HISTORY OF DEVELOPMENT OF INSTRUMENTS TO MANAGE URETHRAL STRICTURES

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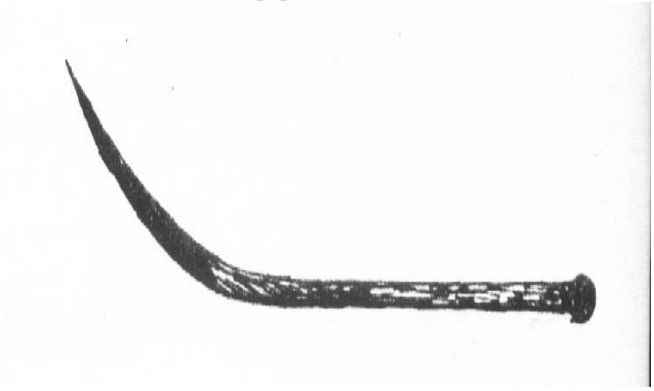
The history of the urethral stricture is a fascinating story spanning over three thousand years. It shows the continuous human struggle to overcome the problem of stricture urethra. It not only highlights the progress of medicine and application of modern technology but also its failure to offer a relative cure of this disease.

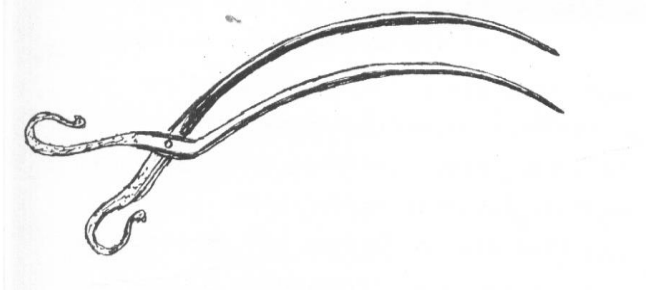
The earliest recorded attempts to treat urethral stricture dates back to the sixth century B.C., when metal and wood dilators were described in the Ayurved (Schmidt et al 1980). The procedure was little changed over the next 2,400 years. Dilatation was done with stalks of plants, feathers, papyrus rolls in Egypt, catheters of copper and bronze in Pompei, metal dilators and "explorers" of the Arabian surgeons. Candles, silk tissues leading finally to plastic catheters were used to dilate strictures in Algerian town called Bujiyah. This town was famous for its honey and beewax in the mediaeval times. The French named their dilators "bougies" and were followed by others. Americans refer to urethral dilators as "sounds" from the metal instrument used to detect bladder calculi by clicking against them before the days of x-rays. Today the words "bougie and sound" are interchangeable [1].

EARLIER HISTORY UPTO 1500 A.D.

We do not find any information about the incision of the urethra in the old well known historical scriptures of Hippocrates, Celsus or in those of the Alexandrian school which could be related to urethrotomy [2]. Hippocrates (5th century B.C.,) Roman period surgeons and Celsus (1st century A.D) all knew about cystotomy which was performed for retention of urine [3]. Sushutra an Indian surgeon who lived before Hippocrates performed perennial cystostomy to remove bladder calculi [4]. Aretacus (80 A.D) did perenial urethrotomy for the first time in the western world to remove calculi impacted in the urethra. Heliodorus in his book "Opera Chirurgica" (90 A.D.,) described internal urethrotomy, where stricture was cut by means of pointed, sharp stiletto for the first time. In the following years stricture surgery was rarely discussed. Dilatation remained the main treatment. Rhazes (850 A.D.,) and Avicena (11th century) both knew of external urethrotomy for the relief of retention [5]. Cordovan Arab Surgeon Abi I-Qasim Khalf ibn Abass Al-Zahrawi (1180 A.D.) portrayed a catheter for the first time. He also advocated cutting new channel into the urethra in a case of innate atresia [2].



Al-Zahrawi's knife used for cutting new channel into the urethra 1180 A.D.

