

A Brief History of Urinary Incontinence and its Treatment

Chairman

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A Brief History of Urinary Incontinence and its Treatment

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I. INTRODUCTION

Ancient reports on urinary incontinence are rather rare and mainly address cases of extraurethral incontinence (e.g. due to a fistula acquired during childbirth) or overflow incontinence (e.g. in males with urinary retention or after spinal cord injury). In later centuries several authors dealt with the problem of postoperative incontinence after perineal lithotomy. Defined surgical techniques for the cure of urinary incontinence were not introduced before the 19th century. First this was limited to fistula repair but at the end of the 19th century new procedures for stress incontinence were introduced and became standard clinical procedures. Other modern techniques, like artificial sphincters or electrostimulation, were alternatives developed in urology in the second half of the 20th century*.

II. EARLY REPORTS ON URINARY INCONTINENCE FROM ANTIQUITY TO THE 18th CENTURY

In contrast to frequent diseases like bladder stones, urinary retention and urinary fistula, descriptions of urinary incontinence and its treatment are rarely mentioned in early medical writings. Associated with the above listed entities only a few episodes of overflow incontinence and extraurethral incontinence are reported. On the other hand the use of different catheters for the relief of urinary retention is described in many early cultures [1, 2].

The first sources dealing briefly with urinary incontinence are Egyptian manuscripts from the 2nd mil-

lennium B.C.: the „Papyrus Smith“ [3] and the „Papyrus Ebers“ [4]. In the 31st case of the „Papyrus Smith“ incontinence resulting from spinal injury is described as followed: „...if thou examinest a man having a dislocation in a vertebra of his neck, shouldst thou find him unconscious of his two arms and his two legs on account of it, while his phallus is erected on account of it and urine drops from his member without his knowing it ...“ [3, 5]. The „Papyrus Ebers“ consists of a collection of about 900 recipes for the treatment of a wide variety of partly poorly defined diseases. Among them one can find remedies “to remove the urine which runs to often“ and “to remove constant running of the urine“ [4, 6, 7]. Furthermore these Egyptian sources already mention devices for the collection of urine in males and also pessaries for women.

An examination of the mummy Henhenit (about 2050 B.C.) by D. E. Derry in 1935 revealed a large vesicovaginal fistula which is most likely due to a birth trauma as it was accompanied by a laceration of the perineum [8, 9].

Greek medicine was dominated by the outstanding work of Hippocrates (460-377 B.C.) who was writing extensively about the diseases of the urinary tract. Despite his discussion on perineal lithotomy he also dealt with the management of urinary incontinence [7, 10].

Giving a detailed description of the technique of perineal lithotomy the Roman author Aulus Cornelius Celsus (25 B.C.-50 A.D.) emphasized the importance of a wide incision that allows extraction of the stone without further uncontrolled rupture of the surrounding tissue, as this would increase the danger of urinary fistula [7].

Claudius Galen (129-201 A.D.) from Pergamon was

* Treatment options established during the last decades are not addressed in this chapter

one of the first do undertake physiological experiments on the lower urinary tract and postulated that micturition is conducted by contraction of the abdominal muscles. Concerning the causes of urinary retention he differentiated clinically between paralysis of the bladder after spinal injury and subvesical obstruction due to bladder stones [7, 11].

Even from the standpoint of medical sciences the Middle Ages represent a dark period for Europe. At this time the ideas of Greek and Roman authors were preserved and tradicted by Arabian medicine, as e.g. in the writings of Avicenna (930-1037 A.D.), until they were finally rediscovered by European scientist of the Renaissance.

Today we are highly impressed by the studies of Leonardo da Vinci (1452-1519), who performed several dissections on human bodies and over a period of about 25 years created a large anatomical work including the lower urinary tract. In his drawings of the bladder he is mainly presenting an open and funnel-shaped bladder neck and only in some of them he is indicating a circular structure at the bladder neck, the internal sphincter (**Figure 1**), which he describes as followed: “...and how the gate of the bladder is shut.” or “...muscles which open and close the passage of the urine into the mouth of the bladder neck.” On the other hand he is not aware of the contractile power of the detrusor muscle and does not mention the problem of urinary incontinence. As Leonardo failed to finish his studies and publish them in the form of a textbook on anatomy his work is only of medico-historical interest and did not influence the scientific development at his time [12].

Ambroise Paré (1510-1590), the most famous surgeon of the Renaissance, also showed great interest in the urinary tract and was one of the first to resect “*carnosities*“ of the urethra with sharp sounds. He described the alterations caused by subvesical obstruction and realized the mechanism of synchronized sphincter relaxation and detrusor contraction during micturition. **Figure 2a** shows one of the first illustrations of a urinal for incontinent males. Another instrument facilitates urination in the standing position after loss of the penis (**Figure 2b**): “*Those that have their yards cut off close to their bellies, are greatly troubled in making urine, so that they are constrained to sit downe like women, for their ease. I have devised this pipe or conduit ... that must be applied to the lower part of the os pectinis ... serving instead of the yard in making of water, which therefore wee may call an artificall yard.*“ [13]

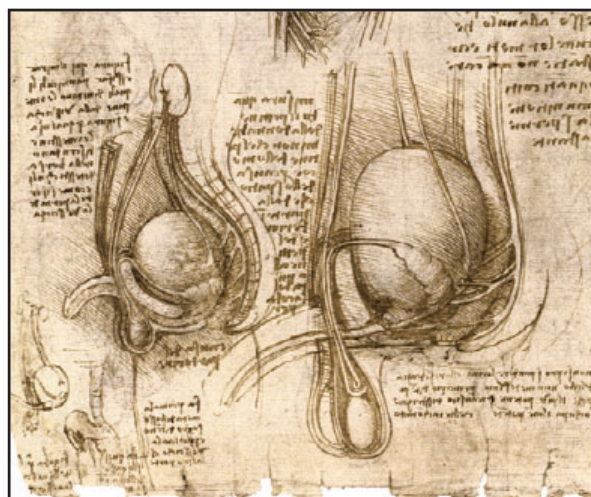


Figure 1. Male genito-urinary anatomy according to Leonardo da Vinci (ca. 1504-1507). Notice the missing prostate gland that was unknown to Leonardo [12]

