TRANSURETHRAL TREATMENT OF BLADDER NECK OBSTRUCTIONS:
Endoscopic Prostatic Resection
Part II

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INTRODUCTION

This is Part II of a reprint, with minor revisions, of a chapter written half a century ago by Dr. Robert Gutierrez for the 1933 History of Urology *sponsored by the American Urological Association and now considered a collector's item. The references have been deleted from this revision but may be found in the original edition.*

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TRANSURETHRAL TREATMENT OF BLADDER NECK OBSTRUCTIONS: Endoscopic Prostatic Resection* Part II

ROBERT GUTIERREZ, M.D.

In 1918 Braasch, in an endeavor to overcome the disadvantages of the Young instrument with its inadequate vision, modified his direct cystoscope so that it could be used as a punch, thereby permitting the operation to be carried out with full vision. The modified instrument, like the original Young punch, had a window in the lower wall of the direct cystoscope close to the distal end; but this end was now left open, and with the lamp retained, the operator could visualize the entire operative field both before and after engagement of the tissue to be excised. He could not only see the tissue to be excised, but also determine its relationship to adjacent structures. Removal of multiple portions of the obstructing bar was facilitated by dilatation of the urethra and bladder with water, which also served to keep the bleeding field free from clots, an annoying complication that occurs when any other type of instrument is employed. But neither this nor Young's instrument made any provision for hemostasis, a handicap that makes it impossible to remove with safety any large amount of tissue. Nevertheless, Braasch's instrument made it possible to avoid such accidents as cutting into the bladder wall or the trigone, or going too deeply into the floor of the urethra.

In 1911 Young had had Loewenstein in Berlin construct for him a punch in which the inner cutting tubular knife of the 1909 model was replaced by a tubular cautery to excise the bar by means of entrapment in the fenestra of the punch (Figure 4, Part I). The outer portion was constructed of two tubes, an outer and an inner, between which a stream of water served to keep the instrument cool. The cautery was controlled by a rack and pinion at the outer end.

Apparently this cautery never became popular because it remained for Caulk in 1920 to develop a cautery punch whose practicability and efficiency, as demonstrated in the hands of its sponsor, made a widespread impression. Caulk at first stated that, except in a limited number of cases, his cautery punch instrument should be confined to cases of contracture of the vesical outlet, and that it was certainly not suitable for use in cases of hypertrophy of the prostate. Subsequently, however, he gradually increased the scope of the instrument until he came to regard almost no prostatic enlargement as outside its sphere of usefulness. His cautery punch, constructed by Phillips of St. Louis, consisted of an outer sheath containing a slot by which the obstruction could be grasped, and an inner sheath, which had at its terminus an iridoplatinum blade instead of a knife, so that the obstruction could be effectively removed while also reducing hemorrhage and absorption. This blade was about 1/4 inch wide and of substantial thickness. The blade was insulated from the main sheath of the instrument by mica plates. At the proximal end of the tube, the current entered through a large contact point with a screw attachment, one pole connected

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with the tube itself, the other with a large copper bar brazed to the surface of the tube and insulated with silk and mica.

In order to burn tissue properly and prevent hemorrhage, the procedure must be done slowly under low heat. To do this, enough heat must be produced in the blade to burn the tissue without heating the shaft of the instrument. For this reason the conductors were made large and of uniform caliber throughout so as to offer minimum resistance to the current, which was thus brought directly to the cautery blade, the only point of increased resistance. In this way intense heat could be maintained for a sufficient period of time without heating the instrument. The inner sheath served as a handle for the instrument. Caulk found that the burning was best done by a slow rotary motion, easily regulated by using the handle as a lever. He used no irrigating attachment, since no dilatation of the orifice was needed, and there is much less danger of short circuiting in a dry field. In order to provide adequate anesthesia, a special form of syringe that attaches to the tube of the instrument was designed, by means of which it was a simple matter to infiltrate the vesical orifice under vision (Figure 7).

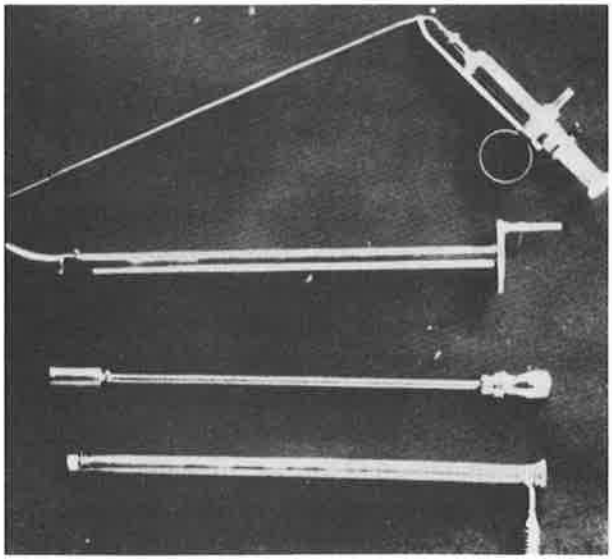

Figure 7. Caulk's cautery punch. Below, two sheaths and obturator; above, the infiltration syringe for local anesthesia.

Keyes regarded the Caulk instrument as fragile and remarked that it "has been known to unwind its cautery blade and perform unpleasant urethrotomies as this blade was being extracted."

Of Caulk's instrument Bumpus said, nearly nine years after its invention:

> "If patent rights would permit the combining of this instrument and Young's punch, I believe an absolutely bloodless operation under adequate vision would be possible, and sufficient tissue could be removed to insure satisfactory results."

While it is true that Caulk's cautery punch does, when properly used, prevent immediate postoperative bleeding, the same cannot be said with regard to late hemorrhage when the slough comes away one or two weeks after the operation. Occasionally there is a case with considerable bleeding at that time, although this is likely to be more spectacular than dangerous. More important among objections to the method is the rather high incidence of secondary infection. Bumpus and Vickery, who tried the method in 81 consecutive cases, observed febrile reactions in 26 cases lasting four days or longer; in all but 7, fever began on the day of the operation.

In 1930 Caulk reported that during the decade in which he had used his method, he had gradually applied it to an ever increasing number of obstructive lesions of the prostate. Larger obstructions to which he had originally believed it to be inapplicable had surprised him by the readiness with which they could be removed. He wrote as follows:

> "In the beginning, this operation was applied to 14 per cent of bars and contractures only. A few years later it was being used in 30 per cent of obstructions; two years ago, 40 per cent; from 1927 to 1928 in 70 per cent, and during the last year in 85 per cent of all obstructions resulting from enlargements of this gland. . . . In all there have been 510 operations by this method with not a single death directly attributable to the

operation. . . . If the prostatic enlargements are graded on a scale of 1,2,3 and 4, I should say that those with grades 1, 2 and 3 can always be cured by this type of surgery, and about 40 per cent of grade 4."

In 1931 Caulk had brought this number of bladder neck operations up to a total of 647, the last 137 operations having been done on 87 patients. In 1932 the total number had reached 781, as reported at the meeting of the American Medical Association in New Orleans. He stated that an analysis of all types of cases had shown that about 85 percent had been cured or practically so by means of the punch, and that the results had been durable and recurrences few.

