, in this case, the pubourethral ligament.

Evaluation of vaginal repair operations according to the 15 criteria:

(1) Invasiveness.
The operation is invasive and may cause not only loss of tissue through excision but tissue damage, adhesions at bladder neck and blood loss, if the infravesical plexus is disturbed. There is less tissue damage and less blood loss with a vaginal repair vis a vis a Burch Colposuspension.

(2) Ease of performance
The operation is easily performed but it requires considerable judgment, especially in the plastic reconstruction of the vagina. Excessive tissue removal may lead to dyspareunia or even apareunia.

(3) Built-in safety
This procedure is a function entirely of surgical skill. If the dissection is taken too far laterally, the infravesical plexus of veins may be injured. Atrophic tissues need to be handled with care. A smaller calibre of suture needs to be used in these instances. Opening into the correct plane is vital to avoid bladder or urethral perforations. Insertion of sutures into the bladder wall at the UVJ may inadvertently obstruct ureter(s).

(4) Short term complications
It is subject to all those listed above. Major complications can occur, such as perforation of the bladder, urethra, and fistulae due to avascularity and blood loss.

(5) Long term complications
Can include dyspareunia from excessive tissue resection, and worsening of the incontinence with excessive scar formation, Hodgkinson.[32] Post-operative urgency and frequency has been reported, Lee.[33]

(6) Applicability to obese patients
The operation is easily performed with obese patients, or in those with poor tissues, but there is a much greater chance of failure due to the greater intra-abdominal pressure generated. The integrity of the operation depends on the integrity of the suture line, especially in poor or atrophic tissues. This can be torn or stretched very easily upon application of intra-abdominal pressure. A strong involuntary cough or sneeze, can easily approach 2.2 lbs/sq in., Petros (1987-90, unpublished data). The pressure needed, to tear a suture out of smooth muscle, the principal supporting layer of the vagina, Goff.[34] 1931, is approximately 2.8lbs/sq inch, Van Winkle.[35] The margin between sutures tearing out, and supporting the suture line for a sufficient period (usually 4-6 weeks) for healing to take place is therefore minimal.

(7) A previously failed procedure
Ingleman-Sundberg stated that this is a contra-indication to the Kelly procedure, and the Ingelman-Sundberg muscle transplant operation should be performed in this instance.[36] The consensus, however, was that an abdominal procedure such as the Burch Colposuspension was indicated.

(8) Blood loss
This only becomes a problem when the wrong plane is entered, or if the surgeon does not immediately institute haemostasis. Haematoma formation is the main post-operative complication (Warrell).[37]

(9) Length of Operation
There is wide variation, depending on the surgeon and his technique. Blood loss can be considerable in a vaginal repair operation, especially if the bladder is dissected away from the vagina and the perivesical plexus is damaged. This bleeding can add considerably to the length of the operation, which is rarely under 30 minutes.

(10) Early Discharge
Generally the patient needs to stay at least 7 days in hospital but often the stay can be much longer, especially if the vaginal repair has been made fairly tightly and the patient is unable to void sometimes for weeks afterwards.

(11) Retention of urine
Because the vaginal repair is carried right to the bladder neck, this creates a tightness which prevents the urethral funneling so essential to reduction of intraurethral resistance (Law of Poiseuille). This may become a problem for many weeks, in patients who have a very tight repair. It is fortunate that the vagina being the elastic organ that it is, urinary function generally returns to normal even in situations where there has been retention for several weeks post-operatively.

(12) Initial success rate
This may be as high as 85% (Jones).[38] Ten year success rates for the Kennedy Operation may be up to 64%, and for the Kelly, 50% (Cullen).[31] Recurrence of the urinary incontinence may be up to 50% of patients in the longer term (2 years), according to Green,[39] or nearly 60% (Ingelman-Sundberg).[36] With muscle transplant (Ingelman-Sundberg Operation) (1952), the success rate may be as high as 94% at 2-5 years, or 84% at 10-20 years, Da Silviera & Piccoli.[40] Quigley,[41] in a review article reported rates between 48% and 63%. Warrell (six month cure rate between 80% and 90%). Bergman et al[42] failure rates for

anterior colporrhaphy was 31%. No attempt will be made to explain the different cure rates other than:

(a) There may be different population samples.