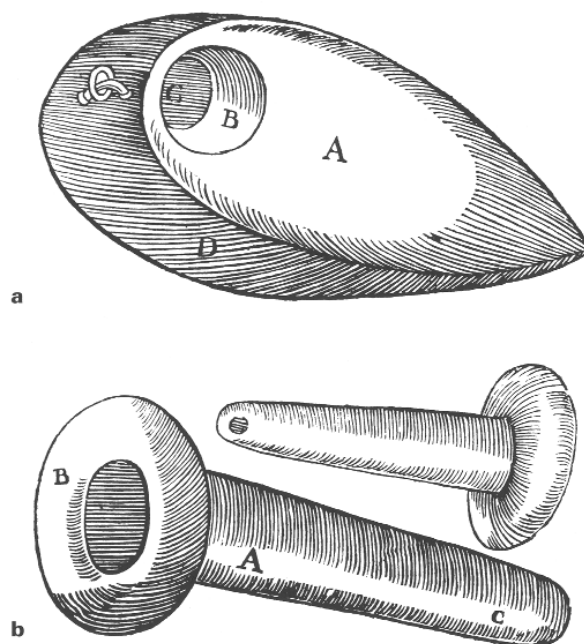


Figure 2 a, b. Urinal (a) and “artificiall yard“ (b) as examples of early incontinence and micturition devices according to Ambroise Paré (1564) [13]

Wilhelm Fabricius Hildanus (1560-1634) provided a modified urinal for the treatment of incontinence in his work „*De ardore et incontinentia urinae, et nova inventione instrumenti, quo inter deambulandum colligitur*“ consisting either of glas or the bladder of a pig that was attached to the body by straps (**Figure 3**) [14].



Figure 3. Urinals made of glas or the bladder of a pig according to Fabricius Hildanus (1682) [14]

In his book “Chirurgie”, which was edited several times between 1718 and 1779, the German Lorenz Heister (1683-1758) dedicated two chapters on male and female incontinence: “Wenn Manns- und Frauens-Personen den Urin nicht halten können” [15]. In his opinion bladder stones or paralysis of the bladder sphincter are the two reasons for incontinence in males. The first has to be treated by lithotomy whereas the second is cured by „Nerven-stärckenden Medicamenten“ (nerve-strengthening drugs).

Besides the use of a urinal as described by Paré or Fabricius Hildanus he suggested a penile clamp (Figure 4a) that was covered with leather and removed by the patient at the time of micturition. With reference to his colleague Winslow, Heister designed a belt that produces perineal compression to the bulbar urethra (Figure 4b). He saw no effective treatment for female urinary incontinence but mentioned a vaginal pessary, formed like a ring, in this case compressing the female urethra.

III. CONSERVATIVE TREATMENT

Empiric therapy with a variety of different recipes was used since antiquity and was for the most part effective on the lower urinary tract due to antidiuretic, cholinergic and anticholinergic ingredients. Some examples from the medical literature of the

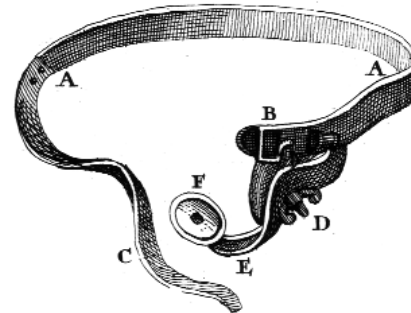
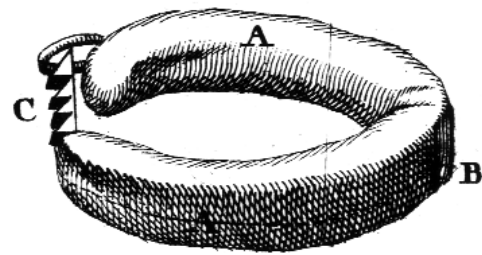


Figure 4. Penile clamp covered with leather (a) and belt for perineal compression of bulbar male urethra (b) according to Lorenz Heister (1747) [15]

18th and 19th century are ergotamine, chloral hydrate, opium (laudanum), colchicine, strychnia and atropine (belladonna) [16, 17]. One of the first modern milestones in pharmacotherapy are the works of Samuel Hahnemann (1755-1843). In his books „Reine Arzneimittellehre“ (1833) and ‘Die chronischen Krankheiten, ihre eigentümliche Natur und homöopathische Heilung‘ (1835) he already differentiated correctly the different types of urinary incontinence and suggested an adequate medical therapy [18, 19].

Hydrotherapy was a major aspect of mechanical therapy using cold water baths, hypogastric douches, aromatic baths and vaginal douches [16].

In 1762 T. Dickson applied blisters to the area of the os sacrum for reflectory therapy of urge incontinence [20]. One of the first bladder distensions for successful cure of the same disease in elderly patients was performed by J. Rhodes in 1858 using a mixture of carbonic acid gas with chloroform [21].

Another alternative were the sacral epidural injections of Fernand Cathelin (1873-1960) from the Hôpital Necker in Paris. Before 1903 he used saline or cocaine solutions for the treatment of different forms of urinary incontinence (Figure 5) [22]. One year later M. Babinski reported on successful therapy of neurogenic bladder dysfunction with lumbar puncture and drainage of cerebrospinal fluid [23].

Les
Injections Épidurales

par ponction du canal sacré

et leurs applications

dans les

Maladies des voies urinaires

Recherches anatomiques, expérimentales et cliniques

PAR

Le Docteur Fernand CATHELIN

ANCIEN INTERNE DES HÔPITAUX DE PARIS

CHEF DE CLINIQUE ADJOINT DES MALADIES DES VOIES URINAIRES A L'HOPITAL NECKER

Avec 32 figures



PARIS

LIBRAIRIE J.-B. BAILLIÈRE ET FILS

19, RUE HAUTEFEUILLE, 19

1903

Figure 5: Frontispiece of the treatise of Fernand Cathelin on epidural injections from 1903 [22]

IV. EXTERNAL DEVICES

Some early examples of urinals and external compression instruments have been presented above. Compared to the devices listed in a medical catalogue from 1906 (Figure 6) we recognize the same principles improved by new materials like India rubber [24]. The „Appliance for Amputation of Penis“ seen on the upper part of this figure is designed for micturition in the standing position, an aspect of quality of life in male patients that was already addressed with the “artificiall yard“ of Ambroise Paré (compare Figure 2b).