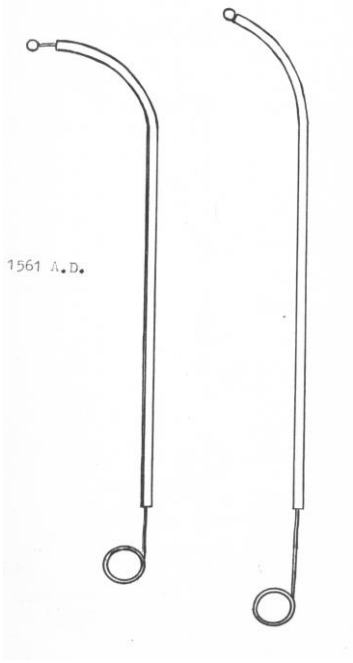


Marianus Sanctus's Instrument for forced dilatation 1550 A.D.

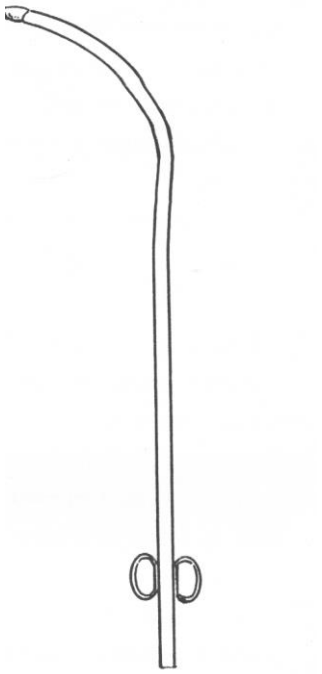
From 1500 upto 1800 A.D.

After the discovery of the new world in 1493 it is believed, Christopher Columbus (1451-1506), brought back syphilis apart from parrots and rare plants. The king and queen of Spain received him with highest honours. In the following years central and Western Europe saw epidemics of "lues" and gonorrhoea. In about 1550 A.D. physicians thought that venereal infection gave rise to ulcers in different parts of the urethra. Different astringent medicines along with bougies were applied to save the urethra from scarring. Wax candles, stalks and even forced dilatation was done. When needed internal urethrotomy and external urethrotomy was performed with cutting, piercing or lacerating instruments in a few cases. Marianus Sanctus 1550 A.D. advocated forced dilatation with his instrument. In 1561 A.D. famous French surgeon Pare practiced internal urethrotomy with cutting canula. The top was constructed like a file which moved back and forth in the wound. At the end of 16th century Diaz invented a similar instrument in Spain.

The first instance which can be regarded as authentic perineal urethrotomy performed for stricture was recorded by Richar Wiseman in 1652 A.D. Tolet, Colot and Solingen described the procedure in 1690 A.D. [5]. There was no progress in the following years.



Pare's Cutting canula 1561 A.D.



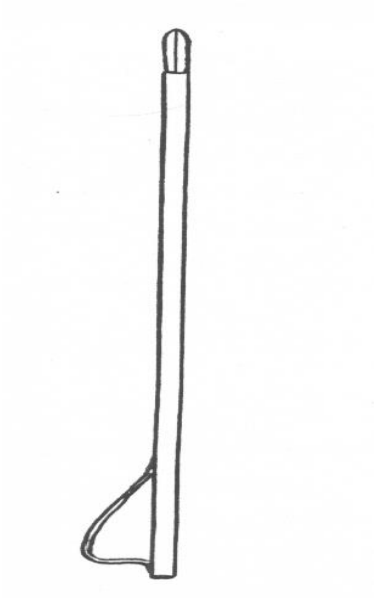
Diaz's Urethrotome (Spain 16th Century)

Great English anatomist and surgeon John Hunter (1728 – 1793 A.D.) applied silver nitrate to open the strictures in 1752 A.D. This was followed by dilatation. He performed perineal urethrotomy in 1783 A.D. at St. George Hospital, London. He also described the incidence of site of stricture for the first time [6]. The highest recorded incidence was in the bulbar urethra. He also warned of a violent breaking through with bougies. At the end of 18th century, in Paris Desault propagated forced catheterization and dilatation with new gum catheters.