Another modification of the Young punch was presented by Geraghty in 1922; it was designed to treat certain types of contracture by sphincterotomy, and accordingly was known as the sphincterotome. Throughout the discussion that followed, stress was laid on the frequency of hemorrhage following use of this treatment, but it was claimed that this could be obviated by the addition of the galvanocautery feature of the newer Caulk technique. In this sphincterotome, Geraghty replaced the inner tube, with cutting edges, of Young's apparatus by a wedge-shaped scoop, which fits closely into the endoscope tube No. 28 F. He used no illumination in the tube, which differed from Young's in that the bladder was filled and the endoscopic tube introduced as far as the bladder cavity; the obturator was left in, and the instrument withdrawn to the point where the water in the tube ceased to come out, indicating that the sphincter was engaged in the window of the tube; the scoop was then introduced and the fibrous ring cut.

In 1923 Maloney developed a "safe and accurate method of removing small obstructions at the vesical orifice under direct vision with the high frequency electrode"; this method of transurethral excision by electrocautery was aided by use of a cystoscope introduced through a suprapubic opening for visual control. This method of electrocoagulation has also been employed by Serrallach of Barcelona and Maraini of Buenos Aires.

Early in 1925 Kenneth M. Walker of London, finding serious electrical difficulties in attempting to use Caulk's instrument in that city, discarded it in favor of an instrument of his own which he called the diathermy punch, and he gave full credit to Mr. Schranz of the Genito-Urinary Manufacturing Company for the ingenuity of its design. In external form it resembled the Young punch, but the sheath was constructed of Bakelite, for purposes of insulation, with a metallic lining. This was the first recorded instance of the use of Bakelite as an insulator in a urethral instrument (Figure 8). The metallic lining came to the surface only at the edge of the window situated below the

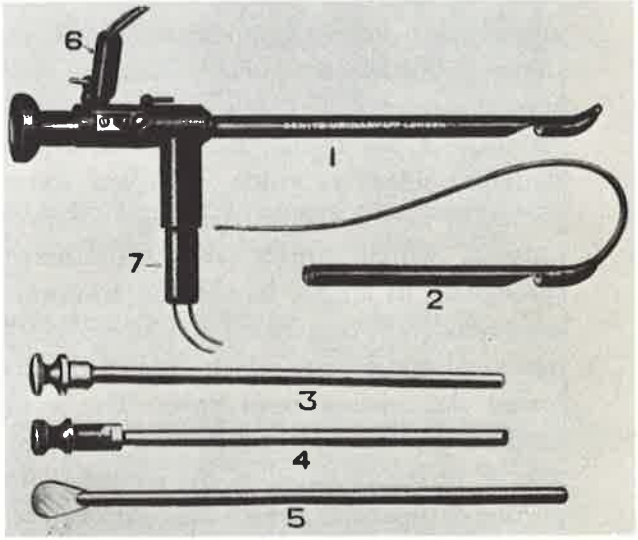

Figure 8. Kenneth Walker's diathermy punch.
1. The punch with its insulating cover of Bakelite.
2. Bougie attached to extremity of same, to act as a guide.
3. Obturator.
4. Inner tube for punching out coagulated tissue.
5. Obturator for removing coagulated tissue from the punch.
6. Current for light.
7. Attachment for the diathermy current.

beak; elsewhere the instrument was insulated from the urethra by the Bakelite covering. It carried a removable system consisting of a telescope, lamp and inlet and outlet tubes for irrigation, which was substituted for the obturator and after the instrument was in position, thus converting the latter into a posterior urethroscope of the Geiringer type. As soon as the current was turned on, the inner metallic layer of the sheath became a urethral electrode, but owing to the insulation conferred by the Bakelite covering, the only point of contact with the urethra was the edge of the window engaging the bar. From this edge it was possible to watch the spread of a line of coagulation which within 10 to 15 seconds whitened the entire area of prostate engaged. The whole procedure was done under ocular control, with all possibility of hemorrhage avoided by the use of diathermy.

In the same year (1925) Rose of St. Louis attempted to prevent hemorrhage by cauterization with a visual instrument, by means of which several punches from the prostatic orifice could be made at one sitting, all under direct, and therefore selective, vision. This was accomplished by having a large, oval, single sheath for cutting, which could carry illumination throughout its length. In addition, hemostasis was provided by cauterizing with an electrically heated platinum plate which immediately followed the cutting steel knife. The knife, cauterizing plate and its conduction wire were a part of, or incorporated in, the narrow sliding portion of the sheath, which was controlled by a thumb ring fastened to an ebony asbestos and steel plate, placed at right angles to the shaft. The ease of cutting with a sharp blade rendered unnecessary any pressure except thumb pressure, which was applied at a point well out of the line of vision. The first cylinders of prostatic tissue were removed with long forceps or pushed up into the hollow tip with a long wooden applicator. A 110 V alternating current was used for heating the cautery.

In 1926 Marion reported that he was using what was practically Paré's instrument for removing the diaphragm that is occasionally left after prostatectomy. The diaphragm results from the fact that at the time of operation the vesical wall covering the adenoma has not been sectioned behind the latter but on its summit. The result is the presence of a floating flap, or tag of tissue, which, according to its size, may become either a simple spur or a diaphragm capable of causing a partition separating the site of the prostate almost completely from the bladder and resulting at length in false diverticula with dysuria, retention and other symptoms. Under such circumstances it is impossible to get the sound into the bladder. The instrument used by Marion is a cutting béniqué with movable blades that are hidden below in the body of the sound. At will one can make them come out at the tip by a rotary movement of the screw wheel on the outside of the instrument. The sound is introduced behind a bougie; once in, the cutting blade is flashed out and the instrument withdrawn, severing the diaphragm on its way out.

An entirely new aspect was put on the subject of transurethral prostatic resection in 1926, when Maximilian Stern presented his new "resectoscope" before the Genito-Urinary Section of the New York Academy of Medicine in January of that year. Said Stern:

> "It has become possible to reduce the problem to a mere cystoscopic procedure by the evolution of a cutting current capable of operating in a water medium and a cystoscopic instrument for its application. This instrument is provided with a small movable ring or loop of tungsten wire, which, when actuated by a suitable current, is capable of removing longitudinal spaghetti-like sections of tissue. The former of these instruments I have named the *resectotherm* and the latter, the *resectoscope.* The resectoscope is essentially a cystoscopic instrument provided with two lens systems or telescopes. One is of indirect vision for examination and diagnosis, before operating; the other, of direct vision type, to be employed while operating, in order that a perspective view may be obtained of the entire prostatic urethra during operation."