Comparable to these devices the use of vaginal pessaries also has a long tradition in the treatment of female incontinence as mentioned above [25]. In 1826 T. Brown designed a sophisticated self-retaining instrument made from ivory that fitted anatomically to the female urethral orifice and avoided urinary leakage. A removable stopper at the end of the hollow device allowed controlled emptying of the bladder without removing the whole device [26].

The idea of perineal compression, as introduced by Heister, was revived as lately as 1960 by S. A. Vincent, using an air-inflatable cushion that was fixed to the perineum with a special belt and expanded manually via bellows to obstruct the male bulbar urethra (Figure 7) [27].

External devices of all kind have been perfected in our century [25] and were even partly replaced by modern surgery and its advances in continent urinary diversion, a development that will not be outlined any further in this chapter [see 7, 28].

A final remark addresses the cultural aspect of urinals and urine receptacles in the history of mankind. Although chamber pots (“matula“) are described in antiquity, the daily use of a urine collecting receptacle (e.g. “bourdaloue“) was only introduced in the late Middle Ages and early Renaissance [29].

V. “ELECTROTHERAPY“

With the development of electro-physiology in the 19th century the application of direct or alternating current for bladder dysfunction became of therapeutic interest. Robert Ultzmann (1842-1889) from Vienna mentioned three indications in his outstanding book „Die Krankheiten der Harnblase“ from 1890 for the use of electricity in the treatment of „Neurosen oder Neuropathien der Harnblase“: acquired paralysis of the detrusor or sphincter vesicae in adults and idiopathic enuresis in children [30]. The catheter-like electrode (“Rheophor“) was introduced either into the bladder (for stimulation of the detrusor muscle) or into the prostatic urethra (for stimulation of the sphincter muscle). Therapy of enuresis in children was suggested with a rectal electrode. Earlier experiments of electrotherapy for incontinence had been undertaken by Nardin in 1864 and were the basis for Ultzmann’s work [31].

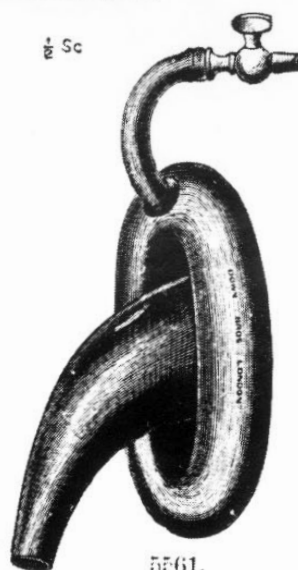
In 1898 L. Frankl-Hochwarth and Otto Zuckerkandl (1861-1921) published their experience with local electrotherapy in nervous diseases of the bladder [32] and „Blasendiathermie“ with vaginal or rectal sounds was still used in hypertonic conditions of the detrusor in 1930 by Josef Kowarschik from Vienna [33]. Modern concepts of electrostimulation of the pelvic floor with so-called plug electrodes were finally initiated by B. R. Hopkinson and R. Lightwood in the 1960’ies [34].

A different approach is the permanent intracorporeal implantation of stimulating electrodes or even com-

India-Rubber Urinals.

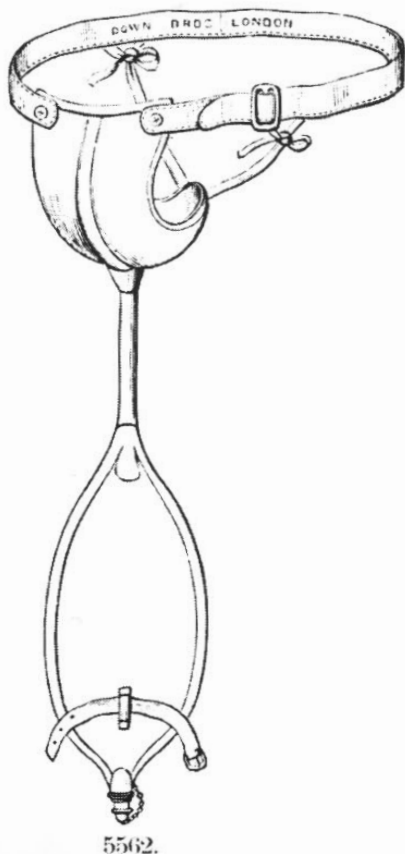
Extracted from "British Medical Journal," October 17, 1903.

Mr. Arthur T. Todd-White sends us a description of an india-rubber instrument which has been made for him by Messrs. Down Bros. for use after amputation of the penis. It consists of a pneumatic collar, which the patient can inflate himself, and a funnel-shaped tube curved downwards about 3 inches long. The patient in using it presses the pneumatic collar firmly against him, with the funnel pointing downwards. He is now able to pass water comfortably without lowering his trousers, which is a great advantage.



5561.

	£ s. d.
Appliance for Amputation of Penis	each 0 10 6



5562.



5563.

For Extroversion of Bladder (Down Bros.' pattern)	each 1 2 6
For Faeces and Urine, male or female	" 1 0 0

Figure 6. Several urinals from the catalogue of Down Bros., London (1906) [24]

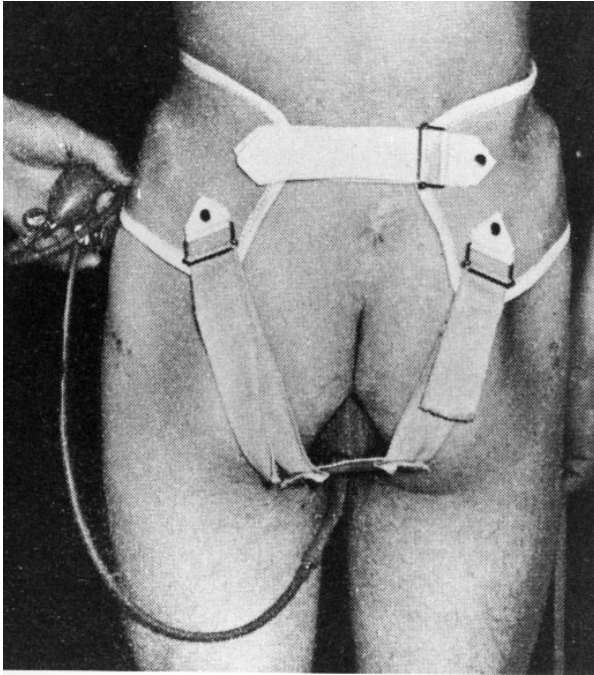


Figure 7. Air-inflatable cushion for perineal compression of the male bulbar urethra according to S. A. Vincent (1960) [27]

plete stimulator systems [overview in 35]: For the treatment of detrusor hypocontractility mainly in spinal cord injured patients W. H. Boyce sewed stimulating electrodes directly onto the bladder in 1954 [36]. A direct stimulation of insufficient sphincteric muscles was tried by K. P. S. Caldwell in 1963 [37]. Another 4 years later T. Burghel attached stimulators to the pelvic splanchnic nerves [38] and H. N. Habib to segmental sacral nerves in patients with spinal cord injuries [39]. Finally the development of the first system for long-term spinal anterior root stimulation, tested in animals in 1969, and the first clinical implantation of such a system in a human being in 1976 by Giles S. Brindley represents the beginning of modern neurostimulation and neuromodulation in urology [35].