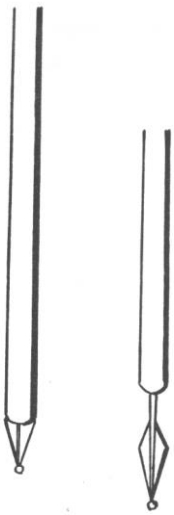
FROM 1800 UPTO 1950

Instruments for blind internal urethrotomy were invented and improved over the years during the 19th century so as to replace the rude, imperfect methods of pushing in rods and stylets in order to puncture, drill or cut the obstructions. The earliest practical advance in the instrumental part of this mode of treatment was done by Hunter's friend and pupil Physic in 1795 A.D. [5]. He invented a new catheter, bearing concealed lancet which could be projected at will to cut the stricture. The first proper instrument was invented in 1807 by Charles Bell. This instrument had a blade on its moving top. The blade was in the form of an oblique quadrangle blunt in front and sharp

at the rear. Civiale (1827) of Necker Hospital, Paris invented a similar instrument, which became very popular among the surgeons in France.



Physick's Straight Urethrotome (1802)



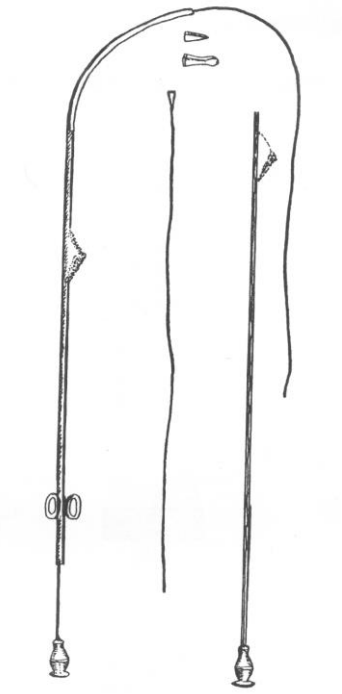
Charles Bell's Urethrotome (1807)

Caustics were widely used to treat strictures in 17th and early 18th century. The agents used were copper sulphate, caustic potassa, silver nitrate and other corrosive agents. Upto 1830 blind internal urethrotomy found more and more advocates while catheterization was abandoned.

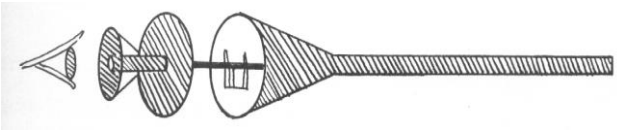
Large variety of urethrotomes were constructed in the mid 18th century among which may be named those of Reybert, Mercier, Maissonneuve, Gibson, Sidillot, Wood, Trelet, Thompson, Taveen, Ivanchich (Vienna) Ebermann (Russia), Bulhoes (Brasil), Pancoast, Otis, Mastin and Gross. Some of these urethrotomes divide the stricture from before backwards and others from behind forwards. The most common instruments in the second half of the century were those of Stafford, Ivanchich, Maissonnauve, and Otis.

The climax of blind internal urethrotomy was reached with Maisonneuve's urethrotome (1855). He first introduced a thin elastic bougie into the bladder, then a metal explorer with a channel was screwed into the bougies. While pushing forward the elastic bougies was rolled into the bladder. Finally the stricture was cut with a triangular knife, running in the channel.

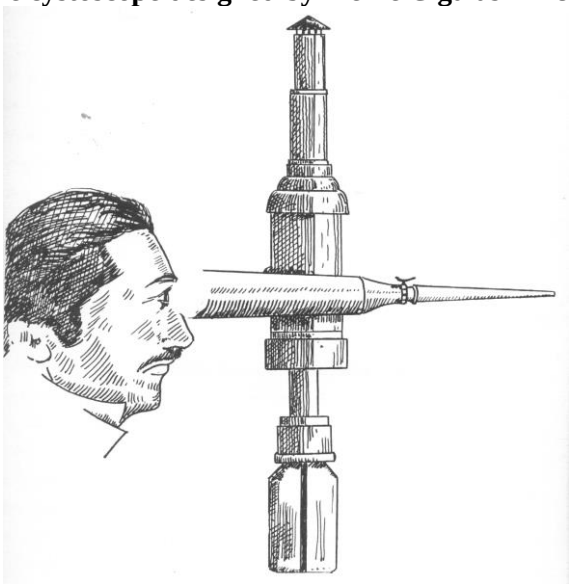
At the same time a new invention showed the possibility of substituting the blind internal urethrotomy with a visible one. Pierre Cigalas in 1826 was the first to see the face of stricture with his primitive cystoscope. In 1853 Desormeaux (Paris) did internal urethrotomy under Endoscopic control using a probe-pointed knife for the first time. He informed the "Societe de Chirurgie" of about 17 cases of urethrotomy in 1865. For a long time he remained the only one who used it