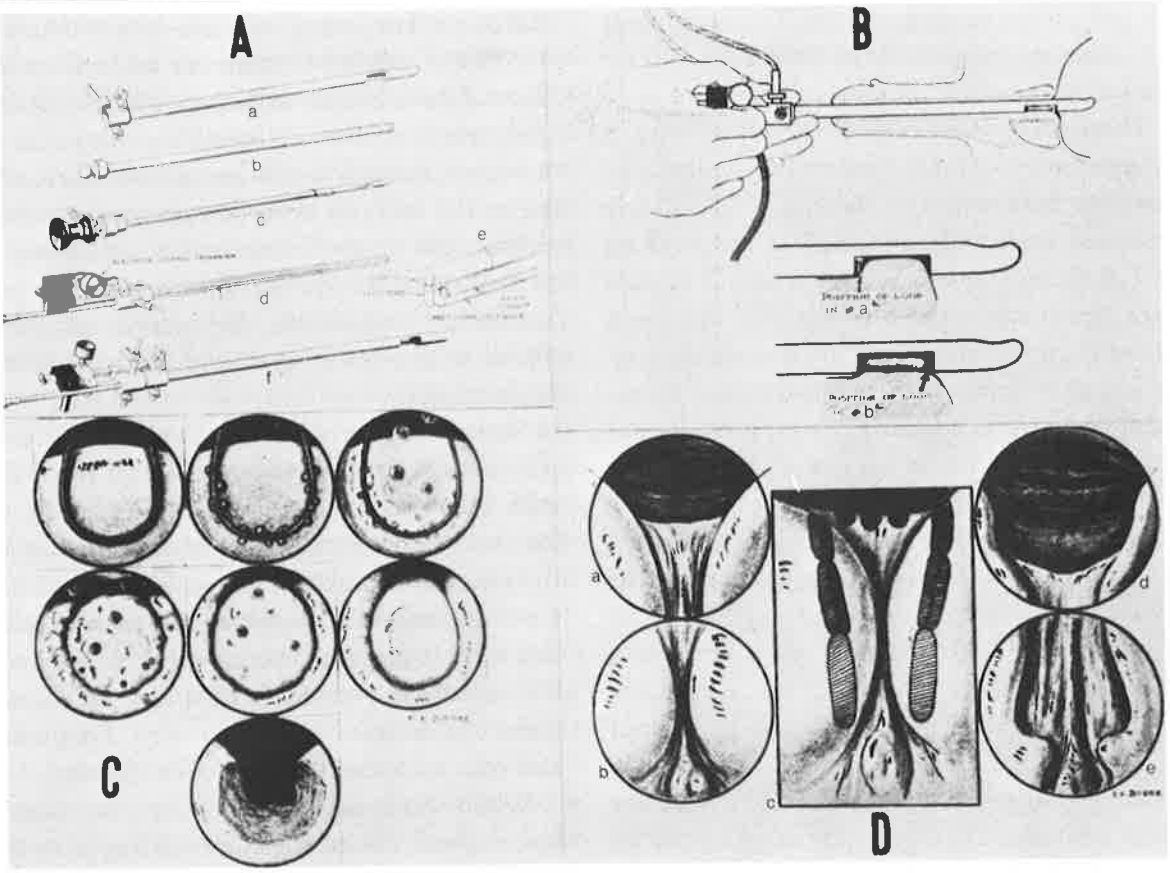

Figure 9. Maximilian Stern's resectoscope.
A. (a) sheath; (b) obturator; (c) examining telescope; (d) movable parts consisting of direct-vision cystoscope, water conduit, light carrier and electrode or cutting loop; (e) enlargement of movable parts; (f) instrument assembled, loop seen in fenestra.

B. Instrument in urethra. (a') hypertrophic prostatic tissue engaged in fenestra; (b') the electrode or cutting loop has passed through the obstructing tissue. Note that the loop cuts from without in, and that the scallop is completely severed from its base.

C. Cutting loop electrode seen at work through the direct vision telescope in various stages of the operation. Notice the resulting tunnel or gutter formation along the prostatic urethra.

D. Steps in endoscopic prostatic resection. (a) cystoscopic view of the vesical orifice, illustrating a trilobar prostatic hypertrophy; (b) the verumontanum with lateral lobes encroaching into the lumen of the urethra; (c) diagrammatic drawing indicating the lines where the lateral and the middle lobes are cut; (d) and (e) vesical and urethral views, showing the tunneling or remodeling of the encroaching lateral and median lobes.

Stern's instrument is about 2 inches longer than the ordinary cystoscopes for application in advanced prostatism and is made in size 27F. It comprises a sheath with its obturator and examining telescope, in addition to the working parts, which are assembled in the compact bundle made up of a direct vision telescope, a light carrier, a water conduit, and a cutting loop or active electrode (Figure 9). The latter is the actual operating element of the instrument.

The sheath carries a receptacle for the indifferent pole of the cutting current. The instrument is thus bipolar, no plate or pad being used under the buttocks as the indifferent pole.

The cutting loop consists of a small ring of tungsten wire about 0.5 cm or less in diameter placed at right angles on the end of a peculiarly insulated shaft and connected at the working end of the instrument in such a way as to slide back and forth in the fenestra. For this Stern found it convenient to employ a manually controlled gear mechanism to ensure even movement and perfect control. The tungsten loop is situated just in front of the eye of the telescope and can be seen resting against the protruding tissue in the fenestra just before its backward thrust begins, and it is visible throughout its entire excursion to the distal end of the fenestra. The "resectotherm" is an apparatus that delivers a radio frequency current of low voltage and is peculiar in that it can be delivered in a continuous flow through the cutting loop under water by virtue of the fact that it does not arc or jump across a gap, thus making it possible to employ a bipolar instrument.

There is no tendency to sparking, and hence all fulguration effects resulting in slough and secondary hemorrhage are eliminated.

Stern believed the mechanism of the current's action is due to molecular disintegration or eruption of cells, as evidenced by the fact that when the current is turned on its action is observed in approximately five seconds by the formation of a luminous ring or halo which causes the eruption of cells in its path as the loop is advanced, leaving no carbonized tissue either on the loop or on the cut surface of the gutter it leaves in the tissues.

With the instrument in place, the current is turned on either with a foot switch or by an assistant. When the halo and the bubbling appear, the loop is advanced until it has traversed the entire length of the fenestra (3/4 inch) through the tissue contained therein, leaving a clean-cut gutter showing only a slight discoloration upon its surface. When the bars and contractures are being removed, a sufficient number of parallel sections are taken from the floor of the sphincter to remove the obstruction completely in its entire breadth at this point. If, however, there is much lateral lobe encroachment, the sections must be removed in a continuous line as the instrument is withdrawn. A certain speed is required, since too slow action causes an undesirable desiccation of tissue which might result in slough and secondary hemorrhage.

Stern's report was based on 46 patients whom he had operated upon, all of them old men, with no selection made of cases. In no instance was there bleeding of any importance or other unfavorable reaction, and the clinical results exceeded all expectations, even in cases that were regarded as frankly surgical. A second treatment was needed in only four cases, and there was no need at all for a third. Frequency and residual urine receded coincidently.

When Stern made his report, only six months had elapsed, but he considered it logical to believe that the results were permanent, since he felt there was a tendency for inflammatory prostatic tissue to shrink after partial resection.

Although Stern stated that he encountered no hemorrhage of any importance, this was not the experience of other workers who used this unmodified method. Of Stern's instrument, D.M. Davis of Arizona said that it functioned very successfully so far as the cutting edge was concerned, but he soon found that the cutting current produced such a shallow coagulation that hemorrhage occurred almost as freely as if he had used a knife. Bumpus wrote that while the instrument reduced the bleeding appreciably at the time of excision, it did not seal the larger arterioles until T.M. Davis of North Carolina, as we shall see later, modified it sometime afterward.

Meantime, Bumpus (1926) had made important modifications in Braasch's instrument which, since it did not provide for hemostasis,

could remove only a limited amount of tissue. To overcome this disadvantage, he controlled the bleeding by coagulating the incised area with a Bugbee electrode used through a direct cystoscope. Johnson, a Fellow of the Mayo Foundation, helped him devise a guide for the electrode so that it could be used without removing the instrument. Bumpus also followed up an idea of Hinman's of San Francisco that had been used in 1917 but never formally published, in which a cystoscope was inserted after the punch operation had been completed, and the bleeding points observed and arrested individually by electrocoagulation with a flexible electrode. Tyvand, also a Fellow at the Mayo Foundation, adapting a device previously employed by Day and Kirwin, constructed for Bumpus a multiple needle electrode for rendering the obstructing tissue ischemic prior to its excision. Accordingly, the completed instrument employed by Bumpus consists of a direct cystoscope with an opening cut in its wall to engage the obstructing tissue after it has been located cystoscopically through the end of the instrument (Figure 10). As soon as the tissue is firmly engaged, an electrode fitted with multiple needle points is thrust into its base and the tissue rendered ischemic by applying a high frequency current along the path of incision. These needles are placed in such a way that they form a semicircle at precisely the place where the tubular knife, which must be very sharp, is to cut. Care should be taken not to coagulate completely the tissue to be removed, but only to mark out by coagulation the course the knife is designed to follow. The needles are removed, the knife cuts and the excised tissue passing through its lumen is removed. The procedure is repeated until a sufficient amount of tissue has been removed to overcome the obstruction. Bleeding points should be taken care of between every two thrusts of the knife. The electrocoagulation should not be too deep since this would produce sloughs that could induce hemorrhage when they come off. Bum-