VI. SURGICAL TREATMENT: VESICOVAGINAL FISTULA

In the second half of the 19th century the introduction of antisepsis and asepsis as well as anaesthesia revolutionized modern surgery. With respect to urinary incontinence this activity was mainly restricted to the surgical correction of vesicovaginal fistulas in the beginning, i.e. extraurethral or extraanatomic incontinence [40]. First efforts were made by Franz C. Naegele from Heidelberg in 1812 who experimented with transvaginal closure of fistulas in

human corpses [41]. Many well-known surgeons, as G. Dupuytren, J. M. Delpech, C. F. Lallemand and J. J. de Lamballe, followed this example over the next few decades [9].

In 1845 Johann Friedrich Dieffenbach (1792-1847), founder of modern plastic surgery, described the disease of urinary fistula, mainly arising from a birth trauma in younger women, and its social consequences for the patient in the following words: „A vesico-vaginal fistula is the greatest misfortune that can happen to a woman, and the more so, because she is condemned to live with it, without the hope to die from it; to submit to all the sequelae of its tortures till she succumbs either to another disease or to old age. There is not a more pitiable condition than that of a woman suffering from a vesico-vaginal fistula. The urine constantly flowing into the vagina, and partially retained there, and heated, runs down the labia, perineum, and over the nates and thighs, producing a most intolerable stench. ... The husband has an aversion for his own wife; a tender mother is exiled from the circle of her own children. She sits, solitary and alone in the cold, on a perforated chair. This is not fiction, but naked truth; and the cure for such an evil is the prize for which we labor.“ Although he contributed many aspects to fistula surgery he still emphasized that the results of the treatment were still poor at his time and that only very few advances had been achieved [40, 42].

In the very same year, 1845, the American James Marion Sims (1813-1883) performed his first surgery for transvaginal fistula repair in three black slaves. The owners lent Sims the three women for the period of treatment and they lived in a small hospital shack behind his house and office. His early techniques were obviously not to successful as 42 surgical procedures are reported on those three women over the next four years. Finally he succeeded with his special technique using silver wires for closure of the defect (**Figure 8**), published in 1852 [43], and therefore he is known to us as the founder of urinary fistula surgery. Seen from the ethical standpoint the circumstances of his early clinical research remain controversial [40, 44, 45].

Only 2 years later Gustav Simon (1824-1876) presented another milestone of fistula surgery, the so-called “*German method*“ with a double row of sutures, one of the whole thickness of the bladder and the other one of the vaginal tissue [46a]. Moreover Simon suggested the “*kolpokleisis*“ in which the vagina is completely closed below the level of the vesicovaginal fistula, a method that did not find wide acceptance (**Figure 9**) [46b].

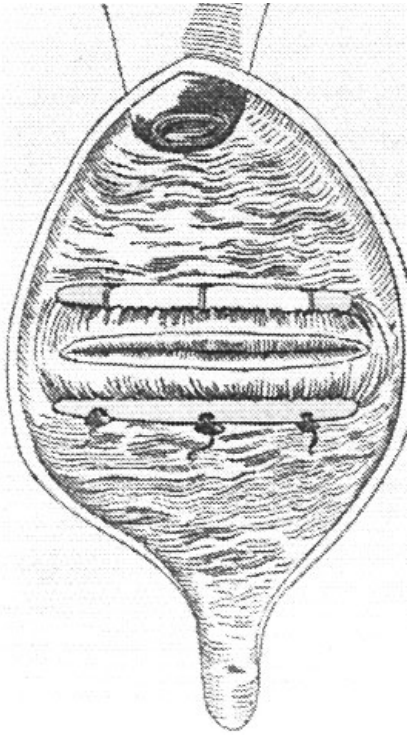


Figure 8. Transvaginal fistula repair with silver wires and clamps according to James Marion Sims (1852) [43]

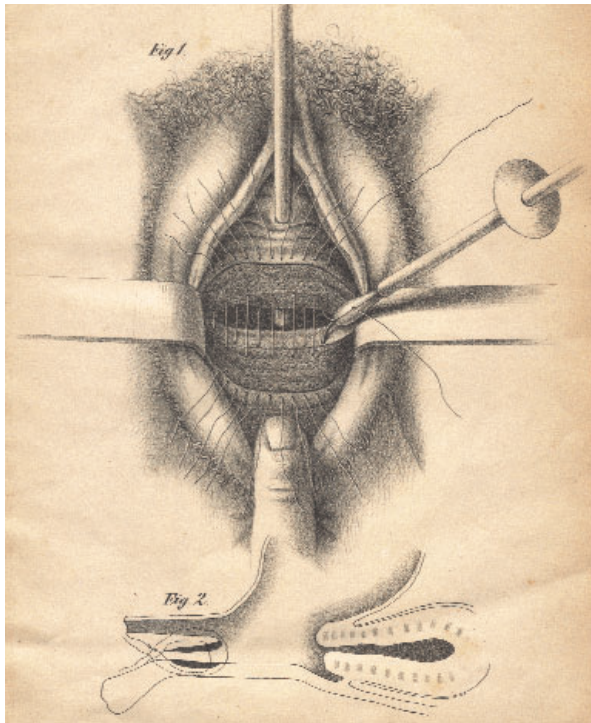


Figure 9. Complete closure of the vagina (“kolpokleisis”) below the level of the vesicovaginal fistula according to Gustav Simon (1862) [46b]

As late as 1890 Friedrich Trendelenburg (1844-1924) finally published the first transvesical approach for fistula repair. In the same paper he introduced the operating position that is still named after him in our days [47].