Maisonneuve Urethrotome



The cystoscope designed by Pierre Cigalas in 1826

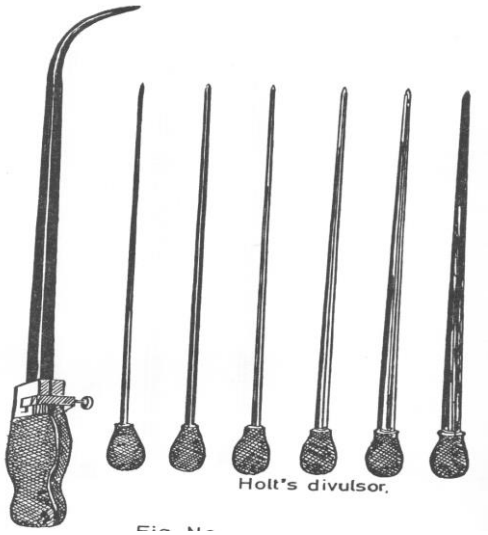


Desormeaux endoscope

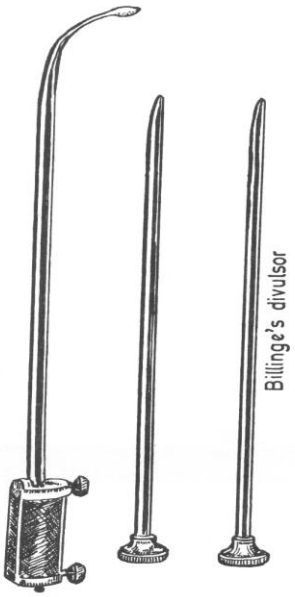
because of bed source of light and primitive optical system [7]. However, blind intervention remained the treatment in those days.

Gradually a new method "Divulsion" was spread for the so called irritable, resilient or elastic strictures. The word is derived from the Latin divollo, "I tear". It was practiced as early as 1835 by Perreve, a French surgeon and at a latter period by Professor Gross and other American surgeons. The original divulsor designed by Perreve consisted of two thin blades united together at on end. After passing the instrument through the stricture, rods of different sizes were pushed between the two blades, for wedging them apart. Perreve improved his instrument by connecting a filiform gum bougie to its extremity as a guide in very close strictures. Holt of Westminister Hospital, London designed a modification of this instrument. The end for the urethra was made olive shaped so that it may not tear the mucous membrance while the other end was fitted with a screw to regulate the separation of the blades. Billings constructed a similar divulsor in America [5]. After the operation quinine and opium were given during the first 24 hours to prevent "urethral fever".

The practice of 'Rapid Dilatation' reached its climax in the last quarter of the 19th century. The recently introduced narcosis with chloroform supported that tendency. Thomas Wakely of London in 1850 dilated strictures by the passage of graduated tubes. Whalebone bougies were prepared with straight angular or spiral extremities for difficult strictures. A small catheter was first introduced into the bladder, and a metal guide screwed on to its end, and one by one the tubes of different sizes were passed. The most complete rod dilators for rapid dilatation were those of Thompson and Riguad.