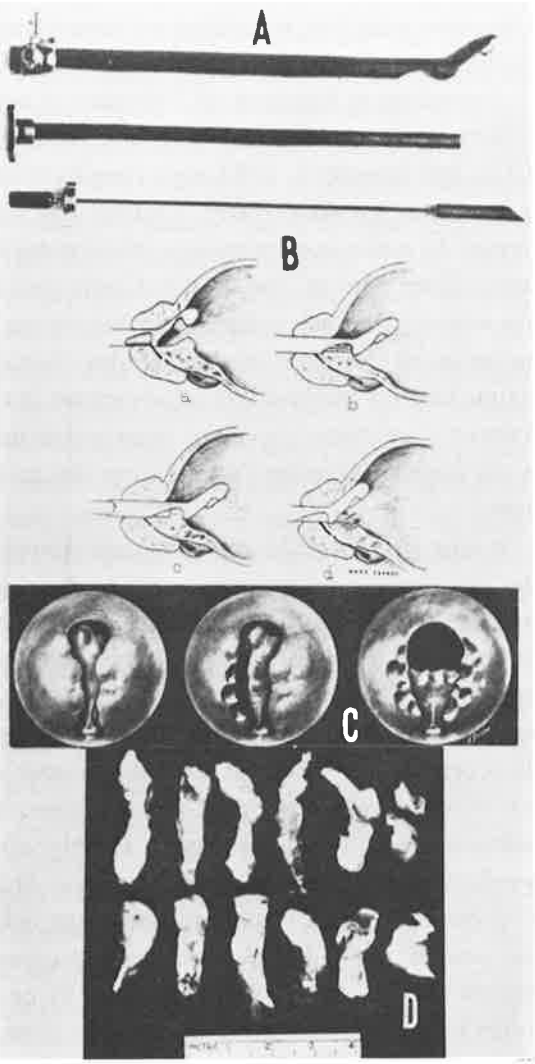

Figure 10. Bumpus's instrument for punch prostatectomy.

A. Modification by Bumpus of the Braasch cystoscope, with tubular knife and obturator.

B. Four steps in transurethral prostatic resection: (a) direct observation of bladder neck to detect the type of prostatic obstruction; (b) instrument engaged and needle electrode in position; (c) tubular knife excising tissue; (d) flexible electrode coagulating individual bleeders after the resection.

C. Prostatic urethra before, during and after resection.

D. Size of tissue pieces and the total amount removed at the time of resection.

pus completes the operation at one sitting whenever possible, regarding prostatectomy as preferable to multiple resections.

According to Bumpus, of 250 cases in which resection was performed between January 1, 1925, and January 1, 1932, only nine required a subsequent prostatectomy. During the same period 30 patients on whom prostatectomy had been done (18 at the Mayo Clinic and 12 elsewhere) needed subsequent resections or incisions of the neck of the bladder. Bumpus claims that his method has an advantage in that if there is a recurrence of the obstruction there is no contraindication to repeating the procedure.

It was also in 1926 that Collings described the first cutting current apparatus in this country, the so-called radiotherm that Wappler had devised for him in 1923. This was a tube machine similar in principle to a radio receiving set. Collings found, however, that in his hands this current would not cut efficiently under water. Accordingly, the spark-gap machine, the "electrotome," was developed shortly afterward, cutting equally well in water and in air. The current in this improved apparatus is like the one in the old high frequency machines, except that the oscillations must be 14 or 15 times faster. This stepping-up process changes the entire character of the current so that the cutting is done without coagulating the tissues; since a minimum of heat is produced beyond the line of incision, tissue destruction does not extend more than 1 or 2 mm beyond the cut. Up to 1929 the electric excision was done with a stiff knife-like electrode through the McCarthy panendoscope. At the suggestion of Collings and Keyes, Wappler modified the foreoblique lens system to give a larger field of vision. Along the top of the telescope was placed Collings's continuous irrigation modification of the McCarthy panendoscope, which steadied the electrode and simplified the operation. After passing the cystourethroscope into the bladder, with that organ partially distended and the flow of water in and out properly regulated, the electrode is engaged upon the middle of the bar to be removed at the "6 o'clock" point. As the current is turned on, violent bubbling appears, the protein molecules being exploded by the jostling of the high frequency oscillations. Upon drawing back the urethroscope and the electrode as a unit, a white furrow is observed about 2 mm in width. This furrow or groove is gradually widened and deepened as the electrode is pushed backward and forward from the verumontanum to the apex of the trigone, literally "whittling away" the bar (Figure 11) until the last obstructing fibrous band has been sawed in two and a clear view can be had through a valley extending from the verumontanum to the trigone, the entire procedure requiring in Collings's hands about 20 minutes.

According to Collings, all except one patient who were operated on from 1923 to 1926 have remained well up to the present time. Of the 28 operated on from 1926 to 1929, one died in 1929 from carcinoma of the prostate and one required a second operation because the first cut was inadequate. Collings regards a proper selection of patients for this type of operation as all important; he specifies the following indications: (a) fibrous prostatic bar, (b) obstructing scar following prostatectomy, and (c) at times, carcinomatous bar from prostatic carcinoma. The advantages he claims for his method are that the operation is performed bloodlessly under constant vision, an elderly patient is not subjected to the grave risk of a major operation and the patient is confined to the hospital only a few days.

Shortly after the invention and introduction of the resectoscope by Stern, Theodore M. Davis of North Carolina began to use the instrument; although he found both the instrument and the technique vastly superior to all methods that had preceded it, he was aware of gaps in its efficiency. He had the same experience as Bumpus and D.M. Davis, of Arizona, that it lacked adequate provision for controlling

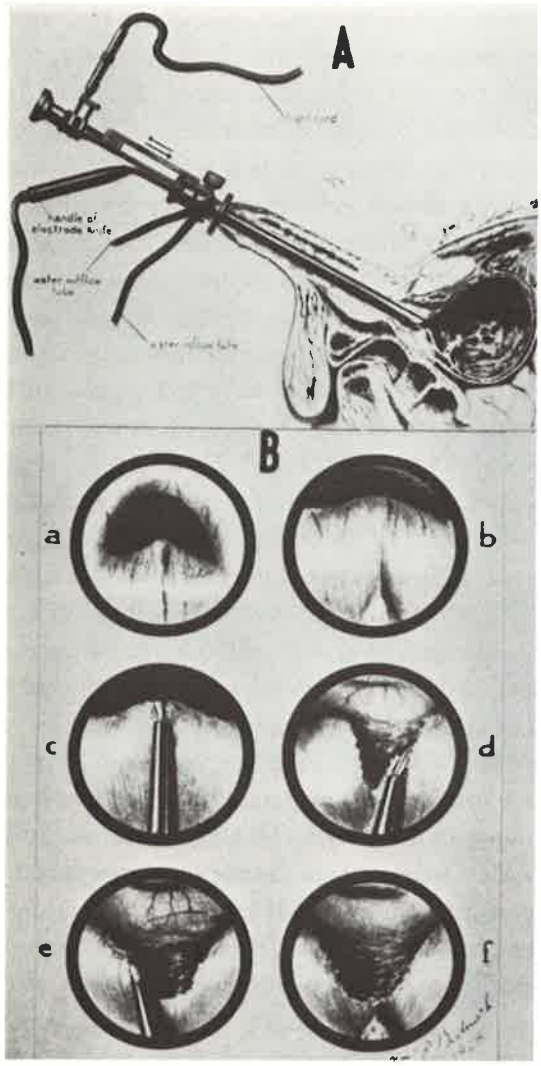

Figure 11. Collings's electrotome.
A. Instrument in place with the long insulated electrode engaged in the hypertrophied tissue at bladder neck.