Today extraurethral urinary incontinence due to complications during childbirth is hardly seen in western countries any longer, but is still a major medical problem in many developing countries with low standard obstetric care [48].

VII. SURGICAL TREATMENT: STRESS URINARY INCONTINENCE

In contrast to the above outlined methods for fistula surgery the operative treatment of stress urinary incontinence developed far later and the reports mentioned before 1900 never became standard of therapy. One of these very early reports came from Frank in 1882, who was an assistant doctor of the well-known German surgeon Bernhard Bardenheuer (1839-1913) from Cologne [49]. In 1881 Frank had operated a 37 year old woman transvaginally by excising a wedge-shaped piece from the posterior urethral wall from the external orifice to a point 1 cm before the bladder neck, including the vaginal and urethral mucosa, (distance *e* to *c* on **Figure 10**). Furthermore he resected a part of the vaginal wall at the

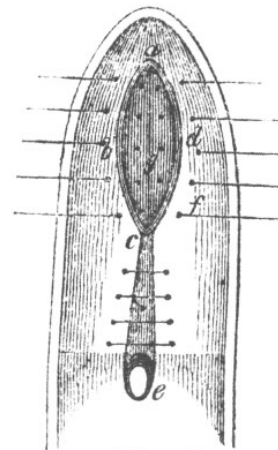


Fig. 2.

e, Harnröhrenmündung, *e c*, Keil an der hinteren Harnröhrenwand, *a b c d*, elliptische Excision der Vagina, *g*, freiliegende hintere Blasenhalswand.

Figure 10. Narrowing of the female urethra by transvaginal excision of a wedge of urethral wall (distance *e* to *c*) and plication of the vaginal wall at the bladder neck (area *a*, *b*, *c*, *d*) according to Frank (1882) [49]

level of the bladder neck (area *a*, *b*, *c*, *d* on Figure 10). The defect was then closed with transverse sutures so that the passage of a 9 French catheter was just possible. The patient was continent at the time of control 4 months later.

Similar methods were reported by F. Winckel from Munich a few years later, who had performed the operation in two sessions in 1881/1882 [50], and by B. S. Schultze in 1888 [cited in 16].

Apposition of the urethral walls by flattening of the outer end of the urethra was suggested by Karl Pawlik (1849-1914) from Vienna (later Prague) in 1883 [cited in 16, 51]. He achieved this by drawing the external orifice of the urethra forward to the clitoris and sharply to each side and fixing it in that position with sutures.

R. Gersuny from Vienna performed the first torsion of the urethra in 1888 and published this technique as an improvement of Pawlik's method one year later [51]. In each session he dissected the entire urethra beginning from the external orifice to the bladder neck and twisted it to one direction before suturing it in the new position. In his first patient he operated three times within two months making a torsion of the urethra of 180°, 90° and again 180° (total of 450°). 5 months later the patient reported a lasting success of this treatment, although micturition time was up to 4 minutes for a volume of half a litre of urine.

Comparable methods of urethral torsion and transfer of the urethral orifice towards the clitoris followed by Alfred Pousson and by Joaquin Albarran (1860-1912), both in 1892, and E. C. Dudley three years later [cited in 16].

The first surgical technique that became a routine clinical procedure was initiated by the uro-gynecologist Howard A. Kelly (1858-1943) from Baltimore in 1900. It consisted of anterior colporrhaphy and plication of the bladder neck with deep mattress sutures. In 1914 Kelly presented the first detailed analysis and follow-up of twenty patients [16], a milestone in the history of urogynecology and standard of care for the next 60 years [52].

In two male patients with postoperative incontinence after perineal urethral and prostatic surgery a combined procedure through a transvesical and perineal approach was performed by Hugh H. Young (1870-1945), also from Baltimore, in 1907 and 1916. In the first step the interior of the bladder was exposed, the mucosa of the trigone denuded and finally the bladder wall was plicated with deep sutures that were inserted with a special boomerang needle holder (**Figure 11a**). The result of this plastic operation upon the internal bladder sphincter is shown in **Figure 11b**. In the second part of the operation periurethral scar tissue was resected via a perineal incision before plicating the remaining tissue of the external urethral sphincter [53].

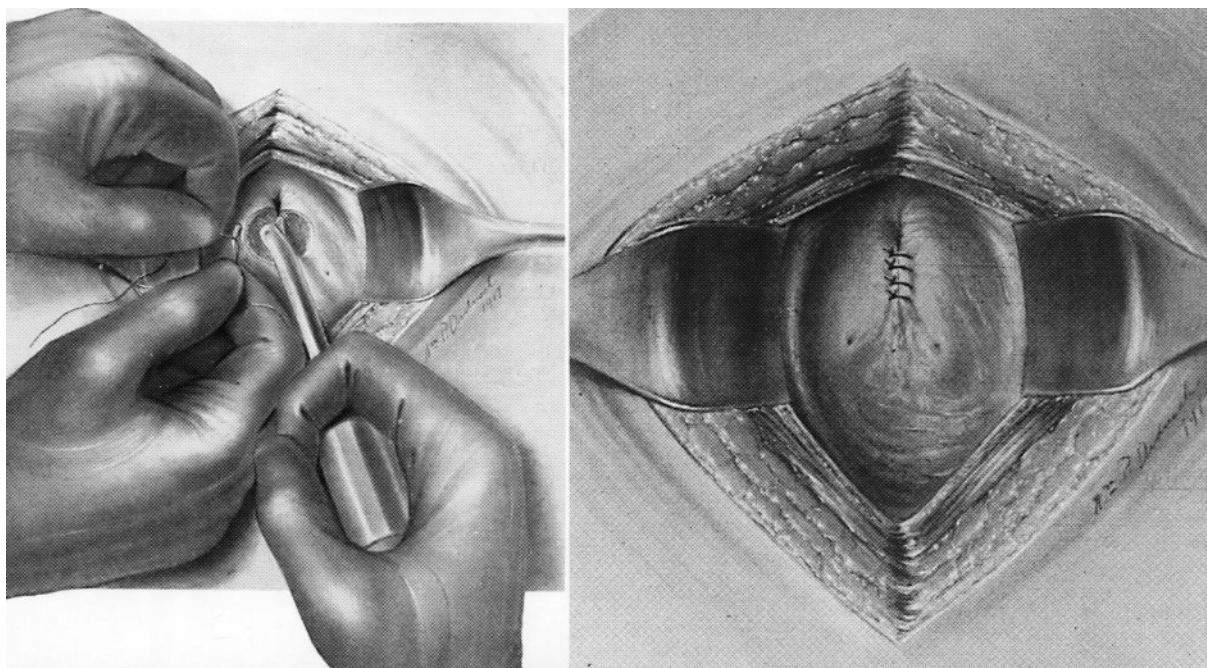


Figure 11. Transvesical approach, denudation of the trigone and deep sutures of the bladder wall (a) for plication of the internal bladder (b) in male patients with postoperative urinary incontinence according to Hugh H. Young (1907 and 1916) [53]