(b) Differences in surgical skill and technique.

(c) Varied/optimistic/imprecise assessment methods.

Perhaps the key factor in longer term failure is the inability of vaginal repairs to reconstitute the pubourethral ligament.

(13) Return to normal activities

The tendency to recurrence (cf. 12, above) imposes an obligation on the surgeon to emphasise to the patient that she must abstain from any stressful activity for at least 6-12 weeks after the operation, the time taken for the scar tissue to strengthen.

(14) Anatomical damage

The vagina and urethral wall is often a problem due to scarring. The particular type of complication depends on the site of the adhesions. In the area of the bladder neck it can cause sometimes quite severe symptoms of frequency, urgency and nocturia (Green).[39] The occurrence of urinary incontinence after cystocoele repair is a well-known phenomenon (Hodgkinson).[32] Fixation of the vagina to the urethra by scar tissue formation may not only prevent the normal physiological workings of the urinary continence mechanism, it may impede or even prevent suprapubic operation to cure the incontinence following failed vaginal surgery. Tightening and narrowing the urethra may cause increased intraluminal resistance according to Poiseuille's Law, resulting in poor urinary flow, as in the Frewen operation.

(15) Mode of action

Other than scarring, the vaginal repair, precisely performed so that there is not excessive tightening of the suburethral vagina or narrowing of the urethra, is certainly physiological, as there is no distortion as such of the pelvic floor anatomy. Ingelman-Sundberg operation is specifically excluded from this comment, as it potentially alters the function of the pubococcygeus muscles.

It is difficult to ascribe success of vaginal repair to bladder neck elevation when demonstrably there can be minimal elevation of bladder neck with a vaginal repair. Nevertheless, there are certain common features that need to be correlated.

(1) The suburethral vagina is tightened.

(2) The modus operandi of Teflon paste, or Gax-collagen injections.

(3) Ingelman-Sundberg's higher rate of cure with muscle transposition.

The latter implies that this maneouvre must restore an additional anatomical, and therefore functional, parameter. The increased closure pressure reported by the Gax-collagen injection similarly can not be explained by improved transmission of pressure. In any case, this increase in pressure may not be permanent. In patients having a vaginal repair, Obrink[27] noted initial increase in maximal urethral pressure immediately post-operatively, returning to pre-operative levels within 3 months. The implication of this is that vaginal repairs work by obstructing the flow as per Poisueille's Law, and fail as the tissues dilate in time.

The modus operandi of the Ingelman-Sundberg operation may be that the transposition tensions the pubourethral ligament, thereby restoring it as the fulcrum point for musculoelastic closure.[40]

CONCLUSIONS

The suitability of vaginal repair as a primary procedure was a controversial topic even historically. Ingelman-Sundberg and Ulmsten believed that there was a very firm place for vaginal repair operation. Green performed a vaginal repair as the operation of first choice if radiologically the urethra was inclined at less than 45 degrees to the vertical axes Stanton,[43] who introduced the Burch colposuspension to the UK nevertheless did not commit himself definitively, but implies that a bladder neck elevation procedure has a much higher success rate, 84% as against 36%. Tanagho[44] who's modification of the Burch operation led to its dominance, categorically statedthat there is no place for vaginal repair and relates worsening of urological symptoms to this procedure. He believes that a bladder neck elevation operation should be performed ab initio. The passage of some years seems to have confirmed Tanagho's view.

Conflicts of interest: none.

REFERENCES

1. Ingelman-Sundberg A & Ulmsten U. Surgical treatment of female urinary stress incontinence. Contr Gynecol & Obstets, 1983; 10:51-69.