B. Diagram of steps in the technique of excising the bladder neck obstruction with Collings's knife electrode: (a) and (b) cystoscopic view of median bar at the bladder neck; (c) electrode cutting at "6 o'clock"; (d) cutting at "5 o'clock"; (e) cutting at "7 o'clock"; (f) the completed tunnel resulting from prostatic bar resection.

hemorrhage. Davis, being an expert in electrical devices, was able to improve the original Stern instrument and to design special methods and instruments for hemostasis so that his operative procedure is now claimed to permit the correction of all types of prostatic obstruction with an accuracy that is seldom surpassed by the most skillful surgeon doing prostatectomy. For success with the Davis method, accuracy of diagnosis is of paramount importance. The operator must have a thorough familiarity with the vesical orifice, must be able to determine the precise tissue that is responsible for the obstruction and then be capable of adapting the form of procedure to the individual case. Only by a complete cystourethroscopic examination, with full visualization of the conditions present, can the true nature of the lesion be recognized.

Davis's equipment consists of a generating machine for producing the cutting current, a diathermy machine for obtaining a bipolar current to control hemorrhage and the resectoscope itself.

This comprises a sheath of 27 or 30 F. caliber with a window 5/8 or 7/8 of an inch near the beak, an obturator to close it during introduction, a telescope and the working parts, which are those of Stern's instrument somewhat modified. The original loops of the loop electrode supplied with the resectoscope were fragile and suffered destruction under a strong heat-producing current. Davis improved the loops by making them of larger tungsten wire with a diameter nearly twice that of the original ones, and employed a small piece of silver tubing to connect the loop with the conducting wire within the shaft, the tubing being so bent that when it is pushed into the quartz tube of the shaft the loop is held rigid by the spring tension of the tubing. Shellac, which in the original instrument held the loop wire within the quartz tube, is used in the new instrument only to seal the end of the quartz tube to prevent loss of current into the bladder fluid. The

improved loop can bear any of the heat-producing currents without the slightest deterioration. Some of these have made in Davis's hand 700 to 1000 sections, with enough diathermy current to control successfully the hemorrhage incident to this number of sections. This change in the loop made it possible to improve the operative technique, since a more powerful cutting current could be employed, sufficient to coagulate slightly and to control most of the hemorrhage in the course of the cutting. Should much bleeding occur, Davis makes use of a foot switch which automatically changes from the cutting to the diathermy current on the loop, using about 600 mamp, which immediately controls the hemorrhage. A second foot switch restores the current from the cutting generator at will. This change is accomplished by means of an electromagnetic triple contact, double action, automatic switch with an interlocking device that prevents both poles of the switch from being in contact at the same time.

With median lobes and contracture of the bladder neck, a sufficient number of parallel sections should be removed from the floor of the sphincter, says Davis, to obviate the obstruction completely, giving a clear view from the verumontanum to the trigone. With enlarged lateral lobes, numerous sections are removed from each lobe, beginning at the vesical aspect. At the close of the operation the operative field is free from the slightest trace of hemorrhage.

It is the belief of Davis that resection is the method of choice not only in bars and contractures, but also in the large hypertrophies where one or more resections are required, and that in inoperable carcinoma relief by resection is to be recommended over permanent suprapubic drainage.

Inspired by the success that followed Davis's work, McCarthy of New York modified his panendoscope, with the cooperation of Wappler, and introduced an instrument that could obtain results exactly the same as those of Davis. The chief difference between the two procedures is that with the Davis instrument the cutting is done toward the bladder, while with the McCarthy instrument one cuts from within the bladder outward. McCarthy incorporated in his apparatus the Bakelite nonconducting sheath already used by Kenneth M. Walker in London which, with the panendoscopic visual system of its originator, provides a highly efficient method of transurethral prostatic surgery (Figure 12). The new loop devised for use in the panendoscope depends on the current furnished by the newly invented McCarthy surgical unit. According to Purcell of Arizona, this unit with its so-called undamped wave cuts very easily but does not give as good hemostasis as the damped wave of diathermy. McCarthy stops bleeding with a foot switch, not by substituting a diathermic for a cutting current, as does Davis, but by merely reducing the strength of the cutting current.

The McCarthy resectoscope and loop can take longer bites and more pieces in a shorter time than the punch. The apparatus, according to McCarthy, meets the ideal requirements by providing: (a) the most precise visualization of the prostatic urethra; (b) the greatest possible flexibility of manipulation under vision of the cutting loop; (c) ample electrical power to exicse the obstructing prostate under water with a coincidental minimum of hemorrhage and of tissue coagulation; (d) interchangeability and ease of manipulating electrodes in the closure of bleeding points; (e) completion of the operation, including the introduction of a No. 24 F. whistletip indwelling catheter, with but one introduction of the instrument, the sheath being withdrawn after the catheter has passed through it; and (f) rapid epithelialization with a minimum of cicatrization. Should it be difficult to control oozing following the operation, a balloon bag has been provided consisting of a very thin finger cot of good quality attached to a calibrated whistletip urethral catheter. This may be inflated with 40 cc to 50 cc of water and

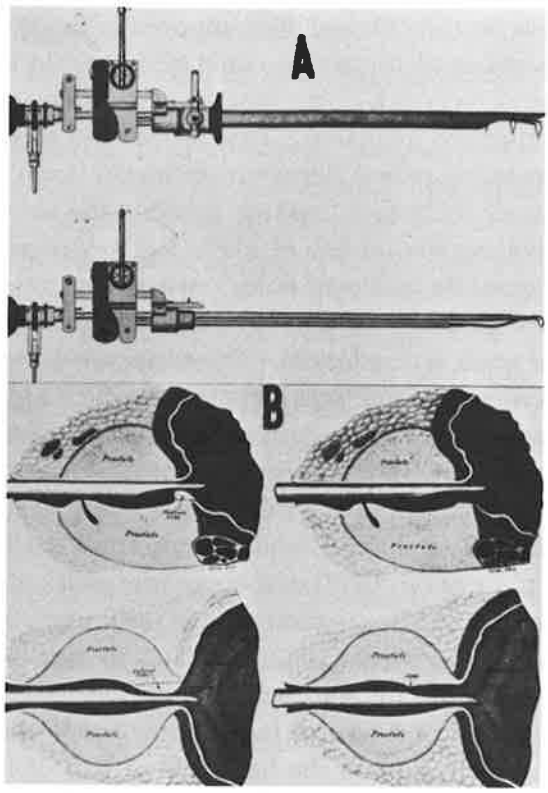

Figure 12. McCarthy's visual prostatic electrotome for endoscopic revision of the obstructing prostate.
A. The instrument assembled with its Bakelite sheath and the cutting loop electrode at its end. The figure below shows the optical construction, wtih the cutting loop withdrawn from the sheath.
B. Steps in the process of canalization of the prostatic urethra.

introduced into the prostatic urethra, maintained in position for one or two hours and then deflated and withdrawn, a No. 24 F. whistletip catheter being introduced for drainage. The bag may be reintroduced at will by first passing the panendoscope. Secondary hemorrhage, according to McCarthy, is to be expected in a small number of cases in any type of coagulation hemostasis.