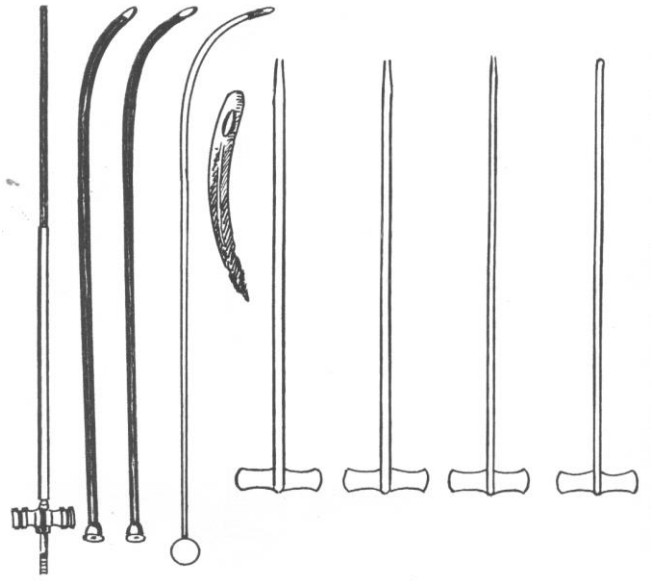
Holt's divulsor



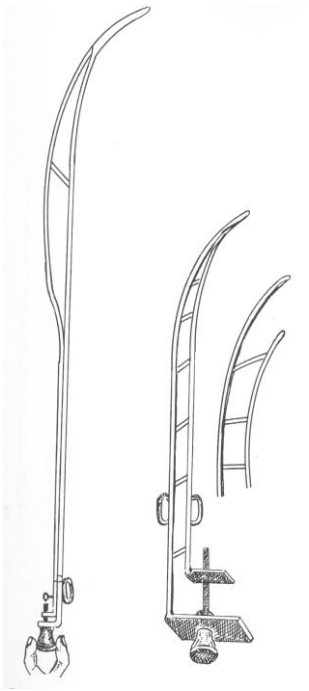
Billinge's divulsor

Otis combined in the same instrument a dilator and urethrotome. He presented his dilating urethrotome in the meeting of the Medical Journal Society of New York in 1871. This instrument is still used by many surgeons [8,9]. The stricture is divided along the upper wall of the canal from before backwards. Without withdrawing the instrument, the blades of the dilator are separated according to the will of the surgeon and is indicated by the dial plate of the instrument. In the same period Du Camp, Arnott and Steurer attempted dilatation by hydrostatic pressure without success [5].

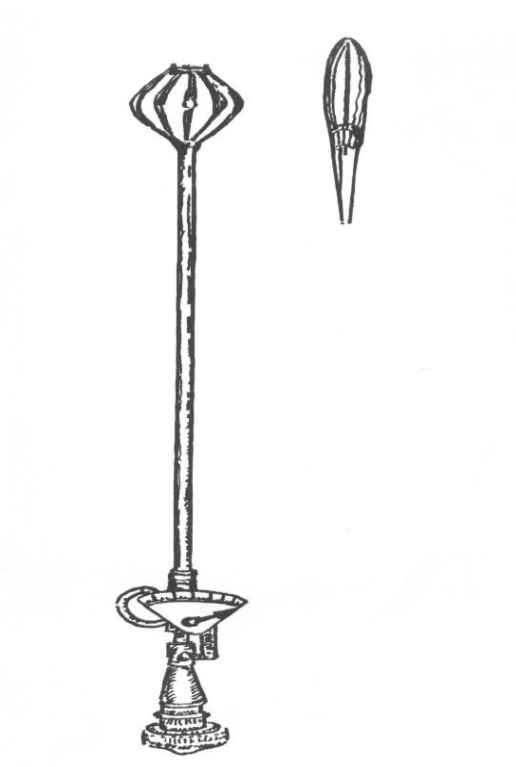
In cases of impassable strictures, perineal urethrotomy (boutonniere) was performed, without a guide. Gouley reported 233 cases of external urethrotomy in first half of 19th century performed by American surgeons with a mortality rate of 12%. Boeckel at the same time reported 28.85% death rate from France and England in a series of 35 cases [5].



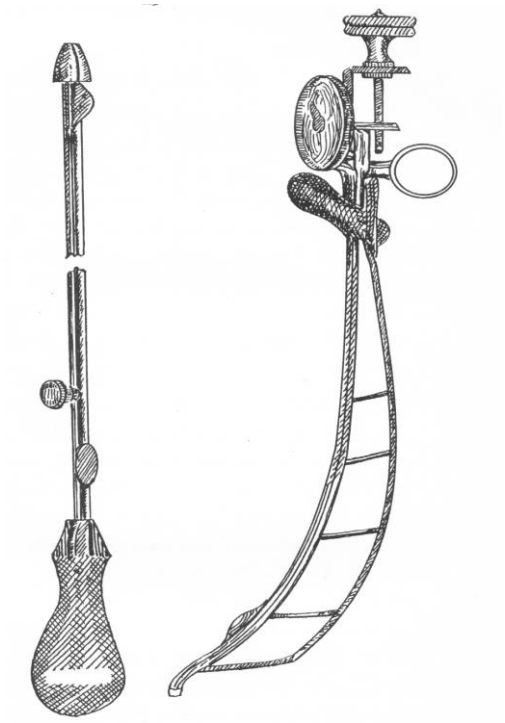
The Wakely instruments for dilating strictures by the passage of graduated tubes



Thompson's dilator Regaud's dilator



The urethra-metre of Otis



Gross's urethrotome-Otis's dilating urethrotome

Syme performed external urethrotomy with a guide in 1844 which became popular later on.