2. Stanton SL, Williams JE & Ritchie D. The colposuspension operation for urinary incontinence. British Journal of Obstets & Gynaecol, 1976; 83:890-895.

3. Hodgkinson CP & Stanton SL. Retropubic urethropexy or colposuspension. Surgery of Female Incontinence, (1980), (Eds) Stanton SL & Tanagho EA, Springer Verlag, Berlin, 1st Edition. 55-68.

4. Spencer JR, O'Conor VR Jnr. & Schaeffer AJ. Comparison of the endoscopic suspension of the vesical neck with suprapubic vesicourethropexy for treatment of stress urinary incontinence. Journal of Urology, 1987; 137:411-415.

5. Tanagho E. Neourethra: rationale, surgical technique and indications. Surgery of Female Incontinence, (1980), Eds Stanton SL and Tanagho E. Springer-Verlag, Berlin, 111-117.

6. Schulte I. (1870) as quoted in Gynaecological Surgery, (1974), John H. Ridley, Williams & Wilkins, Baltimore.

7. Kelly HA & Dumm WM. Urinary incontinence in women without manifest injury to the bladder. Surgery Gynecol & Obstets., 1914; 18:444-450.

8. Schulze KA Wettlaufcr JN. Ventral bladder hernia following Marshall-Marchetti-Krantz procedure for stress urinary incontinence. Urology, 1986; 28:114-116.

9. Ingelman-Sundberg A. Urinary incontinence in women excluding fistulas. Acta Obstets & Gynecol Scandinavica, 1952; 31:266-288.

10. Barnett RM. The Modern Kelly Plication. Obstets & Gynecol, 1969; 34: 665- 667.

11. Kennedy WT. Incontinence of urine in the female, the urethral sphincter mechanism, damage of function and restoration of control. American Journal Obstets & Gynecol. 1937; 33:576:589.

12. Kennedy WT. Urinary incontinence relieved by restoration & maintenance of the normal position of the urethra. American Journal Obstets & Gynecol., 1941; 38:16-28.

13. Nichols D, Milley P. Identification of pubourethral ligaments and their role in transvaginal surgical correction of stress incontinence. American Journal Obstets & Gynecol, 1973; 115:123-127.

14. Warrell D. Anterior repair. Surgery of Female Incontinence, (1986), (Eds) Stanton S & Tanagho E. 2nd Edition, Berlin Springer Verlag, 77-85.

15. Horn B, KoverJ & Marton I. Treatment of stress incontinence by a fibrin bioplast. British Journal of Obstets & Gynaecol, 1975; 82:61-63.

16. Appell RA, Goodman JR, McGuire EJ, Wang SC, Bennett PA, De Ridder PA & Webster GD. Multicenter study of periurethral and transurethral gax-collagen injection for urinary incontinence. Neurology & Urodynamics, 1989;4:339-340.

17. Politano VA. Periurethral polyrtrafluoroethylene in section for urinary incontinence. Journal of Urology, 1982; 127:439.

18. Eckford SD, Abrams P. Injection of collagenic bio-implants to treat female stress incontinence. International Urogynecol Journal, 1991; 2:186. Sixteenth Annual meeting of the International Urogynecological Association, Sydney, September 1991.

19. Stricker PD & Haylen B Periurethral collagen injection. Int Urogynecol Journal, 1991; 3:2-190.

20. Peacock EE. Structure, synthesis and interaction of fibrous tissue protein and matrix. Wound Repair, 1984, 3rd Ed,WB Saunders Co Phil. 56-101.

21. Monis B, Weinberg T & Spector GJ. The carrageenan granuloma in the rat. A model for the study of the structure and function of macrophages. British Journal of Exper Pathol., 1968; 49:302-310.

22. Baden W & Walker T. Urinary stress incontinence, evolution of a paravaginal repair. The Female Patient, 1987;12:89-105.

23. Richardson AC, Edmonds PB & Williams NL. Treatment of stress urinary incontinence due to paravaginal fascial defect. Obstets & Gynecol, 1980; 57:3, 357.