In 1927 Ravich of Brooklyn reported a new combination cystoscopic and irrigating median bar punch and lithotrite before the American Urological Association at its twenty-fourth annual meeting in Baltimore; although his report received much favorable comment, for some reason it was never published. Ravich had used his instrument since early in 1926 on 18 patients at the Jewish Hospital of Brooklyn, 12 of whom were suffering with vesical neck obstruction and 6 with vesical calculi. This apparatus uses the well-known McCarthy foreoblique telescope in a modified Rose punch of No. 29 F. A gently curved beak makes introduction easy with the cautery portion acting as obturator. Large petcocks are provided for rapid and thorough irrigation. Two large handle levers are attached to facilitate the operation. Immediately behind the oval punch blade of the inner tube, the exposed portion is replaced by a fenestrated piece of platinum which acts as a cautery and can be regulated to any desired heat. After the instrument is introduced into the bladder, the cautery and punch are completely withdrawn into the sheath by separating the handles as widely as possible. The fenestra, which is thus uncovered, is fully 5/8 inch in length and permits thorough visualization of the bladder and bladder neck through the McCarthy telescope. Skill and dexterity are not as necessary in localizing and grasping the bladder neck with this instrument as with the older open-air types. As the obstructing tissue is caught within the fenestra, the blade is pushed into it and, while the assistant evacuates the fluid that is present in the sheath, the cautery is turned on and the punched-out portion is thoroughly cauterized at the same time. The hemorrhage is generally so slight that if additional portions of the neck are to be punched out, clear visualization is as a rule obtainable with very little loss of time. Owing to the size of the instrument large pieces can be cut through. The instrument has given very satisfactory results on small fibrotic prostates.

Hemorrhage has at no time been an alarming feature and has become less as familiarity with the instrument has been acquired. The same instrument can be used as a lithotrite by simply removing the inner cautery punch tube and replacing it with a steel tube.

In 1928 Foley described to the Chicago Urological Association his instrument for removing the entire prostate through the urethra.

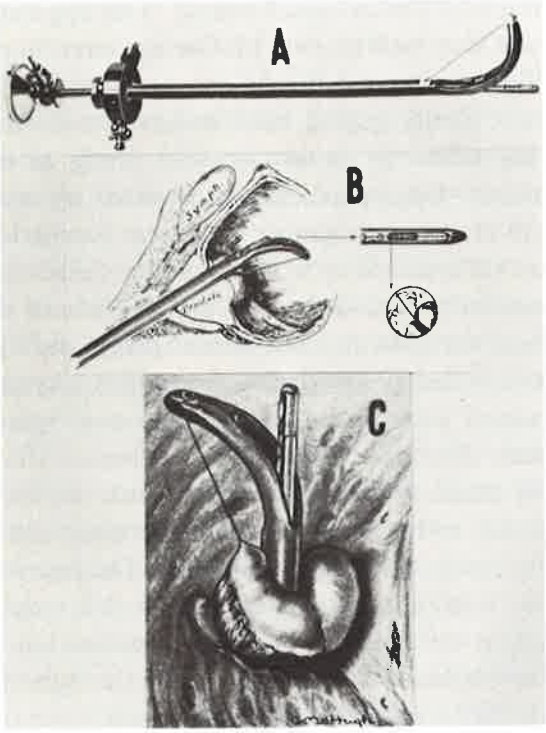

Figure 13. Foley's endothermal cystoscopic prostatic excisor.

A. The assembled instrument, showing the sheath of vulcanized hard rubber and the cutting electrode of steel music wire in the form of a snare.

B. Cystoscopic excision of prostate, illustrating the beginning incision. The wire electrode is seen entering the cleft between the hypertrophied midlobe and right lateral lobe.

C. Vesical view of the completion of the incision around the prostate. The back has been rotated anteriorly and the instrument advanced up into the bladder where the music wire electrode is seen projecting above the vesical neck and excising the prostate all the way around.

He pointed out that the limitation of all previous instruments had been imposed by the small portions of tissue that could come within the bite of a punch instrument, even within that of "multiple punches." His procedure represented a radical departure from any form of punch operation, making possible the extensive excision of tissues under full guidance of vision. By means of Foley's instrument, resection of the prostate to any desired extent, large or small, is now feasible. The excision is accomplished by a fine wire electrode to which a high frequency cutting current is supplied (Figure 13). This electrode is supported by a cystoscopic sheath of vulcanized hard rubber which serves to insulate it, while the electrode itself is a piece of No. 0000 steel music wire attached to the tip of the instrument in a small porcelain bead. The wire is conducted back to the proximal end of the sheath in a tunnel formed by a segment of 22-gauge hypodermic needle tubing embedded in the hard rubber wall of the sheath. There is a spindle device on which the wire can be made to wind at will, rotation of the spindle drawing it taut. The proximal end of the spindle is used as a terminal for connecting the active pole from the high frequency apparatus. The lumen of the sheath serves to introduce a combined right-angle visual telescope and light carrier. The instrument is made in two forms: one for bars and contractures and for small midlobes where no extra removal of tissue is necessary; the other, with a longer and more deeply curved end, for removal of prostatic hypertrophy of higher degree in which large amounts of tissue can be cut off by projecting the electrode from its beak. These large pieces are then cut into small bits by Foley's newly devised high frequency cutting current snare which is capable of passing through the operating cystoscope. Many cuts are required for this process before an excised portion of much bulk can be reduced sufficiently to be passed out in this way. Foley has also been working with R. Wappler to perfect a high frequency generator that

will deliver a current perfectly suited to the procedure.

In 1929 Day of Los Angeles revived a method of electrodesiccation that he first employed in 1913 to control bleeding resulting from a punch of the bladder neck, making use at that time of a needle electrode in a standard Young's punch (Figure 14). At that period visualization was not good and the electrodes, which are homemade, were rather crude. The World War prevented Day from interesting an Eastern manufacturer of electrodes in his device, but the method was nevertheless publicized in 1915 with a report of 10 cases in which it had been used with satisfactory results. Since then excellent insulation for small stiff-stem electrodes has been perfected and his old method has been revived with a new punch of his own devising. As with the McCarthy punch, the refinements of manufacture with easy execution, delicate control and superb vision have been retained. Day's punch was the first to bite from within outward and this enabled it to take unusually large bites with good visualization. The time saved by preliminary electrodesiccation obviates the necessity of high frequency cauterization in the presence of active bleeding, such as is required when the McCarthy instrument is employed. With Day's instrument it is not necessary to remove the instrument after each bite and cauterize the surface before proceeding with further excision. It is not his experience, as one often reads in the literature, that a median bite of the posterior lip is often sufficient or a median bite followed by an additional one on each side. On the contrary, Day has seen the obstruction become greater after three full-size bites than it was before the punch operation was done. It is his view that excision around the posterior and lateral margins of the bladder neck should be repeated until the neck is not only free from obstructing tissue but also even and rounded everywhere. This is what his punch instrument accomplishes under actual vision, thereby preventing subsequent incontinence due to irregular closure of the sphincter. It is his aim to steer a middle course between an unnecessary degree of cauterization on the one hand and too little cauterization, and hence too little hemostasis, on the other. The danger is not from the amount of blood lost, but from the obstruction, dysuria and infection arising from clots in the bladder. Day has also pointed out that after any cautery operation in the bladder or on the prostate, the greatest danger is multiple abscesses of the kidney, which lead to edema or blistering in the bladder wall adjacent to the ureteral meatus, causing obstruction of drainage which, in presence of bacteremia, would react destructively with the kidney. He regards the goal as a minimum of cautery trauma with a maximum of hemostasis, toward which the tube-set resectoscope is a long step forward, superior to any punch operation including his own.