In 1879 Neisser demonstrated the existence of gonococcus. Schaudinn solved the problem of "lues" in 1905, by showing Treponema Pallidun being its cause. Thus it was proved that they were two different diseases causing urethral stricture. Adrian (Strassburg) showed that syphilis and tuberculosis were not a common cause of stricture. This was the final proof that the century old worst strictures were nearly all caused by gonorrhoea [2].

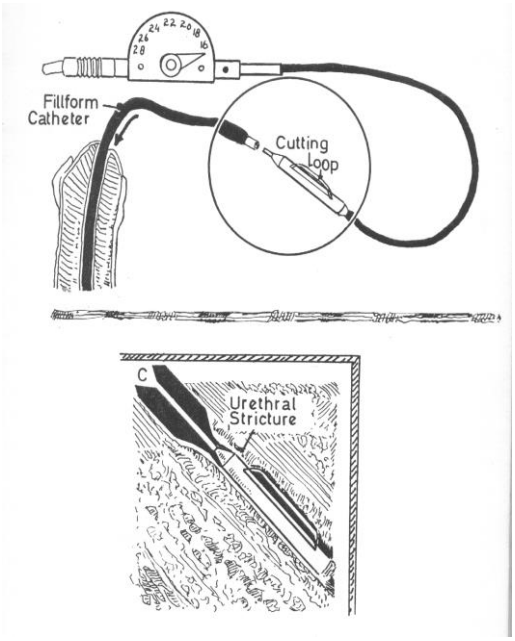
Common complications of internal urethrotomy (acute death by shock, sepsis, rectum perforation, bleeding and others) forced the surgeons to search for new possibilities of treatment. A single stricture of small length of anterior urethra was excised and end to end anastomosis was done [10].

In Berlin surgeons operated with Wossid urethroscope, with galvano-caustic knife or electrolytic needle under visibility. Abscess and fistulae were common complications. Powell (London) improved the instrument in 1922. in the wall of the urethroscope, there was a small tube, where the knife or curette could be pushed forward. The operation took place under visibility in an air filled urethra.

In 1923 the McCarthys Panendoscope appeared giving an optical view of the full length of urethra (0' direct view) which was not possible before [7]. Electrocoagulation under visibility was done for short, multiple strictures with Fischer urethroscope in1937 by Heynemann in Germany. Blind internal urethrotomy with Riba urethrotome by electro-coagulation was also done [11]. Cutting the stricture with electro-coagulation was abandoned as it was concluded that this caused more scarring.

Dilatation with different types of bougies remained the treatment of choice. Blind internal urethrotomy with Otis urethrome was also practiced widely. In cases of impassable stricture of posterior urethra the patient had to lead rest of his life with a suprapubic catheter. Excision and end to end anstomosis was also done in the limited number of cases of strictures in the region of anterior urethra.

Fleming in 1929 observed the inhabitation of Staphylococcus on an agar plate contaminated with a mould, Penicillium Notatum. Florey, Chain and their co-worker prepared Pencillin in a concentrated and stable form. A new era of antibiotics was started and gonorrhoea could be treated in a better way. Number of post gonorrheal stricture reduced to a significant degree during the present antibiotic era [12].

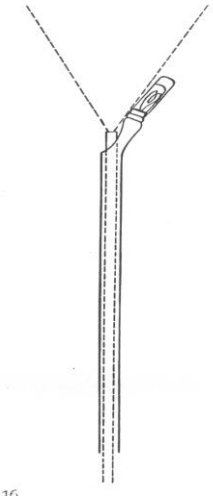


Riba Urethrotome (1960)

From 1950 onwards:

For the difficult and impassable strictures a number of open surgical procedures became available during this period. It changed the outlook for patients with permanent suprapubic catheters. The first was Badenocks pull through operation for posterior traumatic stricture in 1950 and Johannsons two stage urethroplasty in 1953 [13]. In 1956 Peyton and Stream reported the use of a graft of split thickness skin for reconstruction of bulbous urethra [14]. Transpubic repair was done in 1962 by Piere [13]. Great enthusiasm was shown for different types of urethral repair procedure in the following 20 years. Full thickness graft, scrotal and perennial skin inlay urethroplasties, single and two stage free graft urethroplasties and transpubic repair are the few to be mentioned [14,15,16,17, 18, 19]. Much has been written in the past 20 years on various methods for urethroplasty. Only small number of these operations are satisfactory [7] and a steady decline in number of operations in next 20 years have been noted [20].