24. Ingelman-Sundberg A. Urinary incontinence in women excluding fistulas. Acta Obstets & Gynecol Scandinavica, 1952; 31:266-288.

25. Frewen WK. Urethral graft in stress incontinence. Abstract Sixth Annual Congress ICS Antwerp, 1976.

26. Martius H as quoted by Zacharin, Obstetric Fistula, Springer-Verlag Wien, 1988. Mattingly RF, Davis LE. Primary treatment of anatomic stress urinary incontinence. Clinical Obstretrics and Gynaecology, 1984; 27:444-458

27. Obrink A. Pubococcygeal repair ad modum Ingelman-Sundberg A Retrospective Investigation with 10 to 20 years time of observation. Acta Obstets & Gynecol Scandinavica, 1977; 56:391.

28. Bunne G & Obrink A. Influence of pubococcygeal repair on urethral closure pressure at stress. Acta Obstets & Gynecol Scandinavica, 1978; 57:355-359.

29. Reynolds CR & Muller HG. Transvaginal urethropexy. Journal of Urology, 1974; 111:36.

30. Barnett RM. The Modern Kelly Plication. Obstets & Gynecol, 1969; 34: 5, 667.

31. Cullen KR & Welch JS. Stress Incontinence - Reviews, Surgery Gynecol & Obstets., 1961; 85:113-117

32. Hodgkinson CP. Recurrent stress urinary incontinence. American Journal of Obstets & Gynecol, 1978; 846.

33. Lee R. Recurrent stress incontinence of urine: Pre-operative assessment and surgical management. Clinical Obstets & Gynaecology, 1979; 3:661-671.

34. Goff Byron. An histological study of the perivaginal fascia in a nullipara. Surgery Gynecol & Obstets., 1931; 52:32-42.

35. Van Winkle N, Hastings J. Considerations in the choice of suture materials for various tissues. Surgery Gynecol & Obstets., 1972; 135:113-126.

36. Ingelman-Sundberg A. Operative treatment of female urinary incontinence. Annales Chirurgiae et Gynaecologicae, 1982; 71:208-220.

37. Warrell D. Anterior repair. Surgery of Female Incontinence, 1986, (Eds) Stanton S & Tanagho E. 2nd Edition, Berlin Springer Verlag, 77-85.

38. Jones HW. Marshall Marchetti Operation. Obstets Gynecol Survey, 1972; 27:747.

39. Green TH Jr. Selection of vaginal or suprapubic approach in operative treatment of urinary stress incontinence. Clinics in Obstets & Gynaecol., (1977), 20:4, 881.

40. da Silviera G & Piccoli EC. Ingelman-Sundberg operation for urinary incontinence. Acta Obstets & Gynecol Scandinavica, 1977; 56:399-400.

41. Quigley G & King S. Transvaginal retropubic urethropexy; the revised Pereyra procedure: a report of 50 cases. American Journal Obstets & Gynecol., 1981; 139:268-272.

42. Bergman A, Ballard CA & Koonings DP. Primary stress urinary incontinence and pelvic relaxation: A perspective randomized comparison of three different operations. Neurourology & Urodynamics, 1989; 4:334-335. Abstract Proceedings of the International Continence Society 19th Annual Meeting, Ljubljana, Yugoslavia, 7-9 September.

43. Stanton S. Comparison of anterior repair and colposuspension. Gynecol Urol and Urodynamics: Theory and Practice, 2nd Ed, (Ed) DR Ostergard, 1985; 557-560.

44. Tanagho E. Gynecol Urol and Urodynamics: Theory and Practice 1985, 2nd Ed. (Eds) DR Ostergard. p538.

Correspondence to:

Bernhard Liedl
Abteilung fur Urogenitale Chirurgie und Urologie,
Beckenbodenzentrum München,
Denningerstrasse 44, D-81679 München, Germany.
Email: bernhard.liedl@t-online.de