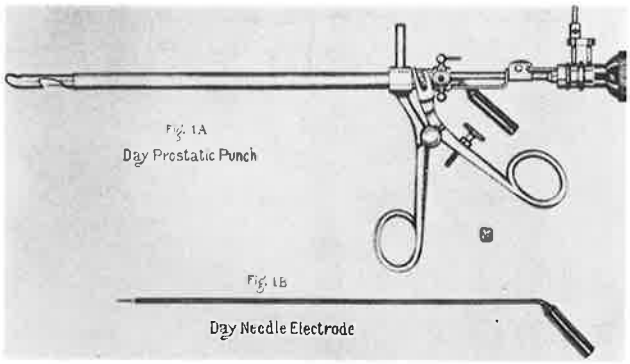

Figure 14. Day's prostatic cystourethroscopic punch with needle electrode.

With this very consideration in mind, namely, the effect of heat as a source of permanent damage to tissues, Kirwin reported in 1931 that with the aid of Wappler he had designed an instrument to resection the bladder neck which combines the good points of earlier models and obviates their drawbacks. It consists of an outer steel sheath with a fenestra on

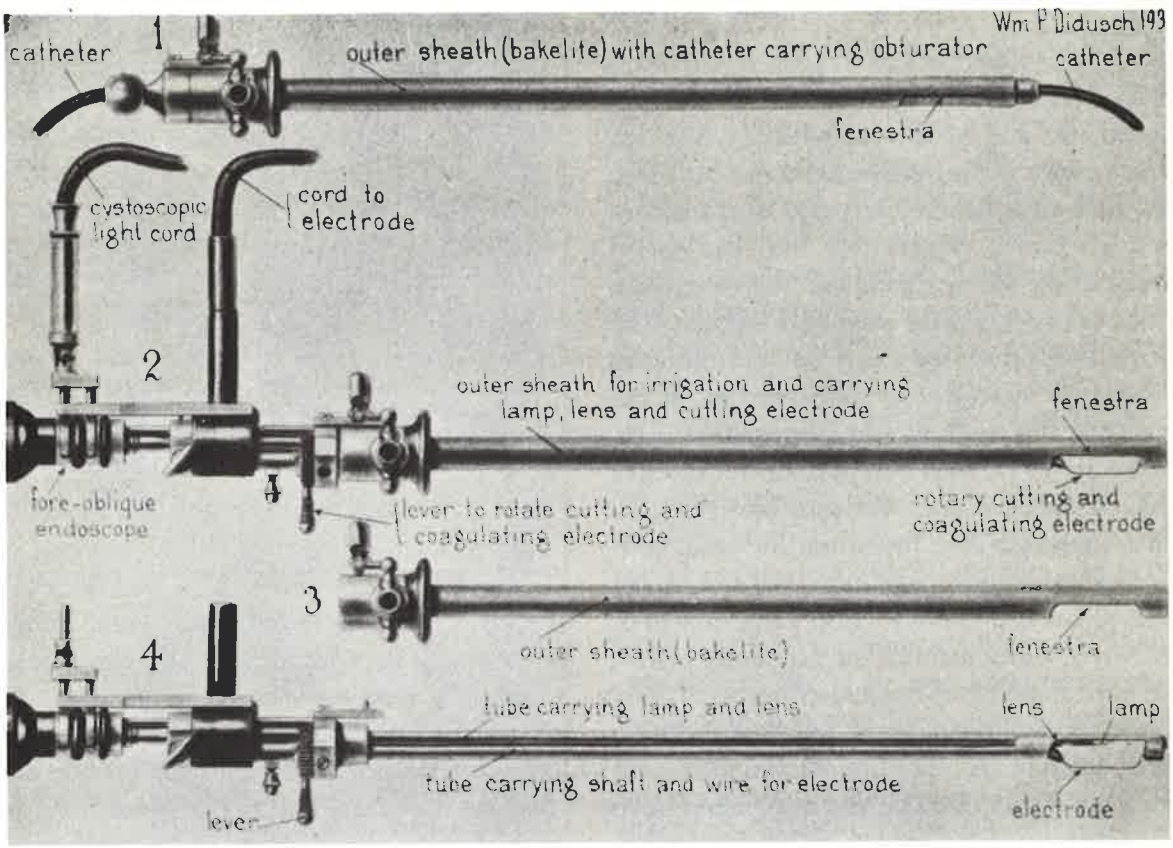

Figure 15. Kirwin's new rotary resectoscope model.
1. Bakelite outer sheath with obturator.
2. Assembled instrument with the foreoblique endoscopic sheath carrying the lamps, lens and the cutting and coagulating electrode. The wire electrode is rotated by means of a lever attached to a shaft.
3. Outer sheath showing the fenestra.
4. Foreoblique endoscope showing the mechanism of the rotary electrode.

one side and a beak on the other (Figure 15). An inner tubular structure replaces the usual obturator and carries the McCarthy lens system, a high frequency needle and irrigating cocks. An especially important feature is a tubular knife which rotates between the two sheaths and acts as an obturator, opening the fenestra when it goes to the right of the operator (Figure 16). Its well-rounded edges obviate the necessity for the tooth usually found on prostatic punches and thus eliminate trauma to the bladder neck while the obstruction is being looked for. The knife is completely independent of sheath, telescope, illuminator, needle and irrigating system so that it can be rotated at will without disturbing or twisting irrigating tubes or cords, while at the same time the main instrument has the freedom of motion necessary for locating the tissues to be excised. An electrode equipped with a Luer needle provides for administering anesthesia to the precise area where the work is to be done. The obstructing tissue is firmly fixed by the needle electrode and desiccated under low heat for about 30 seconds. It is then

resected by rotating the tubular knife, the withdrawal of which removes the resected tissue, leaving the outer sheath in the urethra in which the knife and inner tube may be inserted as many times as necessary. The electric needle and sharp knife edge serve to engage the tissue so that larger sections are obtainable, while the lateral instead of the usual longitudinal punch also prevents the greater part of the engaged tissue from being pushed out, which is often encountered with other instruments. It is important for the operator to exert a continuous downward pressure upon the instrument; otherwise, the protruding mass might not fill the fenestra in order to be held firmly for transfixion with the electric needle. After desiccation the tissues are extremely friable, and if the mass is not held firmly the needle will break away, so that when the knife is rotated there will be nothing there to cut off. If one wishes to use the instrument as a punch, the sliding motion from within outward, as in Day's punch, is available for the purpose.

Kirwin stated that all of the 25 or 30 cases in which his instrument had been used when he made his report in 1931 had benefited both locally and generally, the condition of the general system reflecting the relief from bladder retention and the intoxications traceable to it. Kirwin pointed especially to the following advantages in using his method: (a) the absolute elimination of profuse hemorrhage; (b) the ability to regulate the amount of heat applied; (c) the fact that the circular knife cuts in the direct contour of the vesical neck; (d) the vision assured at all times; (e) the ability to cut a larger section due to the lateral position of the knife; and (f) the fixation of the part to be operated on by a needle that pinions it so that it may readily be engaged (Figure 17).