Another principle, that is still one of the most common procedures for female stress urinary incontinence in our days, is the use of a retropubic sling made from different materials. The first method was described by D. Giordano in 1907 by using the gracilis muscle [54]. He detached the muscle from the thigh and translocated it retropubically as a sling around the urethra.

Three years later R. Goebell performed a sling operation with the pyramidalis muscles in two girls [54]. He separated the muscles from the fascia and postulated an active muscular closure effect on the urethra. Paul Frangenheim (1876-1934) used the same muscles together with the onlying fascia in 1914 [56] and Walter Stoeckel (1871-1961) suggested the combination of this muscle-fascia sling, as shown in **Figure 12**, with a transvaginal muscular plication of the bladder neck in 1917 [57]. This procedure is known as the Goebell-Frangenheim-Stoeckel operation in clinical terminology.

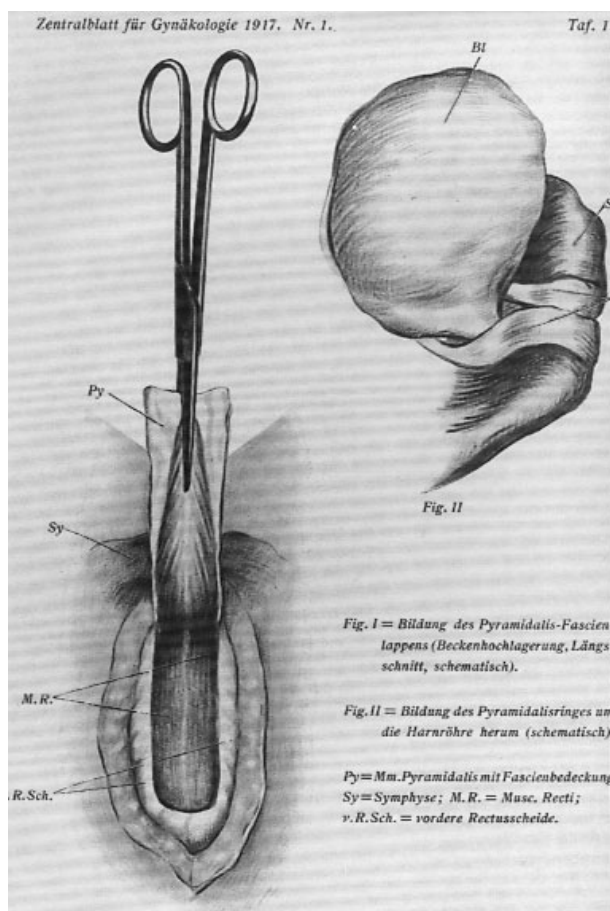


Figure 12. Retropubic pyramidalis muscle-fascia sling according to Walter Stoeckel (1917) [57]

Another modification is the pubo-vaginal sling with bilateral stripes of the rectus fascia described by Albert H. Aldridge in 1942 [58] and later by Terence Millin (1903-1980) [59]. Both of them attached the sling to the rectus muscle and, besides from the mere suspension effect, they also expected an active closure during contraction of the rectus muscles.

Several perineal procedures were suggested using muscles that are anatomically in close relation to the urethra. The first one was introduced by J. B. Squier in 1911 who took parts of the levator ani muscle [60]. In 1926 C. L. Deming again used the gracilis muscle [61] and in 1936 Oswald S. Lowsley (1894-1955) provided a method with the ischiocavernosus muscle [62]. **Figure 13** shows a modified technique of Albert Vergés-Flaqué and Oswald S. Lowsley from New York in 1951 [63].

They separated the outer parts of the anal sphincter and formed a sling around the bulbar urethra in 7 males suffering from postoperative or posttraumatic incontinence.

Cystourethropexy and colposuspension, as it is still used today in urogynecology, was introduced by V. F. Marshall, A. A. Marchetti and K. E. Krantz in 1949 [64] and J. C. Burch in 1961 [65]. As a minimal invasive procedure A. J. Pereyra inaugurated vaginal needle suspension in 1959 [66] and T. A. Stamey first introduced cystoscopic control for this type of operation in 1973 [67].

The variety of different techniques that have been developed for urinary diversion, not only in cancer surgery but also as an ultima ratio for the treatment of urinary incontinence, are not discussed in detail in this chapter. It is worth while mentioning that first attempts were already undertaken in the 19th century. As early as 1864 Baker Brown created an artificial channel under the pubic bone that allowed the permanent introduction of a catheter and D. C. Rutenberg closed the urethra and performed a vesico-abdominal fistula in 1875 for the cure of urinary incontinence [cited in 16].

Several techniques of ureter-bowel implantation were established in clinical practice before the turn of the last century in patients with bladder ectrophy, vesico-vaginal fistula or after cystectomy [see overview in 7, 28].