Endoscopy with conventional cystoscope had its own inherited problems. Simple lens system and tiny distal bulb light gave a poor quality and limited field of vision. Considerable light was lost with simple lens system, and any attempt to increase the illumination resulted in burnt filaments of the bulbs. It was also difficult to construct a direct vision telescope for viewing the urethra with distal bulb illumination. The tiny bulb had to be angulated so that it did not obstruct the

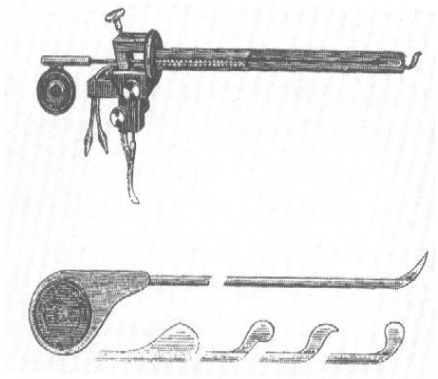


Urethroscope with distal bulb illumination

view. Thus it was difficult to use the instrument with angulated bulb in the urethra. Although the telescope for the examination of urethra were constructed with this type of illumination but their performance was very poor. The width of the field of view was so narrow that only a small area could be seen. The instrument had to be moved constantly to get a better view [7].

Two improvements brought the dramatic change in the field of endoscopy. First was the solid rod lines optical system with better coated glass lenses designed by Harold Hopkins of Reading University, U.K (1959). At the same time tiny bulbs for distal illumination were replaced by glass fiber illumination. So it was possible now to construct a telescope with direct vision which could inspect the urethra with complete field of vision. The commercial production of this solid rod lens system took another 10 years. The solid rods of glass may be 25-60 mm long, with spherical refracting ends. Glass fiber illumination and this system had dramatic effects in the improvement of the modern telescope. The light lost through absorption on the blackened surface of the telescope tube was reduced to minimum.

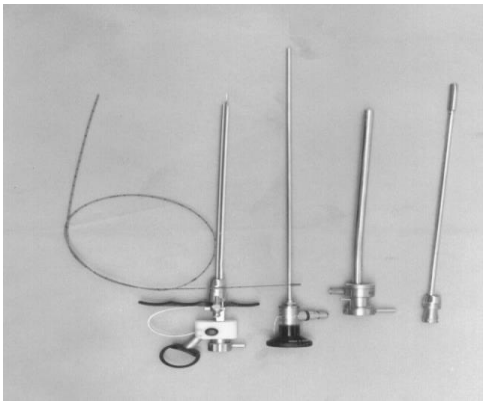
Hans Goldschmidt introduced irrigation-urethroscopy in 1907 while Erich Wossidlo equipped irrigation-urethroscope with several operating instruments allowing internal urethrotomy with galvano-caustic hook. Ultimately these technical advancements in the field of optical system and fiber illumination lead to the invention of modern optical urethrotome,the gold standard of today,s treatment of urethral strictures by Sachs in Germany 1971 [21].



Intraurethrotome of F.M. Oberlander with different knives for the incision of urethral strictures (1910).

He combined the modern facilities of cold light illumination with simple method of urethrotomy by incorporating a moving blade which is retracted within the sheath. The sheath with the blade is passed into the

urethra under optical control with 0º telescope upto the face of the stricture. Then the blade is extruded to cut the stricture. Initially, he started the internal urethrotomy with electrical knife but later observation that necrosis following this electrical incision caused scarring and so this was replaced by simple sharp incision. This technically advance instrument with a cold knife under optical control was constructed initially by Storz and were followed by other instrument makers like ACMI and WOLF. Many authors recommend this procedure as a primary treatment for any type of urethral stricture and is being accepted widely through out the world [1,22,23,24,25]. The limitations and long term results of the method are still debated.



Optical Urethrotome with ureteric catheter

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