Kirwin has since modified his instrument and presented a new model, known as the "rotary resectoscope," at the meeting of the American Urological Association held in Toronto in June 1932. Its chief features are a Bakelite insulating

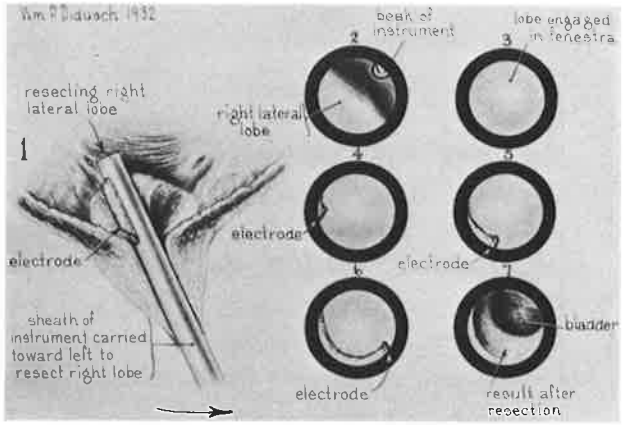

Figure 16. Steps in the technique of Kirwin's rotary procedure for endoscopic prostatic resection.
1. Schematic drawing of frontal view of bladder neck showing the rotary electrode engaged to resect the right lateral lobe.
2-7. Different cystoscopic views of the technique of the procedure and the final result of the operation, illustrating the smooth outline of the remodeled prostatic urethra. (Courtesy of T.J. Kirwin.)

sheath and rotary loop which by means of a lever is rotated to cut and coagulate under direct vision.

Ockerblad of Kansas City was not satisfied with any of the instruments available and set out recently to make a modification of his own. Starting with the panendoscope of McCarthy, he altered it by making a metal sheath with a Bakelite tip or end; by securing the cutting loop to the telescope with clips, thus making the loop rigid; and by devising a sliding guide so that the loop could be drawn toward the operator and into the sheath, thus cutting off segments of tissue. With this instrument he reports that he has successfully resected 30 cases of enlargement of the prostate and prostatic bars. He has found it ideal for small median bars and lobes, making beautiful sections of tissue under full vision and usually without bleeding. The instrument cuts from within outward like Day's and Kirwin's instruments.

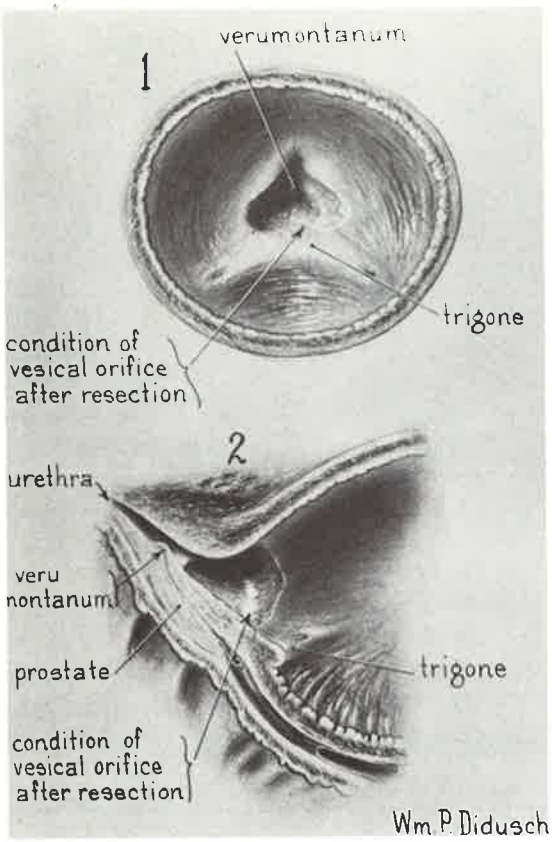

Figure 17. Depiction of the topographical relationship of the vesical orifice after endoscopic prostatic resection.

1. *Outline of the vesical orifice as seen from the bladder showing the area of prostatic resection, floor of the trigone with the ureteral orifices in its angles and the verumontanum at the floor of the prostatic urethra.*
2. *Sagittal view of same anatomical study illustrating the condition of the vesical orifice after endoscopic prostatic resection. (Courtesy of T.J. Kirwin.)*

Ockerblad admits, however, that he has had some troublesome postoperative hemorrhages.

This paper would not be complete without some recognition being given to the men with expert knowledge of electrical science who have designed, perfected and placed at our disposal the electrosurgical devices required for the refinements of modern prostatic resection.

It was the introduction of electrosurgery into the field of urology that made possible the more recent advances in the transurethral treatment of prostatic obstructions. In a recent book by Kelly and Ward the subject has been brought to the attention of the medical profession in a very clear manner, showing its application in surgical urology as well as in the entire field of general surgery.

Both here and abroad many electrical plants have devoted time and attention to perfecting more powerful high frequency machines for therapeutic use not only in urologic but also in general surgery.

The two best-known apparatuses in America are the Davis-Bovie Electrosurgical Unit made by the Liebel-Flarsheim Company of Cincinnati and the McCarthy Surgical Unit manufactured by the Comprex Oscillator Corporation of New York; we are especially indebted to the talent of Frederick Wappler, son of the brilliant Reinhold Wappler, for the conception and development of these.

In the Davis-Bovie unit the functions of removing tissue and controlling hemorrhage are accomplished by two distinct electric currents controlled by two foot switches, namely (a) a powerful *cutting current* for removing prostatic tissue and (b) a highly damped spark gap *coagulation current* for instant, positive and permanent hemostasis. It has not been generally understood that these two functions require two distinct electrical currents; a current that cuts satisfactorily will not coagulate properly and a coagulation current will not cut. It is claimed for this machine that using a suitable spark gap cutting current means that the operation will proceed more smoothly and rapidly, with less primary hemorrhage and therefore with less time spent in controlling bleeding, less formation of clots and less loss of blood. In other words, only a spark gap current (that is, a damped wave) has adequate hemostatic qualities. This machine provides high frequency currents for three distinct though allied pur-

poses that have proved surgically useful in prostatic resection: (a) tissue cutting, (b) electrocoagulation and (c) superficial dehydration, all under water and under direct observation, the correlated use of which constitutes modern electrosurgery.

The McCarthy unit, on the other hand, was frankly designed to eliminate the disadvantages of damped oscillations which are inherent in the spark gap method of generation. It was found that to sever tissue the degree of damping had to be reduced. Only then, according to Wappler, could the cutting effect become more constant in amplitude. Attention was turned to the vacuum tube oscillator which produced continuous or undamped oscillations of high frequency. With correct voltage and attending characteristics, this proved to be the ideal cutting current. To learn about the effect of undamped current in all phases of high frequency practice, it was necessary to build a generator to supply an abundance of power to keep it under perfect control. The courage to do this was amply rewarded not only in the production of a cutting effect more perfect than had been anticipated but also in the improvement of practically all other effects in their medical and surgical influence. The McCarthy Surgical unit is a highly efficient vacuum tube generator which, with its 2,000,000 oscillations per second, is the most modern of all such machines, having a reserve of power that will not be called into use for any application presently developed. It is entirely stable in operation and cannot be thrown out of oscillation by any load in practice. Advanced engineering principles have been incorporated in its design, resulting in a proportionately small size and light weight, considering its powerful output.

In closing this impartial historical review, it seems permissible to remind the reader that although every one of the methods described here has its merits (provided its use is restricted to well-selected cases), the future alone can speak the final word with reference to the value of transurethral prostatic resection. It is obvious that the method has dangers when performed by someone who is not a competent cystoscopist and that this simple procedure requires the same careful preliminary preparation of the patient as does a routine suprapubic or perineal prostatectomy.

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