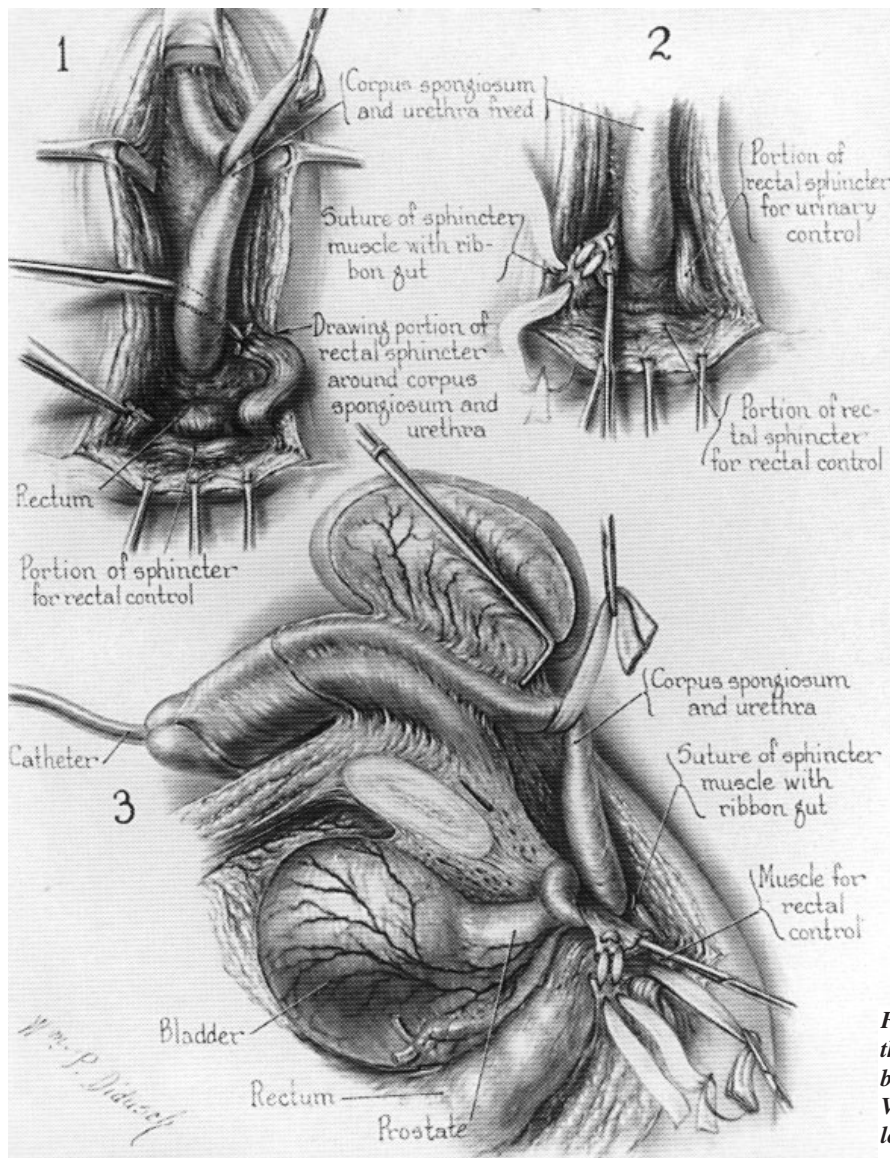


Figure 13. Drawing the outer part of the sphincter ani muscle around bulbar male urethra according to Albert Vergés-Flaqué and Oswald S. Lowsley (1951) [63]

VIII. INJECTION THERAPY

Periurethral paraffin injection for compression of the urethra and cure of urinary incontinence was first suggested at the end of the 19th century by R. Gersuny from Vienna [cited in 57]. H. A. Kelly discussed the danger of embolism after injection of these unabsorbable foreign bodies and pointed out that this treatment only showed a temporary improvement of symptoms [16]. A further report came from B. C. Murless in 1938, who injected cod liver oil (sodium morrhuate) into the anterior vaginal wall [68]. Since 1953 several authors presented endoscopic transurethral injection with sclerosing agents, mostly containing paraffin, like Dondren® [see overview in 69].

The intraurethral injection of polytetrafluoroethylene

(Teflon) was first described in 1973 by Victor A. Politano [70] and Solomon Berg [71]. In 1989 the use of collagen by Linda M. Shortliffe [72] and the injection of autologous adipose tissue by A. S. Gonzalez de Gariby followed [73]. Silicone was not used before the 1990's.

IX. ALLOPLASTIC SPHINCTER

The oldest device for external compression of the male urethra is the penile clamp [15]. It was brought into use again by J. H. Cunningham as an helpful instrument for performing retrograde urethrography, a radiographic method that was introduced by him into urology in 1910, and is still named after Cunningham today [74].

The first artificial sphincter that was designed as an inflatable circular cuff and applied to the male urethra by surgical means was created by Frederic E. B. Foley (1891-1966) from St. Paul, Minnesota and published in 1947 [75]. This ingenious urologist is best known for the improvement of the principles of the transurethral balloon catheter and played a major role in the introduction of commercially manufactured balloon catheters in the 1930's [2]. **Figure 14a** shows the operative steps of dissecting the corpus spongiosum from the corpora cavernosa and closure of the skin around these two separated structures. After wound healing the external cuff of the urinary sphincter ("pneumatic clamp") was put around the urethra, that was now completely covered with skin, and inflated or deflated manually via a pneumatic piston (**Figure 14b**).

It was not before the 1960's that first operations with completely implantable devices were undertaken

[see overview in 76]. In 1961 J. L. Berry provided perineal acrylic implants producing a permanent compression on the bulbar urethra [77]. The silicone-gel-prosthesis of Joseph J. Kaufman from 1973 was based on the same concept [78]. M. Rosen from Australia developed an inflatable urethral compression prosthesis in 1976 [79] and Udo Jonas in 1983 an internal penile clamp, that was implanted at the penoscrotal angle and opened for micturition by external pressure through the skin from both sides [80].

In June 1972 F. Brantley Scott, together with William E. Bradley and Gerald W. Timm, implanted the prototype of the so-called. „Scott-sphincter“ in a 45 year old woman [81]. Finally, 25 years after Foley's publication, the idea of an inflatable cuff for the treatment of stress urinary incontinence had been adopted again and became a standard clinical procedure.

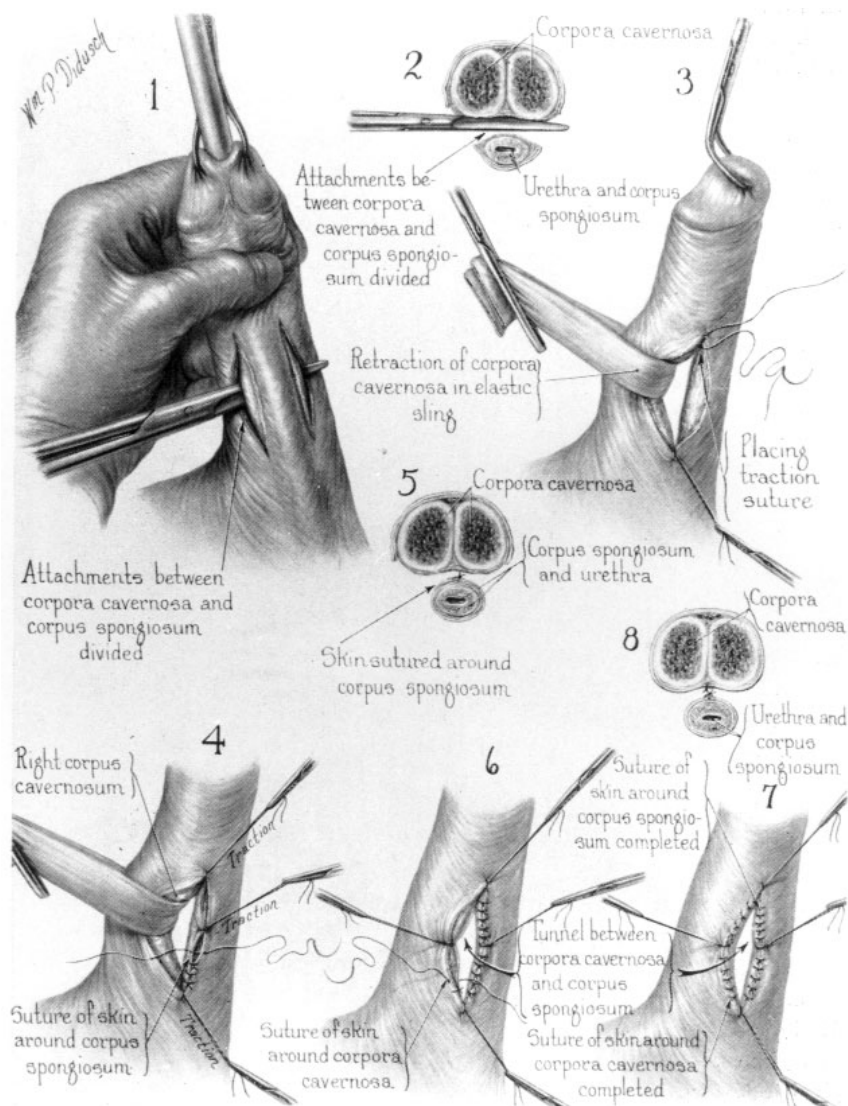


Figure 14 a. In- or deflation of a cuff via pneumatic piston. *Surgical dissection of the corpus spongiosum*

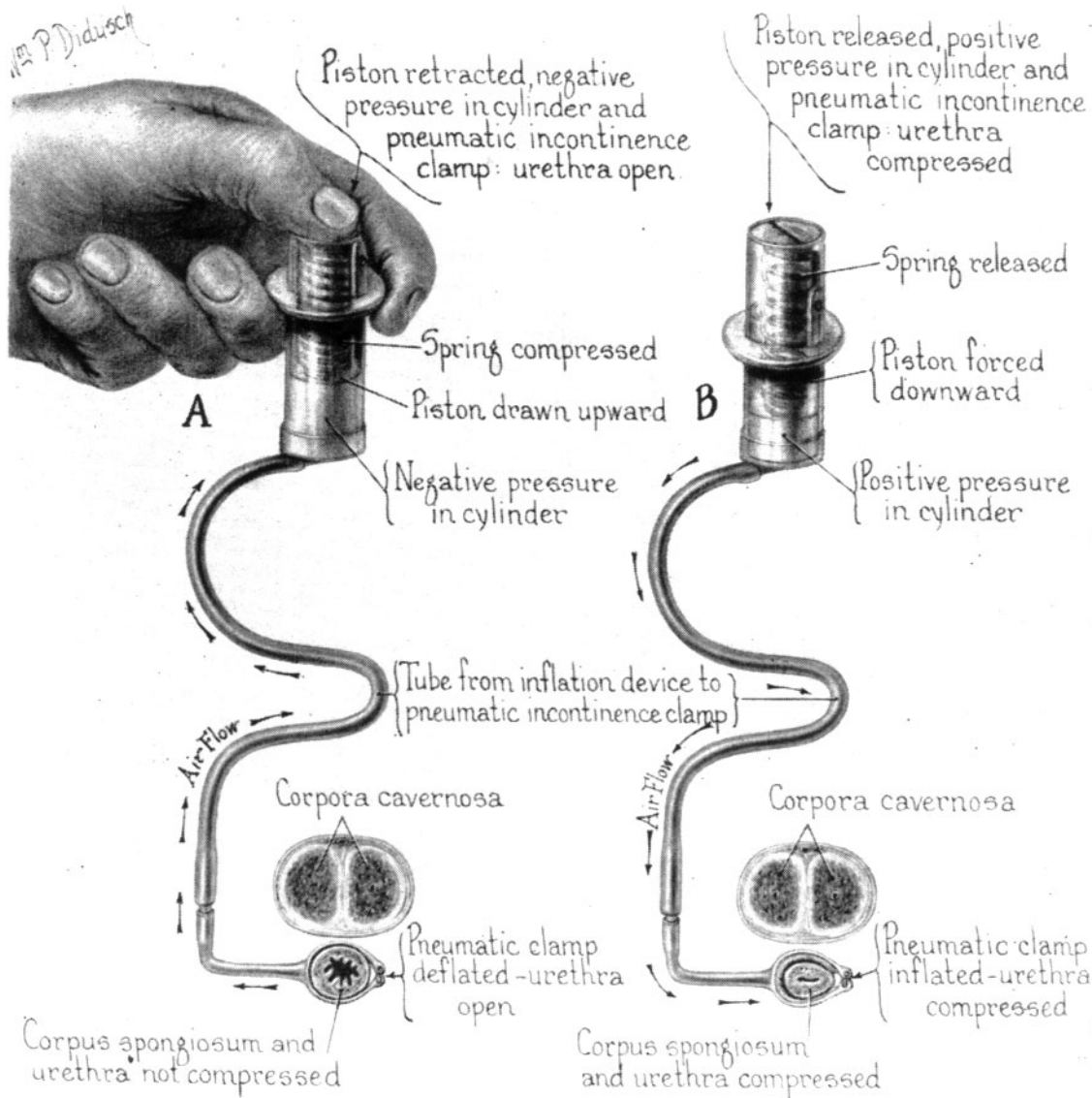


Figure 14 b. In- or deflation of a cuff via pneumatic piston. According to Frederic E. B. Foley (1947) [75]

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